MANAGEMENT

Andrew P. Sage

Department of Systems Engineering and Operations Research, George Mason University, Fairfax, Virginia, USA

Keywords: human errors, knowledge management, learning, management, management control, organizational errors, organizational learning, planning, program management, project management, strategic management, strategic planning, work breakdown structure

Contents

1. Introduction
2. Management Organizational Structures
3. Program and Project Management
4. Cost Estimation Methods, and Work and Cost Breakdown Structures
5. Human and Cognitive Factors in Management
6. Management, and Knowledge Management and Complex Adaptive Systems
Glossary
Bibliography
Biographical Sketch

Summary

Management is at one of its most significant stages in history. The growth of global competition has provided the incentive for refinement and development of management systems. Changes in technology, international affairs, business practices, and organizational and social responsibility are causing managers to re-examine their methods and goals, as well as place increased emphasis on innovation. This is a particular challenge when sustainable development issues need necessarily to be considered.

Management consists of all of the activities required to enable an organization to cope effectively and efficiently within its environment. This will generally involve planning, organizing, staffing, directing, co-ordinating, reporting, and budgeting activities in order to achieve identified objectives.

Organizations can be viewed from a closed-system perspective. In this view, an organization is an instrument designed to enable pursuit of well-defined specified objectives. In pursuit of these objectives, an organization will be concerned primarily with four objectives: efficiency, effectiveness, flexibility (or adaptability to external environmental influences), and job satisfaction. Various authors have criticized the inherent shortcomings associated with this closed-system model of humans performing machine-like tasks. Not only is the "human-as-machine" view believed to be inappropriate, but there are pitfalls associated with viewing environmental influences as "noise," as must necessarily be done in the closed system perspective. This is avoided in

organizations where management is of the open-system type. In the open-system view of an organization, there is concern not only with objectives but also with appropriate responses to internal and external influences of all types.

It is often said that an organization without planning is like a boat without a rudder. One purpose of planning, however, is to define appropriate directions and strategies. These lead to steering and control. Without planning, organizations are subject to the uncertainties affecting the business environment. Planning is the management function that involves setting goals and deciding how best to achieve them. The function also includes considering what must be done to encourage necessary levels of change and innovation. Planning provides a basis for the other major functions of management—organizing, leading, and controlling—both by determining an appropriate course to be followed, and by providing the steering apparatus that enables pursuit of this.

Nevertheless, even the most carefully devised plans at the strategic, tactical, and operational levels mean little if an organization does not have an effective means for carrying them out. That is where organization comes into play. In fulfilling the organizing function, managers allocate and arrange both human and non-human resources in ways that enable plans to be achieved successfully. In the process, the organizing function provides a most valuable tool in supporting and fostering innovation, and in facilitating activities that lead to needed change.

The primary classical organizing principles supporting organizational behavior include:
- division of labor and task assignment
- identifying standard operating principles
- top down flow of decisions
- formal and informal channels of communication in all directions
- the multiple uses of information
- organizational learning.

These principles are vital to sound management and technical direction, based on the realities of human desires and capabilities for organizational growth.

There have been many attempts to classify management functions. Among these is the function-type taxonomy that includes the three planning and control functions of Robert Anthony:
1. **Strategic planning function**. Strategic planning is the process of choosing the highest-level policies and objectives, and associated resource allocations and strategies for achieving these.
2. **Management control function**. Management control is the process through which managers influence other organizational members in order to help them achieve organizational strategies. Management control decisions are those decisions made for the purpose of assuring effectiveness in the acquisition and use of resources to achieve strategic plans.
3. **Task control function**. The process of task control has as its major objectives the efficient and effective performance of specific tasks.

These three planning and control processes relate to one another. While there is often considerable variation among the many task control systems that may be found in a given organization, nearly all such systems include interaction between one task manager and a team of non-managers, or perhaps with an automated system. Task control functions are generally well structured. Management control involves the interaction of managers, generally in resolving unstructured issues in a manner that supports achievement of the strategic plan of the organization. Management control concentrates on the activities that occur within various responsibility centers of the organization.

Any management control system must communicate the right information at the right time and among the right people if it is to function effectively. People must know what is expected of them in terms of task performance. Managers and other decision-makers must have useful information regarding performance results if they are to make plans, provide support, and take other relevant appropriate actions. Although the settings and applications differ widely, modern managers are exploring new ways of using information technology to help workers meet high performance standards.

While planning provides direction, and organizing arranges the resources, the leading function of management adds the action ingredient. Leading involves influencing the work behavior of others toward achieving organizational goals. In the process of leading, effective managers can become catalysts in encouraging organizational innovation.

In this theme level writing, we will discuss some aspects of management in modern times. We will be concerned with describing the classic roles of management: planning, organizing, staffing, directing, co-ordinating, reporting, and budgeting. We will briefly discuss contemporary perspectives on managerial functions: marketing, finance and accounting, logistics and operations management, and strategic management and organizational development. We will be particularly concerned with management of programs and projects including: the estimation of costs, schedules, and specifications; cost benefit and cost effectiveness analysis; team building and leadership; and interactions with customers and suppliers alike. We are concerned with a number of contemporary issues in organizational management: total quality management, organizational learning, re-engineering, and knowledge management. We will be especially concerned with management in the global economy and management for sustainable development.

1. Introduction

There are many definitions that could be provided for the term "management" and such related terms as, "program management," "project management," and "systems management." For our purposes, an appropriate definition is:

> Management consists of all of the activities undertaken to enable an organization to cope effectively and efficiently within its environment. This will generally involve planning, organizing, staffing, directing, co-ordinating, reporting, and budgeting activities in order to achieve identified objectives.

