

CLASSIFICATION OF RISKS AS THE BASIS OF
INSURANCE RATE MAKING WITH SPECIAL
REFERENCE TO WORKMEN'S
COMPENSATION INSURANCE

BY

A. H. MOWBRAY

Classification of risks in some manner forms the basis of rate making in practically all branches of insurance. It would appear therefore that there should be some fundamental principle to which a correct system of classification in any branch of insurance should conform, even though in its application to each particular line the general principle may take what seem to be discordant forms. It is the purpose of this study to seek out this principle and if found, attempt to apply it with special reference to workmen's compensation insurance, in which the problem of a correct classification system seems to be of special importance.

NATURE OF THE INSURANCE BUSINESS

The economic function of the business of insurance has been defined as the safe and equitable distribution of the burden of contingent loss. By safe in this definition, we mean distribution under a system such that there will be no failure to spread the loss occurring to any individual, and that the proportion in which any individual is called upon is not such as to cause him serious financial distress. By equitable is meant a distribution substantially in accordance with the inherent hazard or risk of each of those whose losses enter into the general pool for distribution.

A distribution which by the above test would be condemned as inequitable may under certain circumstances be safe, but probably this never could be so under business conditions. For example were the economic function of the insurance business taken over exclusively by the State and operated as a monopoly with compulsory insurance of all risks, the distribution might be made pro rata on the volume of the exposure without regard to the degree of risk to which the insured is

exposed, much, for example, as the state may collect a school tax as a direct property levy without regard to the number of children any tax payer may have and therefore his participation in the benefits of the system.

When insurance is conducted as a business, however, with various insurers competing for the business and with various persons subject to risk of loss having the right of selection of the insurance carrier, such an inequitable distribution cannot be carried through safely as the process of competitive selection would tend to the destruction of those carriers whose rates were inadequate, or the barring from insurance of the classes for which the rates were inadequate. The failure of the A. O. U. W. and other flat assessment life insurance concerns is directly traceable to their failure to distribute the burden in accordance with this requirement of equity.

The means of distribution when insurance is done as a business, is the premium paid in advance and the business does not perform its proper economic function unless this premium provides for an equitable distribution by being closely adjusted to the inherent hazard of the individual risks. This is equally true of workmen's compensation insurance as of other lines notwithstanding the basic theory of workmen's compensation that the risk of injury is a part of the cost of production and the cost of compensation should be borne by the consumer of the product, the insurance being merely the means of passing it on. This is so because of the natural limitations imposed by competition between producers on the extent and manner of so passing the cost along.

It is unquestionably true that in all adequate cost accounting systems, the cost of workmen's compensation insurance is taken account of, and therefore, to that extent, enters into the considerations which tend to fix the price of the commodity produced. However, the entrepreneur, unless he has a monopoly of an article, cannot fix his price solely on the basis of cost of production. He cannot do so in many instances even when he has a monopoly because there are few, if any, articles for which the consuming public cannot find a more or less satisfactory substitute. Therefore, the price at which the producer may dispose of his goods is regulated by the condition of the market, by the law of supply and demand. While, if all producers are subject

to a charge for workmen's compensation, each will have a greater opportunity to recoup himself than he would were some of his competitors free from this charge, that is only one of the conditions which determine the market price he can obtain for his product and the fine shadings of the cost of insurance from risk to risk cannot be reflected in the market price and recovered from the consumer except in the most rare instances and practically as a matter of pure accident. Therefore the variations in the cost of workmen's compensation insurance directly affect the profits of the entrepreneur. Nor is this overlooked by entrepreneurs in general as witness the weighing of the relative advantages of insurance and non-insurance (self-insurance) by the operators of all large enterprises and the tendency of large risks more readily to consider mutual insurance, due to their desire to figure closely on all their costs.

It does not seem to me the indifference of the small producers to fine points of difference in cost of insurance and their less tendency to seek the lowest cost, is evidence in contravention of the above reasoning. It is notorious that the smaller producer is in general not as close a buyer as the large producer, especially of the less costly items entering into his operations. These economies are crowded out by bigger problems he cannot delegate to others, for, in considering relative values he considers it generally more to his advantage to give his attention to these wider problems.

