Accounting—A System of Measurement Rules

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Written numeration is probably as old as private property. There is little doubt that it originated in man’s desire to keep a record of his flocks and other goods.¹ In recent years it has been fashionable to identify the whole of accounting with measurement and to insist that accounting is a subdivision of the total field of measurement. This chapter contains comments on this view and contains also some general remarks on measurement and its meaning in the broader field of scientific method.

Accounting, as now constituted and practiced, is composed of a group of behavioral hypotheses, techniques for appraising and ranking need, and rules for classifying and measuring that are oriented toward fulfilling the responsibilities and objectives of the profession. The first task is, of course, to determine the needs to be filled. This task requires estimates of objectives, decisions, and information necessary for these needs. Once these preliminary tasks have been taken care of accounting leans heavily on the field of classification and measurement. This chapter then contains an elementary discussion of some classification and measurement aspects of the accounting profession.

Measurement in accounting is directed at achievement of objectives and is therefore a purposive series of operations and conventions. Thus the tests of effective measurement are the tests employed by instrumentalists everywhere—the degree to which it satisfies the objectives compared with the sacrifice (cost) of attaining the satisfaction. The first task in appraising the measurement processes and rules is therefore identifying and weighing objectives and fitting the measurement rules to the resulting needs.²

In part the eagerness of accountants to attach themselves to those who measure may be due to the esteem with which measurement is held in our scientifically-oriented society. Accountants, and it seems practically everybody else, have been fond of quoting over and over the alleged statement by Lord Kelvin that knowledge of nonmeasurable facts and relationships is in effect sheer ignorance. The benefits of measurement seem to be self-evident, for they include the advantages to be derived from a large part of mathematics, but a substantial portion of modern mathematics (e.g., topology, axiomatic systems) need not utilize measurement in the traditional sense, a development that has led Russell to comment:
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... the laws of macroscopic physics are topological laws, and ... the introduction of number through coordinates is only a practical convenience, the laws being such as can, in theory, be expressed without the use of number. The old view that measurement is of the essence of science would therefore seem to be erroneous.

The rigor necessary to identify and bound problems so that they may be subjected to the rules of measurement may have a vitalizing and healthful effect on a profession. Accounting is composed of numerous measurement rules (both implicit and explicit), but unfortunately the applicability of the rules to varying needs has received far too little study and intellectual effort. Let us turn to the operations necessary to carry on measurement and to a brief discussion of some of the more obvious accounting measurement rules.

A discussion of the nature of measurement begins with the ability to discriminate the rules for determining membership or nonmembership of a class (qualitative classification), and moves to the things that have to be done to establish a one-one correlation of the classes with some subset of the real number system (scaling).

In the simplest terms: “Measurement is the general procedure of assigning numbers to the properties of objects.” The most primitive operation necessary for classification or indeed for modern scientific method is the operation necessary for discrimination, i.e., finding whether or not a particular object or property does or does not belong to a specified set. This primitive operation requires the subject to be able to distinguish the required property from all other types of properties and to be able to reach a decision as to whether or not the property is present. In a slightly less primitive form, the subject finds it necessary to pass judgment on similarity in the sense that the properties of two sets can be matched as to their presence or absence and, even less primitively, put in a one-to-one correlation with one another and remainders noted.

So far we have not considered what is necessary for inclusion as a member of the class ‘property.’ The definition of Lenzen is clear: “The properties of things are modes of reaction to conditions that are subject to experimental control.” It is obvious that we cannot observe and manipulate the whole of experience, and that science must isolate in some way the area under consideration—iso late the conditions that can be used in hypotheses and controlled for experiment. Torgerson makes use of the term ‘systems’ to indicate a collection of properties.

Whenever we define or denote a property, it always seems to be a property of something. For this something, we use the term system. Thus, properties . . . occur as aspects or characteristics of systems. To make the circle complete, we might define a particular system as roughly that which possesses such and so properties.

With Torgerson’s expressed belief that there is a distinction between a system and a property, it is difficult for him to agree with the Stevens approach
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to measurement as rules for assigning numbers to events or objects. His statement therefore is extremely critical.

