# Everybody knows how to measure but nobody can do it

**Anmerkung zu Karel Berka:**
**Measurement. Its Concepts, Theories and Problems.**
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Peter Jaenecke[1]

The author characterizes accurately in his foreword the predominant measurement doctrines found in the philosophy of science. He writes that in a very extensive literature „on the practice and theory of measurement and scaling, two one-sided methodological positions are strongly exhibited: on the one hand, the position influenced by instrumentalism, operationalism and neopositivism; on the other hand, the viewpoint based on the formalistic philosophy of mathematics. From a purely empirical point of view, measurement is reduced only to the use of different scaling and measuring techniques. A purely mathematical doctrine of measurement, which prevails today, is reduced to the construction of various scales of measurement, defined merely by purely formally invariant transformations under which their form is unchanged, or, alternatively, to the derivation of the representation and uniqueness theorems from axiomatically defined relational structures. A common denominator of both these antagonistic doctrines is a very broad explication of the concept of measurement, encompassing a mere numbering, as well as an uncritical application of measuring procedures to the widest possible extent" (XI).

[1] Überarbeitete Rezension von: Karel Berka: *Measurement. Its Concepts, Theorie and Problems* (1983). *Zeitschrift für allgemeine Wissenschaftstheorie* XV/2 (1984), p. 354-363.

Based on his extensive studies in the theory of measurement, Berka attempts "to analyze the problems of measurement scales on the basis of the methodological principles of dialectical and historical materialism" (XI), that is, we have to prepare ourselves for a fight with concepts.

And, indeed, Berka's work consists of a jumble of concepts having only a loose relation to each other; a brief glance at the table of contents will confirm this view: (1) INTRODUCTION, (2) MEASUREMENT (explication and definition of the concept of measurement; subject matter, function and scope of measurement), (3) MAGNITUDES (quantities, magnitudes, numbers: a historical excursion; quantities and magnitudes; object of measurement; measurement units, naming and dimension; classification of magnitudes), (4) SCALES (concept of scale; origin of scale; distance), (5) QUANTIFICATION (scaling; counting), (6) THEORY OF MEASUREMENT (representation theories of measurement; kinds of measurement; metrization; representation theorem), (7) THEORY OF SCALES (classification of scale types; scale transformations and the uniqueness theorem), (8) METHODOLOGICAL PROBLEMS OF MEASUREMENT (axiomatization of the systems of measurement; empirical relations and operations; precision of measurement; meaningfulness, validity and reliability), (9) PHILOSOPHICAL PROBLEMS OF MEASUREMENT (materialist foundations of measurement; possibilities and limits of measurement). An extensive bibliography, an index of personal names and a subject index are added.

The reader will notice here that before coming to a theory of measurement, Berka performs a detailed explication of various concepts. But where could the basis be for explaining, say, 'measurability', if not within a theory of measurement itself? It seems to be a quite questionable undertaking to attempt a meaningful explanation of concepts outside their theory. Thus, 'temperature' or 'pressure' for example, get an instructive interpretation only within the theory of heat. But Berka regards the theory of measurement as a concept which had to be explained in the same fashion as 'magnitude' or 'scale':

"One can speak of a theory of measurement in various connections. This situation is caused not only by our peculiar ways of interpreting the concept of measurement ... , but also by our intentions concerning the extent of the theory ... After all, we might consider a general theory of measurement, specific theories of measurement (in particular, those of physical and extra-physical measurements), and theories of a certain kind of measurement, for example, fundamental measurement, which may eventually be specified with respect to a definite scientific discipline. Furthermore, we might consider a theory of measurement of some metrical magnitudes ..., a theory of measurement procedures on a general level, or only a theory of measurement procedures that are either applied in measuring one magnitude or used with the aim of attaining a certain interval of scale values. When we constitute a theory of measurement ..., we may emphasize conceptual, methodological, and operational aspects of measurement, its empirical and mathematical characteristics, or we may consciously concentrate only on an analysis of some of these. These possible approaches are, of course, always influenced by general methodological connections and philosophical views and, thus, must lead to distinct, sometimes even quite contradictory, results, in spite of all the agreement on the choice of the themes" (p. 112).

