Chapter

1

The Holistic Approach to Managing Engineering Operations

This book is intended to help you implement a more rigourous approach to the practice of Engineering Management. In our consulting work we have seen many attempts to improve this management process over the years. Mostly we have been called in when previous initiatives have failed. Our conclusion is that these initiatives have failed for one simple reason. They were narrow, one-dimensional solutions to problems that had many facets. And more often the people who offered consulting services had very little practical background in engineering. In this book we will look at the Engineering process from a holistic approach.

Typically we see the scenario play out as follows: a firm finds that its development projects are taking too long, or costing too much money to complete. A senior manager in Engineering has read a book, attended a course, or has considerable experience in one particular approach, and recommends that the organization simply needs to implement this new way and the problem will be solved. In the best case, a year later the performance in the one area at which the solution was aimed has improved, but there is no broad based financial measure of improvement. In the worst case the organization is in upheaval with pockets of resistance firmly entrenched against the change.

The reason for this failure is application of improved methods in isolation from one another. These solutions typically originate from one of six bodies of knowledge. A body of knowledge is an inclusive term that describes the sum of knowledge within a profession or management practice. A body of knowledge includes knowledge of proven, traditional practices, which are widely applied, as well as knowledge of innovative and advanced practices, which may have seen more limited use. The six we examine are fundamentally sound, and broadly accepted in modern management theory. In this book we will look at how to integrate them into a cohesive approach to making quantum improvements in your product definition process.

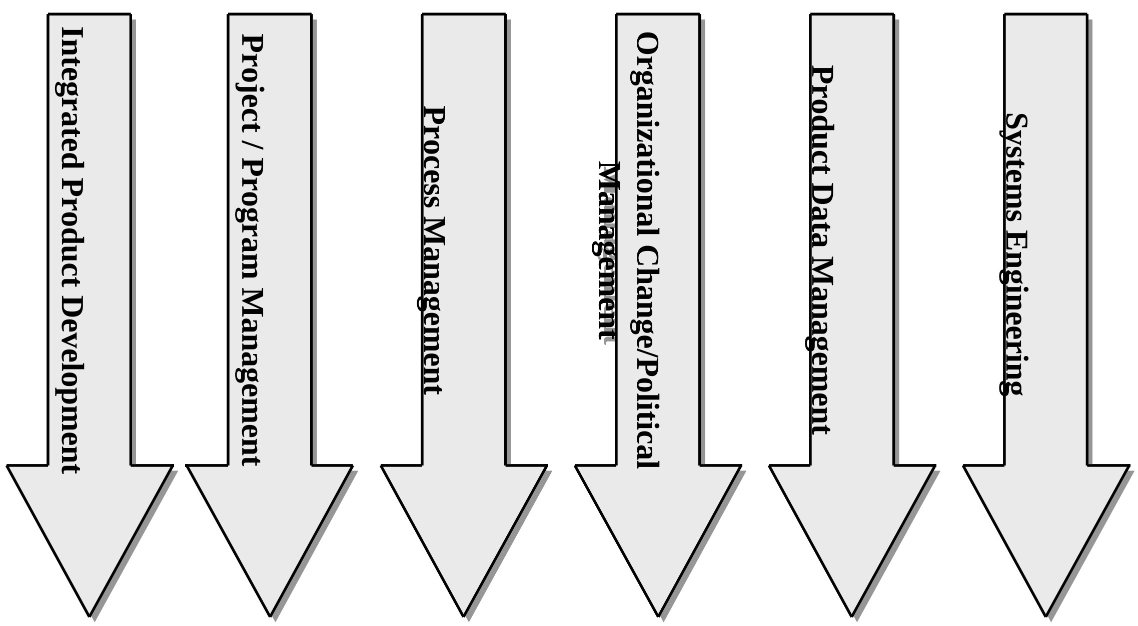
In this first chapter we will examine the six bodies of knowledge that we will integrate to form our approach. We will look at the motivation that led us to take this tact. That discussion will lead us to examine the benefits of the holistic approach. Then we will look at some of the critical success factors that will make the difference as you move to implement it in your organization. Finally, we will introduce what we call the Integrated Enterprise Architecture as a model for managing broad based change programs.

1.1 Separate Bodies of Knowledge

There are two perspectives that top managers have that separate them from the middle. Firstly, the language of the middle is “things”, while the language of the top is dollars. Certainly, top managers have a way of looking at issues from a financial perspective. However, the second characteristic of top managers is the wide breadth of their perspective. Managers will usually rise to the top on their ability to synthesize the input from many different perspectives. They lead their organization on a path that will optimize many, many different variables. This book is written to help give you that breadth. It will help you look at improvements to your product development process from the same perspective as the most successful executive. Then it will help you set a course of action that optimizes all the variables and constraints. It will be particularly useful for engineers and scientists who aspire to executive management. The traditional education and training of engineers is based on the supplied sciences. Scientific training has tended to create people with black and white or right and wrong thinking. This thinking works well when dealing with equations and the design of things. But it falls apart when dealing with people. Unlike things, people exhibit unpredictable behaviour. The interaction of politics and emotions is the greatest challenge management face. And the transition from Engineer/Scientist to management is a major challenge. This transition can only work if the executive takes a holistic approach at applying what are traditionally separate disciplines. We will develop a practical approach you can implement.

This approach, while broad, draws its strength from a grounding in six long-trusted management bodies of knowledge. The problem in the past has been that they have been treated by middle managers as separate solitudes. And they tend to have their own professional bodies that promote them. Middle managers have tended to lock onto one to call their area of expertise. They may have led a crusade to implement Business Process Re-Engineering, Concurrent Engineering, Systems Engineering or Project Management. However, we believe that our approach to integrating these previously separate disciplines has never been documented in management literature.

Figure 1-1: The Six Management Bodies of Knowledge



Let's first examine the foundation, the six bodies of knowledge upon which we base our approach.