The word "organization" appears in this definition, as does the word "plan." It is important to note that a given organization, enterprise, or business will, or at least should, have a plan, very likely a set of plans, to achieve the overall objectives of the organization. Many of these will relate to the way in which the organization provides products and services to its customers or clients. Such a plan generally aims to satisfy both general and specific needs. The general needs are those of the organizational units within the enterprise. Out of these high-level plans and policies will evolve a framework that will enable identification of plans and subsequent activities to fulfill the needs of a specific client for a systems engineering product or service. Each of these concerns is important. The first relates to the way in which the enterprise organizes itself, and the second relates to the way it serves customers (see "Classic roles of management," EOLSS on-line, 2002, and "Characteristics of management," EOLSS on-line, 2002).

Organizations can be viewed from a closed-system perspective. In this view, an organization is an instrument designed to enable pursuit of well-defined and well-specified objectives. A closed-system perspective organization will be concerned primarily with high performance on four aspects of performance quality:
1. efficiency
2. effectiveness
3. flexibility or adaptability to external environmental influences
4. job satisfaction.

Four organizational means or activities follow from this:
1. complexity and specialization
2. centralization or hierarchy of authority
3. formalization or standardization of jobs
4. stratification of employment levels.

In this closed-system view of an organization, everything is functional and tuned such that all resource inputs are optimized and the associated responses fit into a well-defined master plan.

March and Simon, in a famous work on organizations, discuss the inherent shortcomings associated with this closed-system model of humans performing machine-like tasks. Not only is the "human-as-machine" view believed to be inappropriate, but there are pitfalls associated with viewing environmental influences as "noise," as must necessarily be done in the closed system perspective. March and Simon's broadened view of an organization is known as the open-systems view. In the open systems view of an organization, concern is not only with objectives but also with appropriate responses to a number of internal and external influences.

Many other authors have expanded upon these views from a variety of perspectives. Most management studies show that, in practice, plans and decisions are the result of interpretation of standard operating procedures. Improvements are obtained by careful identification of existing standard operating procedures and associated organizational structures. The resulting organizational process model, developed initially by Cyert and March, functions by relying on standard operating procedures that constitutes the memory or intelligence bank of the organization. Only if the standard operating

procedures fail will the organization attempt to develop new standard operating procedures.

Organizational learning results when members of the organization react to changes in the internal or external environment of the organization by detection and correction of errors, as shown in a classic work by Argyris. An error is a feature of knowledge that makes action ineffective. Ideally the detection, diagnosis, and correction of errors produce or result in learning. A major claim by systems designers is that errors in using systems, and in designing systems, are due not simply to probabilistic random events that might be removed through improved system operator or system designer training, or through better system designs. Instead, it is argued that errors are due to two generally more important sources:
1. Errors represent systematic interference and incongruities among models, rules, and procedures.
2. Errors represent some disfunctionality of the effects of adaptive learning mechanisms.

A very important feature and need in organizations is *organizational learning*. Mistakes will occur, but hopefully, individuals and organizations learn from mistakes and ensure that things are done better next time. Almost all discussions of quality concern enhanced quality through continuous improvement. It is difficult to imagine continuous improvement without learning. If an individual or an organization is to re-engineer, there must be some form of learning, or there is no reason to believe that the same mistakes that were made before will not be made again. So, we all need to learn—continuously and throughout a lifetime. The expression "we" refers both to humans and to organizations.

Learning involves the use of observation of the relationships between activities and outcomes, often obtained in an experiential manner, to improve behavior through the incorporation of appropriate changes in processes and products. Thus, learning represents acquired wisdom in the form of skill-based knowledge, rule based knowledge, or formal reasoning based knowledge. Thus, it may involve know-how, in the form of skills or rules, or know-why, in the form of formal reasoning based knowledge.

Learning involves:
*   situation assessment
*   detection of a problem
*   synthesis of a potential solution to the problem
*   implementation of the solution
*   evaluation of the outcome, and the resulting discovery that eventuates from this.

This is a formal description of the learning process. It is also the problem-solving process and involves the basic steps of systems engineering.

Peter Senge has devoted major attention to the study and development of what are called learning organizations. According to Senge, learning organizations are:

> Organizations where people continually expand their capacity to create the results they truly desire, where new and expansive patterns of thinking are nurtured, where collective aspiration is set free, and where people are continually learning how to learn together.
>
> (P. M. Senge, 1990)

Five component technologies, or disciplines, are suggested as converging to enable this learning. These are:
1. systems thinking
2. personal mastery through proficiency and commitment to lifelong learning
3. shared mental models of the organization markets, and competitors
4. shared vision for the future of the organization
5. team learning.

Systems thinking is denoted as the *fifth discipline* and is the catalyst and "cornerstone" of the learning organization that enables success through the other four dimensions. Lack of organizational capacity on one of these disciplines is called a learning disability. One of the major disabilities is associated with implicit mental models that result in people having deeply rooted mental models without being aware of the cause–effect consequences that result from use of these models. Another is the tendency of people to envision themselves in terms of their position in an organization rather than in terms of their aptitudes and abilities. This often results in people becoming dislocated when organizational changes are necessary and this leads to disconcertment.

Each of the five learning disciplines can exist at three levels. These are termed:
- principles, the guiding ideas and insights that suggest practices
- practices, the existing theories of action in practice
- essences, the holistic and future oriented understandings associated with each particular discipline.

These correspond very closely with the principles, practices, and perspectives often used to describe approaches to knowledge and systems engineering (see "Systems engineering and management," EOLSS on-line, 2002.).

Based primarily on works in system dynamics, an approach for the study and modeling of systems of large scale and scope, and on efforts by others; Senge states eleven laws of the fifth dimension:
1. Contemporary and future problems often come about because of what were presumed to be past solutions.
2. For every action, there is a reaction.
3. Short-term improvements often lead to long-term difficulties.
4. The easy solution may be no solution at all.
5. The solution may be worse than the problem.
6. Quick solutions, especially at the level of symptoms, often lead to more problems than existed initially. Thus, quick solutions may be counterproductive solutions.
7. Cause and effect are not necessarily related closely, either in time or in space. Sometimes actions implemented here and now will have impacts far away at a much later time.

