SCIENTIFIC METHODS OF COMPUTING COMPENSATION RATES.—I. M.
RUBINOW.

VOL. I, PAGE 10.

WRITTEN DISCUSSION.

MR. HARWOOD E. RYAN:

It is more than a year and a quarter since the paper under dis-
cussion was published in the first number of the *Proceedings*. The
developments of compensation rate-making since then make it all
the more interesting to review at this time. Dr. Rubinow has
pointed out many of the difficulties encountered through the ab-
sence of statistics which are either extensive enough or which can
be used in combination with other statistics. We are still a long
way from that degree of completeness and uniformity which are
essential to the solution of our most elementary problems. It
would be unfair to belittle the part which has been played in the
determination of basic rates for the various states by the method
of differentials. The application of that method was made prac-
tical by the Rubinow Standard Accident Table. As the author
himself points out, however, the system of law differentials cannot
be carried much beyond the point of applying the Standard Table
to the compensation benefits of a given state as a whole.

In theory there should be a similar table, showing the relative
gravity of accidents for each of several classes of industry; other-
wise there must be introduced into the calculation of differentials
certain serious errors which cannot fail to have a disturbing effect
upon rates so determined. For example, the manual of rates for
Pennsylvania is based upon an average law differential of 1.02,
comparison being made with the original Massachusetts act. The
industries of Pennsylvania upon the whole are more hazardous than
those of Massachusetts so that we may expect the experience to
develop an actual differential which is considerably higher than
1.02. As a practical matter, however, there have been no reliable
figures upon which to base a satisfactory modification of the aver-
age law differential so that the method applied was about the only
one available. The main point is that the determination of rates
for a new compensation state can be, and in practice has been, pro-
jected from existing rates covering a dissimilar act and the results,
however crude, are doubtless far more accurate than could be ob-
tained in any other way.

Dr. Rubinow will perhaps agree with the statement that in this
country with the many different state systems of workmen's com-

pensation and the diversity of constructions adopted in administering the laws, the law differential will soon have to give way to experience in the determination of rates. Aside from the actual values which may be assigned to the various divisions of the Standard Accident Table, there is the further important element of accident distribution. We may mention, for example, the class of permanent partial disability cases (not dismemberment). The Standard Table shows 2,442 of these in each 100,000 accidents. Nothing like this relative number has appeared in any published American statistics, and I am informed that under the New York act the number of such cases is so small as to be altogether negligible. This may be due in part to error in the table. It is certainly due, to a large degree, to the disposition of American accident boards to award a specific benefit in those cases which in European countries are compensated according to degree of impaired earning capacity. The effect of this one factor alone is very great and we do not yet know how far in other respects the idiosyncrasies of American administration will cause more or less departure from the theoretic accident distribution indicated by the Rubinow Table. None of these practical considerations, however, reflect in any way upon the Table or upon its usefulness at a time when it was most urgently needed.

Dr. Rubinow states the formula used in calculating New York rates from Massachusetts data. It may not be amiss here to mention the basis reached on a subsequent occasion for the calculation of rates generally. It is now a matter of history that during September and October, 1915, there was held in New York City a conference of rating associations for the purpose of arriving at a uniform basis for determining manual rates which might be used, with suitable modifications, in Massachusetts, Pennsylvania, and wherever else a rate situation was impending. One of the committees of the conference was composed of actuaries, and was known as the Committee on Loadings and Differentials*—a self-explanatory title. In connection with the subject under discussion the principles laid down by this committee are of interest. It recognized the Standard Accident Table as the best means now available for the calculation of law differentials, at the same time recommending to this Society an early revision of accident statistics based upon American data. It then proceeded to define its own work in the following terms:

"This committee as finally constituted, was appointed to consider 'the question of loadings and the question whether differentials are a proper subject to be treated by this Joint Conference.' Consequently the first matter to be determined was the one of pro-

* The Committee consisted of Messrs. B. D. Flynn, A. H. Mowbray, C. E. Scattergood, I. M. Rubinow, S. B. Black, W. N. Magoun, and the writer, all Fellows of this Society.

cedure to be followed with reference to the general subject of differentials.

"In order to reach a definite understanding of what might be expected of the committee, the questions referred to it were subdivided as follows:

"Under the heading 'Differentials' were considered the following:

"Allowance for (1) differences in compensation acts governing benefits; (2) underestimate of outstanding losses; (3) increasing claim costs; (4) industrial diseases; (5) variation in rates due to merit rating; (6) differences in accident frequency.

"Under 'Loadings' were considered provisions for (1) expense; (2) profit; and (3) catastrophe hazard.

"This classification of the work cleared the way for the determination of the various questions involving differentials."

An important feature of the committee's work was in establishing the principle that expense loadings should be graded in accordance with the premium level of the several states, and in the analysis of expense items which shows clearly the distinction between the expenses of acquisition, administration, service and those imposed by law, such as taxes and license fees. The report of the committee on this subject is worth quoting:

"*Expense Loadings.*—In making provision for expense loading, the committee has deemed it to be its proper function to investigate the actual needs of the business as at present conducted, believing that any movement seeking to reduce expenses, however desirable, is an administrative question rather than an actuarial one.

"The committee finds after a careful study of the disbursements of representative companies, both as to their total workmen's compensation business and of such business as was reported to the states of New York, Massachusetts and Wisconsin, that the average expense ratio, based upon the transactions of the calendar year 1914, has been approximately 40 per cent. of the compensation premium income. An analysis of this ratio shows that it is made up of certain major divisions of expense as follows:

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"Acquisition expense  ...................................  17.5
 General Administration expense  .........................   9.0
     Including:
       Payroll audits  ............................. 2.0
       All other  ................................... 7.0
 Service expenses  .......................................  11.0
     Inspection and accident prevention  .............. 4.0
     Investigation and adjustment of claims  ........... 7.0
 Taxes, licenses, etc.  ..................................   2.5
     Total  ..............................................  40.0
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"The above grouping of expenses is presented by the committee, in order to demonstrate that in considering the possibility of reducing the expense ratio, certain of the items such as 'Texas Licenses, etc.' are not susceptible to reduction by the companies, and that other items, such as 'Service Expenses,' should not be reduced, if efficiency will be thereby impaired. It is evident, therefore, that such reductions as may be effected, must be confined principally to 'Acquisition Expenses' and 'General Administration Expenses.'

"The committee finds further that the expenses naturally divide themselves into three general classes:

"(a) Such expense items as inspections and payroll audits do not vary with the gross premium rate, nor are they incurred as a percentage thereof.

"(b) Acquisition expense and taxes are incurred as a percentage of the gross premium rate, and vary directly therewith.

"(c) Items such as expenses of administration and claim adjustment, are properly chargeable in part in both of the foregoing ways.

"In order to give proper effect to these considerations, the committee undertook to determine what differences in loading should be recognized in the calculation of rates for the various compensation states. It was found impracticable to give full effect to the wide differences which theoretical exactitude would demand. It was felt to be necessary, however, to recognize that a flat loading for all states is improper and inequitable and certain groupings were adopted for the purpose of producing reasonable and practical results. Accordingly the committee recommends the following scale of expense loadings:

For States Having a Differential of	Percentage Loadings.	State Group.
"Less than 1.25	42½	1
1.25 to 1.49	40	2
1.50 to 1.74	37½	3
1.75 and over	35	4

"These results were applied to the probable relative premium income for 1916 and were found to reproduce approximately 40 per cent. loading on the average.

"Pursuant to this plan, the committee has assigned to their respective groups, twenty-three compensation states as shown in the list appended to this report as exhibit "C."

"*Loading for Profit.*—The question of a loading for profit was considered but it was thought to be unnecessary at this time to make specific provision therefor. The committee recognizes, however, that every legitimate business enterprise should take this factor into account and believes that in the future when rates have become more stable and are based upon more reliable experience data, it may be desirable to include a definite provision for profit.

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"Exhibit 'C.'

"State Groupings.

