

ADDRESS

BY THE PRESIDENT

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ACTUARIAL TRAINING AND PRACTICE

It becomes increasingly difficult for an incoming President to find a new theme upon which to discourse. In the very nature of things this must be so, for a presidential address, though providing the opportunity for innovation or controversy, must nevertheless maintain a tradition; that of crystallizing the thinking and of focusing the collective outlook of the profession (as a President stands, not for himself, but for the profession) at a particular period of time. In historical retrospect an examination of presidential addresses reveals a picture of a development and growth and of adaptation and evolution. Whether a President wishes it or not he is bound to conform to this pattern because whatever he says must be a product of his own interaction with the general environment of his time and, in particular, must reflect his interrelationships with actuarial colleagues and the thoughts they communicate.

It is not without significance for the profession that you have chosen for your President an actuary who since he qualified, and indeed a year or so before qualification, has had no working contact with the hitherto conventional field of employment of the actuary. Most of my professional life has been spent in the field of applied statistics and much of it in medical or social research. The significance for the profession is that this kind of career is not now so unusual for an actuary as it was. Five of our Fellows are currently in directing positions in Government statistical departments; two hold professorial appointments in statistics; a few are employed in industry on work which can best be described as management science; the significance for me is that my progress in this career has depended upon the unique qualities of our actuarial training, and that this training has proved indispensable in a field which I had not contemplated entering when as a junior assistant in a pension fund office, I was persuaded to become a student member of the Institute. Oddly enough, like the immediate Past-President of the Royal Statistical Society, Leonard Tippett, I had first graduated in physics—perhaps these are examples of the value of an applied mathematics groundwork. The real significance of it all lies in the ever-widening scope of the profession; its ability to adapt itself to the new intellectual disciplines which new situations in management, be it private or public, have demanded. It is a truism and a somewhat superficial one, that without the new ideas evoked by new situations, our profession (indeed any profession) would die of inanition. For, and

this is a more fundamental truth, the real strength of a profession lies in its ability and willingness to recognize the new situations at an early stage in their emergence. The danger lies in blind complacency.

If we are talking of actuarial training we must not overstate the adaptation and change. Twice in my time as an examination official I have seen apparently radical changes in the examination syllabus and arrangements. These have effected considerable and important changes in subject coverage and emphasis; but what for me have been the fundamental ingredients of actuarial training have remained unchanged.

Almost twenty years ago in a first and inadequate paper to the Institute about local government I maintained 'that managerial policies must be preceded by fact-finding and the careful arrangements of the facts in relative importance to the problem under review, the assessment of time factors and secular trends, the forecast of emerging quantities, the skilful balancing of compensatory factors. Subsequently the construction of the plan, the final synthesis of functional components, is a task calling for breadth of vision, a capacity to visualize the pattern of action in its entirety without being distracted by detail and an appreciation of all that is involved in the relation between the plan and the problem which it is to solve—an ability to keep the formula flexibly linked to the material from which it derives. It is precisely in these procedures that the skill of the actuary may be most effectively exploited. In recent years both Government and industry have discovered that, either directly acquired as part of the curriculum of training or indirectly inculcated by virtue of the type and breadth of logical practice in the hard years of probation, there are qualities possessed by the actuary that adapt him peculiarly for the higher levels of executive responsibility. Actuaries who have entered industrial undertakings on specialist grounds have been called upon to accept wider authority within a short time' (*J.I.A.* 73, pp. 335–55).

These views were not then generally acceptable and were regarded by some as the exaggeration of immaturity. One senior Fellow disagreed strongly with the suggestion (which I did not in fact make) that an actuary necessarily had the qualities of an administrator. The President of the day (Mr A. H. Rowell, now Sir Andrew Rowell) accepted and welcomed the generalization (I hope I shall be as encouraging to the readers of first papers) but stressed as others had done and as I would have done had I been wiser, that in its individual application a great deal depended on personal qualities. One of my most severe critics (Mr H. E. Melville) was in the end my strongest supporter when he added that 'His own impression of local government was that by the standards to which actuaries were accustomed it was inefficient and expensive. There was no profit and loss account; there was no means of testing any department, or the machine as a whole, to see whether it had done a good year's work or not; and there were far too many sectionalized and more or less watertight compartments. There was no general manager responsible for looking after the

organization as a whole. He spoke with quite limited experience, but he believed that that made for waste of effort, duplication and expense'. The people of Newcastle where they now have a town manager would regard this statement as well ahead of events even for an actuary.