8. The actions that will produce the most effective results are not necessarily obvious at first glance.
9. Low-cost and high-effectiveness do not have to be subject to compensatory tradeoffs over all time.
10. The entirety of an issue is often more than the simple aggregation of the components of the issue.
11. The entire system, comprised of the organization and its environment, must be considered together.

Neglect of these laws can lead to any number of problems. Most of these are relatively evident from Senge's description and this interpretation of the eleven laws of the fifth dimension. For example, failure to understand law eleven leads to the fundamental attribution error in which we credit ourselves for success and blame others for our failures.

On the basis of these laws, several leadership facets are suggested. Leaders become:
• designers
• stewards
• teachers.

These are especially important for learning organizations. Each of these leadership characteristics enables everyone in the organization to improve their understanding and use of the five important dimensions of organizational learning. This is said to result in creative tension throughout the organization. Planning is one of the major activities of the learning organization, and it is through planning that much learning occurs.

One of the fundamental notions in studies of human errors is that there is an intimate association between human intent and human error. Therefore, realistic efforts to discuss human error, and to design systems that can cope with human error possibilities, will consider the different types of human intentions and associated errors. In a very insightful work, Reason indicates the importance of knowing whether:
• human actions are directed by conscious intent
• human actions proceed as planned
• human actions achieve the desired result.

Five types of actions result from this observation, as indicated in Figure 1. Successful system designs will create systems that encourage human intentional action and successful act performance.

We have attempted to focus our discussion thus far at a rather conceptual level. We have presented a description and interpretation of some recent studies in behavioral and organizational theory that have direct relevance to systems management. The primary classical organizing principles supporting organizational behavior include:
• division of labor and formation
• organizational letask assignment
• identifying standard operating principles
• top down flow of decisions

- formal and informal channels of communication in all directions
- the multiple uses of inarning.

We must be conscious of these principles if we are to produce management and technical direction perspectives that are grounded in the realities of human desires and capabilities for growth and self-actualization. Also, we must be aware of error possibilities, both on the part of the system architects and developers, and errors on the part of system users. These concerns are very realistic and influence the design of information and decision support systems, software systems, and many other areas that have strong cognitive, human interaction and human factors concerns.
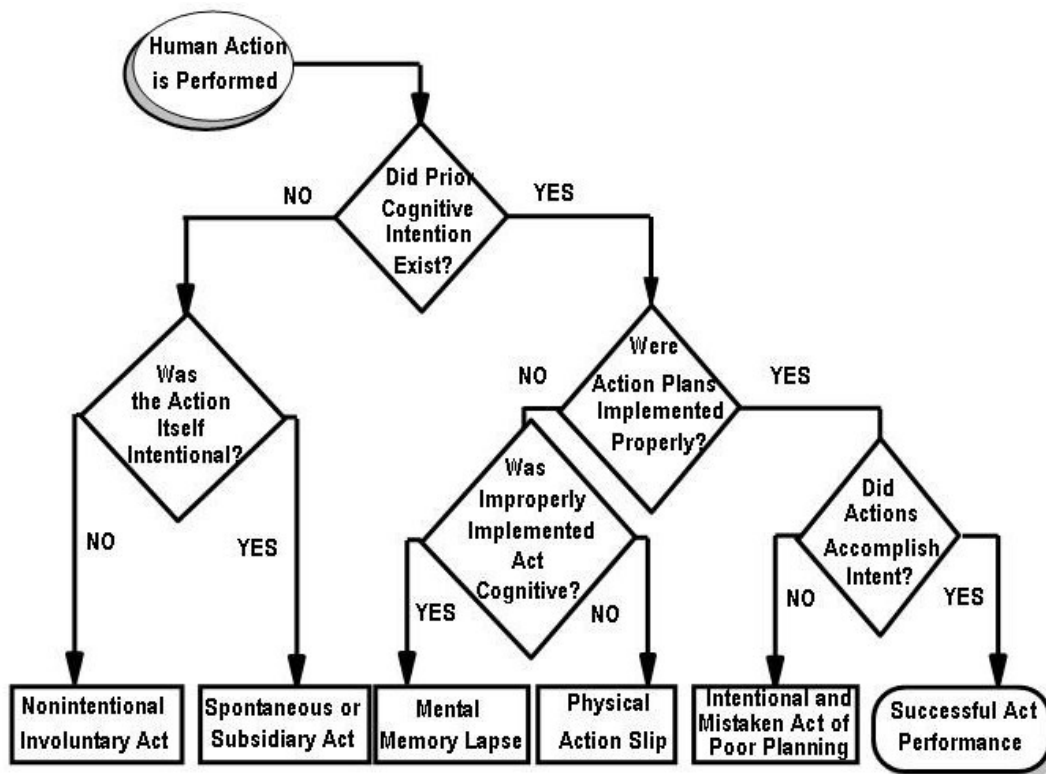

Figure 1. Interpretation of Reason's taxonomy of human actions and associated human error types

Much of our discussion to this point may seem oriented more toward management philosophy than toward management practice. Doubtless, this is correct. We maintain strongly, however, that successful management practice will embody these principles, prescriptions, perspectives, and philosophies. Our management philosophy supports the pragmatic management of large programs and projects. This philosophy should also be incorporated into the systems that we develop, to ensure that they are suitable for human interaction.

There have been many attempts to classify management functions. Among these is the function-type taxonomy of Anthony who describes three planning and control functions:
1. **Strategic planning function.** Strategic planning is the process of choosing the highest-level policies and objectives, and associated resource allocations and

strategies for achieving these. According to Anthony, strategic planning is unsystematic in that the need for strategic decisions may arise at any time and the threats and opportunities that lead to strategic decisions are not discovered systematically or at uniform intervals.

