Statistical needs of non-specialist young workers

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Introduction

The *Statistical Education project 16-19* was set up in 1981 and funded by the Leverhulme Trust. Its brief was to consider the statistical requirements of those 16-19 year old students who were having to learn statistics in the contexts of such academic subjects as geography, economics, biology and psychology as well as in the more vocationally oriented business and technology courses such as those provided by the *Business Education Council* (BEC) and the *Technicians Education Council* (TEC), now combined into one body (BTEC). The project looked at what was currently expected and also what might reasonably be required of such students and proceeded to develop teaching material to meet these requirements.

One of the concerns of the project was, therefore to find out the nature of statistical ideas and techniques being used by young people as they enter employment at the age of 18 or so, following full time education. The interest was in the needs of the general employee on entering and becoming established within the company. It was not concerned with those working in Operational Research or Statistics departments nor with those who are employed as statistics specialists.

To get some feeling for the nature of the problem a large number of managers, personnel managers, training officers and employees in the 18 to *25* age range were interviewed. In addition, where it was not possible to arrange interviews, questionnaires covering the same topics were given to young employees to fill in. It

was not possible within the project's budget to mount a statistical survey to assess the number of employees with different statistical needs. Instead the project team attempted to reach a wide cross section of employees in industry, commerce and government services to find out the use they were making of statistical ideas and methods to make an objective assessment of the needs of employers and to pick up any major points of mismatch between the employers' expectations and employees' knowledge. To put the particular age group in context some younger employees who were doing part-time courses at Further Education Colleges and some older employees who were beginning to reach more senior positions were also contacted.

In spite of the wide range of employees interviewed there was a lot in common in the replies, though clearly there were some organisations that required a higher degree of statistical numeracy from all their employees of the age range in question. Amongst the more specialist employers contacted were the *Transport and Road Research Laboratory*, the *Laboratory of the Government Chemist* and *British Screw.* It is of the nature of these organisations to make greater use than other firms of statistical techniques.

The information we were seeking from employees can be judged from the copy of the questionnaireincluded as an appendix to this report. There were questions on the various statistical techniques that an employee needed, with a request for the context in which such techniques were used. Another section asked about the statistical background of the employee and whether this had been an appropriate preparation for the current work. From the employers we were trying to find out the use made of statistics in the organisation, with particular reference to the work done by young employees, and how important they viewed the use of statistics. Throughout our discussions

the word statistics was used in a broad sense to include the collection and presentation of numerical data; processing, interpreting and drawing inferences from these data and using the data to make decisions.

The rest of this report is a summary of the information obtained.

2. The Views of Managers and Training Officers

2.1 Background needed

Very few employers mentioned any specific background statistical knowledge required of their employees when joining the company or organisation. By far the most common comment, from all types of employer, was that they required a good background in basic numeracy. This could take a number of forms. A bank said that it required good arithmeticians keen on accurate answers; another firm wanted the ability to work with numbers with few errors. Usually, though, numeracy was meant more generally. There was a desire for a familiarity with numbers, a common sense approach, rounding and sensible accuracy and a sound number sense rather than particular statistical skills. That this was more than arithmetic was shown by the request that employees should come with insight into how and why data are collected, and know what data are used for. They should also be able to interpret information and answers intelligently.

The second major background strand requested was literacy. Employees must have the ability to communicate, and this applies to communicating numerical information. This was often allied to a general desire for employees to be able to think logically, to be orderly in their work and to write legibly.

The third general education requirement, though only mentioned by the larger companies, was that there should be a general awareness of how computers are used to process information and a knowledge of what they can (and cannot) do.

In the few more specialist companies that made a greater use of statistical techniques, employers hope to find such things as an understanding of procedures, a grasp of principles, the ideas underlying inferential statistics, of generalising from a sample, of making decisions with probabilities, of making estimates and of the principles of experimenting and of experimental design. This clearly requires a much more substantial background in the education of the employee.

There were several comments that many of the background courses (mostly BEC and TEC courses, but also some professional examinations) included much more than was actually needed. This may be so, but it has to be interpreted in the light of comments made later in this report about the under-use of statistics in many of the companies. More definite was the comment that preparatory courses at schools or college should be more relevant and use data drawn from real life situations.