A more systematic representation of the subject matter may be reached in the context of a theory. Berka, however, showers his reader with a flood of concepts. Taking into consideration all positions and aspects, he leaves the reader very often unclear what is important and what is not. In many cases, it would be a great help for the reader if the author would clearly define his concepts *before* discussing someone else's positions.

If Berka would try to explain the concept 'house', for instance, he would proceed in the following dialectical way: 'One can speak of a house in various connections. For a physicist, a house is an ordered load of bricks ; the owner of a house may regard it as his castle; from the standpoint of a tax officer, a house is a tax object; and so on'. Of course, these claims are not false; rather, they are irrelevant, and, even more, they are misleading if associated with an analysis of concepts, because they characterize different points of view, but not the concept itself.

Throughout the book we find so-called 'there-is-not' assertions which are known to be unproveable: there are no measurement units for non-metrical magnitudes (p. 95, 109) ; "an area or a volume cannot be measured without a prior measurement of length" (p. 119); "in the case of extraphysical measurement, we do not have at our disposal an objectively reproducible and significantly interpretable measurement unit" (p. 211); some properties of real objects are not measurable in principle (p. 215). Berka, as a logician, should normally be aware of the problematic property inherent in such assertions, especially then, if they have the character of natural law.

In his introduction, Berka points out that, although measurement is a quite common procedure in the everyday practice, one should not overlook all the necessary empirical and theoretical presuppositions which facilitated the construction and employment of the measuring devices (p. 1ff). He gives a brief overview about some measuring problems and introduces classificational, topological and metrical concepts:

"*Classificational* concepts, such as *close, cold, long, old,* which are determined only in a qualitative sense, serve the classification of objects on the basis of common characteristics" (p. 5). *Topological* concepts, such as *warmer than, longer than,* "enable us, not only to establish the sameness (or difference), but also to mutually compare at least two objects which possess a given property and, consequently, to arrange them into a sequence" (p. 6). *Metrical* concepts, such as *'50° C warm', '10m long',* "not only express a qualitative characteristic, for example, length, temperature, etc., but already give exact quantitative specifications" (p. 7.) These three concepts – classificational, topological and metrical – occur throughout the book in a variety of different, and therefore misleading, denotations.

The second chapter deals with the concept "measurement'. "An adequate definition of the concept of measurement ... cannot be regarded as the only aim of our analysis. It is much more important for the theory of measurement if we expound what can be meaningfully said about measurement from various standpoints : if we state what are the general and specific characteristics helping us to grasp the core of the method, what its role is in the process of scientific knowledge, under what conditions measure-ment can be legitimately applied, and what indeed measurement is objectively" (p. 14). It is quite obvious "that measurement encompasses different aspects and components of an empirical and theoretical nature, which are mutually conditioned in a very complicated way. In practice, the implementation of the process of measurement appears at the foreground and contains the following: the preparation and performance of experiments employing measurements within a certain scientific area; the choice of suitable measuring operations; the construction and use of measuring instruments; and the elaboration and evaluation of the results of a measurement. On a theoretical level, the relevant problems contain, in particular, a conceptualization of the object of measurement and of its results; a demarcation of basic concepts of the theory of measurement and of the conditions of measurability; the elucidation of the relationship between the empirical and mathematical aspects of measurement; and the constitution of a general theory of measurement" (p. 14f).

An explication of the concept 'measurement' is given by comparing physical with extra-physical measurement. "In spite of considerable divergencies, they agree in characterizing the process of measurement by means of three basic components: the object of measurement, the results of measurement, and certain mediating empirical operations" (p. 19).

After discussing some historical positions, Berka introduces the representational definition of measurement. In this theory, measurement is "understood as a *homomorphic mapping of a certain empirical relational system* (empirical structure) *onto some numerical relational system* (numerical structure)" (p. 25). An empirical (numerical) relational system is defined as an ordered pair consisting of a set of empirical (numerical) objects, and a set of empirical relations.

