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THE CHARACTERISTICS OF TECHNICALLY PROGRESSIVE FIRMS

by C. F. CARTER and B. R. WILLIAMS

IN our book *Industry and Technical Progress*¹ we gave an analysis of the relation between technical progressiveness and certain other characteristics of firms, which might be summed up by the title *general quality*. We concluded (p. 190) that 'technical progressiveness is related to the general quality of the firm; and attention to other aspects of its general quality — for instance, to management efficiency or to salesmanship and market research — helps to create the conditions for technical progress. In other words, the use of science is not an optional extra to be attached to the firm, but an expression of the whole attitude of the firm'. The purpose of this paper is to explain in greater detail our previous analysis, and to invite readers in industry to try their hands at making a similar analysis for their own firms, either for their own interest or (if they are willing to help us in this way) in order to increase our body of data. Although we present this article under our names, as authors of the book, the original work was to a considerable extent due to members of our research staff (Miss M. G. Hanna, Dr. D. L. Cardwell and Miss M. I. Burnikell), and in particular to Mr. W. P. Scott, whose statistical ingenuity was much in demand to deal with the difficulties of the data.

It is not easy to say what 'degree of technical progressiveness' a firm has attained. There is no great difficulty in dividing firms into three classes:

- (a) Those which are in the forefront of discovery in applied science and technology, quick to master new ideas and to perceive the relevance of work in neighbouring fields.
- (b) Those which are quite uninterested in science and technology, and are perfectly content to continue with traditional methods without even examining the alternatives.
- (c) A large middle group, neither outstanding leaders in technology nor wholly uninterested in it.

Any finer subdivision involves a comparison of what a firm has achieved, in the application of science and technology, with the possibilities reasonably open to it, having regard to its size, its market position and the achievements of other firms in its trade. Such a comparison requires a detailed knowledge of many firms in each trade; we possessed such knowledge only for a few trades, and in

¹ Oxford University Press, 1957, pp. 177-84.

general we were seeking to assess the technical progressiveness of firms with little help from direct comparison with other firms in the same line of business. Yet we did not feel it unreasonable to make ratings of technical progressiveness on a scale from 0 to 10. To experienced investigators, many small indications combine to yield an assessment of the technical state of the firm; the assessment is like the mark given by a University examiner to an essay — difficult to justify in detail, because it is based on the combination of many factors, but not necessarily unreliable. We found, in fact, that independent assessments by different members of our staff were in good agreement.

Since, however, our purpose was to relate ratings of technical progressiveness to other characteristics of the firm, we had to consider whether our ratings were independent of those characteristics. As we said in our book (p. 177): 'It is not enough to say that in practice different observers can be found to agree on a rough classification of progressive firms, for it might be that their impressions were the joint result of the observation of a series of characteristics which people naturally associate with progressiveness. We should then find an association between ratings of progressiveness and the characteristics on which those ratings were (perhaps subconsciously) founded, but this association would convey information about the minds of the observers, and not about the real world. The danger is a serious one, for in the course of an investigation one naturally forms preliminary hypotheses — for instance, that progressive firms are ready to share ideas with others; and once such a hypothesis is formed, it may begin to enter into the reasons for the classification of the progressiveness of firms later interviewed.' Our conclusion was, however, that (so far as we could tell) this loss of independence was not serious at the two ends of the scale — firms rating 0 to 4 and 8 to 10: but that it might introduce some doubt in the middle reaches, 5 to 7. Hence we gave our attention mainly to firms which were markedly progressive or unprogressive in technical matters.²

Our original list of characteristics which we thought we might compare with our assessments of technical progressiveness numbered 60; but we found that this number could be substantially reduced by combining overlapping characteristics, and that further reductions were forced on us by inadequacies of the data. Our final list numbered 29, and we defined these so that a high level of performance was that which we observed in technically progressive

² It will be seen from Table II, however, that the relation between the characteristics and technical progressiveness, though more variable in the middle reaches of the progressiveness indicator, remains quite close.

firms. The association between high performance (on the characteristics) and high 'progressiveness' therefore exists by definition; what we were looking at was the relation between performance on the characteristics and medium or low progressiveness.