Integrated Product Development

Integrated Product Development (IPD) was the brainchild of the US Defense industry in the late 1980's. In the IPD approach, Engineers form multi-discipline teams with the mandate to deliver a product that optimizes all the individual constraints placed upon it. These constraints could include budgets, materials, speed, strength, functionality, etc. You could make a list as long as your arm. For the purposes of this book, and to promote a common understanding of IPD we have adapted the definition provided in the U.S. Department of Defense Guide to Integrated Product and Process Development:

Integrated Product Development is... *A management process that integrates all activities from product concept through production/field support, using a multifunctional team, to simultaneously optimize the product and its manufacturing and sustainment processes to meet cost and performance objectives.*

IPD replaces the serial or "over the wall" approach in which a designer completes a design and throws it over the wall to someone in an analytical discipline. They in turn throw it back saying something like "it needs to be stronger". As ridiculous as it seems, most design departments still operate this way. IPD utilizes Integrated Product Teams (IPTs) to allow all affected areas to provide their perspective up front. The IPD approach allows the specialists to collaborate on the design, and collectively present a finished product to a manufacturing team that already knows exactly what it will be receiving.

Concurrent Engineering is at the heart of IPD. The IPTs are multifunctional teams organized around the major components of the product (or product structure). These teams have responsibility for developing a fully functional, producible, highly reliable, product that meets or exceeds customer requirements, program budget and schedule constraints. The teams have authority over all technical, cost, schedule and quality aspects of their products. They are accountable to the respective program manager. Each IPT team member represents the expertise of their functional discipline and is able to provide input to team decisions based on the processes and procedures developed and maintained by their functions. The multifunctional nature of the IPTs ensures early consideration of all issues relevant to cost, schedule, and performance of the product throughout its life cycle. The IPTs should be formed early in the proposal phase of a program and should retain their focus throughout the life cycle of the product. This early involvement of all functional disciplines that are vested in the development and support of a product, is the defining difference between serial and concurrent approaches to managing a program.

Co–location is a key enabler to the IPD process. Through co–location of core members of the IPT, integration team, program manager and appropriate business support resources, the free exchange and timely flow of information among program team members is spontaneous. Brain storming sessions are performed on an as needed basis.

While this early involvement of all appropriate functional disciplines increases initial program costs when compared to the serial approach, the avoidance and reduction in product and changes downstream result in both cost and schedule savings.

Project Management

The work of an enterprise generally involves either operations or projects. They are similar in that they are performed by people, constrained by limited resources and are planned, executed and controlled. Operations and projects differ in that operations are ongoing, and repetitive, while projects are temporary and unique. The Project Management Body of Knowledge surprisingly enough is documented in the Project Management Institute's Guide to the Project Management Body of Knowledge. They define a project as… *a temporary endeavor undertaken to create a unique product or service. Temporary means that every project has a definite beginning and definite end. Unique means that the product or service is different in some distinguishing way from all other similar products or services.*

The Project Management Institute defines Project Management as… *the application of knowledge, skills, tools and techniques to project activities in order to meet or exceed* *stakeholder needs and expectations from a project. Meeting stakeholder needs and expectations invariably involves balancing competing demands among:*

- *Scope, time, cost and quality*
- *Stakeholders with differing needs and expectations*
- *Identified requirements (needs) and unidentified requirements (expectations).*

Project Management involves planning the project, executing the plan, monitoring the execution and wrapping up the project when complete. Good project managers would die for their projects; great project managers inspire a team that would die for their leader.

Process Management

Michael Hammer's book Re-Engineering the Corporation launched Business Process Re-Engineering in the early 1990's. The fact that you do not hear the term as frequently today will lead some to believe it was another management fad. In fact it is quite the opposite. The e-business boom we are seeing today is simply a massive re-engineering project. When we introduce the Integrated Enterprise Architecture later in the chapter, you will see that the impact e-business is having on the movement of data is not possible without fundamental process change. An enterprise runs on a series of processes. Process Re-Engineering involves examining in detail how the organization performs the tasks that create value. Using process thinking, we stop thinking of the enterprise as a collection of functions and begin to see it as a collection of integrated tasks that make up processes designed to create and deliver value to the customer.

These processes run across the organization moving information or physical materials from function to function (or department to department). In process re-engineering, we examine these flows, document them, measure them, cut steps, add new steps, and ask the fundamental question "should this process exist at all?" Michael Hammer landmark Harvard Business Review Article in July 1990 was entitled *Reengineering Work*: *Don't Automate, Obliterate"*

Managing Organizational Change

Not so many years ago a manager had time to worry about the next wave of change that she potentially would have to ride. As a manager in the new millennium, that wave of change has become the perpetual white water. In managing organizational change, we utilize Organizational Behaviour techniques to understand and systematically overcome resistance to change. Engineers in management positions often give short shrift to this “wooly side” of management. They would prefer to deal with laws of physics or physical properties of materials. The body of knowledge is as diverse as Maslow’s Hierarchy of Needs, psychology techniques, socio-political management and military strategy. On its own this discipline is merely mental gymnastics. An improvement initiative that ignores the people aspects will certainly fall from the balance beam. The book The Change Masters 1984 by Rosabeth Moss Kanter was one of the first texts to address this body of knowledge. Its central theme was achieving American corporate renaissance by stimulating more innovation, enterprise and initiative from their people.

Product Data Management

Product Data Management (PDM) is a class of software designed to provide easy access to the mountains of data Engineers create. PDM systems provide a central repository for the design data. Then the authorized people can access the current design documentation with the confidence that they are using the appropriate version. PDM systems help the organization to define relationships between data elements. You can easily locate a given component and then access all related information such as the CAD drawing, the stress analysis, the test results, and the modifications to the component that are in work, approved, or in production. Advanced PDM systems also provide the functionality to help manage the product development process. They can enforce a standard routing, known as a Workflow, and can help project managers monitor activities through the workflow, thereby offering rudimentary project management functionality.

Systems Engineering

Systems Engineering is the practice of coordinating and executing development activities for designing and building systems- large or small, simple or complex. Systems Engineering work begins with the needs of stakeholders, users, and operators, and transforms these needs into a responsive, operational system design and architecture. The deliverable must conform to the demands of the marketplace as well as to the initial set of functional and non-functional requirements.

