

Statistical Trends in Industry and in the Social Sector

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1. Introduction

Few statisticians have not met the frustration of facing a problem which cries out for statistical treatment but where there is blank refusal to use such methods. Excuses range from "we don't need to be clever about it" or "we all know you people can prove anything" or "we've got a computer package to do that *should* we ever wish to". At the other extreme, I am surely not alone in being asked from time to time to carry out very pedestrian consulting tasks: not really requiring detailed statistical method, but needing the "imprimatur" of the professional statistician to ensure respectability. These extremes of suspicious disregard and unwarranted veneration coexist at the present time - they do not represent a time transition from the primitive age to the space age. Fortunately, however, they enclose a vast middle ground of close interaction between statistician and practitioner, and sound application of statistical techniques. It is this middle ground which I will be exploring, in as far as it relates to the fields of industrial, social and governmental applications of statistics - with some indications of present emphases and emerging trends, and implications for support and relevant training.

2. How we got where we are

It is interesting to look back from a present position in which (although still somewhat patchy in some areas) statistics now seems to proliferate in almost all fields of endeavour and "industry". Was statistics not always rooted in real problems? After all "Student" was an industrialist who worked for the Guinness Brewing Co., whilst R A Fisher was concerned (inter alia) with social/eugenic problems as well as agriculture! Rooted perhaps, but hardly invasive or rapidly spreading. The examples were conspicuous because they were exceptional - they promised the new world which

E S Pearson remarked on wistfully in the 1930s, when suggesting that perhaps in 50 years time statistical concepts and methods would be duly applied in all aspects of our lives. We're getting closer to societal acceptance of statistics. It is interesting to recall Joe Gani's paper (1982) to ICOTS 1, where he observed that:

"... statistics is a subject of vital importance; it enters substantially into the quantitative content of many (if not all) other professional studies. Statistical information is pervasive: a detailed analysis of *The New York Times* newspaper for Saturday, 22 May 1982, will leave us in little doubt of this fact. The intelligent reading of such a newspaper, or of any other current information material, therefore makes a basic grounding in statistics essential for all citizens."

It is really remarkable how quickly (in historical terms in comparison with other subjects) statistics has advanced in its day-to-day influence: 40 years germination, 40 years growth and development, 40 years for dispersal? Is this an oversimplification? Of course it is. Consider the remarks of Bartlett (1940): "... while the universities may be beginning slowly to recognise the need of statistics in the curriculum ..., the teaching of statistics earlier, ..., is apparently not, so far, accepted." And then, I can recall only in the 1960s giving remedial help to school-teachers who were swamped by the emerging demands on them to teach this strange new subject. Thirty years later, statistics is taught in all UK schools - in mathematics lessons, in biology, in geography and in many other nooks and crannies.

Of course, rapid growth is bound to be uneven. Some countries have only recently started teaching statistics in their schools. The UK and US spawned modern quality-based industrial methods but their industry spurned them by and large. Only now is the Japanese experience being brought back home. Government statisticians and social organisations are providing ever-more vital pictures of social structure against which planning decisions can be taken. But different countries are at disparate points of progress. Sir John Boreham tells us (Boreham, 1990) of the early stages of a training programme for local statisticians in the Caribbean Islands, whilst in the UK a recent meeting of the Royal Statistical Society was directed to the question of whether governmental use of statistics had not become so sophisticated as to cast doubt on its integrity on some occasions!

3. The present environment

In spite of such contrasts *the first trend that must be remarked is that of wide-spread proliferation of statistics into all areas.* This is particularly rapid in regard to:

- (i) the media (papers, TV, etc.) in addressing all levels of society, and in supporting claims by providing statistical credentials;
- (ii) sociological and societal studies, almost always based on sample surveys, of increasing sophistication;
- (iii) government planning, again utilising a range of statistical survey (and other) techniques and served in many countries by a large regiment of professional statisticians;

- (iv) industry with particularly rapid expansion of statistics in fields of statistical process control (SPC), quality-planning, testing, evaluation and monitoring - from the design stage, through production to marketing and sales. Different sectors have different needs, and are showing different emphases.