Berka supports a moderate representational doctrine: "The point of departure for every measurement is the knowledge of objectively existing relations between the objects and phenomena of objective reality. On the basis of this knowledge we then start to look for a certain numerical expression. At this initial stage, the mapping of an empirical relational system onto a numerical relational system is a homomorphism based only on the correspondence between empirical and numerical objects, between empirical and numerical relations. However, since the numerical relational system is also defined by operations with numbers, in the second stage we proceed in the reverse order. We strive to find suitable empirical counterparts to these numerical operations - counterparts susceptible of meaningful interpretations. If we succeed in finding empirical operations that have properties structurally analogical with the properties of numerical operations, then we can talk about a homomorphic mapping ... in the strict sense" (p. 27).

One of the fundamental epistemological questions in the theory of measurement is: how to bring an information content into a formal system? The representationalist, as well as Berka's, answer: by means of structure equality. But how to achieve it? The representationalist will answer: by proving the so-called representation theorem, whereas Berka answers: by finding suitable empirical counterparts which are susceptible of meaningful interpretations. What is the difference between these two positions? It seems that a clear definition of 'suitable' and 'meaningful interpretation' would lead directly to the prove of a representation theorem, again. In fact, Berka's criticism of the representational position is quite justified (see also p. 153), but no improvement is reached by introducing ambiguous concepts.

After a brief historical excursion about quantities, magnitudes and numbers, Berka strives to give in the third chapter a clarification of these concepts: "Quantity is understood as anything that can be numerically mapped in some way: every quantifiable - countable or measurable - property. Under a quality one understands those properties, or perhaps relations and the like, which are not measurable" (p. 43).

Thus, quality depends on the quite controversial concept of measurability; its meaning can only be determined within the framework of a theory of measurement; on the other hand, however, in a theory of measurement one has to make use of the concept 'quality' in one or another way. The above definition gives a quite circular impression, moreover, the concept of quality is characterized by a problematic 'there-is-not' assertion.

Berka discusses diverse philosophical positions concerning quality, quantity and magnitude. But in spite of reading this section repeatedly, no clearness about the meaning of the basic concepts could be reached. "Either magnitudes are more abstract than quantities or, on the contrary, quantities are more abstract than magnitudes." "From the methodological standpoint, both these conceptions, irrespective of the way they define the relationship between quantities and magnitudes, are entirely congruent." "In the first case, quantity is a particular, concrete instance of a magnitude. For example, the length of a rod ... in meters, is a quantity, while *length is* a magnitude" (p. 45).

In the first case, quantity is a mixture of what in the sciences is called 'intensity', 'true value', or 'measured value', while magnitude denotes the German 'Messgröße'. These concepts stand for totally different things so that it can hardly be true that the one would be more abstract than the other.

As long as no measurement procedure is known, one should speak unspecifically of properties. No sharp distinction is made between 'property' and 'magnitude'. Thus, length, voltage, temperature, resistance are strictly speaking examples of magnitudes, but they may also denote the corresponding properties. Very important is the differentiation among intensity, true value, and measured value. The intensity (of a magnitude of a certain measuring object) denotes an empirical size; its numerical counterpart is the so-called true value; and the result of a measurement is denoted as measured value (Messwert). 'True value' represents a terminus technicus in the theory of errors with respect to statistics. Therefore, the term 'true' should not trigger an unacquainted philosophical discussion. With this concept, the idea is associated that an (empirical) intensity must have a certain numerical amount. All natural laws maintain relations between true values, although, in general, these true values cannot be determined: only in case of a measuring error equal to zero, is the true value known, because then the true value is identical with the measured one.

According to the translator's note, 'magnitude' has to be interpreted as the German 'Messgröße' and 'size' or 'size of magnitudes' as 'intensity' or 'true value' (IX). Having in mind this note, it is incomprehensible what the phrases 'size (magnitude)' (pp. 43, 45, 46), or 'magnitude (size)' (p. 48), or 'measured magnitudes' (p. 85) should mean. The ambiguity of Berka's concepts are also revealed in the phrases 'properties as magnitudes', 'kind of magnitude' (p. 48), 'magnitude of length' (p. 49) and in his distinction between "the *type* of magnitude (for example, length); *kinds* of magnitudes (for example, distance, height, depth, breath); its *specifications* (for example, wavelength); or its *concrete instances* (for example length of my writing desk)" (p. 52). Only 'type of the magnitude' (Messgröße) has a scientific meaning. Kinds of magnitudes are irrelevant, because height, depth, etc., are not real properties of the things, rather concepts devised by human beings for their description. One does not change the kind of magnitude by turning the rod from the horizontal to the perpendicular direction. Finally, the concrete instances can be interpreted again in the threefold way as intensities, true values or measured values.