Group I., Loading 42½%.	'Group II., Loading 40%.	Group III., Loading 37½%.	Group IV., Loading 35%.
Colorado	Connecticut	California	New York
Indiana	Illinois	Massachusetts	
Iowa	Maryland	Ohio	
Kansas		West Virginia	
Louisiana		Wisconsin	
Maine			
Michigan			
Minnesota			
New Jersey			
Oklahoma			
Pennsylvania			
Rhode Island			
Vermont			

"*Loading for Catastrophe.*—In studying catastrophe experi-
ence, the committee met with considerable difficulty in finding
reliable statistics upon which to prognosticate future cost. It de-
cided, however, to make a conservative estimate which would pro-
vide for probable catastrophes upon an annual basis, even though
the occurrence of an annual catastrophe, taking one year with an-
other, is not to be expected.

"In order to limit the problem of measuring the catastrophe
hazard, the committee made a study of certain serious accidents
in the United States covering the years 1892 to 1913 inclusive.
Appropriate values were assigned to each fatal and to each non-
fatal accident. The total loss cost thus determined was used as
the basis for an outside estimate. The committee concluded that
such a loading should be provided for as would produce annually in
the state of Massachusetts $40,000 net after deducting expenses
and in New York about $200,000 annually. The committee believes
that the fairest practical loading for catastrophe purposes is a flat
loading for all classifications of a fixed amount per $100 payroll.
It is assumed that the basic pure premium will provide for an
inherent catastrophe hazard in particular classifications such as, for
example, coal mines.

"With these considerations in mind, the committee desires to
report that a loading of 2 cents per $100 payroll should be added
to the gross premium of all classifications in New York and that
a loading of 1 cent per $100 be likewise provided for other states.

The trend of compensation rate-making in the direction of more
scientific treatment is significantly shown by the very fact that the
conference saw fit to provide for such a committee, and, further, in
the nature of the conclusions reached by it. That there is much

more still to be accomplished is indicated by the final paragraph of the report which is indirectly an appeal to the members of this Society to do their part in promoting the development of proper statistical material for future use in practical rate-making:

"The committee has been guided by a desire to recognize *in principle* the essential considerations which are encountered in the process of constructing proper rates upon a foundation of pure premium results. It does not, however, recommend that all of these considerations be given expression as definite factors at the present time. We have been somewhat handicapped in our work by the absence of proper statistics which would have enabled us to do this, but it is believed that the results obtained are not seriously impaired thereby and that our study will lead to the development of such information for future use."

Next to the statistical foundation for future rates comes the treatment to which such data must be subjected before it can be utilized. Dr. Rubinow has mentioned some of the difficulties which spring from inadequate exposure data. I know it has been customary to discount the value of small statistical volume and we have acquired a certain habit of mind which looks askance upon payrolls that are much under three or four millions of dollars excepting perhaps in the industries of extremely high accident frequency and gravity. I believe we have put too much stress on the effect of serious accidents upon small exposures without realizing that chance has a way of operating unmathematically and at times very waywardly. For this reason the more serious losses should be related, not to individual classifications, but to large groups thereof.

Dr. Rubinow, in the paper under discussion, makes the same suggestion and in the *Proceedings*, Vol. II, pp. 124 et seq. Mr. A. H. Mowbray develops a method for grouping the data of small classifications so that more reliable pure premiums can be obtained. Mr. Mowbray's method contemplates the grouping of data to enlarge the exposure. It then redistributes the actual losses in proportion to relativity of class hazard. The weakness of the method suggested seems to lie in the absence of reliable factors of relativity. Given time enough and hence exposure enough, the pure premiums would furnish these factors. By that time, however, the necessity for grouping would have vanished and the indicated would be the true loss cost. We must therefore seek further in the attempt to smooth out the experience indications. I have in mind in a crude way which is not in shape to present at this time, a method which employs the principle of deductible average. The same principle has been put forward recently as a possible solution to the rating of individual risks with reference to their own experience. If the idea can be utilized in that manner there would seem to be less difficulty in the way of applying it to class experience and to group experience.

Briefly, the point is that the pure premium for workmen's compensation insurance is composed of two elements which can be

readily differentiated. The first is the cost of medical aid and of minor disability losses. The second is the cost of fatal and major disability losses. The occurrence of a loss of the first kind is of little consequence and causes no financial shock to a group or to a class or to an individual employer of moderate means. On the other hand, a loss of the second kind does cause just such a shock and since it is the function of insurance to distribute loss, to absorb shock, it is subversive of its true purpose to charge serious losses against small classes, just as it is unjust to throw such a burden upon individual risks. What should be done is to analyze the more serious losses as to their cause and to determine two main considerations. First, whether the loss was attributable at all to industry, and, second, to which particular group of industry it is chargeable. Occasionally there may be a serious loss which can only occur in connection with a given industry and which the class pure premium should reflect. The line between the class and the group will not be easy to discover or maintain, so that it were best not to carry the process too far nor to attempt to differentiate in this manner other than the losses of greatest severity. Such a method of treating experience data would assign automatically all ordinary or non-serious accidents to industrial classification. The occasional, serious loss would then be scrutinized and assigned on judgment to the classification, group, division or schedule or to the entire payroll exposure, as might seem just and proper to the committee in charge. Relativity of hazard as indicated by the pure loss cost of non-serious accidents may serve as a guide in spreading over the entire number of classifications the serious losses.

ORAL DISCUSSION.

MR. CARL M. HANSEN: May I ask Mr. Ryan what data the Conference had before it which would lead them to believe that there was any foundation for the difference in accident frequency by states in the same classification?

MR. HARWOOD E. RYAN: As a matter of fact, there was nothing at all, so the committee felt it was better to recognize accident frequency in principle only, and not to recommend any factor for use in present rate-making. A member of the committee submitted certain data based upon liability experience, but it had not been analyzed by industrial classifications, and we did not feel that it was suitable for use in our study, especially since the time was growing short.

MR. HANSEN: It was not used?

MR. RYAN: No; accident frequency was simply recognized in principle.

MR. JOSEPH H. WOODWARD: These various discussions all seem to revert back, at one time or another, to the question of cases of permanent partial disability, not dismemberment. I notice that

Mr. Ryan has just referred to this point in discussing Doctor Rubinow's paper. My impression of the disposition of these cases in this country—or in this state, rather—is that they are disposed of in one of three ways:

First: Some of them have received awards as cases of dismemberment. Doctor Rubinow is apparently of the opinion that most of them are treated as cases of dismemberment, but I am not sure that this is so.

Second, there are a number of cases that are continued along as temporary total cases after the time when the injured claimant has really recovered a part of his earning capacity. If he is not able to return to his old work even though he may be physically able to do something else, I think there is a disposition to award him full compensation temporarily. Of course, it may be said that he can do something else—that he can get a job as a watchman, or something of that sort; but as I heard a claim adjuster expressing it the other day, "the watchmen's jobs were all gone long ago."

Finally, there is quite a disposition, I think, to dispose of these cases by means of a lump sum settlement by way of compromise. I believe it will be found that a very considerable number are settled in that way, and probably those cases would get into the statistics as temporary total disabilities.

I think it would be of great value if somebody would take the trouble to investigate a large number of settlements and select those concrete cases where the actual facts, as developed by the claim papers, indicated that there was a physical condition of permanent partial disability, not due to dismemberment, and then find out how those cases were actually disposed of by the Commission or Accident Board, and tabulate those results. It is only by some such means as that, it seems to me, that we can definitely settle this question.

MR. G. F. MICHELBACHER: Out in California we endeavored to rate all the permanent partial disability cases reported to the Commission under our schedule, and I think a bulletin to be issued shortly will contain a lot of information which will help to clear up this point.

MR. I. M. RUBINOW: I really meant to rise in order to ask a question in regard to these permanent total disability cases. Of course, my standard accident table was an effort to indicate the physical facts rather than the various vagaries of American accident boards, and certainly I could not tell what every industrial accident board, with its politics and everything else, was going to do. I thought I could foretell more or less accurately the physical facts. But I recognize that when we are dealing with permanent partial disability we are dealing with something more than physical facts. It is a physical fact with judgment added. From the claim papers it should be possible to separate the physical facts from the judgment added to it.

