This statement was approved for issuance as a Statement on Management Accounting by the Management Accounting Committee (MAC) of the Institute of Management Accountants (IMA®). IMA appreciates the collaborative efforts of the Finance Business Solutions Center at Arthur Andersen LLP and the work of Dr. C.J. McNair, CMA, of Babson College, who drafted the manuscript.

Special thanks go to Randolf Holst, CMA (Canada), Manager of Knowledge Creation at Arthur Andersen, for his continuing oversight during the development of the Statement. IMA thanks the Consortium for Advanced Manufacturing-International (CAM-I) for their support in the development of this SMA. IMA is also grateful to the members of the Management Accounting Committee for their contributions to this effort.
# Implementing Capacity Cost Management Systems

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**IMA INSTITUTE OF MANAGEMENT ACCOUNTANTS**

Advancing the Profession™
I. RATIONALE

Managing the resources of the organization effectively is an essential first step on the path to profitable operations. Resources hold the promise of performance but only in their effective use is this promise fulfilled. If resources are purchased but then idled due to lack of demand, inefficient plant layout, or any of the other myriad reasons for planned and unplanned idleness, their productive potential turns to waste.

Knowing which resources to bundle to provide optimal throughput, gauging the limits of these bundled resources or systems to create value, and tracking their utilization patterns and costs over time is the focus of a capacity cost management system. Emphasizing the relationship between resource capability, its ability to create value, and actual deployment is the key to unlocking the profitability puzzle. As Henry Ford once noted, “a man cannot be paid much for producing waste.” Whether that “man” is a human resource, a machine, a process, or an intangible asset, wasted capacity translates to loss of profit, not gain. Customers will not reimburse an organization for wasted resources—waste comes out of profit.

The ultimate goal is to produce what is needed, when it is needed, and to have the minimal amount of physical and nonphysical resources necessary to meet customer requirements today and in the near future. Achieving this goal begins with a clear understanding of what resources will be required to operate a process, how to minimize the embedded waste in the process, and how to deploy the process and resources of the organization to optimize the value-creation-to-cost relationship. Optimizing the value created per unit of cost—finding the highest level of productivity—requires a solid database of capacity information. This information enables management to choose among a broad number of potential uses of capacity, structures and approaches to addressing capacity shortfalls, and means of creating the highest amount of value for all of the organization’s stakeholders. Capacity cost management (CCM) is a primary source of the information required for an organization to reach its profit potential.

II. SCOPE

This Statement on Management Accounting (SMA) has been written to help an organization understand how to optimize its investment in resource or process capability. The methods and principles presented in this SMA are a compilation of best practice, historical and modern approaches to optimization of a process, and existing capacity cost management models. This SMA supplements the research project titled Total Capacity Management: Optimizing at the Operational, Tactical, and Strategic Levels, published by the IMA’s Foundation for Applied Research (FAR).

The focus of this publication is on implementing a capacity cost management (CCM) system. It is beyond the scope of this publication to discuss the various approaches to designing a process to ensure optimal throughput. Scheduling algorithms and the other issues and practices surrounding daily management of a process are also outside the scope of this document. Instead, attention will be focused on the definition, creation, and application of cost and reporting systems to enable management to make effective capacity design and utilization decisions.

The concepts discussed here apply to:
- large and small organizations; and
- enterprises in all business sectors.
The information in this SMA will help financial professionals and others:
- comprehend the underlying principles of CCM;
- understand the various elements of CCM systems;
- determine the uses and benefits of CCM systems;
- understand the cost implications of committed versus managed resource levels within a system;
- design a CCM system;
- develop reporting and analysis capabilities that will aid management in the effective utilization of the organization’s capacity; and
- broaden management awareness and obtain their buy-in for CCM systems.

Ensuring that the resources of the organization are utilized to their fullest in activities that customers value, capacity cost management lies at the heart of the management process. Gaining the advantages of this management technique begins with understanding its key principles.

III. KEY PRINCIPLES UNDERLYING CAPACITY COST MANAGEMENT

The principles underlying CCM emphasize the design of a system and the underlying flow of the productive process, minimizing the variability and disruption within the value creating flow and optimizing the utilization of resources. Specifically, capacity cost management embeds the following key principles:
- **Systems-defined**: CCM is a system or process-based approach that emphasizes the interdependence of resources, not their individual capability;
- **Customer-driven**: Effective utilization builds from the definition and application of process capability and resources to meet specific customer or market demands;
- **Constraint-focused**: Emphasis in CCM is on identifying, measuring, and tracking the constraints that define the capability of a process;
- **Cost-oriented**: CCM details the relationship between various patterns of process and resource utilization and the total cost of products and of the business;
- **Variability-reducing**: The goal of CCM is to understand the impact of variability, either in the process or the products/activities it supports, on total resources used and output created;
- **Output-focused**: The objective of reducing variability is to optimize the amount of output created for and valued by customers;
- **Waste-minimizing**: Identifying, measuring, and tracking the waste of resources within a process, or as the result of the operation of a process, are key issues of concern within CCM;
- **Decision-oriented**: The motivation for creating and maintaining a CCM system is to support management decisions regarding the use of existing resources, the attainment of new capabilities, and the disposal of resources that are no longer required by the organization;
- **Information-driven**: A CCM system should be designed to provide optimal information about or visibility to the key factors of production. Information value should always drive CCM system design decisions; and
- **Economically sound**: Cost-benefit analysis should be used to set the thresholds for the amount and type of information in the CCM system.

These guiding principles combine to establish the focus of the CCM system, define the boundaries of its database, establish analysis and reporting capabilities for the system, and drive the amount of detail it contains. Capacity cost management systems emphasize the provision of relevant and timely information to aid management in its drive to optimize the utilization of
resources to create value for customers. Understanding the cost of existing processes, the cost implications of process and product designs and changes to these designs, and the impact of idled resources are just a few of the objectives of a well-designed CCM system.

IV. DEFINING THE COST OF CAPACITY

CCM incorporates the complex economics of the organization as it strives to deploy resources to create value for all its stakeholders. The cost of capacity is the first element of this puzzle. Reflecting the relationship between the structure, strategy, and processes of the organization, the cost of capacity includes the set of estimates and utilization metrics used to drive operational, tactical, and strategic decisions. The key issues and concepts that define the cost of capacity include:

- committed capacity costs;
- managed capacity costs;
- bottleneck resources;
- process variation;
- capacity limits (e.g., theoretical, practical, normal, budgeted, or actual);
- minimum or competitive cost;
- capacity utilization metrics;
- time frame of analysis;
- supply chain capabilities (e.g., flexibility and responsiveness); and
- resource cost variability.

Committed Capacity Costs

Several features of a process interact to define its cost of capacity. First, during the design of the process, resource combinations and requirements are set that define the baseline, the minimum cost position of the organization. Resource cost is neither avoidable nor actionable within the boundaries of the process design. The process design also establishes the bottleneck, the process constraints that limit the throughput or value-creating ability of the process. In the same way that the design of a product defines 80-90 percent of its life cycle costs, the design of a processor system determines its cost and performance limits—its committed costs. The committed costs of capacity are driven by the structure of the process and the activities it supports. One of the more visible ways that committed capacity costs affect competitiveness can be found by comparing a virtual corporation to its more traditional counterpart—e.g., Nike versus Converse. At Nike, very little structure can be found. The company does not manufacture its products or ship them—it relies on licensed suppliers to provide the necessary assets and expertise to actually make goods. Nike focuses its internal resources on marketing and R&D, using a flexible supply structure to allow it to respond rapidly to changing fashion and market trends. Nike has a very low level of committed capacity cost.

One of Nike’s major competitors, Converse, has taken the opposite approach to the sportswear market. Converse owns and operates its manufacturing facilities, which are located across the globe. More traditional in nature, Converse ties up far more of its assets, and hence future, in existing plant and facilities. Converse has a very high committed capacity cost within its manufacturing process.

Nike and Converse compete for the same markets and customers but with very different structures. Nike, owning few resources, faces greater risk when raw material or foreign currency rates are moving in unfavorable directions. Converse avoids these risks but faces others as its flexibility and responsiveness are reduced due to its
heavy investment in fixed assets within specific countries and competitive arenas.

As suggested by Exhibit 1, an organization’s committed capacity costs are driven by the design of the manufacturing and other major processes it uses to create value for its customers. As a process is designed, each of the resources it utilizes becomes committed to the defined flow. This creates the potential to embed waste unless the capabilities of the various resources are reasonably balanced.

For instance, if 10 machines are linked into a work cell constrained by a bottleneck activity, no matter how much the other nine machines could produce, the process will turn out product only at the speed of the bottleneck machine. In addition to the potential waste of machines committed to the bottleneck, a number of other resources and costs become embedded in the process, such as labor, space, power, supplies, and fixtures (e.g., tools and dies). No matter what output these resources could provide, they can be utilized only up to the level supported by the bottleneck. Any capability they have in excess of that of the bottleneck is permanently wasted—this is waste built into the process that can be eliminated only through redesign (another form of waste).

**Managed Capacity Costs**

As resources are added to activate a process, managed capacity costs become the focus of attention as illustrated in Exhibit 2. Determining the best way to staff a process and deploy the scarce resources of the organization in order to maximize their utilization to achieve optimal economies of scale requires ongoing analysis of customer demand, supplier capabilities, and resource availability and costs. Where committed capacity costs set the minimum total cost position, even if the organization does not pro-
duce a single unit of output, managed capacity costs represent the cost required to activate these committed resources to create value. Committed capacity costs represent the cost of preparedness, or the fixed asset and process structures and costs that are put in place to meet customer demand.

Deploying these committed resources requires the addition of other factors of production, such as labor and power. If the committed resources are left idle, then managed capacity costs can be avoided. Of course, this state of idleness has a definite drawback—no products or services are made available to customers, so no revenues or profits can be earned. If there is no demand for the organization’s output, then idling its plant and equipment may be preferred to using them. Utilization, the triggering of managed capacity costs, represents the highest cost position for a process—if fully manned processes are left idle, the waste created is significant.