If I were writing my paper again (as perhaps I am) I would say that actuarial training develops, in a unique way, pre-existing ability. This pre-existing ability, like professional competence, is more easily recognized than described. If we could measure it and describe it better, then those who in successive decades have had the task of reviewing the tuition and examination arrangements would have had an easier problem to tackle. For this is what has been in their minds. How best, apart from the simpler task of adapting subject coverage to contemporary practice, to select those essential and innate qualities and to use our intellectual disciplines to develop them. Let me emphasize that I am not here speaking of what we call professional conduct, a difficult but different problem to which I will return later. I am speaking now of intellectual not moral capacity. There has to be a moral foundation otherwise the intellect is liable, though sharp, to be shiftless. Personal integrity is vital; especially in the modern context of intense pressures.

Recently I had the privilege of attending a seminar on the management of research and development (organized by one of our Fellows, Professor P. G. Moore, of the London Graduate School of Business Studies). One of the participants who directed scientific research in one of the larger, if not the largest, international industrial undertakings was asked how he tackled the application of objective management to the inescapable uncertainties of a research programme. His answer was in simple terms. That it was necessary to recognize the really important factors. This, I think, brings us to the heart of good decision-making ability. Mr Usherwood in his presidential address stipulated, in addition to personal integrity, 'for a capacity for clear and precise thinking, and for the prospect of developing a balanced judgment'. I think he was describing the same concept.

This capacity for analysing a situation and separating the important factors is a vital mental quality of the actuary; it can be developed and sharpened, but it must be there. I must stress that it is not merely a question of separating all the factors of a problem; it is a question of judgment as to their relative importance. I have met statisticians and research workers to whom all aspects and all details of a problem are equally of absorbing interest. These people are not the most useful servants of society. They usually find it extremely difficult to bring a study to an end or to indicate how the findings might be applied to practical situations. They have a place as a member of a team, for the meticulous consideration of hitherto unconsidered trifles and they occasionally stumble upon something quite important. Because of their lack of discernment of the important variables they are not capable of designing experiments and

they do not contribute much to the making of decisions. They would not make good actuaries. I am labouring the point because I think it should be laboured. Mr Usherwood was wise to add balanced judgment to clear thinking.

How do we select these qualities? As an indicator of clear thinking as well as a foundation for the subsequent building of a structure of essential techniques we call for a minimal mathematical ability. We shall shortly be announcing changes in our entrant requirements. It will in future be necessary for a candidate entering upon our examinations to have passed the G.C.E. in 5 subjects. Two subjects must be at 'A' level at grade 'C' or above, and one of these must be mathematics. It is clearly unnecessary to examine for mathematical ability those who have acquired a university degree in a mathematical subject. School leavers who have passed 'A' level mathematics at grade 'A' also do not need to be examined: they may not have covered the syllabus which we regard as the right foundation for later training but it can already be assumed that they would find no difficulty in doing so. The rest are required by the Institute to sit for its Preliminary Examination in Mathematics. As it is essentially a task for school leavers, the Preliminary Examination must in shape and content conform to current school teaching practice. One of the first tasks, therefore, of the examination review committee currently sitting under the Chairmanship of Mr Skerman has been to take account of the important changes which have taken place in school mathematics teaching.

It is necessary to put these changes in perspective since I believe that undue emphasis has been placed upon the development of specific teaching projects affecting a minority of schools and insufficient recognition has been given to the more general changes which have taken place as post-war generations of teachers have taken with them to their schools their own traumatic experiences at university. For the basis of the revolution in school teaching was the sharp contrast between the last year at school and the first year of university mathematics teaching which in the years of reconstruction after World War II became a major problem. Advances in university mathematics stimulated or accelerated by the war, which never leaves things as they were, led to the development of new disciplines for conveying and facilitating mathematical thought. In due time entrants to university mathematics found themselves in their first year required to read a language with which they were ill-acquainted. For many the shock was too severe. In the reappraisal which followed, the mathematical publicists gave free rein to their iconoclastic exuberance and to some extent the real nature of the changes which were essentially required was obscured by attacks on matters which were hardly any longer at issue; for example, the use of Euclidean geometry and other uncomfortable disciplines or of disciplines which could be shown to be clearly irrelevant to practical affairs. Constructive steps have been quite general, however. Some schools have joined in specific projects which have developed to the