Stevens’ definition . . . does not mention property. For him, if numerals are assigned to objects according to rules (presumably any rules), we have measurement. And apparently it is the object that is measured and not . . . a property of the object . . . . According to this view, we have measured or scaled a stick, though only at a primitive, nominal level, when we determine that particular stick is a “two.” Thus, for this approach, classification, and even naming of individual instances, becomes a kind of measurement.8

Stevens would insist that the assignment of numbers to football players is a kind of measurement—a nominal measurement. The usual rules that try to identify players and their positions by blocks of numbers clearly constitute nominal measurements, but presumably if letters were used to accomplish the same ends we would not have measurement. Thus numbered accounts would result in measurement while mnemonic or lettered accounts would not qualify.9

While it may seem that there is much ado about nothing in this area, there are several reasons why we may wish to adopt the approach to measurement that Stevens recommends. Certainly the distinction between qualitative and quantitative tends to diminish. It has already been pointed out that modern mathematics is becoming less and less concerned with the usual quantitative aspects of numbers and more concerned with ordering and relating. Thus it no longer is true that a branch of empirical learning must be directly related to numbers in order to enlist help from the field of rigorous mathematics. For example, functional relations no longer need be related to number, and even the familiar greater-than, less-than may sometimes be replaced by other relations such as dominance, ancestor of, etc.

Most accountants will probably agree that the assignment of numbers to identify classes is a trivial distinction to be used as the defining characteristic of measurement, but calling ‘classification’ ‘measurement’ may serve to emphasize the importance of classification. Certainly, Stevens himself has been one of the most effective advocates of classification and its presupposition of the ability to discriminate.

When we attempt to reduce complex operations to simpler and simpler ones, we find in the end that discrimination, or differential response is the fundamental operation. Discrimination is prerequisite even to the operation of denoting or “pointing to,” because whenever two people reduce their complex operations for the purpose of reaching agreement or understanding, they find that unless they can each discriminate the same simple objects or read the same scales they still will not agree. Agreement is usually reached in practice before these most elementary operations are appealed to.10

Torgerson has admitted that classification, when done finely enough, is subject to the procedures of measurement.
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Given that a property is measurable (this is not necessarily true of all properties), the advantages of defining it in terms of measurement, as contrasted with a purely classificatory definition, accrue both in the descriptive and in the explanatory functions of science. In terms of description, it makes for greater descriptive flexibility, since the number of classes is theoretically unlimited . . . . In terms of explanation, it allows for more precise formulation of general laws relating different constructs, and it enables the paraphernalia of mathematics to be extensively applied to science . . . . Theories and laws can be formulated in terms of mathematical equations.11

The characteristic of measurement, aside from the nominal measurement of Stevens, is that some characteristic (property) can be separated from its environment, specified and put in a one-to-one correspondence with the real number system, or some subset of it. If such a relationship can be established generally, i.e., the behavior of the property is isomorphic with a subset of numbers, the operations of mathematics may be applied to the numbers assigned to the property and new configurations can be derived. Unfortunately, it is seldom possible to have a general isomorphic relationship, and the measurement scales are usually limited in that only some of the mathematical weapons may be applied. Let us turn now to some of the scales that may be identified in various measurement systems. Torgerson points out some of the characteristics of the real number system that are relevant to measurement and can be used for a basis of classifying measuring rules.

1. Numbers are ordered.
2. Differences between numbers are ordered. That is, the difference between any pair of numbers is greater than, equal to, or less than the difference between any other pair of numbers.
3. The series has a unique origin indicated by the number ‘zero.’ An important feature of this origin is that the difference between any pair of numbers containing zero as one member is the number of the other member.12

Torgerson selected the three characteristics because they correspond with a common distinction made in the types of measurement scales that are often assigned. Corresponding with the ordering characteristic is the so-called ordinal scale of measurement which is, next to Stevens’ nominal approach, the weakest type of scaling.13 These ordering measurements are monotonic in the sense that they are order-preserving when translated from the characteristic to the number, and are common in accounting, e.g., the typical account numbering of current assets.