The International Council on Systems Engineering (INCOSE) defines systems engineering as… *an interdisciplinary approach and means to enable the realization of successful systems*." More succinctly put, systems engineering is an organized approach to problem solving, by an experienced engineer with a broad, system-wide overview towards solving the problem, weighing options and evaluating risks and constraints.

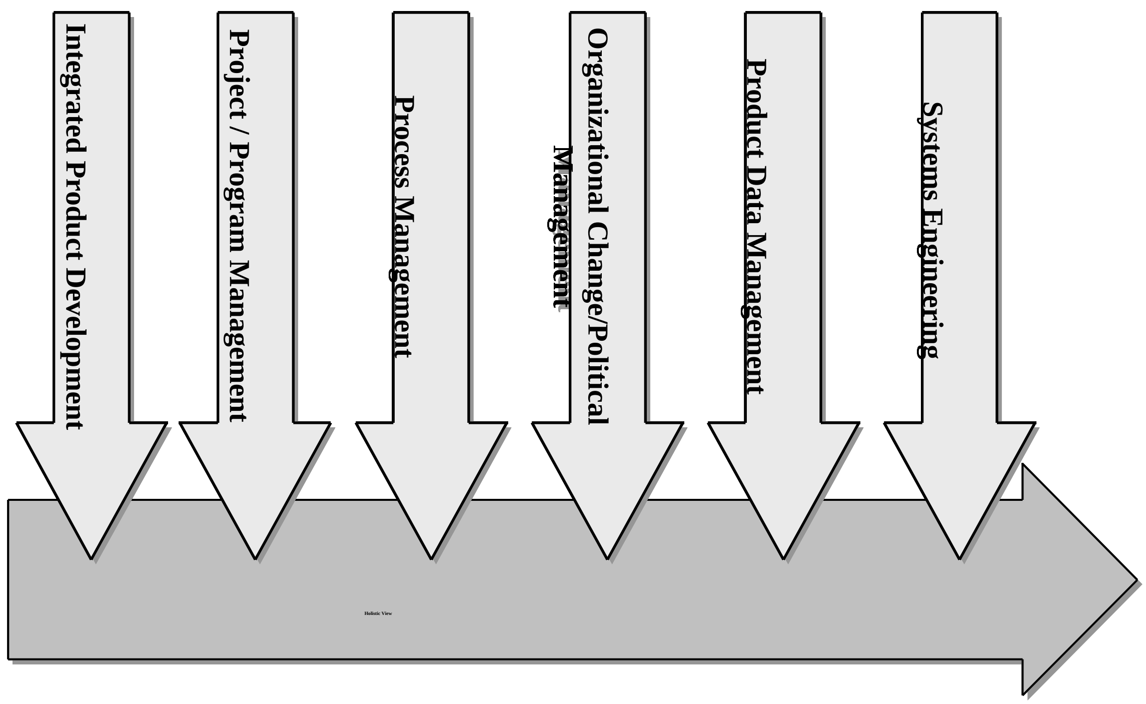
Systems Engineering is responsible for integrating all the technical backgrounds, subject matter experts and specialist groups in a development effort. It starts with defining customer needs and required functionality early in the life cycle, managing requirements, and proceeding into design synthesis and system verification and validation.

A major element of System Engineering is Risk Management. Project Management specialists will argue that Risk Management is just a chapter of the Program Management Body of Knowledge. Indeed the Program Director is responsible for assessing the risks his/her project faces, assessing the potential impact and taking the steps necessary to mitigate those risks. Risk, however, can have as large an impact on cost and schedule as the original product requirements. We have all heard of projects that take twice as long to complete and cost twice as much as the baseline plan. On complex programs managing risk is a major process. From a holistic approach, risk management involves identifying the appropriate senior people and gaining their commitment to assist in managing the technical and business risks on the program. Effective risk management involves elements of timing, managing the political environment in the organization, and being sensitive to the needs of the team, the partners, the customer, and executive management.

1.2 The Holistic Approach

In the Holistic Approach we take the best that these discrete bodies of knowledge have to offer. We rigorously practice what they preach, but we take a step back to consider the impact our actions in one area will have on another. We will redefine the Engineering Process, but we will do it in a way that makes project management simpler and more effective, and in a way that allows for implementation of Product Data Management, and so on. Throughout the book we will identify key points where you should stop driving down one path and examine how to integration concepts from the other bodies of knowledge can create an entire route map.

Figure 1-2: The Holistic View of the Bodies of Knowledge



1.3 The Motivation for taking an Holistic Approach

Programs or Projects, regardless of their scope, size, or complexity, must be acquired and executed in a similar manner, by performing a basic set of activities. A methodology is the organization of these activities into a standard framework, one that is used to guide the planning, execution and management of programs. This allows you to manage programs with repeatable results by approaching them with scientific methods. And making sure these methods are aligned with the human aspirations and political climate.

IPD Objectives

Companies that engineer products stake their future on their ability to continue to play a significant role in the development of new products. As such we must address a basic issue faced by all engineering organizations, namely to reduce cost and overall product development cycle time and improve quality. Typical goals include:

- Meet program cost targets.
- Reduce total program costs.
- Meet program milestones.
- Reduce time to market.
- Reduce engineering change following design freeze

As a management tool, this book is intended to help the management team answer the following questions:

- What work needs to be completed?
- What deliverables will be produced during the process?
- What skills are necessary to complete the work?
- How long will the work take?
- How much will it cost?
- How does each piece of work relate to other work?

- When are program reviews appropriate?
- What resistance do we have to overcome to achieve our goals?
- How do we organize for deployment an enterprise wide architecture?

We aim to provide a standard framework for executing engineering projects, thereby allowing your company to concentrate its efforts on applying skills (e.g. stress analysis, mechanical design, and process design) and not to be defocused recreating the approach for each program.

1.4 Benefits of the IPD Approach

The main benefit is that it provides an effective mechanism for planning and managing an engineering program. And this can be broken down into five more specific benefits:

- to help ensure high quality product and process definition;
- to improve project management and business process definitions;
- to capitalize on experience gained from other projects;
- to establish consistency across projects and divisions;
- and to provide a framework for training.