extent that new textbooks have been written and G.C.E. syllabuses have been adapted to them. On a wider but less specific scale, however, all school teaching has moved in the same general direction. It is this movement which we have recognized in the Institute. The new syllabus of the Preliminary Examination which we shall shortly be announcing will have a new look for some of us but it is not new to schoolmasters who have now been living with it for many years. I have digressed from the subject of selection tests only to emphasize that the Institute at least in relation to mathematical aspects of its training programme is exhibiting a healthy adaptability. Not to keep abreast of current thought would be fatal, not only to recruitment to the profession but also ultimately to much of our practice, certainly to our ability to apply our techniques and attitudes of thought in the new spheres so widely open to us, and of which I shall say something later.

How else do we attempt to select for a capacity for clear thinking and balanced judgment? The Preliminary Examination in mathematics unfortunately is not wholly sufficient. I say 'unfortunately' because clearly the aim should be to select as early as possible partly to avoid waste on the part of our tuition service but more important to allow those who are not well adapted to our professional requirements to consider other career opportunities to which they may be better adapted before frustration has robbed them too much of time or initiative. The first substantial stage, the Intermediate stage, of our examinations is therefore designed partly to present a further process of selection and partly to commence the process of development of the selected qualities. It may be claiming too much to regard these examinations as being so specifically designed. The examinations have evolved over the years and have been shaped by successive committees without necessarily such a simple or such an oversimplified view of their purpose. We do habitually use particular tools or techniques and we must be taught how to use these techniques. It is of course just not enough for us to be able to think clearly; we cannot waste time developing techniques from first principles every time we need them. I do not, I fear, know the source but I recall the injunction that 'it is no good just being a genius. You have to be a genius at *something*'. So there is a need for a certain subject coverage though I sometimes think that for some this need has tended to become an obsession. There are still too many who would like to extend the subject coverage and too few who would agree to reduce it. Moreover I think we have tended empirically to introduce a particular subject coverage as the primary object and only secondarily to consider how this subject coverage should be exploited to fulfil the role of the examination other than conveying familiarity with techniques. However, whether by design or by some process of natural selection the Intermediate examinations do make a heavy demand on clarity of thought. This is especially true of the examinations in probability and statistics. It is less true of the examination in compound interest but the demand is by

no means slight. This quality of the probability examination has for so long been part of our experience that we have tended to make a fetish of it. If we are to be successful in transferring some of our tuition burden to university resources and also (and this has been rather overlooked) of advancing in time the point of selection of actuarial potential, then we must be prepared to depart from our previously held view that only our kind of probability is the right one and that only our way of teaching the subject is the right one. Probability is a subject in respect of which at the Intermediate stage of our examinations we have become out of touch with advances in university teaching. I must not anticipate the conclusions of the Skerman committee which has been devoting attention to this among other problems. I wish only to emphasize that the examination is not perfect as a test of knowledge of probability and that we should not pretend that it is. I do believe, however, that taken together with the other parts of the Intermediate examinations (Statistics and Compound Interest) it is an effective test for selection. I do not believe that it is possible to dismiss these early examinations simply as problem-solving exercises to gain dexterity in technique. It follows that I do not accept that there is such a sharp contrast between problem-solving in the early stages and the exercise of judgment in the later stages of the examinations which is often held to exist. It is possible that we could be more explicit in the use of the Intermediate examinations as a selection test and that both the text-books and the examinations could be less concerned with subject coverage than with the deliberate tests of clarity of thought.

The statistics of the Preliminary and Intermediate examinations indicate two significant features:

- (1) that the poorer passes in the Preliminary Examination in mathematics have a very slow rate of progress in the subsequent examinations;
- (2) that whichever Intermediate subject is considered, candidates who pass at their first attempt have a substantially faster than average rate of progress in subsequent examinations. This of course could be held merely to show that any examination is selective without indicating the specific nature of the selection. It is, however, likely that there is more to it than that.