A refinement of the ordinal scaling process ties the scale to a zero point, without implying that the distance between numbers represents equal intervals. Accounting is full of these measuring scales. The length of time an account is overdue is ordered—in the usual case without special explanations—with the probability of collection; the amount of quick assets may be related in such a fashion to the firm’s short-term, debt-paying ability.
Perhaps the most common type of scaling makes use of equal intervals and makes use of the distance attribute of the natural numbers. The most common variation of this scale is the so-called ratio scale that has a specified zero point or a natural origin of some kind. For a finite set the numbers that identify the degree of a property along with the assumption of equal intervals will determine the scale completely. As Torgerson points out, on a ratio scale the linear transformations that are allowable are limited to those that leave the natural origin unchanged, while if there is no natural origin with an equal interval scale, we are at freedom to select the zero point. The result then is that we may use any type of linear-transformation mathematics. Let us now turn to some of the devices used to establish scales, especially the devices employed by psychologists. It should be obvious that one should have the property to be measured clearly in mind. Some writers have been concerned with differences between ‘fundamental’ and ‘fict’ or sometimes ‘derived’ measurement. For our purposes these distinctions and the postulation of some sort of ‘natural’ law of assignment are not important. One must realize that some properties such as length have operational rules (rules of correspondence) which relate the concept to its measurement rules directly. On the other hand, ‘proprietary interest’ is essentially a constitutive definition and its passage to the empirical world for measurement is usually done indirectly by its relationships to assets and liabilities which can be measured more or less directly through acknowledged rules of correspondence. Social income, for example, is certainly not going to be measured ‘directly’ or by any so-called fundamental laws of nature. What is done, of course, is to define a limited concept of social income in terms of some properties which can be measured by empirical means and which have some intuitive relationship to our feeling of what social income ought to be. This limited concept is then substituted for the more desirable one. Theorists in any field may profitably study and appraise discrepancies between the constructs that are in fact measured with the constructs that are desired. In accounting, for example, it is extremely doubtful whether current working-capital measurements are adequate substitutes for debt-paying ability.

Psychologists have divided their experimental approaches to measurement into three groups: the subject-centered, the stimulus-centered, and the response approach. In the subject-centered approach: The systematic variation in the reactions of the subjects to the stimuli is attributed to individual differences in the subjects. The immediate purpose of the experiment is to scale the subjects, who alone are assigned values. This procedure is widely used in intelligence testing and general testing of physical or mental accomplishment in school work. The stimulus-centered approach, as the name suggests, aims at scaling the stimuli and the subjects, and on occasion the immediate purpose may be to appraise the importance of each.

In the field of accounting we are confronted with the fitting of information to the uses to which it may be put. Thus, a practitioner weighs the attitudes of the users of information and tailors the information to fit his weights. Yet the problem is a dynamic one, and it is possible to change the attitudes of users. He might therefore wish to simplify the approach so that he can scale the
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information (the stimuli) with respect to a standardized set of user reactions for different education levels. The aim is, of course, to improve the usefulness of the information service, and the changing educational level along with constantly shifting conditions mean responsive adjustments must be made in a dynamic fashion. In the short run however practically all problems including variations on the price-level problem can be set up to scale user reaction, and the urgency or desirability of new measurement rules may be resolved in a subject-oriented context.

Yet these distinctions are not as clearcut as one would like. All approaches require judgment. The subjects may be asked to judge which assets seem more liquid, which arrangement stresses A more than B, which form of disclosure seems more forceful. If such requirements are transitive, they may be ordered and subjected to an ordinal scale of measurement.

Let us return to some of the methods or procedures used by psychologists and others to establish scales of measurement. Regardless of the method used, the experiment is usually done over and over with the same subjects or with different subjects or with combinations. This replication is, of course, one of the tools often used in scientific work, and such repeated samples or judgments help to eliminate errors that may be present.