Separating committed from managed costs is one of the first activities completed when a CCM system is designed. These two forms of capacity cost have very different capacity baseline characteristics (amount of time estimated to be available for use) and levels at which they can be affected by actions. The higher the level of committed cost, the greater the need to utilize the process continuously to gain required economies of scale. As the level of managed costs increase, it becomes more critical to ensure that every minute the process is manned for use is effectively deployed to create value for customers. Idle committed costs will never be as significant, though, as the total costs (committed and managed) for a process that is idled when it is ready to make goods or provide services. Understanding the difference between these two basic categories of capacity cost is the first step in creating an effective strategy for designing and deploying an organization’s scarce resources.

### Bottleneck Resources

The role of the bottleneck in constraining the output of a system has been understood for a very long time but was brought to the forefront of the management literature in the mid-1980s by Eli Goldratt in his seminal work, *The Goal*. Focused on maximizing the match between the output of
a process/bottleneck and actual customer demand, Goldratt’s work is premised on the view that capacity has value only if it can be deployed to make something that will result directly in revenues (sales or throughput).

The bottleneck resource paces the entire flow or process in which it is embedded. In other words, the bottleneck is the gateway for value creation within the organization. The bottleneck, the primary constraint, determines how much output the system will produce and when. For this reason, intense efforts should be concentrated on making sure that the capacity of the bottleneck resource is never wasted, such as:

- placing quality control before the bottleneck to ensure that only good units are allowed to consume the capability of this scarce resource;
- off-loading, or finding some way to reduce the demand on the bottleneck;
- examining all products currently passing through the bottleneck to make sure that they really require its attention;
- reducing idle time on the bottleneck by rotating shifts to minimize lost production due to breaks, lunch, shift change, or related factors;
- filling the available capacity per cycle of activity for the bottleneck by breaking batches or finding other ways to ensure that lost capacity is minimized;
- if a machine is the bottleneck, searching for ways to transform internal setup (when the machine is idled for changeover) to external setup (done when the machine is running) and to minimize all forms of internal setup time; and
- prioritizing the flow through the bottleneck to ensure that the products with the highest percentage of value-added are completed first.

The bottleneck resource can be optimized in many ways, including some of the efforts in the list above. Since the bottleneck constrains the output and performance of the entire process or organization, its impact on profitability cannot be overstated. If the bottleneck is kept active making items that customers currently want, profits will be maximized. If the capacity of this scarce resource is wasted, the entire entity and its value chain lose.

Bottlenecks can shift within a process due to process improvement efforts as well as unavoidable variation caused by the specific mix of products or services currently demanded by customers. For instance, the embossing machine in a paper mill has limited capacity but is usually in very low demand, so historically it has not constrained the plant’s overall output. Within a specific month, though, a large number of orders for embossing might be received. If this is the case, then the embossing machine could become the bottleneck, given the current mix of products in production. A bottleneck can change for the short term due to product mix, or over the long term due to process improvements. Removing one bottleneck, though, does not mean the process is unconstrained—it simply shifts the bottleneck to the next slowest machine in the flow.

Identifying and managing bottlenecks in a process, whether service or manufacturing in nature, is one of the primary objectives of effective CCM. The more balanced the process is around its key bottlenecks, the lower the level of waste embedded within it. Total balance, on the other hand, makes every machine or activity in the process a potential bottleneck if any problems occur at that site. The controversy over totally balanced (minimize embedded capacity waste) versus unbalanced flows (significant embedded waste; bottleneck protected) may never be totally resolved. In the end, an organization has to decide which strategy will maximize
total throughput and minimize total waste within a process. There is no one right approach, only key factors to balance in designing a process.

**Process Variation**

One of the biggest challenges facing a process manager is the identification and removal of variation from the flow. Variation causes cost throughout a process, as it creates waste, idleness, and rework at each station or activity in the flow. Variation and the visible signs of its impact (e.g., defects) multiply—they behave like a decay function, as suggested by the following example.

A specific process requires 25 interdependent activities to complete the manufacture of a printer. Recent measurements of the process suggest that first-pass yield is very low, even though the performance of each step in the process is achieving the targeted .98 yield factor. In fact, the performance of each step in terms of first-pass yield for the last six months has been quite good, as the following numbers suggest:

- Steps – 1, 5, 6, 8, 11, 15, 22, and 25: .995 yield
- Steps – 2, 4, 10, 13, 20, and 24: .990 yield
- Steps – 3, 7, 12, 16, 19, and 21: .985 yield
- Steps – 9, 14, 17, 18, and 23: .980 yield

While these numbers may look impressive, the performance of the process, due to its interdependent nature, becomes:

\[ .995 + .990^5 + .985^5 + .980^4 = .7467 \] first-pass yield

The first-pass yield for this process is under 75 percent—one out of every four products has a defect in it that must be repaired, and 25 percent of the capacity of this line is wasted because of variation.

All processes exhibit this pattern of variation. Called variation pileup, it affects all aspects of the process, including its meeting of defined tolerances, level of quality, or delays due to machine or activity breakdowns. Due to the interdependent nature of activities within a process, the decay function described above is always at work robbing a process of its capability and the organization of potential revenue and profits.

The capacity of a process versus its total capability to create good products or services are different concepts. The former reflects its potential, the latter how variation affects this ability through variation and other forms of process fall-off. They are linked through the decay function, which captures the hidden cost of variation. An effective CCM system has to track both the potential value-creating ability of the process and its current ability to reach its theoretical limits.

**Capacity Limits**

The potential of a process can be defined and measured in many different ways, as illustrated in Exhibit 3.

- **Theoretical capacity**: the optimum amount of work that a process or plant can complete using 24-hour, seven-day operations with zero waste, the best the process or plant can be;
- **Practical capacity**: the level of output generally attainable by a process; theoretical capacity adjusted downward for unavoidable nonproductive time, such as setups, maintenance, or breakdowns;
- **Normal capacity**: the average or expected actual utilization of a machine, process, or plant/unit over a defined period of time;
- **Budgeted capacity**: the planned utilization of the affected resources over the coming year; and
- **Actual utilization**: the capacity actually utilized, or deployed, over a specific reporting period.

One of the major issues in implementing any CCM system is the choice of a capacity baseline.
It is not uncommon for an organization to reject theoretical capacity from the outset as being unattainable and unrealistic, but it is considered best practice to utilize theoretical capacity as the baseline measure. The reasons for choosing theoretical capacity as the baseline measure are many, including:

- creating the basis for a stable, reliable capacity cost estimate;
- identifying competitive cost, or the best the organization can be;
- providing a basis for tracking total utilization of the process;
- providing a visible signal of process capability and how well it is being used;
- eliminating the old questions surrounding the cost of incremental business—all production bears the same cost per minute of process consumed;
- providing maximum assurance that new equipment and plant will not be acquired when there is any remaining capacity in the existing processes;
- serving as a basis for tracking progress against continuous improvement goals;
- providing a basis for costing all forms of capacity utilization fairly, including setup, maintenance, production, and idle time; and
- minimizing long-term waste of capacity within a system.

The role of committed versus managed capacity becomes important to understand at this point. Committed capacity costs are the only ones placed on the 24-hour, best an organization can be, capacity baseline. The fixed assets of a process or plant are available to be used at all times—this is fact, not fiction. In any given week, there are 24 x 7, or 168 hours (10,080 minutes) of available capacity on the committed resources.
Managed capacity costs, on the other hand, are experienced only when the plant or process is manned and ready to produce. When managing capacity costs, “theoretical time” is the number of hours the process is ready to make product or provide services because all required resources are available. If a plant is manned for production only 16 hours a day, five days a week, the correct baseline for the managed capacity costs is 80 hours or 4,800 minutes per week.

This discussion suggests several important points. First and foremost is the superiority of time-based baseline measures for capacity. In many organizations, the earned hours within a plant are used as a capacity measure. If the only resource used by an organization is labor, this metric may be an acceptable measure of actual capacity utilization, but very few manufacturing companies today are labor driven. The capacity measure should be defined on the process and its bottleneck resource. The theoretical capacity of the bottleneck area (not the people who populate it) is the basis of the CCM system baseline measures. People are added to physical assets, along with other costs, to bring a process to life. Only the managed capacity cost baseline should be based on their presence—committed costs use 24-7, zero-defect baselines.

The second issue is linked to the first. Specifically, two forms of capacity cost measures have to be kept within the CCM system database for every process:

- \( C_C \) = the committed cost per hour or minute, which is derived by dividing total committed costs for the process by theoretical time.
- \( C_M \) = the managed cost per hour or minute, which is derived by dividing total managed capacity costs for the process by the manned hours, or total theoretical managed time.

If a process is idled when no managed costs are being incurred, the cost to the organization is minimal. On the other hand, downtime and idle time that take place while a process is fully manned, ready to produce, is quite expensive. It is charged with both a committed and managed cost per minute.

This leads to the third point, which is that tracking and charging out the costs of a process have to reflect the state of readiness of the process during the period of idleness. If the lights are out and no one is in, the idle capacity charge is relatively low (only committed capacity costs per minute). When creating a capacity utilization report, it is important to note what state of preparedness, and hence cost, each type of idleness or utilization represents.

Finally, there is no expectation that any plant or process will ever achieve its theoretical capacity limits. That is not the reason for using theoretical capacity baseline measures. The key is that only theoretical time provides a way to measure and report the total status of the plant and process—all other baselines hide information. As was found out too late by a large pet food manufacturer, this hidden information can lead to building a new plant that was never really needed. There was sufficient capacity to meet projected needs for the next 20 years—if the total time available was used as the baseline. Rather than finding ways to use existing resources more fully, this company ended up saddled with a huge ongoing cost from a new plant that would never be fully utilized. This organization is one of the strongest proponents of using theoretical capacity because it knows firsthand what happens when normal or budgeted limits are used. It is a lesson that has also been learned and mastered by companies such as Texas Instruments, Motorola, and Hewlett-Packard.
A CCM system is an information system. Its goal should be to provide reliable estimates that do not change every time production volumes shift, which would be confusing utilization (that is tracked and measured) with the capability (e.g., capacity) of a system. Both pieces of information need to be maintained if the CCM system is to be an effective decision and control tool.