I recognize that in a great many permanent injuries it is hard to tell. A permanent injury is one thing, and a permanent disability is another thing. In regard to the types of settlement mentioned by Mr. Woodward, I really don't know whether it would be possible for the industrial commission to continue paying benefits under total temporary when the man had actually returned to work?

MR. WOODWARD: No. But if he has returned to work, he has almost invariably returned at his full wages.

MR. RUBINOW: That is a condition of affairs peculiar to America. I don't see how a man could get back to work with a stiff arm any more than he could get back to work with a lost arm.

I don't think that I am disclosing any confidential information when I tell you that Doctor Hatch is doing just the thing that Mr. Woodward suggested. He is analyzing twenty-five thousand cases. He has found, I am informed, a great many cases which he says he doesn't know what he is going to do with in the statistical analysis.

In the case of lump sum settlements, I think if a man returns to work and gets a lump sum settlement, the statistics in that case should certainly be very carefully scrutinized. I should be very suspicious when a lump sum settlement was made. I don't understand under what conditions a casualty company would be justified in paying a lump sum unless it is a suspected permanent partial disability.

Then, another thing is the matter of the dismemberments which you have mentioned, Mr. Woodward. Are they dismemberments in all cases, or are they dismemberment awards.

MR. WOODWARD: They include either the loss of a member or the loss of the use of it.

MR. RUBINOW: My table has in mind actual dismemberments. Those things will have to be very carefully looked into, it seems to me, before we are ready to say that the table is not corroborated by American experience.

I want to point out one feature that was criticized by Professor Willard C. Fisher. I am quite sure that my estimate of total disabilities was away beyond the mark. He said he was sure there was not any such number of permanent total disabilities in this country. He pointed out data indicating 33 instead of 110. He pointed out data in Washington for two years. I have analyzed those data for each year separately, and have found that the proportionate number of permanent total disabilities increased with every year. I think in another year or two it may reach 110, or may possibly exceed it. I think the same situation will obtain in the case of permanent partial disability.

MR. I. M. RUBINOW:

AUTHOR'S REVIEW OF DISCUSSIONS.

I appreciate Mr. Ryan's difficulty in discussing my early paper on "Scientific Methods of Computing Compensation Rates." Events have been moving so swiftly in this field of scientific inquiry, and especially was so much contributed to the theory of compensation rates by the Joint Conference over which Mr. Ryan so wisely presided, that my paper at present has a historical interest only; and yet sufficient time has not elapsed to emphasize its possible historical value in shaping the first steps towards a true theory of rates.

There are a few points, however, on which still some misunderstanding seems to exist. It may be true that the Standard Accident Table will have to be modified so as to fall in more closely with American experience, both as to the physical injuries, and to their judicial and administrative interpretations. But the method of computing differentials by means of some standard accident table (whether credited to me or to anyone else), and the method of utilizing law differentials in the computation of rates will retain its very important function.

Mr. Ryan expects "the law differential will soon have to give way to experience in the determination of rates." If by that, the experience of individual states is meant, such a simplified method will be possible only in regard to very few classifications. Books and shoes and textiles in Massachusetts, clothing in New York, coal mines in Pennsylvania, will, in a few years, develop a sufficient amount of such experience. But for the thousand and one minor classifications some method of combination becomes necessary. Without entering at this place upon any criticism of Mr. Mowbray's suggestion (as outlined in his paper in Vol. II, p. 124) it will be admitted that in the very nature of things it permits of a very much greater margin of error than may lurk in the law differential. In all such minor classifications, therefore, the combination of the experience of different states will be absolutely necessary and such combination would be highly inaccurate unless adjusted through a system of law differentials. As a matter of fact, this method has already been widely utilized in the work of the Pure Premium Committee of the Joint Conference.

Mr. Ryan is entirely right in stating that "in theory there should be a similar table (i. e., similar to the Standard Accident Table) showing the relative gravity of accidents for each of several classes of industry," but of course each application of pure theory to real life must be tempered with reason. Upon this suggestion, two limitations may be placed: First, these specialized industrial standard accident tables (as we might call them) need not be as complicated as the original one. It would seem to be sufficient to estab-

lish the varying percentages of the five main groups of accident gravity (death, permanent total, dismemberment, permanent partial and temporary total). The average cost of an accident in each one of these five groups will surely remain fairly constant. What is subject to fluctuation is the comparative frequency of these groups as such. The law differential can therefore be computed for each one of these five groups separately (as a matter of fact this was done for a good many states by the Differential Committee of the Workmen's Compensation Service Bureau), and the final differential for the industry will result from the proper weighting of these five differentials.—Second, from the standpoint of pure theory, a separate complicated computation of the kind described above for each one of the fifteen hundred classifications indicated would seem to be necessary. But as a matter of fact, if it were possible, *i. e.*, if we did know so much about accidents normally to be expected in each industry, then it would perhaps be also unnecessary —rates might be compiled from accident experience alone.

However, all that may be expected in this world of sin from standard tables (and differentials) will be the computation for large subdivisions of industrial activity, such as the textile industry, iron and steel, mining, leather, etc. Such separate tables and differentials are not at all impossible. With the compensation business already exceeding sixty million dollars in annual premiums, and rapidly approaching a round hundred million dollars, and with a Joint Conference of insurance carriers and public authorities for the determination of rates, actuarial work of such finesse is entirely feasible, as the cost would not be prohibitive and the sources of statistical information which have made the Standard Accident Table possible —considerably enriched since then by a flood of American data— will yield all the information necessary for the special industrial accident tables.

There is only one more very serious misunderstanding which I feel called upon to correct because it is perhaps more common among actuaries than statisticians, and has crept even into Mr. Ryan's valuable discussion, namely, that the distribution of industries would materially affect the accuracy of the standard law differential and thereby introduce an error. The manual of rates for Pennsylvania is based upon an average law differential of 1.02, comparison being made with the original Massachusetts Act. " The industries of Pennsylvania, upon the whole, are more hazardous than those of Massachusetts so that we may expect the experience to develop an actual differential which is considerably higher than 1.02."

In this statement, the word " differential " is used in two different meanings. If, in the latter statement by " differential" is meant the true proportion between the " average pure premiums " of the total exposure, then it is evident that this average pure premium which is about thirty-six cents in Massachusetts and may

perhaps rise to $1.00 in Pennsylvania will depend upon the hazardous character of Pennsylvania industries, more than upon any differences in law. It is evident that a comparison of the pure premium on coal mines in Pennsylvania and textiles in Massachusetts would not present a *fair test* of the Pennsylvania law differential.

Again here some actual experience was obtained in the course of the work of the Joint Conference. When the average pure premiums of the four states were compared they seemed to diverge very widely from the theoretical differentials. For a time the author of the Standard Accident Table felt very much disheartened. But when the differences in the distribution of industries were taken into account (by a method elaborated by Mr. Michelbacher and the writer and perhaps too complicated to be explained here in detail) the difference between the theoretical and actual differential shrank considerably. For the remaining discrepancy two explanations may be suggested—either that the original law differential was wrong (which is after all a possibility) or that the influence of still another factor—that of differences in comparative accident frequency within identical industries—manifested itself. While sufficient statistical information was lacking to determine which of the two explanations was nearer the truth, the fact is significant that the excess in the average pure premium manifested itself clearly in the western states, where a higher accident frequency is suspected, and perhaps still more significant is the fact testified to by Dr. E. H. Downey, that the proportion between the average pure premiums of Michigan and Wisconsin—two western states with similar industrial activities—corresponded exactly to the proportion between the respective law differentials.

The entire subject of law differentials presents to the author the most fascinating chapter of the new actuarial science which our Society is building up at present. It is a matter of reasonable pride in the achievements of American science that even thirty years of European experience failed to develop this valuable theory of differentials. The writer trusts that for these reasons his paper, the first to be presented before the Casualty Actuarial and Statistical Society of America, will retain some permanent value which its intrinsic worth alone would not justify.

HOW EXTENSIVE A PAYROLL EXPOSURE IS NECESSARY TO GIVE A DE-
PENDABLE PURE PREMIUM.—ALBERT H. MOWBRAY.