The large purchaser of insurance of any kind is quite as keenly interested in securing sound insurance at the lowest cost as is the large purchaser of any commodity. While, if he has studied the matter, he is usually willing to admit that insurance rates cannot safely be fixed by competition and bargaining, the instinctive desire so to bargain still remains. Where he cannot, as in marine insurance, shop around for the lowest rate any insurer may offer and weight the relative advantages in rates, terms and security offered by several competitors, he usually wants as a minimum consideration, assurance that the rate quoted fits his risk as accurately as may be. Realizing that classification has a large influence on his rate, he presses for such phrasing of the classification as seems to him most nearly to describe his own risk.

Thus accurate rating of risks is called for, both as necessary to the proper performance of the economic function of the in-

insurance business and to meet the demands of insurers for proper rates. Both these sources of pressure for precise rating lie in the interest of the insuring public. A certain amount of inequity in rate making is not a disadvantage to an insurance company equipped with a skillful underwriting staff as by selection of the overcharged risks and careful exclusion of the undercharged, the condition could be made a source of profit to the company. If the rate for each risk is accurately proportional to its inherent hazard only chance will determine the element of underwriting profit or loss and in the long run there will be none.

WHY ARE CLASSIFICATIONS NECESSARY?

The losses which it is the business of insurance to distribute arise out of hazards, that is, the combination of value and exposure of such value to the risk of destruction. These hazards are natural things, that is, they are the results of the action of natural forces, including in some instances psychic forces as well as physical, but nevertheless natural forces which act in uniform ways, or, as we express it, obey natural laws.

As long ago as the days of ancient Greece and Rome the gradual transition of natural phenomena was observed and set down in the Latin maxim, "Natura non agit per altum." If each risk, therefore is to be precisely rated, it would be necessary to recognize very minute differences and precisely measure them.

But just as the human mind is incapable of recognizing and wrestling with the infinite so it is not capable of recognizing and working with the infinitesimal. We do not and cannot perceive the differences in a gradual transition. For example, the rainbow appears to contain six colors, and on first appearance they seem to be fairly sharply differentiated, but as we look more closely we begin to observe they run together. As we spread the spectrum out to greater extent by the use of prisms or other laboratory apparatus so that each color as it appears in the rainbow occupies a greater space, we observe that the colors are not sharply defined but gradually merge, red into yellow through varying shades of orange, and yellow into blue through varying shades of green, but our eyes do not appreciate the infinitesimal changes in color with changing wave length. And this same limitation runs in all fields.

Since we are not capable of covering a large field fully and at the same time recognizing small differences in all parts of the field, it is natural that we resort to subdivision of the field by means of classification, thereby concentrating our attention on a smaller interval which may again be subdivided by further classification, and the system so carried on to the limit to which we find it necessary or desirable to go. But however far we may go in any system of classification, whether in the field of pure or applied science including the business or insurance, we shall always find difficulties presented by the borderline case, difficulties which arise from the continuous character of natural phenomena which we are attempting to place in more or less arbitrary divisions.

While thus acknowledging that classification will never completely solve the problem of recognizing differences between individuals, nevertheless classification seems to be necessary at least as a preliminary step toward such recognition in any field of study. The fact that a complete and final solution cannot be made is, therefore, no justification for completely discarding classification as a method of approach.

NATURE OF INSURANCE HAZARD

Since it is insurance hazards that we undertake to measure and classify, the preliminary step in studying classification theory may well be to ask what is an insurance hazard and how it may be determined. It must be evident to the members of this Society that an insurance hazard is what is termed "a mathematical expectation", that is a product of a sum at risk and the probability of loss from the conditions insured against, *e. g.*, the destruction of a piece of property by fire, the death of an individual, etc. If the net premiums collected are so determined on the basis of the true natural probability and there is a sufficient spread then the sums collected will just cover the losses and this is what should be.