1.4.1 Helping ensure high quality product and process definition

A consistent approach helps ensure high quality product definition through efforts involving both people and technology. The following paragraphs introduce these concepts.

Effective Communication

High quality product definition requires effective communication processes, among project team members and between the team, partners and the customer. One of the greatest benefits of a well-documented approach is that all involved in the development process speak the same language. The team members and the customer agree on what work is involved in each phase of the project. The process promotes effective communication by building regular reviews into the project. These reviews enable all key players to monitor the program's progress and to identify and correct flaws early in the development process.

Complete Documentation

Complete project and system documentation is another key to helping ensure quality product definition. Documentation is produced throughout the course of the project. The documentation is cumulative, in that deliverables resulting from one task, are typically used as input for subsequent tasks. At the project's end, these deliverables become the final design documentation.

1.4.2 Improving Project Management

In the book we will outline techniques for high level and detailed project planning, as well as additional information on risk assessment, estimating and project execution and control.

Project Structuring and Planning

The starting point for effective planning is the Business Process Framework. It provides a way to break down the design activities to help identify deliverables (called a Work Breakdown Structure or WBS), plan major segments of work and determine the program review points necessary for a program. At a detailed level, the process flows provide a foundation for work planning templates and for the project Work Breakdown Structure These templates contain lists of tasks and work steps that represent the work typically involved in the development of an engineered product.

In addition, we will develop a template specifically for defining the project management tasks associated with a project such as the steps for planning the project, setting up the program review process, establishing program specific standards, initiating the project and monitoring and controlling it. By separating these project management tasks from the development tasks, we focus the project manager/engineer on the activities necessary to successfully manage a project.

Project Estimating

Quite simply, the repeatable results that a consistent process can deliver lead to higher quality costs estimates. Better cost estimates lead to better financial management and profitability.

Project Execution

A consistent process assists in project execution by clearly outlining what is expected from a particular deliverable. Process documentation provides a comprehensive reference library, with descriptions of all tasks, to help team members understand the work involved.

Project Control

To enhance project control, the process borrows proven techniques from other disciplines. From industrial engineering, for example we apply the principles of short interval scheduling and tangible deliverables. From financial disciplines, we apply formal reviews to compare actual times and costs to those budgeted. This enables tighter control over project progress and provides valuable feedback to improve the accuracy of future project estimates.

1.4.3 Capitalizing on Experience

To provide the best direction possible, we need to capitalize on experience gained from other development projects. The Process Framework and all of the associated tasks and deliverables are based on years of engineering design experience and many previous projects. As technology advances and your experience grows in using the techniques grows, you should update it to make sure it reflects the latest practices of your organization.

1.4.4 Establishing Consistency

Consistency, both across projects and between different aspects of the same project, is another objective. We outline a common Work Breakdown Structure, to help ensure that all Program and Functional Directors consider the same set of tasks in planning a program.

All project teams will use a consistent approach and common terminology. Common terminology facilitates the rapid transfer of personnel among programs at your company as well as partners and suppliers. As a result you will be able to bring the individuals with specialized competencies you need most onto your project team and bring them up to speed quickly.

1.4.5 Providing a Training Framework

Another objective of our work is to provide a framework for training. Because the tasks cover many aspects of engineering design and program management, it is a natural source of material for your training curriculum. As the embodiment of your engineering process, it provides a firm foundation for training new staff. It gives engineering professionals a common set of standards and procedures upon which to build.

1.5 Overview of the IPD Philosophy

All six of the bodies of knowledge we introduced are important, but Integrated Product Development is at the core of the holistic approach we are advocating. It represents a fundamental change from the way engineering projects/programs have been organized and run in the past. It provides a flexible approach to simultaneous product and manufacturing process development

At the core of IPD implementation are integrated product teams (IPT) that are organized to accomplish tasks required by the project. They work together to consider all life cycle issues from initial product conception to final product delivery. The IPT environment provides a tremendous opportunity to tap into the innovative talents of each team member to improve not only the product but also the fundamental way in which it is created.

IPD is based upon common sense decision making. It involves bringing the right people together at the right time to make the right decisions. It mandates that all IPTs use quality, cost, schedule, and technical considerations as a four-point check during each step of the design process. If a program is operating within the IPD philosophy, each team member will be able to identify their product responsibility, their decision authority, and their responsibilities on the program. While bringing additional manpower (and cost) to the beginning of the development process, IPD methodologies have been proven to "scrap paperwork . . . not product". IPD does this by shifting effort from the back end of the product development process, where changes are costly, to the front end where changes don't impact production.

Within a program, IPD increases focus on and ownership of processes and products, improves horizontal communications, clarifies the interfaces between participating functions, enhances teaming through rapid, open communications, and establishes clear lines of authority and responsibility.

An effective IPD methodology focuses everyone's efforts on heightened customer satisfaction by systematic concentration of effort on the product. The way in which an enterprise organizes, plans, costs, monitors, designs, manufactures, supports, and retires a products is ultimately affected. This is done through the use of plans and schedules that are structured in the same way as the product itself. For example there is a work plan and schedule for the development of the door assembly, rather than a Stress Engineering functional plan.

1.5.1 Comparison of IPD and Traditional Approaches

To better understand Concurrent Engineering we need examine it in contrast with the alternative, the traditional serial approach. Figures 1-3 and 1-4 compares the serial approach to integrated product and process development with the concurrent approach. The important element to note when comparing Figure 1-3, and Figure 1-4 the dramatic reduction in time because processes are performed simultaneously.

