

The Cost of Safety

Cost analysis model helps build business case for safety

By Michael Behm, Anthony Veltri and Ilene K. Kleinsorge

SH&E PROFESSIONALS HAVE OFTEN become victims of their own success in achieving regulatory compliance; many business executives view beyond-compliance spending as a fruitless exercise (Soyka and Feldman 61). Compounding this problem is the fact that SH&E professionals seldom use business models or speak in business terms. Safety jargon is often considered irrelevant and inconsistent with

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standard business terminology and objectives (Hill 25). If the SH&E department does not understand the financial loss to an organization, senior management will find it difficult to understand the financial benefit the safety department provides (LaBelle 38). The end result is that SH&E issues are not fully integrated into the standard business framework; as a result, management views the SH&E function in terms of a compliance-oriented, reactive strategy.

The fact that SH&E professionals need to build a business case for their efforts is well-documented (Hill 19). Knowledge in business and accounting helps SH&E professionals speak to management and maintain credibility (Blair 32). To work more effectively with other financial and operations management personnel, it has been suggested that SH&E professionals must become better versed in the common language of busi-

ness (Adams 23). Cost analysis models are needed to help SH&E professionals measure, analyze and communicate safety strategies in business terms. This article details one such model from the quality management literature.

Relationship Between Safety & Quality

Many authors, including Manzella, Blair, Weinstein and Manuele, have made clear the link between quality management and safety management. Upon reviewing quality management literature, Manuele concluded that the word "quality" is interchangeable with the word "safety," and his premise remains sound (12). To show how safety mirrors the quality function, Manuele inserted "safety" for "quality" in the following statement:

When quality (safety) is seamlessly integrated into the way an organization operates on a daily basis, quality (safety) becomes not a separate activity for committees and teams but the way every employee performs his or her job (203).

The similarities between safety and quality in the construction industry have been summarized as well. Coble, et al introduced the cost of quality (COQ) model as a tool that could be applied for evaluating safety costs (160).

The research presented in this article builds on these concepts and describes how the COQ model can be applied to safety. A case study is provided to demonstrate how costs associated with managing an ergonomics program at two organizations were collected, analyzed and interpreted. SH&E professionals can use this model to track, analyze and report SH&E function-related costs. Thus, the model can help them make the business case by driving decision making and operating action within the SH&E function.

COQ Framework & Its Application to Safety

The COQ framework consists of four main cost activity groups: prevention, detection, internal fail-

ures and external failures—terminology that is well-suited to the practice of safety.

Prevention

Prevention activities are designed to keep defects from occurring. Such activities are viewed as optimal methods of averting downstream defects. They are discretionary, budgeted actions intended to prevent failures. SH&E professionals undertake prevention activities to avoid losses such as employee injuries and illnesses, and property damage. Examples of such activities are safety function involvement in the design of new products, processes, technologies and services; employee training; and safe material procurement.