A common approach makes use of the ability of subjects to discriminate and is known as the differential sensitivity method. The “just noticeable difference” is sometimes known as the jnd or the difference limon, or the DL. The first problem encountered is that the just noticeable difference may be “noticed” in some cases and not in others so that some supplementary rules must be established. The subject may sense a difference 50 percent of the time almost by chance, so that a noticeable difference is inferred only if he differentiates, say, 80 percent of the time. The second step is the formation of the scale. In some cases it can be assumed that the noticeable differences (the DL’s) themselves make up the units of a scale. Explicit allowances and replication may be necessary as the subject becomes more skilled or more discriminating at one end of the scale. In any event, it is assumed that the discriminations are transitive and that they represent equal distances on the scale.18

The above form of discrimination requires comparative judgment of related pairs. One is faced immediately with the possibility that discriminations may have different intensity. For example, suppose that A is judged brighter than B 90 percent of the time and B is judged brighter than C 70 percent of the time. Is the distance from A to B greater than the distance from B to C? Thorndike attempted to meet this problem by postulating that the differences in distance are proportional to the normal deviates of the statements. As Törgerson states:

The general notion “Equally often noticed differences are equal” is thus transformed to the notion that the psychological distance between stimuli is proportional to the normal deviate transform of the proportion of times the (directed) difference is noticed.19

In some cases it may be feasible to ask subjects directly for judgment of quantitative distance. This method is demanding and assumes that they will be
able to estimate distances and place them on the scaling continuum. This type of scaling is done in examination marking by all teachers, and its most common expression is probably a marking scale based on 100.

The estimating task may be made easier for the subject by applying what are known as “fractionation” methods. In this process the subject is given a standard of some kind (e.g., zero, and A = 100), and is asked to select others that are one-half as great, or twice as great, etc. This differs from the previous process in that the subject need not directly estimate the size of the unit. He is asked for a fraction of the given standard, and the researcher then determines a convenient unit. A variation of this approach requires a still more limited ability of the subject and asks for estimates of equidistance. This approach assumes that the subject is capable of stating whether the difference between A and B is greater than, say, the distance between B and C. It goes without saying that if he is able to determine greater than or less than, he can arrive at reasonable approximations of equality.

In some cases a preassumption is made about the distribution of scale value of the stimuli. For example, it may seem reasonable that the distribution is normal or some other familiar pattern. If such a preliminary step is feasible and the stimuli are ordered, the fitting of a scale according to the distribution is not a difficult chore.

Before turning to specific measurement problems in accounting, some philosophical aspects of measurement may be summarized. The similarity between simple classification and more colorful quantitative knowledge should be clear. A quantitative scale with differences that can be related to symbols in the real number system can enlist some of the methods and strength of mathematics. Notice however that some concept of distance is necessary. Ushenko points out that all measurement reduces to “observations of coincidences on scales or dials, the problems of measurement are reduced to the problems of measuring length, of which the major problem is how to determine whether graduations on a scale are congruent . . . ”20 The so-called scientific laws almost invariably call for measurement, and measurement depends on observation and transitivity. With this view there is always the possibility of more accurate measurement with the effect of modifying or setting new laws, equations and definitions. According to Ushenko: “ . . . should this happen . . . the [old] correlation, being a definition . . . would not become false. But the assertion that there are physical processes which can be identified with [the synthetic statement] . . . would then become false.”21 In pre-Bridgman times (and unfortunately today in some areas of accounting) one of the rules of the scientific game was not to question the invariability of the rod. “From this point of view the selection of anything as a standard of measurement is equivalent to a convention that this thing remains invariant throughout the process of measurement . . . the operationalist theory [is an alternative that] . . . explains measurement as a set of operations performed in accordance with specific but arbitrary instructions or rules, among which there are rules how to select a measuring rod . . . Whatever happens to the rod is irrelevant to the results of measurement provided the specifications of the rod are in accordance with the instructions.”22
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The fusing of mathematics and logic has helped restore some status to classification. The logical development of classes and the similar development of mathematical set theory now mean that powerful mathematical tools may be applied to qualitative (non-metric) knowledge. To know that $x$ belongs to the class ‘dog’ is to know quite a bit about $x$ without having seen him. From our knowledge of the class we know something about his habits, his reproductive cycle and methods, the number of his legs, his covering, etc. At this point we need to remember that the ability to discriminate is necessary for both qualitative and quantitative thinking. In fact, discriminating is more primitive than pointing (specifying), and pointing is certainly more primitive than naming.