VOL. I, PAGE 24.

WRITTEN DISCUSSION.

MR. ARNE FISHER:

Mr. Mowbray in this paper discusses the application of the
Gaussian Normal Curve—or as he prefers to call it—the "Law of
Error" to the test of pure premiums in compensation rates. This
particular curve is a special case of the Charlier A type of frequency
curves as expressed by the series

$$F(x) = \phi(x) + A_3\phi^{\text{III}}(x) + A_4\phi^{\text{IV}}(x) + A_5\phi^{\text{V}}(x) + \cdots, \quad \text{(I)}$$

where

$$\varphi(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-(x-M)^2/2\sigma^2},$$

ϕ^{III}, ϕ^{IV}, ϕ^{V} are the derivatives of the curve $\phi(x)$. M, σ, A_3, A_4
and A_5 certain statistical constants (characteristics) of the curve.

When all the terms in (I) except the first one vanish, or may be
neglected as small quantities, we have $F(x) = \phi(x)$, which is the
Gaussian normal distribution in the modern notation as used by
the English biometricians of the Pearsonian school and the Scandi-
navian statisticians and which expresses the deviations from the
mean value in units of the dispersion (standard deviation). Mr.
Mowbray uses the classical Gaussian form for $\phi(x)$. In statistical
work it is, however, preferable to use the modern form instead of
the classical notation which is used in precision measurements.

The point binomial $(p+q)^s$ for large values of s may approxi-
mately be written as $\phi(x)$ when both p and q lie close to $\frac{1}{2}$. How-
ever, in the majority of cases, the curves are skew, or p and q differ
considerably from $\frac{1}{2}$, and we must therefore adopt the Charlier type
A and compute additional terms of formula (I). For small values
of q the type A does not hold, and we must resort to another form,
the Charlier B type, of the frequency curve as expressed by the
formula:

$$F(x) = B_0\psi(x) + B_2\Delta^2\psi(x) + B_3\Delta^3\psi(x),$$

where

$$\psi(x) = \frac{e^{-\lambda}\sin x\pi}{\pi}\left\{\frac{1}{\pi} - \frac{\lambda}{1!(x-1)} + \frac{\lambda^2}{2!(x-2)} - \frac{\lambda^3}{3!(x-3)} + \cdots\right\}, \quad \text{(II)}$$

B_0, B_2, B_3, λ, $\cdots$ are certain characteristics.

Whenever p or q is small this form gives much better results
than type A and is easier to handle in practical computations. In
type A it is in such cases necessary to compute 3, and often more
terms, which when using the methods of moments in fitting the

curve, requires a large amount of labor. In type B it is in most cases sufficient to compute two terms only as for instance is shown in my paper in the *Proceedings,* Vol. II, p. 70.

Turning now to Mr. Mowbray's numerical illustrations, I think the values he gives for q are to be considered as small, which leads us to one of the decidedly skew curves of the B type. At any rate it is readily seen that the first term in type A does not suffice. For this very reason I regret to state that I can not agree with the numerical computations as given by Mr. Mowbray. This fact, however, does not in the least diminish the value of the paper, which I trust will prove a stimulus to an extended study of skew frequency curves by the members of the Society.

There is another matter I wish to mention in this discussion. Mr. Mowbray apparently assumes an unique correspondence between mathematical probabilities and statistical frequency rates (empirical probabilities). As probably some of you know from my treatise on " Probabilities," I am a rather outspoken opponent of such views. A mathematical probability rests wholly on a philosophical definition. A statistical probability is derived wholly from empirical methods and may perhaps have very little in common with the mathematical probability. Yet one sees, almost daily, statisticians apply the laws of mathematical probabilities to statistical probabilities without testing if such statistical probabilities may be considered as approximations of the mathematical probabilities. Such a procedure I think is wrong. It is really surprising why one sees so few tests about the stability of statistical series when we in the Dispersion Theory and the associated criteria of Lexis and Charlier have a very simple method—and an extremely practical one—to test the presence and magnitude of perturbations in statistical series. Mr. Mowbray's investigation I think would probably have yielded better results, if he had based it on the theory of dispersion.

MR. ALBERT H. MOWBRAY.

AUTHOR'S REVIEW OF DISCUSSION:

I am very glad indeed that Mr. Fisher has been induced to review my paper. The one point of greatest doubt in my mind at the time of presenting it was the propriety of using Gauss' Normal Curve. It was very apparent that the frequency function was more truly represented by a skew curve, but only a small section of the curve was to be considered, and this at about the mode which it seemed might have justified it. Mr. Fisher apparently feels that sufficiently accurate results could not be obtained by this method. He is a better judge on this point than I.

At a later time I hope to do some further work on the problem along the lines suggested by Mr. Fisher, but trust that if he or some other member of this Society finds time in the meantime for such a

study this will not deter them from making it and presenting us
their results.

While, as noted in the paper itself, the extent of chance variation
in the incidence of loss is only one element in the determination of
the question under discussion, it is a most important element. As
experience accumulates and particularly if some method of group-
ing and weighting is adopted for determining pure premiums by
formula, it will become more and more important to have clearly in
mind some standard of exposure to be considered dependable.

THE ESSENTIAL FACTORS IN THE COMPUTATION OF THE COST OF WORKMEN'S COMPENSATION.—W. N. MAGOUN.

VOL. I, PAGE 173.

WRITTEN DISCUSSION.

MR. GEORGE D. MOORE:

When one is in entire agreement with the essential factors of a
paper, it is a difficult problem to discuss it, except to bring out in
bold relief certain statements occurring therein.

A single sentence in Mr. Magoun's paper reading as follows:
"It goes without saying that such a refinement in classifications
is impossible for statistical purposes in general," has caused me to
suggest that the title of the paper should be changed to read: The
Essential Cost in the Computation of the Factors in Workmen's
Compensation Insurance. Following this line of argument, I shall
discuss some of the practical difficulties that have arisen in the
attempt to obtain those statistics which are deemed necessary, con-
fining myself to the factor of exposure—the other factors such as
Uniform Classification of Causes of Injury and Nature of Injury
having at this time been practically standardized and a system of
gathering the data having been compiled by the Statistical Com-
mittee of the Workmen's Compensation Service Bureau.

It would seem as though one of the causes why the extraordi-
nary demand which now exists for actual and dependable informa-
tion has not been met is fundamental. The factor of exposure is
based on payroll and this in turn is classified in accordance with
current underwriting practice. The workmen's compensation clas-
sification code is an outgrowth of the now almost obsolete employers'
liability business and this due to competitive methods has been
extended and refined until it would seem as though further refine-
ment could not be made. However, witness the special classifica-
tions which have been promulgated by the New York Compensa-
tion Inspection Rating Board since the advent of workmen's com-
pensation in New York. This refinement has continued, so that
we have over 1,200 classifications; such a large number becomes
both a menace to accuracy as well as to the possibility of collecting

and tabulating exposure by classifications. The accuracy of the data is in direct proportion to the number of classifications and the more classifications are added the more difficult it is becoming to furnish such detailed and at present perhaps necessary analysis. The most difficult and comprehensive analysis at the present time, "Massachusetts Schedule Z," as has been pointed out by Dr. Downey in a former article, indicates that after a lapse of five years, only about thirty manual classifications will give an adequate exposure, and yet we are obliged to tabulate all of these minor classifications without obtaining any dependable data whatever.

Now, gentlemen, those present who have had or are now having actual experience in the compilation of this schedule, in all truthfulness what would you say if each and every state of the many now having workmen's compensation laws were to require a similar schedule? And yet upon the present basis for rate-making that is the method which should be followed. My endeavor is to bring out if possible a further discussion in the interest not only of an opposition to a further refinement but a curtailment of those classifications which we have already. It may be that the solution of the problem does not lie with either Dr. Downey's "entrepreneural method" or the "risk classification method" of the present system. It may be that a modification of both of the systems will give us the desired result. If such a refinement is at present impossible for statistical purposes in general, why not in particular? We are all interested in keeping the cost of the administration of the business at as low a point as possible and yet this item of the cost of compilation is becoming more and more serious each year as well as becoming more and more involved. Perhaps the fact of the matter is that the basis manual should have been compiled by statisticians and engineers instead of by underwriters; the statisticians to consider the essential features from an actuarial standpoint so that dependable data could be obtained upon which to build the rates scientifically and the latter to group the analogous hazards. The manual should then have been left to the underwriters to be applied in covering the risks. The grouping of analogous hazards as has been pointed out has been attempted with more or less success by the Manual Committee of the Workmen's Compensation Service Bureau as witnessed in the new Basis Manual, but this or a similar grouping must be speedily recognized by all parties interested if any relief is to be obtained.