**Minimum or Competitive Cost**

The use of theoretical capacity allows an organization to identify its current minimum or competitive cost position. This is an important number to have on hand as new products or service offerings are evaluated or competitive analysis is conducted. A competitive cost is the lowest cost an organization experiences in making a product or providing a service. If this cost is too high, in other words, it exceeds the price of a competitive product in the market, then the organization has to face that fact. In this situation the only options left to the organization are to exit the market or to undergo radical process redesign to eliminate excess cost (often in the form of idle or excess resources).

The competitive cost number is the correct benchmark for evaluating a request for a special piece of one-time business (incremental analysis). It serves many other roles, such as providing the limits for a continuous improvement tracking system. If downstream products require a lower cost than that currently defined as the minimum, once again, innovative solutions and process redesign become essential. Knowing the competitive or minimum cost, then, provides essential information about the organization’s capability and competitiveness in the market. If an organization, being the best it can be, is still too costly to compete effectively, it will not remain in business for long no matter how that information is communicated to and accepted by management.

**Capacity Utilization Metrics**

The heart of a CCM system is the utilization metrics used to convey information about the status and effectiveness of the organization’s processes. The model illustrated in Exhibit 4 suggests that any organization can subdivide total or rated capacity into idle, nonproductive, and productive capacity. Idle capacity may exist for many reasons. It may offer the company opportunities. At other times, production center capacity remains idle for strategic or legal reasons. Nonproductive capacity may be necessary under existing conditions, but it is an undesirable use of capacity in an ideal situation. Productive capacity is desirable. It provides value to the customers and results in the production of good products and services.

As suggested by the exhibit, there are actually three subcategories of pure idle time—marketable (idle but usable), off-limits, and not marketable. Off-limits capacity exists whenever there are:
- constraints on the use of equipment or processes due to legal restrictions (e.g., hours that an airport can be run are set by local noise ordinances);
- contractual arrangements (e.g., government restrictions on the use of equipment purchased as part of a government contract); and
- management policies that restrict utilization (e.g., decision to run a plant only two shifts, five days a week).

Of these three categories, the last is based on assumptions and prior experience. If new forms of demand are placed on a process, the restrictions due to management policies should be the first ones questioned because these restrictions can often lead to a 30-50 percent reduction in capacity utilization for the facility. This is a lost opportunity to create value and profits with the organization’s resources, which cannot be recaptured downstream. Keeping these facts in front
of management through effective capacity reporting is a driving force in designing and implementing a CCM system.

Not-marketable capacity is simply that. No market or demand exists for the resources—they are permanently in excess. If a plant is designed for demand that never materializes, and no other use can be found for the processes and equipment, then a permanent layer of waste is embedded in the organization’s cost structure. This information needs to be tracked and displayed by the CCM system to ensure that downstream decisions take this experience into account before planning new facilities or capacity. Supporting organizational learning, not pinning blame on the parties that misread future demand, is the goal of tracking and reporting not marketable capacity in the CCM system. Not-marketable capacity should be targeted for abandonment whenever possible.

The second type of capacity utilization, nonproductive capacity, is caused by variability in the

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**EXHIBIT 4. CAPACITY UTILIZATION METRICS**

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process. Taking the form of setups, maintenance, standby capacity, scheduled downtime, unscheduled downtime, rework, and scrap, nonproductive capacity is one of the most easily changed aspects of a process. One of the major objectives of the CCM system is to expose or make visible the levels of waste and variability in a process. An effective capacity reporting system should detail each of these forms of idleness, detail its cause, and report progress made in eliminating the variation and cost from the process. Since much of nonproductive capacity is a fully manned idleness, it is very costly for the organization. Both committed and managed capacity costs are incurred during these events, wasting resources, reducing profits, and reducing throughput that could be sold to generate revenues and satisfy customers.

Both setup and maintenance are normal parts of an operation, but their costs and impact on productivity can be minimized in many different ways. For instance, if preventive maintenance is done during times when the plant or process is unmanned, it will be much less costly than planned or unplanned maintenance completed when a process is fully manned and ready to make product. This logic has driven Ford Motor Company to the use of two 10-hour shifts in its assembly plant in Minneapolis. The two hours between each shift are used to complete preventive maintenance, move materials into the queue, and address any other issue that would create variation in the process during manned hours of production. In other words, the total cost of maintenance can be managed by understanding what form of capacity it is using.

In the area of setups, the issue becomes the time and type of setup that is undertaken. External setup, done when the machine or process is still running a prior job or completing a prior activity, does not affect productive capacity. Only internal setup, which is done while the machine is idled, affects capacity utilization levels. Every minute shifted from internal to external setup increases the organization’s capacity utilization. In a related way, time taken out of internal setup activities by process improvements such as quick changeover techniques reduces the level of nonproductive capacity.

Nonproductive capacity has many different causes. For instance, suppliers can cause nonproductive capacity by delivering products and services that do not meet size, quality, or capability requirements. Customer variability can come from business cycles, seasonal cycles, or erratic order cycles. Internal variability and waste can come from common setups or uncontrolled processes or power failures. Slowdown is another form of variation creating nonproductive capacity, as the need to reduce speeds on a line to accommodate learning, staff shortages, or other issues robs the organization of valuable, productive time. When any or all of these situations exist, they create the need to create reserve capacity or to plan for nonproductive time. Variation creates excess cost for the organization, a fact that the CCM system should make visible.

The breakdown of nonproductive capacity as defined by manufacturing is useful. However, the definitions need to be altered slightly to fit the service industries. Standby means exactly what it implies. For financial service industries, standby will include process balance and variability. Human capital is idle because of process balance or variability (while employees are waiting for work). Variability may come from two different sources—customers or vendors. There is customer variability in banking when tellers are waiting for customers to enter their line. However, if the tellers are interchangeable, the bank must be
careful not to measure customer-waiting time as nonproductive (i.e., the reason the teller is idle is because there is no customer). The consumer lending industry provides an example of vendor variability when a loan originator waits for a credit report from a third-party reporting agency. While yield loss is possible in the service industry, it is considerably more difficult to quantify. For example, how does one measure the productive loss of an inept loan officer? Rework, on the other hand, is a concern for services just as it is for manufacturing. In banking, a careless loan officer creates this type of loss. If the loan application is not completed properly prior to approval, rework is required, and a measurable amount of nonproductive capacity is generated. The original work of the loan officer is nonproductive, as is any time spent by the reviewing committee prior to sending it back to the loan officer.

Setups, although clearly measurable in the manufacturing industry, may be more difficult to measure in the service industry but should not be overlooked. For example, in the insurance industry, the industrial hygiene department may have considerable setup time as they switch from one type of test to another. This may be particularly true for hazardous chemicals testing. Likewise, substantial setup time may be required when measuring noise levels at a policyholder site. The banking and consumer lending industries may encounter setup time when changing the parameters for the autodialer. Both of these examples fall into the category of changeover.

The last main category of rated capacity, productive capacity, is the time actually dedicated to making products and providing services that the customer is willing to pay for. Productive capacity also can be the result of product development efforts focused on improving current products or creating new ones. In either case, the output is being put to work to create value today or tomorrow. Only productive capacity leads to revenue.

Reports such as the one captured in Exhibit 5 should become a permanent part of the CCM reporting package and tracking system. If only 20 percent of the organization’s resources are effectively deployed, there is ample room for improvement in both utilization and profits.
Whether the report takes the form suggested by the CAM-I model, that of Exhibit 5, or any other structure, the goal remains clear—to report actual utilization and track all nonproductive and idle capacity costs so they can be minimized.

An example may be useful at this point. Specifically, a large manufacturing company in the East determined that it actually needed to gain a better understanding and control over its accounts payable department. While any number of models could have been used, it was determined that the capacity-based approach would be most useful.

Analysis of the accounts payable process provided the following insights and information:

- the department spent 45 percent of its time issuing over 30,000 checks. This was deemed productive time;
- opening mail consumed 5 percent of the resources, serving as a form of setup cost (nonproductive time);
- problem resolution with a variety of the organization’s suppliers used up another 30 percent of available time (nonproductive time); and
- errors requiring rework of approximately 6,000 checks per period consumed the remaining 20 percent of available time (nonproductive time or waste).

The costs to operate this department were determined to be $372,000 for the time covered by the study. Of this, $100,000 was for committed costs (equipment and space), the remainder for managed costs (people and consumable supplies). It was also determined that a maximum of 60,000 checks could be processed (50 percent used to process 30,000 between opening and issuing activities). Current demand was being met—it was only 30,000 checks of the potential throughput.

Rework was consuming another 6,000 of the 60,000, resulting in the following:

| Available output capacity (60,000) | 100% |
| Less: actual output (30,000 + 6,000) | 60% |
| Idle capacity—lack of demand | 40% |

The use of active time was then analyzed.

- Productive time
  - (process good checks; 45% x 60%) 27%
- Nonproductive time:
  - Setup (opening mail; 5% x 60%) 3%
  - Supplier problems (30% x 60%) 18%
  - Rework (20% x 60%) 12%
- Total active time 60%

The equipment in the facility, or committed costs and resources, are available all the time, so their utilization patterns differ from the managed costs noted above. Specifically:

| Available time (7 days x 24 hours) | 168 hours 100.0% |
| Utilized time (5 days x 16 hours) | 80 hours 47.6% |
| Idle time | 88 hours 52.4% |

As for the managed costs, the following analysis could be completed:

- Productive committed time (45% x 47.6%) 21.4%
- Nonproductive time:
  - Setup (opening mail; 5% x 47.6%) 2.4%
  - Supplier problems (30% x 47.6%) 14.3%
  - Rework (20% x 47.6%) 9.5%
- Total active time 47.6%

Costs then can be developed for the accounts payable capacity reporting system:

- Committed capacity cost: $100,000 divided by 168 hours $595/hour
- Managed capacity costs: $272,000 divided by 80 hours $3,400/hour
- Cost per manned hour: $3,995/hour
Applying these costs to the various aspects of the process and its utilization yields the following information (note that there are only 48 hours of utilized time):

- **Idle capacity—committed resources**
  - (52.4% of 100,000) $52,400

- **Idle capacity—manned costs**
  - (40% of 80 hours x $3,995/hour) 127,840

- **Productive time**
  - (45% of 48 hours x $3,995/hour) 86,292

- **Nonproductive time/cost:**
  - Setup (5% of 48 hours x $3,995/hour) 9,588
  - Supplier problems (30% of 48 hours x $3,995/hour) 57,528
  - Rework (20% of 48 hrs x $3,995/hour) 38,352
  - Total costs for the period $372,000

As this example suggests, the capacity reporting process helps an organization understand where improvements need to be made and the impact of these improvements on profits. An example is the separation of committed versus managed capacity costs, their combination in the analysis of nonproductive and productive time, and the realization that productive time is only 21.6 hours of the available 168 for the system for the week (12.9 percent). In a related vein, value-added costs are only $86,292 of the $372,000 total budget, 23.2 percent. These two numbers put emphasis where it should be—on improving effective utilization of the process.