There are many unsettled questions of measurement in accounting. Perhaps the most interesting and important applications arise in scaling future prospects into some system of values. The actual rules for recognizing value changes require the definition of new concepts and operations to be substituted for the value construct. Revenue is defined operationally by naming the things to be done to identify and measure it. Expenses are related to rules for measuring cost (sacrifice) and then to further rules for allocating cost to current revenues and to future expected revenues. Thus we agree on a set of instructions for measuring cost and agree to accept the resulting quantity as a measure of sacrifice. Another set of rules is then devised to measure the cost to be matched with revenues. This second type of measurement is an attempt to reflect prospects sacrificed to procure the new values represented by revenues and requires a scaling of expected benefits and the application of the ratio of benefits expired to expected total benefits to the costs to be allocated. The resulting system of definitions and relations is related to time periods and the results are given in income reports. Income, defined in terms of these operations, may differ considerably from nonaccounting definitions! Thus in order to measure value added (or decreased), accountants exhibit a whole series of substitute constructs with rules of correspondence to the empirical world. In each case these constructs themselves require their own scaling and measurement rules. Accountants then devise and issue instructions for combining the intermediate definitions and agree that the result of these measurements shall represent the change in value from operations. The resulting construct of value added, for example, is not quite the same as the one defined as income because of disagreement over capital gains and losses and realization rules. (Of course provision is made in the rules for additional investment, where the value added is offset by sharing the future prospects of the business or of claims to be satisfied.)

A little reflection will show that a concept of income in terms of being better or worse off is literally impossible to scale without making substitutions of this type. In fact, the economist's entire concept of discounted expectations is almost impossible to implement in terms of workable rules and needs some support before being substituted for the concept of being better or worse off. In summary, it should be emphasized that such expressions as: “Intelligence is what intelligence tests test,” or “Income is what results when accountants apply their rules for measuring income,” are true enough in themselves. What such
expressions fail to explain is that constitutively defined constructs should be related to our needs and that substitute constructs are to be judged good or bad to the extent that they accomplish results similar to those derived from measuring the original construct directly. There is no need to be ashamed of being unable to measure many desirable constructs from our theoretical space—e.g., constitutive definitions that have value in a context of given objectives. The trick of substituting something that can be measured for something we would like to measure if we were more competent is well established in scientific work.

Several relatively minor observations may be made at this point, although a detailed discussion may fit better elsewhere. For example, the question of a constant interval scale (straightline) as opposed to a scale that takes account of the time value of money (an exponential) must be faced in dealing not only with depreciation but also with expectations in any form, including those dealing with benefits. When we add compound-interest methods we are changing from a linear scale to a nonlinear scale for measuring expected benefits. Notice also that if we change the discount rate we are changing scales, even though each is a nonlinear scale of the same family.

We might also ask whether an additional scale is needed to show confidence in the accuracy of the measurement or in the adequacy of the theoretical construct. Perhaps we should try to incorporate the degree of confidence or lack of it in the measurement scales that represent value. The long-lamented but tenacious doctrine of conservatism is designed to “allow” for uncertainty by a preliminary screening of the data before being carried to the usual scale and perhaps also by weighting the scale itself in favor of poorer current reports. Wholesale conservatism is objectionable not because it is a crude attempt to allow for differences in reaction patterns. The objections are that a general prescription to “tip the scales” in some direction may be opposed to best professional judgment and that it is often impossible to determine the magnitude of the ‘allowance.’

A related problem arises through combining measures whose degrees of accuracy are widely different. To some extent this is unavoidable, for the measures that make up complicated constructs contain no reason to suppose that the accuracy can be or should be the same in each case. The measurement rules for taking value declines in buildings for example are less reliable than those for taking interest on government bonds, and the two measures along with others are combined to measure income. Again, the objection is not that they are done with unequal confidence—the objection is that they are combined and all are treated as meriting equal confidence without disclosure of differences.