Perhaps we should be less concerned with the number of students we redirect to other professions than with how quickly we can effect any necessary redirection. Clearly we should hope to so manage our recruitment programme as to keep this early wastage as low as we can. We do also have a heavy responsibility to avoid 'false negatives' in our tests. We cannot afford to lose good material.

The ideal situation, to take one perhaps naive view, would then be that having effected perfect selection, there would be no further wastage of candidates; our tuition system together with the professional instruction deriving from actual employment in actuarial offices would concentrate

upon the development of the essential characteristics of the potential actuary, clarity of thought and balanced judgment; that while there might be variation between individuals in the rate of development and therefore in the rate of passage through the later examinations, all would eventually succeed. That this ideal situation does not obtain is evident from the fact that of those who survive the Intermediate examination a proportion still fail to qualify as Fellows. This is not all due to some deficiency in the Institute's methods either of selection or subsequent training. There are always those who are not prepared to make the sustained effort required to pass the necessary examinations; and there are those who find other interests in other forms of employment for which actuarial qualification is not regarded as a particular advantage. It should be noted that, far from being failures the latter group, if properly selected for actuarial training, may also be self-selected for these other forms of employment by the same criterion of clear thinking. But of course there remains the likelihood that some of our later wastage arises from errors in selection or inadequacy of developmental training or faults in the later examinations. As to selection, no systems are perfect and there are doubtless some candidates who ought to be discouraged earlier. The examinations themselves are under review. I ought to stress that they always are under review in the sense that Council looks carefully each year at the reports of the Board of Examiners. At intervals of a few years we take a longer, cooler, look and this is what is happening now.

We do have continually to bear in mind that examinees are undergraduates and that when they graduate they still have to acquire experience. The difference between a technologist and a technician is perhaps that the former never ceases to be a student. There is also a risk that, since a certificate of competence to practice is given on examination alone and since only limited experience is acquired during the period of qualification, a new graduate may be placed in a position of accepting greater responsibility than he ought to carry. This is a risk that all professions face and it is lessened for us by the fact that our average period of qualification is longer than in some others. As in other professions this is a problem to be solved by employers who, in so far as they are represented by senior actuaries, are part of the profession and must be jealous of its reputation.

I mentioned also the possibility of inadequacy of developmental training and here also a responsibility lies upon actuarial employers. A profession by definition consists of a body of skilled practitioners in a particular field who pass on their skills to succeeding generations. We do not have articles of apprenticeship but our students are nevertheless apprentices and they need all the help and guidance which older members of the profession can give them. A tuition and examination system can never be self-sufficient. Though there is no legal contract between master and apprentice there is nevertheless a technological relationship between them which is extremely important and one which cannot be too strongly

emphasized. For this is not only a matter of enriching practical experience and improving skill. There is another important element of development which our tuition and examination system does not and cannot properly encompass. I refer to professional behaviour. Most of us are concerned with financial contracts in a highly competitive world in which the avoidance of self-interest and the maintenance of an independent professional view places immense strains upon integrity. If the Institute is to survive at all, these strains must be met and new generations of actuaries must be helped to meet them. The Institute itself lays down guide-lines and I have been personally impressed, the more so since I have become President, by the work of the professional guidance committee. Their problems seem to me to become increasingly more difficult. But as in all professions individual actuaries guide, by the standards of behaviour they themselves maintain, the generations who follow them. Every one of us is a teacher and if we have any loyalty to the profession we cannot afford to be careless. There may be some who think we are, as a body, too scrupulous. I think they take a short-sighted view.

Like other professions, we jealously guard the expert-client relationship. I have a firm conviction that any slackening of our largely unwritten rules of behaviour could mean disproportionate and irremediable harm to the profession. Once a profession begins to weaken, the process is apt to become self-generating and progressive. For the client, by definition, is largely uninformed. His consultation is an act of faith. If that faith in independent competent advice were to be shaken the consequences could be extremely serious. One has only to consider an alternative situation where strong codes of conduct do not exist. If a situation were to exist where pretentious groups of 'experts' without hall-marks of competence, could jostle each other in advertising activity and could offer recommendations in respect of which the secondary reward to themselves would be confused with direct assistance to the client, then the client would soon recognize that he was in a jungle and would look elsewhere perhaps to some entirely unrelated profession for civilized behaviour. Such bad conditions perhaps do not exist anywhere but it is not entirely a hypothetical situation. An assurance of independent advice directly given from the individual expert to the client will in the longer term prevail over any other inducement. There is freedom in the jungle but it is a predatory environment and life is short.