The sum at risk is in general a term or condition of the policy, fixed more or less arbitrarily—entirely so in the case of life insurance, for example and indirectly so by law in workmen's compensation. Sometimes the policy covers several contingencies for each of which there is a different sum at risk, as for example in personal accident insurance, or in workmen's

compensation where the benefit under the law depends on the extent and nature of the injury not solely on the occurrence. Even in these cases and the still more complicated case of a fire insurance policy covering partial loss, it seems to me the true view is that the sum at risk is fixed subject to the occurrence of the contingency producing such loss. Under this view the variation from risk to risk arises from varying probabilities of occurrence of the contingencies insured against.

Such probabilities are referred to as expressions of chance and in the individual instance appear to be largely the result of chance influences, yet when taken in the mass the stability of these probabilities is well known. A little reflection of a philosophical nature will furnish us the explanation of this regularity. Events in nature do not happen without cause and causes always produce uniform effects, wherefore the probability after all is the expression for the frequency of variation in combination of causes, that is it is the expression of the operation of natural law. Philosophical reflections along these lines enabled Makeham to develop a mathematical expression for the law of variations in human mortality with age that has been repeatedly tried in the graduation of various mortality tables and has proven a substantially correct statement over almost the entire period of adult life. Professor Karl Pearson working along similar lines has broken down the mortality curve into a series of frequency curves that show the varying potency with age of groups of causes and Pearson's curves again have been verified in a number of cases.

We reach the conclusion then that the problem of adjustment of insurance rates for varying risks is the problem of recognizing in those risks variations in the combination of the several causes which tend to produce the contingency insured against and in their strength.

This conclusion, however, does not in itself solve the problem of classification for rate making since we cannot determine by experiment the actual potency of the several causes nor wait for it to be developed in the course of experience. We must learn to recognize in advance those outward characteristics which indicate the presence of particular causes and their strength. In the life insurance field for example, these are sought by means of a physical examination of the person whose life is insured and

while most of the companies confine their business to standard risks, that is, those found to have no peculiar condition indicating an abnormal presence of a particular cause, others have for some time been working in a more extended field and covering lives known to be substandard by reason either of race, of occupation or of peculiar physical characteristics. The basic index of conditions tending to cause the death of the individual of the standard risk type is his age, and this is the standard basis of classification. But where substandard risks are considered it is recognized that there are many men of fifty, for example, who are better risks than others of twenty, and while age may be made the first basis of classification, physical condition, race, occupation and other characteristics are brought in. In the companies having the most extensive substandard business, these variations are recognized by a scheme of numerical ratings analogous to schedule rating in fire insurance and workmen's compensation insurance.

THEORY OF CLASSIFICATION

As pointed out at the outset, we must expect more or less continuous variation in the risks we are compelled to deal with and yet must resort to some system of classification as a first approximation toward recognizing variations between individuals. It seems to me that in this life insurance practice we have the key to a proper treatment of risks for rating purposes, namely a classification system which will extend at least to the point of recognizing major differences in the hazards of individual risks, supplemented by a formula of some kind, following the same general principles as those used in the basis of classification, which will extend the classification system to the point of recognizing minor differences.

Since the problem of adjustment of insurance rates for varying risks is the problem of recognizing in those risks variations in the potency and combination of the several causes which tend to produce the contingency insured against, and since, because there is almost continuous variation from risk to risk both in the combination of the various causes and in the potency of each cause we resort to classification as a first approximation to correct rating with the intention of adding analysis of classification by formula as the second step; the following conclusions

seem to follow respecting the nature of classifications which will prove helpful.

1. The classification should bring together risks which have inherent in their operation the same causes of loss.

An illustration from the field of workmen's compensation insurance may make this clearer. While the finished product of several mills producing cotton cloth from raw cotton may be considerably different; the several steps in the processes of production are identical to a very large degree, the type of help the same and the proportion of the different trades the same. The housing conditions are much alike. And, if we examine their experience over a period of time we find the accidents arising from the same causes. Such risks clearly belong together and a system of classifications which did not bring them together would fail of its purpose. Other instances could be cited but this criterion is perhaps sufficiently obvious without further illustration.

2. The variation from risk to risk in the strength of each cause or at least of the more important should not be greater than can be handled by the formula by which the classification is subdivided, *i. e.*, the Schedule and/or Experience Rating Plan used.

We may illustrate this by the following example.