Detection

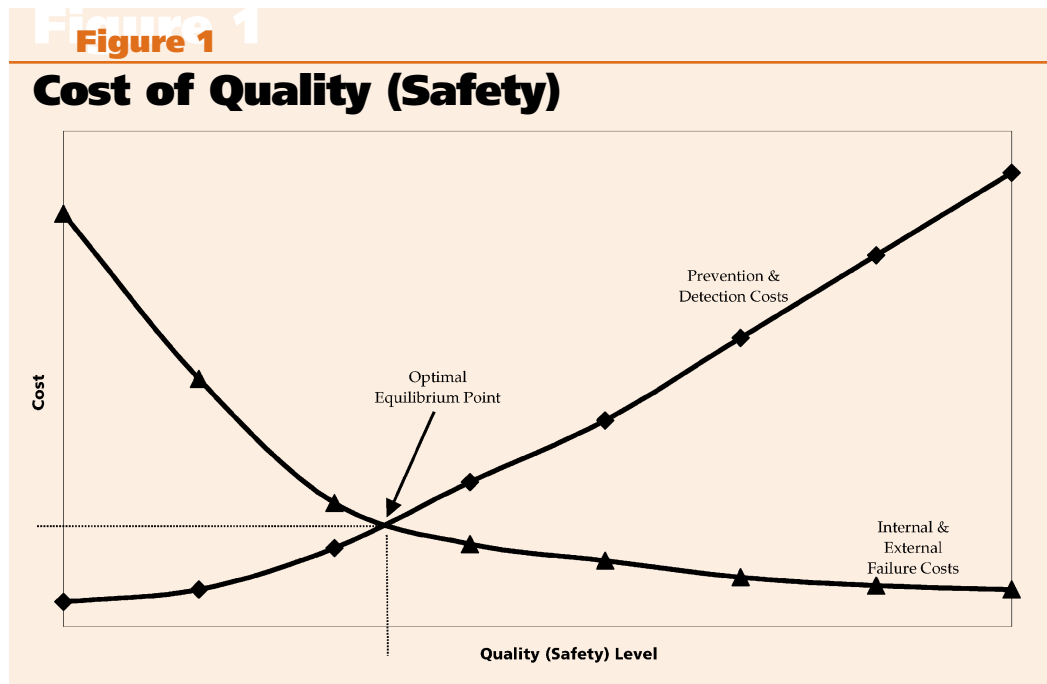
Detection activities, also referred to as appraisal activities, involve inspection of the work in progress to minimize defects. An organization conducts these activities because it understands that not all defects can be prevented or that some are too costly to prevent. It develops procedures and employs quality control inspectors to verify standards. The key distinction between prevention and detection activities is that the former are more likely to avert a defect, but are typically more costly, while the latter identify and correct a defect after it has occurred. In the analysis of overall program effectiveness, prevention and detection costs are combined because they are both proactive measures taken to minimize failures. Their combined cost is compared to total failure costs. The SH&E function is responsible for various detection activities, including safety inspections, industrial hygiene monitoring, safety committee activities and behavior-based safety observations.

Internal Failure

Internal failures are costs associated with reworking, scrapping and other performance defects that occur before the product is passed on to the customer. Internal failures occur inside the facility; they are the costs an organization tries to avoid by managing appropriate prevention and detection activities. Examples of safety-related internal failures are workers' compensation (WC) costs, incident investigations, costs of retraining new employees and provision of PPE after an injury occurs.

External Failure

External failures include warranty costs and product recalls. These costs occur once the product leaves the facility and is passed on to a customer or a distributor. Safety-related external failures include regulatory fines, administrative costs associated with outside



agencies and public-image issues. Public-image costs arise from the reputation of being an unsafe place to work, which can be detrimental to business. For example, a January 2003 Public Broadcasting Service *Frontline* special entitled "A Dangerous Business" reported on the egregious safety record of McWane Inc. If product purchasers or end users boycott a particular organization because of its poor safety record, then the cost of product not sold as a result would be classified as an external failure cost.

Analyzing the Cost of Safety

The cost of safety (COS) model evaluates trends in total safety costs over time. The relationships among safety cost categories offer a useful tool for tracking and analyzing previous costs and for assisting with the budgeting of future SH&E initiatives. An optimal equilibrium point theoretically exists, where total prevention and detection costs equal total failure costs (Chalos 101). This point is dynamic and is found through linear regression. The theoretical optimal equilibrium point suggests a discretionary budgeted amount for prevention and detection costs that will still yield failures, but at a level such that the sum of total SH&E costs is minimized, or optimal.

Figure 1 depicts this model, which is adapted from quality management literature (Chalos 102). As Figure 1 shows, when prevention and detection costs are low, the cost of failure will be high. As prevention and detection costs increase, failure costs should decrease, since more is spent to counteract risk. The COS model must be distinguished from the notion that an organization should have a goal of zero accidents. Beyond a certain level of very high safety (quality), the goal of zero defects (accidents) becomes very costly to attain and maintain. For the SH&E profession, the model shows that prevention

Table 1

Cost of Ergonomics Worksheet Example

Total Operating Costs (TOC)	Year 1	Year 2	Year 3
Prevention Employee ergonomic training. Staff ergonomic training. Proactive workstation evaluations and modifications. Total prevention costs Total prevention costs as % of TOC			
Detection Ergonomics safety committee. Workstation evaluation and modifications from employee concerns or discomforts but before injury occurs. Total detection costs Total detection costs as % of TOC			
Failures (Internal & External) Workers' compensation costs associated with ergonomics injuries and illnesses. Workstation evaluations and modifications after injury occurs. Indirect costs of time away from job—retraining, lost work, etc. Total failure costs Total failure costs as % of TOC			

zation must determine what level of risk is acceptable, what strategies are taken to counteract risk and at what level these strategies will be financed. As with most financial tools, it is up to the organization to interpret the data according to internal standards and management philosophy in order to make appropriate financial decisions. The COS model does not dictate those decisions; it simply presents financial information that can be used to drive decision making and operating action. Interpretation of each COS model is individualized, as the following case study illustrates.