What method presents itself? Not surely by the addition of more and more classifications *ad nauseam*, as pointed out by Dr. Downey. No, certainly not. It may be found, however, in the groups which have recently been adopted. We are now coming to a time when enough dependable data on the larger classifications can be obtained. At least this may be so if we group the data tabulated from various states together. Why not then let us establish for each group a basis rate for each state separately? The

variations from the basis rate for each classification within the
group might have a maximum, say of 20 per cent., not greater than
10 per cent. or less than 10 per cent. of the basis rate. These
variations to be founded upon present obtainable data or where the
data is insufficient, the use of Mr. Mowbray's* formula for "The
Determination of Pure Premiums for Minor Classifications on
which the Experience Data is Insufficient for Direct Estimate" can
be applied. After the establishment of these factors why not dis-
regard the keeping of statistics on individual classifications, con-
fining ourselves to a set of groups, say 300 in number. The tabula-
tion of this data by statisticians should not be unbearable to anyone
and would tend to greatly strengthen the standardization of rates.
Of course there is the objection that would be raised that a certain
class within the group would become in time less hazardous due to
improved machinery and appliances and the measure of this im-
provement could not be obtained for rate reduction purposes inas-
much as the experience was absorbed within the group of which that
class formed a part, but any such improvement should appear in a
more favorable pure premium on the group as a whole and could
be studied in this connection.

If in the plan proposed it would be impossible to obtain the ex-
perience on certain classes within the group, is it not a fact today
that the effect of schedule rating applied to certain classifications is
absorbed by the experience of those classes as a whole, and there is
no endeavor being made at the present time, that I know of, to keep
the experience on schedule rated policies separate.

The foregoing are thoughts that have occurred by the way, and
I believe would require intensive study to make them of practical
value, but something must be done in the near future or we will
be completely swamped by the vast increasing amount of statistical
information which is being required of us.

ORAL DISCUSSION.

MR. HARWOOD E. RYAN: I want to say a word in regard to what
Mr. Moore has said about classifications. I think we are misled,
somewhat, about the classification so far as it relates to experience
statistics. As a matter of fact, the classification is fast losing its
usefulness excepting as a cross reference for the convenience of the
underwriters and employers in finding the rate. The rate is com-
posed of certain elements made up from group experience, and if
we had an absolutely ideal system of grouping the classifications,
you could have any number of classifications without multiplying
the difficulties of getting experience data on the proper basis. You
could lose sight of the classification, just as you do in personal acci-
dent experience. What you do there is to look down the list of

* *Proceedings*, Vol. II, p. 124.

classifications and then assign the risk to the proper hazard group; you then ignore the classification, so far as experience is concerned, and the experience used for rates is the group experience. I think we need not be too much worried about the multiplication of classifications, for it serves to show that the policyholder is being put in the right pigeonhole, and that, after all, is the main reason why the manual has reached such large proportions.

<center>MR. W. N. MAGOUN.</center>

<center>AUTHOR'S REVIEW OF DISCUSSIONS:</center>

One thought has occurred to me in connection with Mr. Moore's discussion, and that is whether there is not a connecting link between the system of experience rating which may be developed and the reduction in the number of classifications—that is, by consolidation of several into one, and eliminating the unnecessary ones by a system of grouping. We are accustomed, I believe, to think of experience rating as a means of providing different rates for two plants that appear physically the same. One has a better experience because of the moral hazard of the plant than the other, and that is reflected by experience rating. But the thought I want to bring out is this: In the manual we have such classifications as valve manufacturing and clock manufacturing. Now, there is no difference in the base rate for the man who makes a very large valve and the one who makes a very small valve. Is it not going to be true that the man who makes a very large and heavy valve may reasonably be expected (other things being equal) to develop an experience which will increase his rate whereas the employer who makes only a very small valve will develop an experience which will reduce his rate. In other words, will it not be true that experience rating may take care of a situation at present unsolved, namely, that of adjusting the rate according to the size and nature of the product of a particular risk within a given classification entirely apart from the question of the moral hazard of such risk. It would seem to me that such a result would tend to make possible a reduction in the number of classifications in the Manual without causing any injustice to the individual assureds.

There are two other points in Mr. Moore's paper to which I would like to refer.

First, in respect to the grouping of industries. Industries may be grouped according to the nature of the business or according to the degree of risk of injury. The International Association of Industrial Accident Boards and Commissions has completed a grouping of industrial classifications, and this grouping proved to be of value at the Joint Conference* on Workmen's Compensation Rates

*See proceedings of the Joint Conference published by the Insurance Department of the State of New York, p. 20.

held in New York City during the latter part of the year 1915. This grouping has the endorsement of the Casualty Actuarial and Statistical Society of America.*

In utilizing a grouping based primarily upon the nature of the business, however, for rate making purposes, it is essential that underwriters and engineers shall determine the varying degree of hazard within a group. A group may contain a number of classifications, all of a similar character so far as pertains to the nature of the product manufactured, and yet there may be a wide variation in the hazard.

A grouping in accordance with the degree of risk of injury means a grouping together of classifications which should take substantially the same rate. So far as I am aware no such grouping at present exists. It can only be prepared from experience and the experience necessary for the compilation of such a grouping must of necessity be built up from the experience in each individual classification. It would seem to be necessary, therefore, for some time to come to keep the individual experience by classifications if we are to ultimately have a grouping for rate making purposes along the lines suggested in Mr. Moore's discussion.

The other point which I wish to mention is in respect to the keeping of experience on schedule rated policies separately. The Pennsylvania Compensation Rating and Inspection Bureau has devised and is using a system of cards for the purpose of keeping the experience on all risks which have been inspected and a schedule rate established thereon. The detailed data appearing on these cards is such that many different studies may be made, for example if arranged numerically by code numbers, groups are automatically formed, which can be compared by size of payroll, credits, charges or by specific items for which credits or charges are made. The Bureau is developing a record of experience, therefore, by industries showing the exact effect of each item in the schedule as it applies to each classification. This may be further refined by individual risks from the data appearing on the cards if it is desired to do so. As the cards are filed by code numbers and each card bears the Bureau file number, the system acts as an index so that if the inspection reports for any given classification are desired they may be readily obtained from the files by reference to the cards.

* See *Proceedings,* Vol. II, pp. 4–6.

SCHEDULE RATING OF PERMANENT INJURIES.—G. F. MICHELBACHER.

VOL. I, PAGE 257.

WRITTEN DISCUSSION.

MR. EDWARD S. GOODWIN:

This paper presents a feasible plan of valuing automatically the great majority of that important class of injuries which are permanent in nature, through the use of arbitrary schedules, and sets forth for consideration excerpts from those which have been constructed for the purpose.

Any scale of compensation benefits to be acceptable in its entirety must produce a proper amount of compensation for all injuries in the aggregate and, at the same time, distribute compensation between specific cases in proportion to their relative importance. Further, as respects the specific case, the amount payable must be distributed to the best advantage; that is, both the rate and period of compensation must be so determined as to best serve the interests of the disabled workman.

By applying the schedules to specific cases percentages of disability are determined which may be converted into periods of compensation through the application of the arbitrary rule of granting four weeks' compensation for each one per cent. of disability. These in turn, even in the relatively few cases of more serious disabilities where life pensions follow the termination of such periods, are uniformly converted by the application of 65 per cent. of the average weekly wages into sums which represent the determined values, exclusive of life pensions, of the disabilities in terms of money. These, in the final analysis, are composite values produced by combining the influence of rates and periods of compensation which have been selected. Having in mind the source from which the schedules, excerpts of which are given, were taken we are justified in assuming that as a measure of compensation the plan produces a scale of benefits sufficiently liberal in the aggregate, and to that extent meets our requirements.