For some reason which now appears eccentric,³ we rated the firms for each characteristic on a scale from 0 to 8. This was done by defining for each characteristic a 'top level' (8 marks), a 'middle level' (4 marks) and a 'bottom level' (no marks), and recognizing three intermediate marks between each pair of levels. The definitions used are given in the appendix to this paper. We think that it is certainly reasonable to recognize a subdivision finer than that into three classes — those who try to apply the definitions to their own firms will agree that they often want to give a mark lying between those for our classes; but we would not now defend a scale of 0 to 8 as necessarily appropriate.

In trying out this scale on some fifty firms, we uncovered a further difficulty. Although our information was for many firms extensive, and the degree of personal contact considerable, we had not always asked the questions which would elicit information on all the characteristics: or the information in our possession was vague and of doubtful reliability. At the stage at which our analysis was made, we could not normally go back to fill in missing information. Furthermore, some of the characteristics were irrelevant to the circumstances of some of the firms; for instance, a willingness to give technical service to buyers is obviously important to a gas-turbine manufacturer, but not to a maker of pottery. In combining together the results for different firms for a particular characteristic, therefore, we used a weighting system: a zero weight (i.e. the mark was ignored or not given) if the information was quite inadequate or the characteristic quite irrelevant; a weight of one for full information about a relevant characteristic; and intermediate weights of $\frac{1}{2}$, $\frac{1}{3}$ and $\frac{2}{3}$ for intermediate degrees of relevance or information. This weighting system introduced a further subjective element into the analysis, but it appeared to be the only satisfactory way of reducing the data to an orderly form.

Having done this, we had of course to be sure to compare equivalent 'bodies of information'; and in the table which follows, the marks for each group for each characteristic relate to the equivalent of ten firms with full information — that is to say, two firms with 'information weighting' $\frac{1}{2}$ were taken as equivalent to one with a

³ Eccentric because 'progressiveness' was rated up to 10. The scale from 0 to 8 arose because it provided sufficient intermediate ratings between the three main levels, and combined conveniently with our weighting system (see below).

weighting of 1. The firms were chosen in alphabetical order from each group until the equivalent of ten firms, with a possible mark of 80, was reached. We do not think that any serious bias was introduced by this method of selection.

TABLE I
RELATION OF RATINGS FOR TECHNICAL PROGRESSIVENESS AND FOR TWENTY-NINE
OTHER CHARACTERISTICS
(Marks out of 80, for three groups of firms)

Short titles of characteristics (numbered as on pp. 94-104)	Technical progressiveness rating			Ratio, '8 to 10' to '0 to 4' marks
	0 to 4	5 to 7	8 to 10	
				per cent
1. Good information sources	20	42	74	370
2. Seeking outside standards of performance	10	51	76	760
3. No secretiveness	21	61	77	367
4. Readiness to co-operate	22	52	77	350
5. Good co-ordination	14	51	73	521
6. Ideas surveyed	22	47	79	359
7. Cost-consciousness in research	18	41	69	383
8. Quantified investment decisions	1	46	74	7400
9. Good management techniques	17	57	76	447
10. High status of science	9	44	78	867
11. Scientists on the Board	20	46	71	355
12. Good chief executive	13	58	79	608
13. Attractive to talent	19	42	70	368
14. Good recruitment policy	29	50	76	262
15. Good training policy	11	43	68	618
16. Enough intermediate managers	10	33	68	680
17. Good intermediate managers	19	32	76	400
18. Managers stimulated	4	37	75	1875
19. Effective selling	16	45	72	450
20. Good technical service	23	53	79	344
21. Ingenuity with shortages	6	55	76	1267
22. Forward-looking tendency	11	54	67	609
23. High expansion rate	23	68	78	339
24. Rapid machine replacement	16	37	71	444
25. Industry scientific	23	19	55	239
26. Good buildings	23	31	49	213
27. Top manager a scientist	8	32	54	675
28. Shop-floor resistance to innovation	64	70	75	117
29. Adequate finance	48	53	75	156