Case Study: Ergonomics Programs

The costs of ergonomics-related activities at two organizations were collected, analyzed and interpreted as part of this research. Company A is the finance department of a large multinational company, with approximately 1,600 employees. Company B is a light-manufacturing facility with approximately 300 employees.

and detection costs must be substantially increased to achieve zero accidents or to get close to zero accidents. According to Chalos, "While slogans such as 'Zero Defects' and 'Quality is Job 1' are appealing, such goals are not attainable without significant incurrence of prevention and appraisal costs" (100).

The optimal-cost approach minimizes accidents (failures) to the point that an organization spends only what is necessary to minimize overall costs associated with safety. This philosophy may be in sharp contrast to the prevailing view within the SH&E profession. From a financial viewpoint, however, the COS model provides the manager with a structure for analyzing costs, preparing budgets and setting realistic goals (for performance, cost, etc.). This model is a short-term model, so a diminishing rate of return would not be experienced; therefore, it must be monitored annually.

The model also makes sense from a risk management standpoint. Some risk is inherent in all activities (Manuele and Main 57). Certain risks cannot be eliminated or nearly eliminated without very high cost, while other risks can be eliminated with little effort and at low cost. The purpose of any cost analysis exercise is to identify these "low-hanging fruit."

The COS model recognizes that some risk must be considered acceptable for an organization's financial stability. One should also recognize that each organi-

Both companies describe ergonomics-related issues as a major safety and cost concern. Ergonomics costs, as opposed to overall SH&E program costs, were analyzed for this study.

Data Collection

The two companies were asked to retrospectively document costs associated with their ergonomics programs over a three-year period. Each received a description of the research and a worksheet with examples of ergonomics costs broken into the categories of prevention, detection, internal failures and external failures. Each company was asked to provide estimated costs for each line item (if applicable), add any line item it deemed appropriate and provide estimated total operating costs for each year. Total operating costs provided a baseline by which to normalize the data and make costs incurred in each year comparable as percentages. Table 1 presents an example of the worksheet and line items.

For these case studies, costs associated with workstation evaluations and modifications were classified according to the timing of those costs (Table 1). For example, if a company decided to evaluate and modify workstations within an entire department because it had identified ergonomics risk factors, this cost was classified as prevention. A workstation evaluation and modification prompted by an employee concern or discomfort was classified

as detection. The difference between the two is that in the prevention activity the organization made a discretionary attempt to prevent failure; in the detection activity, the employee or his/her supervisor detected a symptom and requested intervention. The same activity was classified as an internal failure if it occurred after an employee sustained an ergonomic injury, missed work time or experienced some other type of failure. Since neither company reported external failure costs associated with its ergonomics program, internal and external failures were combined into one category; they are hereafter referred to as "failure."

Challenges in Collecting the Costs of Safety

In the process of collecting and quantifying ergonomics costs, several challenges and observations were identified relative to the COS model. As in many organizations, Company B's ergonomics costs were difficult to locate and calculate with accuracy. Time and energy were required to verify each line item. The fact that these costs were not readily available was a strong indicator that those costs had not been fully analyzed within the company.

It is important to note that the time and costs associated with data gathering must not outweigh the benefit of analyzing those costs. Thus, some organizations may decide to establish the appropriate cost-collecting mechanisms and gather data prospectively rather than retrospectively. At startup or when accounting systems change, organizations should include the SH&E function as they create the chart of accounts.

Another issue was whether to include the cost of safety staff salary—and, if so, where to include it. As with all costs, this would be up to the individual organization or manager. If the goal were to report all SH&E costs to management, then it would be best to include staff salary.

One method of inclusion would be to estimate the percentage of time spent performing prevention, detection and failure activities, then to allocate the salary based on that calculation. In this case, SH&E staff salaries were not included since the goal of the participating companies was to examine ergonomics activities and their financial impact.