2.2 Initiative required

In all but the smallest firms it was stressed that employees work in a well-defined system and, initially, that their work would be mostly routine, such as filling in forms and collecting data under supervision etc. In the early years little initiative would be required; more responsibility would come with age and promotion. This pattern of following instructions and not having to show much initiative was reflected in the statistical work being done. There was a tendency to have to fill in tables rather than to draw up one's own, to have to gather data as specifically requested rather than having to suggest what data to collect. The decision as to what to collect was taken higher up. There were, however, exceptions, and in some companies initiative is expected and

welcomed more than it is in others. Some examples are given in the next section.

2.3 Obtaining data

Although much data collection by young employees is routine there were indications that different skills were involved which could have been usefully included in courses prior to employment. There is a need to know where to get the relevant information and hence of appropriate sources of data. Sometimes this takes the form of having to pick out accurately the relevant data from a large source such as a set of tables or a large computer print out. Observations need to be read clearly and logically; sometimes data from different sources need to be collated and given as a tabulated summary. In some contexts the data source comes from continuous data collection (as in the temperature of a mine). Different companies have their own specialist nationally produced data sources some of which may be nationally produced (such as population data for assessing potential sales). Training in the use of such specialist sources is usually given in the company and is best done here rather than in earlier general education. It gives the background for later when, in a higher position, the employee needs to know what sources are available, where they are and how they can be used. We did find examples where junior employees had to show initiative in drawing up questionaires and in using a telephone to carry out an attitude survey

2.4 Checking data

Time and time again employers referred to the need for young employees to check the data they were recording. This was the

case even when such checking was not in the employee's job specification. It was expected that they would spot suspicious numbers, identify anomalies or pick out ridiculous answers. This was sometimes linked with the need to cross-check figures or to collate statistical information already collected. One source of discrepancy pointed out was the use of different definitions for, on the face of it, the same data (as in unemployment figures where the definition of 'unemployed' has changed over time) There were several references to 'eyeballing data' and this included the idea of a check for gross discrepancies.

2.5 Communicating Data and the use of techniques

The importance of being able to communicate one's findings was stressed many times by different institutions. It ranged from the filling in of simple forms up to report writing for the employee's immediate superior. Clarity of expression is essential not only because it is a good thing in itself but also because, as some managers admitted, not all executive staff are as numerate as they might be and they need things putting simply to help them make sensible decisions. Young employees also need to be able to understand communications from their bosses. Such communications include reports with tabulated data and simple forms of graphical data representation. The general requirement was the ability to summarise data verbally clearly and understandably; facts should be understandable; reports should be unbiased. There was a need to be able to use simple charts and tables to bring out the important points. Some special skills were needed when the communication was to be made with specialists (including specialist statisticians) or with the general public or with the customer. In many cases communication was formalised by the use of standard report forms the design of which was the responsibil-

ity of a more senior member of the company.

Several people commented that a deep knowledge was not essential and that mostly it was the ability to give a basic presentation of data that was required. The need for 100% accuracy in transmission and the need for avoiding processing error were both mentioned.

In general nothing more sophisticated than the above techniques was required of young employees, though more was required as they were promoted and took on more responsibility. Even then the usual position in most companies was the need for simple techniques to be used in a practical application. The relevance of the background data to future decisions was seen as more important, but often used fairly qualitatively rather than in standard statistical testing or estimation. There was a fairly frequently expressed doubt as to the usefulness of 'sophisticated' techniques. In some cases this appeared to be because the people concerned were not too familiar with them themselves. In one major company the word 'sophisticated' was identified as 'standard deviation and things like that.'

Specific techniques found being used by young employees were indeed fairly basic. There was a greater emphasis on recording and using tabulated data than graphically presented data, though examples of bar charts were found. Very rarely were pie charts used in practice.

Much of the tabulated and graphed data were of time series. Here trends had to be identified and trend lines interpreted. Nearly always trend lines were fitted by eye and rarely was anything more complicated than a moving average required from the young employee. Examples of identifying abrupt changes in such time

series were found, and often quite junior employees had to react to these. For example an abrupt change in temperature readings coming from a coal-face might be due to a blockage or a fan breaking down and these need immediate attention. Even within this limited analysis of time series there was usually a series of rules to be followed. It was not always necessary to understand the reasoning behind such rules though this could be helpful in motivating action. Stock control decisions, for example, were usually of a maximum/minimum nature and required no understanding or thought on the part of the young employee as to why the levels had been fixed at these values.