If the organization were, in reality, selling check-processing services, it would receive revenues only for 12.9 percent of the hours and 23.2 percent of its resource costs. The remaining time and costs would be nonvalue-added or waste—reducing the profit potential of the organization by 72.8 percent. The value of CCM can be seen in this example. CCM helps management understand its actual level of performance, identify where improvements are needed, and measure the impact of the change on the organization's profitability.

### Time Frame of Analysis

One of the most challenging aspects of any accounting reporting system is choosing the appropriate time frame of analysis. For the tracking of existing capacity, the logical time period is the current reporting cycle (e.g., monthly). What is the right time frame, though, for setting the baseline measures? Is the short-, intermediate-, or long-term perspective most appropriate?

Given that the driving goal of a CCM system is the creation of stable, relevant, informative cost estimates and reports, the time frame chosen should reflect the type of decision being made and the overall stability of the process. In the product design and development process, the long-term perspective on capacity should be adopted—what is the total life cycle capacity of the process? Is this too much or too little given projected demands and variation in demand? Strategic-level decisions, such as these, require a long-term perspective that includes examining the capability of the supply chain. The level of committed capacity costs is determined during the design stage.

If a product has already been designated for a specific process or capacity, then decisions turn toward optimizing the use of the affected resources over the planning period. Intermediate-term in nature, most of these decisions require multi-year analysis and implementation to achieve their improvement or utilization goals. The definition of theoretical capacity is normally established in the intermediate period, as limits and the desired level of manning (given demand) are identified.
In the short term, attention focuses solely on utilization of existing process capability. The reports suggested in the prior section reflect this short-term focus, with its stated goal of providing information so that improvement efforts can be focused on driving waste and variation out of the process. In the short term, then, the capacity of the process has to be seen as a given. It cannot be acted on in total—only the effectiveness of the utilization of resources can be affected.

In each time period, different aspects of the capacity of the system can be affected. In the intermediate term, staffing and improvement efforts are just two ways the available capacity can be influenced. Finally, in the short term, improvement projects emphasizing elimination of variation and waste can be carried out to increase the level of utilization. In each time frame, different assumptions and constraints can be queried, managed, or eliminated. Knowing what type of issue is under examination, and how long the process will be affected by the decision, drives the type and nature of capacity information provided to management. Where action can be taken and where it is limited are qualitative data, which should be kept within the CCM system database or its supporting systems.

Supply Chain Capabilities
In today’s environment, focusing solely on the internal capacity of an organization is a very shortsighted approach to take. A company does not exist in isolation—it is part of a supply chain that works in tandem to provide products and services to the customer and market. Decisions to augment capacity should always incorporate supply chain capability. It may be more logical to turn to outsourcing of a specific component or service than to duplicate capacity within the supply chain by buying new equipment or creating new processes within one organization.

The flexibility and responsiveness of the supply chain have additional ramifications for capacity management, beyond outsourcing of ongoing or surge production. If the supply chain is flexible, it can respond more rapidly and effectively to changes in customer demand. Less overall capacity is lost in nonproductive or idle time when resources can be flexed to meet new demands. If a supply chain is flexible, inventory buffers become less essential, reducing the potential for obsolete or damaged goods.

In a similar way, the supply chain can have a negative impact on capacity utilization. Specifically, off-standard products or materials from a supplier can lead to nonproductive time for its supply chain customer (the next organization in line) or the final consumer. Missed delivery dates can idle an entire process, leaving an unsatisfied customer at the end of the supply chain. Downstream trading partners can also create variation, as unanticipated surges or changes in demand get sent back through the supply chain, creating erratic flows and unnecessary variation. The impact of this form of problem has been well documented by Peter Senge in his work, The Fifth Discipline, in the form of unnecessary cycles in the demand for beer. Specifically, downstream decisions offering special prices or packages to consumers create an unnatural surge in demand that ripples back through the supply chain.

If the supply chain is nimble, it can rapidly adjust its output to the new level. If it is not, then time lags are built into the system’s response. In Senge’s example, the retailer ran out of beer when the special was offered and placed emergency orders for more beer, resulting in significant increases in production and sales esti-
mates for the brewery. By the time the brewery was able to respond, the special sale was over. The retailer was now returning excess beer to the distributor, which then reduced orders to the brewery, which adjusted all of its output downward once again, setting up a new cycle of shortages in the future.

The interdependent nature of decisions made within the supply chain creates unnecessary variation—variation that grows with the increasing passage of time required to respond to shifts in demand. The capability of the supply chain to respond to shifts in demand, to balance surge production with minimal investment in new resources, and to build changing customer needs into their products and services is a key factor in setting limits for the CCM system and defining the profitability of the overall supply chain.

**Resource Cost Variability**

An unavoidable aspect of creating any cost-based reporting system is the fact that not all resources have the same capability, useful life, or behavior. Some resources can be purchased as needed in exactly the size and capacity required to meet existing demand. Other resources, such as physical plant, have to be purchased in large quantity no matter how much of the total capability they contain will actually be needed.

A reliable, effective CCM system has to incorporate the estimated behavior of the costs of its key resources into its reporting and costing structures. Most of these issues come to bear in the definition and analysis of managed capacity costs, but they can also be important, as limits are set and processes designed (committed costs). If a resource is flexible, can be purchased only as needed, or stored if excess is obtained, it is unlikely to be wasted. On the other hand, inflexible resources that are available only in large purchase packages will be much more open to waste and idleness, even if this excess capacity can be stored for later use.

Embedded in the concept of committed and managed capacity cost estimates, then, is the relevant range for the cost equation and some attempt to identify where major stepped costs will be triggered. The level of detail kept should reflect the materiality of the resource, not only in terms of its cost but also in terms of its impact on the overall process. For instance, if a resource is immaterial in cost but could shut down a process if it is not available (e.g., a screw or other low-cost item) it should be kept at high levels of availability regardless of current demand. If a resource is very costly, its total capacity should be matched to the expected demand plus a small amount of surge capability if there is uncertainty in the forecasts.

The CCM system should record several key characteristics of the resource in order to increase the accuracy of the costing analyses including:

- **Useful life**: How long the resource can be expected to last in use or storage;
- **Purchase package**: What amount of capacity has to be purchased each time;
- **Variability**: How much of the resource is consumed each time a unit is made;
- **Storability**: Can unused capacity be stored for later use;
- **Flexibility**: Can unused capacity be put to other uses; and
- **Cost**: How much replacement or new capacity costs.

Capturing the pattern of resource consumption per unit of capacity provided is important in the CCM system, just as it is in any other costing initiative. The characteristics of a resource create
the underlying economic structure of an organization and its processes. The behavior of cost, so intricately tied to the accuracy, reliability, and relevance of a cost system, can never be ignored in its design and use, as illustrated in Exhibit 6, whether that variability is a natural part of the process or imposed by the costing mode used (e.g., ABC).

V. USES AND BENEFITS OF CAPACITY COST MANAGEMENT

The CCM system is a key factor in determining the organization’s production capabilities and should be indicative of the organization’s strategies. A correctly constructed capacity model can provide management information regarding capacity use relative to corporate strategy. For example, it is useful for its senior management to know that 65 percent of the human capital capacity is dedicated to assuring high-quality service, when their stated vision is to be a low-cost provider of service with average quality.

Thus, capacity cost management systems provide a range of benefits and capabilities to the adopting organization, including:

- better understanding of resource capabilities;
- improved utilization of resources;
- reduction of wasted and idle capacity;
- improved asset acquisition and process design decisions;
better communication about existing and desired performance;  
optimization of an organization’s profitability;  
extended process effectiveness;  
integration of operational, tactical, and strategic objectives and targets;  
 Improved competitive position;  
facilitation of effective product and market decisions;  
support of rapid response to changing conditions; and  
improved ability to integrate activities and outcomes across processes and entities in the value chain or across processes within an organization.

The development of an effective CCM system provides an organization with the ability to analyze a wide range of potential demand and market conditions, identify and establish low-cost positions, given these projections, and ensure that adequate flexibility is maintained in the design and management of a process. For example, an insurance company that decides to expand into three geographic markets may question the capacity capability of the claims department to handle the additional processing. If there is not enough capacity, the company should consider if enough additional capacity could be realized without hiring additional factors of production. For this answer, the organization needs more information than simply practical and excess capacity quantities. The same scenario may hold true for a bank deciding to add more branches. What is the item-processing department’s capacity to handle the additional work?

In both cases above, management could make better decisions with a better breakdown of capacity. That which appeared to be financially unacceptable and seemed to be the only option (when buying 100 percent of the additional capacity) may become feasible if a combination of buying and efficiency improvements are possible.

For example, the data indicates that if the bank adds branches, they need six more full-time employees (FTEs) in the processing department to handle the workflow. Hiring these FTEs would cost $32,000 each per year. The bank has determined that this would render the project unprofitable. However, the manager of the processing department, having just completed a capacity efficiency study, determines that they could handle the equivalent of three FTEs’ workflow by making some changes in their operation. This means that the bank has to find only three additional FTEs. The expansion project is now feasible.

Capacity is the ability to do work. Only when this capability is utilized to create products and services valued by the customer can the organization expect to earn a profit. Capacity is the barrier to be overcome in the search for profitability and growth.

