Chapter 1

Introduction

1.1 INTRODUCTION

Services represent by far the largest contributor to the U.S. economy. Based on data published by U.S. Bureau of Labor Statistics, services and the total employment in the service sectors make up over 75 percent of the U.S. gross domestic product (GDP). As well, up until the year 2018, 96 percent of all 15.3 million new jobs are expected to come from the service sectors. Accordingly, the importance of services to the U.S. economy is clearly self-evident (Bartsch 2009). In fact, systems engineers are ranked at the very top of the list of "Best Jobs in America," with a 45% growth over a ten-year period, according to a Moneyline article (Anonymous 2009).

This chapter provides the definition and characteristics of services in contrast to products. Following this explanation, service sectors in the United States are introduced. A systems view of service enterprises is presented and the principles of service systems engineering are delineated. The skills and capabilities deemed essential to service systems engineers and leaders are then discussed, including how this text will help future graduates acquire the T-personality to meet the challenges of the new millennium. Conclusions are then presented.

1.2 SERVICES VERSUS PRODUCTS

Services are defined as "combinations of deeds, processes, and/or performances provided to customers in exchange relationships among organizations and individuals" (Zeithami et al. 2006). Services have seven key characteristics:

1. Provider and recipients are in direct face-to-face contact—based on the service roles, self-selected by the providers to prefer for such direct contact.
2. In service sectors, the merits of quality and productivity are not well defined (e.g., no physical parameters as existed in the goods sector)—raising issues related to whether cognitive science, organization, and engineering systems are more prominent in service delivery, productivity, and quality.
3. Although the physical assets depreciate over time and use in goods sector, key assets are generally reusable in the service sector. These service assets may actually increase in value. Examples are organization and human resources that derive from knowledge bases and skills realized in service interactions.

4. In the goods sector, equipment is usually newly designed and hence protected by intellectual rights. In services, equipment in application is often purchased and nonprotectable.
5. Services focus on knowledge-based understanding of technology and on how to use technology.
6. For service organizations, the keys to success are to adapt, utilize, and incorporate technological processes and equipment.
7. The right strategy of management of technology for services needs to take these factors into account.

Services are activities that cause a transformation of the state of an entity (e.g., a person, product, business, and region/nation) in a manner that is mutually shaped by its provider and the client. The transformation of the state of a person can be accomplished by services related to foods, healthcare, leisure, hospitality, travel, financial/investment advisement, banking, legal, education, entertainment, mail/package delivery, and others. The transformation of the state of a product is made possible by the design, operations, and maintenance services rendered. The transformation of the state of a business is the result of pursuing management consulting, outsourcing, e-procurement, marketing research, mergers and acquisitions, and others such corporate activities. The transformation of the state of a region/nation requires consulting advice and analysis related to regional/national economic advancement strategy, taxation policy, and other such macroscopic issues.

Services activities are becoming increasingly more diversified. Individual services are relatively simple, although they may require customization and a significant back-office support (e.g., database, knowledge management, analysis, forecasting, etc.) to assure quality and a timely delivery. Product services are also relatively straightforward, as product specifications, performance standards, quality control, installation guidelines, and maintenance procedures require good communication and understanding between providers and users. Business services are complex; some may involve intensive negotiation, work process alignment, quality assurance, team collaboration, and service coproduction. Regional and national services are even more complex, as they may affect policy, custom regulations, export permits, local business practices, logistics, distribution, and other such issues.

Services play an important role in an economy, as illustrated in Fig. 1.1 (Guile and Quinn 1988).

Services may also be classified into either front-stage or back-stage activities, depending on how close/remote the activities involved are to/from the customers. Front-stage activities are those in which provider and client interact directly. Customization leads to high value and high profit, whereas standardization tends to diminish profit margins. Back-stage activities do not directly involve customers and are mostly related to the efficient production of the services.

Services have a varying degree of front- and back-stage activities, which, in turn, have a varying degree of client interaction intensity. Figure 1.2 illustrates these specific characteristics of services. Services are also known to require different levels of labor intensity and degrees of customization, as depicted in Fig. 1.3. Table 1.1 illustrates a number of examples for the front- and back-stage activities involved in services.

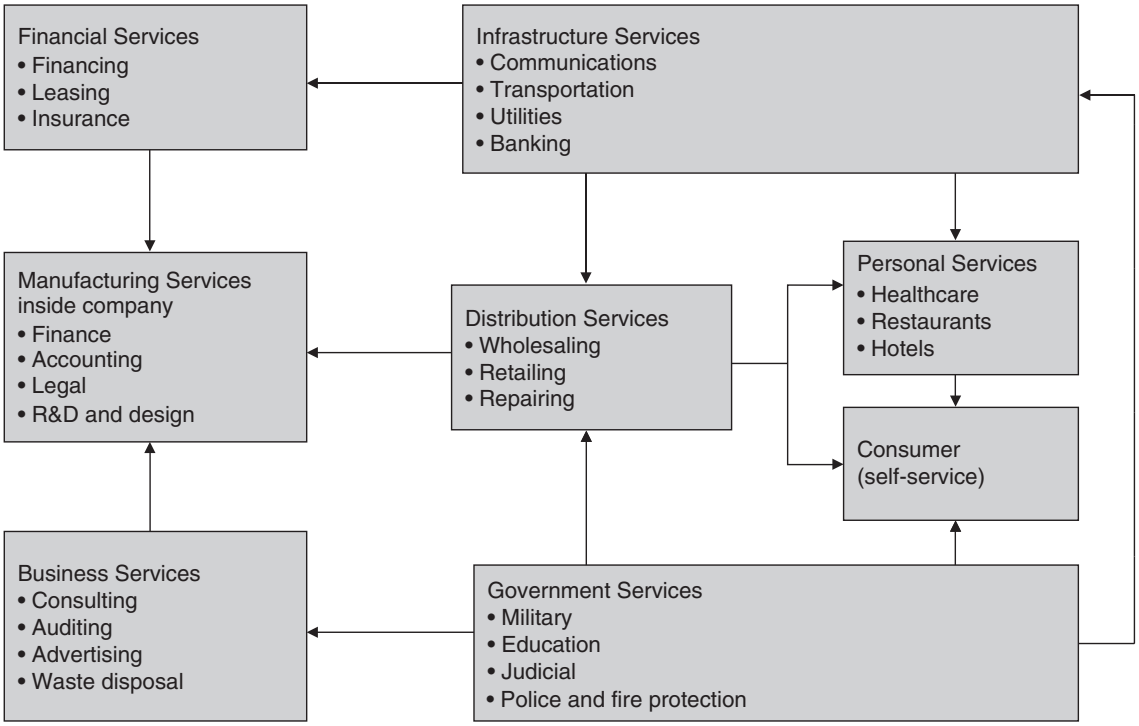


Figure 1.1 Roles of services in an economy. (Adapted from Guile & Guinn, 1988).

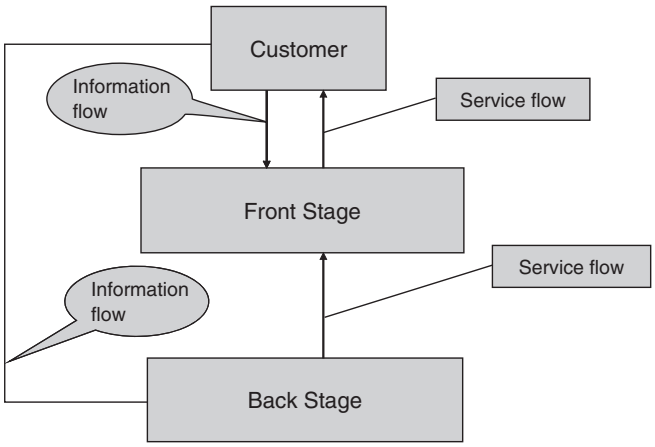


Figure 1.2 Service characteristics.

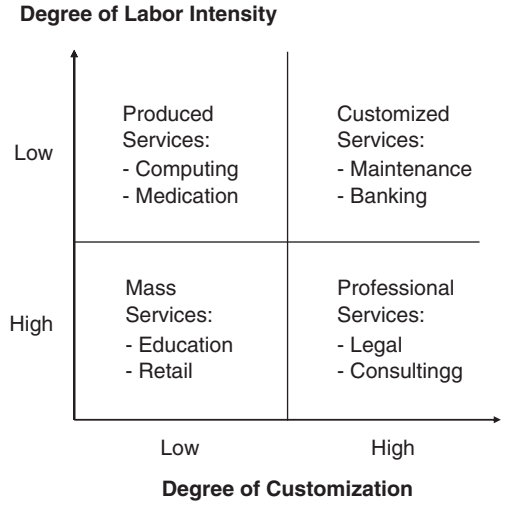


Figure 1.3 Service customization versus labor intensity. (Adapted from Fitzsimmerman et al. 2008)

Table 1.1 Front- and Back-Stage Service Activities

Number	Service Sectors	Front Stage	Back Stage
1	Health care	Working with patients	Setting up and maintaining facilities
2	Education	Delivering lectures	Setting up and maintaining educational facilities
3	Retail	Sales experience	Logistics
4	Professional	Assessment and consultation	Research, data analysis, interpretation, knowledge creation, insights preservation
5	Information	Presenting and delivering	Gathering, sensing, and organizing
6	Communications	Billing	Setting up infrastructure
7	Transportation	Transport experience	Maintaining the fleet
8	Utilities	Delivering, billing, and support	Setting up and maintaining infrastructure

Services may also be classified as high technology and low technology. Flipping hamburgers and sweeping floors are low-tech service activities, whereas conducting an e-market transaction and offering an engineering consultation service are high-tech activities. Technology-intensive services have at least five special features (Tien and Berg 2003):

1. *Information-driven.* The creation, management, and sharing of information is crucial to the design, production, and delivery of services.

2. *Customer-centric.* Customers are generally a co-producer of the services, as in the case of self-service. Customers require a certain degree of service adaptation or customization, and customers must be satisfied with the rendered services.
3. *E (electronics)-oriented.* Services are becoming more e-oriented. Thus, e-access, e-commerce, and e-customer management are crucial to e-services.
4. *Productivity-focused.* Both efficiency and effectiveness are important in the design, delivery, and support of services.
5. *Value-adding.* Services need to add value to the target clients. For profit-seeking service companies, the value so produced assures their profitability. For non-profit service entities, it reinforces the goodness of its policy.