An interesting and important case of measurement concerns the evaluation of different types of disclosure. We do not have any standards at all for comparing the relative strength of a footnote with a similar statement adjacent to the item. Is there for example an ordering that corresponds with the placement in the statement of financial condition? Are there enough lazy readers to justify the belief that the first few lines of the statement are most likely to
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be read? Actually accountants have never examined this hypothesis in a formal way. We may also ask whether the last places in the statements are more important than, say, intermediate locations. Is there a sharp break between the body of the statement and the body of the footnotes? How much is the situation helped by such statements as “the accompanying notes are an integral part of the statement”? If such a statement is made, where should it be placed for greatest effect? We have hardly begun to consider these kinds of things, yet they should be tested by experiment, ordered, and if possible scaled. To many outsiders accountants have hardly begun to learn their craft.

Clearly the internal composition of the disclosure note has some connection with the strength of disclosure—at least for those who read it. Our body of empirical information in related fields is so meager that it is of little service. Additional information might be gathered to indicate the importance of subtotals in the statements; the influence of indentations; or the use of heavier print for items that deserve emphasis. This material is in the field of pragmatics, it is psychological in nature, it is important, and accountants are not studying it!

The following discussion of financial-statement arrangements is meant to illustrate the need for careful ordering and to suggest areas of study that students might investigate. Does the order in the financial statement indicate the order of accuracy of measurement of the individual items? A positive case has some support, for it is probably true that cash is the most accurately measured; receivables may well be second best; certainly intangibles rate last. But if we agree that the order of location represents the order of our confidence in the accuracy of measurement, can the ordering of accuracy be scaled? It is doubtful that an ordinary distance scale could be applied meaningfully, but it may be possible to set up some sort of function that would scale the differences. Measurements differ in accuracy among firms and among themselves from statement to statement, but such a scaling might have general validity and be useful to those who use statements. It might even be feasible to place accountants themselves and accounting firms on some sort of scale of relative accuracy, or relative conservatism, so that users of accounting output could apply these indexes to reported statements and gain some measure of comparability. Revenue agents often have the equivalent of an informal scaling of the honesty of professions and types of workers who assess their own taxes. Undoubtedly their knowledge extends to the relative readiness of certain accounting firms to claim immediate deductions for their clients.

On the other hand, perhaps the order of location on the financial statement may be used to scale the relative importance of the items. It may be possible to set up experiments to measure the psychological distance between places on the balance sheet, and it is not inconceivable that an arrangement of items in the order of dollar importance would result in more meaningful statements and better understanding. Unfortunately the dollar amounts may not themselves measure relative importance. For example, when a firm is having short-term financial difficulties the amount of cash on hand may have an importance far out of proportion to its amount. The fact that almost without
exception accountants place current items first may be due to preoccupation
with current debt-paying ability and the influence of bankers. Study might
indicate that the trend toward this arrangement gathers impetus during or
immediately after each financial crisis or depression. Fixed assets are normally
far more important in terms of dollar amounts, yet even public utilities and
railroads have abandoned placing them first.

In a similar way liabilities on the balance sheet might be ordered as to:
(a) liquidity—urgency of asset distributions for their satisfaction, (b) definite-
ness of payment, (c) definiteness of amount—accuracy of amount to be paid,
and (d) importance of dollar amount. At this stage we are not interested in the
actual scheme of assignment. We are interested in understanding how accoun-
tants may possibly increase the number of information facets by classifying and
ordering data.

It is also interesting to speculate about the relative importance of positions
on the operations report. For example, does subtracting merchandise cost from
sales imply that this cost is recovered first? What about putting corrections of
previous periods first so that the reader may judge how accurate past report-
ing has been? The usual argument is that the most prominent places should
be reserved for the most important information. The volume of sales is usually
given first. Should it be concluded that this is the most important item? What
about placing net income first? Controllable costs first? These questions are
empirical and can be tested by empirical means.

There is room for considerable study of accounting measurement in
terms of whether the methods are response methods or subject-centered
studies. In auditing, for example, accountants are trying to appraise the
trustworthiness of the individuals who make the representations and also
the trustworthiness of the representations themselves. What is the scale of
trustworthiness? The amount of checking to be done is related to estimates
of the adequacy of the internal controls and on how well they are working.
Is there a scale for judging the adequacy of such controls either on paper
or in fact? The amount of checking done by an auditor is obviously related
functionally to the auditor’s appraisal of the trustworthiness of the system,
which includes controls and the people involved. What kind of scales should
study!