Some details and illustrations will follow, but first it is worth asking how the different sectors are seeking to obtain the statistical support they need. Essentially, an organisation can:

- (i) employ its own professional statisticians;
- (ii) depend on the statistical skills of other professionals (engineers, accountants, psychologists, managers) on its staff;
- (iii) engage the services of external statisticians (perhaps via consultancy organisations) as and when required, either on an *ad hoc* basis or on a retainer over a longer period.

All of these approaches are employed but with different emphases in different sectors. As far as (i) is concerned, we should note the trend towards specific detailed training programmes for particular employment areas, exemplified by modular short courses, Masters programmes (e.g. in Social Statistics or Biometrics) or by the UK Government Statistical Service scheme of recruiting trainee statisticians and sending them on a specially commissioned postgraduate course.

The approach (ii) is served by consultancies and higher-education short-course outlets. Both are being called on to provide multifaceted training services: open courses and tailor-made in-house programmes, for reorientation of some workers into statistics *per se*, but more often to provide skills in particular areas (e.g. SPC, sample surveys or clinical trials, design and analysis) for other (non-statistical) professionals. This aspect of statistical education may be characterised as *Statistics for Continuing and Vocational Education*. An emerging trend under this heading is to be found in the increasing provision of work-books directed specifically towards practitioners. These are not broad-based introductory treatments of probability and statistics, but aim to satisfy particular needs for implementation with appropriate motivation and detailed worked examples, e.g. laboratory testing and validation in manufacturing industry, or phase IV clinical trials in pharmaceuticals, or public-sector survey methods. The publishers John Wiley & Sons are introducing a new international *Statistical Practitioner Series* to help to meet needs in this regard.

One inevitable effect of (iii) has been the growth of consulting services both through specialist agencies, and increasingly through higher-education sources such as the universities. The importance of consultancy cannot be over-stressed. I elaborated this (Barnett, 1986a) in the previous ICOTS session in Victoria and will not dwell on it here.

It is not appropriate to try to assess, or double-guess, the particular statistical topics that are, or will be, needed in the different applied fields over the next decade. Space does not allow this and our emphasis is on statistical education and training rather than detailed methodology. I have hazarded a few ideas on this topic elsewhere (Barnett, 1986b). Instead, I will give a few specific examples of recent problems I have encountered, and contributed to, in different fields. These serve to illustrate the richness

of demand and to draw out a few principles of a more general nature.

4. Is nothing sacred?

We shall consider examples from the fields of sport and recreation, social attitudes and local government responsibilities, statistical process control, and clinical trials.

4.1 *Goal!*

Some football teams in the UK have home pitches made of artificial turf. Some commentators feel that this gives them an unfair advantage. The English Football League has just completed a 2-year enquiry and has concluded (EFL, 1989) that no more First or Second Division teams can introduce such pitches and only one per year may be introduced in lower Divisions pending re-evaluation when more evidence is to hand. The most interesting feature was that the Football League did not feel its task was complete without a proper statistical analysis of the data and commissioned such a study. Would this have happened even 10 years ago?

The statistical analysis was quite challenging and, in spite of limited data, yielded quite convincing results (Barnett, 1990). Clearly one needs to compare teams with and without artificial home pitches in terms of the difference between home- and away-performance. Only 4 out of about 80 teams have been using artificial home pitches, and for no more than 10 years. Consider the additional difficulties. How do we measure performance: in terms of goals, results or league-points scored? How do we measure differential home- and away-performance? Suppose team A (with an artificial pitch) has a better home/away differential than team N (with a natural pitch). Is this the effect of the pitch or of the intrinsic quality and skill of the team?

Sports statistics is rapidly growing in attention. Another recent study, commissioned by the UK Health Promotion Research Trust, on the nature of sports injuries (in tennis and football) on artificial and natural surfaces also employed statistical methods to augment physical and physiological considerations (Barnett and Tancred, 1989, 1990).