VI. THE ROLE OF MANAGEMENT ACCOUNTING

There are few areas in the business where the role of management accounting is so intricately tied to operational, tactical, and strategic analysis as in capacity cost management. In the area of capacity management, cost is not an afterthought—it is the driving issue. This suggests that the role of the financial practitioner spans the entire range of capacity analyses and decisions, including:

- providing cost and capacity estimates during product and process design to guide management in the choice of optimal structures;  
- defining the potential alternatives in terms of committed and managed capacity and cost implications;
providing analysis of the least, or competitive, cost for the alternative process and product designs;

developing analyses of alternative ways to handle nonstandard or surge demand on the process;

after implementation, developing the capacity cost estimates for the process;

identifying relevant cost behavior and relevant ranges for the estimates;

preparing periodic capacity utilization reports and analyses for management;

trending improvement initiatives and results for capacity utilization;

constantly updating cost and performance data and reports to incorporate key changes and improvement results;

participating on improvement teams to provide cost analyses for various alternatives open to increase productive time;

actively participating in any decisions to add new capacity to the company for existing products or processes to ensure that purchases are cost-justified; and

supporting all ad hoc analyses of business opportunities and issues to determine the least cost, highest utilization solution to the problem.

Financial practitioners should be involved in every aspect of the capacity cost management system design, implementation, utilization, and maintenance. Serving as a repository of capacity information, the CCM system should be the primary responsibility of the finance function, which should integrate the financial and nonfinancial (operational) information and databases to provide a real-time, flexible, reporting and analysis tool. Ensuring that data integrity is maintained and key cost trends are accurately captured and keeping the reports relevant, with an emphasis on making key drivers of nonproductive and idle time visible, are vital roles played by finance in capacity management efforts.

VII. KEY STEPS IN IMPLEMENTING CAPACITY COST MANAGEMENT

Nine primary steps comprise the design and implementation of a capacity cost management system:

choosing the cross-functional team;

defining the system;

identifying bottlenecks;

creating cost and performance measurements;

defining reporting requirements;

identifying and incorporating existing data;

piloting the system;

providing training and education; and

conducting evaluation and continuous improvement.

As this list suggests, there are many steps in implementing a CCM system that are also common to any major project, while other steps are more unique to capacity initiatives. Choosing a cross-functional team, piloting, training, and continuously improving should always be part of any implementation effort. On the other hand, defining the system, identifying the bottlenecks, choosing specific measurements, and defining reporting requirements are steps that have unique ties to capacity reporting systems.

Choosing the Cross-Functional Team

The development and design of a CCM system requires a solid understanding of system characteristics and capabilities, the capabilities of the supply chain, projected demand (size and type) on the system, and the various costs and revenue implications of resource and system decisions. The CCM system initiative should incorporate experts in each of these vital areas, specifically including individuals from:
- **Marketing**: provides forecast and customer information;
- **Procurement**: helps define supply chain characteristics, constraints, and capabilities;
- **Product design**: details the unique features of the product that place demand on the process;
- **Process design**: provides detail on various process characteristics;
- **Operations management**: helps define existing and potential process capacity, off-loading capability, existing process management, and bottleneck issues;
- **Quality control**: details the process capabilities, rework, and related quality issues such as vendor performance and scrap levels;
- **Information systems**: provides system detail and alternative approaches for storing, analyzing, and reporting capacity results; and
- **Finance**: leads the team, providing cost analysis for the various alternatives and structuring the reporting system.

Finance plays the pivotal role, working in tandem with operations to define the ongoing reporting and management needs that will shape the design and use of the CCM system. The team leader, whether from finance or another function, has significant responsibilities in defining and managing the team process, including:

- defining roles and responsibilities for full-time and part-time team members;
- establishing meeting times and managing meeting details;
- creating deliverable dates and ensuring that the team meets them;
- keeping records of the team’s decisions and analyses for downstream use and for reporting to management;
- providing for smooth communication of project progress, milestones, and open issues for the team and its primary management sponsors;
- developing the pilot reporting system for examination and improvement by the team (straw man development);
- ensuring that all meetings are productive and that any problem issues are handled appropriately;
- recording and ensuring that all deferred problems and concerns are later resolved to everyone’s satisfaction;
- mediating conflicts among team members; and
- ensuring that the final design meets management’s needs and can be maintained with minimal resources.

The team leader should take a leading role in designing, implementing, and maintaining the CCM system, ensuring that the data it includes is reliable, that its analyses are objective, and that all reports are accurate and relevant. The major challenge lies in creating cost estimates that accurately and reliably identify the costs, profits, and implications of various ongoing process and product decisions, given the organization’s existing capacity.

The team should continue to meet throughout the implementation effort, resolving unanticipated problems, providing guidance to the implementation team, and educating the organization on goals and objectives, structures, and meaning of the CCM system. Cross-functional support increases the effectiveness of the effort, as the perspectives and concerns of each affected function and group are addressed early in the design and implementation effort.

The role of senior management in the successful implementation of the CCM system cannot be overstated. Senior management provides the impetus for the design effort, assuring that politics does not derail the initiative or prevent it from
providing the most accurate data possible. In the end, it is senior management who must be able to understand and use the capacity data to guide strategic, tactical, and operational initiatives. They also need to lead the drive toward improving utilization through more effective product and market strategies. The plant cannot fill idle capacity; only management and marketing can achieve this goal. The development of appropriate responsibility for managing the CCM implementation, as well as assigning responsibility for various aspects of capacity management and improvement efforts, should be undertaken by senior management early in the design process.

Having chosen the team members and assigned responsibility for various phases and activities in the implementation, attention turns to defining the system.

**Defining the System**

A CCM system is a systematic measurement process that emphasizes the flow of products and services through key activities and processes. Defining the CCM system entails the following activities:

- defining the processes and activities to be included in the system;
- determining management objectives for the CCM system;
- selecting the critical success factors for the organization that need to be incorporated in the CCM system design and reporting templates;
- reviewing and defining key elements of the process and of the information system that will be used to track its performance; and
- selecting the measurement period for the various data and report structures.

The first step is to understand what parts of the organization are to be included in the CCM system. Both service and manufacturing processes can be tracked through the CCM system, so it is not solely a manufacturing exercise. As the prior accounts payable example suggested, as long as some form of capacity limit can be placed on a system and some measure of its output be made, the CCM system can be applied to the process.

A second major part of system definition is the identification of the objectives the system must meet. There are many different ways to define the boundaries, organize the information, and report results within the CCM system. The determination of how best to capture and report the data must be made based on management’s decision requirements. Is the organization or process in start-up mode? Then emphasis needs to be placed on the effectiveness of the process and its relative costs per manned hour across varying sets of operating conditions. Is abandonment in the future? This turns attention toward the identification of avoidable costs and the flexibility of the process for other uses. While time is an unchangeable force in the CCM system, how the utilization patterns are recorded and interpreted remains open to the design team. The reports should highlight those issues critical to the management of the system, given management’s objectives.

The objectives of the system should reflect the critical success factors of the business. Critical success factors are those features and activities that must be done well for the organization to reach its strategic goals. They are the basis for creating a competitive advantage and should be built on the core competencies of the organization. The CCM system is the source of information on the organization’s effective use of the key resources and core competencies it currently possesses, as well as ways in which these resources can be better deployed through elimi-
nation of nonproductive and idle time. The CCM system can also help identify areas where bottlenecks and capacity constraints may prevent attainment of defined goals and objectives.

The CCM system is a communication tool that uses the language and definitions already in use in the organization. The same holds true for its information system structure. The CCM system should be part of the integrated database, not a stand-alone system. In creating the implementation plan, the project team needs to understand what operational and financial information is already available, where this data resides, what the current capabilities are for integrating diverse data points, and what report writing software will be made available. If the existing information system has shortcomings, attention must turn to finding a cost-effective solution for the problem. Defining and designing the CCM system should be done with an eye toward the underlying philosophy of capacity cost management—to minimize the waste of an organization’s resources. If the CCM system is to live up to its own philosophy, all attempts should be made to use nonproductive and idle information system resources before new costs (and potential waste) are added to the system.

The final issue to be addressed while defining the limits of the CCM system is the selection of a measurement period. Measures that use monthly, quarterly, or annual data are often more useful than daily or weekly data sources because of the costs and complexity of updates. The CCM system should be targeted toward a reporting and measurement cycle that most closely approximates the timeliness requirements of its primary users. If the CCM system is used predominantly as a strategic analysis tool, quarterly and annual data will probably suffice. On the other hand, if operations managers are trying to use the information to drive improvement efforts, daily or weekly data may need to be added to the system. Recognizing that each piece of data and each level of capacity reporting brings with it costs for storing, maintaining, and updating the database, the goal should be to identify the “80 percent” point—the level of detail required to support 80 percent of the capacity-related decisions of the organization.

Identifying Bottlenecks

Once the boundaries of the capacity reporting system have been identified, it becomes important to locate the bottlenecks or pacing resources for each major subsystem. One of the key factors to keep in mind is that each set of linked activities, the process flow, will have its own unique bottleneck.

For example, in the item-processing department in a bank, proof operators constantly wait for documents from branches, other departments, and so on. Although they may have the capacity to produce more good product (i.e., encoded micro-lines), they are constrained from doing so by a required prior activity in the process. The same may hold true in the insurance industry, as underwriters wait to finish processes on a property until the loss prevention department completes its survey of the property.

The goal is not to identify the one and only bottleneck for the entire organization but rather to know for each major process or subprocess where the constraints lie. As suggested by Exhibit 7, the bottleneck can be seen as the neck of a funnel, while the shaded area represents the load being placed on the constrained resource. The output rate, or capacity, becomes the same as the capability of the bottleneck.
This approach, once again, deviates somewhat from the theory of constraints view of capacity management. While it is true that the one dominating bottleneck paces the entire facility, each subprocess has its own unique features. For the CCM system to provide long-term benefit, it has to help pinpoint where the next area of concern should be, especially if several bottlenecks will be tripped at roughly the same time. The incremental cost to increase throughput if only one part of a plant needs to be improved is one thing; the cost to upgrade or eliminate constraints in multiple processes can reduce the attractiveness of an improvement potential.

