MANAGEMENT†

Paper No. 6473

Management in engineering

by

Sir Leonard Owen, C.B.E., M.Eng., M.I.C.E.

Paper No. 6485

The contribution of the universities to the teaching of management

by

Professor John Fleetwood Baker, O.B.E., M.A., Sc.D., D.Sc., M.I.C.E., F.R.S.
(now **Professor Sir John Baker**)

Paper No. 6477

Management and human relations

by

Sir Ewart Smith, M.A., M.I.Mech.E., F.R.S.

Paper No. 6474

The tools of management

by

Stuart Maynard Lovell, O.B.E., E.R.D., T.D., M.I.C.E.

Discussion

The Chairman (Mr R. M. Wynne-Edwards) observed that management was no more of a gift than was engineering ability; it had mostly to be learned. Many more engineers were likely to be concerned in their lives with management than with pure design; it was important, therefore, that they should learn about management. He hoped that the discussion would bring out what they might learn about it, where they might learn it, and how they might learn it, because those matters concerned all young engineers.

Mr A. E. Powell (Partner, Merz and McLellan, Consulting Engineers) noted that Sir Leonard Owen's Paper described in detail an organization built up for a specific object. Many of the items of equipment required had had to be designed from first principles. In the more general field, however, this detailed pattern did not necessarily

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† Proc. Instn civ. Engrs, vol. 17, p. 219-245 (Oct. 1960).

apply, since the co-ordinating organization might place a number of contracts each based on a full specification but leaving the detail work to the specialized organization concerned. For example, in a superstructure contract for a large power plant building—and, indeed, in many similar works—it was usual to include provisional sums and prime-cost items for a number of specialized projects. But there was still the necessity for control and management by someone, to ensure that the multitude of pieces of equipment were suitably designed, manufactured, and delivered to the site in the correct sequence and at the right time. Those duties might be carried out by the general contractor, but ultimately the whole project had to be managed either by the purchaser or by his consulting engineer.

101. Colonel Lovell had stated that leaders were born and not made, but there was clearly no hard-and-fast division here. However, while under the present haphazard methods of training for management it was probable that those who reached the top were some of the born leaders, it was not possible to know how many potential leaders did not rise to managerial positions because of lack of training, opportunity, or encouragement in their formative years.

102. Professor Baker had referred to the mathematical and statistical tools that must be used in management, but management and its techniques could become so specialized that there was a danger of losing the necessary broad approach. For instance, the Institution of Civil Engineers had eight specialized divisions, the Institution of Mechanical Engineers eight even more diverse specialist groups, and the Institution of Electrical Engineers four specialized groups. In the field covered by the three Institutions, therefore, there were twenty groups of specialists, and in addition atomic energy brought in the chemical engineers, the physicists, and all their associated subdivisions. Moreover, specialization in engineering began at a very early age for there was every inducement for a young man to specialize in order to achieve some status.

103. The Institution could do a great deal to foster the general concept that specialization at an early stage was undesirable. It could in its examinations and in its conduct of professional interviews help to spread the gospel that the elegant design of a bridge, a building, or a power plant was by no means the end of the story. It could encourage the writing of Papers on the contractual side of everyday work and on the organization necessary to undertake large projects involving many branches of engineering, and could recognize the principle that any project required someone to drive the job along and therefore to manage it. In fact, the Institution of Mechanical Engineers included in its examination syllabus a subject called "industrial administration", but Mr Powell had reason to believe from contact with the younger generation that this examination was considered by many graduates of that Institution to be a waste of time and an interference with the difficult process of becoming an engineer.

104. Mr Powell then suggested that firms should give the younger engineers every opportunity to learn the tools of management—not only the tools of man-management referred to by Col. Lovell, but the difficult and detailed work of drawing up construction programmes, the breaking-down of work into cost units, and the checking of monthly figures against estimates. It must be appreciated that engineers existed to create something tangible for the use of mankind, and that the solution of a difficult design problem or the elegant solution of some mathematical exercise was only one small stage in the total effort required to produce the completed job. Firms could give young engineers more opportunity to examine and develop organization methods; and they might well consider interchanging their embryo managers, since by this means the young engineer would gain experience of another environment and thereby learn, and possibly teach some facet of management.

105. It had been encouraging to learn from Professor Baker that one of the oldest universities, Cambridge, was sufficiently alive to modern requirements to regard management as a worthy subject for postgraduate courses. The Institution could, he believed, be equally alive to modern requirements, and other universities should consider having similar courses. The physical tools of management—the programmes, the

cost control, and so on—were not best taught at universities, for the student would learn that side of the job much more quickly in practice. But the universities must foster and encourage the philosophy that the student of engineering would eventually have a big job to do and that at all levels the engineer had to manage something and somebody.

106. The younger members of the profession should be encouraged to accept responsibility and to study the philosophy of management in all its branches—not only the management of contracts, but the management of men. Sir Leonard Owen had remarked on the apathy of applicants interviewed for work with the United Kingdom Atomic Energy Authority. The young engineer must be prepared to leave the relative quiet of specialization and to venture into the stormy seas of management, and must learn to develop a sense of responsibility. He would not make engineering decisions on matters such as bridge design without adequate knowledge and proper checking and cross-checking of calculations and designs. It was equally important that managerial decisions should be made not "off the cuff", but as a result of training and knowledge.

Professor J. F. Baker pointed out that in the course at Cambridge, described in his Paper, no encouragement was given to premature specialization in the management field. Mr Powell would know, of course, that other universities were also working in this field.

Mr Gordon Cutcliffe (Head of Education Division, British Institute of Management) remarked that those who tended to specialize in the management education field wondered from time to time whether they had reached such a stage that they could no longer see the wood for the trees. He had been greatly encouraged, therefore, to read the four Papers and to find that they bore out very largely the sort of theory and practice that he and others similarly engaged had heard about in this field. He had in mind in particular a Paper[2] given recently at a meeting of the European Productivity Agency in Paris, in which management education was divided into four stages: the basic educational stage; the introduction into working life, only exceptionally in a managerial post; the first period of limited managerial responsibility; and, finally, the stage of overall direction.

109. It was interesting to find that in Sir Leonard's Paper there were also four divisions or stages, although not the same four: the school; the university; the workshop; and training within the organization. In Professor Baker's Paper there were two stages: a one-year course in the third year or immediately postgraduate; and what he called the "real postgraduate level", at which people came back from industry with some experience. Although those stages were not the same, the important common trend was that there should be such stages, that there was not just one form of management training, and in thinking about the subject it was necessary to have specific objectives and to consider the purpose of the training. Those objectives would vary very much according to the individual.

110. The British Institute of Management had recently carried out a survey of what various firms were doing in the way of management training, and had found that two things stood out clearly: there must be a clearly defined objective, and the training must be directed at the individual. Those might seem to be just matters of plain common sense—the whole of management education was applied common sense—but this was very far from what often happened. He would illustrate that by describing a recent telephone conversation. A well-known engineering firm in the Midlands had asked him what were the six best management courses in Britain? That was like asking an engineer what were the six best bridges. When he had asked "For what purpose?" the caller had been completely confused and did not seem to realize why such a question should be asked. When asked "What sort of people are you trying to train?" again there was no answer. Mr Cutcliffe had then said "Would it be possible for me to come to

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[2] Sir Noel Hall, "Four stages of management development". Seventh Int. Conf. Business Management Education. Paris, 13–15 September, 1960.

see you?" and had been told that the matter was urgent and that the managing director was pressing for an immediate reply. He had then asked for some indication of who the people were, and in reply had received a list of five people, but there seemed to be something wrong with it and he could not follow the pattern or suggest suitable courses. In the end he had visited the firm and it had transpired that these were imaginary people that they had thought up. The explanation was that the firm was American owned, and the Americans had told them to start management training; and this was the way in which they had set about it. That might sound utterly ridiculous, but it was the sort of thing that was happening in Britain.

111. To return to the question of the individual, if someone in the position of Sir Leonard looked at the problem the first thing he would say to himself would be: "What are the things that I picked up myself on the way to the top? What are the wrinkles which I should like to pass on to those who will eventually step into my shoes? What should I be teaching the people immediately under me?" Those were the individual problems. It was clear that Sir Leonard had given a great deal of thought to the subject and had planned a whole series of stages in producing a manager for a specific job. He had not been merely thinking "in the blue", but had certain specific people in mind and would plan one course of training for one person and a different course for another; they required different treatment. The success of a scheme depended on somebody at the top really thinking about the subject, personally training his own subordinates and each of them looking after those below them and so on. The three important things, therefore, were specific objectives, attention to the individual, and management throughout the firm taking full responsibility for this type of training.

Sir Leonard Owen said that Mr Cutcliffe's assumptions were entirely correct. That was exactly what he wanted. He had been fortunate enough, 30 years previously, to be a member of a firm that had started some of the ideas of training from which he had benefited. He did not claim that the ideas embodied in his Paper were perfect, but the principle was right. His great shortage had been in design engineers and project engineers, and he had described the method of training that he had adopted. He had been interested to find just before the Meeting that he and Sir Ewart Smith were not really in agreement on this method, but it was one method. It was necessary to have an objective, and Sir Leonard had described his. The details might be open to argument but the principle was not.

Sir Ewart Smith said that there had been a slight disagreement about some of the details, but he agreed with Sir Leonard's general approach, i.e. that there should be a plan and that top management should take the most profound interest in training of every kind. Sir Ewart's divergence was merely on a matter of detail, on how long people should stay on the drawing board. That depended entirely, in his view, on the man and the background; he might want to stop there for 9 weeks, 9 months, or 9 years.

114. He would follow up the point made by Mr Cutcliffe in emphasizing the need for individual treatment. Sir Ewart had tried to make that point in his Paper. In his view the assessment of people, getting to know them and their attributes and abilities—and very often a young man did not know them himself—was of supreme importance. It was necessary to deal with these problems individually, but to do that the people concerned must be studied in a way in which very few British firms had yet begun to do on the sort of scale required.

Mr J. Taylor Thompson (British Transport Docks—Board of Management) suggested that there were two elements in general control; one was organization and the other was management. They were referred to in the Papers and were closely allied, but different. Management was personal; organization was impersonal. The manager was the operator and the organization the thing operated, like the craftsman and the tool. A good manager could operate a poor organization with reasonable success, and a good

organization could keep a poor manager from getting into very serious trouble. That seemed to be the distinction. The objective must be that both should be good, but it was important to realize that the manager was the man who operated the organization.

116. In management there were two elements; one was personality and the other was knowledge. It might be said that some knowledge was necessary but that the right personality was essential. It was easier to add knowledge to personality than to add personality to knowledge. That made it very important indeed, in selecting men for management courses, to look as much or even more at personality than at knowledge. There could be first-class "back-room boys" who would never become first-class managers. There was danger in thinking that pure brain-power would necessarily make a good manager. That was fundamentally wrong. He did not refer to managers who remained in back rooms with no personal contact with the staff, but of management in the personal sense, of control of the management machine. For such a job a first-class personality with second-class academic qualifications was better than a first-class academic qualification with a second-class personality. It was not a high level of knowledge so much as the right kind of personality that really mattered.

117. Mr Taylor Thompson had noted four important managerial responsibilities. The first was that of selection, training, and cultivation of key staff. The top people could do nothing more important than choose the right men for the key positions. If that could be done, the poorest organization could be built up into a strong one. He had noticed that if selection and promotion were based purely on being quite sure of getting the right man the trades union people were silent; they could be shown that it was to the obvious interest of everyone to have the right man in the job.