We decided that the extent of our information about the distributions involved did not justify the use of statistical tests, and that we would have to be satisfied with such indications as are available from the crude figures. High figures in the '8 to 10' column are, as already explained, to be expected by definition; but for most characteristics the figures in the '0 to 4' column are so low as to suggest a strong relationship to low technical progressiveness. For five characteristics only it seemed that this relationship was doubtful or weaker. Characteristics 25 and 26 show relatively low figures, even for the 'progressive' group; characteristics 28 and 29 show high

figures even for 'unprogressive' firms; while characteristic 27 showed on closer examination a high degree of divergence of marks within the groups, so that the pattern obtained for the groups as a whole seemed accidental. The rejection of these five left twenty-four characteristics for which there seemed to be a *prima facie* case of relation to technical progressiveness. Further details which show why five characteristics have been rejected appear in the appendix. The five include some important items like 'adequacy of finance', but they show no obvious connection with each other.

A further illustration of the relationship can be provided by comparing the unweighted average of the marks for the twenty-four characteristics with the technical progressiveness ratings. The following table shows the average mark expressed (like the progressiveness rating) on a scale from 0 to 10, for forty-one firms whose identity must, in accordance with our pledges of confidentiality, remain concealed.

TABLE II
COMPARISON OF 'CONSTRUCTED' AND 'ASSESSED' TECHNICAL PROGRESSIVENESS RATINGS

<i>Rating constructed from the twenty-four characteristics</i>	<i>Technical progressiveness rating</i>	<i>Rating constructed from the twenty-four characteristics</i>	<i>Technical progressiveness rating</i>
9.94	9	5.82	4
9.87	10	5.56	2
9.84	10	5.40	7
9.71	9	5.14	7
9.69	10	5.00	6-7
9.55	8-9	4.51	5-7
8.98	8	3.85	5
8.85	8	3.42	4
8.70	7-9	3.29	7
8.68	7	3.04	4
8.52	9	2.32	6
8.52	7	2.07	3
8.31	7	2.06	3
8.22	7	1.85	2-3
8.19	8	1.48	3
7.50	7	1.12	4
7.35	7	0.75	2
7.06	8	0.74	3-4
6.61	7	0.51	2
6.47	6-7	0.07	1-2
5.87	7		

The agreement at the head of this table is again largely a matter of definition. The agreement in the lower reaches is reasonably close (the correlation between the two columns of figures is 0.88), though the technical progressiveness ratings tend to be too high — that is, there was an unwillingness to use ratings such as 1, 2 and 3. Some of the differences between the figures (e.g. 3.29 and 7) were for firms for which our body of information was admittedly inadequate.

The characteristics are defined in the appendix; we have taken the opportunity to put them in an order more logical than that used in our book. They form, as can be seen, quite a comprehensive assessment of the attitude of the firm to new knowledge, its research, production and sales policies, its way of making investment decisions, its internal co-ordination, its management and recruitment methods, and the quality of its key personnel. We think they are fairly summed up under the title 'general quality'. But is the association of general quality and technical progressiveness one of cause and effect? After reviewing cases of firms which had recently made the transition from a traditional to a scientific basis, we concluded that in some instances attention to various aspects of 'general quality' not only preceded the technical change in time, but was a necessary condition for making the change. We also noted some firms whose enthusiasm for the application of science was proving self-frustrating, and which had for a time to hold back their efforts in research and development in order to give more attention to other aspects of 'general quality'.

The existence of such cases gives our analysis a certain practical value. It means that we can go beyond an assertion of an unexplained statistical association, and suggest that, in some firms at least, technical progress would be made easier by attention to the first twenty-four characteristics in the appendix. Since we also found an association between technical progressiveness and financial success, this conclusion may be of some interest and profit to business men.