I have spoken at some length of our concern for clarity of thought, balanced judgment and personal integrity as the essential qualities which we aim to select and to develop. This development is what we mean when we speak of actuarial training. I have laboured some points in order to stress that these elements form a central unity of the complete actuary whatever changes may be made from time to time in the subject content of the examination syllabus, which is but a vehicle for the instillation of discipline and thought. I have made it sound rather simple. I ought to

stress that it demands a very great effort on the part of the student and a very great effort on the part of the profession. It is a matter of concern to me and a matter of great pride that at any one time so many of our younger actuaries allow themselves to be locked in this effort of training and consider it a personal honour, as indeed it is, to be invited to do so. I think it follows from what I have said about the secondary nature of subject matter that it ought to be possible to transfer a considerable proportion of our training to university resources. This possibility has been further increased by the flexibility of contemporary university teaching organization. Most universities have to provide for a wide variety of degree subject 'packages', the number of permutations and combinations of subjects exceeding the number of teaching faculties providing them. The number of undergraduates attending any one course commonly consists therefore of a combination of smaller groups taking different degrees and the combination changes from course to course. In these circumstances, the number of undergraduates required, at any time, to justify the maintenance of a particular degree is not so critical. The relatively small number of actuarial students who might be attached to any one university centre, which has hitherto been an obstacle to the transfer of actuarial teaching to the universities, is no longer so much of a difficulty. The Institute has not been idle in this field. It is already taking steps to extend still further the long-standing liaison arrangement we have with the B.Sc.(Econ.) degree at the London School of Economics. It may be possible to proceed to the point at which the degree examinations, optional to potential actuarial candidates, would exempt from all our examinations to Associate level as well as part of the Fellowship examinations. If we can do this in London we can do it elsewhere. This would have the dual effect of significantly reducing the period of qualification, the length of which can be a recruitment deterrent, and of reducing the pressure on our own manpower resources.

It has to be said, however, that it also follows from what I have argued about actuarial training that a new problem would be created; that of reducing the length of time during which the profession as such has the opportunity to develop in the candidate those special qualities to which I have referred, that is, of reducing the opportunity for the profession to exhibit its claim to be a profession in the sense of passing on from one generation to another, a number of skills, an attitude of mind and a code of behaviour. This problem would necessitate for its solution a further increase in the responsibility placed upon the shoulders of actuarial employers. Codes of behaviour are taught, not in the classroom but in the working environment.

If I am correct in my appreciation of the essential qualities of the actuary there are important implications for his avenues of employment.

Most managerial problems call for the rapid appraisal of the important factors in a particular situation and the weighing of the probable

consequences of alternative courses of action. The probable consequences may be, and often are, predicted successfully on the basis of intuitive reasoning or hunches. No one can deny that some appear either to be particularly gifted or at least to have long runs of luck in this way. Few, however, are content to rely on this precarious method. Most prefer a more reliable process of decision making and lean fairly heavily on statisticians who are trained in the way that actuaries especially are trained, and accountants are also trained, to isolate significant variables from a mass of, often, undifferentiated information. In this context all three professions have much in common and it would be narrow-minded to argue otherwise. Their media of technique may be, traditionally, very different but the guiding genius, and this is what matters, is the same complex of clarity of thought and balanced judgment of which I have been speaking. Of course we think that selection and development of these qualities in actuaries is more rigorous. All the more reason, then, for us to enter more boldly the field of management science. The argument gains force when we consider what more is involved in decision making.