Services differ from products in a major way. On the one hand, services involve intensive interactions with customers in the front-stage activities, with a varying degree in magnitude. On the other hand, products are mostly dominated by back-stage activities, which receive only small amounts of customer inputs. This contrast is illustrated in Fig. 1.4.

Nambisan (2001) also offers an excellent contrast between services and products, as depicted in Table 1.2, as related to (1) intellectual property rights, (2) complementaries to other offerings, (3) returns from economy of scale, (4) abstracting knowledge and integrating technology, and (5) connection with users.

Tidd and Bessant (2009) offer another useful comparison between six basic characteristics of products and services:

1. *Tangibility.* Products are more tangible than services.
2. *Perceptions.* Service quality is perceived based on physical evidence (the physical setting at which the service is offered), responsiveness (speed of service and willingness to help), competence (ability to perform the service dependably), assurance (knowledge and courtesy of staff and ability to convey trust and confidence), and empathy (provision of caring, and individual attention)
3. *Simultaneity.* Products are typically made in advance of consumption, whereas services are consumed mostly at the time of production. Simultaneity brings about potential of quality management problems related to the identification and correction of service errors as well as capacity-planning problems to match supply with demand.

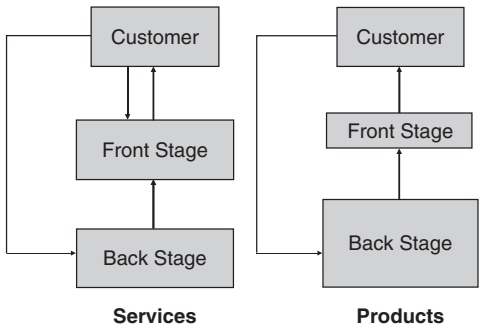


Figure 1.4 Services versus products.

Table 1.2 Services versus Products

Number	Key Issues	Products	Services
1	Intellectual property rights	Very important	Less important
2	Complementarities to other offerings	Very Important	Less Important
3	Returns from economy of scale	A fixed cost structure allows for higher marginal returns from scale.	A variable-cost structure makes increased returns from scale rare
4	Abstracting knowledge and integrating technology	Capture generic product knowledge so that the product can be used in a variety of contexts.	Knowing clients' idiosyncrasies is more important than knowledge abstraction
		Architecture-level technology integration is important for the smooth running of the end product.	Relying on data-interface technology integration; the primary emphasis is on development efficiency.
5	Connection with users	Long-term relationships; users are technologically sophisticated.	Project-driven relationships; users are technologically unsophisticated.

Source: Nambisan 2001

4. *Storage.* Capacity-management problems may arise due to an imbalance between supply and demand. Such problems may be mitigated by pricing (discounts at off-peak time to induce demand), adding temporary workers, and/or outsourcing.
5. *Customer contact.* Services demand high level of customer contact, some more (medical, business consulting) and some less (financial services, information).
6. *Location.* The proximity factor is more important for services than for products, making services more local and less competitive. Only about 10 percent of services in the developed economies are traded internationally.

For services to do well, a company must pay attention to the following:

- Control the variable costs—reusable software assets, knowledge management, process rigor, efficiency.
- Hire the right people for interacting with customers to excel in customization.
- Automate back-office work and outsource low-value activities to achieve speed and quality advantages.

As we have now discussed what services are, let us take a look at the service sectors in the United States.

1.3 SERVICE SECTORS

The U.S. economy consists of three major sectors: agriculture, manufacturing, and services. Over the years, significant changes have occurred in each of these sectors due to technological advancement, market expansion, customer preferences, and globalization.

According to U.S. Bureau of Labor Statistics (Bartsch 2009), the service-providing industry made up about 77.2 percent of total employment in the United States in 2008. This percentage is projected to increase to 78.96 percent by 2018. The total number of jobs is expected to increase by 15.3 million over the ten-year period from 2008 to 2018, and 95.6 percent of this increase will come from the service-providing sectors. The growth of U.S. service sectors is clearly astounding. Figure 1.5 illustrates this remarkable trend.

The service-providing industry in the United States is divided into thirteen sectors:

1. Professional and business services
2. Healthcare and social assistance
3. State and local government

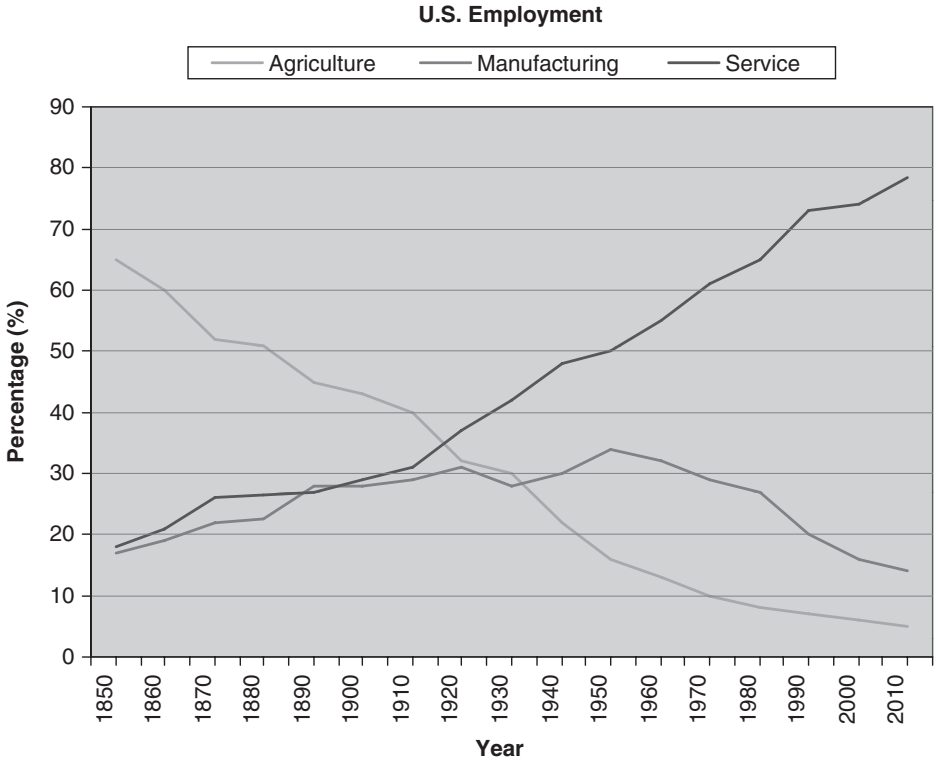


Figure 1.5 U.S. employment trend.

4. Leisure and hospitality
5. Other services
6. Educational services
7. Retail trade
8. Financial activities
9. Transportation and warehousing
10. Wholesale trade
11. Information
12. Federal government
13. Utilities

These are ranked in the order of relative job growth. The total job growth of all service sectors is projected to be 14,601,000. The percentage in Table 1.3 presents the fraction of this total contributed by each service sector. By 2018, a whopping 66.86 percent of all service-providing new jobs will come from the first three sectors alone. Figure 1.6 illustrates the projected percent change in U.S. employment by industry, from 2008 to 2018. This percentage is calculated by the net job change in a given service sector divided by the base job number for that sector in year 2008 (see Bartsch 2009).

It is also interesting to note that the projected total job growth in the United States for the same period is only 15,274,000, only slightly more than the total new jobs projected for service sectors. This chart clearly points out that job losses in other industries, such as manufacturing, agriculture, and mining, are projected to be quite substantial. Projected job growth and decline in occupations are shown in Table 1.A1 (Appendix 1.12.2).

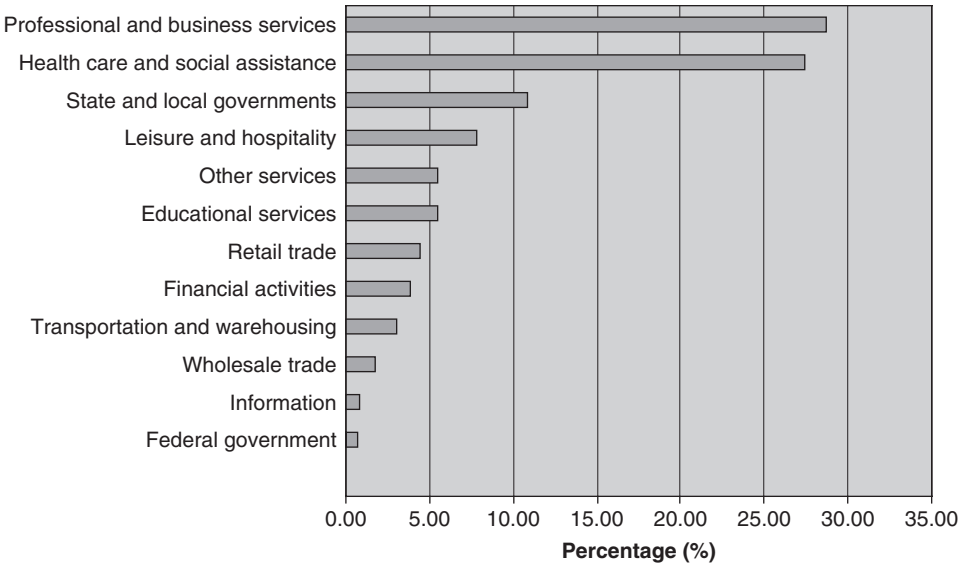


Figure 1.6 Projected percentage change in U.S. employment by sector, 2008–2018 (Bartsch 2009).

Table 1.3 Projected Job Growth by Service Sectors (Units: 1,000 jobs)

	Year 2008	Year 2018	Change	Percentage
Service-providing sectors	116,452	131,053	14,601	100%
Professional and business services	17,778	21,968	4,190	28.70%
Health care and social assistance	15,819	19,816	3,997	27.37%
State and local government	19,735	21,327	1,592	10.90%
Leisure and hospitality	13,459	14,601	1,142	7.82%
Other services	6,333	7,142	809	5.54%
Educational services	3,037	3,842	805	5.51%
Retail trade	15,356	16,010	654	4.48%
Financial activities	8,146	8,703	557	3.81%
Transportation and warehousing	4,505	4,950	445	3.05%
Wholesale trade	5,984	6,220	256	1.75%
Information	2,997	3,115	118	0.81%
Federal government	2,764	2,859	95	0.65%
Utilities	560	500	−60	−0.41%
Total U.S. job growth, all sectors	150,932	166,206	15,274	
Fraction of service jobs in total			95.60%	

Source: BLS, (2009) "Employment Projections 2008–18," (December 10).