118. The manager should not be content to take the nearest man, but should look carefully round the field and go outside if necessary to find the right man for every vacancy that arose.

119. Cultivation of the staff was also a most important managerial function, i.e. to look after their growth in the job and to see that they were happy in their position, their team, and their prospects. The manager had a responsibility to watch over his key people in those respects especially.

120. The second responsibility was the maintenance of good relations among key staff in particular. A great deal of harm was done in the higher and middle ranks of management by petty jealousy and friction. The manager must know what was going on and when difficulties began to arise. The lower staff soon began to detect that their chiefs were at loggerheads and to make the most of it, so that troubles at the top were reflected very quickly at the bottom. There was a well-known phrase "a happy ship", and that should apply.

121. The third responsibility, the regular checking of progress and efficiency, was an obvious one. The manager should make constant reference to graphs showing the trends of all his important functions. He should first decide what the essential checks were on his production, his costs, his labour turnover, and all else that mattered. They should be regularly before him and he should take action on signs of difficulty in any field.

122. Lastly, it was important that the manager should ensure a wise distribution of praise and blame. Unmerited praise was just as bad as unjust blame and both must be avoided, or it would be thought that he did not know the difference between good and bad. He should develop a feeling of pride in the concern and in what was being done, so that the men worked in an atmosphere of success rather than of failure and criticism. Mr Taylor Thompson would like to think that his men went home at night and boasted about their work to their wives and families and felt so proud of it that they wanted to talk about it to everybody. In general, the manager set the standard for everything.

Mr D. H. Little (Superintending Civil Engineer, Admiralty, Pinner) observed that management was as old as civilization and must have preceded any of the professions; nevertheless he was pleased that young civil engineers were not over-interested in it.

A young man of 30 who had studied electrical, mechanical, and civil engineering at Cambridge for 3 years, who had wandered round numerous drawing offices for another 3 years, who had had a few months on construction and 3 months on plant and maintenance, might end up as a good manager, but he would not be a civil engineer. The object of such a training was to produce managers, but if a young man wanted to be a civil engineer why should it be surprising that he showed little interest in such training?

124. Mr Little's understanding of a civil engineer or of any professional man was a man with a sound early training who had subsequently applied himself to his profession. By the time that he was 40 or approaching 40 he would have acquired a skill that was a measure of his usefulness to the community. If the community did not recognize that skill adequately by prestige and monetary reward that seemed no real reason for turning to work study or management as an alternative. Nor was it of immediate concern to the Institution to want the civil engineer not to be a civil engineer. In the Institution it should be possible for engineers to meet and discuss civil engineering and so sharpen their engineering wits that they became better engineers and so of more use to the community and more worthy of better recognition.

125. As for the complaint that they were managed by managers, managers had always managed and the professions had always provided the tools for management. Fifty years earlier an eminent German industrialist had told Mr Little's father that he could buy all the brains he wanted for the equivalent of £1,000 a year. With an appropriate multiplying factor, Mr Little saw no objection to that today. If a civil engineer found in the course of time that he had a bent for management—and, like Col. Lovell, Mr Little thought that managers were born and not made—he would soon change over, but it seemed a waste of training and of the nation's limited training resources to start training managers by putting them through a civil engineering course.

The Chairman said he was delighted that the last speaker had said something really provocative.

Sir Ewart Smith agreed with Mr Little that there was a need for good civil engineers, but he felt very strongly that there was also a need for good managers. Technical problems and organizational problems had become infinitely more complicated and complex. In the old days a single individual could cover all the techniques and problems associated with his work, and perhaps Brunel could even be a manager as well; although in some ways Brunel, with the "Great Eastern" and so on, had not been a good manager and might have achieved better results had he been a better one.

128. It was essential to realize that as technical complexity grew and as the sectors of knowledge became narrower and deeper, increasing attention must be paid to educating, developing, selecting, and using people who were fitted by temperament, natural ability, and interest to join those segments together; because if it were just left to the specialists, and there were different people looking after civil, electrical, and mechanical engineering (to take broad sectors), and nobody trained to organize them and bring them together in a comprehensive and effective way, one could not hope to get the best results. Whatever work an engineer was going to do, and even if it was only design work in an office, it would not harm him and would almost certainly do him a great deal of good to understand something of the thinking and the principles that were gradually evolving in the field of management, whether organizational management procedures or man-management.

129. When a young man had acquired a background of experience and training, and when management had studied him and got to know him, and when (it was to be hoped) the young man had got to know himself better from having seen this wider spread, let him decide, at one extreme of the Gaussian distribution, to be an out-and-out specialist or, at the other extreme, a man with general interests or, as most people, somewhere in the middle.

Mr J. N. McFeeters (Chief Civil Engineer, British Petroleum Trading Ltd) said that if any young engineer who had not read the recognized textbooks on management and business training were thinking of doing so he would say to them, in general, don't! He had recently subjected himself to a course of books on management and had come to the general conclusion that they were so remote from life as he knew it in industry and in engineering that, with one or two honourable exceptions, they offered very little to the study of the subject. They were full of unsound generalizations, platitudes, slogans, and padded out with pep talks, recipes for getting on in the world, and suchlike. Possibly, the worst feature was the constant use of metaphors and analogies, which seemed to be an occupational risk of writers on this subject. He had picked out two examples, one American and one English. The American paper spoke of a financial process which "aids top management in delegating authority, providing sound bench-marks for personnel down the line to use in killing off the worst propositions before they have gone far up the chain of command." The British one read: "A co-operative attitude supports correct perspective in suggesting such instructions regarding procedures should go through an appropriate level." All these attitudes and perspectives and procedures and levels in one sentence made it clear that nothing firm or tangible was being spoken about.

131. The Papers presented to the present Meeting, on the other hand, adopted a direct and practical approach. How earthy was Sir Leonard Owen's statement that "one of the most difficult parts of management engineering is to present the case in such a way that the money is obtained!" With equal realism, Professor Baker had said that "no attempt should be made to train the undergraduate as a manager". Sir Ewart Smith had emphasized that "the leader or manager gives the order not because he is the boss, but because he is as much under compulsion as are the recipients". Col. Lovell had said that "successful management revolves entirely around one major tool, that tool being personality". One might disagree with that last statement and Sir Ewart Smith might call it "a dangerous half-truth"; Mr McFeeters disliked the metaphor that was enshrined in it, but considered it a most succinct expression of a very personal point of view which it was necessary to grapple.

132. The Papers were not entirely free from the metaphorical approach, for two of the Authors had referred to the "managerial pyramid". This was a useful conception and it was easy to understand what was meant by it. In the first place the metaphor of a pyramid made it clear that there was extremely little room at the top! But he was sure that those who referred to the pyramid did not intend to say that any horizontal stratum had to bear the total weight of all the managers above them!

133. There were other interesting geometrical relations concerning the pyramid which were unlikely to have been intended by the users. In fact the pyramid was only a little better descriptively than "personnel down lines, killing the worst propositions with bench marks". A far more useful conception was to be found in the analogy of the body and the members, which was as applicable to industry as it was important for St Paul's theology. Mr McFeeters asserted that for the descriptive study of management—the only study that could be attempted at present—a refined vocabulary of words and concepts was essential.

134. Mr McFeeters disagreed with Sir Leonard's equating the project manager and the chief designer. In the atomic energy industry that might be necessary, but in what Sir Leonard aptly called the "processing industries" it was seldom the case. The designs were usually carried out by others, often by those outside the industry. The processing plants were designed by specialist designers, the jetties and handling gear might be designed by consulting engineers, and so on, and the project manager was concerned with combining these efforts and co-ordinating them, but not basically with designing. Sometimes design skill and management were confused because they might be found in the same person, but that was only a coincidence and the two things were entirely different. The business of the chief designer was to design; the business of the project manager was to manage.

135. He agreed entirely with the three items describing the ideal project manager (§ 22), where the word "design" had quite disappeared. But Sir Leonard's admirable programme for training had given insufficient emphasis to experience of construction sites.

136. Col. Lovell had stated in § 89 that "An essential of leadership is the ability to decentralize responsibility", and had added "it must never be forgotten that the man at the top or in fact the next man above at any stage must accept the final responsibility for the actions of the people to whom responsibility is decentralized". Those sentiments were unexceptionable, but Mr McFeeters had often heard decentralization and devolvement of responsibility declared as their policy by managers who had no ability in decentralizing at all and, indeed, no idea of the sacrifice that they would have to make if this policy were fully and truly carried out in their own concerns. Moreover, he was doubtful about the statement; although it had been repeated a thousand times, that each man at any stage must accept the final or full responsibility for the actions of the people on whom responsibility was decentralized. What did this mean? If each of them asked himself what would happen in the event of a serious mistake being made by someone junior to him it would be seen that this question of *full* responsibility was a highly theoretical concept which had a peculiar meaning in each individual case. That meaning should be thought out by every manager who controlled staff.

137. Sir Ewart Smith had said in § 67 that "It is often said that success depends more on people than on forms of organization. This can be a dangerous half truth". Sir Ewart was demanding that they must not overemphasize the personality side but must pay attention to the organizational structure. But the organizational structure was in no danger of being underemphasized; there was a danger of overemphasis on organization as an alternative to the conception of *the team.* Mr McFeeters greatly preferred Sir Ewart's statement in § 64, that "every individual should be treated as the manager of his own job and should be encouraged to regard himself in that light".

138. Those "founding fathers" who had defined civil engineering as "the art of directing the great sources of power in Nature for the use and convenience of man" had not had it open to them, for various reasons, to recognize that the greatest source of power in Nature was to become man himself. This was a twentieth-century development which the rest of our lifetime would be taken up in analysing and acting upon.

Colonel S. M. Lovell agreed that if decentralization was carried out properly sacrifices would have to be made. But what he had said was that a man must take responsibility for his juniors because unless he did so he would not be building up in them the sense of trust that they ought to feel—that they could be trusted. It was not wrong to make a mistake—one learned by making mistakes—but he would say "Please don't make the same mistake twice".

Sir Ewart Smith, dealing with the analogy of the pyramid, agreed that the top should not rest on the bottom but suggested that in fact the lower strata hung from, rather than supported, the level above them, wherever a horizontal line was drawn. He agreed also that the pyramid emphasized that there was not much room at the top, but he preferred it as an organizational system to that frequently found, in which at the bottom there were the wage-earners, with the foremen and a few under-managers, and well above them a remote board of directors. Whatever structure was adopted, however, there had still to be a top, and everything else hung from it.

Sir Leonard Owen said that one difficult point raised by Mr McFeeters was really a question of "what's in a name?" Sir Owen did not care whether a man was called a "design engineer" or a "project engineer"; the point was that he was the "boss man". The designer made the best "boss man" and had the widest view of the job. The oil industry, if it was to make an elegant whole of one of its big plants such as a refinery,

needed a "boss man", and if he were a designer he would be in a better position to put the pieces bought from America in the right places on the site.

Mr Ian Davidson (Deputy Chief Engineer, Development and Engineering Group, United Kingdom Atomic Energy Authority) said that Sir Leonard had written of his experiences in carrying out a very difficult and somewhat unusual task. Mr Davidson would illustrate this by speaking of his experience in the Calder Hall design team. Once the scheme had been chosen the project had had to proceed on three fronts simultaneously: (i) applied research and development, (ii) engineering design, and (iii) procurement and site construction. Very tight programming had been necessary because specific dates had to be met. That had been no easy task, because several items had involved completely new ideas, about which not much more than a promising line of inquiry had been known at the commencement. He had been impressed by Sir Leonard's faith that obstacles would not merely be overcome, but overcome strictly to schedule. The success achieved must have appeared to be amazing good luck, but it had been due to a conscious effort of will. He asked Sir Leonard how important he considered organization to be, in particular the carefully set-out and precisely dovetailed scheme of staff arrangements.

