USE MANUFACTURING STANDARDS TO DRIVE CONTINUOUS COST IMPROVEMENT

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Manufacturing standards are used in plants for planning capacity, scheduling, setting performance-based wages, determining product cost, and innumerable *ad hoc* process improvement analyses. This multitude of applications for manufacturing standards hides a more significant use. Manufacturing standards can also be used to direct day-to-day management efforts towards optimizing overall plant cost performance. The traditional uses of standards (planning, performance evaluation, and costing) can be integrated with new management thinking (responsibility accounting, activity-based management, and world-class manufacturing) to create a plant-focused method for cost improvement. Daily use of such a management approach will perpetually reduce plant costs.

TRADITIONAL USE OF STANDARDS

A new continuous-improvement approach is based upon the traditional uses of standards. The most traditional use of standards is for defining the expected performance of a manufacturing process. Expected performance is used for production planning, performance measurement, and product costing.

The most common examples of using standards for production planning are in material requirements planning (MRP) applications. In an MRP environment, material yield standards drive material requirements, and throughput standards are used to determine required capacity. One popular MRP package (used by several major food processors) requires a standard for crew, throughput, yield, shrinkage, and efficiency to support planning for each bill of material (BOM) level.

A second type of manufacturing standard is often applied when measuring performance. Such performance standards are based on time and motion studies and rated (theoretical) machine capacities. In practice, many manufacturers adjust these theoretical standards for performance measurement in order to achieve specific behavioral results. Some research indicates maximum worker productivity when the performance standard is set at 140% of the engineered standard [2].

A third variation on standards is the product cost standard. This standard typically includes the usage of direct materials, labor, and factory burden in a proportion designed to fully recover total costs. Product cost standards often are compared to actual costs in labyrinth reports. These reports form the backbone of most cost accounting systems, and are used as the basis for resource allocation, product pricing, and product-line decisions in many companies.

Manufacturing standards have a rich history as critical features in manufacturing environments for other planning, measurement, and control purposes [8] such as:

- **Scheduling.** Promised deliveries are based on standard machine rates and staffing.
- **Capacity planning.** Plant size and line balance are based on the standards set for a manufacturing cell.
- **Setting performance-based wages.** Piecework compensation rates are used for making baseballs, flags, and sales calls.
- **Resource allocation.** Paybacks on capital investments are justified by improvements to standards multiplied by expected volumes.

Traditionally, developing and utilizing manufacturing standards have been limited to the purview of industrial engineers. This is because standards are hard to keep current, difficult mathematically to construct, and are often inconsistently applied. Even companies which can maintain a standards database most often underutilize it. Much of the difficulty in creating and maintaining standards lies in integrating their various traditional applications into a consistent management framework.

Integrating existing applications is now possible through the use of database systems (PC-based or larger) and the transferability of data from other business systems, such as MRP, engineering, cost accounting, and general ledger. The details of implementing such a standards database are not trivial, yet several companies have brought this type of management tool to life in their plants. These companies have organized to deal with the complexity of such systems by building

on current technology, which has evolved to handle the volume and speed requirements of the application.

As a result of new technology, the traditional uses of standards can be melded into new production management tools. In contrast to these technological advances, the development of a suitable management framework to drive cost improvement has lagged. In light of the new technologies, practitioners and academicians are now revisiting the objectives of standards-based management systems and the methodology for effectively using them.

NEW OBJECTIVE FOR USING STANDARDS

Plant controllers and managers charged with bettering cost performance have identified their top priority as improving the *usefulness* of reported information [10]. This need for usefulness, reported by surveys years after Johnson and Kaplan [4] had declared the relevance of traditional cost accounting lost, reflects the view in both industry and academics that a new methodology for cost management must be found [1].

The new objective for using standards in cost management is to increase the usefulness of the resulting information. Information will be truly useful if it:

- Focuses attention on the biggest opportunities
- Provides insight into the root causes of poor performance
- Aides managers in quickly reducing total costs.

To meet these objectives, standards must be used with a well-structured approach—a continuous cost-improvement methodology.

A useful, new, continuous-improvement method has been developed which simply integrates the established uses of manufacturing standards. This standards-based cost management approach combines the proven usefulness of traditional manufacturing standards with elements of world-class manufacturing (continuous improvement), responsibility accounting (plant-controlled costs), and activity-based management (elimination of allocations). This cost-improvement methodology meets the new objectives, utilizes a strong dose of common sense, and is similar to approaches described by several other authors [6].