We now invite readers to test their own firms against these characteristics. We suggest a simplified marking scale from 0 to 4:

A	4
'Not as good as A, but better than B'	3
B	2
'Not as good as B, but better than C'	1
C	0

Where a characteristic is irrelevant, please record the mark X; no 'weighting' of the other marks should be made. *Before* recording any marks for the characteristics, we suggest that readers should assess the technical progressiveness of the firm on the same scale:

- (A) The firm is in the forefront of discovery in applied science and technology, quick to master new ideas, and to perceive the relevance of work in neighbouring fields 4 marks
- (AB) 'Pretty good, but not quite first-rate' 3 marks
- (B) 'As good as the average for the trade in the United Kingdom, but not a leader; probably below standards of scientific advance in some other country' 2 marks

- (BC) 'Weak but not wholly stagnant' 1 mark
 (C) The firm is quite uninterested in science and technology, and is perfectly content to continue with traditional methods without even examining the alternatives. 0 marks

Readers may wish to do this exercise for their own interest; but we also would be very interested to receive copies of the marks recorded, either anonymously or with details of the circumstances of the firm.

THE CHARACTERISTICS OF TECHNICALLY PROGRESSIVE FIRMS

Mark Sheet

Size of firm (no. of employees):

Industry (give Standard Industrial Classification number if known, otherwise description):

Technical progressiveness rating (circle relevant figure)		0	1	2	3	4	
Ratings for characteristics (circle relevant figure, or X if characteristic is irrelevant)	1. Good information sources	0	1	2	3	4	X
	2. Seeking outside standards of performance	0	1	2	3	4	X
	3. No secretiveness	0	1	2	3	4	X
	4. Readiness to co-operate	0	1	2	3	4	X
	5. Good co-ordination	0	1	2	3	4	X
	6. Ideas surveyed	0	1	2	3	4	X
	7. Cost consciousness in research	0	1	2	3	4	X
	8. Quantified investment decisions	0	1	2	3	4	X
	9. Good management techniques	0	1	2	3	4	X
	10. High status of science	0	1	2	3	4	X
	11. Scientists on the Board	0	1	2	3	4	X
	12. Good chief executive	0	1	2	3	4	X
	13. Attractive to talent	0	1	2	3	4	X
	14. Good recruitment policy	0	1	2	3	4	X
	15. Good training policy	0	1	2	3	4	X
	16. Enough intermediate managers	0	1	2	3	4	X
	17. Good intermediate managers	0	1	2	3	4	X
	18. Managers stimulated	0	1	2	3	4	X
	19. Effective selling	0	1	2	3	4	X
	20. Good technical service	0	1	2	3	4	X
	21. Ingenuity with shortages	0	1	2	3	4	X
	22. Forward-looking tendency	0	1	2	3	4	X
	23. High expansion rate	0	1	2	3	4	X
	24. Rapid machine replacement	0	1	2	3	4	X
	25. Industry scientific	0	1	2	3	4	X
	26. Good buildings	0	1	2	3	4	X
	27. Top manager a scientist	0	1	2	3	4	X
	28. Shop-floor resistance to innovation	0	1	2	3	4	X
	29. Adequate finance	0	1	2	3	4	X

Age of informant
 Status in firm

Any such marks will be treated in strict confidence. They should be sent to Professor B. R. Williams, University College, Keele, Staffordshire.

THE QUEEN'S UNIVERSITY, BELFAST.
UNIVERSITY COLLEGE, KEELE.

APPENDIX

DEFINITIONS OF CHARACTERISTICS WHICH WERE CONSIDERED IN RELATION TO TECHNICAL PROGRESSIVENESS

1. *High quality of incoming communication.* This characteristic relates to quality rather than quantity, and no adjustment of the definition for the size of the firm is therefore made.

- (A) The firm takes journals of high repute, including some not necessarily related to the trade (e.g. *Nature*, *Research*); it has good high-level contacts in universities and research laboratories, and it uses them intelligently; it has good means of obtaining information from overseas.
- (B) The firm takes mainly technical journals (e.g. *The Engineer*); it uses contacts in Research Associations or elsewhere in industry to obtain technical information.
- (C) The firm takes trade papers, and perhaps (though in a routine way) the bulletins of one Research Association. It makes no effective use of contacts for obtaining technical information except those ready-made by supplier-customer relations.