143. Professor Baker had made a most valuable distinction between knowledge of management and the activity of managing. He had considered management in relation to the whole field of an industrial firm, and had covered a considerably wider range of employees than Sir Leonard had probably had in mind. It was important that some formal instruction should be available and, as Professor Baker had said, this should be confined mainly to an exploration of principles. Would it be a mistake to circumscribe the field of management too closely in an instructional course, and might it be possible to have some shorter period of instruction for civil engineers who found it difficult, and perhaps unnecessary, to devote a whole year to the subject?

144. Mr Davidson had always felt unusually conscious of the personality, the methods, and perhaps the foibles of his immediate superiors. For lack of training in management he had, in dealing with his own staff, adopted practices that he had found most congenial when applied to himself. That was perhaps unscientific, but in dealing with a most important matter it was not a bad one. These immediate relations, which occurred at every level from the bottom to the top of an organization, were at least as important as the wise policies of those who directed from the top.

Sir Leonard Owen replied that he was a believer in setting down an organizational chart, although in fact he had not always been able to fill it. But he would never fill a vacancy by appointing someone unsuitable. It was better to have a vacancy than the wrong man.

Professor J. F. Baker pointed out that the possibility of running courses in circumscribed fields, and in particular a course for civil engineers, was almost within the scope of the "real post-graduate course" referred to in § 38. Since writing his Paper he had explored this farther, and had invited to the Symposium the two men at Cambridge who knew about management education, Mr Marples and Mr Willett. He asked Mr Marples to describe briefly what they had in mind for the "real post-graduate course".

Mr D. L. Marples (University Lecturer, University of Cambridge) said that at Cambridge it was proposed to have a course that would make the most of the advantages gained by engineers who were, in fact, managing a particular job. They would be brought to the University for a short period, during which an attempt would be made to teach them something about the methods used by research workers, to find out what managers did and what management was about. These managers, when instructed in these methods, would go back to their own jobs and use the techniques to examine their own activities and those of their own departments. Some overtime would be required

so that they could consider what had happened during the day in the light of what they had learned at the University. They would be helped in this by a peripatetic tutor, who would visit them once a fortnight to see what problems they had encountered. The whole group of people would be collecting information on much the same lines.

148. The managers would then return to the University, exchange the information that they had gained, make comparisons, and discuss the validity of the ideas that had been put before them and how well those ideas tied in with their own experience. After this period they would go back to study the relations of their departments with other departments. They would then return to the University for a third period, for a final consideration of the theories put before them and of their own experience.

149. Those at the University hoped that their ideas would thus be put to the test immediately by people who would not be anxious to accept them if they were not really helpful. In return, these people would bring back to the University some knowledge of what went on in their own organizations.

Mr N. N. B. Ordman (Divisional Engineer (Plans), Port of London Authority) said that his premise was that engineers who had attained any appreciable degree of professional maturity were *ipso facto* managers. He based this on the definition published some years before by Sir Ewart Smith, that "management is the organization and control of human activity directed towards specific ends". Engineers were concerned with controlling and directing a variety of human activities towards the end of creating structures or machines. Therefore, engineers *were* project managers. If this was accepted the reasons why Sir Leonard had experienced difficulty in recruiting engineers for senior posts of management were not apparent. Sir Leonard believed that there might be some link between the difficulty he had experienced and the comparatively low standing of engineers in the sphere of remuneration, recently brought to light by the Engineers' Guild. The argument seemed to be that engineers were not paid much because they were not equipped for management posts that might command higher salaries. But if engineering was mainly concerned with management in one form or another, this proposition carried with it the implication that engineers as a whole were inefficient at their jobs. He did not think that this was in fact suggested, but would Sir Leonard amplify his statement?

151. One important factor in the current situation was psychological. Engineers were not accustomed, and in fact not encouraged, to consider themselves as managers, although this was in fact what they were. In this rather gloomy situation there were two hopeful developments. The first was the increasing dependence of society on technologists, and the second was the development of what might be called scientific management. It was probably necessary to accept the affirmation that management must always remain, at least in part, an art; nevertheless, its scientific content was steadily growing. This content was based on disciplines with which the engineer would be familiar, or at least towards which he should have a greater than average aptitude. The engineer was therefore faced with the opportunity and the challenge to equip himself for management in the future.

152. This was where training was of paramount importance. The training curriculum set out by Sir Leonard followed to some extent the training required for Associate Membership of the Institution, except that Sir Leonard advocated that from the fourth year onwards training should be by doing. In so doing he obviously appreciated the point made by Professor Baker that once the universities had imparted knowledge of the activities of enlightened management experience was essential to produce the trained manager. Experience bred confidence and confidence bred leadership. That aphorism pointed to a significant omission in Col. Lovell's treatment of the subject: the leader must have confidence based on experience. Mr Ordman's conclusions, therefore, were that the academic training of engineers should be broadened and taken further; that engineers should be encouraged to consider themselves as managers; and that they

should be given opportunities at as early an age as possible to gain experience in managerial responsibilities and techniques.

Sir Leonard Owen did not accept Mr Ordman's view that engineers were *ipso facto* managers. The Atomic Energy Authority had been unable to recruit people at the higher salaries, although the salaries offered had been a good deal higher than the average brought out by the Engineers' Guild. The plain fact was that they had been unable to get people who were satisfactory, or, to put it another way, who had the necessary managerial ability to get something from their engineers.

Colonel S. M. Lovell entirely agreed with what Mr Ordman had said about leadership, and explained that it was not mentioned in his Paper because of the limitation placed on the length of Papers.

Sir Ewart Smith, referring to a small point of apparent disagreement between Mr Ordman and Sir Leonard, said that he agreed with Mr Ordman that engineers ought to be managers, because engineering involved a managerial function, whatever was being done. He agreed with Sir Leonard that engineers were not trained to regard themselves in that light. The danger—and he had said this at a meeting of the Institution a year or two earlier—was that because engineering was becoming more and more specialized the young engineer was kept with a converging view, very often on detail, and was not encouraged to take the broader view and look at the collaterals necessary for managerial work. That was why Sir Ewart, like Sir Leonard, emphasized the engineer's need for breadth in education at school and college and in his initial training. His real specialization, possibly permanent, should come later.

156. There he disagreed slightly with Sir Leonard. Sir Ewart would from the beginning combine that mixed experience with responsibility. He would put young engineers to do a job, but he would not leave them on it for very long. He would see how they got on and they would see how they got on, and he would then move them to other types of work and see how they did and let them see, too. In 2 or 3 years they would see a wide range of research, design, and production, and would decide what they were interested in. If their management at the same time studied them—and most did not—the management would form an idea of where they would fulfil themselves best.

Mr H. J. B. Harding (Consulting Engineer) emphasized the need for a leader to allow himself to be informed by his juniors of certain details, to ensure that he was leading in the right direction. Considerable advice was available on how to train young men but it was then difficult to inject them, full of ideas, into an existing organization. It might be better first to run training schemes for selected existing managers, for some remained flexible in their outlook while others hardened rapidly.

158. A Scottish accountant with whom Mr Harding had worked believed in having one man too few on a contract, on the ground that the others would work harder. This was an illusion and was inefficient. If one or two spare men were available, then men could be moved around as the situation required, without leaving a vacuum.

159. Specifications for idealized personnel were printed in leading newspapers, without the employer always understanding what he really needed. It would be wiser to take on good men when they appeared and then adapt staff members to conditions and openings as they arose. The present shortage of staff was due to present conditions where two or three men did the work done by one man in the days of the 1930 depression.

160. The principles of management enunciated by Sir Leonard Owen were those to be seen continuously carried out quite successfully by very many contractors' agents, who, on a complicated contract, were carrying out practical management in its most difficult form.

161. Sir Leonard had said that a man of 30 might well be capable of taking high

managerial and technological responsibility. Mr Harding thought that the work that he was doing at the age of 30 qualified for that description, although he did not remember the high rewards mentioned by Sir Leonard. At that time his chief, a very fine leader of men, had had no hesitation in using men of 30 in certain positions, but 25 years later had been apt to consider a man of 45 rather young.

162. Why did Professor Baker require an honours degree for an entrant for his management course? Many a good engineer had a pass degree, and after 20 years all that mattered were achievement and experience.

163. Since criticism was easier than action, the Authors might have found it easier to write Papers on mismanagement, for much could be learnt from observation. Colonel Lovell had got to the root of the matter—it was psychological and depended so much on the personalities in any group. A high academic degree was no cure for a jealous disposition which could upset the working of the most carefully drafted scheme of organization.

Professor J. F. Baker, referring to the requirement of an honours degree, observed that there was now practically no such thing as a pass degree. He would give this advice to those who thought of introducing the subject of management into a university: when undertaking the arduous task of introducing a discipline that might be under some slight suspicion, the real way to achieve success was to make it a difficult discipline.

Mr A. J. Hill (Chairman, Taylor Woodrow Construction Ltd) said that in Britain there were more than 20 million people at work, and therefore between 1 and 2 million managers. There must be more than 50,000 new entries a year into the field of management. The four Papers would help those who had gone a long way along the road, but many others would be confused or even frightened unless they saw some of the simple terms of management.

166. There was one class of person that was very well known—the manager of the old brigade who said that managers were born not made. So often such men had been first-class managers themselves, and were offended by the modern presentation of the subject instead of being converted to the need for specific training of people for the future. Also, the candidate for management often considered that there was a lot of mysticism being built round the subject.

167. The Papers dealt with management, but the Authors had not confined themselves to that subject. Mr Hill believed that there was a difference between management and organization. Organization was a planned method, a theory of how the job should be done if everything went perfectly. Management was what came after organization: it was the application of men through an organized method to achieve the result desired. Management was so much concerned with the human being that it was most important not to confuse it with some of the mere expertise about which there was so much talk. He had heard it said that 90% of the training for management was in the very act of management, and the remaining 10% was the equipping of people to become suitable candidates for management.

168. Mr Hill regarded Sir Leonard's Paper as a very fine work on organization. He saw nothing in it that pointed to management, because it could equally describe an unsuccessful organization and it was well known that Sir Leonard's organization had been highly successful. There was nothing in the Paper to show why the atomic energy set-up had succeeded; there was nothing about the sense of dedication in people's minds and the enthusiasm and the way in which leadership was exercised. It was rather a mechanical description of how something had been set up.

169. Professor Baker's Paper made him rather suspicious. It would be fine to take a few of the 50,000 people a year who went to Cambridge and give them a condensed 12 months' course; but the course smacked of producing a sort of cadetship in management, and many people were opposed to that idea. He suspected that some of those who took the course at Cambridge would say "I learned management last year". There

was nothing in the Paper about some of the important things in management—how to delegate, how to instruct, how to assess problems, how to take a balanced view, and how to take risks.

170. Sir Ewart's Paper was very descriptive of the penthouse in the structure of management, and Mr Hill agreed with every word of it; but it was for the top people, for those who had proved that they could get to the top and who would be making more managers themselves. It was not in such language that it could be used for the more simple and elementary forms of management for which it was necessary to cater. What it said should be said more fully and in some cases more simply.

171. The same could be said of Col. Lovell's Paper, which described the first-class prefect of the business rather than some of the boys in the school who had to be knocked into shape. With 2 million managers in or being produced by Britain it would not be possible to get them all with the tools that Col. Lovell described; some would have other tools but would still get results. Some people would learn but not listen.

