TRANSACTIONS OF SOCIETY OF ACTUARIES
1949 VOL. 1 NO. 1

THE ACTUARIAL EXAMINATIONS

CHARLES A. SPOERL

"Are these the slaves that groan'd along the streets of Mystery?"—WILLIAM BLAKE.

IN THE forefront of actuarial folklore stands the belief that the actuarial examinations constitute a mystery impenetrable by mortal man. Perhaps the vitality of this myth may be ascribed to the undeniable attraction it holds for the successful Fellow. The committee in charge has been content to administer the examinations without going into detail as to their procedures or their objectives—reasonably enough, as long as the system seemed to be stabilized at an effective working level. However, times have changed.

The extensive revision of the form and scope of the examinations in the past five years calls for a straightforward account of just what has been done, why it has been done, and what is expected for the future. The standards we set for our profession should be a matter of the liveliest concern, not just to the Examination Committee but to all of us.

This description of recent developments is intended to lay the foundation for an intelligent appraisal of our examination system. A necessary prerequisite is a record of the results of the examinations. Figures for the past decade will be found tabulated in Appendix I. Away with mysteries!

The last extensive review of the examinations and the educational system took place in 1942. It started at the spring meeting of the Institute as a discussion of H. M. Sarason's paper on how to study for the examinations, but the speakers covered a much wider field than this before they had finished. It was continued as a programmed informal discussion at the fall joint meeting. Figures were produced which showed that the time required by those completing their examinations from first registration to ultimate success had almost doubled in the previous two decades and amounted to about 11 years for the current crop. On the recommendation of the Educational Committee, a special committee was set up to examine the whole field with its primary object "to suggest steps which will enable qualified students to complete the examinations in fewer years." As a secondary object, the committee was to consider how "to attract a larger number of likely candidates to the actuarial profession." The com-

mittee had a formidable title which was officially abbreviated to "Joint Special Committee on the Education and Training of Actuaries, etc.," but it was often called the Beers Committee, after its chairman.*

This committee got to work early in 1943. One way to shorten, if not the average time necessary to achieve Fellowship, at least the time after graduation from college, was clearly to schedule the early examinations to be taken in college rather than after graduation. The present preliminary examinations are the outgrowth of this line of thought. Another problem was what to do about the increasing amount of material in the course of study for actuarial students. The first step in solving this problem lay in greatly reducing the required reading list. Consolidation of parts of the material led to M. D. Miller's monograph on graduation and the other monographs and actuarial studies now in preparation. A more radical attempt to reduce the pressure was the experiment with optional subjects on the last Fellowship examination. First and last, the special committee covered an enormous amount of ground. It functioned for three years; in 1946 it evolved into the present Advisory Committee.

In describing the objectives of the special committee and its successors and the changes made in the examinations, it will be useful to subdivide the field into three natural parts: (1) the preliminary examinations, (2) what might be called the intermediate examinations (interest, life contingencies and other Associateship topics), and (3) the Fellowship examinations. I shall try to avoid as far as possible referring to the examinations by number, since some have changed their scope and all have been renumbered in the past ten years. The last previous general change in the examinations took place in 1938, applicable to the 1939 papers, when the Fellowship examinations in the Society and the Institute were placed on a joint basis. In this account, I shall not consider any examinations prior to those established in 1939, and I will relate the changes made since 1939 to the various examinations as given in that year.

THE PRELIMINARY EXAMINATIONS

The Special Committee felt that the only practical way of shortening the actuary's period of apprenticeship was to encourage the student to take his first examinations in college rather than wait until after his employment in an actuarial job. Moreover, by giving suitable publicity to such a program within the colleges, more students would become aware of the potentialities of the actuarial profession, and our second objective could be furthered. At first glance it might appear that this could be accomplished without changing our traditional examinations, but even a

* The membership of this committee is listed in Appendix II.

superficial study revealed many difficulties. Although our old preliminary examinations were purely mathematical, they could not ordinarily be passed by college students without a considerable amount of special preparation. While the average undergraduate mathematics program sometimes includes College Algebra, it does not cover Finite Differences, and adequate courses in Probability and Statistics are not too common. Many college professors had seen some of their best mathematics students fail in our examinations time after time. They became less and less enthusiastic about the actuarial profession and in some instances even warned their best students away from undertaking an actuarial career. For this we have largely ourselves to blame. We have failed to foster any liaison between our profession and the mathematical profession; I shall have more to say about this later.

Since, then, we wanted to attract college students to our profession, we would have to base at least one of our examinations on the kind of mathematics they would naturally study in college, that is, largely, Analytic Geometry and Calculus. In order that such an examination might fulfill its purpose it could not be tied to a specific published course of reading, but should cover the subject matter of any adequate college program that might be given in the United States or Canada. Moreover, too hard an examination would not be compatible with the program of broadening our field of potential actuaries. If only five or ten percent should regularly pass—and this would be a reasonable figure based on our then existing examinations, assuming no special preparation by the candidates—promising men would continue to be frightened away from the actuarial profession.

Even though this preliminary examination necessarily had to be less strict than our previous standards, there was no thought of letting down the bars. The weeding-out process would commence with the general mathematics examination; more selection would be achieved by means of another preliminary examination. The further Associateship examinations should complete the process. This program evidently would involve one inherent danger—that the men who pass the general examination might believe they have thereby proved themselves natural-born actuaries and go on only to waste several valuable years trying the later examinations for which they are not qualified. We would have to make it clear in our material prepared for the colleges that passing the general mathematics examination is but one step in a screening process, not an infallible aptitude test.

The Beers Committee decided almost at the outset to explore the possibility of working along these lines with the College Entrance Examina-

tion Board. They felt that if our program could be tied into other college programs we could reach more potential candidates than by any other means and also stimulate more interest among the teachers. Moreover, such a relationship should be a great help in preparing a proper examination, since the College Board is one of the principal groups that has really devoted a great deal of study to the technique of setting examinations. We have been painstaking in our examination work, but our papers have always been amateur creations. Working with experts would give us a chance to learn how to do better even if we ultimately decided not to have them administer the examinations.

Our association with the Educational Testing Service began in April 1943. (In 1947 the College Board merged with other organizations engaged in similar work to form the Educational Testing Service; it may save confusion to refer to it by its present name.) Professor S. S. Wilks, one of the leading authorities in Mathematical Statistics, handled the mathematical aspects of the work for them. I will not describe in detail the steps which led to the present preliminary examinations; a general outline will suffice.

(i) *Language Aptitude Examination*

The examination for college undergraduates was first conceived by the Beers Committee as an actuarial aptitude test—perhaps an advanced version, pitched at about college sophomore level, of the Scholastic Aptitude Test so widely used to predict students' success in college. This standard test comprises a verbal* part and a simple mathematical part, and it has been very valuable in predicting success in mathematics and the sciences —more reliable, in fact, than purely mathematical tests.

We were informed that it would be fairly simple to adjust the Scholastic Aptitude Test to the required level, but Professor Wilks felt that the resulting mathematical part would merely duplicate the easier portions of whatever mathematics examinations we decided on. Thus we decided to eliminate the mathematical part, and the resulting purely verbal test is our Language Aptitude Examinaton. Although it will be some years before its value can be proved or disproved, a test of this kind ought to be useful in selecting actuarial students since a large part of the actuary's work deals with words, exact shades of meaning, interpretation, and the like.

Since this test represented a radical departure from previous practice, the governing Boards authorized its use, not as an examination with a high passing mark designed to pass only the best candidates, but rather as an

* The committee often confused "verbal" with "oral" during the early conversations. "Verbal" as used here means that words and word-relationships are involved; all the examinations in question are written examinations.

instrument for weeding out the few who verge on the illiterate. So far, only an extremely small percentage of candidates passing the General Mathematics Examination have failed the Language Aptitude Examination. When enough time has elapsed to make statistical correlations with the later examinations possible, we can decide if we should have more faith in this test and stiffen the passing grade or, conceivably, drop it altogether.

The Language Aptitude Examination is given in two forms—one for the great majority of the candidates, who speak English, the other for French Canadians, who are more at home in the French language. In the three years the examination has been offered, we have had only 24 candidates for this French form out of a total of over 2,100. Even though this proportion is very small, we believe it is fairer to continue both forms of the test, at least during the experimental years.

The Language Aptitude Examination calls for three types of answers: selecting a synonym of a given word from a list of possible answers; filling two blanks in a definition from a list of pairs of words with the object of completing it most satisfactorily; and answering questions of fact or inference based on a given paragraph. It started as a three hour examination, but we have reason to believe that for our purposes a one hour examination along the same lines would produce substantially the same results. Statistical studies made by the Educational Testing Service indicate that this one hour test would be the equivalent in reliability of our three hour mathematics examinations. Accordingly, we are recommending this change for the 1950 examinations. If it is adopted, it may be expected to make very little difference in the quality of candidates who pass it, and it will have the distinct advantage of allowing all three preliminary examinations to be given on the same day. This not only is desirable from the administrative point of view but will be a great help to those who have to make a journey to reach an examination center.

(ii) *General Mathematics Examination*

The main concern of the Beers Committee was to obtain a mathematics examination specifically designed to test college students. I have explained how this led to considering a verbal test as well; the exploration of both fields went on more or less simultaneously. Verbal tests are set up in the modern manner, with a very large number of short questions to answer in a prescribed form. The marking is on a right-or-wrong basis with no partial credit allowed. The Educational Testing Service strongly argued the desirability of constructing the mathematics examination along similar lines. At the time this suggestion first reared its ugly head, the reactions

of the committee members ran the full scale from consternation and horror to the feeling that at last we were "getting somewhere." I am sure that if a poll were taken of our Fellows today, we would find an equally wide range of viewpoints. As I look back on the period from the first appearance of the beast to the decision to take it by the horns—a period marked by the gradual evolution of the committee's thought from a wide diversity of views to substantial unanimity—I am convinced that the only thing responsible for so remarkable a change was the access of knowledge that came with our study of the theory of setting examinations. For this reason, I want to set forth what we learned, so that the members of our Society may see why the style of these examinations has been changed, and, on the whole, understand and sympathize with our objectives.

Examinations in the new style differ fundamentally from those in the old in that, in place of a comparatively small number of somewhat complicated problems, they consist of a large number of questions, each designed to test one definite point. It is important to remember that the new style examinations involve two alternative techniques, which are called "open answer" and "multiple choice." In each of these types, the candidate gets full credit or none at all for each question, but in the "open answer" type he is asked to write the answer in a designated space, whereas in the "multiple choice" type he must select the correct answer from a list of five or more alternatives. Many of the misconceptions regarding the new style examinations arise from a confusion of these two types.*

Actually, two different points are involved. The first is whether an examination of the old style, of the long-question type, can possibly be equivalent to an extensive set of short questions which are marked either right or wrong with no part credit allowable. The other is whether the "open answer" type of examination can be considered equivalent to the "multiple choice" type. In my own instance, both were hurdles, but the first one was the more formidable. In any event, the first one must be surmounted before the second one becomes important.

One thing that carried considerable weight with me was that the College Board, with Professor Wilks as its mathematical adviser, has gradually changed all of the College Entrance Examinations, except the English Composition Examination, to the new basis, with many short questions replacing a relatively small number of complicated problems. Professor Wilks summarized for us the reasons for the change.

The salient point is that, while the old type of examination purports to test the candidate's ability to organize his material as well as his grasp of details of technique, it too often does no such thing, particularly if the

* Examples will be found in Appendix III.

questions are as difficult as ours have been. On those questions where the candidate fails to obtain full credit (the vast majority, on our previous examinations), it is more often than not impossible to determine whether the failure came from missing a detail or inability to organize the material. Those instances where it is perfectly clear one way or the other are a small minority. The best the marker can usually do is to give part credit based largely on his estimate of the ability demonstrated by the candidate to deal with small portions of the subject matter—those crumbs of truth that the marker is astute enough to salvage. That is, the long question has been atomized into the new type of subquestion, but atomized in a manner dictated by the candidate's ignorance rather than a marker's skill.

The old type of examination also involves several other weaknesses. If the subject matter of the question is at all diffuse (shades of our Fellowship examinations!), the grades are likely to be distributed quite narrowly, which tends to cause a heaping up of final marks in the middle of the range, often to such an extent that a change of one percent in the passing mark might change the standing of 5% of the candidates. Moreover, the element of subjectivity is bound to creep in. My own work in supervising the marking of the old examinations amply demonstrated this, but never to the extent dramatized on a problem in Probability,* on which the first marker gave one candidate full marks while the second gave him zero.

In contrast, the use of shorter questions has many positive advantages. A great deal more of the field can be tested with a large number of questions—practically all of it except proofs and demonstrations—than can be covered by a few. This tends to minimize the element of chance which is always a feature of an examination with few questions. The marking is entirely objective and introduces no complications arising from difference of interpretation. The individual questions can be readily tested after the examinations are given to see which are most valuable. We naturally want to find questions which the good students get right and the poor students miss rather than middle-of-the-road questions which do not sort out the candidates. These more significant questions can be filed together, and a study of them should enable the examiners to improve the content of the examinations from year to year.

The Educational Testing Service has developed a further technique which may help us with one of our most perplexing difficulties: to decide whether unusual results on a particular paper are the fault of the examination or whether the anomaly should be laid to an unusual crop of candidates. This technique is used on those of their examinations for which they have a large body of tested questions available. It consists of placing

* Problem 4 of Part 3 of the 1945 examinations.

a number of questions of the same character on two examinations and using the answers to check the general level of the candidates' ability. An extension of this technique may also be used to pre-test new questions.

As the members of the Beers Committee followed these arguments and familiarized themselves with the way they worked out in practice, they became more and more favorably impressed. It developed that many tests in a wide variety of fields were being given by this technique—from the U.S. Army and Navy to the American Medical Association. The examinations of the American Board of Internal Medicine for certification as a specialist were especially effective in answering the criticism that only superficial aspects of a subject were amenable to the modern technique. It became apparent that fundamental principles could be tested as well as operational details. We were particularly reassured by a description of the history of the adoption of the new forms by the College Board itself as described by Professor Wilks—the Board seems to have had the same obstacles to hurdle and the same qualms and doubts as we had.

We became convinced that the Educational Testing Service could without much trouble set a general mathematics examination, on Algebra, Analytic Geometry and Calculus, because of their experience with the subjects involved. Some of us were not so sure the technique was as readily adaptable to the other subjects: Finite Differences, Probability and Statistics; but we decided to see what could be done. Sample examinations were prepared and tried out on several groups of students who had recently passed these parts of our examinations. The results showed that the General Mathematics test was pretty well in hand but that some adjustments and further study were needed before the examination in the special mathematics subjects would be entirely satisfactory. We were all convinced that fundamentally these subjects could be covered by an examination in the new style.