There was often need for an intuitive allowance for acceptable variability, but this rarely required the calculation of anything like a standard deviation or inter-quartile range. At this level even quality control became largely deterministic with the employee required to follow the rules.

There were a few examples where more advanced techniques and more sophisticated ideas were required. One *25* year-old was trying to assess the terms and conditions of employment within his own firm as compared with other similar firms competing in the same job market. This required him to identify what were the appropriate variables, to consider how to quantify unquantified variables (such as availability of sports facilities) and then to recommend how to ensure comparability between companies so that employees would not be tempted to move.

Only one instance was met of a junior employee having to write his own questionnaire to find out attitudes and opinions. Generally it was the few more specialist companies that required their employees to use more difficult techniques. These included the need to recognise sources of variability and of planning to avoid

the effects of variability, making estimates of manpower needs of job costings based on past data, reading quality control charts and using them in practice, predicting sales and other general forecasting. This sounds more high-powered than it generally turned out to be; estimates were rarely precise enough to require conceptually difficult modelling indeed in this part of the work seen there was a great reluctance to use any probability models.

There was the occasional exception. One of a few specialist employers required its employees to be able to cope with simple design of experiments, to develop a feeling for multivariate data and possible impact on univariate regressions, χ^2 tests and t-tests. Another wanted its employees to cope with regression, t-tests and analysis of variance. A third used cusum charts for its quality control, said that an understanding of the Poisson and lognormal distributions was useful but not essential and expected its employees to understand the implications of figures which had been exponentially smoothed. These three employers though, were the exception, usually such level of understanding was confined to the specialist statistics departments. The three companies have to recruit their employees from more numerate and able school leavers with some statistical background.

2.6 The Future Manager

Several times in the preceding text it has been hinted that statistical needs for individuals may grow as the employees get promoted and take on different responsibilities. The extra training may be obtained through taking examinations of the appropriate professional association or through learning on the job (sometimes through in-house training schemes) or by recruiting from a more highly qualified sector such as graduates. There was some

scepticism of the usefulness of the statistical components of many professional examinations. Comments were that such components were found difficult, technical and not always relevant.

One pertinent comment, which we shall return to, was that there was a real need for two types of course. The statistics specialist could have courses as at present (but made more relevant) but the future manager needed a different course. He needed a course which would tell him what statisticians can do, what questions can be answered, what the answers mean and how they can be used in making decisions. This course should also include an insight into data sources, such as national and trade data, how to decide what needs to be measured and how to use data for monitoring processes. Managers need to know about applications generally and then specifically within their own business. They need to be able to communicate with the specialist statisticians in their company.

Many of the managers spoken to stressed that their use of statistics was made largely in the context of making decisions. Data and statistics were part of the input of information for decision making. From this point of view they had to work from the end result required to identify the data needed. They needed to identify gaps in current information available, identify important data, know what and how much information they required and know which data to concentrate on. They also needed to be aware of how accurately the data had been collected and any idiosyncrasies within those data.

Most of the managers had to deal with time series and look for trends. Very few of them did any forecasting using formal models but they did make estimates and they did have to compare

actual data with projected and budgeted data. Decisions were based on the analysis they carried out. In one case the manager was concerned to identify national trends, not so that he could go with them but so that he could go against them. His was a small firm and he could not compete with larger companies following the major trends His market was carved out of minority interests. The idea of assessing priorities arose in several forms. There was the comment that it was more important to avoid making gross errors than to go for optimisation. Another was keen to assess orders of magnitude in an optimisation process so that the prime place for improvement could be identified. It was also clear that one principle was to manage by exception, i.e. look for the gross discrepancy and bring that back into line.

Again the more specialist companies expected the more specialist skills. One such company ran an in-house course for its managers including work on the binomial and Poisson distributions and a study of Type I and Type II errors, but it was stressed that the emphasis was on the use of these in applications rather than the proof of any results. It was also in these same specialist companies that managers were more likely to have to interpret quality control charts for themselves. Most of the managers interviewed felt that they had learned far more about the use of statistics in practice whilst doing their jobs than they had learned through any of the courses that they had attended.