Table 1.4 Global Demographics

Continents	% of Population Aged 60 or Older 2002	% of Population Aged 60 or Older 2050	Working Age Persons per Aged 65 or Older Person 2002	Working Age Persons per Aged 65 or Older Person 2050
Europe	20.00%	37.00%	3.90%	1.80%
North America	15.70%	27.10%	5.00%	2.80%
Asia	8.60%	22.90%	11.10%	3.90%
Latin America	7.90%	22.10%	11.00%	3.80%
Africa	5.00%	10.00%	16.80%	8.90%

Source: 2002 Population Data, United Nations

There are numerous reasons why the service sectors in the United States are expected to experience such rapid growth. A principal reason is the market demand of services due to a change in demographics. Table 1.4 indicates that from 2002 to 2050, the percentage of elderly people in all continents will drastically increase, and the ratio of working age persons to older people is expected to decrease accordingly.

Elderly people need services related to healthcare, hospitality, leisure, financial consultation, and investment, among others. Plentiful of these services will become increasingly computerized and automated, thus offering growth opportunities to computer-IT industries, which are mainly responsible for producing hardware platforms and software tools to facilitate the delivery of such services. The U.S. Congress has

initiated programs that foster the digitalization of patient's medical records, so that healthcare services can be delivered faster and more accurately (Kinsbury 2008). The National Science Foundation has initiated a Service Enterprise Engineering program that sponsors research activities involving multidisciplinary engineering collaboration in healthcare.

Beside market demand for services, another major reason for the expected high growth in the service sectors is the continuous improvement of quality of life in all age groups. Companies in the service sectors strive to innovate new ways to make present-day services cheaper, faster, better, and more convenient to users.

Opportunities are also available due to the generally perceived need to invigorate the productivity in the service sectors, which typically lag behind that of the manufacturing sectors. Tools such as Lean Six Sigma, total quality management, automation, value stream mapping, and others that were advanced and perfected in the manufacturing industry are now increasingly being applied to the service industry.

Services are known to have made increasingly larger contributions to the national GDP than products. Apte et al. (2008) pointed out that the economy is also moving from predominantly material economy (noninformation) to an information economy. As a consequence, the economy may be decomposed into four subsectors:

1. Material products
2. Material services
3. Information products
4. Information services

Future service jobs are likely to become increasingly more information and knowledge intensive. Bloomberg (2010) addresses comprehensively the characteristics of work in a service economy.

As the need for highly skilled systems engineers in the service sectors becomes evident, both U.S. government and service sector leaders will need to start encouraging new educational programs at universities to prepare future service systems engineers to enter this emerging growth field.

1.4 SYSTEM-INTEGRATIVE VIEW OF SERVICE ENTERPRISES

Systems thinking is defined in Frank (2006) as the ability to see the whole picture and its relevant aspects (e.g., emergent properties, capabilities, behaviors, and functions), above and beyond its components, parts, and salient details. Engineering systems thinking is enabled by two components:

1. *Thinking skills*—interdisciplinary knowledge (having expertise in one and being knowledgeable in several others), ability to communicate with others in their fields and cognitive characteristics.
2. *Personal traits*—behavioral competence.

The cognitive characteristics involve seeing the big picture, having an understanding of the whole system and its environment, recognizing the interconnections between components, system synergy, analogies and parallelism between systems, and appreciating the system from multiple perspectives, such as economical, managerial, and social. One needs to be able to take a panoramic view to appreciate the forest, lakes, and the snow-capped mountains, rather than seeing only the individual trees.

For example, the United States has constantly reviewed its energy independence policy, as over 50 percent of the oil consumed must be imported from abroad to meet the domestic consumption. In practicing a system's thinking methodology, any emergent energy resource ought to be evaluated from the viewpoints of (1) technological feasibility, (2) economic viability, (3) environmental acceptability, and (4) resource conservational characteristics.

Boardman and Sauser (2008) offer a useful methodology to graphically diagram the interrelationship between the components of complex systems, such as UK Rail Network, Digital TV Business Model, Intel Community, USAF Combat Strategy, and others. Luczak and Gudergan (2010) point out the evolution of service engineering toward the design of integrative services.

Martin (2009) promotes integrative thinking as a key methodology for managers to make critical choices by processing multiple, sometimes conflicting, views affecting a given complex situation. Table 1.5 exhibits a modified four-stage approach of the integrative thinking process, as compared to conventional thinking.

According to Norton (2000) and Mott (2010), the systems approach focuses on evaluating and reacting to the interconnectivity and interactions between functionally related components of a complex enterprise system. This system-integrative approach applies well to today's complex service systems. It is the management framework that meets the current needs. Figure 1.7 illustrates the system-integrative view about a service enterprise, for which the following notations apply:

A. Enterprise offers service for sales to target customers and clients in exchange for payment.
B. Customer's purchases lead to enterprise profitability, which is the key purpose of the enterprise's existence.
C. Profitability is monitored and documented by financial management, which in turn feeds the information to enterprise management.
D. Business management commits resources to support various internal functions.

Table 1.5 Integrative Thinking

Stage	Conventional Thinking	Integrative Thinking	Paradigm
1. Determining salience	Focus only on obviously relevant features.	Seek less but potentially relevant factors.	Preserve as many different perspectives as possible.
2. Analyzing causality	Consider one-way linear relationships between variables in which more of A produces more of B.	Consider multidirectional and nonlinear relationships among variables.	Key is to discover correlations between many variables.
3. Envisioning the decision architecture	Break problems into pieces and work on them separately or sequentially.	See problems as a whole, examining how the parts fit together and how decisions affect one another.	Take a systems view.
4. Achieving resolution	Make either-or choices, settle for best available options.	Creatively resolve tensions among opposing ideas, generating innovative outcomes.	Combine features to define something new.

Adopted and modified from Martin (2009)

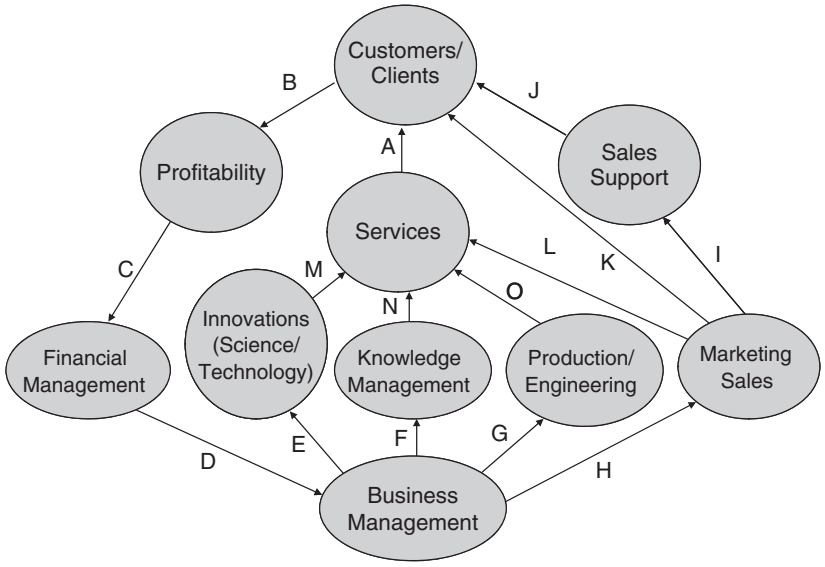


Figure 1.7 Systems view about a service enterprise.

E. Business management supports innovation. Here science and technology play an important role in advancing and delivering new services.
F. Business management supports knowledge management, which represents the key to creating competitive advantages in the marketplace by creating, updating and applying corporate knowledge, both the explicit and tacit kind.
G. Business management supports the production and engineering functions, including cost and quality control.
H. Business management supports the important marketing/sales functions.
I. The marketing/sales supports the sales support, which is critical to achieving customer satisfaction.
J. Sales support interacts with customers, and its activity must be managed carefully.
K. Marketing and sales generate service awareness in the marketplace, solicit feedback from customers, and interact with them to customize the service offering.
L. Marketing/sales suggest new services to be offered to improve competitiveness and profitability.
M. Innovations represent a key contributor to foster enterprise's competitiveness and service differentiation in the marketplace.
N. Knowledge management utilizes the firm's core competency in providing the competitive services to customers with superior knowledge contents.

O. Production/engineering takes care of the generation of services offered, and the control of their cost, quality, and reliability.

Taking the system-integrative view from a service enterprise, we can see various external components that exert significant impact. See Fig. 1.8, for which a different set of notations apply:

A. Governmental regulations have impact on the service sector involved, affecting opportunities and threats present in the marketplace.
B. Global competitions could present threats to the service acceptance in the marketplace.
C. Economic conditions (money supply, employment situation, consumer confidence, investment climate, etc.) have a direct impact on profitability.
D. Change in consumer preferences must be carefully monitored.
E. Global market of talents is critical to the supply of right knowledge workers.
F. Suppliers of capital (e.g., investors, bankers and funds).
G. Technology suppliers (e.g., IT, Web services, open innovations, etc.) have a profound impact on the service business.
H. Globalization (scale and scope) will influence all service sectors.