We might start to classify all textile manufacturing in a single classification, for, though the products differ and the raw materials differ, the processes are much the same and involve the same causes of accidents. But as we pass from the finer classes of cotton and wool fabrics to the coarse products of jute and hemp we find the loss costs mounting because the strength of the causes or at least of some of them is greater. Further, the variations are greater than we find can be adequately measured by the schedule and experience rating plan. Therefore we cannot treat these industries equitably, if we use only one classification for them. We must subdivide and separately classify different textile lines until we get groups of risks in which the same causes of accidents are present and there is not greater variation in their strength than can be measured by the schedule and experience rating plans.

3. The classification should not cover risks which include, as important elements of their hazard, causes which are not common to all.

The canning of fruit and vegetables presents about the same causes of accident and these causes have about the same strength wherever those operations are carried on. But the making of cans brings in new and totally different causes of accidents. The classification covering these operations should be so set up as to exclude this work of can making or else the schedule and experience rating plans should be worked out to take care of the added operations.

4. The classification system and the formula for its extension (Schedule and/or Experience Rating Plans) should be harmonious.

This is probably less a requirement of the classification system than a limitation of the method of construction of the schedule and experience rating plans that are to be used to modify it. Yet it must be clear that consistent results will not be obtained if, for example, the classification system is worked out on the basis of presence or absence of common causes of loss cost and by the schedule we proceeded to apply charges and credits on an arbitrary basis without considering the relation of the several items to cause and cost of losses, finally applying experience rating upon the basis of comparing risk experience with classification experience but using in working out the risk experience average values for loss items highly inconsistent with the classification averages, themselves characteristic of certain combinations of causes which define the classification.

5. The basis throughout should be the outward, recognizable indicia of the presence and potency of the several inherent causes of loss including extent as well as occurrence of loss.

Since we cannot usually determine the cause of occurrences until after the event, we must work from our knowledge of the past, through which we learn to recognize those things which go with the presence of the forces causing the events concerned. These outward indicia must be our guide in classification work.

In devising this system of classification and the formulae for its extension, however, we must not lose sight of its relation to the practical conduct of the insurance business, particularly

to the basis of premium collection. For example, in workmen's compensation insurance the hazard insured against is the requirement of monetary payments under the terms of a compensation law in consequence of injury to employees, but the premium is based upon pay-roll expenditure. So long as this practice continues our classification system must be related thereto, and in viewing causes we should view them in relation to pay-roll expenditure rather than the number of employees, quantity of output, or some other possible measure. In the practical approach to the problem this becomes of considerable importance.

APPLICATION OF THE THEORY TO WORKMEN'S COMPENSATION INSURANCE

When we approach the application of the theory to the problem of classification and rating in workmen's compensation insurance, we naturally associate the cause of accident as noted above with the process or processes carried on by the employer and in general in these will undoubtedly be found the major indicia of the causes of injury to his employes, at least of those causes with relation to the number of such employes. But along with process we must take into consideration the general level of wages and character of the workers as influencing the frequency of accidents per unit of pay-roll and also the extent of indemnity required when injury occurs. On the other hand, we cannot overlook the fact that in the conditions of American enterprise, and particularly in the utilization of by-products, processes tend to become more or less associated and to influence each other, and also that, the degree of standardization of output has a large influence on the hazard of any process.

Going to the extreme of the process point of view, Mr. Fisher some years ago (*Proceedings*, Vol. II. p. 394), suggested that the basis of compensation premium and ratemaking should be the occupation of the individual employes. As a practical proposition it is well recognized by all that it is not possible to go to anything like this length.

The present Manual has grown up out of a Manual in which the major emphasis was on product though it could not be called a purely product Manual. This undoubtedly represents the influence of the entrepreneur, the purchaser of the insurance

who feels or at least claims in almost every instance that his own individual business is unique in certain respects and deserves an individual rate, and who in any event recognizes that his principal business competitors are those manufacturing the same products he does. If he cannot secure an individual rating to his own liking, he seeks a product classification in order to be sure that he does not receive a less favorable rate than they. Indeed he would prefer, were it possible, a competitive rate such as is obtained in maritime insurance.