Figure 1-3: Serial Approach to Product and Process Development

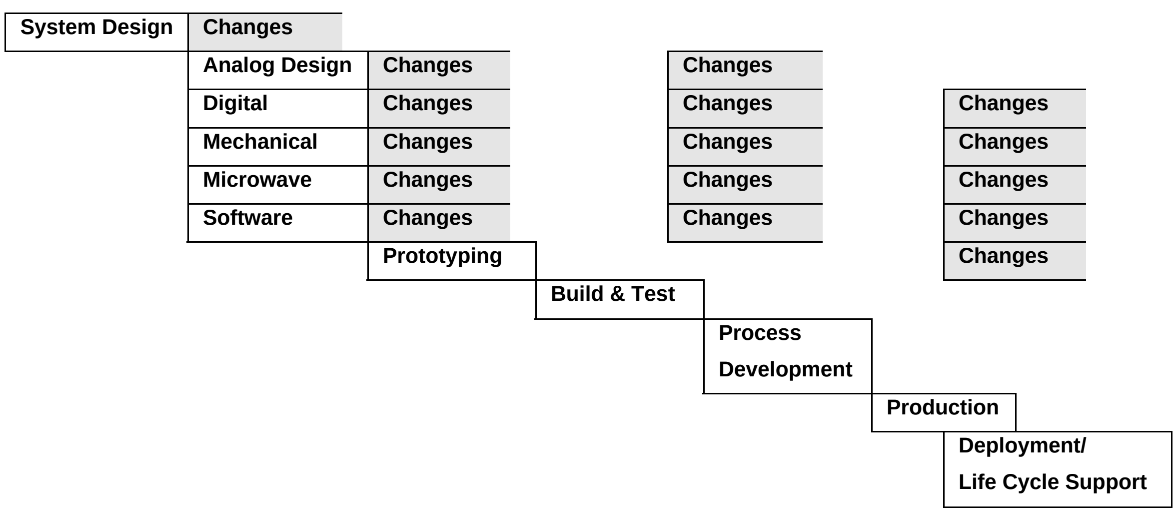
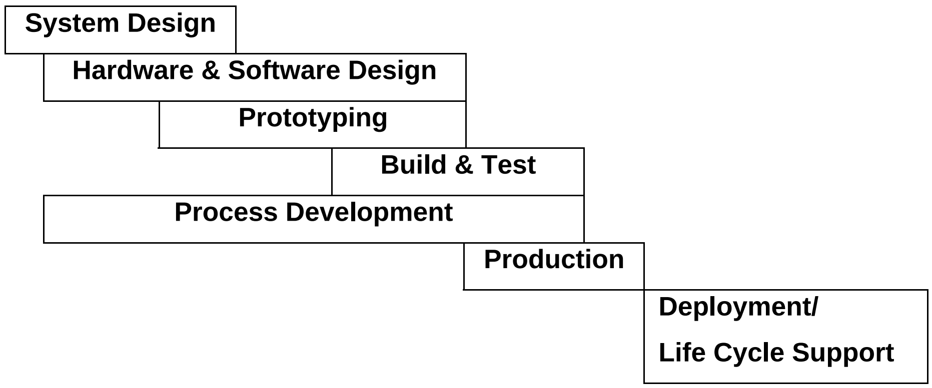


Figure I-4: Integrated Product Development Approach



1.5.2 The Serial Approach to Product and Process Development

In the serial approach, the customer provides top–level requirements during the concept definition stage. Systems engineers refine these requirements before passing them on to hardware and software engineers (see Figure 1-3). Hardware and software engineers create design concepts and document them in the form of "engineering drawings." During the product design phase, these drawings are refined and then passed along to specialty engineering organizations, purchasing, manufacturing, quality, and other support functions. These groups then perform their respective analyses, order materials, select vendors, design and fabricate tools and test fixtures, and prepare logistics plans. At each of these hand–offs, if the recipient did not contribute to the decisions that led to the product he is presented, there is a probability that changes will be needed. These changes can extend the product delivery cycle, increase development costs, increase overall product costs, or result in compromises adversely affecting quality.

In product development, between 60% and 80% of the overall product costs are committed between the concept and preliminary design phases of the program. However, in the serial approach, only a small cumulative expenditure of funding, 5% to 10%, is committed during this same period (see Figure 1-4). This relatively small expenditure during these stages reflects the limited involvement of functional disciplines outside of the engineering. Because of traditional schedule considerations, the design usually gets locked–in after the concept definition stage, without adequate coordination or consideration of inputs from other affected functions. This lack of early design coordination forces disciplines outside of engineering to come up with manufacturing, inspection, and support processes that may not be optimal. Often the impact is an order–of–magnitude greater when resolution of a problem is delayed to the next stage in the process (see Figure 1-5 and 1-6). The factor of ten rule states: It costs roughly 10 times as much to fix a problem if it is delayed to the next process step. In Figure 1-5, notice how committing costs and higher effort at the concept phase dramatically reduces costs downstream at the production & support phase.