Viewed as systems, service enterprises may be considered as consisting of ten interacting components, requiring a systems thinking methodology to address its problems and opportunities (Fig. 1.7). This system-integrative approach must be actively

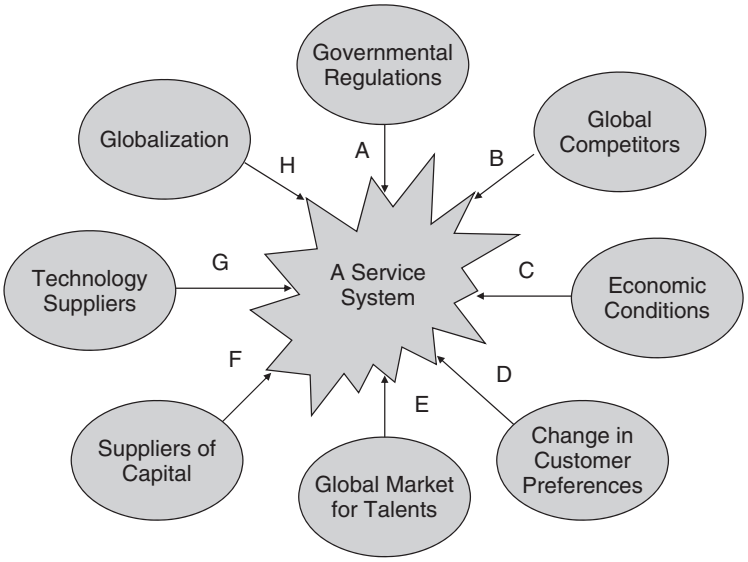


Figure 1.8 Systems view from a service enterprise.

nurtured by service systems engineers and leaders in order for them to maximize their contributions to their employers. Furthermore, they should recognize the following four system characteristics of a service enterprise:

1. A variety of different disciplines contribute to the overall success of the system. Service workers must be able to do their best to communicate and collaborate with others.
2. All functions will need to interact closely with one another and be properly coordinated via engineering management functions such as planning, organizing, leading, and controlling. The use of existing engineering tools such as Lean Six Sigma, value stream mapping, failure mode and effect analysis, and others will be essential for the service enterprise to achieve operational excellence.

   Productivity can also be improved by reorganizing the enterprise's operations and then employing service-oriented architecture (SOA)–based software modules to perform its noncore activities (Merrifield et al. 2008). SOA software modules are designed by following standard specifications so that countless different users can access them via the Internet to accomplish specific predefined outcome. Cost is reduced and productivity is improved by outsourcing these noncore activities to Web-based service vendors. Gartner, an IT research and consulting firm, predicts that by 2010, more than 80 percent of major companies with mission-critical activities will be implementing the SOA-based systems, compared to 50 percent in 2007.
3. Innovation remains the key driving force for a service enterprise to capture new opportunities (e.g., consumer preference, new technologies, special skills, and talents) in the marketplace, to overcome threats imposed from the outside, and to cultivate strategic differentiation and sustain long-term profitability. Innovation requires the active participation of all people in the organization.
4. The success of a service enterprise will need to be built on both strategic differentiation and operational excellence.

1.5 SERVICE SYSTEMS ENGINEERING

Service systems engineering is defined as a multidisciplinary engineering field that addresses a service system from the management, life-cycle, customer, and value-creation perspectives (Tien and Berg 2003). It is a relatively new field that employs scientific and engineering principles to add value to the clients of the service sectors companies. Table 1.6 summarizes the basic definitions and concepts related to service systems engineering.

The basic disciplines in support of service systems engineering were outlined in Tien and Berg (2003), which I have modified as displayed in Table 1.7. It is interesting to note that the disciplines of industrial engineering, operations research, and business management contribute by far the most useful tools for service systems engineering.

Table 1.6 Service Systems Engineering

#	Concepts	Definitions	Attributes
1	Service System	An assemblage of components having interactions with or interdependence interactions with or interdependence of each other	Types: physical or conceptual; open or closed; static or dynamic; business or social; elements components, attributes, relationships; level of abstraction: high (with more component) or low (with less components)
2	Engineering	Disciplines that apply scientific principles to specific projects or tasks to add value or to create knowledge.	Work of engineering involves definition synthesis, analysis, design, test and, evaluation.
3	Management	Plan, organize, lead and control	Feedback (evaluate performance against standards); control (communications, self-regulating, adaptation, optimization and/or management)
4	Life cycle	Elapse time progressing from the initial to final stages of a system's useful life.	Process involves needs assessment, design/development, production/ construction, utilization/support and phase-out/disposal
5	Customer	Recipient of the value package	Understand needs/requirements, manage expectations and assure satisfaction.
6	Value	Outcome of significance resulted from having spent the efforts	Profitability, market share, firm's reputation and industrial standing, better design, innovative products/ services, new knowledge, improved understanding of issues at hand, quality of life to constituents, well being of citizens

Adopted and Modified from [Tien and Berg (2003)]

Table 1.7 Selected Disciplines Regarded as Keys to Service Systems Engineering

Disciplines	Specific Methodologies and Technologies
Industrial engineering	Quality management, cost analysis, risk analysis simulation, human factors, cognitive ergonomics scheduling, manufacturing systems, lean Six Sigma project management, facility operations
Operations research	Optimization, linear programming, logistics Game theory
Mathematics	Probability, modeling
Statistics	Data mining, visualization
Computer science	Software programming, artificial intelligence data mining, service-oriented architecture
Bioengineering	Bioinformatics, informatics
Business management	Strategic planning, operational planning, supervision, financial analysis, marketing management, supply chain management

Source: Adopted from Tien and Berg (2003) with modifications.

Example 1.1 Several articles in the business literature proclaim the potentially large contributions that data mining could make to the service sectors. Present an example in which the application of data mining actually made a difference to a service company.

ANSWER 1.1 Data mining is an advanced numerical modeling technique that could be used to extract valuable insights from databases that record the transactional activities and consumption patterns of customers. A well-known example is the way Harrah's Entertainment applied data mining to improve its profitability (Loveman 2003).

Harrah's Entertainment operates twenty-six casinos in thirteen states. In 2003, it posted $4 billion total revenue. Its current CEO was a former Harvard Business School professor, who spearheaded a database-driven marketing and service-delivery strategies that drastically improved Harrah's financial performance.

For example, the company identified that 26 percent of its gamblers generated 82 percent of its revenue, the Pareto principle. These core customers are typically former teachers, doctors, bankers, and machinists, not the limousine-riding higher rollers. These are middle-aged and senior adults who have a discretional amount of time and income. They prefer free casino chips rather than rooms or dinners. Many of them visit a casino on the way home from work or on a weekend night out. The company also found that happy customers spend 24 percent more annually, whereas disappointed customers spend 10 percent less.

Such information allows the company to fine-tune its knowledge of customer segments using advanced numerical modeling techniques. By designing its marketing program to focus on these elements of customer service, the company secured customer loyalty and superior profitability.

1. Since the core customers are slot machine players, the company redesigned the floor plan to make it easier for customers to find the preferred slot machine designs (e.g., machines with proclaimed odds, the look of machines, etc.) as well as to benefit the company.
2. To encourage customer loyalty, the company introduces the "Total Rewards" card that allows customers to accumulate playing and other credits from any of the company's casinos. These credits form the bases of incentive rewards for the customers. The card system provides a very useful source of proprietary customer data for the company.
3. Train all staff to focus on speed and friendliness (smiling and addressing the customer by name). A detailed customer satisfaction survey is conducted. Bonuses are assigned to those sites that improved their customer satisfaction score by 3 percent or more per year.

   This group-based reward system promotes a self-managed correction at each site, as the weaker departments will be inspired by others to improve quickly in order to avoid dragging down the overall performance of the entire site. The key reason that such a bonus program worked well is because the reward depends on everyone's performance.
4. As speed of service (check in at reception, dining rooms, car parking, etc.) is critical to most customers, the company divides customers into three tiers: gold, platinum, and diamond, in the order of increasing level of service. Three service lines are offered so that customers can observe the perks others

are getting, thus becoming highly motivated to want to move to higher-tier groups. These tiers are typically defined based on the projected "lifetime worth" of the customers to the company.

5. Because customers spend more when they stay in casino hotels, the company offers free rooms to high-value gamblers.

Information technology and telecommunications technologies have aided the service sectors in its growth, access, speed and reduction of costs. These technologies enable real-time decision making from a system engineering approach. The productivity of the service sectors has increased significantly in recent years. High technology services are usually enabled by advanced information/communications technologies. Examples of such technologies are listed in Table 1.8. The enabling technologies therein are described below.

Collaborative software provides Web tools for employees and business partners to work together to make services better, faster, and cheaper. Business intelligence software extracts information from data for optimizing revenue-generating strategies, enhancing cost efficiency, and/or improving customer relations. Synchronization software enables the edits made to one copy to automatically propagate to all copies in the database. Autonomic computing performs self-monitoring and allocates storage resources dependent on demands imposed by data and information. Peer-to-peer networking permits serverless file sharing to promote collaboration. Distributed computing performs decentralized computing by aggregating the unused power of individual computers connected through a network. Extensible markup language (XML) is a metalanguage, which separates the structure and semantics of data from its presentation.

Table 1.8 Examples of Communication and Information Technologies Useful to Services

#	Service Characteristics	Enabling Technologies
1	**Information-driven**	
	Creation	Collaborative software, business intelligence software
	Management	Synchronization software, autonomic computing
	Sharing	Peer-to-peer networking, distributed computing, extensible markup language
2	**Customer-centric**	
	Co-production	Intranet, extranet, Internet
	Customization	Software agents, synchronization software, peer-to-peer networking
	Satisfaction	Software agents
3	**E-Oriented**	
	E-access	Wireless, Internet-on-a-chip
	E-commerce	E-procurement, e-fulfillment, e-supply chain, e-outsourcing, e-auction
	E-customer management	Customer relationship management software
4	**Productivity-Focused**	
	Efficiency and effectiveness	Enterprise resources planning software
5	**Value-adding**	
	Profitability	Financial ratio analysis software, Economic value added analysis

Adapted and modified from Tien and Berg (2003).

Intranet, extranet, and Internet are typical communications channels reserved for internal employees, external interchanges with business partners, and external interactions with customers. Software agents are smart software programs that are capable of processing a vast amount of factors linked by probabilities, causes, and effects in order to define decisions that would lead to customer-preferred outcomes.

Wireless enables high-bandwidth Internet access by cellular phones, laptops, and personal data assistants to create real-time connectivity from anywhere and at any time. Internet-on-a-chip contains protocols necessary for Internet connectivity, allowing the interactions between many sensing devices to facilitate maintenance and monitoring services. E-procurement, e-fulfillment, e-supply chain, e-outsourcing, and e-auction are all software technologies that make the respective processes fast and cost-effective. Customer relations management software helps to track customer activities, provide better customer services, and customize the enterprise's marketing campaigns.