In other words, not all bottlenecks should be improved. One of the key uses of the CCM system is to identify the bottlenecks and then help management prioritize improvement efforts, based on the economics of the situation. There comes a point at which it does not make sound economic sense to continue improving an existing process—quantum performance improvements require a new system or new process. Without a solid basis for assessing the current and potential costs and benefits of eliminating bottlenecks in the process, an organization can actually “improve” its way into reduced profitability.

The identification of bottleneck resources becomes even more important when the impact of the constraint on throughput and potential profits is considered. As suggested by Exhibit 8, the choice of the optimal production mix for a period of time should focus on the demand each product or component places on the bottleneck. Profitability is maximized if the contribution per constrained hour (e.g., throughput in the exhibit is defined as revenue less variable costs) is optimized. The CCM system should provide the data required to make this type of analysis, given the bottlenecks within existing or proposed processes.
The identification of bottlenecks provides the basis for creating the cost estimates used in CCM system reporting and analysis. Uses made of the bottleneck information include:

- determining theoretical capacity limits for the system;
- providing the denominator for the cost equations within the CCM system;
- identifying and defining the pace of the entire system;
- focusing attention on the point in the process where improvements will yield increases in throughput and potential profitability; and
- identifying the point at which throughput and contribution should be optimized, improving the quality of decisions made when capacity is limited.

These are not the only uses of bottleneck data, but they suffice to illustrate how essential the bottleneck and its effective management are within the CCM system. An organization that does not understand its process bottlenecks, investing resources in improving the capacity of the process constraint, and focusing scheduling and management efforts on keeping the bottleneck actively deployed on products and services desired by the customer, will waste irrecoverable resources and profits. The only place where profits can be enhanced is at the bottleneck. Dollars spent to improve any part of the process that does not directly affect either the final product quality or the performance of the bottleneck are wasted. The power of the CCM system is driven by the simple concepts and relationships on which it is built.

Creating Cost and Performance Measurements

The identification of the bottleneck resource paves the way for creating a series of cost and performance metrics within the CCM system. The types of measures developed include:

- **Utilization metrics**: The key set of measures used focus on the various levels of utilization. These include productive time, idle time (all categories), and all forms of nonproductive time. While other types of measures can be used, a time-based capacity metric provides optimum flexibility in analyzing and comparing performance across multiple processes and time periods. Utilization can be calculated as:
Utilization = \frac{\text{hours available} - \text{hours down}}{\text{hours available}} \times 100

- **Cost measures**: Two dominant cost measures should be created—committed capacity cost by process and managed capacity cost by process.
- **Waste measures**: Any number of waste measures can be used within a CCM system to draw attention to different aspects of the process and its performance. Five major types of waste can be defined: definitional waste (capacity loss due to using some baseline other than theoretical capacity), technical waste (due to unbalanced production or technological shifts), structural waste (embedded costs due to high fixed asset levels), management-based waste (arising from manning policies, focus on earned hours rather than throughput, or adding capacity at nonbottleneck areas), and accounting-based waste (waste in standards or use of absorption costing methodologies).
- **Quality metrics**: Zero defects should be the goal of any process. Defects waste capacity and increase the cost of providing products and services to customers. Tracking the number, type, and economic impact of the different forms of quality (prevention, detection, internal failure, and external failure) is useful. It is also important to ensure that defects are eliminated before they reach the bottleneck resource. Placing quality monitoring and measuring before the constraint brings attention to the waste poor quality creates.
- **Improvement metrics**: Tended over time, the cost per good unit produced, the cost per manned hour, and utilization of manned capacity can provide a basis for tracking improvement. The change in these and related metrics over time make up a fourth category of capacity measures.
- **Profitability metrics**: A series of measures of profitability per minute of bottleneck or process time utilized can be developed to guide the scheduling activity and ensure that in times of capacity constraint that the profitability of the organization is maximized. These metrics can be made part of the ongoing reporting package, indicating relative profitability per unit of capacity consumed over time. Goldratt suggests that dollar days, or the dollar of value of a good multiplied by the days until expected sale, is a good measure of how well the capacity of a process is being deployed. The longer it takes to turn throughput into revenue, the less effectively the system is being managed.
- **Throughput metrics**: The number of good units produced by a process over a designated period of time provides information on its reliability, productivity, and effectiveness. Process owners can maintain these metrics, using them to gauge the level of schedule attainment during the shift and over time for a specific process or area. The stability of schedule attainment is another metric that can be used to assess throughput. Efficiency is yet another form of throughput measure, which is defined as:

\[
\text{Efficiency} = \frac{\text{total cycle time earned}}{\text{total manned hours}} \times 100
\]

This metric emphasizes the amount of time the process or system is effectively creating value for the customer. Total cycle time is derived by multiplying the standard cycle time per unit produced times the number of good units made in a reporting period. Costs not “earned” in this way are classified as waste.
- **Delivery metrics**: Any process can be evaluated on various delivery metrics such as on-time delivery, order fulfillment rates, and number of days late. The goal in tracking these metrics within the CCM system is to link them to the idle and nonproductive capacity analysis and
measures to provide the basis for troubleshooting and process improvement.

- **Human capacity metrics**: In the service industries, the main factor of production is human capital. Unlike human capital used during the periods of rapid economic development, today's human capital is primarily tasked with thinking and has become paid thought output. Given that an organization purchases the most capable thinker in the industry within its budget constraints, an increase in capacity is directly correlated with an increase in efficiency. Service organizations provide inputs to their employees while expecting certain outputs. As management views the ratio of input to return, these inputs become part of the measure of efficiency and management of capacity. Rather than material inputs (although some material inputs may be required in the forms of pens, computers, etc.), the inputs are mostly going to be intellectual (such as training, counseling, and operating instructions). Measurement of the efficient use of these inputs is necessary for capacity management.

These categories of capacity measurements are not meant to be all-inclusive but rather provide a list of potential areas where the efficiency and effectiveness of a process can be gauged in financial or nonfinancial terms. In creating a set of measurements for the CCM system, the goal should be to identify the key metrics that can best be used to signal problems in advance,

---

**EXHIBIT 9. GANTT IDLENESS CHARTS**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Dept or Machine Class</th>
<th>% Capacity to Attain</th>
<th>% of Capacity Used on Day Turn</th>
<th>Details of Expense of Idleness Due to:</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>200 45&quot; looms</td>
<td>80</td>
<td>10 20 30 40 50 60 70 80 90</td>
<td>Lack of Orders</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Lack of Help</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Lack of Raw Material</td>
</tr>
<tr>
<td>C</td>
<td>687 - 54&quot; &amp; 58&quot; looms</td>
<td>80</td>
<td>F47 32 289 2 31</td>
<td>135 10</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>F267 80 85 7 76</td>
<td>1473 52</td>
</tr>
<tr>
<td>D</td>
<td>136 - 65&quot; 860° looms</td>
<td>80</td>
<td>F142 62 432 83</td>
<td>441 94</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Symbol</th>
<th>% Unavoidable</th>
<th>% Increase in Expense of Product</th>
<th>% Avoidable</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>20 868 31</td>
<td>18.2</td>
<td>2210 58</td>
</tr>
<tr>
<td></td>
<td>20 5646 65</td>
<td>18.2</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>20 771 1151 66</td>
<td>18.2</td>
<td>50 10 81 83</td>
</tr>
<tr>
<td>D</td>
<td>30 209 02</td>
<td>36.0</td>
<td>256 65</td>
</tr>
<tr>
<td></td>
<td>30 8 852 3089 80</td>
<td>36.0</td>
<td>33 69 1007 45</td>
</tr>
<tr>
<td>E</td>
<td>20 9 92</td>
<td>18.2</td>
<td>44 86</td>
</tr>
<tr>
<td>F</td>
<td>20 3 10</td>
<td>18.2</td>
<td>38 40</td>
</tr>
</tbody>
</table>

track improvements in critical areas, and support ongoing process effectiveness over time.

**Defining Reporting Requirements**

The metrics chosen for inclusion in the CCM system should be defined jointly with the development of reporting capabilities. Both are driven by the information needs of management, which can be identified using a number of tools and techniques including:

- **Interviews**: Managers can be directly polled to determine what types of information and reports they feel they need to improve their decision making and support their analyses and planning.
- **Review of recent ad hoc information requests**: The finance and operations support group are often asked to prepare ad hoc analyses of various aspects of the production process. Many of these information needs can be met on an ongoing basis by the CCM system.
- **Analysis of process performance**: Examining the process and determining where problems can occur can provide the basis for creating reports

**EXHIBIT 10. CAM-I REPORTING TEMPLATE**

<table>
<thead>
<tr>
<th>Rated Capacity</th>
<th>Summary Model</th>
<th>Industry-Specific Model</th>
<th>Strategy-Specific Model</th>
<th>Traditional Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Idle</td>
<td>Not marketable</td>
<td>Excess not usable</td>
<td></td>
<td>Theoretical</td>
</tr>
<tr>
<td></td>
<td>Off limits</td>
<td>Management policy</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Contracts</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Legal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marketable</td>
<td>Idle but usable</td>
<td></td>
<td></td>
<td>Practical</td>
</tr>
<tr>
<td></td>
<td>Scheduled</td>
<td>Process Balance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-productive</td>
<td>Waste</td>
<td>Rework</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Maintenance</td>
<td>Scheduled</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Setsups</td>
<td>Volume</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Productive</td>
<td>Good Products</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

that help management continuously improve bottleneck or process capability and effectiveness. Gantt charts, as illustrated in Exhibit 9, provide a good source of information for tracking and understanding process performance.

- **Review of the literature**: External publications often provide examples of different ways capacity utilization and effectiveness can be recorded and reported. A recent CAM-I publication suggests the use of a reporting template approach (illustrated in Exhibit 10) and the development of strategic capacity metrics (illustrated in Exhibit 11), just to name a few of the analyses and reports that are developed within the CAM-I capacity framework.

- **Benchmarking exercises**: Visiting best practice organizations in capacity reporting areas can provide another rich source of potential formats, information, and metrics for the CCM system. For instance, Hills Pet Food developed its own capacity reporting and analysis system (as illustrated in Exhibit 12) as part of its ongoing drive to improve its understanding and utilization of its plant capacity.