We received authority to proceed with the construction of the new examinations. We hoped to make the change in 1946 but the Educational Testing Service pointed out that because of the dislocations of the war the crop of candidates we could expect in 1946 would not be nearly so representative of what could be expected in the future as the 1947 lot would be. This would tend to upset the studies of the relative value of the questions and retard the work of assembling a file of satisfactory questions. We bowed to the force of these arguments, and the first papers were set in 1947.

The two mathematics examinations were given on an "open answer" basis in 1947. The change to the "multiple choice" basis originated as a result of the extreme difficulty of securing properly qualified markers.

With over a thousand papers to grade involving about 75,000 individual answers we thought it mandatory to investigate the alternative technique. At first blush it would seem that a list of the possible correct answers to an "open answer" examination would be easy to construct. The difficulty is that the answers may appear in a variety of different forms, and each new one that appears during the marking has to be identified as right or wrong. One of our questions, for example, reached something of a record, with over 25 different forms of the correct answer submitted by the candidates.

The principal lay objections to the "multiple choice" answers are that candidates are invited to work from the list of answers back to the questions; that the form of the answer may give the solution away; that guessing is encouraged. These are valid criticisms of poorly constructed examinations, but those skilled in the technique are able to find questions which avoid these pitfalls or minimize their effect. Substitution of the possible answers in the given equations may be made a longer process than the direct solution by a suitable selection of numerical values; the form of the correct answer may be disguised by technical devices. As for the encouragement of guesswork, the test of a proper series of "distractors," as the false answers are called, is that an improperly prepared student should be more likely to pick a wrong answer than a blindfolded student would be!

The construction of "distractors" is apparently an art. They are usually based on wrong answers given by persons taking the examination in an "answer only" form, but there is more to it than can be described here. At one session we all took a hand in constructing them ourselves. In grading the papers, an allowance is made for questions not answered by the candidate. If there are eight choices given, he receives a credit of one-eighth of the number of unanswered questions. He is notified of this procedure in advance so that he won't be tempted to guess against the experts.

The final argument in favor of "multiple choice" was furnished by a study published in *The College Board Review* in 1947* based on the Board's Comprehensive Mathematics Test given in the two forms to different groups of students, each group answering the same questions but in the opposite style. The conclusion reached was that the reliability of the two forms is substantially the same. The study also considered the long-question examination, which emerged in last place. We were convinced that the two forms of short-question examination were to all intents and purposes equivalent, but that the "multiple choice" type offered by far the more satisfactory solution of the marking problem. Ac-

* Vol. 1, No. 2, page 17. The Examination Committee has a few copies for inspection.

cordingly, the 1948 examinations were changed to this basis. The actual marking is done both by markers with stencils and by an electrical machine which "senses" the marks of the special pencils furnished the candidates. When the results do not agree, a rare occurrence, they are reconciled by an examiner.

(iii) *Special Mathematics Examination*

The construction of the Special Mathematics Examination in short-question form accompanied the work on the other examinations, but in dealing with this relatively unfamiliar field the experts had to take their Finite Difference texts out of moth balls and give themselves a thorough review. In the three subjects covered there was no "bank" of tested questions available, and the enterprise necessarily involved more thought and insight. The members of the Special Committee assigned to work with those who set the questions redoubled their critical efforts. Though it is not possible to prove it yet, I believe we have achieved, on the whole, satisfactory questions and learned a great deal about the technique. The examination was first given in 1947, in "open answer" form; it was changed over in 1948 to the "multiple choice" form.

(iv) *Promotional Problems*

The second objective of the Special Committee—to make an actuarial career attractive—was tackled along with the construction of the examinations. The Committee prepared the booklet with which we are all familiar, describing the actuarial profession, its ideals, its needs and its opportunities. Material advertising the new examinations was sent to the colleges; notices appeared in the mathematical journals and other likely places. A series of prizes was established by the actuarial societies for the best undergraduate students, and a further series was offered by the Canadian Life Officers Association, for which Canadian candidates are eligible. As I have noted, there has been considerable feeling in the colleges that an actuarial career offers a poor alternative to the variety of industrial jobs which have been opened to mathematicians as a by-product of the war. We believe we have something good to offer the student with a mathematical bent, and we have been trying by these various means to attract his attention.

A rather baffling problem has arisen in this field. The examination which has been designed for these mathematics students necessarily cannot be so severe as our old ones were, for reasons which I have gone into. The initial selection is thus not so strict as formerly. Nevertheless, since we have been instructed to maintain our standards, there has to be a drastic weeding-out process somewhere in the course of Associateship

examinations. Where shall it be? We have tried to grade the Special Mathematics Examination on a somewhat stricter basis than the General Mathematics Examination, and no doubt this is a step in the right direction. In 1948, for the first time, the Life Contingencies Examination was taken by students entering under the new system, who had taken the General Mathematics Examination in 1947. The results were discouraging. The Part 4 Examination was distinctly on the hard side but, even with a lower passing mark than ever before shown in my records, only 22% passed. It was evident that many candidates were very badly prepared indeed; more than 36% had marks under 30. I believe a great deal of the trouble was the unexpected difficulty of mastering a text by oneself as compared with the comparative ease of a course in college. The old preliminary examinations required the student to learn to study by himself; this was the feature we were most reluctant to abandon when we made the change. A good part of the selection accomplished by the old examinations was the elimination of those students unable to practise this rigorous discipline.

The question is: should we stiffen up the General Mathematics Examination or resign ourselves to using the Life Contingencies Examination as the weeding-out point? Alternatively, should we make the Special Mathematics Examination the hard one? I confess we are not yet entirely clear as to the best solution to this problem. We cannot afford to make the General Mathematics Examination so difficult that we build up our old reputation again; we cannot, equally, over-encourage young men only to disillusion them after several years of fruitless study. Possibly the solution lies in emphasizing the tentative and preliminary character of the General Mathematics Examination; possibly it is to lay a much heavier barrage of warning as to the difficulty of the Life Contingencies Examination and of developing the necessary discipline needed to study by oneself. We have some hope that the dilemma may be avoided altogether. The outcome of the 1949 Life Contingencies Examination* was much more encouraging, which may be a direct result of the slight stiffening of the passing mark in the 1948 General Mathematics Examination. We are trying to maintain this 1948 standard, and in another year or two we will have a better idea whether our problem has been solved or whether it will need further study.

(v) *General Procedure*

Before leaving the preliminary examinations I should like to describe how they are administered. Specialists of the Educational Testing Service

* See Appendix I.

work up suggestions for the papers during the fall of the year, and a meeting is held in December with our Preliminary Examinations Operating Committee, consisting of three members. Officials of the Educational Testing Service are also present as are some of the members of the Advisory Committee (successor to the Beers Committee) and, occasionally, other members of the Education and Examination Committee who are interested in the work. The examination questions under consideration, which have been passed around in advance, are criticized one by one. Some of the battles are magnificent. Ultimately a set of papers is decided on. After the examinations are given, the Educational Testing Service marks the papers and presents the results, of course anonymously, at a meeting similar to the December one. Passing grades are decided upon at this meeting, prize winners are selected, etc.

Subsequently a statistical analysis is made of each question, which checks the relative difficulty of the examination and sorts out the questions that should be of value (with suitable changes) in future examinations. The results of the 1948 examinations were compared with the college grades of a number of the candidates so that we could obtain an idea of what sort of men are passing. The report indicated that in the average college we passed about 80% of the "A" students and 25% of those with "B" averages, although the results were far from uniform and varied considerably from college to college. We are making a similar study of the 1949 examinations.

We feel that the new system is a success. We believe we have replaced a considerable amount of guesswork by a much more reliable examination technique. At the same time, we expect to study the results most carefully. I believe that although we all expect much from these new examinations, we are not so committed to them that we will be blind to faults and insensitive to trends. We will continue to be on the lookout for new ways to test the system, to keep it abreast of the times and to improve it in every way possible.

THE INTERMEDIATE EXAMINATIONS

In contrast to the fundamental changes in the preliminary examinations, the other Associateship examinations have changed very little. The Compound Interest Examination was merged with the Life Contingencies Examination in 1946, necessitating part credits for the years 1946 to 1948. It was felt that in a contraction program a separate Interest examination was the logical candidate for the axe. Those aspects of this subject that are not inherent in Life Contingencies can be adequately covered in a few questions and do not need a three hour test.

At the present time, studies are being made to ascertain whether half of the Interest and Life Contingencies Examination might not well be put on the same basis as the preliminary examinations; that is, short questions with multiple choice answers. We would not expect the Educational Testing Service to administer this part of the examination. Instead, they have recommended an expert skilled in this form of test who can work with the Part 4 Operating Committee in constructing questions. If the change is made, the examination will still take six hours: three hours on each basis. Each half would cover the entire field, although it is to be expected that Compound Interest might be weighted more heavily on the multiple choice half.

The advantages of giving the examination in this twofold form are many. If it is possible to learn to set good questions in the new style, this portion of the examination should have all the merits already discussed: more complete coverage of basic subject matter, and ease and objectivity of grading with no loss in reliability. There would be two added advantages. First, it would be possible to concentrate on problems in the other half which get away from purely mathematical manipulation. We could ask, instead, more searching questions designed to bring out the candidate's grasp of general principles. Second, it would be possible to correlate the results of the two halves of the text, and this would give us a positive check of our own on the new technique. This, to my mind, would be most informative whichever way it worked out. It would provide a landmark in a country where the sands have been shifting rather rapidly of late.

Provided we are convinced an adequate examination can be prepared along these lines, we shall ask for authority to put the new system into effect, but with the definite understanding that the change will not be permanent unless the results are satisfactory. I am reluctant to keep changing the examinations around, since one loses the advantage of statistical comparability if one does so. Still, there is even less justification for continuing with a change that has proved itself unsatisfactory. I believe that, as far as we can see now, this change is in the right direction. If we can secure enough good questions, I hope we will be allowed to try it out. We are not unmindful of the fact that in many respects this Life Contingencies Examination is the basic one of the entire set, and we therefore feel that it is important to experiment with a technique that may improve its reliability.

The last Associateship examination—the present Part 5—has not changed much in content, except that Graduation is now confined to its elementary aspects. Graduation has always been a special stumbling block for the students. Mr. Miller's monograph has helped enormously to sub-

due this *bête noire*, and restricting the scope of the test has brought this part of the examination into line with the rest of it. Two other projected studies—on Construction of Tables and Selection—are partly finished and the completed parts have been published as study notes. They have proved extremely helpful. Because of the new books it has been possible to enable the student to assimilate a much greater amount of material without adding to the time he must spend on it. Had it not been for these aids to the students we might well be considering a nine hour examination for Part 5.

This last Associateship examination will, of course, always be necessary. The only thing that could produce younger Associates would be the widespread establishment of first-class college courses in Life Contingencies. Unless these courses were really first-class, they would be of little value. If they ever should be available, the college graduate could have the first four examinations under his belt at the time he gets his diploma. If he were bright, he could be an Associate a year later. If he could then absorb enough practical experience to exhibit equal facility in the later examinations, he might achieve Fellowship in two or three more years.

THE FELLOWSHIP EXAMINATIONS

The main problem in regard to the Fellowship examinations has been how to cope with the new developments—new papers, new ideas, a greatly expanding field. It is the last examination that has had to bear the brunt: the other two have come to be standardized and are probably pretty well stripped to a minimum. The only change made in them has been the elimination of Banking and Finance. The Beers Committee felt that of all the subjects this could most easily be spared, especially in view of the many developments since 1930 which are still in the realm of controversial opinion. Perhaps the time has come to reconsider; monetary controls have an increasing influence on the investment markets. A desirable modification might be to incorporate a part of this Economics material into the Investment readings.

There has been considerable discussion in regard to switching some of the topics from one examination to the other, usually Valuation from Part 6 to Part 7 and Surplus Distribution from Part 7 to Part 6. While such a rearrangement is in some respects a more logical one, nearly all the topics covered by these examinations are intimately related to one another, and, in fact, this is only one of the interchanges which have been proposed. So far, all suggested rearrangements have foundered on the ugly rock of Partial Credits. Unless an even greater advantage could be demonstrated, the general opinion has been that the dislocation during the change-over period would outweigh the other considerations.

As standardized in 1939, the last Fellowship examination covered Law, Policy Forms, Pensions, Social Insurance, Agency and "General Topics of Actuarial Interest," defined as Fraternal, Industrial, Accident & Health and Group Insurance, Reinsurance, and Topics of Current Interest. In 1942 the candidate was given the opportunity to choose three questions of a block of five and skip the other two. In the years 1943 to 1945, a modification of this practice was extended to all three Fellowship examinations. The Special Committee came to the conclusion that this practice was at best a makeshift; the time had come for drastic revision. Two general steps were considered necessary: excluding some of the subjects altogether, and placing the rest, all except Law, on an optional basis. The committee felt that a large part of the drafting of policy forms is an art and that the Law examination would cover the other phases; that fraternal insurance and accident and health coverage are specialties; and that important aspects of reinsurance and industrial insurance would be adequately covered under such headings as gross premiums, selection, surplus distribution, etc. Placing the other subjects on an optional basis was done only after considerable discussion; the determining factor was the impossibility of asking the students to cover the tremendous volume of reading necessary to secure an adequate knowledge of all these subjects. The committee feared that this step might lead to specialized actuaries with large blank areas in their training but felt that the other alternative—an actuary with a smattering of everything and adequate knowledge of nothing—was even worse. As finally constituted, the examination consisted of 30% on Law and 35% on each of two subjects selected in advance by the candidate from Advanced Graduation, Retirement Plans, Agency Problems, Group Insurance, and Social Insurance.

The objections to this form of examinations have continued to be voiced. Some felt that students working for companies doing no group business were automatically discriminated against. It was suggested to add a topic, Advanced Selection of Risks, to attempt to make up for this. The anomalous position of Advanced Graduation has frequently been commented upon. But the real trouble came with the marking of the first examination to be given on this basis. The average grades in the different optional subjects varied over a large range. Did this mean that the papers were of varying difficulty? If so, could the mark on the Law paper be used as a common denominator, and what marking adjustments would be most equitable? Chairmen of the operating committees who have had charge of this examination should be eligible for a special decoration.

As has been announced, we are ready to call quits and return to the old system. This we think is now feasible because the tremendous reading

lists are rapidly being consolidated and will soon be issued in study note form and, it is hoped, ultimately as monographs or actuarial studies. Advanced Graduation will be dropped. It is distinctly a specialty, and it is doubtful if research will suffer at all from this action. The student who is particularly interested in this abstruse subject is almost invariably one who has it in his bones and doesn't need an examination to coax it out.