THE COST-IMPROVEMENT METHODOLOGY

Managers find that standards are truly useful when utilized in a systematic way to answer fundamental questions such as, "How many could we make?" "How much should it cost?" and "Am I doing this as well as I could?" A standards-based continuous-improvement program answers these questions, thereby giving managers a basis for directing an organization's limited resources to the highest dollar-valued improvement opportunities.

The system which supports a continuous-improvement methodology contains these four elements:

- Standards are used to define and numerically describe the theoretical manufacturing process.
- Actual production results are entered into the system.
- Improvement opportunities are then quantified as the difference between the standard performance and actual production data.
- The daily set of improvement opportunities are filtered to present only the most significant, in a way that links the opportunities to both events on the plant floor and their impact on financial reports.

These elements are applied to every production lot and every line in a plant, every day. Timing, coverage, and consistency are important elements of the system, but it is the final element noted above that marks the real departure from historical approaches. While daily variance reports have been a common tool in many systems, missing have been reports structured to aid prioritization, problem solving, and financial analysis.

Once this type of underlying standards-based reporting system is in place, plant managers follow a three-step process to employ the continuous cost-improvement methodology:

- Identify the significant cost-improvement opportunities
- Control manufacturing events to realize cost improvement
- Demonstrate plant cost improvements in company financial reports.

STEP ONE: IDENTIFY THE REAL COST-IMPROVEMENT OPPORTUNITIES

Real cost-improvement opportunities are found in the difference between actual cost performance and the theoretical best (theoretical efficiency is determined from engineering time studies, rated machine capacities, formula yields, and standard prices). Comparison of actual costs to the theoretical best measures the *real* improvement opportunity. Unfortunately this measure has not been the simplest to apply and, as a result, plant reporting tools have typically included less helpful data, such as:

- Variances to padded standard costs rather than to theoretical manufacturing standards

TABLE 1: Traditional Manufacturing Report

	Current Period Costs						
Product	*Labor*	*% Var.*	*Material*	*% Var.*	*Burden*	*% Var.*	*Total*
#3130	$64,600	(3%)	$452,200	(2%)	$129,200	(3%)	$646,000
#4619	$48,700	(1%)	$340,900	2%	$97,400	1%	$487,000
#4615	$223,800	0%	$1,566,600	(1%)	$447,800	(2%)	$2,238,200

- Indirect and noncontrolled costs mixed up with controlled costs
- Manufacturing performance reports showing percentages and quantities, but not costs.

The most misleading performance measure in plants today are positive variances to artificial standards. Plants have been forced closed by lower cost competitors while managers reported positive production variances to the very end! Instead of managing to measures available from traditional reports, managers really need to manage out the excess costs of labor, materials, and indirect resources. Excess costs are *all* costs beyond the theoretical best. Managers who know the magnitude of all excess costs can focus immediate attention on eliminating the biggest excess costs.

To illustrate the contrast between traditional measures and the information management really needs to maximize performance, consider the likely management decisions made from the reports shown in Tables 1 and 2.

Based on the information in Table 1, a manager may decide to shave labor costs from product #3130 and to reduce overhead expenses. Unfortunately, these actions will have very little impact on overall cost performance. In order to take more effective action, the manager would need to manage from other, most likely informal, information systems.

Table 2 illustrates how theoretical standards and actual cost data directly focus a manager's attention on the best cost-improvement opportunities. If the report in Table 2 were provided to the same manager, she will put a priority on reducing material losses on product #4615. She will find out what controllable events occurred which caused the losses during the reporting period and utilize her resources to fix the problem. The impact of this action would be significant.

Underlying this simple process of problem identification and solution are two items—established manufacturing standards and an information system which links manufacturing events to plant, product, and process cost reports.

The algorithm which links total plant financial performance to product cost reports, like that in Table 2, is similar to the way a bill of material links component costs to product costs. Because plant costs represent the dollarized sum of all manufacturing events, daily production data and manufacturing standards can be rolled up to daily total cost figures.

The difficulty in configuring and using this type of system is the level of discipline required by management to assure daily data capture and maintenance of the standards. The necessary level of discipline is consistent with that of other database-driven manufacturing systems, including manufacturing resource planning (MRPII) [7]. As if to underscore this need for discipline, consultants involved in implementing these new standards-based management systems report doing them in conjunction with MRP and material management system implementations.