2. *A readiness to look outside the firm.* Some firms set themselves very high standards of performance, and to do so must have a good knowledge of practice elsewhere, perhaps throughout the world. Others set themselves no outside standard, being content to judge present performance by what they have achieved in the past. This is a characteristic which, more than most of the others, needs to be judged in relation to the size of the firm.

Large firms:

- (A) There is extensive world-wide travel by executives, and a lively interest in progress at home and abroad; standards are set by the best practice anywhere in the world.
- (B) Occasional overseas visits and a fair range of contacts in the United Kingdom; but no immediate urge to achieve world leadership.

- (C) There is no significant effort to find out about, let alone to equal, the best world standards.

Medium firms:

- (A) At least one visit per year is paid to relevant leading countries in the industrial field concerned; there is a high standard of performance.
- (B) Overseas visiting on technical matters is rare; British contacts are mainly in the same industry; the standard of performance is to do a little better than competing British firms.
- (C) The firm is mainly satisfied with current standards.

Small firms:

- (A) There are occasional overseas visits, and extensive contacts in several industries in the United Kingdom; the firm is consciously trying to grow, and is interested in what goes on elsewhere because of this.
- (B) Contacts are mainly within the industry and at home; the standard of performance is to do a little better than competing British firms.
- (C) The firm is introverted and self-satisfied, with no external contacts of much significance to its technique.

3. *A willingness to share knowledge.*

- (A) There is a marked readiness to share knowledge — technical, managerial and commercial — wherever possible. Visitors are welcomed; executives and technical staff are encouraged to take part in activities which are not directly linked to the firm's interests — e.g. by attending and by giving papers to learned societies.
- (B) The firm is prepared to share only a limited amount of knowledge. Participation in outside activities is restricted mainly to the firm's own industry — e.g. to its own research or trade association.
- (C) The firm is obsessed by the need for secrecy, even on matters which to an outside observer appear quite unrelated to its competitive position.

4. *A willingness to take new knowledge on licence and to enter joint ventures.* This characteristic and the next one are included as tests of willingness to be stimulated.

- (A) It does not matter whether new knowledge comes from within the firm or from outside, or whether it is a sole

venture or involves co-operation with other firms; if the knowledge offers a chance of useful technical progress, the firm will do its best to obtain it. It will be willing to by-pass its own research and development departments if it can thereby obtain something better which has been developed elsewhere.

- (B) The firm is willing to be parasitic on others, but only for fully developed ideas; it has no concept of bringing in an idea and taking it further through the firm's own efforts.
- (C) The attitude is 'parochial'; the firm is quite uninterested in knowledge coming from outside, unless this is forcibly brought to its attention, e.g. in buying a new machine.

5. *Effective internal communication and co-ordination.* This implies⁴

(i) that there is effective team work by departments when new developments are being planned. Thus evaluation of the potential market, of the costs of production, and of the capital position of the firm, involves and interests various departments of the firm well before a decision to undertake a new development is made;

(ii) that responsibility, authority and the objectives of the company are so specified and understood that individuals and departments work together effectively;

(iii) that the differences in outlook in research, development, production and sales do not hold up projects, or lead to their being pigeon-holed; and Board decisions (where required) are given without undue delay.

- (A) A high standard of performance on all of these.
- (B) Mediocre performance on all, or some good and some bad.
- (C) Poor performance on all.

6. *A deliberate survey of potential ideas.* This characteristic relates to the willingness to be stimulated by incoming technical information and ideas, and to keep possibilities under continuous review.

- (A) Incoming literature is closely scrutinized by technologists capable of understanding its implications. There is a conscious endeavour to find new ideas, and an enthusiasm for them when found; if they are not used at once, they are kept constantly in mind.
- (B) A survey of potential ideas is carried out over a restricted field, or its effectiveness is limited by inability to comprehend the implications. The firm is *interested in*, rather than *enthusiastic about*, new ideas.

⁴ *Industry and Technical Progress*, p. 180.

- (C) The firm is not looking for new technical ideas at all, and is not interested in them, unless they are served up ready-cooked on a plate.