The new examination will feature Law, Retirement Plans, Group Insurance, Social Insurance, and to a somewhat lesser degree Agency Problems, since the literature on this subject is not nearly so well developed. The decision to eliminate the options was practically unanimous. All of the men who have worried about this problem for the past five years are relieved that it has been possible to take this step and are grateful to those whose literary drudgery has made it possible.

THE EDUCATION AND EXAMINATION COMMITTEE

No account of the examinations would be complete without a description of the way they are handled. The Beers Committee wrote three reports, in 1943–1945, embodying the suggestions which have greatly changed the examinations themselves. As early as 1943 the Educational Committee discussed the desirability of a centralized committee to handle all matters pertaining to the education and examination of students. They recommended working with the Beers Committee to explore the field. A subcommittee went to work in 1945; it proposed a new method of handling the examinations, which took form as the present Education and Examination Committee. Formerly these two functions were handled by separate committees. The Educational Committee decided the syllabus, the Examination Committee set and marked the questions. A Problems and Solutions Committee published the answers to the early examinations and indications of suitable methods of solution. There was also a Committee on Actuarial Studies, the work of which was incorporated in the new committee.

A serious weakness of this system was that the Educational Committee never learned anything from the examinations, since they never saw the candidates' papers. Furthermore, the grading of papers was done by a miscellaneous aggregation of men who in many instances had no special understanding of some of the questions. Too often they considered service on the committee a worthy chore but, after all, primarily a chore.

Under the present system, which started with the preparation of the 1947 examinations, the various committees were merged and what might be called a vertical organization was established. Each member of the Committee is assigned one subject on one examination, for example, Gross

Premiums on Part 6. One other member is assigned to this subject and the two work as a team. They start the examination year by bringing the study notes and model solutions up to date; later, they propose questions in their specialty for the examinations; finally, they mark the papers. In addition to this routine cycle, they are expected to make suggestions for improving the system; for example, to indicate where monographs or actuarial studies are necessary. They may also be asked to prepare or contribute to monographs, in fact, to work on any problem that shows up in their field. I do not know a man on the Committee who does not take great pride in his work. Marking papers is still a chore but, instead of being cogs in a large and mysterious wheel, the men are now really examiners in a specialty. They are in a position to learn from the examinations how to improve the papers. They are encouraged to take over as experts, and the results have been extremely gratifying.

This general pattern is followed on all the examinations beyond Life Contingencies. On the Life Contingencies Examination the specialization outlined is not useful or necessary. There is an Operating Committee in charge of all three preliminary examinations, whose functions have been described. Thus there are six operating committees, each with a chairman who is in general charge. These operating chairmen supervise the work of their committees. Each year their work culminates in making final readings of such of the borderline examination papers as need them, tabulating the examination marks and recommending a passing grade.

The top brass consists of a General Chairman, an Education Chairman and Examination Chairman, together with their three assistants: Vice-Chairmen for Readings, Panel Notes, and Examinations, whose duties are indicated by their titles. In addition to the working members of the Committee, there is a series of experts in the various fields covered by the examinations who have agreed to serve as consultants in their specialties; they assist the members of the operating committees when called upon.

While I have been primarily concerned with the development and administration of the examinations, a few words outlining the other functions of the Committee may not be amiss. These fall to the Education Chairman and his two assistants. Each part of the course of reading is constantly studied. We have a definite policy of rounding out the reference material. As the reading list on a subject grows larger, some orientation and consolidation is attempted through the study notes. When the number of references has multiplied to such an extent that the student begins to have real difficulty, we project a monograph or actuarial study which will to a great degree take the place of the long, unwieldy list.

The general scope and performance of the Committee is watched over

by an Advisory Committee, which assumed the duties of the Beers Special Committee when it disbanded in 1946. This committee consists of the three top men of the Education and Examination Committee, *ex officio*, together with three or four other members.

Meetings of the full Education and Examination Committee are regularly held in the fall at the same time as the Society's meeting. These gatherings have been well attended, and, I believe, are an essential part of the system. A general discussion of all aspects of the educational program and the examinations starts before dinner and continues far into the night. All members of the Committee are encouraged to take part, to criticize, make suggestions, even just to blow off steam or bait the brass. Each discussion has uncovered a number of situations that needed seeing to, and these have subsequently been thoroughly explored in the proper quarters. A great many of the improvements in our system have been direct results of these free-for-alls.

In addition to these general meetings, the operating committees meet from time to time as the need arises. The general chairman and the vice-chairmen keep in close touch and have frequent meetings. Most important are the ones where passing marks are determined. Occasionally there are meetings with the Advisory Committee.

As a result of the new dignity of the Committee members, the morale of the Committee is at a high point. From having to cajole, threaten and browbeat young men into serving on it, the situation has so far reversed itself that a waiting list open to all interested Fellows is now maintained. This is not only a healthy sign in itself but very fortunate in that it is becoming possible to diversify the Committee to an increasing extent—geographically, by size of company, by age, etc. Ideally, a recent Fellow should plan to serve at least three years on the committee so as to be of maximum usefulness and to get the most out of the experience himself. The operating chairmen and the higher echelons are recruited from the experienced Committee members. An interested, active Committee, well diversified as to origins and with a low but definite turnover, will go far toward keeping up with the problems we constantly face and finding the solutions most useful to our Society.

UNFINISHED BUSINESS

The major problem which lies ahead is the establishment of effective statistical methods of evaluating what the examinations are accomplishing. A comprehensive record system has been started by means of which we will be able to follow individual students or groups of students from their first registration through the entire series of examinations. Various studies suggest themselves: what the first examination really proves

which examination should be the hardest, etc. Extensive investigations have not been attempted because of the distortions of the war years. Now that these have just about worn off, we have organized a special section of the Committee to be in charge of all statistical studies. Such studies probably will be confined to the performance of students who registered for a preliminary examination in 1947 or subsequently.

Other methods of following up the examinations are also contemplated. Mention has been made of the cross-check with the colleges to ascertain what grade of students is passing the General Mathematics Examination. We are trying to develop some sort of system for making a corresponding check with employers during the first few years of the students' careers.

An aspect of the present examinations that is being seriously questioned is the practice of holding examinations twice a year. This originated as a postwar measure; we wanted to enable the men returned from the armed services to catch up as rapidly as possible. Informal polls of groups of students have been taken during the past year to ascertain how they feel about continuing the system. Opinion seems to be rather evenly divided, with a slight majority in favor of making it a permanent feature.

However, there are several points against it. For one thing, the marking of the November examinations conflicts with the heavy year-end work in the life insurance companies and puts an unreasonable burden on the committee members who handle it. The resulting delay in reporting the results to the candidates often dislocates their study programs. More serious are the complaints we keep hearing from the older actuaries that the students spend so much time on their examinations and pass them so rapidly that their practical experience suffers. The accelerated program tends to produce Fellows whose views are too much on the theoretical side and who need a year or two of further practical experience before they are up to the well-rounded standards of past years. It is contended that if the annual examination schedule were restored, students would be better able to pursue the theoretical and practical sides of their education at the same time. Not the least of the benefits of such a program would be the reduction in study hours and its consequent let-up of pressure.

The time has about come for us to take a definite stand, and we would greatly welcome a broad expression of opinion.

In connection with the earlier examinations I referred to our rather unfortunate relationship with the teaching profession. The following is quoted from a letter received by the Beers Committee some years ago:

"Now, in the case of the actuarial profession, there has occurred during the past twenty or thirty years, almost a complete divorce between those

practicing the profession and those training young men for the profession. The relationship which does still exist is more of the nature of a number of personal friendships between actuaries of large insurance companies and professors at some of the colleges and universities over the country, this friendship being used largely for the purpose of getting young men interested in actuarial work and trained to take the first few actuarial examinations. This relationship does not seem to extend to a good solid professional level. Joint meetings and discussions between actuarial groups and college or university groups are rarely held for the purpose of presenting and discussing technical problems, teaching problems, and other matters which are of mutual interest to actuaries and teachers of actuarial science. One almost never sees references in mathematical or statistical journals as to what is going on in the actuarial world, and rarely any references in actuarial journals as to what is going on in the field of college training of men for the actuarial profession. It seems to me that unless a closer liaison can be worked up to the professional level, between the actuarial profession and the mathematical and statistical teaching profession, there is likely to be an increasing danger that the actuarial profession will lose more and more of its share of intelligent, imaginative and enterprising young men. These young men will simply be siphoned off into those professions for which such liaison does already exist, or will surely be established after the war.

"The question that naturally forces itself at this point is how can this ever-widening gap between the actuarial profession and the mathematical and statistical teaching profession be reduced? I do not believe it can be narrowed down unless there is some cooperation between the organizations representing these two groups in the form of (1) joint meetings for presentation and discussion of technical papers and other matters of mutual interest and (2) joint committees for studying problems of mutual interest (particularly the training of actuaries)."

To me this provides considerable food for thought. I urge the members of our Society to give serious consideration to strengthening our relationship with the mathematics profession.

* * *

I have tried to remove the mystery from our actuarial examinations. Since these examinations form the basis of deciding who is to be called an actuary, this is a matter of great concern to all of us. The Education and Examination Committee has no desire to hand down decrees from an ivory tower. It is true that we have an Advisory Committee charged with the responsibility of general supervision, but it seems to me that the ex-

aminations are so important that all of our members should be interested in making sure we select the right kind of men for the profession. I hope that this history of the last decade will stimulate general discussion and produce suggestions and criticisms enabling us to maintain the finest possible examination system.

APPENDIX I

RESULTS OF THE ACTUARIAL EXAMINATIONS, 1939–1949

OLD PRELIMINARY EXAMINATIONS

YEAR	NO. OF CANDIDATES	NO. SUCCESSFUL	RATIO	EFFECTIVE RATIO*
	Part 1—Algebra			
1939	483	28	6%	28%
1940	437	71	16	24
1941	385	68	18	25
1942	289	87	30	38
1943	114	28	25	33
1944	95	31	33	42
1945	87	16	18	29
1946	216	71	33	43
	Part 2—Calculus and Finite Differences			
1939	396	61	15%	23%
1940	344	62	18	25
1941	293	57	19	26
1942	230	81	35	41
1943	88	29	33	41
1944	49	18	37	43
1945	74	23	31	37
1946	153	47	31	39
	Part 3—Probability and Statistics			
1939	357	102	29%	34%
1940	282	75	27	33
1941	212	56	26	31
1942	178	82	46	51
1943	67	28	42	47
1944	54	21	39	53
1945	45	20	44	50
1946	112	33	29	33

* Ratio of successful candidates to those receiving marks of 30 or more.

NEW PRELIMINARY EXAMINATIONS*

Year	No. of Candidates	No. Successful	Ratio	Effective Ratio†
	Part 1—Language Aptitude			
1947	704 English 11 French	465 8	66% 73	66% 73
Total	715	473	66%	67%
1948	664 English 6 French	410 3	62% 50	62% 50
Total	670	413	62%	62%
1949	759 English 7 French	459 4	60% 57	60% 57
Total	766	463	60%	60%
	Part 2—General Mathematics			
1947	628 Whole test 5 First half 92 Last half	193 4 66	31% 80 72	38% 80 73
Total	725	263	36%	44%
1948	771 Whole test 1 First half 33 Last half	181 1 11	23% 100 33	27% 100 33
Total	805	193	24%	27%
1949	938	203	22%	25%
	Part 3—Special Mathematics			
1947	223 Whole test 22 First half 56 Last half	51 11 42	23% 50 75	29% 58 76
Total	301	104	35%	42%
1948	388 Whole test 11 First half 19 Last half	81 4 2	21% 36 11	25% 36 12
Total	418	87	21%	24%
1949	502	91	18%	23%

* During the two transition years partial credits were allowed students who had passed old-style preliminary examinations.

† Ratio of successful candidates to those correctly answering at least half the number of questions corresponding to the passing grade. There is no significant difference for Part 1 because of the low passing grade.

INTEREST AND LIFE CONTINGENCIES EXAMINATIONS

Year	No. of Candidates	No. Successful	Ratio	Effective Ratio*
	Old Part 4—Interest			
1939	214	56	26%	33%
1940	174	45	26	31
1941	176	44	25	32
1942	142	98	69	74
1943	69	20	29	37
1944	58	30	52	55
1945	62	29	47	52
	Old Part 5—Life Contingencies			
1939	121	32	26%	34%
1940	128	34	27	35
1941	121	30	25	34
1942	104	30	29	36
1943	81	29	36	41
1944	59	30	51	51
1945	51	17	33	40
	New Part 4—Interest and Life Contingencies			
1946	35 Whole test	14	40%	47%
	110 Life cont.	54	49	54
	3 Interest	2	67	67
Total	148	70	47%	53%
1947	86 Whole test	37	43%	51%
	82 Life cont.	27	33	42
Total	168	64	38%	46%
1948	157 Whole test	33	21%	33%
	54 Life cont.	14	26	39
Total	211	47	22%	35%
1949	217	71	33%	43%

*Ratio of successful candidates to those receiving marks of 30 or more.

LAST ASSOCIATESHIP EXAMINATION
(Part 6, 1939–1945; now Part 5)

Year	No. of Candidates	No. Successful	Ratio	Effective Ratio*
1939	158	43	27%	33%
1940	137	39	28	35
1941	99	21	21	30
1942	93	30	32	42
1943	55	11	20	27
1944	55	16	29	34
1945	63	19	30	39
1946	235	63	27	29
1947	231	87	38	40
1948	197	96	49	52

* Ratio of successful candidates to those receiving marks of 30 or more.

FELLOWSHIP EXAMINATIONS

Year	No. of Candidates	No. Successful	Ratio	Effective Ratio*
	First Fellowship Examination (Part 7, 1939–1945; now Part 6)			
1939	94	27	29%	33%
1940	95	29	31	32
1941	87	27	31	34
1942	70	25	36	40
1943	37	16	43	46
1944	28	13	46	46
1945	34	18	53	56
1946	96	45	47	47
1947	118	59	50	51
1948	126	49	39	40
1949	118	49	42	44
	Middle Fellowship Examination (Part 8, 1939–1945; now Part 7)			
1939	81	21	26%	30%
1940	81	22	27	28
1941	90	26	29	32
1942	77	30	39	41
1943	49	17	35	35
1944	39	15	38	41
1945	41	23	56	58
1946	96	50	52	55
1947	102	46	45	46
1948	123	65	53	54
	Last Fellowship Examination (Part 9, 1939–1945; now Part 8)			
1939	57	15	26%	30%
1940	66	17	26	27
1941	63	17	27	28
1942	65	22	34	36
1943	44	17	39	39
1944	37	18	49	49
1945	37	22	59	59
1946	86	37	43	44
1947	97	42	43	44
1948	99	43	43	44
1949	106	43	41	42

* Ratio of successful candidates to those receiving marks of 30 or more.