So far as the product is manufactured by the same process and from the same materials in all cases a Product Manual tends to recognize variation in causes in the same way as a Process Manual. The difficulty with a Product Manual lies in the multiplicity of products which have to be dealt with, the close resemblance of certain products to each other both in outward appearance and in materials and processes involved, and on the other hand the great variation which sometimes occurs in the production of practically identical commodities. A system of classification based solely on product tends to equalize the cost of production but is unfair to the entrepreneur using the less hazardous processes. The practical solution would seem to lie in something of a compromise between these two ideas, having in mind also certain practical considerations as suggested by Mr. Michelbacher in his paper on "The Technique of Rate Making" (*Proceedings*, Vol. VI p. 201), viz.:

"Classifications should meet certain general qualifications. They should be clearly phrased so that their scope may be readily understood by every one who used them. They should represent units for which accurate pay-roll and loss records can be kept. There should be no possibility of manipulation, either for the purpose of misapplication in classifying risks or of 'juggling' pay-roll from one classification to another carrying a lower rate. The statistician in the home office of the insurance carrier should be able to allocate the pay-rolls, premiums, and losses to the classification to which they belong."

The present Manual does represent something of a compromise between the two ideas of a product Manual and a process Manual but the changes which have taken place seem to have been dictated more by consideration of the extent of the practical use made of various classifications and the desire to prevent

misuse of the Manual than by any formulated theory such as we have developed.

A continuous evolution along these lines without studied guidance may ultimately produce a classification system that follows this theory we have developed. But evolution is a slow process and when precedents have much weight it is even more tedious. If in the above we have discovered the correct theory of classification, ought we not to make a serious studied effort to square our practice of Manual making with it? This may be done in either of two ways:

(1) We may discard the present Manual and seek to build in its place a new Manual by processes which, being based upon our theory, must "ipso facto" produce a Manual that conforms to it; or

(2) Taking the present Manual as the starting point, we may critically review it in all its details seeking wherein its classifications and rules conform to our theory and wherein they fall short, and endeavor to correct the deficiencies so disclosed.

While there is much to be said in favor of starting any attempt at the solution of a scientific problem with a clean slate, the first course involves an extensive amount of difficult research at no small cost in time and money. Because of the continuity of the phenomena studied the Manual so produced would still be found at times difficult to apply. And if the changes from the present Manual were extensive and abrupt there would be great disturbance of the business and opportunity might be so given for abuses which would create other and perhaps more serious difficulties than have been encountered in the past.

While I have explored this approach to the problem even to the point of laying out the general lines the research must follow if it is to serve the purpose, I doubt the expediency of the undertaking and believe procedure in the second way will in the end prove more profitable. A further advantage of working in this way will be that we need not undertake the task of a complete revision at one time but can proceed with as much or little at a time as expediency may dictate, attacking first those points where the present Manual seems weakest. The following is suggested as a plan of procedure in revision of the Manual to conform to our theory of classification.

PROGRAM FOR STUDY AND REVIEW OF THE MANUAL

1. Having, after review of the Manual as a whole or by reason of complaint in particular cases, selected as a starting point a classification or group of classifications which are not giving satisfaction there should be obtained descriptions of all risks in such classification and in classifications in any way related to it. These descriptions should furnish a complete picture of each risk in all its aspects and should include but not be limited to an engineering description of raw material, processes, equipment, etc. The more intangible elements such as enter into the personnel arrangements, wage levels, etc., should receive full consideration. With these descriptions available a comparative tabulation should be made listing the characteristic features of each risk and special note should be taken of differences found in risks now classified together and of likenesses in risks thrown into different classifications.

2. Complete accident records for these risks covering a considerable period of time and including an analysis by cause and cost should be obtained and an effort made to correlate the causes of accident with the characteristics noted in the tabulation already made. The effort should be to determine the importance of each noted characteristic as an index of one or more causes of loss including causes of accident and causes tending to alleviate or aggravate the results thereof.