7. *A consciousness of costs and profits in the research and development departments (if any).* This is reflected in:

- (i) the criteria used when selecting projects;
- (ii) decisions to drop projects half way if their commercial justification disappears;
- (iii) the economic use of scarce technical skills;
- (iv) the extent to which the Director of Research tries to inculcate cost-consciousness in his staff.

- (A) The consciousness of costs and profits is apparent in all of these.
- (B) It is only partially or imperfectly apparent.
- (C) It is hardly apparent at all.

8. *Identifying the outcome of investment decisions.*

- (A) There is a routine procedure for costing projects in all marginal cases — using as basis a standard, or a good historical, costing system.
- (B) Such costing is not based on adequate information about current or past costs; or it is not undertaken as a regular routine.
- (C) No significant effort is made to give ‘hunches’ the (apparent) precision of cost estimates.

9. *Use of management techniques.* Such techniques as work study, methods study, budgetary control systems, and methods of production planning and control were considered.

- (A) Various techniques are in effective use.
- (B) There is some limited use of the techniques; or a wider, but ineffective use, due (for instance) to failure to understand why or when or how they should be used.
- (C) There is no significant use of specialized management techniques.

The standard of performance for this characteristic was quite high, except for the firms of the lowest technical progressiveness.

10. *High status of science and technology in the firm.* This characteristic is only relevant if the firm is large enough to employ scientists and

technologists, and it must in all cases be interpreted with reference to the nature and needs of the trade.

- (A) The firm gives scientific and technological staff a high status, and all departments regard their work as important; they are represented by a powerful and sympathetic voice on the Board.
- (B) Scientists and technologists are occasionally uncertain of their standing, or conscious of lack of liaison with their work, but they are generally satisfied.
- (C) The firm regards scientists and technologists as 'back-room boys' of no great importance, and their views are little considered in the making of policy.

11. *Use of scientists and technologists on the Board of Directors.*

- (A) Not less than 20 per cent of the Board are graduates (or equivalent) in the relevant technology.
- (B) Not less than 20 per cent of the Board have other formal educational qualifications (but of lower level than a degree) in the relevant technology.
- (C) No members of the Board have formal scientific or technological qualifications.

12. *High quality in the chief executive(s).* Whatever the formal structure of management, it is usually possible to identify a dominant personality, or occasionally a dominant group of equal status. The judgment of the quality of this dominant person or persons is necessarily subjective; we imagined ourselves to have bought a majority shareholding in the companies and the three levels of performance are answers to the question 'What should be done with the man (or men) at the top?'

- (A) 'Leave him where he is, without question.'
- (B) 'Leave him, but give him some strong assistance, in case there is trouble in the future.'
- (C) 'Fire or retire him at the earliest opportunity.'

13. *An ability to attract talented people.* Has the firm an ability, as well as a desire, to attract a trained and able staff? The following factors were considered:

- (i) the reputation of the firm (e.g. with University Appointments Boards);
- (ii) the attractiveness of the industry;

- (iii) the prospects of promotion offered, and the extent to which these may be blocked by members of the owning family;
- (iv) the salaries and salary-prospects offered;

These were examined in relation to such evidence as was available of the recruiting experience of the firm.

- (A) Recruiting experience is good; the firm is of good standing, and its arrangements are such as to be attractive to able candidates.
- (B) Mediocre on these matters.
- (C) There is difficulty in recruiting talented people; the firm is not attractive to them.

14. *A sound policy of recruitment for management.* This characteristic is concerned with the extent to which a firm makes deliberate efforts to recruit people of high calibre.

- (A) There is a conscious and effective policy of seeking out talented people for executive posts; or, if they come by recruitment from an owning family, of training them appropriately, and bringing in 'outsiders' if they would be better than the available family talent.
- (B) There is some limited desire to find talented people for management, but without the clarity of mind necessary to achieve it. Relations with University Appointments Boards are unsystematic; 'family' recruitment is undertaken without a clear appreciation of the quality which should be expected. There may be an intake of mediocre people for middle management, which fails to provide candidates for promotion to higher posts.
- (C) The intake is predominantly of 15-year-old school leavers; the rule is 'start early and start at the bottom'.