APPENDIX II

Special Committee on the Education and Training of Actuaries, etc. (1942–1946):

H. S. Beers, *Chairman*
F. B. Gerhard
H. R. Lawson
W. O. Menge
E. H. Wells

Supervisory Committee for Preliminary Examinations (1943–1946):

H. S. Beers, *Chairman*
G. W. Fitzhugh
F. B. Gerhard
J. R. Herman
H. R. Lawson
W. O. Menge
C. A. Spoerl

First Education and Examination General Committee (1946):

J. R. Herman, *General Chairman*
F. B. Gerhard, *Education Chairman*
C. A. Spoerl, *Examination Chairman*
H. R. Lawson, *Vice-Chairman for Readings*
M. D. Miller, *Vice-Chairman for Panel Notes*
V. E. Henningsen, *Vice-Chairman for Examinations*

First Advisory Committee (1946):

H. S. Beers, *Chairman*
E. M. McConney
E. H. Wells
F. B. Gerhard, *ex officio*
J. R. Herman, *ex officio*
C. A. Spoerl, *ex officio*

APPENDIX III

Examples of Problem Types

The first three are taken from the article in *The College Board Review* referred to in the text (Vol. 1, No. 2, page 29). The fourth is quoted in the *Journal of the American Medical Association*, Vol. 138, No. 4, page 258.

1. Old style type—

   This type of problem is designed to measure performance of a connected series of operations. The amount of credit received by the candidate for each problem depends upon the reader's judgment of the completeness and accuracy of the candidate's solution.

   Two guns are fired at the same instant and an observer hears the report of the guns 3 seconds and 5 seconds later. The angle at the observer's eye subtended by the distance between the guns is 38°43′. How many feet apart are the guns? (Assume that sound travels 1100 feet per second.)

2. Open answer type—

   In this type of problem, the candidate is given full credit if his final answer is correct, and no credit if it is wrong.

   A car travels from N to P at an average rate of r miles per hour and returns from P to N at an average rate of t miles per hour. What is the car's average rate for the whole trip? _____m.p.h.

3. Multiple choice type—

In this type of problem answer-options are given. The incorrect answer-options are based on the most popular wrong methods of solution adopted by students. As an example of the "multiple choice" type, the foregoing "answer only" problem is presented below with answer-options.

A car travels from N to P at an average rate of r miles per hour and returns from P to N at an average rate of t miles per hour. What is the car's average rate (in miles per hour) for the whole trip?

$$(A)\ \frac{r+t}{2rt} \qquad (B)\ \frac{2}{r+t} \qquad (C)\ \frac{r+t}{2} \qquad (D)\ r+t \qquad (E)\ \frac{2rt}{r+t}$$

4. Multiple choice type—

A physician, 76 years of age, had diabetes for many years. He received 20 units of crystalline zinc insulin daily in divided doses. He experienced sudden onset of impaired vision while he was reading the newspaper, with transitory confusion and disorientation. There was painful sensation above the right eye and tenderness in the right supraorbital notch. The examiner's finger was not seen as it came up on the left side of the face until it reached the midline; the patient perceived it at the usual location as it came up on the right or from above or below. The right optic disk was indistinct, while the left was normal in appearance. There were no other abnormal physical observations.

It is most probable that the syndrome described was due to:

1. A retrobular (arteriosclerotic) hemorrhage on the right side, involving the optic and supraorbital nerves.
2. Hemorrhage from a small aneurysm of the internal carotid artery just at the circle of Willis.
3. Rupture of a craniopharyngioma (Rathke pouch cyst).
4. Thrombosis of a branch of the right posterior cerebral artery.
5. Thrombosis of the cavernous sinus.

DISCUSSION OF PRECEDING PAPER

JAMES A. CAMPBELL:

My excuse for presenting a discussion of this paper must be that for some 18 years I was the examination supervisor in London, Canada and had an opportunity to observe the reactions of the students to the papers which they had to write and also to discuss some of their problems with them. During that time I may have become converted to some extent to the candidate's attitude toward the actuarial examinations.

However that may be, I enjoyed very much reading Mr. Spoerl's paper. He has an interesting style and a pungent turn of wit on occasion which makes his paper stand out as compared with the normal pedestrian level of mortality investigations and other actuarial specialties. I found Mr. Spoerl's explanations of the development of the new form of examinations very clear and logical, and in many respects I feel that I agree with what the Committee has been doing. Mr. Spoerl has, as he said, "tried to remove the mystery from our actuarial examinations." To the extent that we now know the passing ratio over the past 11 years he is undoubtedly correct, but there are still some mysteries which might be susceptible of explanation.

One of these mentioned by Mr. Spoerl himself is the problem of why graduates in honour courses in mathematics have had so much difficulty with our early examinations. It has always seemed to me that there may be two or three reasons for this. In the first place many graduates in mathematics completely underestimate our examinations and do not study for them. In the second place those who do study find it boring to go back to subjects they took in the first and second years at college. In the third place the difficulty in passing is an almost inevitable result of the form of our examination, consisting as it does of problems only. The typical university examination includes some straight bookwork. This means that the student who has honestly prepared himself goes into the examination room with a certain minimum of marks at his credit simply for the expenditure of the time to write the answers. On the remainder of the paper, consisting of problems, success on a little more than half the problems will probably produce a first class standing. When a student used to this kind of paper comes up against a paper as difficult as ours have been in the past, one which consists entirely of problems, his ratio of about 50% to 60% success on problems which gave him a good standing in his univer-

sity course leaves him with a failure. Obtaining about 70% to 75% success in a group of problems is more or less a matter of chance in the case of the average good student.

From this standpoint the substitution of the long examination with a large number of questions is definitely a move in the right direction. It is not quite so certain that the change to the multiple choice form of answer is an equally favourable feature for the candidate. If there is one question with 25 possible correct answers, as mentioned by Mr. Spoerl, then no doubt there are many questions with two or three possible correct answers, so that the student on the multiple choice examination has not only to find the correct answer, but has to get it into the form which has been chosen by the examiner. By the nature of the case this form is more likely to be abnormal than normal because of the necessity of making all the answers given reasonably plausible. This is not, of course, an argument against the use of the multiple choice examination, but merely a suggestion that the same set of questions given in the two different ways might produce somewhat lower marks on the multiple choice answer method than on the open answer method. I presume, however, that since the marking takes into account the actual range attained by the group of candidates, this is not too serious a matter.

However, it is a little disturbing to find the passing ratio on the second and third examinations diminishing consistently from 1947 to 1949. It would be interesting if Mr. Spoerl would tell us whether in the opinion of the Examination Committee this is simply a fluctuation or is due to changes in the examinations made by the Committee during that period.

One of the most puzzling parts of the record is the drop in the passing ratio for candidates who tried the whole of Part 4, from 43% in 1947 to 21% in 1948, and the subsequent rise to 33% in 1949. Mr. Spoerl refers to this and indicates that the 1948 examination was "distinctly on the hard side." He mentions that many candidates were badly prepared and I suppose that there was a certain amount of speculation on this examination by students who had passed Parts 1 and 2 but still had Part 3 to complete, and thought they might as well try Part 4 too.

With respect to Part 4 itself, a study of the examinations for 1947, 1948 and 1949 impresses one with the length of the questions. By this I do not mean the time which might be taken to answer them but the actual number of words which are involved in placing the question before the student. After all, this is a mathematical examination and it would seem that the editorial blue pencil might be used more freely so as to bring the questions within a limit which might be understood in a brief reading. On the 1949 examination there is one question which consists of 100 words all

in one sentence. The sentence is quite clear and understandable but it does require time to read and careful concentration. One of the old ideas about writing examinations was that it was desirable to read the whole examination paper through right at the beginning and then start with the question which seemed easiest. If all the questions are long and all are equally difficult this maxim is very difficult to follow.

I wonder whether this point does not explain to a very large extent the difference between the examinations of 1947 and 1948 for Part 4. In the 1947 examination the morning paper started off with three very straightforward questions which every well prepared student should have been able to handle. In other words, everyone started off well. Similarly, the first question in the second paper, while considerably longer, was quite straightforward.

In the 1948 examinations the first question in the first paper was really not too difficult but it was long in appearance and required concentration, while the first question in the second paper was also long and required a certain amount of ingenuity to work out the most satisfactory method of attacking it.

I have a feeling that a good many examination failures occur in the first half hour of the examination when the candidate is unsuccessful with the first question which he chooses to attack and becomes somewhat panicky with the thought of the time he has lost without achieving any results. As a consequence he does not do full justice to the preparation which he has made. It is my understanding that in examinations with a large number of questions, such as those set for Part 2 and Part 3, there is a progression from relatively simple questions at the beginning of the paper to more and more difficult questions as the paper goes on. In other words a sort of warming up period is provided for the candidates. Perhaps the Examination Committee might consider the same kind of arrangement for Part 4 and the later examinations. This could be done by providing one or two straightforward questions which a thoroughly prepared student should be able to answer. The other questions on the paper may be as difficult as the Examination Committee deems desirable and the present standard might still be maintained.

There is another point about the Part 4 examination of 1948 which it seems might be considered rather carefully. There are several questions in the Life Contingencies section of this examination where the answers must be expressed in a specified form or conditions are laid down as to the tables available. There has always been a question in my mind as to the suitability of such questions in later actuarial examinations. After all, these may be considered to some extent as postgraduate examinations

and we are really interested in finding out whether the candidate has a sound knowledge of life contingencies and other subjects on the syllabus and not particularly in whether he happens to remember a specified method of achieving certain results. So long as the result is accurate it seems to me that our objective has been attained. I realize that this may make things very difficult for the examiner, but frankly in any contest between the examiner and the candidate I find myself on the side of the candidate.

So far as examinations 5, 6, 7, and 8 are concerned, I do not think I have much comment to make. The passing ratio on these examinations has to be mentally adjusted a little for speculative tries. There are probably a good many students who prepare themselves thoroughly for one examination and superficially for another in the hope that they may happen to strike an easy paper. I must admit that I did the same thing myself on one occasion. If we knew how many of these speculative attempts there were we might find the true passing ratio to be as high as 75% where I think it might reasonably be for examinations 7 and 8. This is a professional course and as it approaches completion the probability increases that the candidate is a suitable person to become a Fellow of the Society and, like other professional courses, some of the later examinations may be drawn up in the knowledge that a very large proportion of the candidates will probably pass.

The actuarial examinations have one encouraging feature. It has been my own experience, and I think perhaps the general experience as well, that anyone who passes the examination dealing with probability, finite differences and statistics has a very excellent chance of at least attaining the rank of Associate. As a matter of fact practically all of them eventually reach the Fellowship level. This is an indication that while minor changes may be required in the examination syllabus and methods from time to time, fundamentally there is not a great deal wrong with our examination system.

LYLE H. BARNHART:

After reading Mr. Spoerl's paper one can definitely appreciate the various problems confronting the Education and Examination committees in the effort to attract qualified students into the actuarial profession without lowering the high standards of the examinations.

The statistics of Appendix I indicating the ratio of the number of successful candidates to the number of candidates should be of some satisfaction to students. Heretofore after each examination there have been rumors as to the passing percentage, but in general the student has

not had these figures. I believe it desirable to publish annually in future Year Books such statistics regarding results of the examinations for the current year.

From the point of view of those who failed, Appendix I might be considered a sort of mortality study. For example, on May 1, 1948 there were 211 candidates for the Part 4 examination. There were 47 successful candidates or 22% and 164 unsuccessful candidates. This group of failures may be segregated into those who did not study but took the examination just in case they might hit on the right questions, those who studied but had not had sufficient time to cover the syllabus and those candidates who had a complete and thorough knowledge of the syllabus but were unsuccessful.

Naturally one could not expect the first two groups to pass the examinations with insufficient preparation. But what of this latter group, most of whom were A students in their college mathematics. Time after time such students present themselves as candidates only to find that the Examination Committee team had developed a new set of plays which the students' defensive team could not solve. Incidentally, it would be interesting to know if the divorce rate among actuarial students is higher than that of the general population.

The reason for such failures should be carefully examined by the various actuarial committees concerned with the subject of actuarial training.

One reason for the failure of such students is that they lack the "puzzle" instinct of being able to solve the unexpected within the time limits of the examination. However, students lacking in this characteristic are proving to be quite successful in their actuarial pursuits since real problems are not solved under examination conditions.

Another reason for the failure of such students is the lack of the right kind of training. Continuous practice in the right kind of problems will offset the absence of the "puzzle" instinct mentioned in the first reason above.

Actuarial examinations are often based on intricate details which obscure the main point at issue. Except in our so-called actuarial schools, mathematics in this country is based on mere applications of the theory not requiring a student to memorize intricate details.

Since too few of our students obtain proper training in their college courses, this training must be obtained by home study after college.

It is encouraging that the Educational Committee is continuously preparing organized material for study. It is probable that when this organized material is completed the average students, who are energetic, will pass their examinations with greater frequency than at present.

Since my most recent experience has been with Parts 4 and 5, my comments will be confined to these examinations.

It seems to me that the Part 4 syllabus is the minimum requirement for the examination, rather than an average or maximum requirement. It may be suitable if the student has had a thorough college actuarial course or has tutoring in his studies after college.

Life Contingencies by Spurgeon is the essential authority, which we have, on actuarial mathematics and is designed to make the student's path as little thorny as possible. However, the book is lacking in Statistical Application of the Mortality Table, lacking in procedure on Construction of Tables and lacking in the procedure of unraveling probabilities. These are some of the deficiencies which result in nervousness in the examination room which proves disastrous.

Mathematics of Investment, by W. L. Hart, is entirely too elementary for the average student. The student who thinks he is prepared for the examination can usually solve readily all of the problems in the book and an overconfidence is thereby created. However, this overconfidence is easily erased by the immediate shadow which is cast on the student's face as a result of the first view of the examination questions.

The working of solutions of past examinations is helpful, but this is not enough.

Due to these deficiencies a number of us found it necessary to expand the syllabus to include a now discontinued British correspondence course known as the Marples Classes.

Previous to World War II the Marples Classes were available in North America. There has been no agent in North America for this correspondence course since the war. However, there are a few copies still available. This course is of much value to the untutored student as it provides some of the techniques and thorns which confront the student on the examination.

In my opinion some of the techniques provided by this course should be made a part of the syllabus.

The introduction of panel notes including Mr. Miller's *Monograph on Graduation* has greatly facilitated the studying for Part 5. However, the syllabus for Construction of Tables from the Records of Insured Lives does not appear to provide practical principles which enable one to proceed with ease when one is confronted with a problem in which the data are not normally segregated. This is especially true with those of us who work for a small company and who may never have much experience along the lines of constructing such tables. However, presentations on this subject by Mr. Duffield (*RAIA* XXXVII) and Mr. Beers (*TASA* XLIV)

greatly clarify many points on this subject. These papers are not a part of the syllabus, but they do provide the missing link.

