Trane's SOUP Accounting

It's a system of utter practicality!

BY RONALD B. CLEMENTS AND CHARLENE W. SPOEDE, CMA

MRP II, JIT, CIM, TQC, TQM, SPC, ABC, and TCM[1] are just a few "cures" that are supposed to bring American manufacturers to "world-class" manufacturing status in the 1990s. Which "pill" or combination dose of pills is the real remedy, and how do we design a cost accounting system to support this new wave of alphabet soup solutions?

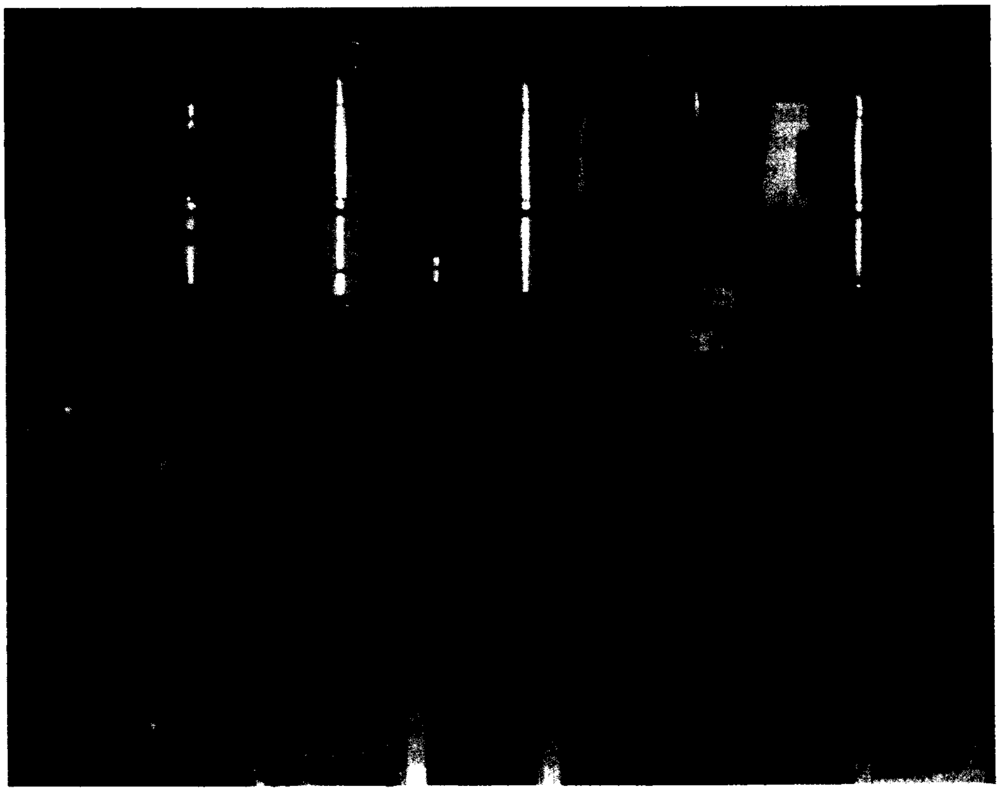
When faced with this dilemma at the Trane Co., we blended some of the new ideas with traditional approaches to create a cost accounting system for our business. Our system may not work for others. We learned through our experience that there is no recipe that will work for all companies, but our approach may provide a guide to how you can design your own system to meet your own goals with simplicity and low cost. The mechanics of our cost system may seem relatively easy when compared with the management decisions that are required to change and improve your business.

The Trane Co. is an operating sector of American Standard, a leading worldwide producer of air conditioning systems, bathroom/kitchen fixtures and fittings, and a major European manufacturer of commercial vehicle braking systems. Sales for 1991 were $3.6 billion. The Trane Co. plant in Pueblo, Colo., produces water chillers for commercial and industrial building air conditioning applications.

Trane business systems and manufacturing processes use ingredients from all of the alphabet soup solutions just mentioned. We are not dedicated to any single one because we have found we cannot totally ignore any of the approaches. Each concept has some advantages that can improve manufacturing processes dramatically. We refer to our new manufacturing efforts as demand flow manufacturing (DFM), a variation of just-in-time (JIT) to which we have added our own unique features. Because our manufacturing system uses many of the alphabet soup philosophies, we refer to our new accounting system, developed in tandem with new manufacturing procedures, as SOUP (system of utter practicality) accounting.