15. *A willingness to arrange for the effective training of staff.* This relates to the training of managerial and technical staff, and not to instruction at the shop-floor level. The assessment is related to what is reasonably possible for the size of firm concerned.

- (A) The firm is highly 'training-conscious'. If it is large, it has formal internal management training schemes, and good systems of graduate apprenticeship or other training for technologists. Smaller firms are expected to encourage staff to take external degrees, and to make full use of training facilities at local technical colleges.

- (B) Some lip-service is paid to the need for training schemes, but there is little vigour in their execution.
- (C) Training exists only when it is forced upon the firm.

16. *Adequate provision for intermediate managers.* This we explained in *Industry and Technical Progress* (p. 182) as follows: 'Comparing firms of similar size and environment, we find that the unprogressive firms have relatively fewer intermediate managers. Senior management is thus burdened with trivial matters, and has neither the time nor the mental agility to think of long-term policy. By providing for more intermediate management posts, the progressive firm frees senior executives from the worry of day-to-day problems, and incidentally provides a better ladder of promotion and a way of training for higher management. There can, of course, be too many levels of management, but we have not found firms which have obviously erred in this direction.'

- (A) There is significantly more provision for intermediate management than in other firms of similar size.
- (B) Average provision.
- (C) There is as little management intermediate between the top and the shop-floor as can be contrived.

17. *Good quality in intermediate management.* These definitions are related to the type of manager who might control 40-80 operatives (not to shop-floor foremen). Moderately progressive firms in matters of technique tended to show a low score for this characteristic.

- (A) Intermediate managers are able to comprehend the workings of the process with which they are concerned, and can (in addition to discharging routine functions effectively) make intelligent suggestions for improvement.
- (B) They know what is going on, but are not of the calibre to suggest substantial improvements.
- (C) They work to inflexible rule-of-thumb methods, without real understanding of the process or of how it might be improved.

18. *An ability to bring the best out of managers.*

- (A) There are notable signs of stimulation, bringing the best out of junior managers and helping them to develop higher abilities.
- (B) Intermediate.

- (C) There are notable signs of frustration, conflict and discouragement in the ranks of management.

19. *An effective selling policy.*

- (A) The firm sells aggressively, determined to be a leader in its industry, and it maintains a first-rate sales force. Its reaction to a 'sellers' market' is to put out new efforts, or to prepare actively for bad times to come. It sees no reason to relax its normal pace of development.
- (B) The firm has an average sales force, and makes some effort to meet competition, but it lacks the drive to be a leader in selling policy. Its reactions to a 'sellers' market' is to contemplate new development, but it is easily diverted from this by the difficulties which it encounters.
- (C) The firm is happy if life is easy; its reaction to a 'sellers' market' is to sit back and enjoy it.

20. *Good technical service to customers.*⁵ This characteristic does not in general apply to manufacturers of consumer goods.

- (A) The firm has a definite routine for giving technical service, backed either by technical sales staff and appropriate laboratory facilities, or by a readiness to second top-rank designers or technologists to help customers.
- (B) The service is regular, but not of a high standard; or of a fair standard, but not regularly offered.
- (C) A poor service is available, only on special request.

21. *Ingenuity in getting round material and equipment shortages.*

- (A) The firm is prepared to make its own materials and equipment, if it is held up by serious shortages; or, if this is not feasible, it will scour the world for alternative sources of supply, and use great ingenuity in obtaining any necessary government sanctions.
- (B) There is some activity in response to shortages, but it lacks clarity or drive.
- (C) Shortages are accepted with Oriental resignation as Acts of God, and the firm waits with hands folded until they are relieved.

⁵ It has been suggested to us that a better form of this characteristic, which would apply to consumer good trades, would be 'a willingness to give any sort of service to customers' - including the making of special designs, or the giving of quick service from stock, as well as strictly technical service. We retain the narrower form, however, to secure comparability with our original analysis.

