

# The business of

A hand in a black glove holds a black pen with a yellow tip, poised to write on a document. The document features technical drawings, including a circular seal with the text 'FEDERAL BUREAU OF INVESTIGATION' and 'DEPARTMENT OF JUSTICE'. The background is a complex, textured pattern of blue and yellow.



# TRIBOLOGY

*When it comes to conserving energy and raw materials, lubrication engineering can play a major role. Accurate accounting tools can help make your case to business managers in the language they understand.*

By Andrew &  
Valli Batchelor

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## Conservation of energy and materials is a topical issue, with much being said or written about the depletion of such natural resources as petroleum. Conservation

is a useful means of reducing consumption of vital resources and involves the proactive application of advanced engineering techniques such as those that are found in tribology and surface engineering.

Tribology is the study of friction and wear to control the waste of energy and materials. A major restriction in the wider application of tribology for this purpose is the lack of accounting accuracy in the context of engineering and manufacturing. It is, thus, difficult to justify the initial investment in tribological technology when the financial savings cannot be measured accurately or measured at all.

This article illustrates this problem with a case history and shows the importance of improving accounting accuracy to realize genuine, cost-effective savings in energy and materials.

### Introduction

Much has been written and said about the shortage of materials and energy. Much more will be written and said on these topics in the future. Some commentators or analysts conclude that these shortages are more apparent than real; that is, they maintain that there are vast sources of renewable energy.

But for practical purposes, the lack of materials or cheap energy has to be factored into business planning. One method of reducing energy and materials requirements in industrial machinery is to effectively apply prescriptions of surface engineering,<sup>(1)</sup> tribology<sup>(5)</sup> and condition monitoring.<sup>(6)</sup> Tribology is the study of friction, wear and lubrication,<sup>(2)</sup> and condition monitoring is the technology of controlled proactive maintenance.

Numerous studies have revealed that the major cause of unscheduled stoppages or breakdowns in machinery is excessive friction and wear. The International Tribology Council has estimated that approximately 1% of a nation's gross domestic product could be saved by the effective application of existing tribological knowledge.<sup>(3)</sup>

The classic examples are the failure of a \$100 bearing delaying the use of a \$10 million aircraft or a \$10 blunt cutting tool preventing production from a \$10 million

machine tool system. In a form of condition monitoring, oil samples are collected and analyzed by advanced microscopy or spectroscopy to reveal the release of minute quantities of metal wear debris. Other forms of condition monitoring involve measuring noise and vibrations, but these usually offer a shorter warning period.

The release of wear debris into the lubricating oil provides a warning of future bearing failure, thus allowing machinery to operate until the failure point without damage. It has been found that the combination of condition monitoring and responsive maintenance is much cheaper than scheduled maintenance periods. Scheduled maintenance periods are the traditional method of controlling mechanical failure to raise reliability and productivity to acceptable levels.

Tribology and condition monitoring are continually developing subjects which offer new materials, lubricants and techniques to manage or eliminate friction and wear problems in industrial machinery. However, many industries still pursue the traditional methods regardless of cost—typically hidden costs and unnecessary low levels of productivity or high production costs. The following example illustrates the essentials of the problem.

### Case History

About 20 years ago, a new surface coating technology was developed called Friction Surfacing. Friction Surfacing is related to Friction Welding; the innovation is moving the rotating material along the surface so that a deposit of material is released.

Friction Surfacing is found to be an efficient means of depositing thick, high quality coatings, for example, hard alloy steel on plain carbon steel.<sup>(7)</sup> Friction Surfaced components are produced commercially in Europe. Tests by various workers have confirmed the quality and benefits of Friction Surfacing.