Any project of this magnitude requires the complete support of top management and the entire management team. Inasmuch as the cost system interacts with all other functional areas, cooperation, compromise, and willingness to consider new ways of doing things are required in order to make major changes. The common mission of "world-class manufacturer" must be shared by the entire leadership team, and company culture must be favorable to change.

As we wanted to move quickly, we decided to develop our new manufacturing procedures and our SOUP accounting system in a brand-new environment. Our objective was to start up a plant in Pueblo, Colo., using everything new—hu-



Trane employee shows one of the water chiller units, produced via demand flow manufacturing.

man resource philosophy, products, processes, technology, and business systems—at a new location with new people and a culture of continuous improvement. We wanted to give our ideas every opportunity to succeed.

Of course, whatever can be done in a new plant can be done in an existing facility also. The only differences are the priorities of what must be done and the additional time that may be required to convince all members of the team to embrace the ideas and help develop the new system. Priorities will vary based on the specifics of a particular manufacturing facility and are determined by spotlighting where the greatest benefits can be achieved. In an existing facility the major obstacle to change often is the attitude, "We have been doing fine," and "If it ain't broke, don't fix it." Unfortunately, a financial disaster often is required to create the survival environment where people are impelled to break old patterns of behavior.

Our Pueblo plant is designed to manufacture four distinct product lines, each in six to eight size ranges. Additionally, we produce four different subassemblies, also in six to eight size ranges, for affiliated plants. Our business is a custom sales order business in which we build each unit to a unique order based on the customer's selection of standard features and options from a large number of possible combinations. A potential customer could order one of 60 million distinct product configurations.

Our overall business philosophy is to deliver a quality product in minimum time while controlling work in process through the use of our DFM system, which pulls materials as needed similar to the way a JIT KANBAN system operates. This philosophy is supported by a quest for simplicity and lowest total cost. Our cost accounting system must complement and support this philosophy. Thus the expense to collect detailed cost information must be justified and truly must add value. In addition, the cost system to support this new business must support our external reporting requirements as defined by the Securities & Exchange Commission, the Internal Revenue Service, and generally accepted accounting principles.

POLICY DECISIONS

After much discussion, we decided to retain a standard cost system. Our preference for a standard cost system is driven by corporate policy and our tax conventions with the IRS but, more important, from our desire to monitor cost changes. Most of our product cost consists of materials. A standard cost system exposes material cost changes, especially material costs as a result of bill of material changes and part substitutions.

In addition, the use of conversion labor and overhead standards allows for easy unit-level conversion costing. The key considerations when developing conversion (labor and overhead) standards are:

1. Our guiding motto is "approximately right" or "close enough."
2. You don't need a significant amount of engineering input.
3. An annual review for each cost pool should be adequate.

In the past, considerable time and effort had been devoted to achieving *precise* labor and overhead costs. We decided that the time and resources devoted to achieving this previous degree of precision was not cost-benefit effective and, in fact, encouraged a misguided level of confidence in the final numbers. Although engineers traditionally have been used to develop overhead standards, you, as a financial manager, should have access to all the necessary information to determine the total costs of any pool, including direct costs and any allocation methodology. Once you have the total costs you need to decide only how many units will be pro-

OPERATING RULES FOR COST SYSTEM DESIGN

1. **We will use a frozen standard cost system based on absorption accounting. Full absorption will be at 85% of capacity (corporate policy).**

   [This met our need for consistency within the corporation and reporting to external entities. Also, it matched our preference for a standard cost system.]

2. **All labor and overhead required to convert raw material into finished goods are defined as conversion cost and added only at major subassembly points or upon completion of the units.**

   [We need to cost a completed unit as it ships out the door to relieve inventory and match costs with revenues, but we do not need a cost for each individual part or subassembly. At this point, most people ask the question, "What about service parts?" We decided to design the system as if we did not have service parts. Then we came back later and added the complexity needed, but only for the service parts, not all the parts in the system.]