Enterprise Resources Planning (ERP) software links the performance data of all departments of an enterprise and creates high quality reports to allow for fast decision making. Financial Ratio analysis compares the financial performance indices of an enterprise against those in industry in order to allow an external benchmarking. Economic Value Added analysis defines the real value added due to the operation of an enterprise by subtracting the cost of doing business from the net profit reported in its Income Statement. Such analysis is known to focus management attention to company activities which are important from both the short term and long term perspectives.

Example 1.2 Customer focus is something every service company is energetically talking about. However, it is easier said than done. How can customer focus be realized?

ANSWER 1.2 Based on a study of Royal Canadian Bank, Harrah's Entertainment, and Continental Airlines, Gulati and Oldroyd (2005) suggest that pursuing a customer-focus strategy is a journey that requires three preparatory steps:

1. Build a comprehensive database about the customers.
2. Analyze and interpret the data to gain insight into customer from past behavior.
3. Anticipate what customers would need in the future.

Information generated about customers is then made available to all customer-facing employees. The company induces a major shift in employee attitude to keep customer initiatives at the forefront by training their employees to acquire and practice customer-oriented skill sets. The company institutionalizes the customer-focus program by constantly monitoring and reviewing its companywide implementation. An employee reward system is set up to recognize those who deliver outstanding customer service.

1.6 SKILL SETS FOR SERVICE SYSTEMS PROFESSIONALS

Different services require skills at different quality levels, as shown in Table 1.9. New and innovative services are typically realized by people at service quality level ten.

Table 1.9 Skill Quality Levels

Level	Description
1	Able to follow role script in method when all resources are made available and there are no exceptions and supervisory function is active to validate each step before execution to avoid errors.
2	Able to follow role script in method when all resources are made available and there are no exceptions to be processed, with minimal supervision and corrections from project manager and other levels/roles using method.
3/4/5	Able to follow roles script in method when all resources are made available and there are few/several/many exceptions (nonstandard requirements)
6	Able to follow role script in method when not all resources are made available and there are many exceptions (nonstandard requirements)
7	Able to follow role script in method and improvise as required
8	Able to do all roles in method
9	Able to do all roles in all methods
10	Able to improvise and innovate new offerings

Companies in the service sector need to pursue strategic differentiation in the services they offer in order to sustain and extend market competitiveness and achieve long-term profitability. Market competitiveness must be built on service innovations such that the service packages offered to customers are constantly renewed and uniquely differentiable from the competition. Marketing management, financial analysis, and cost accounting are important tools to employ, when choices need to be made to achieve long-term strategic advantages.

Operational excellence is also important, as the service-providing employers need to minimize waste, streamline operations, and enhance productivity in order to maximize profitability. Engineering management principles related to planning, organizing, leading, and controlling will be needed to guide these operations. Quite a number of tools perfected in industrial engineering can be readily applied to pursue short-term results.

The importance of "Adoptive Innovators" for the service industry is advocated in Anomalous (2007). These *T-shape professionals* have the breath of cross-disciplinary knowledge and capabilities to interact with others in building and managing teams, programs and projects, corresponding to the horizontal bar of the T, while possessing in-depth knowledge and capabilities in specific technical domains, corresponding to the vertical bar of the T; see Fig. 1.9. Specifically, T-shape professionals have a service mindset and are versed in a large number of service disciplines.

1.6.1 Service Mindset

A service mindset consists of practicing a customer-focus paradigm in the creation, delivery, and servicing of value packages to meet customer's important needs, with a keen understanding that achieving customer satisfaction is the driving force for long-term corporate profitability. Adoptive innovators must adopt and practice this service mindset.

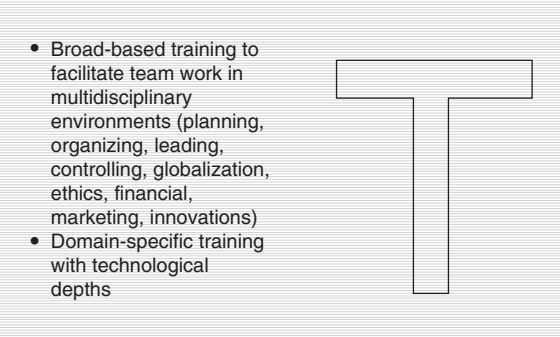


Figure 1.9 T Personality.

1.6.2 Service Disciplines

Anonymous (2007) outlines fourteen service disciplines that T-shape professionals need to master. I added a few more and put together a set of seven composite service disciplines, which are mutually exclusive and collectively exhaustive:

1. *Service vision and leadership.* Create vision, set directions, and make decisions that determine value in relation to new service offerings, business models, supply chains partnerships, market segments, and emerging technologies.
2. *Service creativity and innovation.* Invent new service offerings, experience, value proposition, or systems and pursue innovation programs to achieve market success.
3. *Service productivity and value creation.* Utilize management tools to monitor business activities (e.g., regulatory compliance, innovation, and financial data), create value through customer interactions, effectively utilize human resources, manage service knowledge portfolios, assess financial viabilities of new service offerings, improve all processes, control quality, and appraise performance.

   Management tools may include IT/computer-related tools (e.g., data mining, Monte Carlo simulation, analytical modeling, ERP, etc.) that support decision making, customer interactions, and service distribution and logistics, as well as industrial engineering tools (e.g., Lean Six Sigma, TQM, value stream mapping, FEMEA, 5 S, and Kanban).
4. *Service design and development.* Engage emerging technologies (e.g., Web-based collaboration and design tools) to invent new service systems as well as to improve existing ones.
5. *Service customer focus.* Apply marketing tools to understand customers' needs, foster customer collaborations, and create customer expectations.
6. *Service ethics and professionalisms.* Set high standards and implement corporate codes of conduct.
7. *Service globalization.* Assure methods of supply through tiered partnerships and exploit global networks of resources to capture new opportunities.

Not all of these service disciplines are equally important to the service enterprises. Table 1.10 points out that the majority of these composite service disciplines contribute

Table 1.10 Services Disciplines and Their Relative Roles in Companies

#	Composite Service Discipline	Strategic Differentiation	Operational Excellence
1	Vision and leadership	x	
2	Creativity and innovations	x	
3	Productivity and value creation		x
4	Design and development	x	
5	Customer focus	x	
6	Ethics and professionalism		x
7	Globalization	x	

directly to the creation of strategic differentiation (thus, sustainable competitive advantages of the service enterprises), while the remainder are useful to foster operational excellence.

These seven composite service disciplines are designed to impart broad-based knowledge and perspectives to graduates corresponding to the horizontal part of the T, whereas their in-depth technological training in selected specialty fields corresponding to the vertical part of the T.

For service systems engineers to be successful, they need to diligently acquire and practice skills and capabilities that would enable them to add value to the service industry. A group of twenty-four skills were recommended in Sorby et al. (2006) to be pertinent to B.S. service systems engineers. These twenty-four skills can be regrouped into six categories:

1. *Management of service systems.* These skills include scheduling, budgeting and management of information systems, leadership.
2. *Operations of service systems.* Engineers should be proficient in process evaluation and improvement, quality improvement, customer relationships, uncertainty management.
3. *Service processes.* These skills include performance measurement, flowcharting, work task breakdown.
4. *Business management.* Business skills include project costing, business planning, change management.
5. *Analytical skills.* These skills include problem solving, economic decision analysis, risk analysis, cost estimating, probability and statistics.
6. *Interpersonal skills.* Increasingly, service systems engineers are expected to excel in professional responsibility, verbal skills, technical writing, facilitating, and team building).

In a 2009 report, Carnegie Foundation for the Advancement of Teaching emphasized critical thinking, problem solving and teamwork, and a multidisciplinary approach. Choudaha (2008) suggested a number of required skills and attitudes for master's degree graduates, based on an online Delphi study. This list includes integration, collaboration, adaptability, critical thinking, interpersonal competence, problem solving, system conceptualization, and diversity orientation.

For service systems engineers at the master's degree level, I have added the following six categories of skills and capabilities to be covered in two 3-credit courses at the graduate level:

7. *Knowledge management.* Service systems engineers should be familiar with definitions, strategies, success factors, hurdles, and best practices in industry.
8. *Creativity and innovations in services.* These skills include creative thinking methods, success factors, value chain, best practices, and future of innovations.
9. *Financial and cost analysis and management.* Additional business skills include activity-based costing, cost estimation under uncertainty, T-account, financial statements, ratio analysis, balanced scorecards, and capital formation.
10. *Marketing management.* Market forecast, market segmentation, marketing mix—service, price, communication, and distribution—are important marketing tools.
11. *Ethics and integrity.* Service systems engineers must be held to high ethical standards. These include practicing ethics in workplace and clear knowledge of guidelines for making tough ethical decisions, corporate ethics programs, affirmation action, and workforce diversity, as well as global issues related to ethics.
12. *Global orientation.* Increasingly, engineers must be aware of emerging business trends and challenges with regard to globalization drivers, global opportunities, and global leadership qualities.

These twelve categories of skills and capabilities constitute the SSME-12 skills, which, in turn, are closely linked to the seven composite service disciplines. Service systems engineers are advised to focus their education on acquiring and practicing these SSME-12 skills, as a part of their basic education for the horizontal part of the T personality, so that they are in a position to contribute effectively to these seven composite service disciplines.

Example 1.3 Assume that you are a highly paid consultant to an ambitious university administrator who is starting a new master's degree program in service systems engineering. In three years' time, the administrator wants to make the degree program a great success in the eyes of students, industry professionals, and the university, Explain your planning advice to this administrator and what specifics you would like to see included in his plan.

ANSWER 1.3 For the degree program to be successful from the viewpoints of students, the university and industry professionals, the interests of all three groups of stakeholders must be sufficiently satisfied.

Students want courses that are reasonably tough and demanding, that challenge their thinking abilities, and that allow them to gain new perspectives and skills. They want to be exposed to ways they can continue to accumulate knowledge, receive good grades, have time to enjoy university life, network with a large number of new friends, and secure good jobs after graduation.