Recently there has been considerable interest in the attitudes of investors,
and at least one writer has tried to establish standards for good reporting,
although so far he has not tried to scale deviations from the standards.21 We
need to set up experiments to find what investors read; what they value highly;
how adaptable they are to new procedures—e.g., how educable they are. Thus
both subject-centered and stimuli-centered methods are needed. We do not
know, for example, the importance of ratios in analysis. Is a current ratio of
four to one twice as good as a ratio of two to one? Is the measure continu-
ous? Does it match a linear scale? Are there relevant ranges for decisions of
various kinds? Are there serious dangers in trying to estimate future plans by
scaling static levels at the beginning of an interval?
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Finally, accountants may ask whether the debit-credit rules themselves are types of measurement. The purpose of these rules is to indicate changes resulting from certain events in a firm’s history. In this sense they correspond to some aspects of plus and minus rules. The assignment of position to indicate direction of change is combined with a natural zero element and qualifies for nominal measurement. Unfortunately there is no ordering in the basic debit-credit rules and we must add further measurement rules to provide higher-type measurement scales. “Assets = Sources of Assets” is true if and only if the scales selected to measure assets and sources of assets make the equation true. Thus it is a tautology only after the measurement rules have been selected. We might, for example, measure sources of assets in terms of the number of individuals contributing or the number of physical items, or by other rules without much purpose. The equation does not specify the exact scales, but it offers a very important constraint on the scales that are selected.

Notes


2. This view is in harmony with that expressed by Russell L. Ackoff in *The Design of Social Research* (Chicago: University of Chicago Press, 1953), pp. 69-70. “. . . scientific quantification is a way of assigning numbers to properties, objects, and events so as to yield useful information . . . . Thus ‘efficiency in use’ is the key to scientific quantification . . . . Ideally the decision to qualify or quantify, and how to quantify or qualify, should be based on a systematic comparison of costs.” The view expressed is opposed to that of William J. Vatter, “Contributions of Accounting to Measurement in Management,” *Management Science*, October, 1958. “The central problem in any measurement process is the selection of the measuring unit,” p. 28. In most cases the selection of the unit is conventional and of minor importance.


5. It is interesting to note that some textbooks on modern mathematics require only that a set be subject to unambiguous methods for determining inclusion or exclusion. Many exercises then are of the type: “Do the redheaded male residents of Chicago form a class?” Presumably the problem is to find whether or not the rule for inclusion is unambiguous. These exercises may be useful but, unfortunately, they are not mathematics. These problems require further
rules of correspondence for determining empirically (in fact) who is or is not to be included. Psychology, scientific method, physics of optics, legal definitions of ‘resident,’ and all kinds of non-mathematical considerations are necessary to answer this question.

7. Warren S. Torgerson, Theory and Methods of Scaling (New York: John Wiley and Sons, Inc., 1958), p. 9 The admitted circularity is, of course, completely unnecessary, and results in part from Torgerson's approach to the definition of property. “Properties are essentially the observable aspects or characteristics of the empirical world” (p. 9). He is emphatic in pointing out that a book is a system construct while weight and thickness are property constructs. Carnap takes a somewhat different view and feels that the distinction should be made according to the type of predicate involved. “A one-place predicate designates a property. (E.g. 'Book' designates the property of being a book; 'Blue' designates the colour blue, a property of certain things.) We shall call this property the intension of the predicate.” Rudolf Carnap, Introduction to Symbolic Logic and Its Applications (New York: Dover Publications, Inc., 1958), p. 40.
9. Torgerson is unrelenting: “His [Stevens'] nominal scale refers to the processes of . . . classification, with the trivial restriction that numbers be used to name the objects or name the classes of objects.” Ibid., p. 17.
10. S. S. Stevens, “Psychology and the Science of Science,” Psychological Bulletin, 36 (1939), reprinted in Readings in Philosophy of Science, ed. Philip P. Wiener (New York: Charles Scribner’s Sons, 1953), p. 164. “We combine operations when they satisfy the criteria of a class; and the concept of that class is defined by the operations which determine inclusion within the class” (p. 168).
11. Warren S. Torgerson, op. cit., pp. 11–12. Many will not admit that “unmeasurable” properties exist. Torgerson’s definition of measurement keeps his use of nonmeasurable properties from being ridiculous.