Other challenges were also encountered. Should certain capital expenditures for process improvement be included

in the COS model? For example, if a new piece of equipment is purchased and it is known that it will reduce ergonomics risk factors, should its cost be included as an ergonomics cost? The answer will depend on the cost object, which is defined as anything for which a measurement of cost is desired (Horngren, et al 30). If the cost object is safety, then it would be included in the cost of safety. However, an organization may include the same cost in multiple cost analyses (e.g., safety and quality).

What about the base costs of WC and other safety-related insurances? A company needs insurance to be in business, so should the base cost be included in the model? Again, it depends on several factors. If the goal is to report, track and analyze all costs associated with an organization's safety program, then this cost should be included. However, if the goal is to analyze specific program costs, such as those of an ergonomics program, then it would not be appropriate to include such fixed costs. The decisions made in response to these challenges and others will depend on the goal of the cost analysis.

Table 2

Company A: Cost-of-Ergonomics Data*

Year	Prevention	Detection	Internal Failure	External Failure	Total Costs
1	0	0.00008	0.00248	0	0.00256
2	0.00032	0.00005	0.00203	0	0.00240
3	0.00041	0.00005	0.00143	0	0.00189

*as a percentage of total operating costs

Figure 2

Company A: Costs of Ergonomics

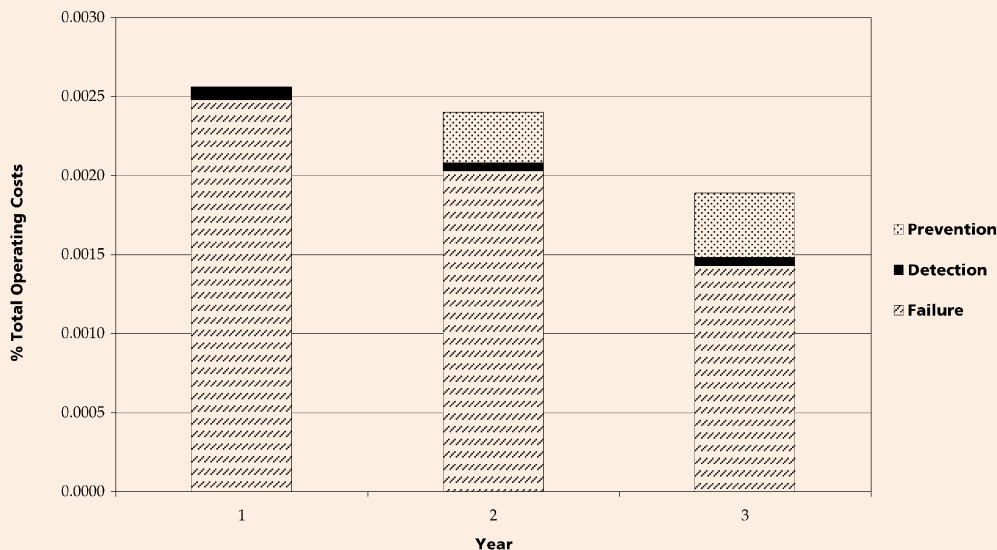
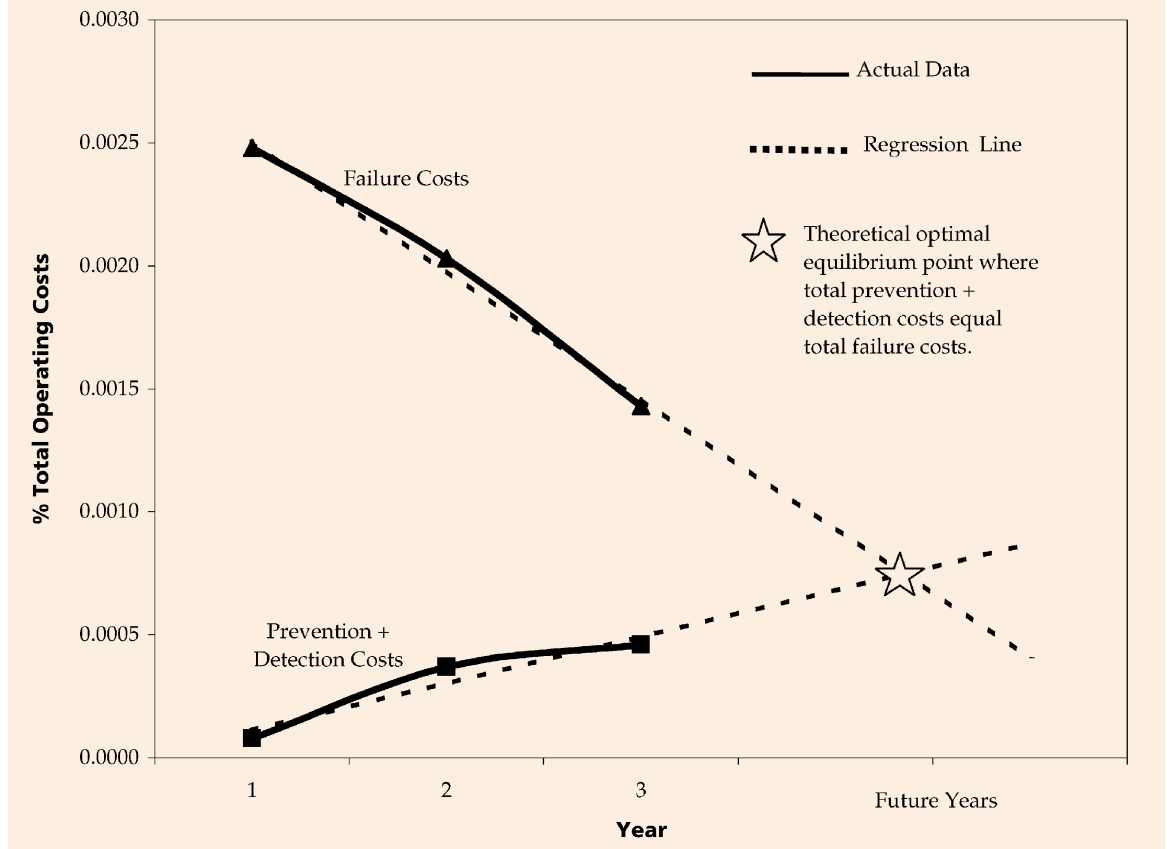