The purpose of Friction Surfaced coatings is usually to prolong cutting tool life by minimizing the wear that causes blunting of the cutting tools. The cutting tool, usually made of plain steel, is given a hard, wear-

**Tribology and related subjects have the potential to offer useful savings in operating costs and improve productivity of most industrial systems.**

resistant coating. Informal surveys revealed that out of a range of user companies in Great Britain, only one company, a maker of a very popular form of chocolate-coated confectionary bar, actually ventured to use the new technology of Friction Surfacing. This confectionary manufacturer required a hard, strong chocolate on the exterior of its confectionary bar to prevent collapse of the chocolate coating during storage or while being held in the hand of the consumer. The hard strong chocolate caused rapid wear and blunting of uncoated cutting tools.

The confectionary manufacturer had sufficiently accurate accounting procedures to find that the investment in Friction Coated cutting tools was actually rewarded by the longer service life of the cutting tools. The other companies did not maintain such accurate accounting procedures and so were unable to determine unequivocally whether the Friction Surfaced tools were cost-effective. Because of this uncertainty, these companies did not purchase Friction Surfaced tools.

### Financing conservation measures

Typically, a decision to invest in a new long-life lubricant or wear-resistant component involves an initial payment followed by a series of savings in operating costs. This is illustrated in Figure 1.

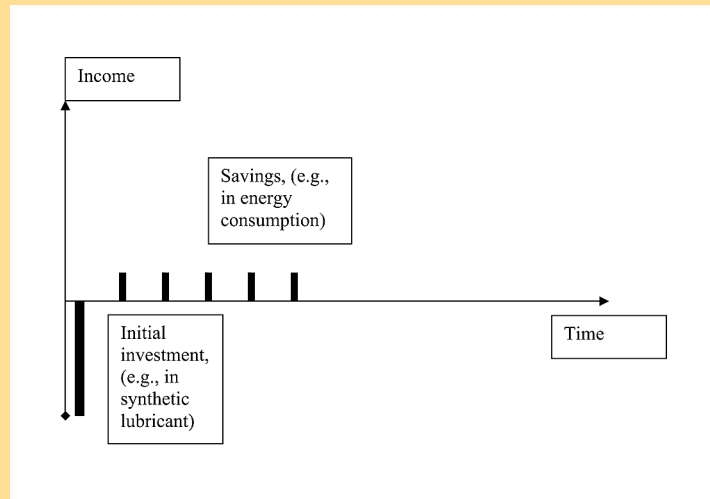
In financial terms, the net present value (NPV) of the series of savings has to be greater than the NPV of the initial investment. If the NPV of the savings is modeled as a form of annuity, it can be seen that the value of the savings is dependent on the required rate of return of the business. In other words, the decision to invest in an energy/materials conservation measure is not simply a technical decision but also is based on financial criteria.

This is an idealized form of the finance model in more accurate terms. The savings can be modeled as a series of reductions in larger operating costs as shown in Figure 2.

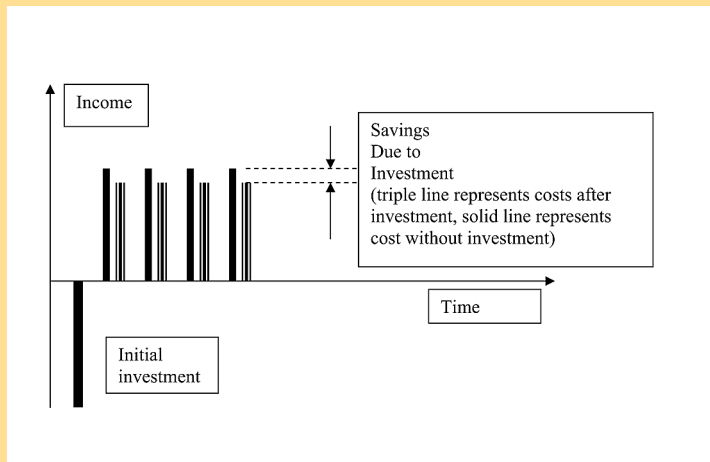
Determining the precise value of operating costs is where the problem of accounting accuracy may occur; there is always some uncertainty in the value of the savings, as illustrated in Figure 3. This uncertainty, if large enough, completely obscures the size and occurrence of the savings. Thus, management is unable to determine