Based on these mixtures, Berka gives a quite confused interpretation of the magnitude's dimension: "It follows from the characteristics of magnitude as functions with empirical arguments and numerical values, that every magnitude can be expressed by some *named number.* Naming refers to the empirical variables that characterize the qualitative component of magnitudes, while numbers represent their quantitative determinations". "The nominal component of a metrical magnitude, represented by named cardinal numbers, is identified with so-called dimension ..., while the numerical component is interpreted as a set of multiples or portions of the measurement unit" (p. 55). "Therefore, it is not correct when any magnitude $X$ in physics is generally expressed as a product of a numerical value $\{X\}$ and a measurement unit $[X]$ according to the relation $X = \{X\} \cdot [X]$" (p. 57). In no way could one consider this expression as a definition "of the concept of magnitude, or of the value of a magnitude, which would contain in the definiens the numerical operation of multiplying the measurement number and the measurement unit" (p. 58). Berka overlooks here the facts (1) that the magnitude $X$ defined in the equation above is a measured value, and (2) that the unit is a numerical value too, since it denotes a special intensity embodied by a material standard. Thus, 5m means that the length of the measuring object is five times the length, say, of the standard rod in Sèvres. If we now change the unit to cm, then we have m = 100 cm, and $\{5\} \cdot [100 \text{ cm}] \neq 500$ cm, because, following Berka, no multiplication is allowed.

In a final section, Berka gives a classification of magnitudes. There are "discrete, metrical and non-metrical, physical and extraphysical, fundamental and derived, dimensional and dimensionless, scalar and vector magnitudes, and the like. We might still complement this by a further division of magnitudes, for instance, into extensive and non-extensive, additive and non-additive, primary and secondary" (p. 73). This variety of concepts still increases because most of the attributes are applied for the concept 'measurement', too, as for example, 'derived measurement' (p. 115). We will discuss this confusion of concepts later.

Chapter four deals with the concept 'scale' which is used with manifold meanings in the literature. Berka distinguishes between conceptual and material scales: "A *conceptual scale,* in short a *scale,* is characterized by a certain ordered interval of numerical values, the so-called *scale values,* which can be theoretically assigned to the measured magnitudes" (p. 85).

*"A material scale,* in short a *gauge,* is determined by an ordered set of marks on the measuring instrument, and in most cases by a set of numerals the reading of which enables us to assign numerical values to the size of the measured magnitudes." "Material scales are characterized by *numerals,* whereas in the case of conceptual scales we deal only with *numbers"* (p. 85).

Under the concept of quantification (chap. 5), Berka understands "a transition from classificational concepts to metrical concepts, or any other procedure by means of which empirical variables are associated with numerical variables", for example the operation of counting (p. 101). He discriminates between three different levels of quantification: numbering (numerical designation), ordering (scaling) and measurement (pp. 101, 104). Note the arbitrary use of the concept 'measurement' here, which is neither in accordance with his own definition nor common in scientific research.

In his theory of measurement (chap. 6), Berka discriminates between 'topologization' and 'metrization'. Topologization is defined by two binary relations $K$ and $P$. These relations might be generally interpreted as *coincidence* and *precedence;* they are characterized by the axioms of equivalence ($K$) and (weak) ordering ($P$) (pp. 135ff), respectively. The mapping from the empirical relational system ($E$, $K$, $P$) onto a numerical relational system ($N$, $=$, $<$) might be expressed by *correspondence rules* which bring into correlation empirical and numerical characteristics of both relational systems (p. 134, 138). Metrization is the extension of topologization by adding the operation of addition (p. 140).