3. **There will be no detailed labor reporting because direct labor is less than 5% of product cost.**

   [Our experience told us that the cost—people and computers—required to track actual labor would never pay for itself in the form of savings.]

4. **Purchased parts will be issued by backflusing at major assembly points or for completed units. All plant materials are stored at point of use. There is no stockroom.**

   [This reduces the material handling cost and eliminates the need for stockroom personnel, who add no value to the process.]

5. **All low-cost items (nuts, bolts, screws, labels, and the like), which represent 76% of our part numbers but only 3% of the total cost of the product, will be carried on the bill of material as $.00 cost. These items are expensed to manufacturing overhead when received.**

   [This means we don't review standards each year and we don't measure any purchase variation from standard. At the same time, we left these items on the bill of material so our MRP II system will plan them and they are available for service parts analysis. Because historically we had shown labor and material costs to four decimal points on the bill of material, this was one of the more controversial decisions we made.]

6. **Conversion costs will be grouped by cost pools that bear a direct relationship to distinct processes within our plant. The number of cost pools will be minimal.** ■

cessed through the cost center to absorb the cost and what "driver" within the cost center will be used as the base to allocate the costs to the units. Most of these choices are policy decisions.

Clearly the standards are not precise, and you expect some variation, so there is no need to update them constantly. We have found that, unless major changes occur, an annual review of the pools and the allocations within each cost pool are adequate to provide sufficiently accurate information for our financial statements. Rather than rely on unit variance information, most managers base overhead control decisions on total costs incurred.

Our business computer system included a prepackaged, integrated, closed-loop system. We decided that the mechanics of our cost system must operate within the capabilities of this software *without* program modification. The use of an integrated database software improved our ability to eliminate redundancy in our cost system. Transaction data needed to be entered into the system only once. In addition, we found we can eliminate 80% of the paper and transaction detail if we so desire. A model of our cost and management system structure is shown in the illustration in Figure 1.

COST ACCOUNTING SYSTEM OBJECTIVES, PHILOSOPHY, AND IMPLEMENTATION

With this background, we set out to design a cost system with the following objectives and philosophy. Our major guidelines to achieving these objectives are keep it simple, and keep it low cost.

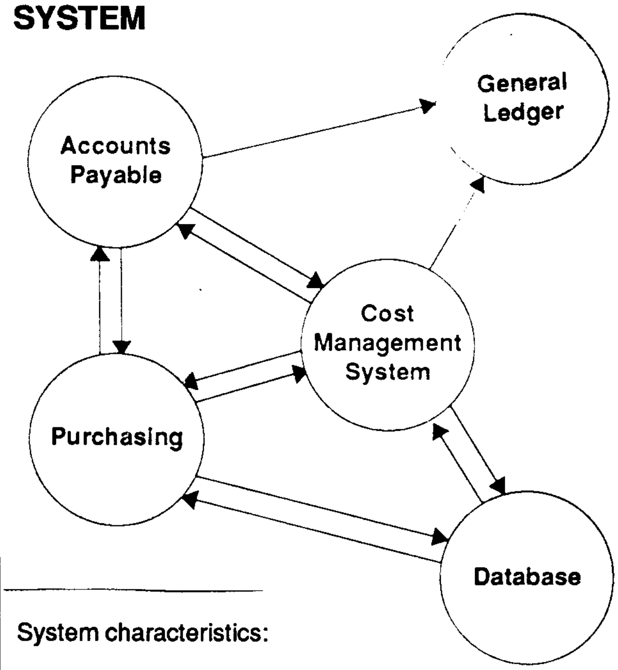
- The cost system is a subset of the business philosophy. It must fit and complement the business philosophy and reflect plant operating characteristics.
- The cost accounting system should be *simple*.
- The cost accounting system operation should be *low cost*.
- The system should eliminate artificial, unnecessary reporting steps.
- The system should *not* reward production for building inventory.
- Accounting exactness *does not equal* accurate product cost.
- Cost the unit but not each individual part.
- Eliminate detailed labor reporting—labor and overhead are combined into conversion cost.
- Apply conversion cost based on total product cycle time (or some other base you deem appropriate).
- The cost system must meet the external reporting requirements as set forth by the SEC and the IRS and must meet GAAP.