Figure 1-5: Cost Impact

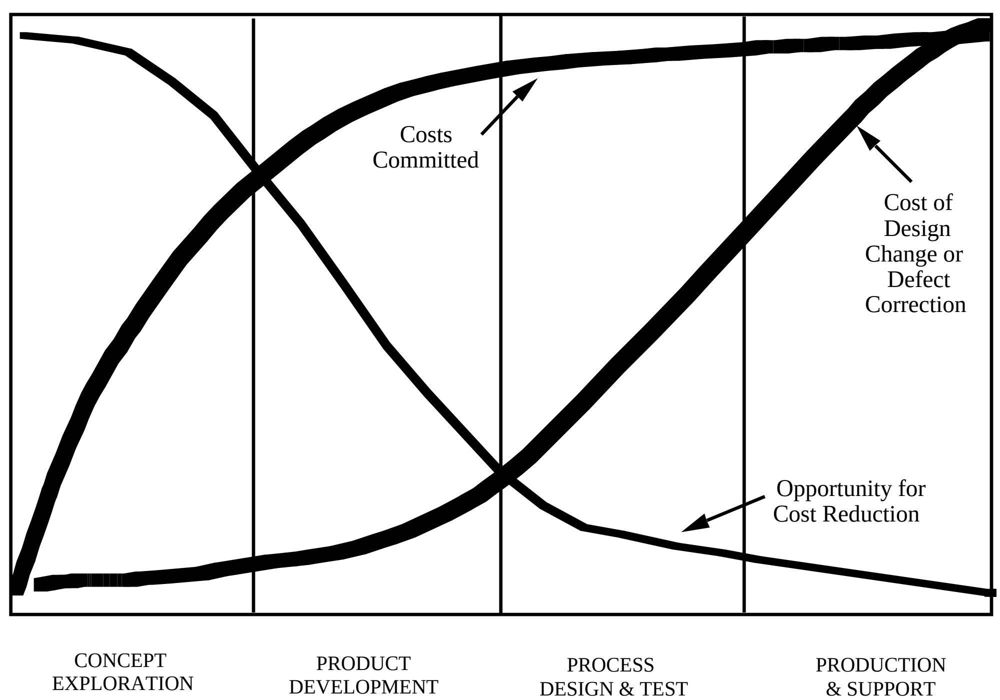
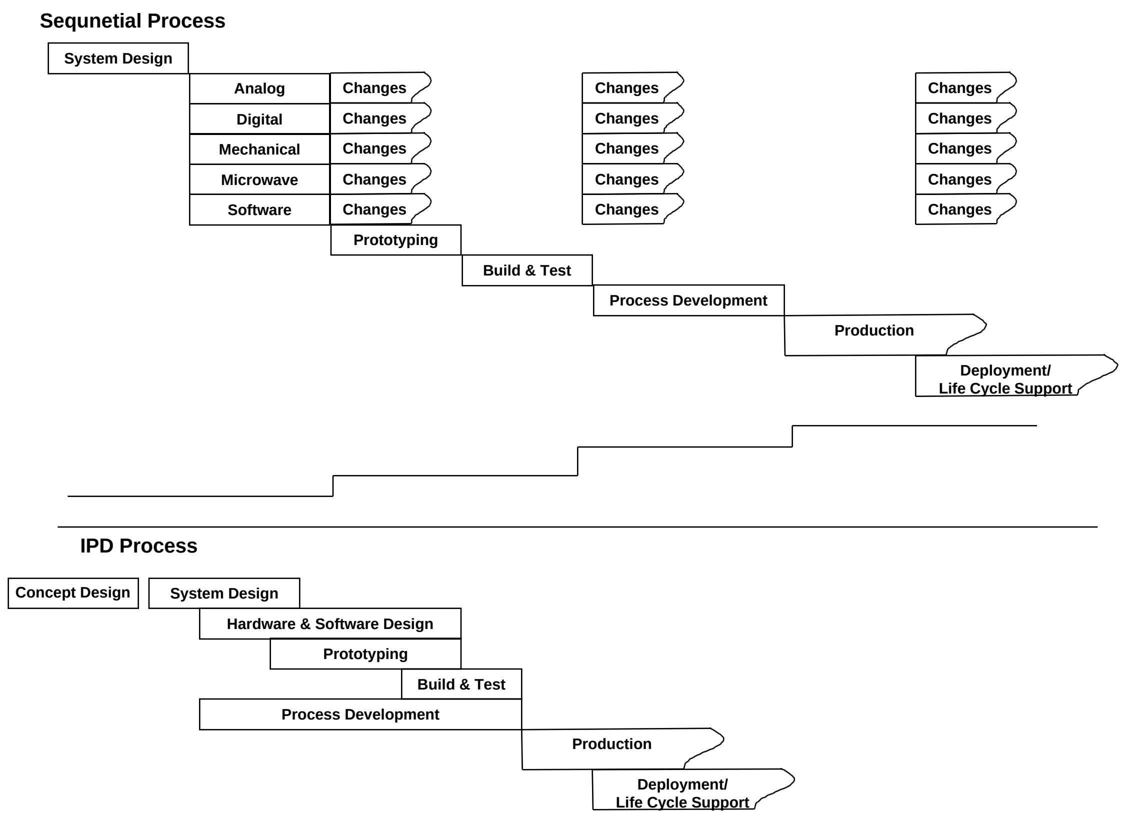


Figure 1-6: Cost Impact of Change



1.5.3 Team Comparisons

While an IPT is similar to other work–related teams in many respects, it also differs from them significantly in several ways. *Table I–1* provides a comparison between an IPT, a producibility team, and tiger team, teams with which most employees are familiar.

Perhaps the most significant differences between the IPT and work–related teams are in the areas of responsibility, authority and duration. The differences point to a need for changes in the approach to team decision–making, and interaction among the functional organizations.

1.5.4 Empowering the Integrated Product Team

To empower a person or team is to grant, the person or team, the power or authority to perform a certain function or task. An IPT is empowered to make decisions concerning specific aspects of its product within defined requirements. Empowerment of the team does not mean that management relinquishes its authority. Rather, management shares authority with the team and maintains the prerogative of periodic review.

The success of an IPD approach to product design can be attributed to IPT empowerment and synergy. Synergy results from assembling a team capable of working together to ensure that all product life–cycle requirements are addressed during upfront design - an effect that could not be accomplished by team members working only as individuals. Periodic program reviews ensure that an IPT is addressing and meeting their individual product accomplishment and performance criteria, as well as program requirements, plans, and cost targets.

Table 1–1 Comparison of IPT and other Teams

Team Parameter	IPT	Producibility Team	Tiger Team
Objective	Product delivery	Cost Effective Production	Problem solving and proposals
Orientation	Design for life cycle (proactive)	Ensure that design is producible (reactive)	Solve the problem (reactive)
Responsibility	Deliver product to realistic specifications at low cost in minimum time	Recommend changes to save manufacturing and inspection costs	Recommend and implement solutions
Authority	At team level	Functional managers and designers	Team leader and functional managers
Leadership Function	Facilitate, coordinate, spokesperson	Coordinate	Coordinate, direct
Duration	Concept design from proposal to disposal	Short term, starting after detailed design	Short term for duration of problem
Structure	Multifunctional teams addressing product systems	Multifunctional teams critiquing key designs	Multifunctional teams solving a specific problem

The main difference between an IPT and other types of teams is that an IPT is given overall responsibility for and authority over a specific product and its associated processes, throughout its life cycle. The IPT is given comprehensive responsibility for the development of a system or subsystem, consistent with product design requirements. This includes responsibility for managing team resources in implementing the development program. The IPTs continuity, responsibility, and authority empower it to do its job of delivering a reliable, maintainable, high–quality product, on time and at the lowest cost.

1.6 Critical Success Factors in Implementation

To implement a new engineering process effectively, it is important to understand the interrelated characteristics. These characteristics, listed below, are a compilation of best practices at various engineering companies. They represent the core principles and themes, which embody a truly revolutionary environment.