22. *A readiness to look ahead*

- (A) The firm has a formal policy covering anticipated development during a considerable period, and it relates current development activity to that policy. For large firms, the furthest limit of planning will be 10 to 15 years ahead: for the smallest firms, about 3 years.
- (B) The firm has some explicit policy for current development, but this is not part of a 'long-term' policy based on a study of possible market conditions in the future.
- (C) There is complete concentration on day-to-day problems and on the current order-book.

23. *A high rate of expansion.* 'Expansion' here means the rate of increase of assets.

- (A) Assets are increasing by not less than 10 per cent per annum; or, alternatively, by a substantially higher percentage than the rate of expansion of the industry.
- (B) Assets are increasing by not less than 5 per cent per annum; or, alternatively, at a rate which appropriately fits the rate of expansion of the industry.
- (C) Assets are not increasing. (Firms which have recently arrested a long-term decline are, however, rated higher than this, as (B) or between (B) and (A).)

24. *Rapid replacement of machines.*

- (A) The policy is to scrap plant early; in consequence, the proportion of new plant is high, even in departments which have not expanded.
- (B) The firm runs new machines side by side with some of considerable age; it has no policy of scrapping early, but is glad of opportunities to get new plant in the course of expansion.
- (C) The factory keeps going mostly on well-thrashed machinery of considerable age, and the firm is proud of this fact.

The five characteristics which showed no regular or definite connection with our assessments of technical progressiveness were as follows:

25. *Membership of an industry with a strong scientific or technological background.*

- (A) The nature of the process requires the employment of scientists and high-grade technologists, and (if the firm is

- large enough) the conduct of research and development. In engineering, the test is that the product requires the use of special raw materials, or demands knowledge of production methods in a scientific industry (e.g. chemical engineering.)
- (B) The nature of the process requires people who can comprehend what is happening, but not at a high level; limited scientific facilities will suffice; engineering work is perhaps intricate, but does not require exceptional knowledge.
 - (C) The firm *could* be run by rule-of-thumb or traditional methods, without any scientific help. The cruder forms of engineering are here included.

This characteristic has some relation to technical progressiveness, but a fair number of technically progressive firms are to be found in non-scientific industries.

26. *Adequate buildings or site.* This was included on the assumption that old buildings may inhibit the use of modern methods, and that technically progressive firms would take action to free themselves from the limitations set by sites or buildings. The connection proved, however, to be slight.

- (A) There are adequate new or middle-aged buildings; there is room for expansion, or (if there is no room) active steps are being taken to find it.
- (B) Intermediate.
- (C) The buildings are old, and have grown up in an untidy manner; the site is inadequate; no effective steps are being taken to remedy these difficulties.

27. *Scientific or technological training of the key personality in the firm.* This is related to characteristics 11 and 12; but whereas the evidence suggests that scientists are often found among the directors of technically progressive firms, and that their dominant personalities are of high quality, there was a significant number of cases in which the dominant people were not scientists. (Where domination is by a group of people of similar status, the qualifications of the majority of this group are taken.)

- (A) The key personality is a graduate (or equivalent) in the relevant science or technology.
- (B) He has other formal educational background in the relevant science or technology.
- (C) He is qualified, if at all, only by experience.

28. *Resistance to innovation on the shop-floor.* This refers to personal problems like the conservatism of foremen and operatives, and not to union resistance. Few firms reported any significant difficulty; those that did were about equally divided between the technically progressive and the unprogressive.

- (A) Resistance is either non-existent, or is foreseen and successfully overcome.
- (B) There is some resistance, but it does not seriously impede the application of new scientific or technological methods.
- (C) There is resistance which prevents or seriously delays the application of new methods.

29. *Adequate finance.* Shortage of finance was only an occasional problem, and could not be said to have a definite relation to technical progressiveness.

- (A) The firm is able to meet all its financial requirements, by outside borrowing if necessary, and can thus finance its expansion.
- (B) The firm is conscious of some financial limitation, but this cannot so far be regarded as a serious hindrance to the use of science and technology.
- (C) The firm is definitely short of money — either because profits are low, or because the rate of expansion is high.

(A slightly different definition, which we now see to be imperfect, was used in our original analysis, and the figures in the last line of Table I are thus subject to amendment.)