2.7 Computers

The relationship between the use of statistics in a company and the use of computers was found to be an ambiguous one. Comments ranged from those who said that they did not do any statistics since the computer did all that sort of work for them to those

who said they expected to be able to work interactively with the computer to get the most from their statistics. The first attitude is clearly a worrying one since, at best, it shows a lack of understanding of the nature and purpose of statistics. Young employees were usually either having to prepare data for putting into the computer or having to read the output from a computer having first identified the appropriate table. Positive comments were that employees would be expected to know that the computer does not do everything, that they should be able to discuss intelligently what goes into and comes out of the computer and be aware of what the computer can do. They need to be able to read the data carefully and know the standard definitions being used. They might have to call up tables of data in specific formats from the computer and there were examples of the computer doing some of the graphical representation and of working out simple derived statistics to help with report writing. Major use of computers was within the larger companies though there was evidence of the spread of microcomputers and their use outside the realm of just keeping records. This led one manager to express the hope that future employees might come with experience of small computers and of using packaged software with them in a business context. Several managers were of the firm opinion that computerised decisions needed interpreting and that the major decisions should not be made by the computer.

It was only in few the more specialist companies that an ordinary well educated employee might be expected to use standard statistical packages (SPSS was mentioned) or work with the computer interactively in a major way.

3 The views of young employees

Where we could, we tried to talk to young employees about the use they were having to make of statistics. These interviews were arranged through the companies and it soon become clear that we were talking to those with a better educational background and with a greater than average contact with statistical ideas. This information then became useful as an indication of the upper bound of knowledge and level of application required. To supplement this we left questionnaires to be filled in by a wider range of employees. No attempt was made to make the number of questionnaires proportional to the number of employees in a given area. We were interested in the breadth of response and were not funded to attempt a full-scale survey to obtain a quantified estimate of the number of people requiring different skills.

3.1 Results of the interviews

In the interviews we were trying to identify the type of statistics being done and the views of the employees on their background training for this work. Backgrounds included BEC and TEC national level courses, 0- and A-Level courses and some courses for the professional associations. Comments on the professional courses were that there was too much emphasis on probability, the course content was too complicated and not sufficiently specifically related to the profession. There should have been more on the meaning of data, more practical examples and a closer look at market research data and their use. Comments on the BEC and TEC courses were that they tended to move too quickly into theory and complex calculations. There should have been more on the background of statistics. They wanted a more detailed briefing on how statistical ideas might be used at work, on the con-

texts in which the data might arise and on the general point of it all. Nearly all said they should have been more related to practical data and sales figures. Several said that too little emphasis was given to reading and simplifying tables and on making comparisons and decisions. Those who had done 0- or A-Level courses with a statistical component said that they found useful the work on data presentation, sampling and averages. They would have liked more on forecasting and on moving averages. No one we spoke to had used normal distribution theory, any formal probability, the Poisson distribution, the binomial distribution or the formal tests of significance that had been in their courses. They too would have liked more real life examples in their school or college courses. Generally they felt their courses included much more than was needed at work and this matches the findings of those who have surveyed the needs of younger employees than those we were talking to -see, for example, *Bailey* (1981). The uses of statistics we found amongst those we interviewed included most of the elementary ideas described in sections 2.3, 2.4 and *2.5* above though they were expected to show rather more initiative than implied in section 2.2. One employee worked in a company with a large number of different outlets. He had to identify the appropriate variables for measuring the work load and efficiency of each outlet and devise an appropriate weighted statistic based on these variables to decide on the number and type of employee that should be employed at each outlet. It turned out that his background for this was "failed 0-Level mathematics" and his chief source of help was his copy of M J Moroney's *Facts from Figures.* When asked why he did not seek help of the statistics department in the company he replied that that would reflect badly on his competence and spoil his chances of promotion.

Other, more standard, statistical techniques used were the analysis of numerical answers from a questionnaire, picking out rel-

evant information from tables of data, using data from market research companies, spotting outliers (using non-technical methods), using and calculating percentiles, plotting time series and sketching in trend lines, making predictions and having a common-sense approach to decision making.