172. It was necessary to take into account many of the shortcomings of human beings in management. With so many managers there must be shortcomings, and there were slow starters who were sometimes good runners in the end. It was also necessary to take into account the "marrying" of people in positions of responsibility; for example, where the No. 1 man had first-class qualities although some were missing he should be accompanied by a No. 2 who was complementary to him.

Sir Leonard Owen said that his first job as a manager in starting the Atomic Energy Authority had been to decide what sort of organization he ought to have. At fairly regular intervals, because he had not been successful the first time, he had had to alter this organization. That was a job of management; one of the first things that the good manager did was to get a good organization and then change it as the situation changed.

Sir Ewart Smith thought that Mr Hill was inclined to believe that managers were born and not made. That had at one time been true of foremen, but it was not true any longer, because it implied that every man gained his knowledge by sheer personal experience, and if that idea were adopted progress could not be very fast. The human race had progressed faster and faster because more and more it was learning to pass on the accumulated knowledge and experience of one generation to the next. The development of speech had been the first such step; writing, some 5,000 years ago, had meant a very big step forward; and printing, 500 years ago, had again been a big step. If he had his way students would be allowed to take books into examinations, and he would set questions to discover whether they understood what was in the books. About 50 years earlier, mechanical methods of storing and reproducing sounds and sights began to be developed, and more recently there had been the great development of electronic apparatus.

175. The progression would be noted: speech, 50,000 years; writing, 5,000; printing, 500; photography, gramophones, and so on, 50. The rate was accelerating, as would be expected, because all progress was cumulative. We had progressed technologically because slowly and painfully we had begun to take advantage of those means of transferring the knowledge and experience of one generation to the next. That had been done in science and technology, but at the present time there was a complete lack of balance between the ability to handle scientific and technical knowledge and the ability to handle people and to organize and manage things. It was necessary to apply to the managerial problems of mankind the same scientific approach of objective analysis and synthesis that in the past century or two had been applied in the scientific field.

176. Sir Ewart believed that it was completely possible to do this, and he therefore disagreed with Mr Hill and believed that management could be and should be taught. To teach management to anyone at any level, however, was not to make him a manager; he must, of course, have the requisite qualities. Unless they tried to crystallize their views and experience, as they were at present attempting to do by disputation, and put

them before the rising generation, they could not hope to make the progress that was possible, and might not even avoid the dangers that lay on every side.

Professor J. F. Baker said that Sir Ewart had really answered Mr Hill's criticisms of the academic approach, but if Mr Willett had anything to say on the subject perhaps he might be called on.

Mr F. J. Willett (Assistant Director of Research in Industrial Management, Engineering Department, University of Cambridge) said that it was important that the distinction made in § 31 of Professor Baker's Paper between the use of the word "management" to mean the activities of being a manager and its use to describe a body of knowledge should be recognized. Engineering education had faced the same problem; Papers presented to the Institution in the 1860's and 1870's showed the same arguments raised about engineering in universities as are now centred upon management education. Engineering, it was said, was something done by engineers, and it was learnt by being an engineer. One hundred years of experimentation with engineering education suggested that engineering activity was still basically learnt by experience, but that it was essential that a stratum of engineering knowledge was provided first, as a basis on which subsequent experience was organized. The same held true of management, and that necessary stratum of knowledge could be developed.

Colonel S. M. Lovell agreed with Mr Hill that inevitably there were some things missing from the Papers, but said that, having had experience of working with progressive firms such as that to which Mr Hill belonged, he felt that Mr Hill would agree that there was no harm in setting targets. If one set one's sights sufficiently high one might not always achieve them, and there might be the man who would learn but not listen, but by setting a high target it should be possible in the end to get better results.

Mr C. R. Miller (Senior Partner, Messrs Urwick, Orr and Partners) said that he had three points to make. First, as an Associate Member of the Institution of Mechanical Engineers he would correct an impression, which might have been given by Mr Powell, that the Industrial Administration Group of that Institution was rather a waste of time. It was hard work for graduates who had to take the Part C examination, and their immediate reaction would probably be that it would be discontinued. But experience had shown that it was very well worth while. He looked forward to the time, perhaps in the near future, when the Institution of Civil Engineers would have a similar group, so that they could discuss common problems of management and organization.

181. His second point had been made already by Sir Ewart. The problem today related more particularly to the middle area of the pyramid of management. If the pyramid did not have proper steps it was more difficult for people to reach the top, and it was probable that they would get there later than they would if they received proper training and if steps were provided. It was by middle management that a senior manager controlled his organization. A visit to a civil engineering job would give a clear impression of how good site management was, and it was there that 80% of the cost was involved.

182. Engineers must also be managers, at the levels of site engineer, contract manager, or chief engineer. Was the best training for a proposed swimmer to throw him in at the deep end and see whether he would swim? Was it good that the manager should gain his experience by exposure at the expense of his subordinates? Even if the training was not always practical or perfect there was a crying need for management training, and each year saw improvements.

183. For the past 2 years he had been concerned with training for management for the civil engineering and building professions, and two lessons had emerged. The first was the casual manner in which many senior managements sent executives on courses. The second was what his general manager might expect of an executive on his return

from a 4 to 6 weeks' management course. Too often the attitude was: "Here is a contract 90% complete and £40,000 in the red—get busy and sort it out now that you have learned to manage." When it had been sorted out and was still £38,000 in the red, the general manager would say: "Enough of management training, Jones has failed to make the job profitable."

The Authors agreed with Mr Miller's remarks.

Mr D. H. Hughes (Senior Engineer, Messrs J. D. and D. M. Watson, Consulting Engineers) observed that Sir Leonard had spoken of the grave shortage of managing engineers, but Mr Hughes, speaking as one who had always been managed, had never been aware of such a shortage; in fact, he could recall occasions when the opposite had been the case. His experience showed that if there was any shortage it was in the middleweights—the sub-agents, experienced setting-out engineers, and design engineers with a few years of good experience. It was on them that a firm depended for its output and they were the key men who were always sought after. He thought that what Sir Leonard was really saying was that management engineers were reluctant to join the process industries. If that were so, a simple explanation was that an engineer capable of holding a directorship would prefer to hold it in an engineering firm rather than in a process industry.

186. Mr Hughes suggested that the timing of Professor Baker's course was wrong. Twenty years earlier, the enthusiasm of Professor Baker's lectures had given him the impetus to be an engineer. He was glad that at that time the management course had not been invented, and that he had been able to spend his third year at the university in doing something which at least seemed like engineering. He would suggest that the management course should be for men aged 30 or so, who would enthusiastically support it if it could be taken at evening classes. It did not seem likely that such men could go away for several weeks at a time for a course; they all had jobs to do. The reason why strange people appeared at such courses was simply that the men for whom they were intended could not be spared and somebody else was slipped in to make up the number. It must be dreadfully dull for men in their early 20's to take the course. They had still to learn that engineering consisted mainly of mud, Irishmen, and a shortage of carpenters. At that stage of his career a young man should be studying Col. Lovell's fascinating philosophy, and the best way in which he could do that was by working as a civil engineer.

Professor J. F. Baker said that he agreed with a great deal that Mr Hughes had said. When one of his pupils took the management course in his third year, Professor Baker regretted that he was not studying civil engineering; but one could not have it both ways.

The following contributions were received in writing.

Mr C. G. Evans (Manager, Process Engineering Department, Deering Milliken Research Corporation) observed that Sir Leonard's Paper created the impression of an egoistic management whose conception of a manager was altogether too rigid. In § 15 he had mentioned the difficulties that arose from a lack of understanding between top management and the engineer. It was vital that each should have faith in the other, but this could develop only from mutual understanding and common interest. Sir Leonard had outlined a typical management structure, which was valid for almost any engineering project; but he had then suggested that the processing industry was vastly complicated with interaction between all the artificial compartments into which engineering skills had been compressed by management. Was that really true? Was not an ocean liner, a public works project in a foreign land, the administration of a city, the running of a government department (all fairly old arts), just as complicated?

189. Certainly, engineers must accept blame for their inability to convince res-

ponsible authorities, but this did not absolve those authorities from blame for their failure to understand the engineer. One of the arts of good management was to extract the truth, and if authority had failed to understand its advisers it had failed in its job. There was much talk of specialists who could not manage, and of a shortage of engineers. He suggested that there was no shortage of engineers, but there was a very wasteful and inefficient use of engineers, of which the plentiful supply of specialists and the lack of managers were symptoms. This was a management failure.

Mr John M. Darracott (Senior Engineer, Bechtel Corporation, San Francisco) observed that, as outlined in §§ 58–62, one of the main objectives of an organization should be a dynamic progress or growth, not necessarily in size or numbers of personnel in conformity with "Parkinson's Law", but in the development and use of the latest and best techniques in all fields of endeavour, including the use of the relevant fields of specialist knowledge such as accounting, social science, law, and economics. If the organization was to begin to achieve this objective it was essential that the employee should be encouraged to develop and use his knowledge and skill to the limit of his capabilities. This helped to provide an employee with a reasonable objective in that part of his life that was devoted to earning a living.

191. In order to achieve this essential growth of the individual some organizations in the United States were using a method whereby a personal objective was agreed to by an employee and his departmental manager for a fixed period of between 3 months and 2 years; at the end of the period the progress was reviewed by the two individuals. This provided an agreed development objective during a predetermined period for the growth of the individual and should also provide the necessary manpower for promotion to the higher levels within the organization.

192. In the field of industrial development, a project for the construction of a new process plant involved the co-operation and co-ordination of a very large variety of interested parties. These parties had to act as one *unit* (or organization) for the completion of the project, but each had a strong tendency to proceed with its detailed work before the clarification of the general overall principles involved in the project as a whole, owing to a desire to get ahead or to make use of available manpower which would otherwise be idle.

193. Regarding the sequence of operations mentioned in § 14, it was essential that all interested parties should carefully review the project at each of the following stages if a well balanced design was to be provided:—

(i) Preliminary alternative schemes.
(ii) Preliminary alternative budget costs.
(iii) Revised preliminary scheme.
(iv) Revised preliminary budget cost.
(v) General arrangement, drawings, and specifications.
(vi) Detailed drawings and bill of quantities.
(vii) Ordering.
(viii) Detailed shop drawings.
(ix) Manufacturing and construction.
(x) Start-up.

194. Referring to the subject of motivation (§ 63), Mr Darracott believed that in order to encourage the engineers to develop the best balanced solution available at the time it was necessary that each of the above items should be considered and agreed to in sequence by *all* the interested parties, and that the correct degree of design criteria should be clarified for each stage. This enabled the specialist engineer to work out and have executed the solution which he considered to be the most satisfactory. This gave him the responsibility and acknowledgement for "managing his own job". It also helped to eliminate ill-considered judgements based on inadequate data that required a compromise solution, which was psychologically unacceptable to a competent engineer.

195. It was of the utmost importance that the seven or eight dates referred to in § 19 should be adhered to meticulously in a 2½-year programme and that other secondary dates should be kept flexible to allow for the fluctuation of the work load in the various diverse organizations involved in a project. In order to maintain the key dates in the programme it must be accepted by all concerned in a project group that it was desirable that action should be taken at the top level of the organization to consider the priorities of the work on hand and to re-allocate the staff sufficiently early to allow the smooth production of a project. This meant that top management must be told when strong action was necessary, which might be two or three times a year on a large-scale project. The present state of knowledge was inadequate for the provision of infallible programmes.