I will close this discussion with the following comments:

Our examinations are greatly influenced by British practices, either directly or indirectly. The solving of exceedingly intricate problems is a characteristic of the British examinations. These questions suit the British student since he is taught that way. In general they do not suit the American student because the majority of college teachers don't teach that way. They teach application of theory without the intricate details.

Since the colleges in general provide inadequate training, the professional actuarial training is at present obtained almost exclusively by home study and in the office of a practitioner. Previously this was a characteristic of the professions of medicine, law, and engineering. We know that students of the latter three professions are now adequately trained in properly supervised universities. Therefore, wouldn't it be constructive for the Society of Actuaries to similarly arrange actuarial schools which are sanctioned by the Society of Actuaries?

ROBERT J. KIRTON:

I should like to offer some verbal comments, as I have not prepared a written discussion. What I have to say may be divided into three parts, rather like Caesar's Gaul. I want to say a little bit about what the Institute of Actuaries has been doing in the last few years, to offer one or two comments on Mr. Spoerl's paper, and then to say something about subsection 1 of informal topic 7, "Is the current rate at which actuarial students are entering the profession sufficient to meet the probable future demand for actuaries?"

On reading Mr. Spoerl's paper, the first thing that struck me with amazing clarity is the almost exact parallel of the problem you are seeking to solve, the trend of your thoughts during the war years, and what we have been doing on the other side. The parallel is exact even to the fact that in the interwar period we had that average time for passing, eleven years.

I know quite well that is a very heterogeneous factor, between the brilliant who take four years and others who take up to twenty and even thirty years.

The action taken by the Institute of Actuaries was to appoint in June 1944 what we know there as the Lever Committee. That is a very high-powered committee with practically all our best men serving on it. The problem we were seeking to solve was just the same as you are seeking to solve, to decrease this figure of eleven years.

Now, sir, if I may come to where we diverge: We face the same problem, but we diverge in our treatment of it. We have introduced two things into our new syllabus which is gradually coming into force; we are giving statistics a more formal treatment, and we are introducing an economic background into our investment part of the syllabus. But, on the other hand, we are removing some of the more complex questions in certain subjects. We are adopting what we have called a progressive approach, which means, instead of teaching a student all about—say—compound interest, then life contingencies, then other matters, the subjects move forward hand in hand and we are hopeful that it will prove to be an easier path for the student by which to acquire knowledge.

We are also adopting specialized emphasis in our final examination. Having insisted that the student should be grounded in all phases of the work, we let him elect to take the final paper in life assurance subjects or in pension funds, friendly societies and social insurance or in advanced statistics; in other words, a general grounding, but a specialized emphasis on his final.

We try, sir, to give our students three half days off a week for study. I am afraid that falls to the ground when the pressure of work becomes too heavy in the midwinter and in the summer holiday season. A lot of us are striving hard in the organization of our offices to give the student a chance to do work other than late in the evening when he is tired.

The last thing I mention here is the most important contribution. We are rewriting the complete set of textbooks to cover everything except the final. Only in the final will the student have to dig and delve among original papers and discussions. I think there are textbooks in about twelve subjects being written, some of them in two volumes. It is a monumental task, but I am hopeful this will be helpful to the students and we do feel in England our profession should have a complete series of textbooks.

The medical profession, for instance, doesn't study from a set of papers that were not primarily arranged for the purpose of study.

Now I would like to touch on the selection of students. I think we all want to avoid the "stik it" actuary. We examined the problem of aptitude tests and set up a special committee to deal with that subject. What we failed to find was this: While you can test by mathematics a 17- or 18-year old boy's analytical ability, he may lack the synthetic constructive ability which he will require for the later parts of the examination. While we could find aptitude tests which would test the immediate quality of a man, it is very difficult to think of tests which will test what a growing youth will be in four years' time.

I think, for myself, I would rely mostly on the interview, where the

student comes forward, wishing to join the Institute of Actuaries. He has to be sponsored by two of our members and I feel that a very heavy burden lies on those members to satisfy themselves that he has the mental ability and strength of character to go through with what, after all, is a very stiff examination.

Now, if I may turn, sir, for a moment, to Mr. Spoerl's paper, I have read that with absorbing interest. I wish I could have reread it and digested it thoroughly. The thing you would expect to strike me most forcibly did so—the short answers to short questions. I was impressed by Mr. Spoerl's support of this idea, but what worries me is this: That approach may be all right for many professions, but in our profession for an actuary to be fully qualified, he has to be able to write a report, a logical report, well balanced and well developed, and I feel, when he comes to the latter parts of the examination, when he must answer that sort of question, he may get a bit of a shock if he has only had to put down the short answers or even just indicate the choice among a number of put-forward short answers. I am a little worried there.

I think it may do for some professions where the report-writing problem does not come up so acutely.

The other point I wish to comment on is the closer integration with the teaching profession, but I will deal with that matter when I come to the informal subject 7.

We at the Institute have amateur examiners, I am afraid!

We are dropping the half-yearly examinations. We feel it is an immense burden on our young manpower, the best of our young manpower, in setting and correcting the papers. They have served their purposes in giving the returned serviceman the opportunity to get there quickly by hard work. They are showing signs of encouraging students to "have a go" when they were quite insufficiently prepared.

Now, turning, sir, to topic 7, the current rate at which actuarial students are entering the profession, the experience of the Institute may be of interest to you. In the middle 1930's our intake of students at home was about 125 per annum. That dropped in the immediate postwar years to 70. We took a certain amount of action. We published two leaflets, one for schoolmasters and one entitled, "Would you like to be an actuary?" for schoolboys. A number of us have gone down to various schools in our country and given talks and lectures to senior boys at those schools. We are improving our *liaison* at the universities at the moment, and now our intake is back to our prewar level and is, in fact, slightly exceeding it.

The quality compared to prewar level, due to the fact that a greater number of boys now go to university in England, is, I think, improving—

a rather more widely educated group ranging from university graduates down to people who take the school certificate, which is our minimum, with the weight lying perhaps a bit below the degree standard.

As regards what our fellows do, there is a significant trend toward our fellows going overseas, mainly to take up employment in overseas insurance companies and government service. Based on that, I attempt, sir, to answer the question which is posed by subsection 1 of this subject. The forecast of the Institute is more than usually difficult. The home demand of British life offices may be stationary at 275 to 300 actuaries, but, under the new syllabus which I have just discussed with you, I suppose we must hazard a guess that we might get 30 new fellows every year at the end of 6 years, and, allowing for wastage by death and retirement, we might hazard a guess that that will provide an annual increment of about 20 new fellows, which is rather less than double prewar. The greater part of the balance will be absorbed outside home life insurance—in local government, transport undertaking, commerce, and so on, which are all tending to acquire actuaries in our country for various reasons. Those figures are a guess.

Well, sir, if I may conclude, I think it is absolutely vital for the future of our profession that our examinations should take less time to qualify, that we should teach the student width; they should stimulate and not narrow. I think mutually, sir, we should watch the progress of the results of our two bodies over the next five or ten years and I think we can most hopefully learn from the results of each other.

WILLIAM B. WAUGH:

Mr. Spoerl is to be congratulated for his very fine report of the work of the Examination Committee. It is particularly interesting to those of us who have been writing the examinations during the period covered by the report, and my views here represent one such student's reactions to this paper.

The one Educational Testing Service Examination that I wrote sold me completely on the short answer type of paper. What impressed me most was that it reduced mere memory work to a minimum. As Mr. Spoerl mentioned, a great fault of the previous early examinations and still a fault of the present examinations is that type of question which requires the student to reproduce from memory small, often obscure sections of the reading. A typical example from an old finite difference paper would be "Develop Lubbock's Formula." To prepare himself for this question the student must memorize every formula and proof in the book, for it is unlikely that many students could prove Lubbock's Formula

from scratch, even if they knew what Lubbock's Formula was, and that requires quite a chunk of memorization itself. The new examinations might cover the essential steps in such an involved proof by a few short questions, and in the time so saved cover many other important sections of the work, the student's knowledge of which would not be tested by knowing the proof of Lubbock's Formula.

I believe that most students would give three hearty cheers if short multiple choice questions were extended to the later associateship and fellowship examinations. Anyone who has committed to memory 13 misleading deductions that can be drawn from mortality statistics, 7 essentials of a valid contract, hundreds of unimportant facts concerning obsolete mortality tables, and all the items on the first 5 pages of the convention blank, will realize how much time could be saved if the student did not have to remember the correct answer, but had only the far less exacting task of recognizing it. I feel that the difference between the two operations is tremendous. To recognize the correct answer requires only an understanding of the subject, but for the present detailed type of question a student who understands the work has only begun to study. Fully two-thirds of my time was spent in methodically memorizing table after table of facts that might be asked by some unkind examiner. In many cases the examiner did ask me to reproduce certain of these facts, and presumably I received a much better mark for having memorized them, but I doubt that I will be a better actuary for having done so.

However, this situation is not the fault of those setting the questions. Under the present type of paper consisting of a few, long, comprehensive questions, certain articles on the syllabus lend themselves only to the detailed type of question which I have been criticizing, and the examiner must set such a question or none at all. If a section of the paper consisted of numerous short questions of the multiple choice type, these articles could be covered adequately and far more completely, while cutting down the amount of preparation required by the student. Such a paper would have all the correlative advantages which Mr. Spoerl has outlined in his paper.

The committee is intending to experiment with Part 4 by putting half the paper on a short question basis, and half to remain as at present. I would like to see the same experiment carried out in the later parts, with those sections of the course which are primarily detailed in type being covered by short multiple answer questions, with the rest of the paper devoted to broad general questions which may be necessary to show a student's over-all knowledge of the subject and his ability to organize the work.

I am pleased that the Education and Examination Committee has revealed percentages and number passing, but the why and wherefore of those percentages and numbers is still a mystery. Perhaps enlightenment here is asking too much, because, after all, such facts are not made public by any society. However, I am surprised that the percentage passing Part 8 seems to stay stubbornly in the neighborhood of 40%. When a man has successfully navigated all but one examination, I should think he should be given a better than 40% chance of getting the last one. Perhaps when the committee's extensive statistical studies are completed we may reach the happy stage of having most of the failures early, and passing upwards of 75% on the fellowship parts.

It is interesting to note that a reason advanced for returning Parts 5 and 7 to the spring is that students pass the examinations so rapidly that they have not enough practical experience. Such a remark shows clearly that the Special Committee has had a large measure of success in its objective "to suggest steps which will enable qualified students to complete the examinations in fewer years."

ZEHMAN I. MOSESSON:

Mr. Spoerl has written a paper which is both instructive and entertaining. He has taken a great deal of the mystery away from the actuarial examinations. For this actuarial students owe him many thanks. Certainly this paper should help to raise the morale of students who read it and realize the painstaking care with which Mr. Spoerl and his associates have approached the task of setting and grading the actuarial examinations. I am almost sorry that my own examinations are behind me and that I can no longer benefit as a student from Mr. Spoerl's excellent paper.

If at some future time the Education and Examination Committee feels it is possible to indicate what the passing marks have been on past examinations, I believe this information would be valuable to the students.

Mr. Spoerl has made an eloquent plea for strengthening our relationship with the mathematical profession. I should like to report to you that some progress has recently been made in this direction. The President of the Mathematical Association of America has appointed a committee of five members of the Association to prepare a pamphlet for college students majoring in mathematics in order to give them information about the opportunities open to them after graduation.

The Chairman of the committee is Dr. Mina Rees of the Office of Naval Research, who will write the section on "Positions for Mathematicians in Government." Professor H. W. Brinkmann of Swarthmore College will write on "A Career in Teaching." Professor S. S. Wilks of Princeton Uni-

versity will write on "Opportunities for the Statistician." Dr. S. A. Schelkunoff of the Bell Telephone Laboratories will write on "The Mathematician in an Industrial Laboratory." I am writing the section on "Actuarial Opportunities." The entire committee will pass on the pamphlet as a whole.

The really encouraging thing about the committee from the actuarial point of view is that the actuarial profession is not being neglected and is, in fact, being given equal "billing" with the other four sectors of professional opportunity. I hope that the pamphlet will be a further means of spreading knowledge of the actuarial profession. It should certainly strengthen our relationship with the mathematical profession.

W. RULON WILLIAMSON:

I will comment upon only two points, and will not attempt to tie these two comments directly into specific items in Mr. Spoerl's presentation.

The survival picture of our examinations inevitably suggests the civil service examinations in old China. They, too, were made so difficult that only a small proportion of the radix of the survival table ever completed them, and the final qualification occurred at such an advanced age, that the potential residual period of job-holding was brief. This might account for the traditional Chinese "squeeze," to make up for lost time—the squeeze that is today quoted as a major rationalization of the transfer to the "do-good-promises" of the communists. It may then be a sort of moral issue that led us to shorten our examinations, and it could well make us consider setting our educational process with less of the plucking technique of the ancient Chinese!

On the other side, the dropping of certain subjects—accident and sickness, money and banking, economics, for example—has taken place when we are direly in need of men to work in these precise areas, and the discussion of these things under our so-called "social security" programs faces a lack of trained men to advise our legislators. The discussion of insurance, savings, assistance and relief has had a decidedly Gilbert and Sullivan air. The modesty of our members may be becoming, but in their absence the bravado of those not at all actuarial has dire consequences.

We have not yet met the need of furnishing enough men in many fields which our British colleagues have considered essentially actuarial.

EVERETT G. BROWN:

It is with considerable reticence that I attempt to say anything regarding such an involved subject as Actuarial Examinations and my only justification for this effort is a viewpoint concerning our examinations

which I feel should be expressed. My views undoubtedly will be considered radical but it is my opinion we should not be too well satisfied with our progress to date.

I will very frankly admit that I could not pass Actuarial Examinations today and that this inability has extended over a long period of years. My viewpoint, accordingly, is based upon practical considerations which are of importance to our profession. I am sure others have had experiences similar to mine. You probably are not interested in ancient history, but a personal reference is necessary as a background for these remarks.

I was graduated from High School in 1911 and began work in a life insurance office immediately. I completed my last Fellowship Examination 10 years later in 1921 without the benefit of college or university training and with two major changes in companies and official position during the 10 year period. No one knows any better than I do what I missed by my inability to enjoy college training and I have never ceased to be somewhat ill at ease in the presence of Phi Beta Kappas and other brilliant students, particularly in the field of mathematics.