3.2 Results of questionnaires

As indicated above the questionnaires went to a broad range of employees. Again, to put the work in context, some were given to people outside the 18-25 year-old age range. A copy of the questionnaire is given in Appendix 1 and a total of 156 questionnaires from 51 different firms were analysed. This only includes all those who indicated in at least one place that they did use some statistics in their work. The rank order of items which these employees said that they used is given in Appendix 2. From this it appears that young employees are involved with collecting data by counting or measuring. They are much more likely to be concerned with tabulated data than with graphically represented data. This work with tabulated data includes drawing up the tables, reading and interpreting tables, extracting appropriate data from larger tables and simplifying tabulated data.

The only statistical calculation that comes at all high up the list is the calculation of the mean. The rank of 34 for the calculation of variance or standard deviation may be too high since some comments on the questionnaire alongside this item showed that variance was sometimes taken as a synonym for variability. In each case more people have to read or understand a particular form of representation than have to be able to construct it for themselves.

One of the surprising, and perhaps alarming, features of these

results is the low position of all the items on probability and on probability distributions. Even the item ‘use of words such as likely and uncertain’ only ranks 22 whilst the writing of reports based on data ranks 4.

A lack of understanding of what is involved was shown by the several people who said they had to use a statistical test to compare two or more sets of data (rank 34) yet did not (in their perception) use any of the basic statistical distributions (ranks 50, 51 and *52).* It is also an interesting comment on the level of statistical work being done that many people have to make projections (rank 16), detect and estimate trends (rank 11), allow for variability in estimates (rank 13) and make decisions based on data (rank 13) without any use of probability on a 0-1 scale (rank 46) or as a measure of uncertainty (rank *35).*

4 Final Comments

Attitudes amongst employers towards the use of statistics varied widely. There was in many cases a certain amount of apprehension and a feeling that any other than elementary statistical techniques were not suitable for use in industry and commerce outside the specialist areas. This shows itself in the emphasis given to the rough and ready techniques used and the fairly frequent use of the word 'sophisticated' in a pejorative sense. Often this seemed to stem from background courses which had introduced such techniques rather quickly and which had not shown how they could be used successfully in practice. Other people expressed a feeling that they were sure that they would make greater use of statistics in their work if only they knew what could be done. Clearly there is a major educational task in convincing future managers of the benefits of proper statistical analysis and in giving the rudiments of statistical knowledge to the general workforce. This implies that general background courses and service courses in statistics should emphasise usefulness and reality rather than cleverness, and that more complex statistical ideas and techniques can lead to greater efficiency and are not just part of some academic exercise.

The project was helped greatly by the many firms who willingly gave their time to talk to team members. Special thanks are due to *British Telecom*, the *National Coal Board*, the *Midland Bank* and *BP* all of whom gave extensive interviews.

Reference

Bailey D E (1981) *Mathematics in Employment (16-18)* Report February 1981 University of Bath

Appendix 1 Example of Questionnaire

The University of Sheffield
Statistical Education Project (16-19)
Questionnaire

The aim of this questionnaire is to find out the use being made of statistics at work by people aged 18 to *25.*

The information will be used to make more relevant the statistics being taught to the 16-19 age group at schools and colleges.

The word *statistics* is to be taken in a broad sense. It includes any collection and presentation of numerical data, processing, interpreting and drawing inferences from these data and using the data to help make decisions.

Thank you for your help in completing this questionnaire.

A General

Name of employer.....
Nature of business.....
Nature of your job.....

B. Statistics in Your Work

B1 Obtaining data

Do you have to obtain your own data? YES/NO

If YES *do you have to:*

Context

a.Decide what data to collect *YES/NO*
b.Do your own counting or measuring *YES/NO*

c.Design and use your own recording sheet *YES/NO*

Do you have to use a questionnaire to obtain data?