2. **Management control function.** Management control is the process through which managers influence other organizational members in order to help them achieve organizational strategies. Management control decisions are those decisions made for the purpose of assuring effectiveness in the acquisition and use of resources to achieve strategic plans.

3. **Task control function.** The process of task control has as its major objectives the efficient and effective performance of specific tasks. In an earlier work, Anthony described task control in terms of two related functions. Operational control functions were accomplished for the purpose of assuring effectiveness in the performance of operations. Operational performance functions were associated with the day-to-day decisions made while performing operations.

These three planning and control processes relate to one another as indicated in Figure 2. While there is often considerable variation among the many task control systems that may be found in a given organization, nearly all such systems that may include interaction between one task manager and a team of non-managers, or perhaps with an automated system. Task control functions are generally well structured. Management control involves the interaction of managers, generally in resolving unstructured issues in a manner that supports achievement of the strategic plan of the organization. Management control concentrates on the activities that occur within various responsibility centers of the organization. It would appear that the system management function described here, and elsewhere in the systems engineering literature, is fundamentally similar to that of Anthony's management control.
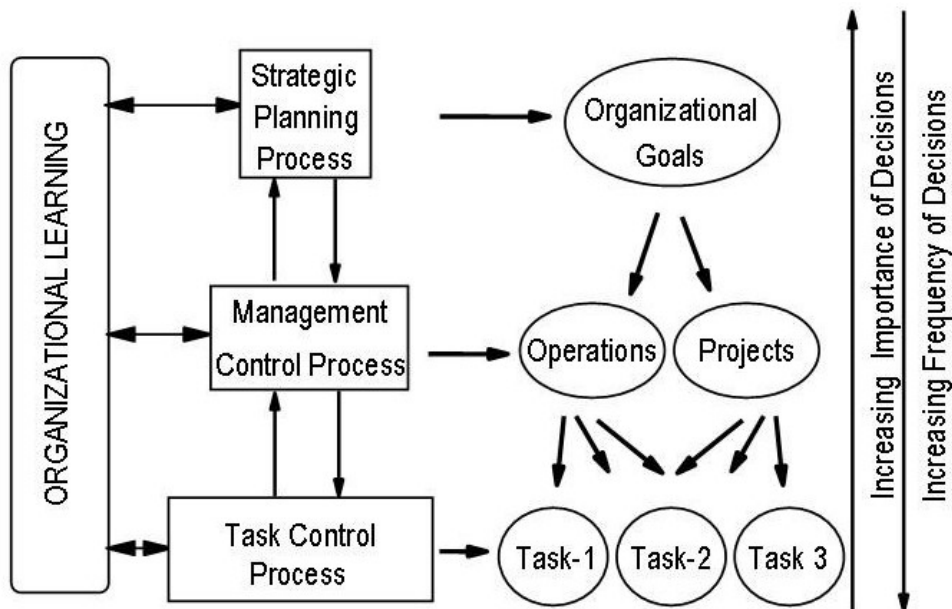

Figure 2. Flow of organizational information and associated planning and control decision flow

Other discussions of organizational management will concentrate on activities of a management team, as contrasted with the decisions that they make. It is not unusual to find seven identified management functions or tasks in the classic enterprise management literature:

1. **Planning,** which comprises the identification of alternative courses of action that will achieve organizational goals.
2. **Organizing,** which involves the structuring of tasks that will lead to the achievement of organizational plans, and the granting of authority and responsibility to obtain these.
3. **Staffing,** which comprises the selection and training of people to fit various roles in the organization.
4. **Directing,** which refers to the creation of an environment and an atmosphere that will motivate and assist people to accomplish assigned tasks.
5. **Co-ordinating,** which involves the integration and synchronization of performance, including the needed measurements and corrective actions, such as to lead to goal achievement.
6. **Reporting,** such as to ensure proper information flow in the organization.
7. **Budgeting,** such as to ensure appropriate distribution of economic resources needed for goal achievement.

This POSDCORB theory of management is a very common one and is described in almost all classical management texts.

It is quite clear that these functions are not at all independent of one another. As details of these functions are provided in essentially any introductory management guide, we will not pursue these in any further detail here. It is important to note that, collectively, these are the tasks of general enterprise management. They apply to systems management in its planning activities, which involve anticipation of potential difficulties and the identification of approaches for detection of problems, diagnosis of causes, and determination of promising corrective actions. They apply also to systems management and its control activities, which involve controls exercised in specific situations in order to improve efficiency and effectiveness of task controls in achieving objectives.

Planning is a prominent word in much of the foregoing. We can identify three basic types of, or levels for plans:
- organizational plans
- program plans
- project plans.

One of the major differences in these types of plans is their duration. Organizational plans are normally strategic in nature and can be expected to persist over a relatively long time. Program plans are intended to achieve specific results. For large programs, it is generally desirable to disaggregate the program plans and controls into a number of smaller projects.

Three fundamental activities are involved in management as a decision-making effort. These are precisely the steps of the problem solving or systems engineering process (see "Systems engineering and management," in EOLSS on-line, 2002):

- Formulation of issues.
- Analysis of alternatives.
- Interpretation of the impacts of the alternatives to enable the selection of the most appropriate alternative.

These steps are encountered at several levels, or phases, of organizational management activities. They begin at the strategic level and result in the preparation of strategic plans, which are then ultimately converted into tactical and operational plans, and then implemented as management controls or task controls through an effective planning process.

At this highly aggregated level, it may be difficult to envision specific management activities. While there are many more finely grained steps into which the aforementioned three steps may be partitioned, three general and nine specific levels of activities appear especially important steps in systems management.