On May 1, 1921, immediately after I had completed my last Fellowship Examination, my company had $100 millions insurance in force. We now have $750 millions insurance in force not including Deferred Annuities which represent probably the equivalent of another $100 millions. My only purpose in quoting these figures is to indicate that with the growth of our business and increasing community responsibilities I have not had much time during the last 28 years to think about whether or not I could pass Actuarial Examinations. My interest in the examinations has been devoted almost exclusively to efforts to encourage promising individuals with interest or training in mathematics to enter the actuarial field and take the examinations.

The almost universal comment regarding our examinations by those who have tried them and by those who have seen them has been "they are too hard." In his paper Mr. Spoerl says, "We cannot afford to make our General Mathematics Examinations so difficult that we build up our old reputation again." With due respect to the Committees and the great amount of valuable work they have done, I do not believe they have gotten rid of the old reputation.

When the special committee set up its primary objective "to suggest steps which will enable qualified students to complete the examinations in fewer years" and its secondary objective "to attract a larger number of likely candidates to the actuarial profession," I felt we were on the right track.

Furthermore when the Syllabus was published with the following

statements, "This is a three-hour achievement examination based on the material usually covered in the first two years of mathematics in American and Canadian colleges and universities" and "This examination will normally be taken by the mathematically talented undergraduate at the end of his sophomore year, but it is not restricted to college sophomores," I thought we would soon see an accomplishment of the objectives of the Committee.

The question is "Have these objectives been accomplished?"

With the record of 1949 indicating that 60% of the candidates passed the Part 1 examination, 22% passed Part 2, and 18% passed Part 3, it would appear that candidates are failing at a relatively high rate. What is the reason? Are the candidates unprepared or are the examinations too difficult? As only the candidates are permitted to see the examinations we must base our conclusions on information which has come to us and in my case it has been to the effect that the examinations are too difficult and centered too much on problems of a special nature.

It is my information that Part 2 of the 1949 Examination contained 70 questions which must be answered in a three hour period. That means less than three minutes per question!

The Syllabus indicates that the examination "is based on the material usually covered in the first two years of mathematics in American and Canadian colleges and universities." I do not know how many college sophomores took the examination, but I imagine the number was relatively limited. Probably the examination was taken mainly by candidates who had completed four years of college and extra studies besides, and still only 22% received a passing grade. From the results, I am drawn to these conclusions: *first*, that the examination was not based on material covered in the first two college years; *second*, that the questions were even more difficult than anticipated by the candidates because the problems were of special nature; and *third*, that the examination was entirely too long.

I have the impression, both from Mr. Spoerl's paper and from other sources, that the Educational Testing Service may be using actuarial students as a testing field and, if so, I do not believe it is fair to these students. The results also seem to indicate something detrimental to students has occurred: 1947 Part 1 66%, 1949 60%; 1947 Part 2 36%, 1949 22%; 1947 Part 3 35%, 1949 18%. Has our group of candidates become less proficient or have the examinations been made more difficult?

We want mathematics professors of universities to prepare students for actuarial examinations. Is it fair to them to fail such a high percentage of candidates primarily because the examinations are based on material not covered by the college courses?

Is it fair to actuarial students to expect them to be proficient in the solution of special problems or, as a matter of fact, any problems in the short space of less than three minutes? Some of the solutions could not even be copied from books in three minutes if you had the book open before you at the proper place.

Some people will say I am talking heresy. Maybe I am, but I have almost convinced myself that it would be good for the Society if the first three examinations were dispensed with entirely. We should give adequate information to the mathematics departments of colleges and universities and all prospective candidates that thorough grounding in algebra, calculus, probabilities, finite differences, statistics, etc., is essential to success in Actuarial Examinations. We should then accept candidates for examination beginning with Part 4.

Would we have any more failures? I do not believe so, because there would be so much greater incentive to go to work in earnest. As it is now it takes two or three years of drudging preparation for the preliminary Actuarial Examinations after university work is completed before you can even begin to study life contingencies. Have you ever talked to prospective actuarial students and had them ask you how the mathematics required for Parts 2 and 3 is used in the daily operations of a life insurance company? Or have you ever had a new mathematics major just employed in your actuarial department ask you to point out the connection between integral calculus, finite differences, etc., and the recording of net and loading on premium cards or the reserves per M on valuation cards?

I think we should recognize the practical aspects of our work and help our students gain the proper perspective as soon as possible. This perspective comes after the student has spent his time studying life contingencies.

Mr. Spoerl says the question is: Should we stiffen up the General Mathematics Examination or resign ourselves to the using of the Life Contingencies Examination as the weeding out point? I think we shall find that the Life Contingencies Examination is the weeding out point regardless of what we do about the General Mathematics Examination or the Special Mathematics Examination. By keeping these mathematics examinations extremely difficult, as they appear to be at the present time, we may give our students the wrong impression; namely, that success with such examinations indicates that success can come in the Life Contingencies Examination without adequate preparation.

Can we enable "qualified students to complete the examinations in fewer years"?

Can we attract "a larger number of likely candidates to the actuarial profession"?

It is my opinion that it can be done by starting actuarial candidates with Part 4, which itself should be moderated somewhat in severity. Candidates should not be expected to handle involved purely theoretical or research problems in a six hour examination. They should be expected to know the fundamentals upon which they can build their knowledge as they acquire it in practice and in study for subsequent examinations.

If this plan should be adopted, it is a certainty that unprepared candidates will fail, but will the record be any worse in Part 4 than it has been in past years: 62% in 1947, 78% in 1948, and 67% in 1949?

The record should be better because there will be a new incentive for candidates to spend their time in very useful preparation without being forced to experience the delaying process now necessitated by our Preliminary Examinations. Furthermore, if candidates have made a mistake and find they cannot pass actuarial examinations, we shall still have made a contribution to our companies, because many of these candidates will make good employees in our actuarial departments or in other departments always seeking promising talent.

As our candidates complete their examinations, it is to be expected that their time will be occupied more and more by company problems, but even so those who are interested in advanced mathematics will continue their studies and investigations in this field.

With the growth of the companies and the organization of new companies, the need for actuaries and actuarial students is becoming greater each day. The Society can render a service to the companies and our profession by developing new actuarial talent. I think the way is open through a system of examinations "which will enable qualified students to complete the examinations in fewer years" and with less drudgery along the way.

In these remarks, heretical as they may be, I have suggested an examination procedure by which I think our purpose could be accomplished.

EDMUND B. WHITTAKER:

Some of the old-timers are inclined to think we are letting the newcomers off easy, but I think the business of becoming an actuary is so much tougher now that you have to have a more broad and general base and not so much specialization.

We are wrong, however, in respect to spending too much time and too much effort in trying to train anybody who happens to drift into our pro-

fession, instead of attacking the fundamental problem of getting the right people into it in the first place.

Some suggestion has been made in Mr. Spoerl's paper that we talk to college professors on subjects of technical interest. I cannot imagine anything more useless than getting a dozen college professors down to New York for a seminar on osculatory interpolation. They would leave town with even less idea of what an actuary does than they have now and we would never get any practical actuaries.

I have called probably on more professors and colleges than anyone in this room. I have been doing it for twenty years. Getting the right kind of person is a sales job. You cannot do it by mail any more than you can sell life insurance by mail.

Back in 1930 we figured we could use two new Fellows a year, so we decided to hire six students annually, expecting two to flunk the examinations, and two to be taken away by other companies. That has worked out rather well. We have lost 51 altogether to other companies out of 135 hired over a period of twenty years. We fired nine. We have 24 who have stopped taking examinations but who have assumed duties in other parts of the company, generally quite important ones. Of the remaining 51, we have 27 Fellows, eleven Associates and thirteen students in good standing.

The only way to run a successful program is to get your preliminary selection done by the professors, and you have to convince the professors of the type of man you want. That is very hard because the type of man we want—the type of man who can do the job our actuaries do (for example, collective bargaining with labor leaders)—is the type of man who does not normally major in mathematics. You have to make him major in mathematics. You have to sell him that there is a future in mathematics that he doesn't know about. You cannot get at these people without the complete cooperation of the professors.

We build up contacts. As my contacts retire and die, I leave the problem of getting new ones to my younger associates. I have only three colleges left. I have three other people doing the contacts elsewhere. You have to get on personal terms with the professor. There are two banes. Some colleges insist that you deal with the head of the department. The head of the department is generally somebody who is thinking in the middle of next week and cannot appreciate any practical problem, so you have to find some way to get behind him and get to somebody who has practical sense. That is very tough. There are other colleges where you are fortunate to have a head of a department who can help you, but you find every four years, because of a rotating chairmanship, you have to

deal with somebody new and you never get anybody to know what it is all about.

I do not want you to gather from this that I disparage college professors. Far from it. My father is a college professor of mathematics, my brother is one, and my sister married one. When I was a boy nobody rated a meal in our house unless he was a college professor, and he had to be an LL.D. to stay overnight. I can say from a long experience that not more than one-third of all college professors are any good as actuarial student contacts.

In the colleges where I really have contacts I get their best men by a scheme that we devised two years ago. It seemed to us the ideal method of hiring actuaries was to do your weeding out before the guy gets on the permanent payroll. We got an appropriation from our Board of Directors to give ten scholarships of $500 a year to boys in their senior year and in their junior year. We offer summer jobs to people at the end of their sophomore year and sometimes the junior year. From college we bring them into the company and they stay there for two months in the summer. They do the practical work in various sections of the actuarial and group departments. They get a lecture every Monday morning on the fundamentals of insurance, and one of the officers tells what job he does so they get an idea of the variety of work there is in a life insurance company. We give them a little mathematics and we give them examinations, and at the end of the summer we award scholarships to the ones we would like to have. We can size them up before we get them on the permanent payroll, and it enables the boys to decide whether they would like to be bottled up in an office or do graduate work. There has been a great tendency under the GI Bill of Rights to go to graduate school even though most students are not suited for it.

We hired 17 summer students in 1947. We offered ten scholarships. We said to the boys, "You do not have to make a contract with us to come back. If we cannot sell you on coming back, we won't want you. We want a gentleman's understanding that you will direct your studies, as far as possible, to passing the actuarial examinations and we hope we will see you again next summer."

Four turned them down. So we gave only six.

The second year, out of 15 people, we gave nine, and this year, out of 15 people, we gave ten. It is true two of the boys are trying for Rhodes scholarships. They told us so. They are still getting their $500.

If you can get a person to get these examinations out of his system when he is at college, so when he gets on the permanent payroll he can go

home to study Spurgeon instead of Hall & Knight, it has great value. It enables you to bring the boys in at a higher starting salary because of automatic examination raises without disturbing the salary system throughout the company. I do not think it costs you money. I think you save money. The time and expense in training people whom you never saw before the end of their senior year and having some of them flunk is, in our opinion, more expensive than putting up scholarship money.

There is nothing I hate more than firing somebody; as far as the student's morale is concerned it is better for him to know before he leaves college that he is not suited for actuarial work than it is for him to try it for a year and then get another job with a year of failure behind him.

HAROLD R. LAWSON:

In this paper Mr. Spoerl, to use his own words, has dispelled the mystery commonly associated with the Society's examinations. (The only mystery still remaining is how to pass them.) In spite of the objectiveness of Mr. Spoerl's approach, his treatment of the subject matter is so clear and so logical that one is left with the feeling that at long last our examination system is about as good as it could possibly be.

As a long-time member of the Education and Examination Committee, I would be the last to repudiate all the good work that has been done and the degree of success that has been achieved. Nevertheless, we all know that nothing in this world is perfect and that everything we do represents a choice or compromise between more or less imperfect alternatives, and this is certainly true of our examination system. On an occasion of this kind I think it only proper that we should give our attention, not only to the merits of what we are doing, but also to the defects, however irremediable they may be. There are quite a number of these which are apparent to me, or have been suggested to me by others, and in the interests of brevity I am simply going to list them without discussing them individually.

In connection with the Preliminary Examinations, the most important criticisms of which I know are the following:

1. No textbooks are recommended for the General Mathematics examination.
2. No fixed passing mark has been established or publicized among students.
3. The examinations are essentially speed tests.
4. No mention is made in our literature of the number of questions that each examination will contain.

5. Students do not have the erstwhile important advantage of being able to study old examination questions.
6. No educational assistance is available to students who have already graduated from college.
7. The new examinations appear to pass a different group of students from those who would have passed the old type of examination, and we are not sure that this is a better group.
8. It should be possible to assume the knowledge which these examinations are designed to test, in the case of students who have graduated with high grades from colleges and who pass the later mathematical examinations.

With regard to the Intermediate Examinations, and to the circumstances under which the students study for them and try them, the following criticisms should be considered:

1. The correlation between these examinations and the Preliminary Examinations is distressingly poor.
2. It is impossible for students to thoroughly master the subject matter in a few months of cramming at night.
3. Life contingencies is not a subject requiring office experience, and this is equally true of the construction of tables, including graduation.
4. Study groups have sprung up again, creating an inequity between students in different areas, and between large and small company men.
5. Study notes, and model answers to old examination questions, are of limited value without personal contact between the instructors and the students.
6. Young men recruited for the actuarial department of a company suffer some loss of dignity and prestige, as compared with young lawyers and other college men, because of being still in the "student" category.
7. It is harmful to the individual student, and socially objectionable, to require him to do so much night study over a long period of years.
8. The young actuary, because of his studies, does not have the time to do creative thinking and research during the years when he is most capable of this work.
9. In all respects—aptitude, training, lack of adequate time, etc.—we members of the Education and Examination Committee are mostly amateurs in the field of education.

Each of the foregoing criticisms could be discussed at length and we could decide on its individual merits. For the moment, however, I want to consider them collectively, and I suggest that they boil down to this:

The Preliminary Examinations should be eliminated entirely, or at least waived for the graduates of approved universities. The latter course would not be so difficult as one might think, since we are already grading the universities according to the success of the students on our examinations. If a student can pass in life contingencies and graduation, can we not assume that he knows enough about calculus and analytical geometry, and other subjects in pure mathematics? These things are but a means to an end, but we seem to consider them an all-important end in themselves.

Let us turn over the teaching of life contingencies and construction of tables to the universities. In other words, let our regular educational institutions handle all those Associateship subjects for which practical experience is in no sense essential. It is wrong that young men who have already spent four or five years in college should graduate without the basic knowledge essential in our profession and have to make this up by intensive cramming at night over a period sometimes of many years. Why could they not have learned this work at college, in preference to carrying some other subjects of less importance?

I am suggesting that we have but one examination, which might be in two or three parts, to admit a man as an Associate of the Society. In other words, he would first graduate from a university where he specialized in actuarial science, and then he would try our admission examination, much in the same way that a young lawyer or doctor tries the state bar or medical association examinations. The college graduates, possibly with degrees of Bachelor of Actuarial Science, would form a category of practical actuaries who could also find work in teaching or statistics or other lines; the Associates would be actuaries recognized by the Society, and the Fellows would be in a sense actuaries who have taken a postgraduate course.