Universities like to see an expanding enrollment size, new research opportunities that could bring in grant money and scholarly recognition, novel courses that would set them apart from other schools, and collaborations with industry in the forms of internship, joint development, and industrial advisement.

Employers welcome flexible degree programs, which allow customization to their specific needs, high quality of service workers who can contribute without the need of excessive retraining, and opportunities of joint development program with universities to address their specific problems and needs.

The administrator should conduct a comprehensive survey to ascertain these interests, and then define specific action steps to address each of them. Together, the action plan comprising of all these action steps will move the program toward success in the interest of all three groups of stakeholders.

1.7 ROLES OF TECHNOLOGISTS VERSUS MANAGERS/LEADERS

Any services enterprises will need both technologists and managers/leaders, although their roles are different. As a technical contributor, the service engineer focuses primarily on the operational aspects of the work—what it takes to get a technical assignment accomplished and how the assignment can be done in the most efficient and speedy manners. The service engineer in a managerial position will focus on the strategic aspects of the work, such as what work should be done, why it should be done, who should be assigned to do the work, what resources should be used to do the work, and in what order of priority. Specifically, service managers get involved in the following steps:

- Setting goals for the group, department, or enterprise.
- Establishing priorities.
- Defining policies and procedures.
- Planning and implementing projects and programs to add value.
- Assigning responsibilities and delegating the commensurate authorities to others while maintaining control.
- Attaining useful results by working through people.
- Processing new information and handling multidisciplinary issues.
- Making tough decisions under uncertain conditions.
- Finding the proper solution quickly among several feasible alternatives.
- Doing things right the first time, with a sense of urgency.
- Coaching, teaching, and mentoring others.
- Dealing with people—handling conflicts, motivation, and performance correction.

Table 1.11, which is adopted and revised from Aucoin (2002), illustrates the fundamental differences between the work done by engineers and that performed by managers.

Table 1.11 Work Done by Service Engineers and Managers

Characteristics	Service Engineers	Managers
Focus	Technical/scientific tasks	People (talents, innovation, relationships); resources (capital, knowledge, process know-how); projects (tasks, procedure, policy)
Decision-making basis	Adequate technical information with great certainty	Fuzzy information under uncertainty (people's behavior, customer needs, market forecasts)
Involvement	Perform individual assignments	Direct work of others (planning, leading, organizing, controlling)
Work output	Quantitative, measurable	Qualitative, less measurable, except financial results when applicable
Effectiveness	Rely on technical expertise and personal dedication	Rely on interpersonal skills to get work done through people (motivation, delegation)
Dependency	Autonomous	Interdependent with others
Responsibility	Pursue one job at a time	Pursue multiple objectives concurrently
Creativity	Technology centered	People centered (conflict resolution, problem solving, political alliance, networks building)
Bottom line	"How" (operational)	"What" and "why" (strategic)
Concern	Will it work technically?	Will it add value (market share, financial, core technology, customer satisfaction)?

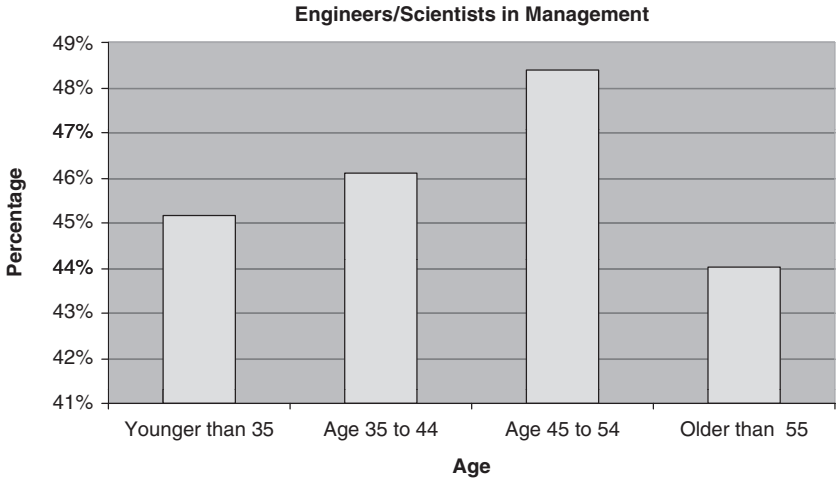
Adapted and revised from Aucoin, B. M. "From Engineer to Manager: Mastering the Transition." Artech House Publishers (2002).

In a 2002 report, the National Science Foundation described the employment situation of U.S. engineers and scientists. Out of a total of 2,343 engineers and scientists, 46.1 percent held management and administrative positions. Figure 1.10 suggests that this percentage varies only slightly with age. About every one of two engineers or scientists has taken on managerial or administrative responsibilities.

Service engineers who aspire to become managers are advised to fully understand these differences and the requirements associated with the management work. An individual should assess the compatibility of these implied requirements with his or her own personality, aptitude, value system, personal goals, preparations, and other factors, so that he or she is convinced that taking on managerial responsibilities will indeed lead to long-term happiness.

According to a survey reported by Badawy (1995), service engineers move into management because of one or more of the following reasons:

- Gaining financial rewards
- Exercising authority, responsibility, and leadership
- Acquiring power, influence, status, and prestige
- Receiving career advancement, achievement, and recognition
- Combating fear of technological obsolescence
- Responding to a random circumstance—an opportunity that is suddenly available



Source: National Science Foundation, Women, Minority and Persons with Disabilities in Science and Engineering: 2000 (NSF 00-327)

Figure 1.10 Engineers/scientists in management.

It is important that individual services engineers become aware of the advantages and disadvantages of being either technologists or managers/leaders, so that they make the best choices for themselves. Those who are not so sure of which way to go could consult resources such as those contained in Appendices 1.12.3 to 1.12.6.

1.8 PREPARATION OF SERVICE SYSTEMS ENGINEERS/LEADERS

1.8.1 Customer Focus

One way to determine how service systems engineers/leaders should prepare themselves is to first understand what a service enterprise aims to accomplish. Frei (2008) offers an excellent perspective in this respect and points out four things a service enterprise must get right:

1. *Understand what the customers are particularly looking for (convenience, friendliness, flexible choices, price, and others) and what the enterprise is willing to deliver.* It requires a strategic decision to optimize the benefit to cost ratio.
2. *Define ways to pay for the added work that is required to improve customer satisfaction.* For example, raise price, not change price but collect feedback for future use, and introduce more self-help capabilities for customer.
3. *Manage employees.* Recruit, select, train, monitor, and job redesign to deliver the needed service excellence.
4. *Manage customer behavior.* Design the service to foster this preferred behavior.

It is evident from this list that service systems engineers/leaders must learn to be customer focused. However, being customer focused is necessary but not sufficient for service systems engineers/leaders to be effectual in a service enterprise. There exist areas beyond customer focus that require training in order for systems engineers/leaders to be fully prepared for the market.

1.8.2 Three-Decker Leadership-Building Architecture

Future service systems engineers/leaders need acquire the useful T personality by having a broad set of skills for managing relationships, communicating and collaborating with others in multiple disciplines, and envisioning the future to define what are the best courses of action (the horizontal part of the T). As well, these engineers need to acquire a set of in-depth technological skills to enable them to properly implement these actions. They should strive to master the SSME-12 skills set at the proper skill quality levels, acquire a systems view of service enterprises, communicate with workers in multiple disciplines, practice the engineering management functions (planning, organization, leading, and controlling) to teams, projects, and programs, while making use of their understanding of the business fundamentals, and exert leadership in contributing to achieving strategic differentiation and operational excellent of their employers. For this purpose, this text is organized into three parts:

I: The Functions of Engineering Management (Planning, Organizing Leading, and Controlling).

II: Business Fundamentals for Service Systems Engineers and Leaders (Cost Accounting and Analysis, Financial Accounting and Analysis, Marketing Management).

III: SSME Leadership in the New Millennium (Systems Engineers as Managers and Leaders, Ethics, Knowledge Management, Innovations in Services, Operational Excellence, Globalization and Appendix, which contains thirty-plus business cases addressing SSME issues of relevance).

Figure 1.11 illustrates our "Three-Decker Leadership-Building Architecture," which is the design basis of this text.

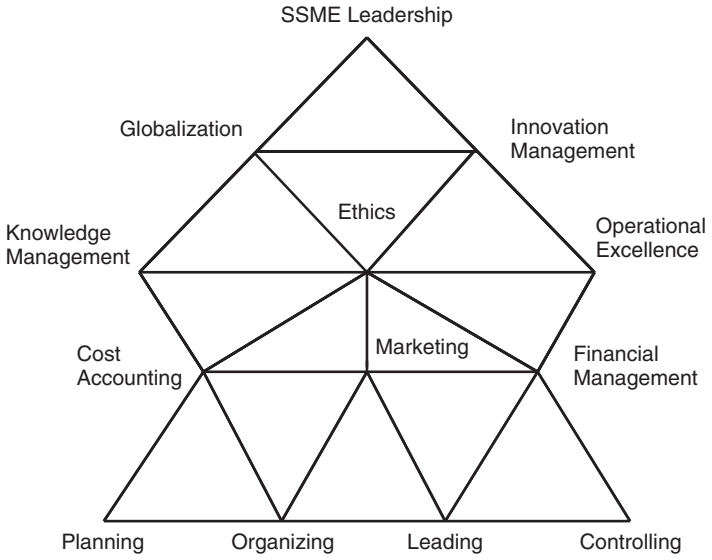


Figure 1.11 Three-decker leadership-building architecture.

1.9 CHALLENGES IN THE NEW MILLENNIUM

Globalization will continue to intensify the cross-border transfer of investment capital, technologies, talents, and other resources, as service companies seek newer markets, link with foreign business partners, and capture location-specific opportunities. Service systems engineers/leaders need to prepare themselves for this future by being capable of eight functions:

1. Thinking globally, acting locally.
2. Recognizing new local opportunities and mobilizing the required corporate and other resources to capture them effectively.
3. Engaging in open innovation to foster the creation of strategic differentiation.
4. Creating business partnerships and alliances on a global scale.
5. Managing global teams of members with diverse backgrounds (e.g., culture, business practices, language, and value) to pursue organizational objectives.
6. Resolving conflicts of planning, organizational, and personal types.
7. Implementing local and emerging technologies to add value.
8. Investing to master location-specific business factors (culture, language, business methodologies, governmental regulations, personal network, etc.).