Considerable space might be here devoted to the discussion of Tables I, II and III but, as they are all based on personal judgment and have been systematically compiled, it seems best to waive any minor differences of opinion and accept them as examples of constructive effort and proceed to consider the problem further upon the basis of ultimate results.

Having assumed that a combination of the values of all cases as finally expressed gives an aggregate amount of compensation that is equitable the question arises as to the fairness of the plan when applied to the specific case, having in mind not a composite value but rather the correctness of both the period and rate of compensation.

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At this point, the following facts may well be emphasized; that, ignoring for the time being cases involving life pensions and limits, the rate of compensation is in all cases 65 per cent. of the average weekly wage and in like manner the period of compensation in weeks is four times the finally determined percentage of disability.

It would seem that, while a fixed rate and arbitrarily determined percentages may produce correct values, they do not necessarily permit of an ideal method of distribution as respects rate and period. For instance, for a disability rated 60 per cent., 65 per cent. of wages is payable for 240 weeks; for a less serious disability, say one rated at 20 per cent., the rate remains constant at 65 per cent. but the period is 80 weeks. The resulting amount of compensation for the first 80 weeks is the same in each instance and consequently the workman most seriously disabled and therefore in need of a greater amount of assistance may receive the lower total income. To illustrate: If we assume that the determined respective percentages of disability and losses of earning power are relatively the same (and they must be at least roughly proportionate if the schedules are properly graduated) then the man 60 per cent. disabled may earn about 40 per cent. of his wages and receive as compensation 65 per cent., total 105 per cent.; the man only 20 per cent. disabled may earn 80 per cent. of his wages and receive as compensation 65 per cent., total 145 per cent. The situation is further aggravated by the fact that at the outset the more seriously injured man has a lesser chance of earning even the lower percentage of wages ascribed to him than has the other of earning the higher figure.

From the foregoing it would appear that if we assume the amount of compensation as finally expressed by the product of rate and period to be correct for each case it would seem better in minor cases of disability to extend the period with an equivalent reduction of rate. If the periods thus produced prove to be too extended then a fair assumption would be that the amount of compensation for such minor cases should be reduced, preferably through the operation of a reduction from the 65 per cent. rate, and the saving added to the benefits prescribed for the more serious cases.

A man who has been seriously disabled, say to the extent of 80 per cent., receives 65 per cent. of his average wages for 240 weeks and then a pension of 20 per cent. for life, an abrupt drop even though he may have regained a portion of his former earning power. As rehabilitation is not instantaneous at the end of 240 weeks or any arbitrary period a gradual grading off of the rate of compensation with a corresponding extension of period might well be incorporated in the plan to advantage. If in very serious cases this were supplemented by adding thereto the saving which could be made in connection with the treatment of minor cases a more humane plan would result. This is particularly true in that the 20 per cent. is supposedly a rather scant provision, in the event that

the workman has dependents incapable of self-support. Incidentally, a good distribution would follow such a grading in that compensation would be conserved to meet subsequent needs instead of being exhausted in whole or in part at an earlier date simply because it was available at that time in quantity.

In conclusion, it may be stated that the plan outlined seems to possess advantages over some existing methods of valuation in that it gives consideration to certain of those factors of importance not ordinarily considered, but that it might be improved by providing for a different distribution of the payments as respects rates and periods of compensation and possibly to a lesser degree between disabilities of varying degrees of severity. The discussion of certain features has been purposely omitted in order not to duplicate data already available in Volume XV, pages 166 to 173, *Transactions of the Actuarial Society of America,* where a discussion of Professor Whitney's views may be found.

MR. WILLIAM LESLIE:

I have only words of commendation for Mr. Michelbacher's clear and lucid statement of the compensation problem presented by permanent injuries and the attempt in California to solve that problem by schedule rating. However, no matter how staunchly we may advocate the economic and social principles involved in schedule rating of permanent injuries, we are at once struck with the vast number of assumptions based upon a priori reasoning and investigation which were required in the construction of the permanent disability rating tables described by Mr. Michelbacher. A certain fear is bound to creep into our minds as to whether or not the tables applied in practice will measure with sufficient accuracy the degree of disability which is likely to result from a certain injury. In making any practical tests to determine the accuracy of the tables, there should be borne in mind Mr. Michelbacher's statement to the effect that the tables deal with the average man so far as education, health, adaptability, etc., are concerned and sufficient cases should be examined to make this average man the basis of the test.

In advance of a practical test, one would be very much more inclined to believe in the accuracy of the tables if more stress had been laid on the reasons for making certain assumptions and, where experience elsewhere had been followed, the reference had been given.

Very briefly, what are the points about the construction of the schedule, which may lead us to doubt its correctness?

In establishing a relation between the ratings for the same injury and occupation at age 15 and age 75, Mr. Michelbacher quotes Professor Whitney's original assumption that a 10 per cent. disability at age 15 corresponds to a 20 per cent. disability at age 75.

He then states that the tables were based on the assumption that a
10 per cent. disability at age 10 corresponds to a 17½ per cent. dis-
ability at age 75. This change has evidently been made because
of a resulting simplification in the formula connecting ages 39 and
75. It seems like a confession of weakness as regards the ac-
curacy of the assumption, because a change of 2½ per cent. in a
rating at age 75 is very considerable. In fact, it is just one-half
the amount of change in the ratings at 75 found upon going from
one table to the other. At this point of his paper I believe Mr.
Michelbacher should have explained fully the basis of Professor
Whitney's original assumption, together with the reason and jus-
tification for modifying it. As it now stands, one is led to believe
that it would be fully as correct to say that a 10 per cent. dis-
ability at age 15 corresponds to a 15 per cent. disability at age 75
or that a 10 per cent. disability at age 15 corresponds to a 25 per
cent. disability at age 75. Under the California law, which allows
four weeks' compensation for each one per cent. of disability and
a maximum weekly compensation payment of $20.83, a difference
of even 2½ per cent. may mean a difference of as much as $208.30
in the amount of compensation payable. The tables themselves
have been worked out to give ratings to one-fourth (¼) of one per
cent. and, therefore, the relation between the ratings at ages 15
and 75 should be established on a basis which we are reasonably
satisfied is more substantial than guess work.

The assumption has been made that a boy of 15 has perfect
power of accommodation and a man of 75 has none. Further, that
this power of accommodation is a linear function of the age and de-
creases uniformly with the increase in age. How would a change
in this assumption affect the tables? Suppose instead of assuming
ages 15 and 75 as the lower and upper ages respectively, ages 20
and 60 had been taken. A new assumption connecting the ratings
at ages 20 and 60 is all that would have been required, which pre-
sumably could have been determined as accurately as the one used.
A change, therefore, in the limiting ages of the tables would only
change the ratings between the limiting ages in so far as it would
affect the correspondence between the ratings at the upper and
lower ages. Suppose, however, that instead of the power of ac-
commodation being a linear function of the age, it were to decrease
rapidly between ages 15 and 30, stay nearly constant between ages
30 and 45, decrease rapidly again between ages 45 and 65 and
then decrease slowly to age 75. This or any other similar assump-
tion might be made and could probably be supported by fairly
conclusive reasoning. It would obviously make a material differ-
ence in the ratings at various ages.

In constructing the plus and minus tables, additions were made
to the ratings at age 75 and by keeping the ratings at age 15 con-
stant the ratings for intermediate ages were found by interpola-
tion. Is it correct to keep the ratings at age 15 constant for the

same injury in all occupations? If for the standard table there is a certain relation between the ratings for ages *15* and *75*, then should the same relation exist for other tables? The tables about which Mr. Michelbacher is talking have been formed on the basis of one set of answers to these questions. What result would it make in the tables to assume for instance that the ratings at age 15 should vary for different tables or that the same relation between the ratings at ages 15 and 75 should exist in all tables, or that both of these conditions should exist? How would such tables work out when applied to practical cases? The answers to these questions would involve considerable work, but would undoubtedly be extremely interesting. They do not affect the theory of schedule rating but they do affect its practical application very materially.