STEP TWO: CONTROL MANUFACTURING EVENTS TO REALIZE COST IMPROVEMENTS

In addition to using theoretical standards to identify cost-improvement opportunities, management reports must relate performance to manufacturing events. Once a standards-based performance reporting system is established, continuous process improvement occurs through a daily assessment of opportunities followed by actions which will change future manufacturing events. Events are changed through controllable factors such as the bills of material, product mix, production crews, schedules, methods, and equipment.

The continuous cost-improvement framework presents plant performance data in a way that not only prioritizes opportunity, but leads to action. Because cost-improvement opportunities most frequently come from a plant's three biggest manufacturing cost elements, these elements should be the focus of management reports:

- Direct material yield
- Direct labor efficiency
- Controllable indirect costs.

TABLE 2: Report Identifying Improvement Opportunity

Product	Total controlled	Manufacturing variances			
		Labor	Material	Indirect	Total
#4615	$513,676	($12,010)	($54,066)	($7,388)	($73,464)
#3130	$161,891	($2,655)	($30,036)	($2,051)	($34,742)
#4619	$116,972	($3,888)	($15,684)	($15,888)	($35,460)

Management action is typically the result of analyzing these three elements. Similar to the illustration in Table 2, these elements can be reported for products, production lines, work teams, or cost centers. Starting from cost impacts, managers can investigate detailed reports for causes, and can identify and talk to the workers involved in the most costly events. Managers can identify patterns in how material usage, downtime, and efficiencies affect total plant costs. Throughout the process, action is focused on the most important controllable factors by measuring performance relative to all theoretical opportunities for improvement.

Action on plant costs can be further improved by classifying costs as controllable and noncontrollable. The apparent impact that manufacturing managers have on costs is increased when noncontrollable costs are broken out from those generated by the plant. Noncontrollable costs may include the standard cost of raw materials, transportation, sales, administration, some depreciation, taxes, etc. The impact on manager's attention of breaking out controllable costs is illustrated in Tables 3 and 4.

In the example in Table 4, the plant manager can see that his improvement opportunity of $222,000 is a significant proportion of all costs he should have managed: $498,000. The manager's improvement opportunity is 45% of the controllable costs rather than the approximately 4% of total costs shown in the traditional presentation.

In my research with Deloitte & Touche, the application of this costing methodology has been effective in a variety of plants. A maker of jams and jellies who had reduced production lot sizes discovered yield losses of 60% of controllable costs. A meat processor found the actual costs of special labelling could not be recovered in the price. An assembly operation manager discovered that excessive downtime caused a product line to cost 150% of the theoretical standard.

In each of these examples, the traditional manufacturing cost system failed to accurately quantify the size of the opportunity, causing it to be overlooked during *ad hoc* cost-improvement programs. In a continuous-improvement environment, similar issues are managed daily, with reduced plant costs achieved continuously.

STEP THREE: DEMONSTRATE PLANT COST IMPROVEMENTS IN COMPANY FINANCIAL REPORTS

Tying plant cost reports to the financial reports empowers plant managers with the knowledge of how their cost-improvement efforts directly affect financial performance. According to a recent survey, top managers feel that the monthly financial reports are their

TABLE 3: Traditional View

Cost summary	Standard	Variance
Raw material	$3,543,000	($150,000)
Packaging	$1,502,000	($25,000)
Direct labor	$167,000	($28,000)
Indirect labor	$169,500	($5,500)
Benefits	$91,500	($10,000)
Other indirect	$70,000	($3,500)
Rent and taxes	$23,000	($0)
Equipment	$20,000	($0)
Total plant costs	$5,586,000	($222,000)
% Variance		4%

TABLE 4: Controllable View

Cost summary	Standard	Variance
Controlled costs		
Raw material	$0	($150,000)
Direct labor	$167,000	($28,000)
Packaging	$0	($25,000)
Benefits	$91,500	($10,000)
Indirect labor	$169,500	($5,500)
Other indirect	$70,000	($3,500)
Total controlled	$498,000	($222,000)
% Variance		45%

most important performance reports [6]—more important than labor efficiency, yield, and downtime reports. Therefore, to meet the new objective called usefulness, the standards-based cost-improvement system must tie in to the financial reporting system. This agreement of plant costs to the financial statements is accomplished by valuing production using costing standards which are defined in terms of theoretical standards and maintained in the same database. The main benefits of integrating daily performance reports with financial statements are:

- Variances between performance and financial plans can be traced to the events recorded in daily performance reports.
- Downtime, efficiency, and usage variance are reported in dollars—not percentages or ambiguous units.
- Financial performance can be appraised in real time, rather than two weeks after month end.
- Corrections to negative trends can be made faster.