4.2 *Training the team!*

Statistical Process Control and the ideas of Deming and Taguchi have long influenced the Japanese production processes to their great benefit. And yet the ideas stemmed largely from the UK and the US, where they have not been conspicuously applied. Instead of concentrating on an overall regard for quality throughout the design-production sales cycle and striving for worker commitment in the process, the UK/US approach has been one of "quality control": looking at the product at the end of the line with the risk of concluding "Oh dear! It's not too good is it?" Pearson (1971) remarked:

"I spent some time [in 1931] with Walter Shewhart and his colleagues at the Bell Telephone Laboratories in New York. Shewhart had for several years been advocating the use of statistical control charts and other simple techniques in the control of industrial quality, both within and outside the Bell organisation."

That's where it started in the US, but Japan is where it flowered.

All of a sudden we are finding a rapid rebirth of attention in the UK and the US to the total quality concept, with appropriate statistical support methodology. The US has led this renaissance with a concentration on Deming methods, facilitators, quality circles and the notion that we should not seek to satisfy the customer but to "delight" him or her - and where the customer is not outside the gates, but next in line in the industrial process. The British Deming Society was founded in 1987!

But things can move quickly. It was fascinating to be involved recently with a UK car-parts company of 1000 employees which decided to plunge in whole-heartedly and introduce a company-wide Deming retraining one-year process from the Chief Executive to the most junior clerical worker. This was a big investment but the cell-based structure of the company was propitious and it is to be hoped that the training scheme bears fruit.

4.3 *What would you do?*

Surveys abound; all areas (particularly social, governmental, public relations and marketing, etc.) seek views of interested-party groups (local inhabitants, voters, purchasers, etc.) as basic input for policy-making. The trend is for more and more surveys on a wider-and-wider base. Here is another UK example, from just two years ago (but possibly already a little dated).

A survey for a regional Fire and Civil Defence Authority, conducted in the summer of 1988, yielded 2500 replies to a detailed questionnaire of 30 questions regarding people's preparedness for and awareness of the implications of possible nuclear attack.

A wide range of different attitudinal and factual matters covered such fields as housing (including heating, lighting and cooking), possible actions by individuals or households in the event of an attack, details of dependants, individuals' assessments of their chance of survival and the possession of household items, from yellow buckets to stirrup pumps, though not many knew what the latter were.

An interesting feature of the survey was the remarkably high response rate. At nearly 70%, this was double what is often found in postal surveys, and clearly indicated an interest and willingness to discuss the topic. About 40% of respondents said that given two days' notice of attack, they would seek to build a shelter, although only seven people said they actually possessed a purpose-built fall-out shelter already.

More than 10% of respondents said that they would attempt to leave home during a war crisis, despite anticipated government advice to stay put, and this would obviously put great pressure on local services. Further, nearly 50% of respondents indicated a readiness to help in the event of a crisis or to take in people who had lost their homes.

4.4 *Do this!*

It is again interesting that the local authority felt it needed to work with a university group for this work - to give it professionalism and authority (perhaps even respectability). This is an encouraging trend and even the credibility factor should not be despised. It points to statistics coming of age in the eyes of society. Two other brief

examples illustrate it, both from the pharmaceutical industry. While the statistician is often called on to design and analyse clinical trials, some recent experiences proved of a different order. In one case an internal staff-incentive scheme was to be introduced with prizes and trips abroad. There was little statistical challenge in design or calculation, but a statistician was called in to act as the professional in charge, so that the scheme was seen to be fine and fair. In another, a team of statisticians were asked to contribute to a clinical trial - not to work with the drug company or doctors to design it, not to analyse the results, *but* to guarantee that *the data* collected by trial operatives and analysed by the statisticians *were sound*. This is not a mundane task; it can be quite challenging and it is another emerging trend.

5. Concluding comment

I have tried above to identify some features and trends in statistical practice in relation to the industrial and social fields. Only brief coverage has been possible. A major need is to identify clearly the implications for teaching and training, and to follow them through.

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