- ***Customer Focus***

  The primary objective of the integrated product teams (IPT's) is to satisfy the customer's needs better, faster, and at less cost. These needs include product specs, delivery dates, and quality levels. The customer's needs should determine the nature of the product and it's associated processes.

- ***Concurrent Development of Products and Processes***

  Processes should be developed concurrently with the products they support. It is critical that the processes used to manage, develop, manufacture, verify, test, deploy, operate, support, train people, and eventually dispose of the product be considered during product design and development. Product and process design and performance should be kept in balance. Development decisions must be directed and viewed with respect to the impact on the product life cycle.

- ***Early and Continuous Life Cycle Planning***

  Planning for a product and its processes should begin early in the underlying research for the product and extend throughout the its life cycle. Early life cycle planning, which includes examining the roles of customers, functional organizations, and suppliers, lays a solid foundation for the various phases of a product and its processes. Key program events should be defined so that the resources can be applied and the impact of resource constraints can be better managed. The program milestones should be documented in the form of an Integrated Master Plan, containing associated criteria for successful route map, dependencies, IPTs responsible, and supporting Statements of Work.

- ***Maximize Flexibility for using a Sub-Contractor and Partner***

  Requests for Proposals (RFP's), Proposals, and contracts should provide maximum flexibility to deploy IPTs, contractor/partner unique processes and commercial specifications, standards and practices.

- ***Encourage Robust Design and Improved Process Capability***

  Advanced design and manufacturing techniques are used to promote quality through design, products with little sensitivity to variations in the manufacturing process (robust design), and focus on process capability and continuous process improvement. Plan to use tools to reduce process variability such as "six–sigma" and lean/agile manufacturing concepts.

- ***Event Driven Scheduling***

  A scheduling framework should be established which relates program events to defined criteria. This is the basis of the Integrated Master Plan or IMP. This event driven scheduling reduces risk by ensuring that product and process maturity is demonstrated prior to beginning the next activities and should be documented in the form of an Integrated Master Schedule (IMS). Every event that appears in the program IMP must be included in the program IMS. The IMS then serves as the master schedule for all detailed tasks of the IPTs.

- ***Multidisciplinary Teamwork***

  Multidisciplinary teamwork is essential to the integrated and concurrent development of a product and its processes. Team decisions should be based on the combined input of the entire team (engineering, manufacturing, test, financial management, customers and suppliers, etc.). Each team member needs to understand their role and support the roles and constraints of the other members. The manpower planning for the program should be driven by the program Integrated Master Plan and Integrated Master Schedule. The planned skill mix must be supported by the functional area managers.

- ***Empowerment***

  Decision-making, authority, responsibility, and resources to manage their product should be driven to the lowest possible level commensurate with risk. Decisions include establishing budgets, schedules, resource and facility planning, etc. The team accepts responsibility and is accountable for the results of their efforts. This may be documented in the form of team agreements, a recognized best practice.

- ***Seamless Management Tools***

  A framework should be established that relates products and processes at all levels to demonstrate dependencies and interrelationships. A single management system should be established that relates requirements planning, resource allocation, execution and program tracking over the product's life cycle. This integrated approach helps ensure teams have all available information thereby helping the team to make decisions. These tools help ensure all decisions are optimized toward the customer's needs, and the products' life cycle goals.

- ***Proactive Identification and Management of Risk***

  Critical cost, schedule and technical parameters related to system characteristics should be identified from risk analyses and user requirements. Technical and business performance measurement plans, with appropriate metrics, should be developed, collected and reviewed to track achievement of technical and business parameters.

- ***Management Commitment***

  The change initiative begins with management from the manufacturer, partners and the customer committing to the new process. Management in this sense is not limited to program management, but includes functional and the support organization management as well. To be successful, a willingness to embrace this philosophy must run throughout all organizations, strategic partners, sites and functional organizations. The absence of management commitment is the major reason change initiatives fail.

- ***Communication***

  Efficient, timely communications, data flow and collaboration to make decisions and perform tasks are essential. Communications must be open within teams as well as between teams. Improved communications will always mitigate risk.

- ***Continuous Process Improvement***

  The formulation and tracking of appropriate IPD process metrics are essential to appraising and improving product development policies, standards, and processes.

- ***Integrated Product Team Leaders***

  Careful selection and training of IPT leaders, members, and facilitators is a key starting point. It is very important to provide IPT leaders with leadership training, meetings management, consensus building etc.

- ***IPT Environment***

  The success of the new engineering process depends on the environment in which the IPTs must function. In a healthy environment, managers assume the role of facilitators and coach of the teams and their members. As well they must assume ownership of the functional processes that support the program. Managers will be called upon to sponsor and champion teams, acting to remove barriers to success, and empowering teams to get the job done within specific boundaries.