Based on these objectives, overall philosophy, and guidelines, we developed the detailed operating rules discussed in the sidebar on page 47. Once we had established these guidelines and rules, we proceeded with implementation. As you might expect, all rules and guidelines weren't fully developed at first. Some of them evolved over time as we got into more detail and understood the limits of our software and the limits of our bill of material structures.

While we were developing the cost system, Trane's materials people were designing a bill of material that was modular and flat (four levels maximum). It had none of the traditional bill of material subassembly relationships. Look at Figures 2 and 3. Figure 2 portrays a traditional bill of materials for a wagon, while Figure 3 shows a "flattened" version.

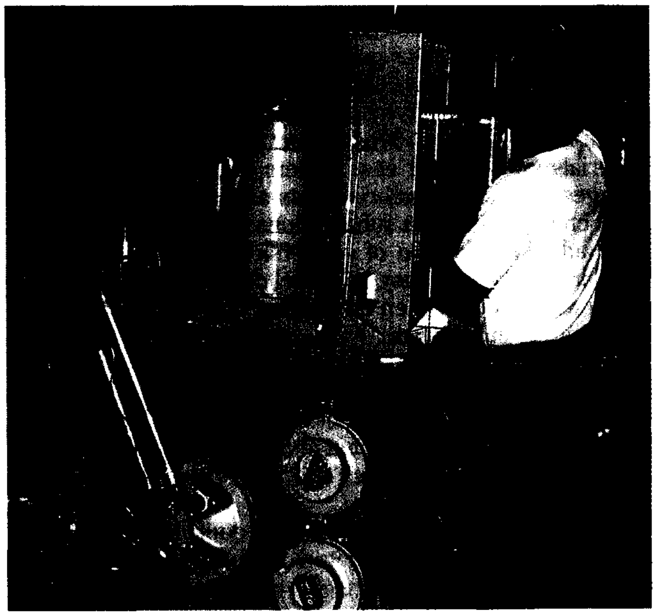
With a traditional organization, Trane's bill of materials might have 10 to 12 levels, which are indicative of the number of levels of subassembly. Manufacturing, engineering,

FIGURE 1/CLOSED-LOOP BUSINESS SYSTEM



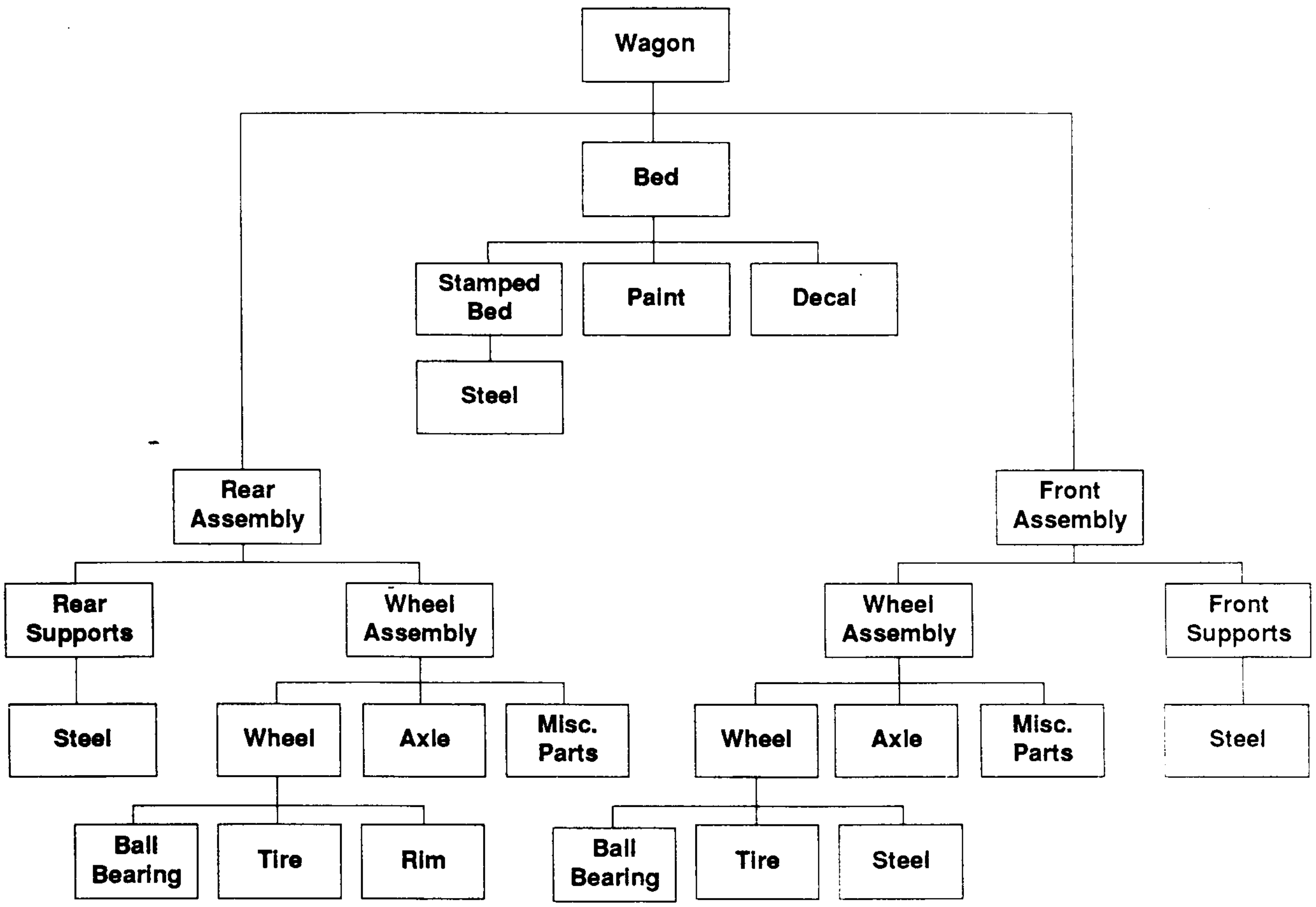
System characteristics:

