

less "solutions" such as expert systems, fuzzy logic, neural nets and the like. Decision makers in industry will be seduced by such "solutions" unless they hear of success stories involving statistical methods. We have found such anecdotal evidence very effective in convincing them that it is worth allocating the necessary resources. Through publications and talks at conferences, case studies will also serve to attract to the field students who might otherwise pursue careers in engineering.

3. EDUCATION AND TRAINING

There has been considerable discussion in various publications about what courses should be taught to engineers and quality practitioners in industry. A major reason for the ineffectiveness of academic training in industrial statistics is not so much *what* is taught, but *how* it is taught. In this regard, universities in Japan have been even less effective than those in the U.S. In fact, Japanese companies engage in massive (re)training of their employees in statistical methods for quality improvement (see Box et al., 1988).

There are a few things to be learned from the training methods used by Japanese industry. Industrial training in Japan is closely tied with product development and process design organizations, and there is exten-

sive use of case studies directly related to the students' work environment. Courses typically meet several days per month over a period of many months, so students can try out the ideas in job-related projects between class sessions. There is often a follow-up, with the instructor and the student's supervisor, to see how the student has been applying the methods learned in his/her real work environment. In contrast, many training programs in the U.S. are built around the short-course format, with students getting intensive training over a three- to five-day period, with little or no follow-up to consolidate the knowledge gained and to ensure that the methods are being used.

If universities are to respond adequately to the needs of industry in terms of education in industrial statistics, it is imperative that there is a partnership between both groups. Statisticians and others from industry should play an active role, as consultants/advisors, in the development of university curricula in industrial statistics. The faculty members, for their part, should be willing to forge relationships with industrial partners and obtain access to real data and practical experience working on real problems. A fuller appreciation for the context in which statistical methods are used in industry is crucial for developing and teaching courses in industrial statistics. Such experience will also help to shape the research directions.

Comment

T. J. Orchard

David Banks covers a lot of ground, mostly useful and all interesting. Any practicing or potential industrial statistician will benefit from reading and reflecting on the article, even those parts with which they disagree.

It has been a long time since I was in manufacturing industry and I am out of touch with the latest developments in statistical methods. In spite of that I know enough to accept the value of research in the proposed areas. I am now more concerned with management and so I concentrate my remarks on David Banks' thoughts about TQM.

The view seems to be presented that TQM is all very

easy and the concepts are just common sense which should be apparent to any high school student. This overlooks the need to sell the contribution that simple tools and statistical thinking can make in process and product improvement. Experts must be aware that what may be common sense to them may not be apparent to less experienced people. (Although my son can now look down to count the rapidly appearing grey hairs on my head, I can still remember his problems in learning to walk. As an expert I knew it was common sense to balance on one foot and move the other, but it was not immediately obvious to him!) If we statisticians are that clever and knowledgeable, we should have the common sense to listen and communicate with our customers in terms they understand. And our customers may be fellow employees needing a bit of advice and training.

In spite of the provocative remarks, I do not doubt David Banks' understanding of what makes a good

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industrial statistician. He quite rightly identifies the need to build a very deep understanding of the industry which employs them. This remark stimulated me to go back and read again Hahn and Boardman's (1985) excellent *Amstat News* article on the statistician's role in quality improvement. There is little point in quoting selectively from it. I think it is worth reading from time to time no matter how clever and experienced a statistician we think we are because it focuses on the personal traits we require to be effective as industrial statisticians.

David Banks presents confusing messages about TQM, perhaps in an attempt to be provocative. He may be right to claim "that there are dozens of definitions of TQM, but none with any mathematical precision," but it is clear to me that Dr. Deming's philosophy provides a well-defined and consistent approach which can be applied successfully in any industry (not without sustained effort over many years). I am certain that the long-term gains from TQM will not, as seems to be claimed, be realised by "any new theory of management."

Being provocative may stimulate thought but I think a potential industrial statistician reading "TQM correctly shifts corporate attention to the customer, at every level of the business. From the TQM perspective, each employee is a two-legged profit machine" will develop quite the wrong attitude toward management and the role of statisticians in improving their employer's business. This is because TQM is about the man-

agement of people. It may be easier to see this in service industries (which now account for well over half of GDP in developed countries) but it applies equally to manufacturing. Reading *Out of the Crisis* helped me develop as a manager and I am sure corporate executives will benefit from it too. If nothing else, it should teach them not to look at employees as two-legged profit machines. Dr. Deming's advice on driving out fear, instituting training and removing barriers is all about improving people and their working environment. It may be true that any good manager can apply the nonstatistical aspects of a TQM philosophy. Statisticians should realise that they can do that and more, because we should have good analytical intelligence and the knowledge to select and use appropriate techniques. This is why we can make a unique contribution, if our attitude is right.

Although I have concentrated my remarks on TQM, I know that industrial statistics is not just about TQM and that it is important to have some statisticians who can apply advanced techniques (incidentally, I agree entirely with what David Banks has to say on the topics needed to be covered in industrial statisticians' training) but I am sure we can contribute more if we can dispel fear and can institute training in the simple techniques which are central to most process and product improvement schemes. By doing so we will ensure that industrial statistics continues as a growth industry – whose products are appreciated by contented customers.

Comment

G. K. Robinson

It is good to see such a candid article on industrial statistics. I agree with David Banks that the way forward is to discuss our problems and uncertainties frankly and honestly.

I have little direct knowledge about industrial statistics in the United States. However, it seems reasonable to assume that Australian experience is relevant, since many senior managers in the two countries have been influenced by the same consultant gurus.

The first of my comments is to suggest that Banks has ignored the fundamental question of whether stat-

isticians should take a role in changing the managerial climate, the second looks at the overall thrust of Banks' article from a different viewpoint and the third refers to Taguchi's work.

1. THE ROLE OF STATISTICIANS IN CHANGING THE MANAGERIAL CLIMATE

Deming (1982), Joiner (1985), Hahn and Boardman (1985) and others have argued that statisticians have an important role to play in changing the managerial climate of enterprises in ways which are often referred to as "Deming's 14 points for management" or as Total Quality Management (TQM). Most statisticians have not thought about this view or consider it to be an overstatement. However, the statisticians that agree

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