The assignment of ratings to various injuries for the standard man and the assignment of occupations to various forms depends upon judgment, backed up by foreign experience and local investigation, and, therefore, may be right or wrong according as the judgment used was good or bad. This condition would exist no matter how correctly the assumptions used in preparing the tables had been made. It is one of the necessary evils attending the introduction of a new plan, for which there exists no statistical basis; but it is in my opinion of minor importance as compared with the construction of the tables themselves. It will take but a comparatively short time to accumulate sufficient data on which to establish relative ratings for injuries and occupations, but it will take a very long time to collect enough data to determine the relation between the ratings for different ages.

It is rather interesting to note that California statistics show the average age of injured workers to be lower than 39. I presume this age was taken in the construction of the tables because of a calculation made by Professor Whitney, which is described in a publication of the California Industrial Accident Commission as follows:

"It was assumed that a man of age 39 could be taken as typical of the whole working population; that is, that the average cost for compensation to all workmen as a whole would be the same as the cost for a man of 39. This was based upon an actuarial computation of the cost of compensation among a population between the ages of $15\frac{1}{2}$ and $59\frac{1}{2}$. These limits were taken after a study of the census figures for California."

The establishment of the 52 occupational groups is particularly commendable, not only because of the greater ease in constructing the original tables, but also because of the readiness with which it lends itself to the rating of additional occupations.

MR. I. M. RUBINOW: There is quite a difference in the character of Mr. Michelbacher's and Mr. Goodwin's papers. I agree with a good deal that Mr. Goodwin has said in his paper. Of course, Mr. Goodwin's criticism should have been directed toward the ordinary dismemberment schedule as well.

I think the California plan has been overestimated, although there are two very definite virtues of that plan which I think need not be minimized. But because of these two existing virtues the fact has been disregarded that there are a great many faults in the remainder. There are two reasons why the California schedule is superior to any of the twenty-seven dismemberment schedules existing in the various states, and they are that it recognizes the influence of age and occupation. Whether these factors have been properly weighted or not I don't know. Of course, nobody knows. Take, for instance, the assumption that the factor of age is a constant, so that compensation increases on the assumption that the injury or disability increases in direct proportion to the rise in age. That is a rather broad assumption. I don't know what there is to substantiate it. I somewhat doubt it. The best thing that can be said of the California schedule is that it presents the judgment and observations carefully made by careful and honest people.

I am discussing the California plan rather than Mr. Michelbacher's paper, because he has correctly and carefully described that plan. After we have given those two credits to the California plan, I think we all recognize that it carries several faults. It still retains full payment for part time in cases of disability that are partial in character and may last for life.

Now, there is one criticism that may be made of the California plan. I am not familiar with the conditions in California, and do not know whether the schedule has any binding legal force or not.

I am always suspicious of a statement that any particular law is satisfactory to everybody. If you talk to people in New York, everybody is satisfied with the New York act. If you go to Massachusetts, you have the official statement that the act is satisfactory to everybody. The fact that no one kicks is not evidence that a plan is a good one.

A peculiar feature of the California Act is that it recognizes temporary and partial disability. Now, if a man suffers from temporary partial disability, he is entitled to get partial compensation as long as the temporary disability lasts, which may be three hundred weeks. No one can tell whether the thing is temporary or permanent until the man is dead. After that, of course, we know there is no chance of improvement. There are a great many conditions which I think need not necessarily be permanent. So there is at least in law a selection between the two methods. The criticism of the California system is that it begs the entire question.

If you take the German or Austrian experience you will see after thirty or thirty-five years they have at least developed a large body of experience. They have had hundreds of thousands of permanent partial disability cases which have been adjusted by all kinds of people, and as a result of those thousands of adjustments and thousands of discussions, considerable judgment has been involved. As a matter of fact, in Europe they use dismemberment schedules in an advisory capacity, indicating the probable disability in various injuries dependent upon various occupations, and a man can study those books.

Now, if you assume that you know it all, and adjust your injuries on that know-it-all theory, then you lose all your chances of learning by experience. The California people had the opportunity to get the experience. I have no criticism to make of Mr. Michelbacher's actuarial or mathematical basis. But the trouble is that it also assumes the correctness of the original schedule, for which there was no basis of information. Secondly, it assumes the absolute correctness of the rehabilitation theory, which I think in many cases is obviously incorrect. I doubt the basis of truth of that principle.

I think that people injured so as to suffer permanent disability are entitled to specific consideration, just as a patient who comes to a doctor is entitled to have himself examined and not be treated according to actuarial formulas. I think you will recognize that that comparison is a valid one.

We are dealing with social diseases. I have not the time to analyze the cases that Mr. Michelbacher mentions; but the fact that your arithmetic balances will not furnish a man or his widow with bread and butter.

MR. ALBERT H. MOWBRAY: I would like to call attention to the fact that the fundamentals of the California plan were presented by Professor Whitney in a paper before The Actuarial Society of America appearing in the *Transactions*, Vol. XIV, p. 308 et seq. The discussion took place at the next meeting and is reported in the *Transactions*, Vol. XV, p. 166 et seq. I think it would be well for the students who wish to follow the whole problem to read this paper and discussion. It is also perhaps in order to point out that some of the members of the Massachusetts Industrial Board were rather favorably impressed with the California plan, and certain studies were made by employees of the Board in Massachusetts of typical cases, and those are reported in the second annual report of the Industrial Board of Massachusetts, which, perhaps, will throw some light on this discussion from a practical point of view.

MR. G. F. MICHELBACHER: The question of partial temporary disability is disposed of by applying the definition of "permanent injury" to the individual case. If a man has not lost a function or a part of his body, he receives compensation for partial temporary disability while partially disabled.

MR. RUBINOW: Of course, every injury is the loss of a part of the body or the loss of a function.

MR. MICHELBACHER: I mean permanent loss of function or dismemberment. A man must have suffered an injury resulting in a stiff finger, or the partial loss of an eye, or a dismemberment, if he is to be considered permanently disabled. If the injury results in a bruise or a fracture, or a disability of that character, a man receives compensation for total disability while the total disability lasts, and then compensation for partial temporary disability as long as partial disability lasts, with, of course, proper regard for the limits set forth in the Act. I think that answers that question.

About the theory itself, I don't think Professor Whitney ever intended the theory to be absolutely scientific in every way. The question of considering the power of accommodation a linear function, as far as age is concerned, has been discussed a great deal. Mr. Phillips of St. Louis, for instance, assumes that the power of rehabilitation varies with the hardening of the arteries, and has used blood pressure statistics to develop a more or less complicated theory of accommodation.

MR. RUBINOW: My objection is to that method without individual attention.

MR. MICHELBACHER: The man does get individual attention. These cases remain within the jurisdiction of the Commission for 245 weeks. If the Commission finds that an award is excessive, it may decrease it or it may increase it if it is found to be insufficient.

I am not in favor of using detectives to trail a man in order that his compensation payments may be terminated as soon as he helps himself by making an honest attempt to secure employment. This method takes away the incentive to get out and find a job. The proper method is to encourage the injured man to secure work in which he can use his injured member, and for that reason we give each permanently injured employee the amount of money which we have determined the average man of average health and of average inherent adaptability in each occupation requires to enable him to get on his feet again and then turn him loose to find his own salvation. The period of time covered by these payments gives the average man sufficient time to rehabilitate his earning capacity. If the amount awarded in this manner is excessive, a certain part must be considered a subsidy well spent in re-creating an honest and industrious worker. If it is not sufficient to cover the actual period of disability the following section of the Workmen's Compensation, Insurance and Safety Act provides additional compensation to carry the worker along until the disability has terminated: "Nothing contained in the foregoing schedule of permanent disability indemnity shall be held to limit the amount of compensation recoverable for any such permanent injury during any period of total incapacity resulting from that injury."

MR. G. F. MICHELBACHER.