1. Online purchase order, material receipt, and accounts payable match (quantity and prices).
2. No paper used between purchasing, receiving, and accounting.
3. Integrated for material standards, purchase price variation, inventory valuation, unvouchered liabilities, and voucher interface to the general ledger.



Trane's production management uses no computerized shop floor control or labor reporting system. Employees work on individual units as a whole.

FIGURE 2/TRADITIONAL BILL OF MATERIALS



and finance no longer needed these relationships to be defined in the bill of material. Each functional area had determined independently and jointly that the expense of maintaining these traditional relationships in the bill of material did not provide any value to the business. Thus they were abandoned in favor of the modular BOM.

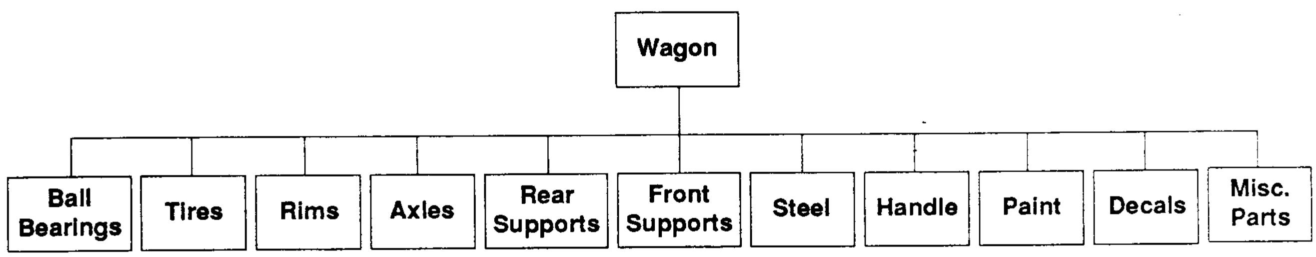
Many benefits resulted from designing a flat bill of materials. Business operations were simplified, and the ongoing cost of running the business was reduced. The new bill of materials design reduced the number of part numbers in the system, the number of engineering drawings, and the number of parts to cost.