12. Ibid., p. 15. Stevens distinguishes four kinds of scales: nominal, ordinal, interval and ratio. Nominal scales require little more than determination of equality. Ordinal scales require the determination of greater than, but the intervals may be unequal. Interval scales imply equality of intervals (differences), but the zero point is conventional. Ratio scales permit the determination of equality of ratios and imply an absolute zero. Clearly accounting uses all types. See S. S. Stevens, “On the Theory of Scales of Measurement,” op. cit., pp. 677–690.
13. C. H. Coombs places a quasi-ordered or partially-ordered scale between the nominal and ordinal scales. The objects themselves can be nonordered or partially ordered, or fully ordered, and the properties can also be of the three types. See “Mathematical Models in Psychological Scaling,” Journal of the American Statistical Association, XLVI(1951), pp. 480–489.
15. Torgerson takes pains to point out the relationship of measurement to theory formation and model building. “. . . fundamental measurement itself is an example of the construction and verification of theories. Any particular scale type can be considered to be a formal model. If rules of interpretation are laid down which connect the model to observable data, the model becomes a theory, and as such can become subject to empirical test.” Ibid., p. 25. Note also: “The meaning of the numbers assigned to the elements of the model is specified by the model. Rules of correspondence are established, relating elements and properties of the model to observable data, thus converting the model into a testable theory.” Ibid., p. 38. Incidentally Torgerson, in turn, leans heavily in this area on Carl G. Hempel, Fundamentals of Concept Formation in Empirical Science (Chicago: University of Chicago Press, 1952).
16. With regard to fiat measurement, Torgerson states: “. . . one or more observable properties are selected high on a priori grounds are judged to be related to the concept of interest. A measure of the observable property itself . . . is taken as the measure of the concept of interest . . . . The discovery of stable relationships among variables so measured can be as important as among variables measured in other ways . . . . The major difficulty with measurement by fiat is the tremendous number of ways in which such defined scales can be constructed.” Ibid., p. 24. Notice Torgerson’s nonpositivist approach in his use of “natural laws,” “fiat,” and “a priori.”
17. Ibid., p. 46.
18. Torgerson states: “If a stimulus B is ‘just noticeably greater’ than stimulus A, and stimulus C is ‘just noticeably greater’ than stimulus B, then the distance on the psychological continuum...
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that separates $A$ and $B$ is equal to the distance separating $B$ and $C$. This notion may be taken as an assumption subject to further test, or as a definition of what is meant by equality of intervals on the psychological continuum . . . . Given the definition of what is meant by equality of intervals, i.e., equality of jnd’s, we have only to devise experimental methods for obtaining jnd’s in order to obtain a scale possessing a unit of measurement.” *Ibid.*, p. 133. For a more complete discussion of this and following procedures see: P. Guilford, *Psychometric Methods* (New York: McGraw-Hill Publishing Co., 1936, 1954).


“1. Each stimulus when presented to an observer gives rise to a discriminable process which has some value on the psychological continuum of interest.
2. Because of momentary fluctuations in the organism, a given stimulus does not always excite the same discriminable process, but may excite one with a higher or lower value on the continuum . . . .
3. The mean and standard deviation of the distribution associated with a stimulus are taken as its scale value and discriminable dispersion, respectively” (pp. 159–160).

22. *Ibid.*, pp. 158–159. Apparently too many accountants have accepted the instruction to use an historical monetary unit and have not questioned whether the accounting constructs thus operationally defined have any relevance to needs. Physicists have similar problems. “In view of . . . experimental results, one is led to postulate that stretches are congruent at a distance if they prove themselves to be congruent when adjacent. In effect, we postulate that the distance between two points on a solid body is unchanged in a displacement . . . it is meaningless to ask if this convention is really true [or] if there were a more fundamental definition of length or distance.” Victor F. Lenzen, *op. cit.*, p. 290.