Under this plan the supply of practical actuaries would be adequate for all the needs of insurance companies, large and small, governments, consulting offices, and so forth. The plan would also avoid most of the objectionable features of our present examination system, and bring about that closer association with the teaching profession that Mr. Spoerl so eloquently advocates.

PETER M. TOMPA:

As one of the latest "additions" to the Examination Committee, may I be permitted to say a few words which may be classified under the heading of "discussion"?

When our President, Mr. McConney, approached me in June of this year and offered to appoint me to the Committee, my first reaction was

one of awe. Having just passed my last fellowship examination, the Examination Committee appeared to me like a multi-headed Hydra watching with Argus eyes over the secrecy of the proceedings. I am sure I would have declined the honor, had I not been working in an organization which counts among its officers two ex-members of the Committee. Both these gentlemen reassured me and explained to me that the Committee may be the combined Hydra and Argus I imagined it to be, but that its individual members are just fellows like you and me.

What these two gentlemen did for me, Mr. Spoerl's excellent paper will do for future candidates who will be elected to the honor of membership on the Committee. It removes the Argus feature from among the characteristics of the Committee and will assure everybody of the open and warm-hearted leadership necessary to weld a multitude of individuals into an intelligent working unit willing and able to tackle all problems within its competence. I am proud to belong to it.

HARRY WALKER:

Drawing on my experience as a member of the Education and Examination Committee for a number of years, I should like to describe the manner in which the Committee attempts to eliminate, as far as possible, the element of subjectivity which, as Mr. Spoerl has pointed out, is bound to creep in in the grading of the old type of examination. Since the old essay type of examination is still used for Parts 5, 6, 7 and 8 and, under present plans, will continue to be used for at least half of the Part 4 Examination, it is important to point out that the Committee is convinced that its grading procedures, by and large, remove any possible inequities resulting from the subjective grading of an individual question by an individual examiner.

The grading process for the Part 4 Examination, which I shall describe, conforms, I believe, to the pattern generally followed by the Part 5 to 8 Committees. All papers are given a first reading with all candidates' answers to a given question marked by a single examiner, in order to avoid the inequitable treatment that could result from two candidates who submit equally good answers receiving different grades because one examiner has adopted a more rigorous standard than another. No one is passed or failed on the basis of this first reading alone unless it is apparent that his total grade will be substantially above or substantially below the ultimate passing mark. For example, in the 1949 Part 4 Examination no man was passed or failed on the basis of the first reading unless his grade was at least 15 points above or 15 points below what was finally decided upon as the passing mark. All other papers, which obviously included the paper of

any candidate who stood even an outside chance of passing, were given a second reading with each question marked by an examiner who did not mark that question on the first reading. To encourage independence of thought on the part of the examiners, the examiner giving a paper the second reading is not acquainted with the grade assigned on the first reading.

It is true, as Mr. Spoerl points out, that the subjective nature of the grading process becomes apparent when the results of the first two readings on each question are compared. In the determination of part credit for an imperfect answer, the two examiners will quite often not agree, the first examiner allowing, say, 8 out of 10 points, and the second examiner, say, 6 points. It has been comforting to us, however, to note that despite these differences between the two readings for the individual questions, for the most part the total grade on the first reading agrees quite well with the total grade on the second reading. Of the 124 Part 4 papers given at least two readings in 1949, in 24% of the cases the total grade on the second reading differed by 1 point or less from the total on the first reading; in 47% of the cases the total grade differed by 2 points or less; in 64% of the cases by 3 points or less and in 79% of the cases by 4 points or less. You can thus see that in 79% of the cases an average of the two readings differs from either reading by 2 points or less. Noting this, we have had the feeling that substantial justice was being worked in using this average to determine the candidate's mark, and that a candidate whose paper was marked down on a given question by a tough examiner received compensation in liberal treatment on some other question.

However, we do not stop with a second reading but a third reading is given to the paper of any candidate who came within 5 points of the passing mark on either one of the first two readings. In the case of the third reading, the examiner is told what grades have been assigned to the candidate's answer on each of the first two readings and he is asked, where there is any great disparity between the first two readings, to give support to one or the other of such readings. For the most part the average of the two readings or of the three readings, depending upon whether the paper received two or three readings, is used to determine the final mark assigned to the candidate but the Part Chairman reviewed the paper of any candidate whose mark was at all close to the passing mark if there was any substantial disparity in the grades assigned by the different readers to any particular question. In effect, therefore, such borderline cases received a fourth reading by the Part Chairman who has the authority to superimpose his judgment over the judgment of an earlier examiner to eliminate the inequities that would result from a straight averaging process in such

cases. With all this care that goes into the grading process, I personally have had the feeling that while in some instances a borderline candidate is passed or failed depending upon the subjective reaction of an individual examiner reading his paper, we have succeeded in avoiding the failure of a candidate who clearly should have passed the examination and the passing of a candidate whose paper clearly indicated that he should have failed. While the multiple choice type of examination should eliminate entirely the subjective element in the grading processes, I think it is important to have the members of the Society appreciate that a real effort toward attaining this ideal has been made by the Committee in grading the old type of examination and the Committee feels that it has been successful in its effort.

THOMAS N. E. GREVILLE:

I was very much interested in reading Mr. Spoerl's paper, both in relation to my personal experience with the examinations and also because of the fact that I have devoted considerable time and energy over a period of years to study classes with the object of preparing students for certain parts. It is not surprising, therefore, that I have frequently thought very seriously about various problems relating to the examinations. In fact, this paper has given me the opportunity I have been waiting for, for a long time, to get certain things off my chest.

In my opinion, the revision which has recently been taking place over a number of years has been, on the whole, highly beneficial. I heartily endorse the reduction in the length of the syllabus which has been effected through the consolidation of material by means of monographs and study notes, and I am deeply grateful to those members who have devoted so much time to this worth-while objective. I also think the Committee deserves to be highly commended for the very evident improvement in the type of questions asked. It seems to me that the great majority of questions are now designed to test whether the candidate has an intelligent grasp of the subject rather than whether he possesses a phenomenal memory for details, as was too often the case in past years. If in the remainder of my discussion I appear to emphasize certain defects which, it seems to me, still need to be corrected, this does not indicate that I am not fully aware of the great progress that has been made.

Mystery Surrounding Examinations

In his first paragraph, Mr. Spoerl relegates to the limbo of folklore the prevailing impression that there is something mysterious about our examinations. I am sure he is entirely right. Nothing is mysterious when you have come to understand it. However, the prevailing impression has a

very real basis, and it will continue to exist in the minds of our students until a satisfactory explanation is given of certain peculiarities of our examinations. In a very long career as a student and teacher (which is still continuing in both capacities) I have both taken and given a great many examinations. I spent a total of seventeen years taking the actuarial examinations and took several of them a number of times. I have lost count of the total number of actuarial examination papers I have written, but I started when there were twelve examinations and have actually passed that many, since examinations were, in each case, eliminated by consolidation or otherwise, after I had passed them.

It is a very general observation among teachers and students that there is a high correlation between the student's impression when leaving the examination room as to how well he did on the examination and his actual performance. I think most teachers would agree that there is something very peculiar about an examination in which there is little relationship between what the student thinks he did and what he actually did. Yet, on the basis of my own experience and that of many other students with whom I have talked and whom I have tried to prepare for examinations, this is notoriously true of our examinations. Time after time students who left the examination room confident of having passed have failed to find their names in the list of successful candidates, and others who would not have given two cents for their chances of having passed have been surprised and delighted to read their names in the list.

Other circumstances help to reinforce the impression of mystery which surrounds the examinations. Only a few years ago a certain candidate who wrote to the Examination Committee about his paper was informed that the one of several topics covered on which he had fallen down was a topic on which he was probably at that time the outstanding authority among our members. In fact, one of his papers on this subject was included in the readings for that examination.

It would appear that the Committee has somehow failed to get across to the student just what type of answer will be found acceptable. Many of us have had an uncomfortable feeling, particularly in connection with certain topics in the fellowship examinations where a difference of opinion on certain matters is possible, that it is not enough to be familiar with the subject matter—that it is also necessary to use psychology in order to size up the kind of person who is likely to be reading the paper and write the kind of answer that will meet with his approval.

I am sure that any light that Mr. Spoerl can throw on these difficulties will be most valuable to students.

Time Element

I remember very clearly that at a meeting held in Atlantic City some years ago, Mr. Beers, as Chairman of the Special Committee, read a list of points which he stated were going to guide the Examination Committee in the future. One of these points, which I remember most clearly because it has been honored so much more in the breach than in the observance, was to the effect that the examinations would no longer place a premium on speed as had been the case in the past. In most of our examinations it would not be possible to answer all the questions adequately in the time allowed even if one kept writing continuously at the greatest possible speed and did not need to take any time to think about anything. Almost everyone emerges from the examinations with writer's cramp, speaking very literally. As this is the complaint which most frequently has been heard about the examinations over a long period of years, it is a little peculiar, to say the least, that Mr. Spoerl's long paper contains no reference to this point.

It would be very interesting if he would present some exposition of the philosophy of setting an examination too long to reasonably expect its completion by the candidate within the time allowed. My students for the preliminary examinations are unanimously of the opinion that this is as true of Parts 2 and 3 as of the examinations administered directly by our Society. I have known some professors who were of the opinion that they could get a wider spread between the members of a class by giving an examination so long that only the best students could complete it and they sincerely felt that such an examination provided a more reliable measure of the capacities of different students.

However, I think it should also be considered that setting too long an examination does not only make it impossible for the candidate to finish it. The resulting feeling of hopelessness and futility makes it extremely difficult for him to think properly about the questions and to set down clearly even what he knows. This type of examination favors the brilliant individual who is fairly successful in making quick decisions and snap judgments and systematically discriminates against the slow, careful, plodding type. I should be interested in a poll of actuaries as to whether this is desirable and whether persons of the type first mentioned are those who will make the best actuaries.

Errors in Examination Questions

From time to time it has happened that errors have been made in setting the examination questions. For example, the illustrative solutions

which have been distributed to students indicated that there is a lack of consistency in the given data in question 1 of Part 5 in 1947. In question 3 of the law part of Part 8 in 1946, a required question was asked on material labeled as "optional" in the syllabus. Other examples could be cited, although I am happy to say they have become less frequent over the years. Such mistakes on the part of those setting the questions are very demoralizing to the student. No adjustment which may be made in the grading of the papers can really compensate for the time lost in puzzling over such inconsistencies. Surely these questions must be gone over by a number of individuals before being printed, and I can see little excuse for errors of this sort.

Conclusion

In conclusion, I should like to praise the present Education and Examination Committee and the former Special Committee for their very constructive approach to the problems related to the examinations. Everyone admits that great progress has been made, and if the tone of this discussion has been highly critical and sometimes severe, I am sure Mr. Spoerl will understand that I have been expressing feelings which have been accumulating over a long period of years and are not in any sense personal.

HARRY M. SARASON

Words mean different things to different people. To avoid disappointment to students who have passed the early examinations, and are taking the Life Contingencies Examination, Mr. Spoerl mentioned the possibility of "emphasizing the tentative and preliminary character of the General Mathematics Examination," and said we might "lay a heavier barrage of warning as to the difficulty of the Life Contingencies Examination." Cold figures tell a truer story. Some of these figures are in the paper under discussion.

Other pertinent facts which I would want expressed in figures if I were a professor advising prospective actuarial students are: What percentage of A students can pass the General Mathematics Examination and the Special Mathematics Examination with only the kind of review such students would normally spend on similar college examinations, say 2 or 3 weeks of spare time review at most? What percentage of B students? What is the time required by A students so that they are almost sure to pass? Just what are the study habits of successful students? What portion of successful college students who have passed the General Mathematics Examination can obtain actuarial employment? What portion of successful students of the Special Mathematics Examination? What business

progress is now being made by successful students? By unsuccessful students? Just how much harder do students have to study for Life Contingencies than for the pure Mathematics Examinations?

Advice as to how much harder students have to study for Life Contingencies might be individualized according to the grades of the individual students on the earlier examinations, if their grades on the earlier examinations prove to be a good criterion of their relative difficulties on Life Contingencies. In order to get accurate facts for students regarding how much harder one must study to pass Life Contingencies, a survey of study habits of students might be needed.

A consideration of these questions brings up some possibilities for revision of the examination system just as a consideration of the student's difficulties with Life Contingencies brought to Mr. Spoerl's mind the possibility of increasing the difficulty of the Special Mathematics Examinations. In view of the fact that a number of students take Special Mathematics courses in college, it seems impossible to make this examination difficult enough to test the student's ability to "study by himself."

On the other hand, if emphasis is given to specific advice to prospective students, it might be possible to make the pure mathematics examination still easier without making it so easy that persons studying Life Contingencies would be handicapped by a lack of mathematical background. Then, according to the margin of success in passing the pure mathematics examinations, varied advice as to how much harder the student will have to study on Life Contingencies should be made available to prospective employers of each such candidate and probably should be published on the pass lists. This would provide the initial selection of students. This would also save a year of study for many students. If we set a low pass mark, those who can't pass even under those circumstances should be flunked out of the system, certainly if they fail repeatedly.

I am advocating that "we" give them the facts, and I don't want to pussy-foot on the question of what I think those facts are. Here is my opinion of the facts as they could now be told to college professors. Most A students now pass the early examinations. Many B students can now pass the early examinations. Only 20 percent of all students pass these examinations, so it should be very rare that anyone besides an A or B student should take these examinations. After they have passed the early examinations, the percentage passing the Life Contingencies examination each year is somewhat under 50 percent. Only the upper 10 percent of a mathematics class, and only those who were prepared to study *at least* 15 hours a week for 8 months a year should consider taking the examinations. Such students could then reasonably expect to complete the exam-

inations in 6 or 7 years. (We want to "maintain our standards." Consequently, our old standard as to the type of entrant must still hold.) We have no actuarial vocational guidance charts, aside from vocabulary and mathematics tests; but embryo accountants who wish for something harder than C.P.A. examinations to pass are probably of the same breed of cats as proper actuarial students.

I would add that we *should* "maintain our standards," and that the solution, in so far as recruiting in a kindly way is concerned, lies in (1) emphasizing that only the upper 10 percent of a college mathematics class should consider actuarial examinations; (2) getting the information to as many high schools as possible that once in every few years they graduate a mathematician who should get into actuarial work, either directly or through college; (3) emphasizing that the number of employed Fellows of the Society is about 1/1000 of 1 percent of the employed population; (4) perhaps employing more students during depression times when other opportunities are still more restricted; (5) lowering the pass mark on the pure mathematics to where the B student will almost surely pass; (6) dividing those who pass into groups, the top group of which would contain only about three-fourths of those who now pass; (7) flunking out of the actuarial examinations all college students who do not pass the pure mathematics in 2 trials, but giving high school graduates 3 or 4 trials; (8) flunking out of the system all those who fail the Life Contingencies examinations twice by margins of more than 10 points, except that those who passed in the top class in the pure mathematics might be given a third trial.