1.7 The Integrated Enterprise Framework

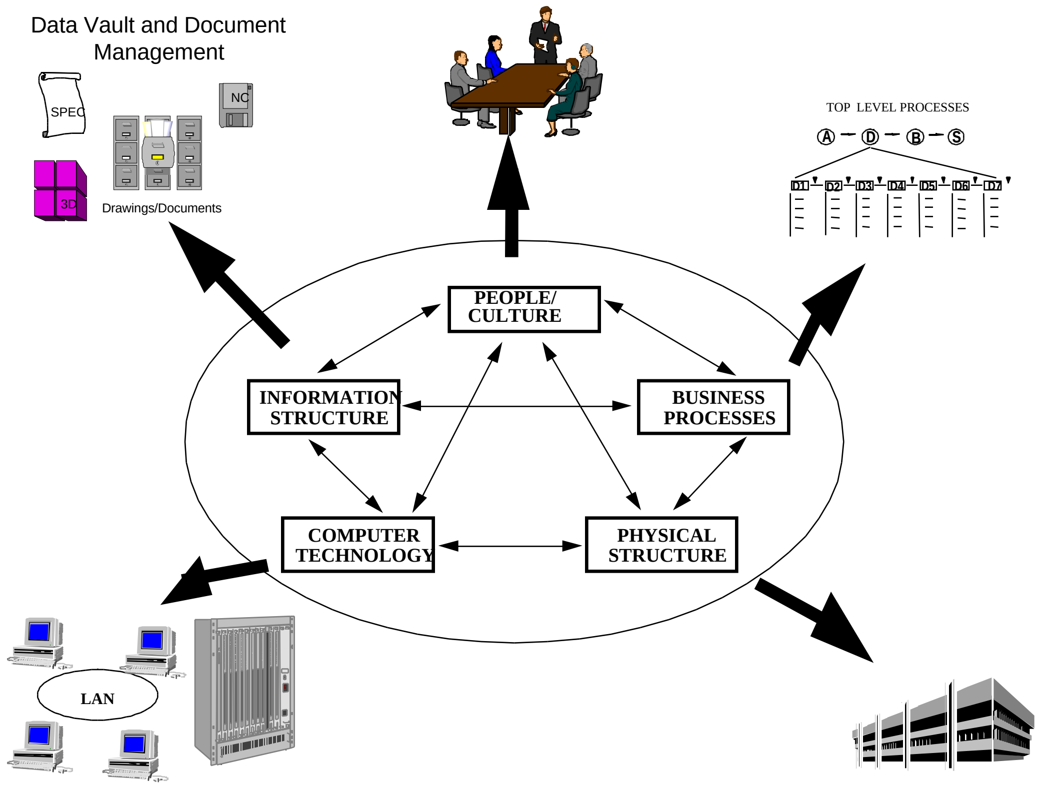
The process framework of an enterprise is only one element of its infrastructure.

Top management at any enterprise should develop an Integrated Enterprise Framework. The Integrated Enterprise Framework, as shown in Figure 1-7, is a way to help people keep the principal structures or domains of change of the business in balance, as they make changes to the way work is performed. It ensures implementation plans cover all aspects (e.g., training, attitudes, technology, location, organization, etc.). The principal domains of change of an enterprise are:

- People/Culture/Philosophy
- Business Process structure
- Physical structure
- Computer/Technology structure
- Information/Knowledge structure

For example e-business initiatives focus primarily on redefining the business process and information structures of the enterprise. The internet allows different companies to collaborate using common data to improve processes, improve service and reduce costs dramatically. It is important to understand at this point also that in this book we will not be looking at strategies for implementing e-business solutions. The framework we have presented transcends technology. We deal with the management process. The operational processes of how to conduct a stress analysis or the right data protocols for sending design documentation to a partner is the subject of another text. There is a great deal of hype on e-business or e-engineering. No technology ever has or ever will improve business performance without an efficient process that foster human innovation within a politically aligned organization.

Figure 1-7: Integrated Enterprise Framework



We will deal with strategy. The strategy for any enterprise should contain two components. Firstly, there should be an external strategy. There are many good texts on business strategy. For example, Michael Porter, Competitive Strategy is excellent. In this text however, we will focus on developing an internal Operations Strategy. Implementing a new engineering management process then is a major element of the Operations strategy. As such, your implementation should consider the degree of fit or misfit between the new processes, the concurrent approach and the IPTs and the domains of change described above. For example, implementing IPTs will be much more complicated in an organization that has a history of autocracy. Similarly, Concurrent Engineering will create substantial amounts of corporate data. Therefore, the support of the I/T organization will be crucial for supplying the necessary horsepower.

Before an enterprise can design future state processes, management should develop a process framework which covers the entire enterprise. The process framework identifies and documents process boundaries, inputs, executions and outputs. This architecture is used as a common framework for improvement efforts. The top level process model Figure 1-8 encompasses all work at an enterprise including:

- Conduct Strategic Management
- Conduct Program and Operational Management
- Execute Business
- Support Business

In Figure 1-8 the "Execute Business" process is where we focus the majority of our attention in further developing processes that are efficient and effective. The "Execute" process is often referred to as the "Core" process. The core processes; "Acquire", "Define", "Build" and "Support Customer" need to be broken down, or we use the term decomposed, at least two levels deeper. In some cases they should be further decomposed to the Task and Workstep level. In practical terms you cannot improve a process unless you analyze at the level where work gets done. Figure 1-9 identifies a top level process framework that incorporates the external customer processes. In this example we demonstrate how internal processes must be aligned and coordinated with customers and suppliers in the "supply chain".

Figure 1-8: Top Level Business Processes - Example

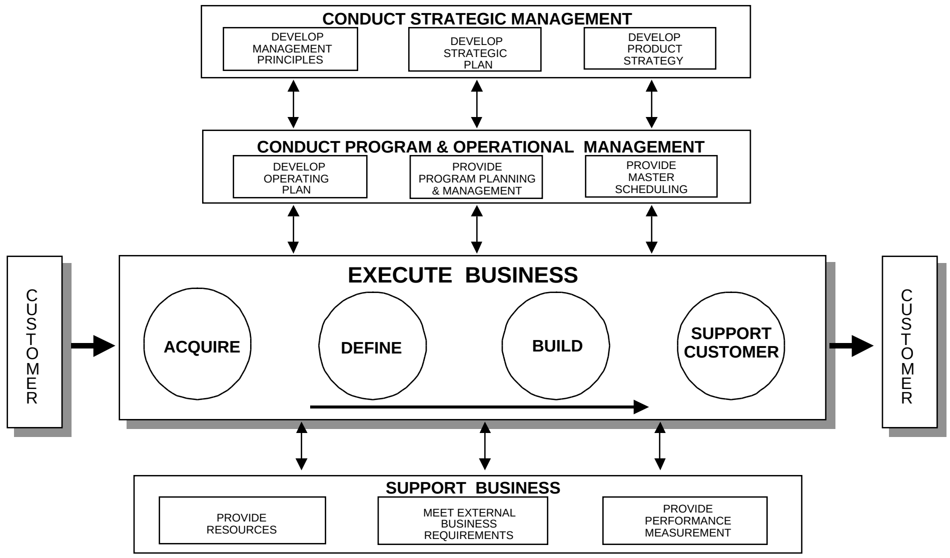


Figure 1-9: Top Level Process Framework
– Example Courtesy of Ontario Store Fixtures Inc.