Many times during the implementation process we found ourselves making decisions that could have added complexity to the system. We resisted these temptations as best we could. Any feature or option that might have been added to the system was left out if it didn't get a usage factor of 80% to 90%. For example, if a repetitive process applied to only 10% to 20% of our units, we did not attempt to track the cost of the double processing to the specific units. Also, we left out anything that we "might" need in the future because we felt we could always add features to the system, but we knew from experience that we would never take them out of the system.

COST POOLS

We defined the plant's conversion cost pools as illustrated by the plant layout in Figure 4. Our manufacturing plant is extremely capital intensive. Cost pools are differentiated mostly by capital intensity and are

FIGURE 3/FLAT BILL OF MATERIALS



broken down by distinct processes. Each cost pool represents the completion of a major assembly or the entire process to assemble a complete product.

Our efforts were simplified by three factors:

1. Our plant has very few assets that are used in multiple processes or products. Our assets are set up by process, and parts are not trucked throughout the plant.
2. We have been very aggressive to outsource as many "low tech" parts as possible, which simplifies our manufacturing plant and supports our demand flow philosophy.
3. Production management did not want or need any form of computerized shop floor control system or labor reporting system. Production flow is regulated by a series of KANBAN-type systems, is synchronized by the production master schedule, and operates based on a philosophy of one-piece flow. That is, the transfer batch between stations is one unit.

The conversion cost pool is a grouping of costs that are representative of a distinct process in the plant. The costs included and the magnitude of these costs are illustrated by the Cost Conversion Pool–Widget (R) in Table 1. As you can see, there are some allocations (for example, from engineering) to the cost pool, but, for the most part, these costs are actual direct costs based on a representative sampling or an extrapolation of actual cost at a lower production volume base. Table 2 shows how the total costs from the Cost Conversion Pool–Widget (R) would be allocated to the different size ranges produced.

Unfortunately, a financial disaster often is required to create the survival environment where people are impelled to break old patterns of behavior.

PERFORMANCE MEASURES

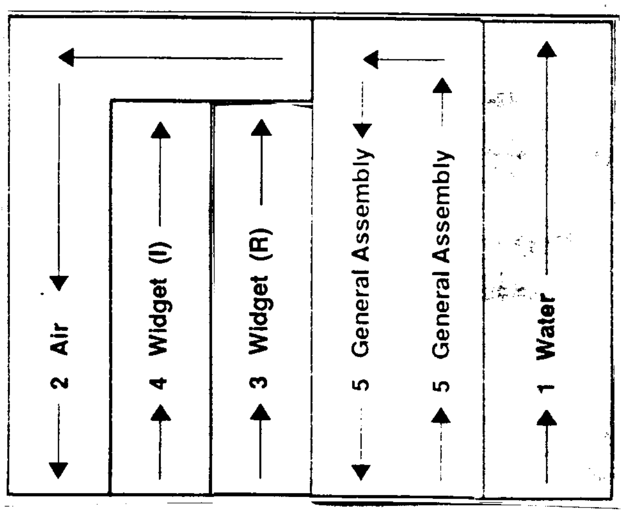
The issue of performance measures in our new environment created an additional challenge. We wanted to be careful not to put a series of measures in place in the organization that would lead to optimization of local areas to the detriment of the manufacturing system as a whole. Our criteria for performance measures were:

1. They should be few (five or fewer).
2. They must be understood clearly by all employees.
3. They should be calculated from readily available data.
4. If the measurement were a true global measure, the absolute number is not of primary importance. The trend rate and the rate of change are significant.

We finally settled on the following *six* measures:

1. *Sales Per Employee.* This measure is simple and is one to which all employees can relate. It emphasizes the output of the entire system versus some other measures that tend to emphasize local optimization rather than optimization of the entire system.
2. *Inventory Turnover.* This is a measure of the velocity of the system and a trend indicator for cash flow. It reflects the rate of conversion of purchased materials to cost of

FIGURE 4/PLANT LAYOUT AND COST CONVERSION POOLS



The arrows indicate flows.

The numbers 1 through 5 represent the total number of cost pools in the plant that reflect one cost pool for each product.