196. Management in the United States was particularly aware of these considerations. This was a result of the experience gained in the construction of many 150-MW coal-fired power stations on virgin ground, in a period of 30 months from the date of the decision to build the plant to full output.

Mr N. F. Richards (Director of Public Works, Nyasaland) noted that the task of the Projects Manager had been clearly and precisely set out in §§ 11–22. He could endorse the statements in § 15 about the need at the scheming stage to: (*a*) choose the right scheme, and (*b*) present it in such a way as to obtain financial authority for it to proceed. The body that controlled the purse could be more easily persuaded of the "rightness" of the chosen scheme if the best of the alternative schemes which had been considered but rejected were described in some detail and the reasons for their rejection stated. This established the fact that the Projects Manager was not merely submitting the first scheme which came to mind, and it had the further advantage of tending to prevent the body which controlled the purse from putting forward its own alternatives for which it might thereafter retain a sentimental regard in spite of counter-arguments.

198. In Her Majesty's Oversea Civil Service it was not uncommon to find engineers who had become frustrated and unco-operative as a result of their failure in the past to obtain financial approval for their proposals. As Sir Leonard had said, this was usually due to their inability to present their case in a convincing manner, and it was essential that the younger engineer should be taught how to prepare reports on engineering projects and be made to appreciate that such reports were an excellent discipline in making him think and plan as an engineer. At the same time he could sympathize with the engineer when the people who held the purse strings were what might be described as "Readers Digest" experts on everything. Possibly it was true to say that at this stage the Projects Manager was selling himself as well as the project, and that his success or failure would depend to a very large extent on the trust and confidence placed in him.

199. Sir Leonard had rightly stressed the need for programming the work and the fact that this was seldom done efficiently. Reputable civil engineering firms produced programmes for straightforward road contracts which were beautifully drawn out in considerable detail but which were quite impracticable, being based more on wishful thinking than on a proper appreciation of the works involved and the staff and plant available, and making quite inadequate allowances for delays and contingencies which past experience showed would almost certainly arise. It seemed that such programmes were prepared in drawing offices by people who did not know what was really involved in the execution of the project, and this might be due to the fact that so many "practical" engineers who did know what was involved regarded as a waste of time anything other than "getting on with the job".

200. The preparation of preliminary estimates of cost was a most difficult process because, after all the known facts had been evaluated, an allowance had to be made for those unknown factors which would emerge only during the final stages of design and construction. In arriving at the contingency provision to include in a preliminary estimate, the engineer must rely heavily on past experience of similar projects and must,

where that was applicable, assess the possible margin of error in the information available to him. This preliminary estimate was of vital importance; it might well decide the fate of the project, and it would be used as a yardstick by which to measure the final "cost" of the work. It was essential, therefore, that an engineer should try to avoid making a rough guess of the capital cost until he had sufficient facts on which to base an intelligent estimate, and it was most helpful if in the first instance each project was shown in the capital programme with a "design estimate of cost" only, which would cover the cost of carrying the investigations and designs to the stage where a firm estimate of the capital cost could be made.

201. Mr Richards hoped that Professor Baker's Paper would convince engineers of the need to acquire a more basic "knowledge about management". A great deal had been written about management, but much of this was debatable and must be examined critically. Unfortunately, the authors were seldom available for this purpose. The value of a course such as that introduced at the University of Cambridge was that it provided, in the words of the Author, "for a return to the ideal of a joint exploration of knowledge by both student and professor".

202. Unfortunately, the course was open only to graduates of Cambridge with at least second-class honours in mechanical sciences, natural science, or in mathematics. There was an urgent need for similar courses for honours graduates from other universities. It would be advantageous if courses could be arranged on a "sandwich" basis so as to facilitate attendance by engineers who were managers or potential managers in industry. A special problem was that of the many engineers holding positions of managerial responsibility in Her Majesty's Oversea Civil Service, and Mr Richards urged that arrangements be made to provide courses in management for those officers during their vacation leaves in Britain.

203. One fundamental attribute of a successful "engineer manager" was that he was at least as interested in engineers as in engineering—in people as in things. He must feel that the efficient management of an organization responsible for engineering services was more satisfying than providing any one of these services himself, and he must not feel when he left the drawing board or the works site for the manager's desk that he was deserting his profession or ceasing to practice engineering.

Mr A. R. Parish (Project Manager, W. A. Atkins and Partners), referring to Sir Leonard Owen's Paper, mentioned an additional reason for the shortage of Project Managers. A common pattern for the personal progress of a competent engineer was from university or technical college to design office, thence through increasing management responsibility within his chosen technical sphere until, after he had practised for some years, the opportunity for broader management responsibility loomed. Whereas the first steps had formed a natural progression, the final one involved a considerable leap in the dark. Technical education and early professional experience stressed engineering as an applied science with the implication that, given reliable data and adequate time, the optimum technical and economic solution to any problem could be calculated. Management, on the other hand, involved the taking of decisions, which might often have to be based on woefully inadequate information, and on the spur of the moment. There was generally no technique available for precalculating a management decision and, once taken, time might prove it to have been a wrong decision, but it was impossible to know whether it was the optimum; further, management involved the unpredictable human relationship. A basic conflict therefore arose between the feeling for precision inculated into the engineer during his early training and the inexactitude and empiricism of management. There was thus a mental barrier which few engineers might wish, or be able, to surmount, and consequently there were few candidates for the broader responsibilities.

205. Having stated the problem, what was the answer? One solution that immediately suggested itself was to train men straight from university for engineering management, and so avoid their becoming immersed in detailed technicalities. Apart from the

obvious difficulties of selection, many engineers had little respect for a manager who had not, in some stage of his career, shown that he had mastered a technical subject and, of course, the effect on general morale of selecting "silver spoon" candidates for senior positions could very well be disastrous. Probably Sir Leonard's point in § 25(*b*) was the most hopeful, but the universities would have to avoid any stress on vocational training and revert to their true job of training young men to think for themselves.

206. Sir Leonard and Professor Baker had differing views on the training of engineering managers, and Mr Parish did not fully agree with either. Sir Leonard was advocating a management training on the job that, at a time when "sitting next to Nellie" was deplored as a method of training workpeople, was inadequate. Apart from contact with other functions in his own organization, a wider view must be given to a manager by contact with the commercial world, other branches of industry, and government. That necessarily required outside training and, in Britain, we had woefully few facilities.

207. Mr Parish disagreed with Professor Baker's views on teaching management to undergraduates or immediate post-graduate students. As academic exercises, management subjects might be included in degree courses but he doubted whether they would leave sufficient impression on the student to be of value at the time, some years later, when the knowledge would be required. It was becoming increasingly accepted that at least 1 year's experience in industry was a desirable prelude to a university course in engineering science, and he believed that some small aquaintanceship with practical management was a necessary prerequisite to a course on management.

208. He supported Sir Leonard's views made in § 25(*c*). Engineers were sated with technical literature, but in Britain they were woefully short of published material on engineering economics and engineering management. As an electrical and mechanical engineer, he believed that civil engineers were in the best position to advance this proposal, since they were accustomed to dealing with site conditions and battling with the vagaries of nature, and should be less affronted by the imprecision of management than engineers of other disciplines who were accustomed to more exact control of the engineering environment.

Mr G. A. Wilson (Chief Engineer, Port of London Authority) observed that management was a subject on which many engineers were willing to express their feelings and defend them vociferously. The cause of this interest could be found in § 64 of Sir Ewart Smith's Paper, where he set out the working conditions sought by all. If these conditions were lacking—and they frequently were lacking, irritation and strife would result. Engineers, who were trained to examine situations, realized that good management was the key to the problem.

210. The reason for the confusion which surrounded the ideas on management was that management was in a state of transition, passing from the period of the born manager to the period of the trained manager. Even the objectives of management had changed, and the processes by which they were achieved now had to be learnt. This was emphasized in Professor Baker's Paper, which described the Cambridge course and illustrated two facts—that management could be improved by instruction, and that engineers must be trained if they were to be good managers. The need for training was the predominant idea in Sir Leonard Owen's Paper also.

211. Mr Wilson then expressed some of his personal beliefs. First, engineers were no more gifted managers than any other group. Those engineers who trained in management might succeed, but because their profession made them more concerned with things than with human beings they might have an initial handicap.

212. Secondly, a good engineer would be improved if he studied management, but if he became a manager he would be a loss to engineering. This of course would not be a loss to commerce, industry, or to the national effort which would in fact, benefit. He was not referring to the project managers of Sir Leonard, who continued to guide technical teams and retain their technology.

213. Thirdly, the objectives of management as set out in Sir Ewart's Paper, particularly in his six conditions, demanded high intelligence and wide learning, but not engineering. For an engineer who took up management, the engineering would only have been an educational discipline like history, language, or any other subject.

214. Fourthly, it seemed wasteful to train engineers and then divert them to management. Of course, a few might have missed their vocation, and the change in this case was beneficial, but in a properly adjusted society the engineer should be rewarded for his contribution so that his talents need not be diverted. This happened in Continental countries where at the present time technological advances were being made so rapidly that much concern was felt in Britain.

215. Mr Wilson's conclusion was this: by all means train the engineer to understand management, but in order that technology may flourish pay him as an engineer at least until he is sufficiently unproductive for translation to the board of directors.

Mr W. S. Bickerstaff (Civil Engineer, War Office) observed that Sir Leonard had stated that the recruitment of senior design engineers had been almost impossible. To some degree that may have been due to the particular requirements for the posts and not necessarily to a lack of knowledge or experience of management, since design and project management were not new to civil engineering in Britain and civil engineers had been found for high posts in other fields. Would Sir Leonard give some details of the method of assessing the suitability of candidates for senior posts? To what extent was the interview relied upon?

217. Had consideration been given to the possibility of training older engineers who lacked some of the requirements for the posts but were otherwise suitable? This would have some advantages over "catching them young" and promoting engineers of comparatively small experience at an early age, which in itself might cause resentment among older and more experienced staff and might even offend against some of the requirements of good management. The Institution attached considerable importance to experience in the make-up of the engineer.

218. With regard to the teaching of management, most engineers' duties included some management from a very early stage in their careers, and it was desirable that at least the undergraduate's attention should be drawn to the importance of good management and his interest in it awakened. This could be done by introduction of suitable material into lectures on other subjects—a "liberalization" of the subjects—as indicated in Professor Baker's Paper, and by additional lectures on management subjects which undergraduates could attend. More detailed study should then be possible in post-graduate courses, and Mr Bickerstaff supported the plea for facilities in evening courses. Few engineers, at the stage in their careers when they could most benefit from such a course, could attend a full-time course lasting a year.

Mr Archibald Shaw (Civil Engineer) remarked that the human aspect in management had been stressed. There were many examples of the natural born leader. In order to improve the breed and to meet the generally acknowledged need for more real leaders in the technical and professional classes, it was necessary to pass on what had already been learnt.

220. Quite apart from the hard school of experience, the Universities could help; but the courses should not have such dull titles as "Industrial Organization". They must be alive and exciting. Why not simply call them "Human Relations", or better still, "Human Nature"?

Mr Barry Warmisham (Divisional Surveyor, Hertfordshire County Council) emphasized the need for management at all levels to appreciate that the training of staff should be a continuous process. The training outlined in the Papers appeared to stop at a particular stage in a man's career; but this training must be continuous, be initiated from the top, and not consist solely of management training.

222. It was a duty of management to ensure that the talents and skills of its employees at all levels were as widely developed as possible. The Papers seemed to be concerned with the upper levels of management only.