If YES *do you have to:*

		Context
a.	Decide what questions to ask	*YES/NO*
b.	Design your questionnaire	*YES/NO*
c.	Find facts	*YES/NO*
d.	Find opinions	*YES/NO*
e.	Allow for non-response	*YES/NO*

Do you have to use data collected by someone else YES/NO

If 'YES' *do you have to:*

	Context
a. Find the source of the data	*YES/NO*
b. Assess the accuracy of the data	*YES/NO*
c. Check any definitions used	*YES/NO*
d. Extract appropriate data from larger tables	*YES/NO*

B2 Representing data

Do you have to put data into tables or represent data graphically? YES/NO

If 'YES' *do you have to:*

	Context
a. Draw up tables of data	*YES/NO*
b. Draw bar charts	*YES/NO*
c. Draw pie charts	*YES/NO*
d. Draw histograms	*YES/NO*
e. Draw scatter diagrams	*YES/NO*
f. Draw graphs of time series	*YES/NO*

g. Use logarithm or other specialist scales
YES/NO

h. Draw cumulative frequency diagrams
YES/NO

B3. **Data reduction**

Do you have to analyse data by simplifying tables, calculating averages etc. or drawing trend lines. YES/NO

If YES *do you have to:*

Context

a. Simplify tabulated data *YES/NO*
b. Calculate the mean (average) *YES/NO*
c. Calculate the median *YES/NO*
d. Calculate the range *YES/NO*
e. Calculate quartiles or percentiles *YES/NO*
f. Calculate variance or standard deviation
YES/NO
g. Calculate index numbers *YES/NO*
h. Calculate moving averages *YES/NO*
i. Draw trend lines *YES/NO*
j. Calculate a correlation coefficient
YES/NO

B4 Probability
Do you have to use the ideas of probability? YES/NO

If YES *do you have to:*

Context

a. Use words such as *likely* and *uncertain?*
YES/NO

b. Use probability as a measure of uncertainty
YES/NO

c. Use a 0-1 scale of probabilities *YES/NO*
d. Assign probabilities to events *YES/NO*
e. Use probabilities in calculations *YES/NO*

Do you have to use any probability distributions?
YES/NO

If YES *do you have to use:*

Context

a. The uniform distribution *YES/NO*
b. The binomial distribution *YES/NO*
c. The normal distribution *YES/NO*
d. Any other distributions (please specify)
YES/NO

……

B5. **Interpretation and inference**

Do you have to interpret data or write reports summarising data? YES/NO

If YES *do you have to read and interpret:*

Context

a. Tabulated data *YES/NO*
b. Bar charts *YES/NO*
c. Pie charts *YES/NO*
d. histograms *YES/NO*
e. Scatter diagrams *YES/NO*
f. The results of simulations *YES/NO*
g. Do you have to write reports based on the data **for others to use?** *YES/NO*

Do you have to make estimates based on data? YES/NO

If YES *do you have to:*

Context

a. Detect and estimate trends *YES/NO*
b. make projections *YES/NO*
c. Allow for variability in estimates *YES/NO*

Do you have to use any statistical tests (e.g. t-test, χ^2)
YES?NO

If YES *do you have to:*

Context

a. Compare two or more sets of data *YES/NO*
b. Use a test of significance *YES/NO*
c. Allow for Type I and/or Type 2 errors
YES/NO

Do you have to make decisions based on data?
YES?NO

If YES *please give details, including the context.*
.....
.....

B6. Other uses of statistics.

Do you use statistics in any other ways not given above (e.g. designing experiments) YES/NO

If YES please give details
……
……

C. Your Statistical Background

Did you study 0-level or CSE in Statistics YES/NO

Please indicate which of the following O-level/CSE subjects you studied and whether they contained any work in statistics.

Mathematics	YES/NO (include statistics?) YES/NO
Geography	YES/NO (include statistics?) YES/NO
Biology/ Env Studs	YES/NO (include statistics?) YES/NO
Economics	YES/NO (include statistics?) YES/NO
Social Studies (or similar)	YES/NO (include statistics?) YES/NO
Other (include A-level)	YES/NO (include statistics?) YES/NO

School

What subjects/courses did you study after the age of 16?

A-level.....
BEC courses.....
TECcourses.....
Others (please specify).....

Which, if any, included some work in statistics?

Work

Have you or are you currently taking any course with a statistical content YES/NO

If YES *please state.*

a. The nature of the course(s).....

b. The duration of the course(s).....

c. Statistical content of the course(s)

……

……

Is there any statistics, which you feel would be beneficial to your work, which you haven't previously been taught?

.....

.....

.....

.....

On what school courses (if any) do you feel this statistics could best be included?

.....

.....

.....

Higher Education

Did you stay in full-time education on leaving school? YES/NO

If YES *please state:*

a. Course title.....

b. Duration of the course.....

c. Did the course have a statistical content?.....