AUTHOR'S REVIEW OF DISCUSSIONS:

I think Doctor Rubinow assumes that the rehabilitation theory has been accepted absolutely in California and carried to its logical conclusion in the provisions of the law relating to Permanent Disability. I pointed out in the second paper that this theory has not been accepted in California for serious permanent injuries. That is to say, there is a limit beyond which the injured employee in California is assumed not to be able to fully regain his lost earning capacity, and it is for this reason that pensions are allowed for serious permanent disabilities. In other words, it is assumed that the rehabilitation theory works well up to a 60 per cent. permanent injury, and that if a man receives an injury which is rated over 60 per cent., he cannot fully regain his earning capacity; that handicapped by so serious a disability, he cannot be expected to regain more than a maximum of 40 per cent. of his former earning capacity and for that reason some permanent pension must be provided to make up the difference between what he can theoretically earn and 40 per cent. of his former earnings—the amount he must be given to insure his own upkeep.

Under this theory payments are made for 240 weeks to enable the injured man's family to rehabilitate itself, and then following these payments the injured man is given a sufficient permanent pension to enable him with the amount of wage he is physically able to earn to take care of himself. It is taken for granted that the family will get along satisfactorily after the payment of compensation for 240 weeks—the period for which death payments are made.

Now, as far as the California plan is concerned, it is an attempt, under the present system, to administer the Workmen's Compensation Act automatically. There are plenty of checks and balances. Doctor Rubinow has pointed out that the Schedule is not a hard and fast rule. It is not necessarily adhered to in each decision. In fact, there are several decisions of the Commission where the Schedule has not been strictly followed. The Schedule has been adopted by the Commission as a guide, and I think nearly every one will agree that some sort of guide which will insure a standard method of taking care of these cases is perfectly legitimate.

When I spoke of the present method of administering Workmen's Compensation Acts, I referred to the absolute impossibility of rating permanent disabilities in, say, California in exactly the same way as they are rated in Europe. If you will take the definition of permanent injury which we use in California, namely, an injury that involves either the loss of a function or a part of the body, you will find that there will be in the neighborhood of six hundred cases per year, or two or three cases for each day the Commission offices are open. The Commission at the present time is

almost flooded with litigation, and as this pressure increases, the personal attention which the Commissioners are able to give these cases is, of course, diminishing. I venture to say the decisions of the Commission are now largely written by a legal department and are in the majority of cases merely signed by the Commissioners. Of course, that is not a commendable state of affairs. It is absolutely essential that the procedure be limited to cases where there is actually a controversy. The Schedule has reduced the number of cases heard by the Commission by, I should say, one-third, and has therefore allowed the Commission more time to deal with cases that involve real mooted questions.

With reference to Mr. Leslie's discussion which is devoted almost entirely to a review of the assumptions which were made at the time the schedule was constructed, it should be pointed out that in general the assumptions were made as simple as possible. It was realized that there would be considerable opposition to a schedule based upon empirical assumptions and in order to remove any obscurity which might be introduced by the use of complicated formulas of one sort and another, it was thought wise to limit the application of the theory to as simple a form as possible. For this reason, the power of accommodation was assumed to be a linear function of the age. This permitted the use of simple interpolation in deriving the values for the various ages. The fact that these values are carried to the fine point of one-quarter of one per cent. need not necessarily prove their incorrectness, for this refinement was made in order that attempts to use the table for various ages would produce uniform results. If the table had been computed for every tenth age, for example, it would not have been necessary to make this refinement, but in the use of a table of this character for intermediate ages, it is absolutely certain that an attempt would have been made to interpolate a value for the age in question. Realizing this fact, values were computed for odd ages and a rule was inserted in the schedule requiring the use of a definite procedure in determining ratings for all ages. This provision has had the effect of definitely establishing one rating for each injury, age and occupation.

As I have stated, the assumption that the power of accommodation is a linear function of the age has been severely criticized. It is probably not the scientifically correct assumption, but any other theory with reference to this assumption can be based on nothing but a more elaborate hypothesis, and with the idea of simplifying the theory underlying the schedule, the assumption of a linear function was the simplest assumption that could be made.

With reference to the assumption that the ratings at age 15 should not vary for different tables, it is merely necessary to point out the fact that there can be no occupational factor in the case of a boy of age 15, for it is difficult to conceive of a case where a boy of age 15 has become definitely established in an occupation. To

be sure, there may be cases where a boy of age 15 has entered upon his period of apprenticeship, but a provision in the Act requiring that compensation be computed on the basis of the wage this boy will theoretically earn at the attained age of 21 removes any possibility of discrimination in his case. The fact that the relation is the same between the ratings for ages 15 and 75 in all tables is again an assumption which makes for simplicity. Other methods have been suggested and Mr. Phillips of St. Louis has even gone so far as to eliminate all tables except Table "A" and to provide a series of factors or differentials whereby ratings in this table may be extended to cover the various degrees of occupational use.

The assumption of 39 as the average age has caused considerable controversy, principally because no one has ever been able to check this figure. The fault probably lies with the writer who has not made clear the reason for this assumption. Age 39 is not the average age of workers who are injured in California. As a matter of fact, it is slightly higher than the average age of injured workers anywhere in the United States. It is, however, the average age of the working population in California and was taken only after a careful computation which involved the use of population figures taken from the 1910 census for California. Using these figures, it was ascertained that the average age of persons between the ages of 15½ and 59½ in the population of the State was 36. On the assumption that age 65 is probably more nearly the "scrap-heap" age of industrial workers, this result was advanced to age 39. It should be noted that in this computation the population of working age was taken and that no attempt was made to find the injured workers' population or the working population. It is also interesting to note that age 39 is the average injured annuitants' age in California, this fact having been established by the following computation. It was assumed that 8,892 injured persons were sent to purchase 3½ per cent. life annuities computed on the basis of the American Experience Mortality Table for their respective ages. In order that these annuities might more nearly conform to the compensation payments, the continuous annuity was used as a basis for this computation, as the value of this annuity is a very fair approximation of the value of the annuity which is payable fifty-two times per annum. It was determined that the cost of these 8,892 weekly life annuities would be $159,102.41, or an average cost per annuity of $17.8928. The cost of a similar annuity computed for age 39 is $17.1946. Consequently, age 39 may be assumed to be a very reasonable approximation when the interest rate is 3½ per cent.

The assumption of the relation between the ratings for the same injury and occupation at age 15 and age 75 was first made by Professor Whitney, who assumed that the disability for the boy of age 15 was one half the disability for the man of age 75 who had sustained a 20 per cent. impairment. In modifying Professor Whit-

ney's formula based upon this assumption, it was necessary to some-
what materially alter this assumption in order to secure a working
formula.   It is acknowledged that the relation which produces the
result shown in the schedule under Table "A," namely, that a 10
per cent. disability at age 15 corresponds to a $17\frac{1}{2}$ per cent. dis-
ability at age 75, is entirely the result of this endeavor to create a
workable formula.   In other words, it is an accidental result due
to the desire to simplify the method of procedure, and may or may
not be a "confession of weakness."   You must understand that at
the time the schedule was constructed, considerable study was given
to the problem, not that complicated formulas might be derived,
but that the formulas which were used might be made as simple
and understandable and workable as possible.   Any one with care-
ful study at that time could have made an assumption substantially
as correct as this one.   This is admitted.   But results obtained by
the use of this formula were results which could be justified by
general reasoning and they were consequently taken in the absence
of definite information to the contrary.   In this connection, the
following interesting check on this assumption may be mentioned.
In evaluating injuries for the standard man who had been assumed
to be an unskilled worker, it was found necessary to request the
aid of surgeons.   The first blank prepared with this object in view
asked for several estimates for each injury based upon varying ages,
and it is interesting to note that in the opinion of the surgeons
furnishing the estimates, the percentage corresponding to 10 per
cent. for age group 20 and under was about 26 per cent. for age
group 61 years and over.   These limits would give a greater varia-
tion in the ratings for ages 15 and 75 than those assumed.   Conse-
quently, the rating tables, if anything, lean toward conservatism,
as far as this factor is concerned.