223. Some speakers had valued experience mere than training, but mere experience of changing techniques was less important than formerly. Also, it was possible to obtain bad experience without being aware of it.

224. From the need for all managers continuously to train and be trained, there arose another requisite quality of management, and that was the ability to teach, by example or otherwise. Much could be done by personal contact also and time must be found for this because good leadership demanded time.

Mr S. B. Thomas (Harbour Engineer, Ministry of Transport) observed that the dispute about the structure of the pyramid symbolizing the tapered organization of a work's team was needless, since it ignored an intrinsic and vital property of both. The base of the pyramid, its successive and decreasing layers, and apex taken together formed a coherent whole. A work's organization depended on a team of workmen with various skills, organized by supervisory grades and all directed by a solitary executive. Omit the workpeople and the management was pointless; omit the leader and the organization lacked direction and would fail to achieve its purpose. The team depended for success on integration of the activity of each of its members. It was surely wrong to dissociate these elements and emphasize the importance of management at the expense of the rest, and vice versa.

226. The organization, then, must be an integrated and purposeful team of men. Men indeed were the material through which management worked to achieve its objective, and they and their manager as individuals mattered. If the manager would direct a contented and successful team he must treat them as individuals. To do this he must be mature in himself.

227. No amount of training would produce an effective manager out of the young person lacking the needed qualities and capacity of mind. Therefore, managers were both born, yet had to be made. But did we, as individuals or corporately, discharge the duty we owed to the rising generations to recognize and stimulate the growth of innate potentials of character and mind so that their aspirations to responsible leadership in later life should become a reality? A due succession must be assured, and the difficulties that Sir Leonard had experienced in making senior appointments suggested that the task had been less successful than was supposed.

Mr W. Kirby Laing (Chairman, John Laing & Son Ltd) was disappointed not to find in the Papers any definition of the duties and tasks of a manager. In considering a subject such as this it seemed appropriate to commence with a definition of these responsibilities. The first essential was to realize that a manager must always have a "boss". This applied however lowly or exalted the managerial position held, whether managing a section of a drawing office, a construction site, or a whole firm. There must be someone to whom the manager was responsible—either the chief designer, the superintending engineer, or the board of directors. These people must define the objectives of the organization, and it was the responsibility of the manager to see that they were achieved. The action taken by the manager could be tabulated thus:—

(i) He must decide the methods to be adopted.
(ii) He must allocate tasks to individuals.
(iii) He must co-ordinate the work of these individuals.
(iv) He must institute methods of control which must give the means of:
  (*a*) measuring results;
  (*b*) finding reasons for any adverse trends;
  (*c*) taking remedial action.

229. This led naturally to the tools of management that were to be available to him, and those included in Col. Lovell's Paper should more properly be called "the personal

attributes of the manager", and thus his Paper was really an extension of that by Sir Ewart Smith. Mr Laing suggested that the real tools of management were:

(i) administrative organization;
(ii) financial control (i.e. management accounting);
(iii) production control (i.e. planning and progressing with all that was involved in that title, such as work study); and
(iv) operational research and analysis.

Mr D. E. Glover (Assistant Engineer, Port of London Authority) was interested to note that tacitly at least the discussion had been concerned with affairs basically internal to the organization. Management was of course concerned with other matters as well, but it appeared that the basis of economical considerations in this field were now generally accepted and, therefore, did not need discussion. He would therefore confine his remarks to the internal problem.

231. The discussion made it clear that very many engineers now believed that a basic understanding of the forces at work in the field of management was as important to the profession as a sound grounding in, for example, mathematics or the theory of structures. But points made by the Authors (with the possible exception of those by Sir Ewart Smith) and by speakers did not concern the underlying forces in management, but were about techniques based upon necessarily limited personal experience. They had not attempted to understand the basic forces that ultimately governed the failure or success of any management decision. This was indeed the system used with considerable success to train technicians, and it was the system under which the earliest civil engineers evolved. But in a highly educated community it was not good enough that professional engineers should be content to be technicians in management. They ought to be, and should wish to be, its technologists.

232. The basic content of this "management technology" was the fundamental understanding of people, of their motivations, philosophies, and beliefs, in all their bewildering array. The basis, therefore, consisted of the same subjects as the basis of sociology, i.e. social history, social philosophy, and social psychology.

233. Professor Baker had come close to this conclusion in § 35, but Mr Glover did not agree that it was difficult to find a course of study in which all these subjects were treated. For a number of years the London University Extension Diploma in Sociology had fulfilled this need although it was doubtful whether many engineers had taken the opportunity to study for this Diploma through the courses arranged by the Department of Extra-Mural Studies of that University. The courses were of 4 years' duration.

234. Courses of this sort appeared to avoid the problems referred to by a number of speakers. They did not interfere with the normal work of the engineering departments at the universities; they did not conflict with the student's natural preoccupation with his main subjects, either during his university course or immediately after; and they did not require the student's employer to release him during the day from his normal work. In addition, there seemed to be positive advantages in that they did not involve the setting up of yet another speciality which must increase the gulf between the technologist and the rest of society. The fact that courses of this sort were attended by people from all walks of life was in itself beneficial to anyone required to undertake managerial responsibilities, and they could be truly recreational.

235. As to the timing of such courses, this should be as early or as late as the man himself began to feel the need for it. This left the academic world with the problem of seeing that an adequate number of courses were available throughout Britain, and top management with the duty of bringing their engineers at a reasonably early stage in their careers into positions of managerial responsibility where they must soon begin to feel the need.

236. Having mastered the basic discipline it might be necessary for some engineers to submit themselves to courses of instruction in special techniques of management, but

the majority should be able to learn to apply their new knowledge as they had already learnt to apply their engineering theory, i.e. by exercising it on practical problems during the course of their everyday work.

Mr A. G. Gullan (Chief Superintendent Designs, Air Ministry Directorate-General of Works) referred to the emphasis placed, particularly by Professor Baker, on the new approach to educate the undergraduate and graduate in the principles of industrial management. For the authorities, Sir Leonard Owen, in § 27, had referred to the young men's scholastic and university requirements. For industry, Sir Ewart Smith had emphasized the need for teaching the young engineers. In § 67, Sir Ewart had stated "The Author has already stressed that a good organizational structure should be 'simple in form, balanced in its proportions, and continuous' ". Recently, Mr Gullan had heard of the problems of three young men who had attained high scholastic qualifications, one studying civil engineering, one chemical engineering, and the third law. All had been accepted by Cambridge but had been informed that they would have to wait for a whole year before entering the University. Unfortunately, no advice was forthcoming from the schools, who were detached from the professional bodies and industry, or from the university authorities on how these young men could best be employed during the gap in their training. In one case, that of the civil engineer, the parent was recommended to approach this Institution and again, unfortunately, the advice and guidance was of little or no help.

238. These were not isolated cases, nor were they due to the cessation of National Service. The planners and management should have envisaged the situation. Would the Authors recommend what young men should do if their parents were faced with similar circumstances? In fact, two of the young men had found other employment, which included washing cars in a local garage, until they had obtained more suitable employment in a German factory where they could live in the country and learn the language until they could resume their studies.

239. At the other end of the scale, it would be interesting to hear whether the Authors had any advice to offer the Government. The Treasury was located part of the way down the pyramid, and at the base their departments, nationalized and local authorities, were restricted in the planning and execution of their engineering work to a financial year. These authorities were therefore unable to carry out their works of construction during the most suitable seasons of the year.

Col. A. P. Smith (Commander, 27 Engineering Group, T.A.) commented on the training of Royal Engineers for management. He emphasized that he spoke as an individual sapper and not as an official War Office spokesman, and that his remarks would not apply to R.E.M.E. or Royal Signals.

241. Sappers had been training military engineers for management for 150 years since the School of Military Engineering was founded. The problems posed and the solutions offered in the Papers had a degree of familiarity and similarity to those of military engineers, and so an outline of aims and methods would be relevant.

242. Col. Lovell's and Sir Ewart's Papers could be used as military instructional material with little alteration. After all, men were the same inside their battledress or boilersuits.

243. It was often said that officers' powers under the Army Act and Queen's Regulations simplified military management; but they had no power of summary discharge, except through elaborate and slow legal processes, for any offence however heinous. In war, the worst punishment was the court martial and the firing squad which the enemy could execute, far more summarily and unpleasantly. So, in the long run, soldiers obeyed their orders because they had a certain confidence in their officers and because they were determined not to let their pals down.

244. Many sappers had sat at the feet of Professor Baker and of Sir Charles Inglis.

Col. Smith hoped that sappers of tomorrow would be attracted to the Part 2 Tripos in Industrial Management.

245. Like Sir Leonard, the army trained managers from the beginning, but for the different reason that it recruited officers from school at the age of 18. The aim of the training was to produce a military engineer—a profession and an intellectual discipline, quite distinct in its own right. He must be a soldier, able to advise and persuade commanders and their staffs, at all levels, on the military implications of the engineering problems of a battle, campaign, or administrative situation. He must be able to state the military risks involved in the solutions offered to the engineer's problems. The commander must then decide. The military engineer must also be trained to appreciate advances in civilian technique and their application to the military problem.

246. Sappers had to be sound constructional engineers, skilled in the command of engineer units using both our specialist battle engineering skills such as equipment bridges or minefield clearance, and almost all engineering and building techniques. A sapper could expect to plan, build, control, operate, and maintain railways, roads, airfields; huts and camps; small power stations and electric distribution nets; simple and complex water and petrol, oil, and lubricants supply systems, beaches, small harbours, and inland waterways. Sappers had built shipyards and designed the lighters and landing craft launched from them.

247. In more esoteric disciplines, survey of the very highest class was needed to launch a ballistic missile of any type with a hope of its hitting the target. Military engineers employed geologists, geophysicists, and water diviners, to find water. They still maintained a close connexion with bacteriological and chemical warfare. They were among the pioneers of tanks and of aircraft used for warlike aims, and were now watching the developments of hovercraft and vertical lift aircraft.

248. So sappers must be prepared to command, plan, and advise on a very broad field. No commanding sapper could be an Admirable Crichton equally skilled in any problem. Therefore he must have sound, very quick, and very broad engineering judgement so that he could decide what was good enough for a campaign or a battle—a problem almost as skilled as the design of major structures to last a generation. He must be able to get things done; to write and to talk, briefly and clearly. Above all, he needed character and human sympathy.

249. In two world wars it had been found that civilian engineers were quick to learn the military engineering trade and that as a body they had the highest personal qualities. Military engineering success in those wars had been due, in very large measure, to temporary and reserve army R.E. officers.

250. Col. Smith then described the Royal Engineers' present methods of achieving their aims. Basic training was orthodox and conventional. It stood like a Scotch derrick on three interlinked legs: Sandhurst, the military university; an engineering degree at Cambridge; or the Military College of Science, supplemented by practical courses at the S.M.E.; and as the king post, ample regimental experience. This training occupied an officer for 10 years—from the age of 18 to the age of 27—of which, unfortunately, only 3 years was now likely to be spent on regimental duty.

251. Col. Smith then gave details of further and specialist training. At the age of 28, all sappers returned to the S.M.E. for a further 9 months' advanced study of the military application of civil engineering technique. Civil, mechanical, electrical, transportation, and oil engineering and survey were included. Nuclear and electronic engineering was also touched on.

252. After this course officers could specialize. Those who wished could take the Staff College entrance examination and try their foot on the road which could lead to the most senior ranks in the army. The Corps had not been unsuccessful in this line in the past. The present Quarter-Master General and Master-General of Ordnance were former sappers, and this was not unusual. Each controlled the spending of the order of £100 million a year—quite a fair-sized job. Basic sapper training appeared to be helpful to staff officers dealing with logistics.