TABLE 1/COST CONVERSION POOL—WIDGET (R)

DETAILED COST ANALYSIS[1]

Cost Category	Basis	Annual Cost
Building	Square Foot (%)	$ 94,000
Depreciation		
Machining/ Assembly	Assets	517,000
General/Factory/ Maintenance	Square Foot (%)	23,000
Taxes	Capitalization	166,000
Labor and Benefits	Number of People	1,035,000
Engineering	Number of Engineers	371,000
Maintenance	Extrapolation[2]	45,000
Hard-to-Measure Materials, Supplies, Spoilage, Waste, Disposal, Other	Extrapolation[2]	559,000
Total		$ 2,810,000
Average conversion cost per widget		$ 2,810[3]

[1] Number of widgets produced 1,000
Capacity 1,175

[2] Based on an extrapolation of actual costs charged to the conversion cost pool.

[3] The total cost to produce 1,000 widgets is $2,810,000, or an average conversion cost of $2,810 per widget.

TABLE 2/WIDGET COSTING ANALYSIS[1,2]

UNIT MIX ANALYSIS

Size	% of Total	No. of Units Produced	Cycle Time Basis[3]	Total Cycle Time	Conversion Cost Per Unit
10	15%	150	100	15,000	$2,626
20	35%	350	100	35,000	$2,626
30	30%	300	110	33,000	$2,888
40	20%	200	120	24,000	$3,151
		1,000		107,000	$2,810 (average)

Total Cost $\frac{\$2,810,000}{107,000} = \$26.26$ (Each conversion allocation unit for 1,000 widgets is costed at $26.26 per widget.)

[1] Defined capacity of widgets is 1,175 per year.

[2] Costing policy is 85% of capacity.

[3] Cycle time reflects machine time plus line assembly time. Size 10 is the basis of the calculation, and size 40 takes 20% more machine and assembly time.

TRANE'S PLANT OPERATING CHARACTERISTICS

Overall Plant Philosophy
- Flat organization,
- Hold overhead to absolute minimum (lower cost/higher risk),
- Err on the side of simplicity (KISS),
- Challenge every assumption,
- The only constant is change.

Work Cells
- Equipment grouped by product not process,
- Limited supervision (50 to 1),
- Work cell leader rotates every 60 days,
- Only three labor grades throughout plant,
- Job rotation is a requirement for everyone,
- No shop floor labor reporting.

Reduce Work-in-Process
- Velocity driven, not batch driven,
- No repair stations,
- No inspectors.

Outsource Aggressively
- All sheet metal,
- Manufacture where you add value,
- Rings of defense.

Reduce/Streamline Material Handling
- Receive/ship at point of use (13 trucking doors),
- No central stockroom—materials stored at point of use,
- Cycle count regularly—top 50 dolloar items monthly.

Material Requirements Planning (DFM)
- MRP gets material to plant—DFM/MPS controls flow within plant,
- Shallow bill ofmaterial (four to five levels maximum),
- Bill of material accuracy goal equals 99%,
- Only one company bill of material,
- Sales order business (six to 10 orders a day),
- Standard options/features equal 60 million possible combinations.

Cycle Time
- Order processing, one to two days,
- Material planning, 30 to 50 days,
- Production, six to 16 days (25% to 50% of industry average),
- Widget manufacturing on continuous shift (seven days a week, 24 hours a day).

Production Management
- Master production schedule is bible (what to make—build parts to schedule),
- No computerized shop floor control (KANBAN type control),
- Flow manufacturing—tooling and fixtures—visual aids standardization (how to make),
- Minimum shop paper (no route sheets),
- No production control department/no industrial engineering department/no quality department/no timekeeping department,
- Visual shop floor control system (KANBAN style).