Figure 3

Company A: Optimal Equilibrium Point



Analysis: Company A

Table 2 shows Company A's reported ergonomics costs as a percentage of total operating costs for the four COS activities and as total cost of the program. Figure 2 illustrates the trend and relationship of these costs over the three-year period. This company's ergonomics program was not well-developed prior to Year 1 and provided only a reactive approach to ergonomics cost and injury control. The organization recognized that ergonomics-related costs and accidents had become a financial issue. In Year 1, it decided to evaluate and modify every workstation over the subsequent two-year period, beginning with those workstations and tasks identified as higher risk.

As Figure 2 shows, the total cost of this ergonomics program has decreased in each of the three years. Closer analysis indicates that the sum of prevention and detection costs increased, whereas total failure costs decreased. This trend demonstrates that prevention and detection activities budgeted for and undertaken have successfully influenced failure costs.

Figure 3 demonstrates this trend and provides a theoretical optimum cost of the ergonomics program. It suggests that in future years Company A should increase budgeted activities for ergonomics prevention and detection activities. This increase in discretionary budget should produce a decrease in failure

costs. Furthermore, if the program is properly managed, its overall cost should decrease. Note that the optimal point in this case is actual, not theoretical. Because of this company's previous reactive strategy and its subsequent financial decisions, it is a strong possibility that the optimal point is fairly exact. When Company A did act, it did so in a well-structured, properly financed manner. It took the time to analyze the trade-offs between prevention and detection costs and failure costs. The result is a decreasing trend in overall ergonomics costs and an expected continued decrease in subsequent years.

Specific Recommendations for Company A

Company A has already analyzed each workstation from an ergonomics perspective. In the short term, it may be able to achieve little more in terms of prevention activities except with respect to workstations for new employees, or new workstations or tasks added for current employees. Furthermore, previous prevention activities will continue to reduce failures in subsequent years. These preventive measures must be monitored to ensure continued effectiveness—which is a detection activity.

An ergonomics safety committee was the only line item detection activity in years 2 and 3. To reach the goal of decreasing the overall costs of ergonomics

ics, Company A should consider increasing detection activities in order to identify risk factors associated with the prevention activities previously funded. Any additional SH&E investment would assume a similar rate of return and would be justified and analyzed as any other investment.