253. Senior engineers training for Sapper appointments were offered the following possibilities:—

(i) The Technical Staff Course at the Military College of Science. This aimed to train officers of all arms in the scientific and engineering problems of specifying, designing, and developing armaments or military equipments of all types.

(ii) Long Technical Engineering courses, in which many students had been attached to civil firms and partnerships. The general pattern was a 2-year course of a few months at the S.M.E. and the rest on attachment. All major branches of engineering were covered. It was planned to increase the number of officers so employed.

254. There were two new lines of technical training of great importance. The first of these included regimental projects, e.g. the Christmas Island base in support of the nuclear weapons trials. Works of this kind were planned and carried out by R.E. officers and normal R.E. units. The training value was large and the scope was wide. A Paper on Christmas Island was to be presented early in 1961*. The old military works service had now been "civilianized" after existing in one form or another for 300 years. The duty was specially allotted to the Corps in order to train R.E. officers in peace time, in the execution of large projects. In war, in a theatre where the civilian works organization did not operate in peace, Royal Engineers would still be responsible for military works. To gain the necessary experience it was proposed to keep about 120 officers from captain to colonel and 470 N.C.O.s employed either on attachments to civil firms or in the Works Service. Officers would, of course, rotate with other military duty. So in the end there might be about 400 at any time who had had this training—some 30 or 40% of the strength of the Corps. If this special establishment could be achieved, and if the regular regimental projects went smoothly, it might be possible to replace the experience lost by the "civilianization" of works, and indeed to broaden its field.

255. The major problem in training sapper officers to fit them for senior engineer appointments was to keep the right balance between technical, regimental, and staff experience and to ensure that the officers had had executive responsibility at reasonably senior rank in each of these lines. It was a matter of career planning as well as of attendance at courses.

Mr R. C. de Souza (Senior Engineer, G. B. Kershaw & Kaufman, Consulting Engineers) pointed out that in a lecture to the Institution a few years earlier, Sir John Cockroft had stated that the civil engineer, by reason of his training, should appear in top management. Why then was he so seldom in this position? Was it because he was lacking in the knowledge of modern management techniques? To try to find out why, Mr de Souza had enrolled 3 years earlier for an evening course of 2 years' duration in management study, endorsed by the B.I.M., and held at Regent Street Polytechnic. Soon after he had started the course he had happened to mention this to the principal of a firm of consulting engineers, who had immediately replied "What on earth for?" He believed that this remark typified the attitude of the average civil engineer to management.

257. He had reached the following conclusions:—

(i) In Britain the professional engineer had a poor status because people were more appreciative of professions other than engineering, possibly as a result of confusion with the engineering trades.

(ii) Civil engineers were inclined to be rather insular, and this attitude had made them somewhat less acceptable to others. They were quite happy to be

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* This Paper was delivered by Brigadier R. B. Muir at the Institution of Civil Engineers on 2 February, 1961.

concerned with the technical aspects of an enterprise, and gave little thought to the other equally important commercial, financial, and legal aspects.

(iii) The business, public, and human relation sides of management should be taught to engineers at some stage of their training instead of being "picked up as they go along".

(iv) In a capitalistic society all undertakings, even non-profit organizations, had to be run on a pay-your-way basis to be successful, and this required more than engineering knowledge.

258. Mr de Souza suggested that the Institution should give more publicity to the subject of management, and that a compulsory section on management should be introduced at the Professional Interview stage.

Mr G. A. J. Begg (Division Engineering Director, Imperial Chemical Industries Ltd) believed that there was a tendency to overlook the fact that the excellence of any work of engineering construction depended primarily upon the excellence of its design; the manager of any big project must therefore be a competent and experienced designer himself if he was properly to guide and inspire his staff. The teaching of organization and management in engineering was by no means new; it had been recommended at a famous conference on "The education of engineers" in 1881, and it was in the curriculum of Mr Begg's own university, Manchester, when he was studying engineering in 1920.

260. The difficulty lay in deciding what sort of instruction should be given to a young engineer. Although Professor Baker's curriculum was a good step forward, no one had so far attempted to distinguish between the true scientific principles of human behaviour and the rule-of-thumb precepts that were passed on from generation to generation as the principles of good management. The subject of management was at a stage similar to that of engineering 100 years earlier, when designs were carried out by rule-of-thumb methods.

261. It was not until engineering subjects such as mechanics, hydraulics, thermodynamics, properties of materials, etc., had been studied scientifically in universities and research establishments that engineering design began to advance. There would be no advance in the field of management until the subject was tackled in an analytical and properly scientific manner. The engineer was vitally concerned with the properties of the materials that he used; could no one explain to him the properties of human beings, his most valuable material?

Mr James Ford (Staff Engineer, City Engineer's Dept, Lower Hutt City Council, New Zealand), referring to §§ 18 and 19, remarked that there was a close analogy between programming and navigation, and this was worth examining because it brought out certain salient features of making and using a programme. When a ship was due to make a voyage, the course it was to follow was laid down in advance. As the ship proceeded on its voyage, its navigators made frequent checks to see that it was on course. If found to be off course the ship was brought back on to it as expeditiously as possible, and there would also be a prompt investigation to discover how it came to be off course. In addition to the frequent checks of position, the navigator must be alert to any special circumstances that might affect the ship's course, such as a strong and persistent side wind. The ship was adequately equipped with navigating instruments, data, and aids. These were constantly being improved, and so the precision of the navigator's art increased.

263. The analogy, then, was this: the programme was the course laid down for the project, and somewhere in management was a function to be exercised comparable to navigation to see that the course prescribed was being followed.

Mr R. C. Sansom (Civil Engineer, Building Research Station) stated that his comments were made entirely on his own behalf. He had been left with a slight feeling of uneasiness after reading through the Papers, because three of them were weighted

towards industrial or "factory" conditions. There seemed little relevance in these three Papers to the profession of civil engineering, which after all was the primary concern of the Institution. Surely, civil engineering contractors, in particular, had a valuable contribution to make on the subject of engineering management—not least on the necessity for keeping one's feet firmly on the ground.

265. He would take issue with Sir Leonard, and over §§ 1, 6, and 29 in particular. Surely there was ample evidence in the complicated preliminary investigations, the design, and the construction of large civil engineering projects at home and abroad, such as hydro-electric schemes, bridges, harbours, motorways, etc., that civil engineers were not necessarily devoid of management ability, even if they were unwilling to hail it as a science in itself or to embrace so-called "modern management techniques" indiscriminately.

266. It was not entirely surprising that young men choosing civil engineering as a career should prefer to practice it, rather than enter the quite different atmosphere of a giant industrial organization. No doubt all cherished the broad terms in which the Institution's Charter was drawn up, but a wider use of civil engineers in the building industry would be a more natural development. In some Continental countries this was so, and there was evidence that it benefited the levels of both technical and managerial competence.

267. The engineer's status at present, referred to by Sir Leonard in § 6, resulted from many more factors than he had quoted. For example, it was unfortunately true that an old profession such as civil engineering—unless it had an organized and intelligent pressure group—tended to lose prestige to the newer and therefore more publicized activities such as plastics, electronics, and atomic physics.

268. A certain "room for manœuvre" was the indispensable accompaniment of exercising professional skill and judgement, and engineers had not always resisted to the extent they should the imposition of close limits, controls, and inquisitions, by persons who did not understand the interplay of technical and economic factors involved in many civil engineering projects.

269. The purely personal qualities in management ability, such as leadership and personality, had at least as good a chance of being developed in civil engineering practice as elsewhere. More attention must be devoted, however, to planning, programming and progressing, work study, cost control in execution, feed-back of information on costs and productivity, and communications.

270. Mr Sansom hoped that increased attention to the above subjects would be focused through papers and discussions within the Institution. In this setting all the technical and managerial aspects of engineering could be presented as an integrated whole, and the "modern management techniques" would be kept in their proper place—as tools.

Mr I. D. C. Imbert (Director of Public Works, Barbados) noted that in §§ 1, 2, 6, and 9 Sir Leonard had bemoaned the fact that there was a "grave shortage of management engineers in Britain". In § 25 he had stated what he considered were the reasons for this shortage, and in § 27 had recommended a syllabus for training managers. Mr Imbert agreed with those views, but considered that they gave an incomplete picture of, and omitted a number of basic reasons for, the situation.

272. Young engineers were not given a chance to assume executive responsibility early enough in Britain. There was far too much insistence by employers on experience and corporate membership of one of the major institutions. In many cases, a potentially brilliant leader lost all opportunities for achieving success merely because, for one reason or another, he had been unable to obtain corporate membership of an institution. It was here that the Continent, the Commonwealth, and the Americas had scored major successes over Britain. In those countries young engineers were given opportunities to prove their worth very early in their careers. Mr Imbert had himself

assumed executive responsibility at the age of 22, and control of a Colonial Public Works Department at the age of 29.

273. Most engineers today were terribly lacking in broad education. Sir Leonard had partly covered this in § 25(*b*), but he had not probed far enough. Specialization started in the schools nowadays, and the sort of "instruction" given by most schools was not calculated to produce broadly educated men. Most British universities did not seem to improve this situation at all. On the whole, Continental and Commonwealth universities provided engineering education of greater breadth and depth than did most British universities, and they produced graduates more fitted for top management.

274. In his recommended syllabus (§ 27) for training managers, Sir Leonard had not gone far enough. The school education should include history and at least one classical subject. Such subjects were essential for a broad understanding of people and events and, moreover, gave the student a clear understanding and grasp of language. This command of language was vital for successful managers, as was clearly stated in §§ 15 and 16. The university education should be broad not only in terms of engineering principles but in other spheres of knowledge. A course in at least one of the arts should be compulsory for engineering students.

275. Professor Baker had given a clear exposition of the post-graduate course in management at Cambridge. Such a course provided a very real contribution to the task of producing managers. But Mr Imbert was not convinced that some of the subjects in the post-graduate course should not be taught at the undergraduate level, as implied in §§ 36 and 37. Every undergraduate should be taught the basic principles of economics, finance, accounting, and law. Knowledge and awareness of these subjects very early in an engineer's career were vital for managerial success. Among the subjects outlined in § 51 was social history. Did this include a broad history of mankind? If not, it was a deficiency that should be remedied.

276. Sir Ewart had explained very lucidly what was necessary for "top management" to succeed. He had also clearly described the conditions that were likely to have an adverse effect on management. But he had not given a solution. It was all very well to explain clearly the essentials for managerial success, but how did one proceed to achieve them?

277. Colonel Lovell had best expressed what successful management meant and needed. One point, however, which should have been made was that although personality was essential for leadership, it could not be fully developed without broad education. Therefore, many a potential manager might never reach the top.

278. In a rapidly developing world the need for top managers was becoming increasingly vital. Employers, therefore, should be vigilant in their search for the right young men, and having found them should unhesitatingly promote them to positions of responsibility, regardless of their apparently immature years.

Mr D. C. Robertson (University of Cape Town) observed that the fact that worried the profession today was that the men at the top of large industrial and technical organizations were as likely as not to be purely administrative men. The blame in more recent years had been laid at the door of teaching institutions, in that it was alleged that engineering students did not learn about economics or administration and were thus clearly unfitted for the managerial posts which by implication were considered better than the plain engineering posts. As in many maladjusted situations the answer was a complex one.