The challenges faced by service systems engineers/leaders are indeed multidimensional.

Chapter 14, titled: "Globalization," contains a six-dimensional model of these new challenges; these six dimensions include inside, outside, present, future, local, and global.

1.10 CONCLUSIONS

Services are activities that involve intensive interactions with clients or customers in front-stage operations. Service enterprises are best reviewed and studied as systems, as they contain components that interact with one another and react as units to external threats and opportunities. A systems engineering approach is particularly suitable for studying, making decisions, and taking actions involving issues in services. A variety of established techniques in industrial engineering, management science, and other disciplines may be beneficially applied to improve both the competitiveness and productivity of services.

Because of the perceived high demand for services in the future, some of the service sectors in the United States are projected to grow steadily in the next ten to twenty years. These sectors offer the best job opportunities for those who exhibit the service-dominant and customer-oriented mindset, acquire and practice the right skills (e.g., SSME-12 skills) to add value, and display the T-personality to contribute to both the strategic differentiation and operation excellence of service enterprises.

This text provides three parts (engineering management functions, business fundamentals, and service leadership) designed to provide a broad foundation for preparing future service systems engineers/leaders to meet the challenges in the new millennium. The challenges have six dimensions of inside, outside, present, future, local and global.

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1.12 APPENDICES

1.12.1 Definitions of General Service Terms

These are selected definitions commonly used in service systems engineering. They are adopted from Anomalous (2007).

- **Service**—Value co-creation by interactions between knowledgeable providers and their customers with unsatisfied needs.
- **Service system**—A configuration of resources (people, technology, organization, shared information) that co-creates value.
- **Service mindset**—A focus on the innovating interactions between customers and service providers to co-create value.
- **Adoptive innovators**—Capable of integrated systems thinking, broad-based communications in cross-disciplinary domains, while being deeply involved in some technology/engineering areas, the T-professionals.
- **Back-stage service activities**—Activities that do not involve direct interaction with the customer (e.g., information processing).
- **Customer service system**—A system that provides value propositions and searches for win-win co-creation opportunities.
- **Service-dominant logic**—This logic advocates that service involves co-creation interactions during the process of creating, proposing, and realizing value propositions.
- **Front-stage service activities**—Activities that involve direct interaction with customers.
- **Service computing**—The use of information technology (IT) to support customer-provider interactions.
- **Service design**—The application of design methods and tools towards the creation of new service systems and service activities with special emphasis on quality, satisfaction and experience.
- **Service economics**—The definition and measurement of service activities in an economy. Typical measures include productivity, quality, regulatory compliance and innovation.

- **Service engineering**—The application of technologies, methodologies and tools toward the advancement of new service offerings and the improvement of service systems.
- **Service experience and service outcome—**The customer's perceptions of the process and results of a service interaction or relationship. Customer's perceptions are based in large part on customer's expectations, which may change over time, causing some experience to be viewed as deteriorating when an objective measurement of results demonstrates otherwise.
- **Service innovation**—A combination of specific innovations in technology, business model, social-organization, and demand with the objective to improve existing service systems (incremental innovation), generate new value propositions (offerings) or build new service systems (radical innovations). Service innovations may also result from novel combinations of existing service elements.
- **Service mindset**—An orientation geared toward the innovation of customer-provider interactions, combined with interactive skills to enable teamwork across technical disciplines and business functions.
- **Value proposition**—A specific package of benefits and solutions that a service system intends to offer and deliver to others.

For additional definitions, reader should refer to Anomalous (2007).

1.12.2 Projected Growth and Decline of Occupations in the United States (2008–2018)

Bartsch (2009) provides a detailed projection of jobs in various occupations for the year 2018, whereas the actual job numbers for the year 2008 are used. The "Change Percentage" denotes the projected job change in percentage over the ten-year period of time from 2008 to 2018 in each occupation is calculated by dividing the "Total Change" by the base number of 2008 jobs. As illustrated in Table 1.A1, some occupations are projected to grow very rapidly in the United States, whereas others are forecast to decline drastically.

1.12.3 Are You Management Material?

Would you like to know more about yourself? Take an "Emotional Quotient Test" offered by Portfolio.com, at www.portfolio.com/infographics/2007/05/eq-quiz.

1.12.4 Ten Factors for Survival and Success in Corporate America

To be successful in corporate America, one needs to pay attention to the following common-sense success factors:

1. *Excellent performance.* Make sure that all assignments are performed well, as "You are only as good as your last performance." Pay attention to ensure that both the performance and its impact are properly recorded and made known to people in the organization who affect your career growth. Self-promote as needed.

Table 1.A1 Growing Occupations—Projected Employment from 2008 to 2018 (in thousand)

Occupational group	Employment 2008	Employment 2018	Change Number	Change Percent
Total, all occupations	150,932	166,206	15,274	10.1
Total Service-related Occupations	116,452	131,053	14,601	12.5
Management, business, and financial occupations	15,747	17,411	1,664	10.6
Professional and related occupations	31,054	36,280	5,227	16.8
Service occupations	29,576	33,645	4,069	13.8
Sales and related occupations	15,903	16,883	980	6.2
Office and administrative support occupations	24,101	25,943	1,842	7.6
Transportation and material moving occupations	9,826	10,217	391	4
Construction and extraction occupations	7,810	8,829	1,019	13
Installation, maintenance, and repair occupations	5,798	6,238	440	7.6
Production occupations	10,083	9,734	−349	−3.5
Farming, fishing, and forestry occupations	1,035	1,026	−9	−0.9

Source: BLS Employment Projections 2008–2018

2. *Personality.* Project a mature, easy-to-work-with, positive, reasonable, and flexible personality. How one acts and behaves is important.
3. *Communication skills.* Pay attention to skills related to asking, telling, listening, writing, and understanding.
4. *Technical skills and ability.* Keep one's own professional capabilities (e.g., analysis, design, integration, product development, tools application, etc.) current and marketable.
5. *Human relations skills.* Constantly review ways of interacting with people and make sure that you are creating and maintaining acceptable working relationships. Avoid being labeled as "not able to work well with other people."
6. *Significant work experience and assignments.* Seek diversified business and engineering exposure and high-impact assignments to build up your experience portfolio. Doing so will increase your ability to add value to the organization.
7. *Self-control.* Improve your ability to stay cool and withstand pressure and stress by, for example, taking courses in leadership training. According to a CNN report in 2001, a British military training camp was offering training services to business executives, subjecting the executives to a high-pressure artificial military environment to toughen them up for handling the real-world business environment.
8. *Personal appearance.* Follow the example of superiors to fit yourself into the corporate image. Dress for success.

9. *Ability to make tough business decisions.* Take careful chances when needed. Anyone can make the easy plays, but only great people make the tough plays.
10. *Health and energy level.* Take care of your health and maintain a high level of physical vitality.

1.12.5 Most Common Reasons for Career Failures

Some service engineers fail in their careers for one reason or another. Enumerated below are seven common reasons for career failure; these are relevant to technologists as well as managers.

1. *Poor interpersonal skills.* A lack of interpersonal skills is the single biggest reason for career failure. Few people are fired or invited to resign due to deficiencies in their technical capabilities. As a measure of social intelligence, interpersonal skills are important to achieve success in any organization. One needs to be sensitive to the feelings of others, able to listen and understand the subtext in communication, give and take criticism well, strive to build team support, and be emotionally stable.
2. *Wrong fit.* From time to time, a person may find it hard to adapt one's abilities, styles, personalities, and values to the culture and business practices of the workplace. The workplace may assume a cultural norm that is unfamiliar to some individuals. It is well known that rigidly layered corporations operate differently from dynamic partnerships or entrepreneurial start-ups. The individual's core value system, with priorities, profit motives, and social or environmental preferences may not be fully compatible with those of coworkers on the job. In addition, the chemistry among coworkers within a unit, department, or company could also be a source of conflict. Often, the management style of the superior is difficult for the individual to adapt to. In cases of such a wrong fit, the best strategy for the individual is to move on.
3. *Unable to take risks.* Lack of risk-taking abilities is a major stumbling block to the advancement of one's career. For fear of failure, some engineers stay in their current positions for too long and are not willing to accept promotions that require relocation within the company or to venture out for new positions outside of the company.

   Others feel comfortable with the technical work they do because they are able to control all of the key components of their work (e.g., data, facts, analysis, procedure, and equipment) and the quality of its outcome. Naturally, some of them may feel uneasy when requested to take on managerial responsibilities that involve (1) people who may react differently; (2) data that are often incomplete and inaccurate; (3) objectives that are usually multifaceted; and (4) decision-making steps primarily based on personal intuition and judgment. The inability to take calculated risks could lead to failure in one's career progression.
4. *Bad luck.* Sometimes, engineers get hurt by business circumstances that are beyond their control or expectation (e.g., mergers and acquisitions, corporate downsizing, change of market conditions, change of business strategies,

advancement of technologies, etc.). Career disruptions due to bad luck can happen to anyone. However, one should be able to recover quickly if one's record demonstrates that past achievements consistently produced value to employers, and such value-creation capabilities are widely marketable.

5. *Self-destructive behavior.* Certain engineers exhibit work habits or behavior patterns that are self-destructive. Examples of self-destructive behavior include working in secret, resistance to change, being excessively aggressive, having an uncooperative attitude, picking fights with people, becoming overly argumentative, being readily excitable about trivialities, and displaying a lack of perspective. Such behavior is clearly unwanted in any group environment.
6. *Lack of focus.* Some engineers pride themselves on being a jack-of-all-trades, getting busily involved in almost everything, but being good at nothing. Failing to focus on creating value to the employer is detrimental to one's own career.
7. *Workplace biases.* Under ideal conditions, all workplaces should be free of biases with respect to race, gender, age, national origin, religious beliefs, and other individual qualities. In reality, some workplaces are managed more effectively and progressively than others. Individual workers need to monitor the real situation at hand and take proactive steps to avoid being hurt by such biases. Engineers serve themselves well by constantly checking against these bias-based failures and proactively managing those over which they can exercise some control.