For observation of the important factors in a management situation is often a multidisciplinary study. Engineers, chemists, physicists, mathematicians (in the role of statisticians or otherwise), economists, may all play a part in a joint examination of some problem concerning production or commerce, the object being to optimize efficiency. The problem is one of isolating and weighing significant factors in a system so that the results of action or of outside influences can be predicted and thus the system can be brought under control in optimal conditions. I may interject that at the highest level this is what is required for the control of the national economy—an effective analysis. A number of economists have exerted their efforts to this analysis. Perhaps we also need some actuaries on the job. In industry, studies of the kind I have described were especially intensified and developed during World War II, the object being then to optimize the war effort, both productive and destructive. The phrase ‘operational research’ was coined to describe this kind of co-operative effort, linking factory floor, laboratory, transport system and other parts of manufacturing organizations. If I might digress for a moment I would confess to the personal view that this loose label of ‘operational research’ has been a mistake in two ways. First, most of the special techniques developed have been applications of probability mathematics and they belong almost entirely to the mathematical statistician. There was no great need for a new label, so indefinite in its meaning. The second mistake is that since most of the techniques have been borrowed from the statistician, operational research has no roots of its own, no distinctive ethos. Just as their techniques are borrowed, operational researchers have no field of their own and tend to attach the label O.R. to any field in which their techniques may be used (even the field from which they originally borrowed them), population studies for example.

To return to management science, since I have argued both that management science is a multi-factorial exercise and that actuaries are especially selected and adapted for such exercises the implication is obvious. This is not a new point but I want to make it with a new force. We should stop paying lip-service to a possibility and face up to an actuality. Hitherto many actuaries have suffered self-restricting inhibitions—that they are narrow technicians and not well-equipped general statisticians; that they are calculators and isolated from management. These inhibitions can have the damaging effect of divorcing them from the real world of decision so that they are actually more capable of solving equations than human problems. There are some people, in the pensions field for example, who are not slow to make this kind of criticism. So let us stop talking of ourselves and management scientists as ‘we’ and ‘they’. Of course we cannot enter this field for the asking or because of professional qualifications in themselves; in every field ability has to be demonstrated before it is recognized. But there is no need to tie our own hands behind our backs. We can compete with others on more than level terms. The management science field, especially the consultant field, is populated by practitioners many of whom are less well equipped than we are. It is a rewarding career in more ways than one. In a few words, industry of the future is going to be dominated by the management orientated information man. Those who manage information are going to be closest to decision-making itself. Some of our colleagues have already demonstrated the truth of these remarks and I commend their perspicacity and sense of adventure.

There is one information field close to us which demands attention. I refer to non-life insurance. The need for proper statistical organization has been highlighted by recent events and is readily accepted by the industry. The need for statisticians with an understanding of the administrative problems of non-life insurance is agreed. Because they have been traditionally linked with life assurance are actuaries going to shrink from offering their statistical skills? This lends point to what I have said about inhibitions. They may expect no admission just because they are actuaries but at least they might stake their claim as statisticians. No bewildering mathematics need be offered to management; only the essential statistical organization inherent in the simple truth that contracts have a finite and not an infinitely short term and that the state of accounts at any one time is not a test of solvency. There are other problems outside our special interest on which I will not dwell except to express concern that the public are so gullible as to accept insurance without questioning its adequacy so long as it appears to be cheap. I hope the industry will not leave the necessary education to bitter experience which might unjustly tarnish the general image of insurance but that they will take some steps themselves to put the record straight.

Another area of decision-taking where multiple factor analysis, intuitive or explicit, is important, is investment and this is a field in which a growing

number of actuaries either in direct association, as officers or consultants, with life assurance or pension fund institutions or as members of stock-broking firms are playing an important part in the conduct of the national economy. Investment analysis is essentially a matter of maximizing the degree of objectivity in assessing capital and income prospects by codifying past experience and using this experience as a basis for more reliable extrapolation into the future. There are undoubtedly limits to the degree of objectivity which can be injected into this operation. No national economy can be subjected to laboratory experiment and no national economy can be isolated from others; nor are all the operating factors identifiable or measurable. At least, however, the known important factors can be monitored and in the development of the necessary statistical and computer techniques actuaries have made notable contributions. This will be amply demonstrated in a paper to be read at this Institute later this session. The Institute has underlined the importance of this field to the actuary in a number of different ways. First, and largely due to the sagacity and persistence of Mr Menzler, we have introduced a Certificate of Finance and Investment as an overt recognition of the completion of the relevant parts of our examination and as a public demonstration of actuarial interest and expertise in this field. We have also introduced at the Fellowship stage an examination at an advanced level for those of our Fellows who wish to specialize in the management of assets as a counterpart to the management of liabilities. Second, we have this year conducted a highly successful Investment Seminar in which acknowledged experts from outside the profession and Fellows of the Institute and of the Faculty with special experience, gave talks on a wide range of investment and economic subjects. Third and by no means least there is the contribution we make on a continuing basis to the construction of the *F.T.*-Actuaries Index (which replaced the earlier Actuaries Index). This is an important part of the task of codifying experience to which I have already referred. We do maintain an investment research committee jointly with the Faculty. Many of our Fellows are also active participants in the Society of Investment Analysts with whom we have close relations: as we do also, of course, with the Stock Exchange.