1. Issue formulation.
    1.1. Environmental monitoring.
    1.2. Environmental understanding.
    1.3. Identification of information needs.
    1.4. Identification of alternative potential courses of action.
2. Issue analysis.
    2.1. Identification of the impacts of alternatives.
    2.2. Fine tuning the alternatives for effectiveness.
3. Issue interpretation.
    3.1. Evaluation of each alternative.
    3.2. Selection of a "best" alternative.
    3.3. Implementing the selected alternative.

The managers of specific functional efforts, as well as managers in general, perform each of the activities that we have just identified. These activities are appropriate at each phase in a management effort, as well as in such special cases as development of crisis management plans. In addition, the need will generally exist for appropriate contingency or crisis management plans, which will be implemented if the initially intended plans prove unworkable. A management crisis exists whenever there is an extensive and consequential difference between the results that an organization hopes to obtain from implementation of a strategic plan, and what it actually does obtain. This difference may have a variety of causes; a common element in all is that the organization has, somehow, misjudged either the environment in which it is operating, or the impacts of its chosen courses of action on the environment. A crisis may occur because of failure to identify a potentially challenging new opportunity, or as a result of an existing situation that is threatening the health or survival of the organization. The preferred solution in either case is crisis avoidance. An acceptable, but somewhat less preferred, solution is extrication from a crisis situation. The key to each of these "solutions" to a crisis is effective management of the organizational environment. Some activities may be performed at an intuitive level, based on experiential familiarity with

particular task requirements. Some should be performed in a formal analytical manner because they are initially unstructured and unfamiliar.

In each of these activities, information is of critical importance. Information is needed about the external environment to facilitate understanding of that environment. The first step in issue formulation is identification of a set of information needs relative to management objectives. In parallel with this, the preliminary identification of potential alternative courses of action is made, and these potential courses of action further act to frame the information needs for proper analysis and evaluation of these alternatives. All of these activities are accomplished as part of issue formulation. The issue analysis and issue interpretation steps are equally rich in terms of their need for information.

Systems management and management control are vitally concerned with the processing (broadly defined to include acquisition, representation, transmission, and use) of information in the organization. Generally, information is now recognized as a vital strategic resource and will be so treated here. A simple three step reasoning process leads to this conclusion:
1. Organizational success depends upon management quality.
2. Management quality depends upon decision quality.
3. Decision quality depends upon information quality and context, such that information becomes actionable knowledge.

It is, of course, necessary that information be interpreted as knowledge in order to lead to effective and actionable knowledge. This suggests a major role for context and experiential familiarity with tasks and the environments into which they are embedded such that information can be processed effectively. Earlier we noted that one of the major tasks of management planning and control is that of minimizing the ambiguity of the information resulting from the organization's interaction with its external environment. This is accomplished in order to:
• better enable the organization to understand its environment
• detect or identify problems in need of resolution
• diagnose the causes of these problems
• identify alternative courses of action or policies to correct or resolve problems
• analyze and evaluate the potential efficacy of these policies
• interpret these in accordance with the organizational culture and value system
• select an appropriate priority order for problem resolution
• select appropriate policies for implementation
• augment existing knowledge with the new knowledge obtained in this implementation such that organizational learning occurs.

This task of minimizing information ambiguity or equivocality is primarily that of management control. It is done subject to the constraints imposed by the strategic plan of the organization. In this way, the information presented to those responsible for task control is unequivocal. This suggests that the task control function receives information inputs primarily from those at the management control level. It suggests that there are planning and control activities at each of the three functional levels in an organization. The nature of these planning and control activities may be quite different across these levels, however, as is the information and knowledge, which flows into them.

Regardless of the hierarchical level at which planning is considered, a plan is a statement of what ought to be, together with a set of actions or controls that are designed to cause this to occur. Of course, the interpretation of "ought" may vary considerably as a function of the level at which planning is accomplished. Also, there may be a number of uncertainties that may act to prevent a normally useful set of activities from achieving the objectives that they should achieve.

In general, planning involves four major activities:
1. Identification of goals to be realized, some of which may already be fulfilled to some extent, at the particular level of planning under consideration.
2. Identification of current position relative to the goals such that it becomes possible to specify a set of needs that, when fulfilled, will lead to goal realization.
3. Identification of past, present and future environments such that it becomes possible to understand effects of the constraints on, and alterables of, realistic courses of action.
4. Identification of suitable alternative courses of action designed to lead to need fulfillment and goal attainment.

These planning elements are associated with an organization's internal environment, including its culture and standard operating policies, and the external environment. We also need to identify measures or metrics so that we can determine success in need satisfaction, goal attainment, and activity accomplishment. These should be linked together in order to identify and understand relationships in the elements of planning.

Implied in the identification of strategic planning options is:
1. An external environment analysis to identify the present context in which the issue being considered is embedded and to forecast possible future situations.
2. An internal environment analysis at the level of the organization where planning is being accomplished conducted in order to determine available resources and to identify the organizational culture.

We can disaggregate this still further. We can speak, for example, of a general environment, or management control environment, as those elements affecting all organizational activities within a specific domain: cultural, demographic, technological, and so forth. Also, we can speak of a task environment as those elements specifically affected by, and affecting, the particular organization and alternative course of action in question.

At this point in a planning effort, we have scoped out the issue considerably and identified a number of possible courses of action. Up to this point, we have accomplished formulation of the issue. The major planning ingredients needed for a complete and useful plan are:
*   realistic objectives
*   identification of a course of action together with suitable and observable activities measures.

To achieve these, we need to analyze the options that have been generated to determine their impacts on needs. In dealing with a large and complex issue, a variety of systems

analysis tools may need to be used. After this analysis, we need to obtain an interpretation, reflecting the value system of the clients. Management control efforts are carried out with respect both to programs that ultimately result in the delivery of operational systems, and to the operational and task-related activities of the systems engineering organization itself. The interpretation activities of management control will include evaluation of these impacts and selection of an alternative course of action, with respect either to program deliverables or to adaptation of operational efforts within the corporation to improve performance.