Certain articles address the factors that cause engineers to fail as managers. Engineers may be handicapped by a number of perceived shortcomings that do not allow them to become good managers. These perceived shortcomings are reviewed next, even though some of them represent a repetition of those already itemized:

A. Lack of Political Savvy. Engineers tend to be straightforward, honest, and open, and have strong views based on verifiable facts and data. According to Broder (1992), some engineers

1. Hate company politics. They tend to be technically intelligent, but sometimes politically amateurish.
2. Do not build a personal network.
3. Are uneasy trying to fit into an organizational culture because of strong beliefs, unique value systems, rigid principles, and inflexible attitudes.
4. Have an engineering mindset that is rational, efficient, and introspective. They may see things as either right or wrong, and may not be willing or able to accept different shades of gray. For holders of midlevel and top-level managerial positions, this mindset may confer disadvantages when attempting to resolve conflicts, handle disagreements, and foster alliances.

B. Uncomfortable with Ambiguous Situations. The technical training of engineers is based on equations, logic, experimental data, and mathematical analyses; this tends

to make engineers see the world as orderly, certain, and black and white. The business environment in the real world causes some engineers to

1. Be uncomfortable with approximate or incomplete answers, since they have been trained well to recognize indeterminate problems and declare them unsolvable. They are not used to the idea of introducing additional assumptions and making such problems solvable. Some engineers
   a. Hate problems with inaccurate or unknown factors.
   b. Dislike planning with uncertainty (e.g., strategic planning).
2. Want to avoid using intuitive knowledge. They prefer cognitive knowledge, which is based on facts and data, and thus they lack the ability and willingness to make tough decisions by using intuition and gut feelings.

C. Tense Personality. Some engineers are too serious in their approach to professional life. They may be unable to say no and unable to request for help, allowing their personal ego and pride to get in the way. Afraid to be wrong, they may have the tendency to take mistakes personally.

D. Lack of Willingness to Take Risks. Some engineers are conservative in nature. They may have a low tolerance for uncertainties. Because of their tense personalities, they may not be comfortable taking risky opportunities to reach for higher levels of rewards. Some graduates with a master's degree in business administration (MBA) are said to be "often wrong, never in doubt"; they continue, in spite of often being wrong, to try new risky approaches until they reach their goals. Engineers are quite different in this respect. While having strong self-confidence in their own technical capabilities, many engineers do not like to take chances.

E. Tendency to Clinch on Technology. Some engineers do not feel comfortable leaving their fields of technological strengths when assuming managerial responsibilities. They tend to lean on technology as a safety net. From their viewpoints, technology is more readily controllable, and they are fearful of losing their sense of control. Some of them even have the uninformed notion that technology is the only thing worthy of respect, valuable, intellectually pure, and deserving of their efforts. Their perspectives are limited, causing them not to recognize that other functions that may be technically less intensive, such as customer service, marketing, procurement, production, and supply-chain management can also contribute equal, or in some cases, more value to the organization than engineering and technology.

F. Lack of Human Relations Skills. Because of their conservative nature, some engineers may be reactive in social settings and remain inflexible in dealing with a diversity of issues and people. Some of them may be readily argumentative and self-righteous when confronted with viewpoints radically different from their own. Over time, some of them may be perceived as suffering from a lack of human relations skills and the inability to become good team players.

G. Deficiency in Management Skills and Perception. One of the noted shortcomings of highly talented engineers is their lack of willingness to delegate. Some of them are not able to work through people and help others to succeed. They would prefer to ensure high quality by doing the projects or assignments themselves. A plentiful of them are unwilling to train subordinates for fear that one day the trainees may become technically more talented than themselves.

Other engineers may have the tendency to utilize self-imposed, ultrahigh standards in appraising employees. They have difficulty tolerating below-par performance by teammates or coworkers. Still other engineers have the tendency to over-manage and over-control their subordinates.

H. Not Cognitive of a Manager's Roles and Responsibilities. Some engineers are unexpectedly promoted to managerial ranks because they performed well as technologists. Due to a lack of preparation on their part, these newly promoted engineers have either limited or no understanding of what managers are supposed to do—that is, to add value by efficiently assigning resources to the right projects. They lack the preparation to do a manager's job. They are not aware of the fact that people problems require more time and attention than technical problems. Because of a lack of exposure to nontechnical, but equally important issues, they have not acquired the background required to deepen a well-rounded business sense.

I. Narrow Interests and Preparation. Some engineers are specialists in narrow technical fields. As a consequence, they have narrow technical viewpoints and limited vision and perspectives beyond technologies. They are not prepared to deal with accounting, marketing, production, finance, and other broad-based corporate issues outside of technology.

Numerous engineers may suffer, to varying extents, from some of the shortcomings just cited. Engineers who aspire to become managers should carefully examine their strengths and weaknesses and commit their efforts to making sure that all of these factors for failure are minimized over time.

1.12.6 How to Manage One's Superiors

Both engineers and engineering managers need to properly manage their respective superiors. On the one hand, the superior needs the active support of all employees to succeed, as most of the work is done by the subordinates. On the other hand, all of the subordinates need their superiors' support to move forward along their individual career paths.

The power of a superior should be taken seriously. One of the primary reasons for job turnover is personality conflict with the individual's own superior, not because of technical performance.

It is also of critical importance that one understands the corporate mindset. Whenever the organization appoints a group leader or manager, the following unwritten rules apply:

1. The organization knows that no one is perfect and that the appointee is no exception.
2. The appointee's strengths are valued more than the trouble caused by his or her weaknesses. Even if the appointee appears to be difficult for some subordinates to deal with, the organization counts on him or her to lead the group and add value. Unless the appointee clearly violates the stated rules, the organization will back the appointee most of the time.
3. To achieve the goals of the organization, the organization trusts the views and desires of the appointee over those of his or her subordinates.

The organization also expects employees to behave in certain ways. These include being attuned to the superior and not insisting that the superior adjust to the employees. Work closely to support the superior and help him or her to succeed. Avoid questioning the superior's judgment and decisions, as the superior typically has access to more and better information and data than the employees and may not be in a position to share such information or data freely.

In readying oneself to manage superiors effectively, it is useful for employees to form the following habits:

1. Understand the business and personal pressure the superior is under, his or her values and motivators (achievement, success, recognition, money, value systems, priorities, principles, and other factors), work style (peacekeeper, conflict lover, riser or setter, channel oriented), and personal style (optimistic, fighter).
2. Expect modest help, and request it only when you really need it. It is better to get help from your own networked coworkers and friends.
3. Be sensitive to the superior's work habits. Watch how he or she receives data and information and works on it. Learn his or her preferred mode of communications—face to face, phone, e-mails, or staff meetings, for instance.
4. Stay in touch with the superior, unless he or she does not want to be bothered regularly.
5. Present materials clearly and without complex details and jargon.
   - Emphasize the significance (the benefits and realizable impact) of your technical work to the group or company, not its technological complexity, sophistication, or elegance.
   - Use concise language to elucidate ideas and recommendations clearly.
6. Do not defend a cause unless it deserves it. Keep it in perspective. Do not complain when you do not get all that you asked for.
7. Exercise self-control. Manage your own overreactions or counterproductive behavior.

The following set of guidelines (Gabarro and Kotter 2008) for managing the superior–subordinate relationship is recommended:

1. Accept that your superior's support is important to you. Understand how important your support is to your superior.

2. Understand your own response to the superior's style and personality, and manage it. Respect the style and orientation of your superior to his or her work. Understand your response to your position in the hierarchy and how you feel about working within a structure.
3. Learn to take feedback objectively, not personally, and maintain your sense of self and your own uniqueness.
4. Push back when necessary, but only for business reasons and to maintain personal integrity; do not push for political gain or to embarrass the superior.
5. Learn the superior's goals, aspirations, frustrations, and weaknesses. Study and understand what the superior thinks is important. Study and be able to emulate the superior's communications style for the sake of being heard.
6. Be dependable; follow through on serious requests for information and work output.
7. Display respect to others and expect respect from others in all matters of business and on-the-job interpersonal interactions regarding time, resources, and alternative work styles.
8. Be honest and share all relevant data about the situations and concerns at hand.
9. Keep private any criticism and conflict that may arise between the two of you, and always work for a jointly satisfactory solution.
10. Be manageable by and available to those beneath you.

1.13 QUESTIONS

1.1 Tom Taylor, the sales manager, was told by his superior, Carl Bauer, to take an order from a new customer for a bunch of products. Both Tom and Carl knew that the products ordered would only partially meet the customer's requirements. But Carl insisted that the order was too valuable to lose. What should Tom do?

1.2 Nancy Bush, the plant manager, needs to decide whether to make or buy a component for the company's core product. She would like the advice of her production supervisors, since they must implement her decisions. However, she fears that the supervisors will be biased toward making the component in house, as they tend to favor retaining more work for their people. What should Nancy do?

1.3 Student A, in order to graduate on February 4, works hard to finish her master of engineering report by the due date of January 8. She is planning to return to her country immediately thereafter and get married. If she graduates on June 10, the next available graduation date, she will have to pay a tuition fee to keep her student status active for one more semester. That would be a substantial financial burden to her.

Her advisor, Professor B, is hesitant to accept the report as presented. The report includes a major marketing activity designed by Student A to promote a new service package of a local company. Because of logistics, this major marketing activity is scheduled on January 20. No customer feedback data, which are required to demonstrate the value brought about by the report, are available before January 8. Professor B cannot bend the rules to pass the report without these data.

Put your innovation hat on and recommend a way to resolve this conflict.

1.4 The engineering manager of Company A proposes to install an automated bar-code scanner costing $4,000. He estimates that he can save about 100 hours of labor time per month, as products can now be scanned much faster. He reasons that at the wage rate of $15 per hour, the benefit for using the automated bar-code scanner is $1,500 per month, and the scanner can be paid back in 2.67 months.

As the president of the company A, do you agree or disagree with the way the president computes the cost-benefit ratio? Why or why not?

1.5 The new millennium imposes a number of new challenges to business managers, who are different from engineering managers and technology managers. Name a few of such challenges.

1.6 In the literature, it is generally said that innovations in the service sectors are lagging behind those in the manufacturing sector. Explain why it might indeed be so.