.....

.....

Thank you very much for your help.

Appendix 2.

Summary of Questionnaires

A. Item Analysis

No. of times	Rank	Item
112	1	Have to do their own counting or measuring
93	2	Have to draw up tables of data
84	3	Have to read and interpret tables of data
82	4=	Have to assess the accuracy of someone else's data
	4=	Have to write reports based on data for other people to use
81	6	Have to decide what data to collect
80	7	Have to calculate the mean
74	8	Have to design and use their own recording sheet
71	9	Have to extract appropriate data from larger tables
66	10	Have to check definitions used in data collected by other people
62	11	Have to detect and estimate trends
59	12	Have to simplify tabulated data
57	13=	Have to find the source of data
	13=	Have to allow for variability in estimates
	13=	Have to make decisions based on data
54	16=	Have to calculate the range
	16=	Have to make projections
42	18=	Have to draw bar charts
	18=	Have to draw graphs of time series
33	20	Have to draw histograms

32	21	Have to read and interpret bar charts
31	22=	Have to use a questionnaire to find facts
	22=	Have to use words such as ‘likely’ and uncertain’
30	24	Have to calculate variance or standard deviation
29	25=	Have to use logarithm or other specialist scales
	25=	Have to draw trend lines
	25=	Have to read and interpret histograms
28	28	Have to calculate the median
27	29	Have to calculate quartiles or percentiles
26	30	Have to assign probabilities to events
24	31	Have to allow for non-response to questionnaires
22	32=	Have to decide what questions to ask on a questionnaire
	32=	Have to read and interpret scatter diagrams
21	34	Have to use a statistical test to compare two or more sets of data
20	35=	Have to design their own questionnaire
	35=	Have to use a questionnaire to find opinions
	35=	Have to use probability as a measure of uncertainty
18	38=	Have to draw scatter diagrams
	38=	Have to read and interpret pie charts
	38=	Have to read and interpret the result of simulations
17	41	Have to draw pie charts
16	42	Have to draw cumulative frequency diagrams
14	43	Have to calculate correlation coefficient
13	44	Have to use probabilities in simulations
12	45	Have to calculate moving averages
11	46=	Have to use the 0-1 scale of probabilities

	46=	Have to use statistics in other ways not given elsewhere in the questionnaire
10	48	Have to use a test of significance
7	49	Have to allow for Type I and Type II errors
6	50	Have to use the normal distribution
4	51	Have to use the binomial distribution
3	52=	Have to use the uniform distribution
	52=	Have to calculate index numbers
1	54	Have to use a distribution other than the uniform binomial and normal distributions

Note: Only questionnaires with at least one positive response to the use of statistics were analysed. 156 such questionnaires were returned.

B. Applications of Statistics mentioned in Questionnaire Replies

Barclaycard - Business analyst
Choice of equipment. Design of a system. Methods for clerical work.

Department of Education and Science: Systems analyst
Comparison of projects - forecasted costings. Comparison of data from different sources. Forecasting future clerical work loads from current workloads.

Department of Education and Science ADP support
Monitoring and justifying development in terms of cost versus benefit

Ministry of Agriculture Veterinary services

Disease incidence. Planning for disease control. Contingency planning for Civil defence. Planning for vaccination programmes, disease eradication.

Ministry of Agriculture Land Classification
Soils and climatic data.

Ministry of Agriculture & Fisheries Civil Emergencies Div.
Food supplies in emergency conditions. Claims from EC disaster fund for losses due bad weather
.
Inland Revenue
Show results from individual office and region in tables. Ensure that output is being maintained both with regard to the number of cases and in monetary terms.

Inland Revenue.
Formulating audit pressure.

Careers Office
Adapting data from local and central courses to meet local needs. Comparison of new data with previous data. Data on unemployed, trends in unemployment. Destination of school leavers. Manpower planning. Youth unemployment rates. Effect of unemployment by age, qualifications. Number of people on YOP schemes. Staffing increases. Re-allocation of staff. Budget conservation. Extracting data from records.

British Telecom
Behaviour characteristics of semi-conductor devices. Assessing reliability of devices Measurement of component characteristics. Work study and timing measurements. Analysing market research results. Disputed bills.