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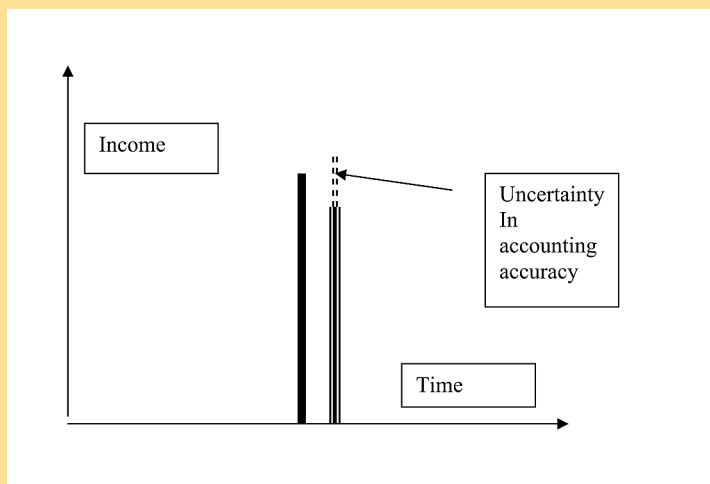
**Figure 1. Simple model of payback from investment in energy or material conservation measures.**



**Figure 2. Refined model, showing savings as reductions in operating costs.**



**Figure 3. Uncertainty in existence of saving in an imprecise accounting environment.**



whether the initial investment was justified. In most cases, management does not venture to try the new technology.

It is generally stated in tribology literature that the value of savings from the extended life of, for example, a new ball bearing can be summarized as follows:<sup>(4)</sup>

**Total savings = Number of cases times the individual savings per case.**

A quoted instance is for worm gears where a 5% reduction in power consumption from the use of lubricant enriched with solid lubricant was equated to the cost of electrical power and the number of worm gears used in the United States. <sup>(4)</sup> For three million worm gears, the annual saving in electricity cost was estimated at \$600 million (U.S.) in the 1980s.

This equation illustrates the accounting problem—typically the number of cases is very large and the individual saving is very small. Precision in the measurement of the individual savings is critical and not often achieved. An important part of practical tribology involves planning and prediction of how these incremental savings in operating costs can be measured accurately. Tribologists need to cooperate closely with accountants to ensure that a meaningful quantitative demonstration of savings is obtained. Such demonstrations of the financial value of tribology are essential for the promotion of tribology in all industries.<sup>(3)</sup>

## Conclusions

Key points to take from this article include:

- Tribology and related subjects have the potential to offer useful savings in operating costs and improve productivity of most industrial systems.
- Considerable care is needed to maintain accurate accounting systems to ensure that savings can be verified and offset against the costs of implementing changes or improvements.
- A specific measurement problem is that the total savings or reduction in operating costs is the cumulative result of a very large number of small savings, which are often difficult to measure.
- Investment or development proposals for new tribology projects would bene-

fit from close cooperation between tribologists and accountants to ensure reliable measurement of the predicted reductions in operating costs.

So the next time you are called by management to rationalize the cost of proper lubrication practices, make sure you have accurate accounting data. You'll get much further with business managers if you speak the language of dollars and cents. <<

*Andrew Batchelor attends the School of Engineering and Valli Batchelor attends the School of Business and Economics, both at Monash University in Malaysia. The authors gratefully acknowledge the support of both schools and the university for their support of this work and its communication. You can reach Andrew and Valli at [andrew.batchelor@eng.monash.edu.my](mailto:andrew.batchelor@eng.monash.edu.my) and [valli.batchelor@buseco.monash.edu.my](mailto:valli.batchelor@buseco.monash.edu.my)*

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