In any large and complex effort, it will be necessary to break a program down into several project plans. A successful project plan must identify and detail:

- what is to be done
- who will do it
- with what resources
- in what time period.

The course of action element, what is to be done, must meet the needs of the client and must possess sufficient quality and functionality. Sufficient is typically a very subjective term that depends on the client's needs, priorities, and available resources to meet these. There are many causes of management failures:

1. Difficulty of defining work in sufficient detail for the level of skills available.
2. Problems with organizing and building the project team.
3. Project staff is reassigned prior to project completion.
4. Failure of clients to review or understand requirements and specifications.
5. No firm agreement on program plan or project plans by management.
6. Insufficiently defined project team organization.
7. No adequate set of standards.
8. No operational level quality assurance or configuration management plans.
9. No clear role or responsibilities defined for project personnel.
10. Project perceived as not important to individuals or organization.
11. No risk management, or crisis management, provisions.
12. Inability to measure true project performance.
13. Poor communications between management and members of the organization.
14. Poor communications with customer, or client, or sponsor.
15. Difficulty in working across functional lines within the organization.
16. Improper relations between program and project performance and reward systems.
17. Poor program and project leadership.
18. Lack of attention to early warning signals and feedback.
19. Poor ability to manage conflict.
20. Difficulties in assessing costs, benefits, and risks.
21. Insensitivity to organizational cultures.
22. Insufficient formal program and project guidelines at the level of procedures.
23. Apathy or indifference by program or project teams or management.
24. Little involvement of project personnel during program planning.
25. Rushing into project initiation before adequate definition of key tasks.
26. Poor understanding of inter-organizational interfaces.
27. Poor understanding of intra-organizational interfaces.
28. Weak assistance and help from upper management.

29. Program and project leaders not involved with team.
30. Credibility problems with task leaders.
31. No mutual trust among team leaders.
32. Too much unresolved conflict.
33. Unrealistic schedules and budgets.
34. Power struggles at various levels in the organization.
35. Lack of appropriate attention to strategic quality assurance and quality management.
36. Too much reliance on established procedures, which turn out to be inappropriate for the task at hand.
37. Lack of appropriate attention to knowledge management efforts and the resulting failure to transfer data to information to knowledge.
38. Lack of concern for the human dimensions of organizational performance.
39. Implementation of reactive policies with little or no concern for interactive and proactive approaches to everything.
40. Concentration of attention on symptoms and their removal, and not upon institutional and value related issues.

Most of these will cause programs and projects to fail to finish their scheduled activities on time and within budget. Most of these failures are human failures and human systems integration failures. And this list is incomplete! It can easily be expanded.

There is often disagreement within various groups concerning which of these factors are most important, and which is likely to be responsible for the failure of programs and projects. For example, top-level managers will generally indicate that front-end planning, including identification of system level requirements, is very important. Program and project engineers will usually consider this to be less important. On the other hand, program and project engineers will likely perceive technical complexities of a program as very important and wish to devote significant effort to understanding these. Program management will often consider this relatively less important than such factors as identification of requirements and establishment of requirements specifications. Both groups will generally identify customer changes in specifications during program completion as being a major factor in time slippage and cost overruns. On the other hand, clients will not perceive their requirements as changing. They will perceive that these were very poorly identified initially, and perhaps poorly translated to specifications which were then implemented in an error prone manner. We believe that these differences in perceptions strongly support the use of prototyping techniques and the use of support systems for issue exploration and judgment, so as to enable full understanding of tasks to be undertaken as early as possible in the systems engineering lifecycle. Most importantly, they suggest the incorporation of risk management procedures throughout the lifecycle, and operational and strategic level quality assurance and management of both process and product.

-

-

<div style="background-color:#9acd00;padding:20px;text-align:center">

TO ACCESS ALL THE **54 PAGES** OF THIS CHAPTER,
Visit: http://www.eolss.net/Eolss-sampleAllChapter.aspx

</div>

Bibliography

Anderson, E. S. 1994. *Evolutionary Economics: Post-Schumpeterian Contributions.* New York, Pinter. [Excellent presentation of evolutionary economics for economic growth.]

Anderson, P.; Meyer, A.; Eizenhardt, K.; Carley, K.; Pettigrew, A. (eds.) 1999. Special Issue on the Applications of Complexity Theory to Organizational Science, *Organizational Science,* Vol.10, No. 3, pp. 215–379. [A journal special issue on the application of complex adaptive systems to organizations.]

Anthony, R. N. 1988. *The Management Control Function,* Boston, Mass., Harvard Business School Press. [A classic work on this subject.]

Argyris, C. 1982. *Reasoning, Learning and Action: Individual and Organizational.* San Francisco, Calif., Jossey-Bass. [An early and seminal work on individual and organizational learning.]

Argyris, C.; Schon, D. A. 1978. *Organizational Learning: A Theory of Action Perspective.* Addison Wesley, [An early and seminal work on organizational learning.]

——. 1996. *Organizational Learning II: Theory, Method, and Practice.* Reading, Mass., Addison Wesley. [An extension of the earlier work on this subject.]

Arthur, W. B. 1994. I*ncreasing Returns and Path Dependence in the Economy.* Ann Arbor, Mich., University of Michigan Press. [An excellent work on path dependence and its effect on economics and consumer behavior.]

Axelrod, R. 1997. *The Complexity of Co-operation: Agent Based Models of Competition and Collaboration.* Princeton, N.J., Princeton University Press [A classic work on complex adaptive systems.]

Axelrod, R.; Cohen, M. D. 1999 *Harnessing Complexity: Organizational Implications of* a *Scientific Frontier.* New York, Free Press. [An exceptional work on complex adaptive systems in organizations.]

Brown, S. L.; Eizenhardt, K. M. 1998. *Competing on the Edge: Strategy as Structured Chaos.* Boston, Mass., Harvard Business School Press. [A very useful overview of complex adaptive systems and management.]