Tying cost reports to financial reports does not mean that frequent detailed reconciliations between plant costs and financial accounting journal entries are needed. Instead, reconciliations to the general ledger can be made either monthly or quarterly. Reconciliations may result in plant cost adjustments (efficiency differences, volume variances, inventory shrink, etc.). Other adjustments may be required on the financial accounting side for price variances or accounting conventions. By applying accounting controls around these reconciliations, feedback properly acts to maintain the discipline of the entire cost-management program.

Consider the example in Table 5. In Table 5, large over/short values indicate potential problems in either conforming to product specification or in recording actual usage. Appropriate corrective actions such as increasing cycle counts, revising a formulation, updating control procedures, or installing a meter to accurately monitor usage should be considered. Conversely, nominal variances may prompt action to relax costly controls or data collection procedures.

BENEFITS

As the manufacturing and business systems environment has grown more complex, traditional cost-management systems have become less useful. The examples shown illustrate an approach to cost management which combines the best features of traditional systems, namely the use of manufacturing standards with new technology and current management practices (ABC, responsibility accounting, and world-class manufacturing). The result is a manufacturing cost system which provides clear, quantitative information to drive continuous improvement.

TABLE 5: Account Reconciliation Report

Financial Report Reconciliation Month Ending 09/30/93	*Cost @ Standard*	*Process loss*	*Over/short*	*Actual loss*	*Last reconciliation*
Raw materials					
HFCS Hi Fructose	$73,789	$4,427	($1,540)	$2,887	09/15/93
Frozen Fruits #12345	$201,809	($2,018)	$2,010	($8)	09/24/93
Packaging					
#23 Glass Jars	$21,456	$1,287	$0	$1,287	09/22/93
Labels: #433	$3,716	$409	—	$409	—
Cartons: #322	$5,046	$16	—	$16	—
Labor					
Line 2	$12,879	$902	$120	$1,022	09/30/93
Line 1	$32,987	$990	—	$990	09/30/93
Maintenance	$4,789	$718	—	$718	09/30/93
Material Handling	$3,241	$49	—	$49	09/30/93
Indirect					
Building	$998	—	$243	$243	08/31/93
Utility	$1,576	—	$132	$132	08/31/93
Wastewater	$692	—	—	$0	—

Key:

Process loss	Difference between standard and daily measured usage
Over/short	Difference between running total and cycle counts or actual costs from the general ledger
Actual loss	Sum of Process loss and Over/short
Reconciliation date	Day of most recent cycle count or general ledger reconciliation

The benefits of this cost-improvement approach are in prioritizing the real opportunities, providing relevant performance measures, and giving useful feedback to operating managers. The standards-based approach is effective because it consistently directs managers to those manufacturing events which cause the most excess costs.

Manufacturing facilities which are employing this continuous cost-improvement approach have a variety of operating characteristics. They run from 20 to 150 SKUs per day, vary in crew size and run rates, and range from minor to significant packaging costs. Each has different complexity in setup, run rates, and bills of material, resulting in thousands of potential sources of inefficiencies and multiple drivers of downtime. By applying a systematic analysis to controllable variances, each day's thousand possibilities become two or three significant operational problems which can be quickly traced to a product, a line, and a crew. Rapid response to those few specific daily events reduces scrap and increases overall efficiencies.

The benefits of this approach can be contrasted to the weaknesses of two prevalent manufacturing performance measures—budget variances and headcounts. These measures have little relevance to manufacturing managers because budgets contain many short-term fixed and non-plant-controllable costs, and headcounts are less important than utilization, material yields, overtime, and customer service policies as a driver of cost overruns. A total controllable cost view pares away the irrelevant parts of traditional cost reports and directs a manager's attention to where cost drivers need to be analyzed and managed.

SUMMARY

Manufacturing standards have provided managers with insight into operations, planning, and control issues. Yet traditional management systems have underutilized standards because they are hard to maintain, inconsistently applied, and complex. The emergence of database technology, with the new thinking on world-class manufacturing, activity management, and responsibility accounting provide the basis for a new use of standards.

Standards can be given new value when used to drive continuous cost improvement. Key elements are identifying real opportunities from the gap between theoretical standards and actual performance; structuring reports to link opportunities with controllable manufacturing events; and demonstrating the impact of plant operational performance on financial reports. The benefits are in the usefulness and relevance of the resulting management information, which enable continuous progress toward operational improvement and a position of cost leadership.

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