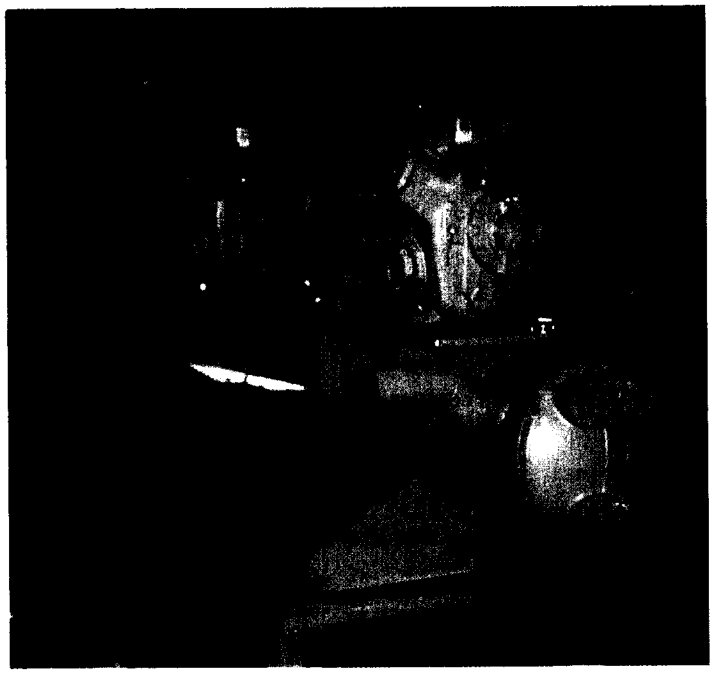
THE COST ACCOUNTING SYSTEM PROCESS

- Material, which is 70% of product cost, is backflushed at unit completion.
- Conversion cost (labor and overhead combined) is applied at unit completion.
- There is no labor reporting. Efficiency and rate variations are not tracked.
- Low-cost parts expensed to overhead:
  4% of BOM (bill of material) cost equals 76% of total BOM parts.
  96% of BOM cost equals 24% of total BOM parts.
- Work-in-process estimates are adjusted quarterly to reflect current production rate and manufacturing cycle time.
- Bill of material is modular, with a direct relationship between sales features and options, and reflects "pile of parts" concepts.

sales.

3. *Customer Services Costs as a Percent of Sales.* This is the cost of field service on shipped products during a 12-month warranty period.
4. *Manufacturing Cycle.* This measure tracks the time in days it takes to convert raw material and purchased parts into a finished product. (Order processing was not an issue as it already had been reduced to one to two days.)
5. *On-Time Shipping Percent.* The percentage of time we ship customers' orders when we say we will ship them is revealed by this measure.
6. *Return on Net Assets (RONA).* This is pretax income divided by the average net assets employed in the business.

These performance measures meet our requirements. Only RONA needed a significant amount of explanation to bring all of our employees up to speed on the various performance calculations and their meanings.



In Trane's SOUP accounting, the units (such as this water chiller) are costed, not the individual parts.

Any new cost system, no matter how simple or streamlined, should not compromise your audit or internal control requirements.

EFFICIENCY AND CONTROL

When you are developing a new cost system, you need to understand that the move toward simplicity and the reduction of accounting transaction detail does not mean a lack of control. In fact, we believe it is just the opposite. Our previous obsession with accounting exactness and direct labor reporting to the minute and to the nearest cent distracted us from what really was important. To retain the reporting of direct labor efficiencies or indirect labor ratios—or any other traditional form of labor reporting—will guarantee your DFM efforts will fail. These reporting mechanisms encourage your production organization to build parts that aren't needed or to build parts before they are needed. As you eliminate excess inventory and drive down the dollars of inventory in work in process, your traditional manufacturing efficiencies measures will get significantly worse in the initial stages of the implementation. Consequently, the first time you point out to the production organization that labor efficiency is declining, you will have torpedoed your entire DFM project. Also, any new cost system, no matter how simple or streamlined, should not compromise your audit or internal control requirements. It is just that these elements of your business are now viewed from a different perspective.

We believe you need to examine all of the techniques available in the alphabet soup library and apply only those techniques that fit your business goals and objectives. Trane's plant operating characteristics, as developed in response to the new techniques adopted, are summarized in the sidebar on page 51. Once plant operating characteristics have been defined, your cost system must be designed to provide the information required to support the manufacturing system. The sidebar also outlines a description of Trane's cost accounting process. Whatever you do, in designing manufacturing processes or in designing cost accounting systems, you cannot overemphasize the need for simplicity. ■

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[1]For a refresher: MRP II is manufacturing resource planning, JIT is just-in-time, CIM is computer-integrated manufacturing, TQC is total quality control, TQM is total quality management, SPC is statistical process control, ABC is activity-based costing, and TCM is total cost management.

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