Clippinger, J. H. III (ed.), (1999). *The Biology of Business: Decoding the Natural Laws of Enterprise.* San Francisco, Calif., Jossey Bass. [A useful work on green management.]

Costanza, R. 1994. Three General Policies to Achieve Sustainability, In: A. Jansson, M. Hammer, C. Folke, and R. Costanza (eds.), *Investing in Natural Capital,* ch. 24, Washington, D.C., Island Press. [A very good discussion of principles to enhance sustainability.]

Cyert, R. M.; March, J. G. 1963. *A Behavioral Theory of the Firm,* Englewood Cliffs, N.J. Prentice Hall. [A seminal classic work on management and organizational psychology.]

Davenport, T. H.; Prusak, L. 1994. *Working Knowledge: How Organizations Manage What They Know.* Boston, Mass., Harvard Business School Press. [An excellent work on organizations and knowledge management.]

Desimone, L. D.; Popoff, F. 1997. *Eco-Efficiency: The Business Link to Sustainable Development.* Cambridge Mass., MIT Press. [A very useful presentation of the interaction between management and sustainable development.]

Fiskel, J. 1998. *Design for Environment: Creating Eco-Efficient Products and Processes.* New York, McGraw Hill. [An excellent work on green management.]

Fosberg, K.; Mooz, H.; Cotterman, H. 2000. *Visualizing Project Management: A Model for Business and Technical Success.* 2nd edn. New York, John Wiley. [A very useful presentation of the principles and practices of program and project management.]

Garvin, D. A. 2000. *Learning in Action: A Guide to Putting the Learning Organization to Work.* Boston, Mass., Harvard Business School Press, [A management perspective on learning organizations.]

Ginsburg, H.; Opper, S. 1979. *Piaget's Theory of Intellectual Development.* Englewood Cliffs, N.J., Prentice Hall. [A seminal work concerning cognitive growth and an exposition of the growth model of Piaget.]

Graham, J. D.; Hartwell, J. K. (eds.), 1997. *The Greening of Industry: A Risk Management Approach.* Cambridge, Mass., Harvard University Press. [An excellent discussion of green management.]

Hammond, K. R. 1990. Intuitive and Analytical Cognition: Information Models. In: A. P. Sage (ed.), *Concise Encyclopedia of Information Processing in Systems and Organizations,* Oxford, UK, Pergamon. pp. 306–12. [A useful presentation of the spectrum of cognitive styles.]

Hart, S. L. 1997. Beyond Greening: Strategies for a Sustainable World, *Harvard Business Review,* Vol. 75, No.1, pp. 77–83. [A useful presentation of green management principles.]

Hart, S. L.; Milstein, M. B. 1999. Global Sustainability and the Creative Destruction of Industries. *Sloan Management Review,* Vol. 41, No. 1, pp. 23–35. [A useful presentation of green management principles.]

Janis, I. L. 1982. *Groupthink.* New York, Free Press. [Presents a thorough discussion, and case histories, of how organizations can reason in very flawed ways.]

Kahneman, D.; Tversky, A. (eds.) 2000. *Choice, Values, and Frames.* New York, Cambridge University Press. [Contains very useful presentations of heuristics and biases in individual and organizational reasoning.]

Kelly, S.; Allison, M. A. 1999. *The Complexity Advantage: How the Science of Complexity Can Help Your Business Achieve Peak Performance.* New York, McGraw Hill. [A useful overview of applications of complex adaptive systems to organizations and management.]

Mangusson, L.; Ottosson, J. (eds.) 1997. *Evolutionary Economics and Path Dependence,* Brookfield, Vt., Edward Elgar. [A valuable discussion of evolutionary economics and path dependence and their relationships.]

Mansell, R.; When, U. 1998. *Knowledge Societies: Information Technology for Sustainable Development.* Oxford, UK, Oxford University Press. [Useful discussions of the need for information technology and knowledge management in sustainable development.]

March, J. G. 1994. *A Primer on Decision Making: How Decisions Happen.* New York, Free Press. [An excellent discussion of many of the contributions of this author, and others, to management decision-making.]

March, J. G.; Simon, H. A. 1958. *Organizations.* New York, John Wiley. [A seminal work on the subject of organizations and their management.]

Meppem, T.; Gill, R. 1998. Planning for Sustainability as a Learning Concept. *Ecological Economics,* Vol. 26, No. 2, pp. 121–37. [Useful discussion of leaning and sustainability interrelationships.]

Mintzberg, H. 1973. *The Nature of Managerial Work.* New York, Harper and Row. [A seminal work on the management activities.]

Mintzberg, H.; Ahlstrand, B.; Lampel, J. 1998. *Strategy Safari: A Guided Tour Through the Wilds of Strategic Management,* New York, Free Press. [An excellent work on various approaches to strategic planning and management.]

Nonaka, I.; Takeuchi, H. 1995. *The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation.* New York, Oxford University. Press. [A seminal work on knowledge management.]

Norman, D. A. 1988. *The Psychology of Everyday Things.* New York, Basic. [An excellent work on behavioral psychology, including slips and lapses and forms of human errors.]

Project Management Institute. 2000. *A Guide to the Project Management Institute Body of Knowledge.* Newtown Square, Pa., Project Management Institute. [An excellent work on program and project management principles.]

Rasmussen, J.; Pejtersen, A.; Goodstein, L. G. 1994. *Cognitive Systems: Engineering.* New York, John Wiley. [A useful work that describes the use of skills, rules, and formal knowledge for judgment and decision-making.]

Reason, J. 1990. *Human Error.* Cambridge, UK, Cambridge University Press. [An excellent work on human errors and their cause and correction.]

Reinhardt, F. L. 2000. *Down to Earth: Applying Business Principles to Environmental Management.* Boston, Mass., Harvard Business School Press. [An excellent work on green management.]