Now for the Fellowship students. Let's give them the facts. One of the facts in which they are most interested is a set of specific answers which obtained a full mark on various examination questions. I believe this might help the more competent actuary the most because the more successful the actuary is the less accustomed he is to discussing obvious fundamentals and relatively minor details in his daily work. Consequently, he is more likely to omit these fundamentals and details in preparing for and writing the examination.

If publishing solutions that really earn full credit would help the Fellowship students, that would pose a difficulty for the Examination Committee. The Committee has been instructed to "maintain our standards." We are now passing a substantially higher percentage of Fellowship students than 7 years ago. That can be justified on the assumption that panel notes and various educational activities enable students to "assimilate a much greater amount of material" and, hence, that the student has added (probably) 5 points to his grades. I do not have the exact facts as to the

grade distribution, but if the Examination Committee had assumed 5 or 6 additional points as the value of this educational activity, and had lowered the pass mark accordingly, I believe at least one-fourth of those failing on Fellowship parts would have passed last year.

There is another place where we might make the facts available—to the Examination Committee. Let's not mistreat the Examination Committee. Let's give *them* the facts.

Suppose the Fellowship pass mark, the dividing line between pass and failure, were determined by Committee members who had in their hands the ratings of most of the candidates according to their competence as actuaries. When more than one candidate came from a single company, the candidates from that company could be ranked according to their competence as actuaries. From my observations, the Fellowship pass mark might well be lowered on the basis of that information. The competent actuary is not likely to be one of those who "spend so much time on their examinations . . . that their practical experience suffers."

From the progress of candidates who passed Life Contingencies in 1947, I believe that half of those who eventually become Fellows will do so by 1950, or about 3 years later. Allowing one year for passing Part 4, and allowing 2 years for passing the earlier parts on *current* examination procedures, this is a median of 6 years. Considering the estimates involved, it may be that the median will be 7 years.

A median of 6 or 7 years to become a Fellow is very comforting. But it is also something to examine from 2 angles: (1) About half of the candidates take more than the median time. (2) The record is being established in economic times comparable to those in the twenties, and the figure is comparable to those in the twenties. The median was longer when the depression hit us in the thirties. On the program of this meeting, we are being asked if there are too many actuaries. Also, according to the paper, some complaint has been registered about new Fellows who need a couple of years more of practical experience. That points to the possibility that we may start cutting down on the number of successful candidates and lengthening the passing time by tightening up on the examinations.

It seems to me that if our median examination passing time has been lowered and the average age of attaining Fellowship is lowered still more, we owe our new Fellows less than formerly. Consequently, it becomes less and less incumbent upon us to pass so few Fellows that all of them will be assured of actuarial work at salaries which will support a comfortable living scale. We can tighten up on our recruiting, and we can discuss frankly the financial prospects of those who will be successful. But these seem to be the only kind of steps which the various educational committees should

take in connection with the law of supply and demand for actuaries. We should not ask the Examination Committee to go back toward the "good old days" when long study hours for 10 years were usual and, to quote Mr. Pedoe, "should turn any young man into a monster." As the examination system produces more Fellows, or produces Fellows with only 3 or 4 years of practical experience, we should adjust our personnel programs. There will some day be a shortage of strictly actuarial work, but there will never be a shortage of work for actuaries.

CECIL J. NESBITT:

Mr. Spoerl deplores the lack of *liaison* between the mathematical and actuarial professions. One result of this lack is that the actuarial mathematics we require our students to "master" for the examinations is somewhat out of touch with modern mathematics. The great mathematicians of this century have made much use of abstract, general relations which have led to powerful methods capable of solving problems that are very difficult to handle by direct methods. In much of our actuarial mathematics, however, the stress is on elementary, direct relations without much consideration of the general ideas that lie behind the direct relations. I believe we should take some modest steps to teach general ideas and lay somewhat less emphasis than at present on special problems. With this in mind I have the following suggestions for the mathematical examinations and their study materials:

1. In the general mathematics examination we should be alert to trends in the college teaching of elementary mathematics. As an example, we should be aware that some pure mathematicians are critical of the time spent on analytic geometry as it is usually taught in elementary courses. Their feeling is that too much energy is spent on trivial relations and on solving by elementary methods problems that could be more easily handled by advanced methods such as vector analysis. There are also some mathematics teachers who are attempting to bring the spirit of modern pure mathematics into the teaching of elementary courses.

2. For the special examination study material we need a more careful and rounded development of the theory of finite differences with less emphasis on trivial applications than is now provided. We should abandon such hoary volumes as Hall & Knight and Whitworth for probability theory (it was a shock to see Hall & Knight back on the syllabus after we had thought it was decently buried). In their place we should adopt or develop a book that gives a moderately rigorous treatment of the main theorems of elementary probability theory together with a reasonable number of applications. For mathematical statistics we should keep in touch with the courses at leading institutions in that field. At present

there appears to be some gap between the examination material and the courses offered by the mathematical statisticians of my University.

3. For the interest and life contingencies examination I believe there should be less stress on intensive knowledge of special relations and more stress on knowledge of the general principles of the subject. The examination might then be made to cover a more extensive and useful field; for example, there might be a more adequate treatment of multiple decrement theory including disability theory. The examination itself should not be so long that it tests the speed and memory of the candidate rather than his real understanding of the theory and its applications.

Possibly the foregoing leaves the impression that I think actuarial students should be trained as pure mathematicians interested only in theory and who might have difficulty if faced with a complicated application. That is not my opinion at all. My idea is that we should have a better balance than we have at present between theory and applications. If actuarial mathematics is treated with a little more emphasis on general principles it should provide more power in regard to applications.

Mr. Spoerl and his colleagues on the Education and Examination Committee deserve much appreciation for the progress they have achieved in regard to the examinations. We are much indebted to Mr. Spoerl for his full, frank and lively account of their work.

AUBREY WHITE:

Mr. Spoerl has done an excellent job of explaining and defending the present examination setup and the work of the various committees which led up to it. It is difficult to find anything to criticise either in this paper or in the results of the work of the committees, if we accept their objectives. It is on this point that my discussion turns, and as a new member of the Education and Examination Committee I should point out that the opinions expressed herein are my own and not those of the Committee.

In the last paragraph of this paper Mr. Spoerl points out that "these examinations form the basis of deciding who is to be called an actuary." He forgot to add, "by the members of this Society." It seems to me that we have here the ingredients of what is now a vicious circle. We define the examinations as the criteria of a qualified actuary, and an actuary as one who has passed these examinations. What we need to do first is to determine, without reference to either ourselves or our current standards, the minimum qualifications which should entitle a man to call himself an actuary and then design our examinations so as to test for these qualifications at the outset.

For several reasons, I believe we are now decidedly on the wrong track.

The following considerations appear to indicate quite clearly that a change in objectives is overdue:

1. There is a real and serious shortage of men adequately trained to fill the numerous lesser actuarial posts available throughout the country who are not at the same time of high enough caliber to be in great demand among the wealthier and more actuary-conscious organizations. This has led to the creation of a group analogous to the "failed B.A." of India, for very much the same reasons as produced that group.

2. There is a real and justifiable desire on the part of those men who have passed our current rigorous examinations and help to keep the reputation of this Society on a high level, to maintain the high standing of the senior membership in our organization.

3. There is a large group of experienced and able individuals outside our membership who have attained actuarial recognition in their organizations or their communities because they proved that they were capable of doing what none of our members was available to do. Admission of these men on some sort of membership basis would add far more to our deliberations and our sphere of usefulness than it could detract from our reputation.

4. Our present division into Associates and Fellows is clearly a copy of the British organization, and was copied at a time when circumstances made the distinction a real and useful one. At that time there was not much in the duties of an actuary that could not be performed by any good mathematician with some knowledge of the construction and use of mortality and morbidity tables; an Associate, in those days, was such an individual. Also, with distances relatively small and meetings quite largely attended, there was definite point in allowing the student at a moderately advanced stage in his training to attend these meetings and learn from actual contact with the members. A good indication of the relatively high standing of the Associateship in those days is the large number of men who never bothered to go any further, and who currently hold positions of considerable actuarial importance throughout the country. The British are keeping pace with the times by training their Associates in the fundamentals of a broad range of actuarial subjects, saving only the fine points and specialties for the Fellowship. We, on the other hand, have created a situation wherein an Associate is expected to be an expert on a few aspects of actuarial science, while a Fellow knows all that and considerably more besides (or so his degree indicates).

5. The other "learned professions" have retained the principle that the lowest grade in their group represents a fairly complete grounding in all aspects of their profession, while the advanced grades indicate either

fuller experience or a high degree of specialization. We see in medicine the interne, with his medical degree, the physician with his practitioner's license, and the specialist, presumably with a considerable amount of postgraduate study in his specialty. In the law we have the graduate of the law school, the qualified barrister, and the doctor of laws (excluding the honorary type). In the scholastic field the B.A., the M.A., and the Ph.D. are similar logical steps. The comparison with our system is obvious (and odious).

In order to resolve these anomalies it appears to me that three steps are essential. In the first place, we should create a degree, to replace our present Associateship, which would indicate that a man has studied all of the essential aspects of actuarial work and has indicated by sitting for examinations that he has understood it and remembers it well enough for all practical purposes. This would require that our syllabus be revised to include all pertinent reading on those subjects considered essential and that the examination standards be revised to require only a reasonable knowledge of each subject.

Secondly, a further class should be permitted, including those of our present Associates who do not choose to qualify for the above described classification, and those men from outside our group who might be considered qualified by their work and their experience to meet with us. I would suggest that this class retain the present title of Associate and the above described group be granted a new title, such as Member.

Thirdly, present Fellows would retain their current status and would be joined by those among the Members who could pass a relatively searching test in those subjects not included in the Membership syllabus, if any. Such subjects might include underwriting, law, group, pensions, social security, advanced graduation, investments, and even distribution of surplus. Alternatively, these subjects might be included in the Membership syllabus, in which case the Fellowship could be granted to those passing Membership examinations with the highest standing. I would also suggest that an Associate could become a Member and a Member a Fellow by meeting one or the other of the following tests:

a) Attaining a position of actuarial responsibility, and maintaining such a position creditably for a period of, say, five years. *Prima facie* evidence of this qualification might be the active and intelligent supervision of one or more Associates or Members as a part of the duties of such a position.

b) Showing satisfactory evidence of original research and a high degree of skill in some branch of actuarial science, by presentation of satisfactory papers or preparation of a thesis.

I would contemplate that Associates would be entitled only to attend meetings, join in the discussions, and present papers. Members would be permitted to vote for officers and hold membership in the various committees. Fellows alone would be entitled to hold office or head up committees.

The foregoing is admittedly somewhat radical, but I am convinced that a solution along these lines must eventually be attempted. Perhaps our discussions will serve to bring about some active thinking on the two questions—"What is an Actuary?" and "How May One Be Trained?"—in that order.

(AUTHOR'S REVIEW OF DISCUSSION)

CHARLES A. SPOERL:

I am gratified by the large number of discussions evoked by my paper, "The Actuarial Examinations." Many are suggestions for improving the educational system and the examinations which I am sure the Advisory Committee will give careful consideration. It would be presumptuous of me to attempt to sum these up in a sentence or two. I must be content with thanking the authors—for pleas to hand the early stages of our program to the professors, for warnings against the professors; for doubts as to the virtue of multiple choice answers, for pleas to put all the examinations on this basis; for suggestions for syllabus changes and fundamental changes in procedure and in the meaning of Associateship and Fellowship.

I will confine these remarks chiefly to answering points raised in some of the discussions. In reply to Mr. Campbell's question, the difficulty of the preliminary examinations has not been changed from 1947 to 1949. The Committee decided the 1947 passing grades were a trifle too liberal; they are satisfied with the general level of 1948–9 and expect to continue it.

Mr. Barnhart's feeling of the inadequacy of *Hart* and *Spurgeon* is shared by the Committee; a search for a good Compound Interest book is going forward and a new text on Life Contingencies is being written.

I think part of Mr. Greville's confusion arises from comparing our examinations with those at the end of a college course. Ours must be countrywide and objective rather than parochial. When one works with a professor for a term, he ought to have a good idea as to his success in the final examination, since the test is merely more of the same thing he has been doing. Men taking our tests are faced with a far more impersonal document. They are not, however, entirely in the dark as to our requirements. As a guide, we publish model solutions to show what we consider adequate answers. I do not believe we place a premium on speed. On the Preliminary Examinations, a study of the papers appears to show that failures

should be ascribed to the progressive difficulty of the questions rather than lack of time. On the later examinations, the candidates get writer's cramp from trying desperately to pad their answers, with the hope of striking at least one spark from the irrelevant material, if only by accident.

Mr. Brown, I am afraid, has been relying for his information on the Preliminary Examinations on candidates who failed to pass them. It is thus not to be wondered at that his impressions do not jibe with the realities of the situation. The great majority of candidates for Part 2 are actually undergraduates. There is no writing down of long answers—an "x" in a box is all that's needed. I have seen every problem that has appeared since the examinations were adopted. It is my opinion that the subject matter of Part 2 is strictly as stated in the syllabus and the papers do not involve "problems of a special nature." I sympathize with Mr. Brown in his hope that if the Preliminary Examinations were abolished, candidates would do better on Part 4, but I am afraid the wish is father to such a thought.

I am very glad Mr. Walker saw fit to supplement my paper with a description of the mechanics of marking the examination papers. While the exact methods vary from one operating committee to another, the same general approach is common to all. I hope this account of the process will be widely read by candidates. One gets a bit sensitive about being considered an ogre year after year.

Finally, I especially want to thank Mr. Kirton of the Institute for his discussion. Though the Atlantic separates us, it is remarkable how similar some of our problems have been, as well as many of the solutions. The divergences are also striking. The progressive approach adopted by the Institute is entirely different from anything we have in America and we shall be most interested in watching the progress of this method. Mr. Kirton put his finger on the weak link in our chain of examinations when he remarked on the difficulty of a student's adjusting himself to a long-answer technique after a diet of multiple choice. It seems to me all of the trouble does not arise from the contrasting examination forms. It is with Part 4 that the candidate must start studying by himself rather than taking the subjects in school. This is the more difficult adjustment. I believe there has probably been too much concern about just what kind of examination a candidate faces. The main thing, to my mind, is to try to give him the best preparation possible and then to test his knowledge by whatever method is most reliable. If a candidate is adequately prepared, he should have nothing to fear from the examination—even if it should appear on phonograph records.