Specific recommendations for Company A:

1) Ensure that the ergonomics committee is being properly used, that its role and functions are properly defined and that the committee is budgeted accordingly (detection).

2) Hire an ergonomics consultant to periodically evaluate modified workstations (detection).

3) Implement an employee self-awareness program designed to promote early detection of any ergonomics-related problems, issues or concerns (detection).

4) Implement an ergonomics education program that addresses employees' off-the-job activities and hobbies (prevention).

Analysis: Company B

Table 3 shows Company B's reported ergonomics costs as a percentage of total operating costs for the four COS activities and as a total cost of the program. Figure 4 illustrates the trend of these costs over the three-year period.

As noted, this company had trouble calculating and verifying specific ergonomics costs. It had established an ergonomics program prior to Year 1, yet costs were not effectively analyzed or tracked. The company financed employee training and modified workstations.

Figure 4 shows the total cost of ergonomics steadily rising over the three-year period. Failure costs have increased, with a significant increase in Year 3. The company attributes this increase to one large WC claim and expects costs in subsequent years to decrease. However, the data indicate cause for continued concern. One can conclude that the allocation of budget to prevention and detection activities has not been fully effective. These activities did not adequately minimize the risk of ergonomics-related injuries, and, therefore, should be re-evaluated. If risk is not adequately controlled through proper funding, additional—and costly—failures are likely.

When these two companies are compared, opposite trends are apparent. In Company A, failure costs started high and are decreasing; prevention and detection costs started low and

are increasing, but have not yet met or surpassed failure costs. Company A is a classic case of how strategic funding of prevention and detection expenditures can produce a decrease in failures and a decrease in overall program costs.

By contrast, in Company B, prevention and detection costs began high, while failure costs were comparatively low. Failure costs then dramatically increased in Year 3. Prevention and detection expenditures did not produce a decrease in failure costs. Figure 5 shows the theoretical optimal point for Company B. Because only three data points are available and because this company has not previously quantified and analyzed ergonomic costs, use of the theoretical optimal point would be ill-advised, as it is highly speculative and will be quite dynamic in subsequent years.

It is not suggested that this be the only model used to develop a discretionary budget for the ergonomics program. Company B needs to properly evaluate risk factors and develop a fiscally responsible strategy to

Table 3

Company B: Cost-of-Ergonomics Data*

Year	Prevention	Detection	Internal Failure	External Failure	Total Costs
1	0.00028	0.00022	0.00029	0	0.00079
2	0.00043	0.00022	0.00032	0	0.00097
3	0.00023	0.00034	0.00073	0	0.00130