Richards, D. J. (ed.) 1997. *The Industrial Green Game: Implications for Environmental Design and Management.* Washington, D.C., National Academy Press. [An excellent work on green management.]

Rostow, W. W. 1990. *The Stages of Economic Growth: A Non-Communist Manifesto.* 3rd edn. New York, Cambridge University Press. [An early seminal work on economic growth in organizations and nations.]

Rouse, W. B. 1991. *Design for Success: A Human Centered Approach to Designing Successful Products and Systems.* New York, John Wiley. [An excellent work on design and management of the production process.]

——. 2001. *Essential Challenges of Strategic Management.* New York, John Wiley. [An excellent introduction to the principles and practices of strategic management.]

Sage, A. P. (ed.) 1990. *Concise Encyclopedia of Information Processing in Systems and Organizations.* Oxford, UK, Pergamon Press. [A work that describes numerous issues that relate to information management and information processing in organizations.]

——. 1995. *Systems Management for Information Technology and Software Engineering.* New York, John Wiley. [Contains chapters that describe the ages of strategy, quality management, and reengineering in organizations.]

Sage, A. P.; Armstrong, J. E. Jr. 2000. *An Introduction to Systems Engineering.* New York, John Wiley. [Contains a presentation of systems engineering and engineering management principles, and an introduction to management.]

Sage, A. P.; Rouse, W. B. (eds.) 1999. *Handbook of Systems Engineering and Management.* New York, John Wiley. [This work contains many chapters that relate to program and project management, and other management issues.]

Savage, C. M. 1998. *Fifth Generation Management: Co-Creating Through Virtual Enterprising, Dynamic Teaming, and Knowledge Networking,* San Francisco, Calif., Butterworth-Heinemann, [An excellent work on management in modern organizations.]

Schumpeter, J. A. 1934. *The Theory of Economic Development: An Inquiry into Profits, Capital, Credit, Interest, and the Business Cycle.* Cambridge, Mass., Harvard University Press. [An early seminal work on evolutionary economics.]

——. 1939. *Business Cycles: A Theoretical, Historical and Statistical Analysis of the Capitalist Process.* New York, McGraw Hill. [An early seminal work on evolutionary economics.]

——. 1942. *Capitalism, Socialism, and Democracy.* New York, Harper. [An early seminal work on evolutionary economics.]

Senge, P. M. 1990. *The Fifth Discipline: The Art and Practice of the Learning Organization.* New York, Doubleday. [Contains excellent discussions of the characteristics of learning organizations.]

Senge, P.; Kleiner, A.; Roberts, C.; Ross, R.; Roth, G.; Smith, B. 1999. *The Dance of Change: The Challenge to Sustaining Momentum in Learning Organizations, Currency.* New York, Doubleday. [Contains excellent discussions of the characteristics of learning organizations.]

Sheridan, T. B. 2002. *Humans and Automation.* New York, John Wiley. [An excellent tutorial on the role of human-system interaction. In the development and use of automated systems.]

Simon, H. A. 1978. Rationality as Process and as Product of Thought. *American Economic Review,* Vol. 68, 1978, pp. 1–16. [An early influential work on individual and organizational decision-making.]

——. Rational Decision Making in Business Organization. *American Economic Review,* Vol. 69, No. 4, September, pp. 493–513. [An early influential work on individual and organizational decision-making.]

Somerville, M. A.; Rapport, D. (eds.) 2000. *Transdisciplinarity: Re-Creating Integrated Knowledge.* Oxford, UK, EOLSS Publishers. [A compendium of papers on the need for trans-disciplinary approaches in dealing with contemporary challenges.]

Weick, K. E. 1979. *The Social Psychology of Organizing.* Reading Mass., Addison-Wesley. [A seminal work describing how and why organizations form.]

Wohl, J. G. 1981. Force Management Decision Requirements for Air Force Tactical Command and Control. *IEEE Transactions on Systems, Man, and Cybernetics,* Vol. 11, No. 9, pp. 618–39. [An early and seminal discussion of a model for sensing and action in organizations.]

World Bank, 2000. *Greening Industry: New Roles for Communities, Markets, and Governments,* Oxford, UK, Oxford University Press. [Contains excellent discussions of green management.]

World Business Council for Sustainable Development, 1998. *The Sustainable Business Challenge.* Sheffield, UK, Greenleaf Publishing. [Contains noteworthy presentations concerning excellent the need for sustainability considerations in business and industry.]

Biographical Sketch

Andrew P. Sage received the BSEE degree from the Citadel, the SMEE degree from MIT, and the Ph.D. from Purdue, the latter in 1960. He received honorary Doctor of Engineering degrees from the University of Waterloo in 1987 and from Dalhousie University in 1997. He has been a faculty member at several universities and, in 1984 he became First American Bank Professor of Information Technology and Engineering at George Mason University and the first Dean of the School of Information Technology and Engineering. In 1996, he was elected as Founding Dean Emeritus of the School and also was appointed as a University Professor. He is an elected Fellow of the Institute of Electrical and Electronics Engineers, the American Association for the Advancement of Science, and the International Council on Systems Engineering. He is editor of the John Wiley textbook series on Systems Engineering and Management, the INCOSE Wiley journal *Systems Engineering* and is co-editor of *Information, Knowledge, and Systems Management.* In 1994 he received the Donald G. Fink Prize from the IEEE, and a Superior Public Service Award for his service on the CNA Corporation Board of Trustees from the US Secretary of the Navy. In 2000, he received the Simon Ramo Medal from the IEEE in recognition of his contributions to systems engineering and an IEEE Third Millennium Medal. He has been elected to the US National Academy of Engineering in 2004. His interests include systems engineering and management efforts in a variety of application areas including systems integration and architecting, re-engineering, and industrial ecology and sustainable development.