- **Examination of current reports**: It is not unusual for an organization to maintain some capacity reports even when a formal system for developing and supporting them is not in place. Operational and financial managers should be contacted to find out if they have any existing reports, formal or informal in nature, that they would like to have included in the CCM system reporting package.

- **Variance analysis**: Prior to the implementation of the CCM system it is often useful to complete a variance analysis of existing capacity utilization as illustrated in Exhibit 12.

Whatever source is used to determine the reports that should be incorporated in the CCM system, the goal is to identify them as fully as possible. This ensures that needed data is built into the capacity measuring system and incorporated into the database used to support ongoing report writing. While new reports can be added,
the lack of specific forms of data can make it difficult to respond to new reporting needs in the future.

Identifying and Incorporating Existing Data
The CCM system should make use of existing data wherever it is found. Two primary sources should be explored during the design effort: operational and financial data. Operational data normally includes some measures of downtime (often by cause), current rated capacity for the facility (most often in earned hours), quality and productivity measures, and good units produced. These measures are already familiar to the users of the future CCM system, which can be a benefit if the measures identify useful features of the process or its performance, or a handicap if they fail to illuminate the right features of the process.

Existing operational data can also take the form of machine status data, maintenance reports, and cellular performance tracking data that captures, in real time, key effectiveness and efficiency metrics. Delivery data is often maintained at either the cell or plant level as part of the customer satisfaction or quality databases. The goal is to search for as many existing sources of data as possible. Data becomes information when it is imbued with a purpose. The CCM system reporting and analyses capabilities redefine the purpose behind the collection and analysis of these disparate forms of data.

On the financial side, the presence of an activity-based costing (ABC) system can aid greatly in the design and implementation of the CCM system. Due to its inherent structure, ABC provides information on the relationship between key activities in the process, total process and product cost, and the impact of improvement efforts.
For example, package material may be identified directly to products. Different grades of package material may have a major impact on setup times, types of equipment, and process variability. For ABC and capacity model reporting, this package cost is part of the packaging process.

Having identified existing data sources, it becomes important to determine the optimal way to incorporate this data into the CCM system. In many cases, it is possible to develop linkages within the information system that move data from areas where they are currently collected to the CCM system, without the intervention of any personnel. In other cases, it becomes necessary to reenter data because it is currently too difficult to use in a shared environment.

Since reentering data is a waste of back-office capacity, this solution to a data incompatibility problem should trigger an improvement initiative to create consistency in the databases used by the organization.

In the end, there will be some data requirements that cannot be met using existing sources of data. Creating new data collection routines and methods becomes important when data shortages are identified. New data should be minimized as it has both a cost and behavioral impact on the organization. Whatever is measured is seen as important. If the CCM system requires that certain forms of new data, such as cycle times and nonproductive time by category, be measured and entered into the database, it will draw attention to these areas. In many cases this is exactly what the implementation team desires. In others, it can create undesirable consequences such as mean-ends inversion or misdirection of attention to nonessential events.

Piloting the System
Having completed the design of the CCM system, defined reporting requirements, and identified the sources of data for its use, attention turns to piloting the system. The goals of the pilot effort include:

- identifying data problems and ways in which to bridge them;
- determining if reports can be generated as intended;
- gathering feedback on the value of the planned reports to management;
- identifying areas where new reports or analyses are requested once management understands the system’s capability;
- determining the best way to display reports;
- determining the best way to distribute reports (online, paper, or both);
- identifying flexibility and responsiveness of the CCM system to ad hoc report and analyses requests; and
- testing key metrics to determine their behavioral impact and information content.

It is often useful to pilot the system in one part of the organization before it is implemented across the entire company. The pilot site provides the team with a chance to correct problems and enhance the system’s capability before it becomes widely used. It also provides a basis for assessing the reliability of the system including its accuracy, based on other reports and analyses developed and maintained by the organization. Finally, the determination of the best way to deploy technology enablers to improve the effectiveness, data collection capabilities, and information content of the CCM system is best done while the system is in pilot stage. Exploration, analyses, and adjustment, all key parts of the implementation process, are best completed in a controlled setting with managers who have an openness to change and a
willingness to use the CCM system-based information.

**Providing Training and Education**
The pilot implementation does not need to be completed before the training and education efforts are begun. Training the personnel who will maintain and use the CCM system is a critical part of the implementation. The information contained within the CCM system is often new to the organization. Understanding what it means, how to use it, and the best way to make improvements in performance, based on capacity metrics, represent new challenges to most companies. The learning required to use capacity analyses effectively should not be left to chance—it requires active effort.

All persons who use or are affected by the CCM system should be trained in its structure, constraints, and capabilities. During this training, new reporting requirements as well as potential problems with the system are often identified. In this way the training effort serves to provide the first set of CCM system improvement projects and activities. If the system is still in the pilot stage, these changes can be incorporated rapidly, increasing the perceived value of the system and the level of downstream user buy-in to the initiative.

Training and education are two very different exercises. During training, individuals are given hands-on exposure to the use of the CCM system, including the keyboard commands that are needed to generate reports, access information, or enter data. Education, on the other hand, focuses on understanding the information provided by the CCM system and how best to interpret and use it in decision making, planning, and control efforts. Education seeks to expose users to the “why’s” behind a specific type of report or analyses; training tells them “how” to access the data required. Both efforts need to be undertaken if the true potential of the CCM system for improving performance is to be reached.

It is often helpful to use outside contractors to develop and complete the education and training initiatives. Working with the implementation team, the outside contractor often can find innovative and effective ways to combine education and training into a rich learning experience. Unless the organization has trained educators on its payroll, it is often wise to turn to outside sources for this unique and focused skill set. Effective delivery of the education and training effort can ultimately define the success or failure of the CCM system initiative.

**Conducting Evaluation and Continuous Improvement**
Every aspect of a company’s performance needs to be developed and maintained within an environment of continuous improvement. The CCM system is no exception to this rule. Improvement programs must be instituted as new information needs are identified, data requirements surface, or problems related to the ease of use or usefulness of the system are found. In some cases, the improvement will simply be to make the system easier to use. In other situations, new information needs may surface as users become more comfortable with the CCM system. Serving its customers and the managers of the organization, the CCM system must be constantly examined and assessed to determine if it is meeting critical information needs.

Continuous improvement can also focus on eliminating redundancy or unnecessary detail from the CCM system. During the design phase, it is often better to include data that might be useful than to try to incorporate new data in the system.
after implementation. If data is being collected that is not used in any of the key reports or ad hoc analyses conducted over a reasonable period of time (e.g., one year), it becomes a candidate for elimination. Maintaining a CCM system is not a cost-free exercise. As with all the uses of the organization’s scarce resources, the CCM system must be constantly evaluated to ensure that it continues to provide benefits that exceed its costs.

Once implemented, the CCM system can be used to help an organization optimize its capacity utilization and reduce the costs of operations.

VIII. OPTIMIZING CAPACITY UTILIZATION

Optimizing the value-creating ability of an organization’s or value chain’s capacity is an ongoing, interactive process that constantly evaluates current performance in light of changing customer and market requirements. Optimization can be pursued from several different perspectives:

- maximizing throughput;
- maximizing profitability;
- minimizing total cost of operation;
- minimizing wasted resources (idleness);
- maximizing flexibility and responsiveness;
- minimizing investment; and
- maximizing economies of scale (technology).

Maximizing Throughput

Maximizing throughput is one of the major ways to achieve optimization of capacity utilization. Throughput, or production for which there is an identified demand, is the direct source of revenues. When it is maximized, the resources of the organization are, by definition, being used to their fullest effective level. The easiest way to maximize throughput is to build inventory. If the throughput does not have a ready market, though, it can just as easily become waste.

Unsold inventory does not create value for customers or profits for the organization—it consumes resources in its storage, transaction tracking, and disposal.

A second way that throughput can be maximized is by making those products or providing those services that consume the least amount of the bottleneck resource. This approach is clearly no better than simply building inventory. Maximizing throughput, then, must be pursued through process improvements that allow the organization to respond to customer and market demand rapidly and effectively. Taking waste out of the system and redeploying the freed resources to new production to meet customer requirements is the only acceptable way to achieve optimization through throughput maximization. If this strategy for optimization is pursued, it is important to develop metrics that will signal where dysfunctional or undesirable methods and behaviors are being used to achieve stated throughput objectives.

Maximizing Profitability

Contribution analysis is one way in which an organization can pursue optimization of capacity utilization through a profit maximization strategy. The strengths of this approach are many, including gaining the highest return on investment, gaining the maximum benefit for unit of resource deployed, and providing flexibility for growth through improved profitability.

Pursuing a profit maximization strategy is not without its risks, though. It is often possible to achieve short-term profits at the cost of long-term strategic positioning. For instance, a specific customer or product might be currently consuming significant amounts of capacity without any direct revenue or profit being generated. In the CCM system, this development is seen as productive
capacity utilization. Yet, if profit maximization is the driving goal, it is quite possible that development of new products and customers may be delayed or avoided. While short-term performance may be strong, it is quite likely the organization will lose viability in the long term. Today’s profits always have to be balanced against the long-term best interests of the organization.

If profit maximization is pursued, it is important to build some form of “pseudo-profit” into development efforts to ensure that they move forward according to plan. Once this development use of capacity is safeguarded, the relative profitability of one order or product versus another becomes a logical basis for allocating remaining capacity.

**Minimizing Total Cost of Operation**

Minimizing total costs of operations suggests yet another way that capacity optimization can be defined. In this case, attention turns to finding low-cost alternatives to meeting customer demand, such as moving production to areas where labor rates are low. Any number of approaches can be used to deploy this optimization strategy, including reducing material cost (and quality), substituting technology for people when economies of scale provide savings, and increasing run sizes to achieve a low-cost position.

If costs are minimized, there is no guarantee that profits or performance will be maximized. Since price is set by the market based on the amount of perceived value in a product/service bundle, the very act of minimizing costs can actually reduce the value content of the product and its market price. Profit, the difference between price and cost, is improved when resources are deployed to those products and services that are highly valued by customers (e.g., receive a premium price). If cost reductions remove activities or value from the product/service bundle, they can actually result in capacity maximization and profit minimization at the same time.