*as a percentage of total operating costs

Figure 4

Company B: Costs of Ergonomics

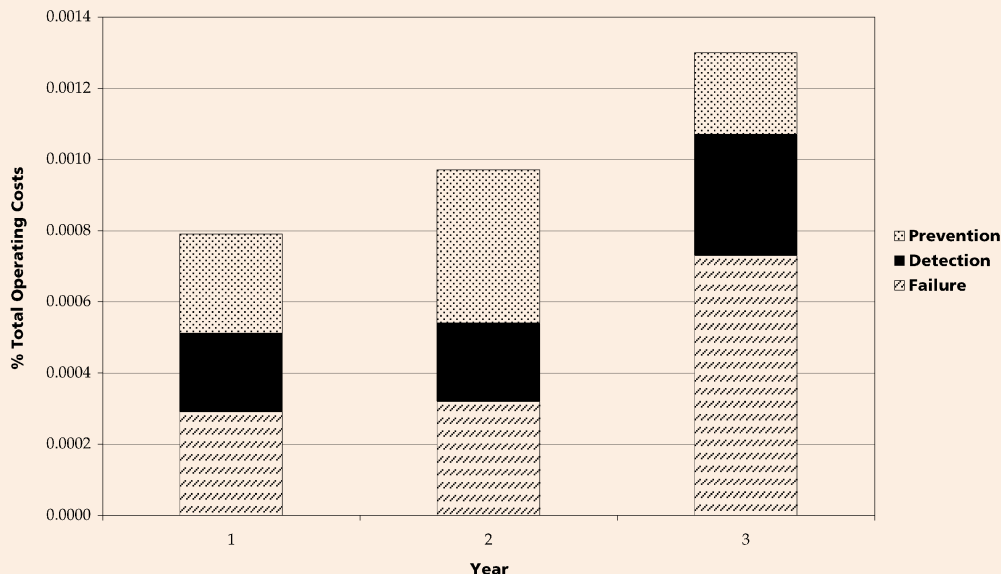
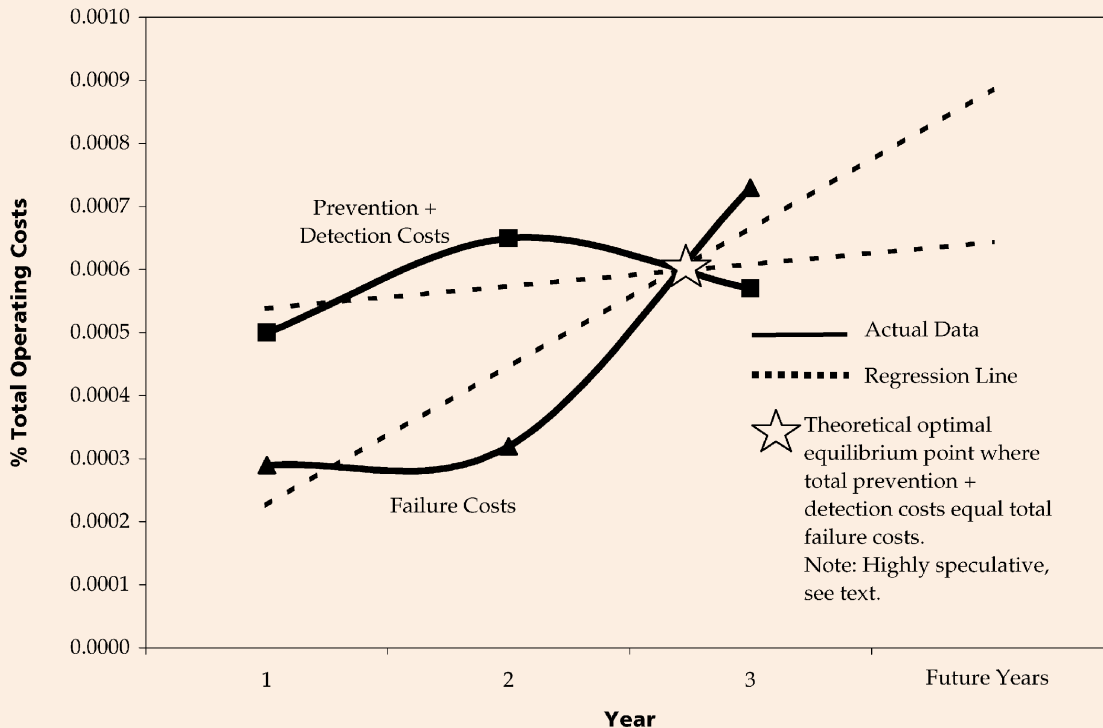


Figure 5

Company B: Optimal Equilibrium Point



counteract that risk. For example, consider whether data from only years 1 and 2 were available for Company B; these data would suggest analyzing prevention and detection costs and possibly reducing them to meet the cost of failures. Had that decision been made, the risk associated with the incident in Year 3 would have still existed. Therefore, the COS model should be used in conjunction with other management practices to develop discretionary budgets for Company B's ergonomics program.

Another financial consideration is to evaluate any cost savings associated with not making an investment to counteract the injury in Year 3. If the present cost of preventing an injury is deemed to be greater than the cost of the injury, it would not make financial sense to make the investment. However, such an investment may certainly make sense from a humane and business ethics standpoint. Furthermore, this same risk factor likely affects more than just the one employee who was injured.

These observations suggest the use of contingent liability modeling (see sidebar pg. 29) to show that prevention and detection activities were necessary to prevent failures even if they had not yet occurred. Discussions with business researchers indicate that this method of evaluating potential failure costs within the COS model is plausible, but must be applied prudently. As with any financial tool, contingent liability data must be used consistently year to year, and the numbers must be realistic and make financial sense.

ets, then invisible costs must be considered.