Civil Service: -public service.
Preparing updates for a series

Civil Service -government reprographics
Production. Costing. Stores

Manpower Services Commission - area manager
Operational manning and budgetary control. Forecasting business values based on assessment of labour market activity, staffing resources and the previous operational year.

Dept. of Transport - Principal
Manning and fee levels.

HM Customs & Excise
Credibility checks.

Foreign & Commonwealth Office - Dept. Admin Officer
Estimates. Forecasts. Costing installation work. Financial and staffing estimates.

LAMSAC. -Research Assistant
Manpower resource studies. Details of work and staff in local government departments. Establish staffing models to estimate staff required. Types of houses, drainage.

Grasslands Research Institute
Design of experimental projects. Calculating moisture content of crops. Comparison of treatments. Comparison of seasonal patterns, seasonal trends.

NDP. Trainee Research Executive
Reporting results of surveys. Deciding which are the salient

issues.

Harrison - Rubber & Asbestos manufacturers
Stock purchasing. Monthly balance Anticipating customers requirements. Maintaining stock funds balance with cash flow.

De-Lusso Kitchens Ltd
Allow for machine deficiency.

Whitbreads
Dated product prices. Bad debt provision. Monthly transport cost analysis. Car expense and plant hire analysis. Projections for fuel and telephone accounts. Variance analysis against budget. Evaluation of stocks. Production prizes to customers. Monitor sales in promotion exercises.

Introduction / withdrawal of brands. Distribution drives in specific areas. Decisions on advertising expenditure. Check sales against stock. Future ordering. Reduce levels, service levels. Pay negotiation strategy. Product quality and equipment problems.

Formulation of trade strategy. Monitor performance of public houses. Absenteeism rates. Distribution of costs. Adjustment of mill settings to get correct malt extract yield. Work within quality control parameters. React to trend of beer losses. Laboratory results to improve plant hygiene.

Budget preparation. Performance of a number of retail outlets in a particular market segment. Volume of sales figures. Whether to install new products or withdraw old ones. Complete alterations or invest in new public houses. Remove

licences due to poor public performance. Decide action to take after stock results produced. Global data to determine trading trends. Beer tasting trials. Deciding on optimum contract quotations.

Valuation of property. Identify trends and seasonality in sales patterns. Use quality control data to improve the product. Whether or not to develop a site. Dining room usage

Trent R H A
Reading meters. Blood pressure, blood counts, e.c.g. Audiograms. Physiological measurements. Fuel consumption figures. Allocation of learner nurses.

South Yorks PTA
Bus reliability and MT failures

Sheffield City Council
Attendance at council day centres.

British Steel et al
Measuring defects and paint marks. Gauging up of test rigs, meeting tolerances. Threshold of defects in steel. Assessing data as to suitability for computer. Quality control of steel standards, Sample analysis of steel chemical composition. Predict monthly usage of coke. Stock control of coke. Deciding what specifications to work to. Density and hardness of steel.

Tungsten Carbide
Size of drilling buttons, quality control.

Assay Office
Assaying checks of three months data. Quality of metal up to

standard or not.

Sheffield Smelting Co.
Improving metal quality.

Sheffield Castings
Stress rupture testing.

RHP Bearings
Fatigue and life calculations. Chemical composition of metals.

Sheffield City Poly Food science technician
Rate of bacterial growth.

Stones Brewery
Original gravity of beer samples.

Halifax Building Society
Branch inflow and outflow figures. Number of accounts opened. Distribution of types of account. Arrears of payments.

Yorkshire Bank
Number of cheques taken per month. Number of accounts opened. Assessment of workload of individual and of branch. Ordering of stationery. Amount of cash needed in a branch.

Some other practical examples of statistics mentioned in interviews.

Packaging of confectionery
Insurance salesman advising a potential client
Breakdown of sub-stations
Estimating the possibility of insurance claims.
Decisions on opening and closing new garages

Estimating the amount of insulating material needed for cavity wall insulation
The effectiveness of different methods of advertising
Comparison of rates of remuneration and conditions of employment
Trends and patterns in individual customer's accounts
Where to place an autobank
Spending in the staff canteen
Stock control in public houses
Customer credit worthiness
Analysis of accident statistics
Assessment of efficient staffing levels
Routing of tankers

and many others on financial planning, budgeting, sales etc.