**Minimizing Wasted Resources (Idleness)**

There are few reasons not to pursue a reduction in idle and nonproductive capacity within an organization. As a maximization strategy, the implicit goal of this approach is to find ways to redeploy resources to productive uses. Simply eliminating waste will not automatically optimize utilization. The freed resources need to be used to create more value for customers or meet new demand in the market—not to create unneeded inventory. Otherwise there is simply a transformation of one form of waste into another.

Minimizing waste is a viable secondary capacity optimization strategy when joined with profit maximization, for instance. If waste were minimized, then it would appear that either costs are minimized, as managed capacity costs are avoided (committed costs are unaffected by this strategy), or profits are maximized as more throughput is generated with the same level of resources. If the freed resources cannot be effectively redeployed, then it becomes critical to find ways to remove the excess capacity from the system.

**Maximizing Flexibility and Responsiveness**

Flexibility is a critical dimension in an effective competitive strategy in the global environment. One way that capacity optimization can be defined and pursued, then, is by seeking to achieve high degrees of responsiveness to the changing requirements of the market. If this flexibility is highly prized it may lead to price premiums. In a related way, flexibility can provide a solution to other undesirable situations, such as the need to produce to inventory to achieve cost and performance targets.
A flexible system can be easily redirected to new uses. The cost of this optimization strategy is often found in lower efficiencies—a flexible system seldom achieves the same level of throughput and economies of scale as dedicated facilities can attain. Then again, dedicated facilities can fall victim to market shifts in demand or high levels of idleness and nonproductive time, both of which can be avoided if the process can be flexed to meet new needs. The tradeoff between flexibility and efficiency needs to be measured and understood before this strategy is pursued.

Minimizing Investment

Many organizations are turning to vendor partnerships and virtual structures to reduce the amount of investment made in capacity. This strategy for capacity optimization takes a simple approach—minimize the resources tied to the existing product/service bundle. Within a virtual structure, few fixed assets are maintained. Attention is focused on a few core competencies critical to long-term market success. Any non-core activity or resource is outsourced.

The benefits of minimizing investment as a capacity optimization strategy include increased flexibility and responsiveness, reduced inventory risk, and improved returns on investment. The risks, though, come from the precarious nature of the virtual structure—it can survive only if the market conditions are right. Specifically, the organization has to be able to exert enough power in the market to drive suppliers to meet its demands. If industry capacity becomes constrained, it can become quite costly for the virtual corporation to get needed products and services.

There are clearly other ways to minimize investment, including the reliance on leased rather than purchased equipment and plant and the use of people rather than fixed assets for the majority of production. While utilization of capacity may be high in these situations, it is also possible that costs will be higher than in an organization that has a higher level of investment. Unless cost and profit performance is compared to investment levels, these undesirable trends cannot be detected. Once again, the bundling of several optimization approaches provides the greatest potential for overall performance improvements.

Maximizing Economies of Scale (Technology)

The exact opposite of minimizing investment is to pursue state-of-the-art technology solutions to achieve the greatest economies of scale in the industry. In this case, the capacity optimization strategy narrows down to one key dimension—productivity. Buying assets that provide the highest possible throughput and yield can put an organization in an enviable cost position in the industry. It can also, however, place it at risk as technologies or competitive demand change.

The classic example of this problem was the crisis faced by the steel industry in the United States during the 1970s and 1980s. Economies of scale had traditionally been the source of competitive advantage in this industry. As the oxygen-rich blast furnace became available, though, it reduced the benefits of scale. These furnaces could provide the same quality of output in smaller lot sizes at higher levels of efficiency and profitability than the large-scale operations they replaced. Pursuing capacity optimization through scale will always place an organization in a position of exposure and risk if technology advances make these investments obsolete.

It is best to choose several dimensions of capacity as the basis for the optimization effort. Similar to the experience in performance meas-
measurement, a balanced capacity approach (e.g., balanced capacity scorecard) is best. Low cost and profit maximization may be pursued jointly if resources are focused on the areas where cheap resources are available to meet a currently unmet level of demand. For each optimization strategy, the goal must be to identify what business risks each represents to the organization, then choose one or more offsetting strategies to ensure that these risks are reduced or managed.

### Exhibit 13. Responsibility and CCM

<table>
<thead>
<tr>
<th></th>
<th>Business Team</th>
<th>Manufacturing Team</th>
<th>Support Team Human Resources</th>
<th>Support Team Finance</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>Idle</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not marketable</td>
<td>Excess Not Usable</td>
<td>70%</td>
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</tr>
<tr>
<td>Off Limits</td>
<td>Management Policy Contractual Legal</td>
<td>60% 100% 80% 20%</td>
<td></td>
<td></td>
<td>20%</td>
</tr>
<tr>
<td>Marketable</td>
<td>Idle but Usable</td>
<td>80%</td>
<td></td>
<td></td>
<td>10%</td>
</tr>
<tr>
<td></td>
<td>Non-productive</td>
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<td></td>
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</tr>
<tr>
<td>Standby</td>
<td>Process Balance</td>
<td>10% 30% 10% 40% 10%</td>
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</tr>
<tr>
<td></td>
<td>Variability</td>
<td>20% 30% 10% 40%</td>
<td></td>
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</tr>
<tr>
<td>Waste</td>
<td>Scrap</td>
<td>10% 60% 10% 10% 10%</td>
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<td></td>
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</tr>
<tr>
<td></td>
<td>Rework</td>
<td>10% 60% 10% 10% 10%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Yield loss</td>
<td>40% 20% 10% 20% 20%</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Maintenance</td>
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</tr>
<tr>
<td></td>
<td>Unscheduled</td>
<td>60%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Setups</td>
<td>Time Volume Changeover</td>
<td>50% 40% 20% 10% 30%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Product Development</td>
<td>70% 20% 10%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Good Products</td>
<td>80%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Good Products</td>
<td>100%</td>
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Regardless of the perspective used, optimization will not occur unless the appropriate level of responsibility is assigned for results. One way in which responsibility for optimization and improvement of capacity utilization can be assigned is by individual manager or function within the organization as illustrated in Exhibit 13. As the exhibit suggests, the various forms of idle, nonproductive, and productive utilization of the organization’s capacity can be traced to different groups. For instance, the business team has the greatest control over, and hence responsibility for, idle time. The business team has ultimate control over what products and services are provided to customers, in what quantity, and from what source. Management fills idle capacity—the plant cannot accomplish this feat.

On the other hand, the manufacturing team has the greatest degree of control over nonproductive time and therefore should be charged with improving these results. The exception to this is in the area of changeovers, where once again the management team has significant influence (50 percent). Inventory and batch size policies normally begin with top management, who set limits and define objectives in this crucial area. If small batches are required, then the number of setups will increase. The manufacturing team responds to the schedule developed by management, having little direct control over the nonproductive time setups can create.

The goal in assigning responsibility for various forms of capacity utilization is to ensure that action is taken to make improvements. An effective control system seeks to assign responsibility for outcomes to those persons or units that can best influence them. Accountability and controllability must be matched if the CCM system is to be accepted by the organization and provide useful insights and learning for the managers who access or control it.

Responsibility for various forms of nonproductive, idle, and productive capacity does not always reside inside the organization. Major customers can have a significant influence on the effectiveness of capacity utilization, as illustrated in Exhibit 14. For instance, Customer A is seen as driving 20 percent of the idle but marketable category of capacity. Perhaps this customer has suspended shipment on a scheduled order or reduced the size of its shipments under a blanket order. This capacity is available but has been set aside for this customer. It is up to the management team to work with the customer either to increase shipments or release the capacity for other uses.

Since Customer A currently accounts for 30 percent of the good production of the facility, it would seem best to find ways to focus on it to find ways to reduce nonproductive time, such as yield loss, and idle but marketable time. This is a significant customer who should be approached as a partner to identify ways to increase capacity utilization and thereby lower the costs of meeting existing and future demand. It may be necessary to share in efforts to improve yield as well as the cost improvements this initiative provides. The lessons learned by organizations deploying effective integrated supply chain management suggest that these joint efforts can have major payoffs for both parties.

Within the field of performance management, it has long been recognized that an organization will get what it measures and rewards. Without the proper assignment of responsibility for capacity utilization, with the ability to control results, the CCM system will not achieve its ulti-
mate objective—optimization of the organization's resource capacity. Optimization cannot be achieved without clearly identifying what is desired and who will be held accountable for attaining defined goals. The CCM system is, in the end, a performance management tool that has to be actively managed to ensure it creates desired behavior. Whether the desired behavior results from improved decision making based on the data provided by the CCM system or as an outcome of assigning responsibility for achieving utilization objectives is not the issue. Defining and driving the organization toward capacity optimization must be the basis for designing and using the CCM system.

<table>
<thead>
<tr>
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<tbody>
<tr>
<td></td>
<td>A</td>
</tr>
<tr>
<td>Idle</td>
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<td>Idle but usable</td>
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<tr>
<td>Standby</td>
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</tr>
<tr>
<td>Process balance</td>
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<tr>
<td>Variability</td>
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<td>Waste</td>
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</tr>
<tr>
<td>Scrap Rework</td>
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<td>Scheduled</td>
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<td>Setups</td>
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<td>Good products</td>
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IX. CONCLUSION
The design and implementation of a capacity cost management system provides a company with many benefits, including the ability to improve its profitability and increase its productivity. Highlighting areas where improvement efforts can be expected to yield utilization or throughput gains, the CCM system is the source of vital information on the effectiveness of resource deployment.

The CCM system is a reporting and communication tool that can serve many purposes and many users. Providing the means to drive out waste, improve yields, and increase management’s ability to understand and influence key processes, the CCM system is a vital part of the total information system in any firm, whether manufacturing or service.

Capacity management applies to the service industry as much as it does to the manufacturing industry. It has become just as important for service organizations to understand the capacity of the human capital they employ as it is for the automobile manufacturer to understand the capacity of its robots and other equipment. The CCM system should be thought of in the same manner one thinks of the speedometer and fuel gauge of a car. The CCM system is just one more performance measurement instrument to guide the organization along its course.

BIBLIOGRAPHY