There is one last field I want to discuss—computer technology. There has been a good deal of lip service paid to the revolutionary impact of the computer upon the professional life of the actuary. Speaking with some experience of computers myself I would say that the impact of the computer is important but that it has *not* been presented in the right terms. There are two common misconceptions about computers and these misconceptions are found as much among actuaries as among other professions. First, that it is making adequate use of computers simply to transfer to them business or data-processing operations hitherto carried out by conventional punched card machines. Second, that an understanding of their potentiality can only be gained, and can sufficiently be gained, by

a detailed knowledge of programming. If I may deal with the second first I can agree that some knowledge of programming is necessary to understand the logic of the computer, and especially an extensive acquaintance with programme languages, i.e. with their scope and orientation (to business methods or to numerical analysis), is necessary to obtain a proper grasp of the potential of the computer. But detailed programming is best left, like typewriting, to those who specialize in these skills. These skills are scarce but not as scarce or as expensive to produce as those of the actuary or statistician. 'Do-it-yourself' programming is a wasteful diversion of professional manpower. The worst misconception is that computers are simply a new vehicle for old procedures. This is a retrogressive and not a progressive attitude. What we need are not just computer users but computer thinkers. The challenge of the computer is not to do accounting or pay-roll procedures: indeed I doubt whether they are ideal applications of the computer. The challenge is to harness the potential of the computer to accomplish tasks which could not be contemplated without the computer. Long step-by-step procedures as, for example, in network analysis for routing transport or other forms of communication would, if carried out manually, take an impracticably long time. Exact solutions can now replace intuitive approximations. Some of these approximations were incredibly good but in economic terms not good enough. Similarly numerical taxonomy is another step-by-step procedure which enables seemingly intractably undifferentiated data to be classified and new concepts to be distilled. It is an essential part of modern information systems. It is not practicable otherwise than on a computer. It might have important applications in insurance, for example, in the classification of risk groups. Model building as an essential tool of management science needs the assistance of a computer to handle the mathematical equations in which these models are expressed. Mr S. Benjamin has already shown how this enables us to abandon the traditionally deterministic basis of our consideration of mortality rates, interest rates and rate-fixing. The world around us is stochastic not deterministic. The computer enables us to recognize this and to examine in the space of minutes, years of stochastic experience. Finally, modern organizations are delicately poised systems which have to be optimized and kept in equilibrium. Here we have the essential cybernetic situation where rapid information feedback through the computer achieves control. All these imaginative applications are a challenge to the analytical thinking of the actuary and the statistician. It must be answered by imagination in new methods and not mere consolidation behind established procedures. I believe that actuaries have an immense part to play.

One final word about our profession and its relation to others. New generations of actuaries are clearly going to be more orientated to mathematical statistics than most of us who are currently practising and there must be a greater need for collaboration with kindred professions. I refer

especially to the Royal Statistical Society which, since its foundations in 1834, has been responsible for advancing the subject of statistics and to the Institute of Statisticians, of comparatively recent origin, which is the corresponding professional body to look after the competence and conduct of the statisticians. We do have close relations with these bodies. I hope they will be closer still. Our own strict code of conduct has evolved over a period of more than a century and has withstood many difficult tests. The Institute of Statisticians who still have before them many of the problems which are behind us would, I am sure, benefit from our experience. Intellectually there would be much mutual benefit from increased transfusion of ideas between all three bodies. The Institute of Chartered Accountants and the Institute of Cost and Works Accountants, like us, are undergoing changes in the scope of their work which must have repercussions for their educational systems. An exchange of experience would be mutually helpful. We are a very strong profession and we have no need of insularity. Indeed to be inward-looking would be fatal. We can be proud of our great tradition of service to society but we must not rest on tradition. So at the same time we can and must still keep a wide vision, a sense of adventure, and a capacity for invention.