280. First, the past could be blamed. Undoubtedly the profession had had among its members many who would have snorted with rage had a junior member been caught reading a book on economics. The same engineers would have regarded the purely clerical and administrative man with a feeling approaching disdain. Yet the administrative man had become his master, often outlining for him the broad requirements of the engineer's job. Secondly, the engineer's very training, which aims to produce a "sound" man, has been his worst enemy. In the 1930's it was difficult to justify many

projects and these were turned down. It was only a few years later that the world's expanding economy made these same projects eminently justifiable. The early 1930's, which were a difficult time for the profession, tended to produce an unfavourable atmosphere for the civil engineer—an atmosphere from which he had never really recovered.

281. Thirdly, engineers today were regarded as being too valuable in their own sphere to be used as managers. The tendency, therefore, was to insulate the engineering department of a big undertaking from the managerial side to the advantage very often of the "administrative" men and to the detriment of the engineers. Here, the engineer himself might be to blame. He might prefer to be left to his technical problems and regard himself purely as a professional man. If he was a senior man he very often held up a long chain of promotion by this attitude.

282. What was thought to be important was teaching the engineering student what might be called "the words". The principles of economics, business relations, and leadership were generally familiar to any well-read and right-minded man. Mr Robertson hoped that Professor Baker would clothe these principles, creating what would approximate to a science. A fair analogy was the subject of soil mechanics. Its principles had been known to engineers for many years but it had taken a Terzaghi to clothe those principles in a mantle of definitions and correlations and so help to establish a new science.

283. Professor Baker had recognized an important fact. He realized that management was a subject for mature students; and here, perhaps, was a final pitfall. In his last year at the university no student would devote much time to anything but the study of engineering. He would regard management as an auxiliary, and no right-minded teacher would insist that as such it was an essential subject for the student's engineering degree.

284. At the University of Cape Town some introduction to the principles of management had always been given in the degree course, but it was realized that even if the facts and principles taught were fully understood by young engineers it would be half a lifetime before they would be used. Therefore, the courses in managerial training should be for those who felt that they were approaching the phase of their careers when such training was needed. At Cape Town the Department of Commerce was then running a 2-year Diploma Course in Management to be taken by those persons, engineers and others, already professionally qualified and in employment, to fit in with their professional full-time duties. But it was too early to say how these additional managerial qualifications would help the engineer in practice.

Mr N. N. Maas observed that Sir Leonard had discussed very ably organization, method, and planning, but not the essence of management. This comment applied also to the Paper by Professor Baker because while, admittedly, the four aspects listed in his Synopsis could respond to academic treatment, the essence of management could not. There was no soul in these two Papers.

286. But this could not be said of Sir Ewart's Paper, nor of the exhilarating one by Col. Lovell. Together, these two Papers emphasized the principles and tools by which good management must be guided. While it was impossible for the top manager in a large establishment to be in personal relation and acquaintance with all his employees, he could use these principles and tools towards his immediate subordinates. He could choose men that were capable of treating their own immediate subordinates in the same way, and so on right down to the man in charge of a small section of shop, office, or gang, for in that man the qualities of management were all important.

287. Also, the top manager should try to be seen occasionally by all his employees, and should ensure that his influence was felt all the way down the line. He should show that he was a human person like all those who worked under him. Any reprimand must be seen by all to be just, and a very careful eye must be kept on any suspicion of intrigue in respect of promotion or other matters.

288. Mr Maas would not mitigate the importance of the organization, method, planning, and wise administration stressed in the first two Papers. They were absolutely essential to the smooth running of any large establishment, but they should not be emphasized at the expense of real management as exemplified in the last two Papers.

289. He would like to add to Col. Lovell's four tools: learn, listen, lead, and laugh, a fifth one, namely, love.

Mr B. T. Turner (Assistant Director of Engineering, The English Electric Co.) remarked that basically for all major engineering undertakings two types of engineers were required. There were the specialists who were experts in one particular field, and the all-rounders who were versatile engineers covering the whole field of any project.

291. The project engineers or managers controlled the project programme from the broad aspects of the work. They covered such facets as programming, co-ordination, budgeting, utilization of manpower, contracts, licensing, facilities, customer liaison, etc., and their work brought them constantly into contact with the numerous specialists required. The specialists, on the other hand, might have to deal with many project managers, depending upon the number of separate projects which were running concurrently in the organization.

292. Essentially, the forte of a project manager was personality backed by good sound technical knowledge over a wide field. He could be likened to the medical practitioner who had at his disposal a number of specialists to advise in particular fields. On the other hand, the *sine qua non* for a specialist was technical ability, knowledge, and skill in one field.

293. While the project manager must be able to understand the theory and underlying principles of any specialist's design, he was not responsible for the details but must ensure that the chosen design fitted in with all the other work associated with the particular project for which he was responsible. He has to be time and money conscious, and above all he had to get on with people.

294. It was regrettable that the definition of engineering given in the Institution's Royal Charter of 1828 left out the handling and controlling of men and only referred to man's ability to control non-human nature. It failed to recognize the management responsibility of engineers for human organization.

295. Unfortunately, present technical education was aimed more at the specialist engineer than at the project engineering manager. Too much emphasis was placed on the "physical" sciences and not enough on the "human" sciences.

296. Few, if any, lectures were given on "The structure of industry" or "The effective employment of engineers" or "How to present a case and run a meeting". Logical planning, programming, and recording of the progress of a project throughout its various phases of design, development, construction, and commissioning were generally ignored. While a great deal of this type of education was left to industry, much more could be done by universities and colleges of technology if they invited industry to provide suitable lectures on a part-time basis to cover these subjects.

Mr P. F. Martin (Messrs Brimer and Martin, Consulting Engineers) believed that engineers were content to abdicate managerial responsibilities to anyone willing to take them over. This attitude was partly responsible for the lack of esteem in which the general public held the profession. More and more one heard engineers complain: "our business isn't run by engineers any more, it's run by accountants and lawyers". This was a reflexion upon the attitude of the profession to one of the principal jobs of the engineer—be he contractor, consultant, or industrialist—namely that, in its broadest sense, the job of an engineer was to manage a job to the satisfaction of his client or shareholders. In engineering organizations with more than a few brilliant engineers the satisfactory production of the job was often marred by administrative (or managerial) inefficiency.

Sir Leonard Owen, replying to the discussion, said that on reading the many questions asked about these four Papers, he found it difficult if not impossible, to give a brief statement that covered them all. The discussion had been stimulating and the main feature of the Papers was the interest shown in them.

299. One point concerning his own views on management, on which there seemed to be considerable misunderstanding, was a theme which ran through some of the questions to the effect that he believed that engineering projects could be managed by people who were not engineers but who had been trained in management. Nothing could be further from the truth. He believed that engineers must manage engineering projects and that they would do it better if they had had some training in management rather than having just drifted into it. There were many modern tools of management which engineers should know about and it would repay them a hundred-fold to acquire this knowledge.

300. There appeared to be some further misunderstanding that he thought that a good organization was all that was required. Again, nothing could be further from the truth. He would rather have a job run by people of skill and personality with a bad organization, than a job with a good paper organization but manned by people without the necessary skill and personality. Finally, he would comment that the former alternative was unthinkable, because people with skill and personality would make it their first job to see that their organization was good.

Professor J. F. Baker, replying to the discussion, was gratified by the interest that these Papers on management had aroused among the members of the Institution, and was heartened by the general support of the work begun in Cambridge. He re-emphasized that the present Cambridge Examination in the Principles of Industrial Management was not intended to be management training. He agreed with those who had suggested that undergraduate or immediate post-graduate courses were too early a stage, and the university the wrong place, for such training. It was in his view the right stage and place to introduce the young engineer to the basic sciences and languages by which the managerial environment could be comprehended, in terms of which he could assimilate his practical experience.

302. Cambridge had developed, in conjunction with Churchill College, a new approach to the "sandwich" post-graduate management course which would interest those Members who spoke in favour of such developments, and he welcomed the contributions of Mr. Begg, Mr Robertson and others who supported their contention that there was a primary need for a very considerable research effort in this field.

Colonel S. M. Lovell, in reply to the discussion, wrote that on re-reading the comments of the whole Papers, both oral and written, he could not help feeling that some of them showed a narrow approach by many engineers to management, by giving requirements for specific types of project. This surely was exactly what the Papers were trying to avoid by dealing with management in its largest and all-embracing sense.

304. In answer to Mr Kirby Laing, Col Lovell said he thought he had covered Mr Laing's points in two places of his Paper. He would not disagree that he had described the personal attributes of the manager, but this aspect he had deliberately chosen as described in the opening part of his Paper as being the most fundamental.

305. With regard to Mr Laing's suggestion as to the real tools of management, Col. Lovell felt that those described were really organization not management. He felt there was a difference in these two things, and whilst the competent manager became the competent organizer, the "Alice in Wonderland" argument did not follow that the competent organizer became the competent manager. Again he had discussed this particular point in § 74 of his paper.

306. Replying to Mr A. G. Gullan, Col. Lovell said that if, unfortunately, a wait for University entrance was necessary, he knew other alternatives to those mentioned. He had heard of candidates who had decided what type of job they wanted to do in the

future and then sought to obtain employment with that type of firm during the period of waiting. This did not seem unduly difficult to achieve, and obviously served a useful purpose.

307. The question of giving advice to the Government was, of course, considered by most people to be their prerogative, which again they usually freely exercised, as Col. Lovell knew only too well from his experience in local government. Giving evidence before a Select Committee at the House of Commons, Col. Lovell had made the same point about working at the wrong time of the year apparently caused by having to "balance the books" every financial year end at the 31st March. There must obviously be some reason for having to do this and which was not the compass of the engineer to answer. But with certain projects which were the result of long-term planning, would it not be possible to release at least the greater proportion of these to long-term financial commitments?

308. In answer to Col. A. P. Smith, Col. Lovell said that with 28 years' service in the Reserve Army Sappers and 6 years during the war, he had learnt much about management from the Sappers that had been of great use to him in civil life.

309. He would also like to add that the long technical engineering courses served another useful purpose. He had been fortunate enough to have both officer and N.C.O. personnel attached to him on these long courses during the construction of the Doncaster By-Pass. The personnel concerned had proved willing, competent and of very great assistance to him. He hoped he would be able to get more on his major projects in the future.

310. Col. Lovell accepted the point made by Mr Imbert. As he had explained to an earlier speaker, space was limited in Papers, There were obviously many facets of leadership which needed a whole treatise to explain but that was the value of the discussion, both oral and written, that followed.

311. Col. Lovell was glad that Mr Maas agreed with him. He had, in the space of four paragraphs, succinctly expressed what Col. Lovell had set out to do in the longer Paper he had written. After reading all the comments he still thought, like Mr Maas, that his approach had not been thrown out of the window. Certainly add love to the four tools, in fact, it was a very good addition.

312. In conclusion, Col. Lovell said he had finished his original Paper with the following phrase, "That since the whole subject, as far as the Author is concerned, embarks on the enjoyable experience of expressing nothing but personal beliefs (perhaps a somewhat unique experience before a learned Institution), then by acknowledging this he disposes of any suggestion that he is writing as an expert on the subject".

313. He now more than ever felt that he had been right to finish in that vein. What endless possibilities the discussion had opened up; what vast and varying views had been expressed; there was certainly food for much further thought in the discussion. If progress was to be made what a vast amount remained to be accomplished. The discussion had ranged sufficiently wide to write a whole book—whether it would be authentic and comprehensive would remain to be seen. It certainly could be very wide-ranging, extremely interesting and illuminating. How obviously right the Institution had been to bring this subject under discussion.