Specific Recommendations for Company B

Company B's data highlight the significance of not fully understanding costs associated with a specific SH&E program. If ergonomics cost data are not collected and analyzed, prevention and detection budgets—and, thus, activities—will not be as effective as they could be. Furthermore, this case study indicates the disconnect of the SH&E function from other business functions that are tracked, analyzed and funded for business success. Data from Company B also reveal the impact that one injury can have on an SH&E program's financial statement.

The data suggest that prevention and detection activities should be re-evaluated for increased effectiveness. Company B needs to reorganize these activities to better minimize the risk of future failures while not drastically increasing their discretionary budget. Furthermore, the fact that the costs were difficult to collect suggests that the data may not be as accurate as stated. Specific recommendations for Company B:

- 1) Use the prevention and detection budget more for engineering controls than for training. The program has been heavily weighted toward training; however, training and behavior modification are often erroneously applied as solutions to problems and have limited effectiveness when incident causal factors are derived from workplace and work method design decisions (Manuele 19).

Many SH&E investments are made to reduce risk factors for which accidents have not yet occurred and whose costs are invisible. Deming recognized the importance of understanding these invisible figures and contended that managing an organization using only visible figures is one of the seven deadly diseases that afflicts most Western companies (97-98). If the purpose of using the COS model is to report all costs associated with the program, then contingent liability modeling is not practical. However, when the goal is to understand the interrelatedness of costs and to prepare discretionary bud-

2) Begin to track all SH&E-program-related costs so that the activities can be analyzed from a financial standpoint. By knowing the true costs of safety, the organization can plan and budget for the necessary activities to reduce failures across all SH&E initiatives, including ergonomics.

Conclusions

The contrast between Company A and Company B highlights the importance of proactively analyzing and funding SH&E programs rather than taking a reactive approach. For organizations to go beyond compliance and truly influence and improve employee safety, SH&E professionals must make the business case for those strategies deemed appropriate to counteract risk. The financial toolset that SH&E professionals use must be ever-evolving, yet remain congruent with their organizations' business strategies.

The overall cost of ergonomics for both companies may not be very high compared to overall operating costs, and this may be the case for other companies as well. In these examples, the overall cost of ergonomics is approximately \$1.00 to \$2.50 per \$100,000 of total operating costs. When approached from this view, the analysis of costs associated with the programs may seem trivial, especially when humanitarian and compliance considerations are the primary seller to upper management with respect to budgetary decisions that affect SH&E initiatives. However, the exclusive use of these customary approaches to justify initiatives is

precisely why the SH&E function gets left out of decision making in reactive organizations or during an economic downturn, when organizations focus solely on historically value-added activities.

The case study illustrates a method of using the COS model to analyze ergonomics costs. This model has applications to any other SH&E program. Other potential uses:

- 1) Analyze total SH&E costs in a specific department, facility or corporation.
- 2) Compare or benchmark SH&E costs across departments or facilities (as long as costs are measured in the same way). This exercise may reveal specific prevention and detection activities that truly impact failures in a cost-effective manner.
- 3) Track and report SH&E-related costs both internally and externally, such as in an organization's annual report.

The COS model is not perfect, but it can be used as a foundation to make business sense of the SH&E function. Some costs, such as prevention and detection activities, are easily quantified, while failure costs may be difficult to quantify and estimate. This model provides a financial tool that an organization can use to drive decision-making and operating action within the safety function. In addition, the COS model can be used to make the business case for the safety function so that SH&E professionals can communicate more effectively with senior-level executives about safety activities and their purpose within the organization. ■

Contingent Liability

A contingent liability is an existing condition, situation or set of circumstances involving uncertainty with regard to possible future financial loss (Mellman, et al 231). If some future event occurs (e.g., incident, failure), then a financial obligation might result. The probability of an incident or event occurring and the range of costs to respond to and recover from the event must be estimated. Senior-level executives tend to be interested in reducing liabilities, particularly if the costs of the event erode competitiveness.

To be recorded in financial statements, a contingent liability must be both probable (a probability of occurring greater than 50 percent) and able to be reasonably estimated (Stickney and Weil 481). Although it is difficult to accurately characterize and quantify contingent liabilities, they are important to the practice of occupational safety and health, and should not be ignored. Understanding the potential financial loss to an organization will help SH&E professionals select and set priorities for prevention and detection activities. The use of contingent liability modeling data in financial tools is an area for future research.

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