The exact way in which this correlation study will work out cannot, of course, be foretold. Unfortunately I have not now access to data from which I can personally test by experiment how it would be likely to go. It seems fairly obvious that if we know certain accidents have so arisen in connection with the operation of certain machines that we assign the machine as the cause we may from a study of exposure to such machines in connection with such accidents work out an approximate index for the machine. We would then be able to say quite positively that the use of a process involving the presence of those machines was an indication of the probability of accidents of this type, the degree of probability varying with the proportionate exposure to such machines. To cite another example, the use of acids as raw material is an index of acid burns as a probable cause of loss and perhaps an index of explosions. We hardly need to multiply the illustrations.

There will doubtless be a large proportion of the total loss cost in all industries which cannot be so attributed to causes as to assist us in selecting the outward signs of its probability. This residue, it seems to me, will be likely to be of such a nature that it will not be of primary significance for determination of classifications. However this may be, if classification of risks is for the purpose of ratemaking then classification should be based only on those characteristics which are real indicia of hazard and unless we rely upon impression we cannot distinguish such characteristics from others of no importance for our work without some such study which will test whether and to what extent a particular characteristic is an indication of the presence of forces tending to produce or prevent loss.

In passing it may be noted that as was pointed out in Mr. Whitney's paper at our last meeting, the problem of correlation between loss cause and observable characteristic is an essential feature of the problem of developing a rating schedule and if that work has progressed to a sufficient degree it may be that substantial help from this other study can be had.

3. If upon such study of this tabulation and these loss records it be found that the differences in risks classified together are with regard to characteristics which are not found significant or important as indicia of causes of loss, then the risks are properly associated in a single classification and the only change indicated by the investigation would be the association with them of other risks which might have in the past been separately classified and which differed from them only as respects characteristics found to have no considerable significance as indicia of loss causation. If on the contrary the features which distinguish some individuals from the class be found to be significant indicia of loss causation, the classification phraseology or rules which were responsible for their being so classified should, if possible, be so amended as to make suitable provision elsewhere for such risks.

It must be apparent that the converse of this proposition would likewise be true, and if risks in several different classifications were found to have in common all characteristics which are really significant as indicia of loss cause and to differ only in characteristics of no particular significance with respect to loss causation, then the Manual probably errs in treating them

in different classifications and the several classifications should be brought together in a single classification. It might still be expedient for underwriting purposes to maintain separate classifications, but for ratemaking purposes it should be clearly understood that the intent was to treat them as a single classification.

In connection with this work the importance of the Manual rules cannot be overlooked, and in determining whether or not any change in a classification should be made in the light of the evidence brought out by this study, careful examination should be made to ascertain whether or not the Manual rules were in any respect responsible for such association or misassociation of risks. Nor should we overlook the further fact that any system of classification is more or less a network and that a single classification cannot be changed without affecting in greater or less degree the nature of the material which goes into the other classifications.

4. When revision of the classifications has been completed and certainly before undertaking a revision of rates the present grouping of classifications should also be reviewed in the light of the information we will have developed. As with the association of risks into classifications, the association of classifications into groups should be upon the basis of possession of common characteristic indicia of hazard. The process of grouping should be synthetic and may be facilitated by the use of cards on which are noted the important hazard indicia of each classification and their relative weight.

In carrying forward the differentiating of risks within classifications we use Schedule and Experience Rating Plans. The underlying theory of sound schedule rating is the recognition of the hazard (loss causation) value of physical characteristics and the placing of a proper charge against the characteristic when found more frequently in an individual risk than the classification as a whole with corresponding credit for its absence. And the Experience Rating Plan requires that classification experience be that of a body of risks of so homogeneous a character as respects total hazard that the true rate for any risk will be found by taking an average of its own indications and that of the classification weighting each by its volume of exposure.

Thus the schedule will be but a natural and logical subdivision of classifications made in the way proposed and the clarification of classifications by this analytic study will tend toward that homogeneity anticipated in the experience rating plan.

If I am not mistaken a thorough combing over of the Manual by this method would also disclose logical relations between classifications and groups which would have high utility for ratemaking purposes.

Of course, practical conditions in a competitive business world impose restrictions on our freedom of action that cannot be ignored if we are to obtain a truly scientific solution to the problem. And of this fact we must not lose sight. The nature of these limitations are indicated in the quotation I have made from Mr. Michelbacher's paper.