But there remains the important question, under what assumptions it is proper to talk about a homomorphic mapping? Berka answers: we have to find suitable *empirical* counterparts to numerical operations (pp. 27, 124, 134, 183). Why do we not have to find suitable *numerical* counterparts to empirical operations? By what right are we justified to prescribe the nature the formal properties it should have? Such a requirement seems like the prophet who ordered the mountain to come to him. Cannot the search for a suitable empirical counterpart be a search for a perpetuum mobile? By what right are we justified to assume that the set of numerical objects must be numbers? Why not, for example, a set of functions?

We get the answer to these questions from the fundamental fact that in physics an intensity is measured by comparing it with another intensity. The procedure of comparing two intensities involves all essential characteristics of measurement. From this really basic understanding the complete theory of measurement can be developed, so that it might be considered as its basic axiom.

During the measurement procedure, a transmission of the intensity under study to a measurable intensity must occur. This process represents a *mapping in the empirical domain.* The measured value, which is read off from the measuring device, belongs always to the latter intensity. We need, therefore, a so-called measure function allowing the conversion from the measured value into the corresponding value of the intensity under study. It should be noted that for determining a length by means of a measuring rod, such an empirical mapping also takes place physically, if the rod is positioned next to the measuring object. In this simple case, the measure function has the trivial form $y = 1 \cdot x$, and the computation of $y$ is correspondingly trivial. Nevertheless, it is a computation, as can be seen more obviously by changing the unit so that the factor one before $x$ has to be change, for example, in the factor 100. That is, in physics there are only indirect measurement procedures, in contradiction to Berka's view: "Direct measurement is based on an immediate comparison of the measured object with some standard object (measuring device) or with the scale of the measuring instrument. Indirect measurement includes a direct measurement of something else, of the same or other magnitudes, as well as calculations carried out on the basis of geometrical, physical, and other laws" (p. 130f).

Because the mapping in the empirical domain is a process going on in reality, the measure function, which is its description, is a natural law. Thus, the underlying law of the spring balance is $y = m\,x$, where x is a length, y the weight searched for, and m is a material constant depending on the special properties of the spring used. In this example, the weight is measured by means of a length. Other examples are the measurement of the temperature by means of the thermal cell (or mercury or gas thermometer), of the time duration by means of a clock, of the distance by sonar or radar, of the altitude by a barometer and so on. In Hempels's language (p. 129) we would have to say that in physics there are only derived measurements by means of law.

"Why physical laws are indeed invariant as to the size of the measurement units of magnitudes that are involved in them" (p. 72)? The question is left unanswered by Berka, but the answer is very simple: because each measurement procedure is based on a natural law. Berka has overlooked this important fact. For him, "measurement makes sense only if it produces a basis for a formulation of numerical laws" (p. 214); metrical concepts "enable us to formulate numerical laws" (p. 7, see also p. 72).

On the contrary, only the knowledge of a law enables us to perform a measurement at all. Therefore, any mapping from an empirical onto a numerical relational system has to be performed on the basis of empirical *processes* and numerical *functions.* This can be seen very clearly if we look at the description of a measured value. We do not say, e.g., the length $l$ of an object is 5, rather, $l = 5$ m, that is, the length of the object is 5 times the length of a certain standard object. There is a widespread misunderstanding in the philosophy of measurement that the correspondence has to take place on the level of empirical objects and numbers. But such a correspondence may be secondarily the consequence of comparing processes and functions.

Berka (and his predecessors) did not understand these quite elementary facts. Thus, he is forced to construct arbitrary interpretations, which is, quite annoying, with regard to physics, especially in his lengthy discussions on dimensions (pp. 55-73) and the kinds of magnitudes (pp. 73-82 and 115-133). What we need is not "some taxonomy of magnitudes" (p. 73), but a drastic diminution of its variety.

According to the measuring principle in physics, it is not meaningful to speak about fundamental and derived magnitudes, because 'fundamental' and 'derived' do not occur as a physical properties, rather, they are conceptual aids. If we subdivide fish in net-fish and fishing-rod-fish depending on whether they are caught by a net or by a fishing rod, we have to take into account that some sorts of fish will fall into both classes. Thus, we should not be surprised if we find that physical magnitudes are found to be fundamental as well as derived (pp. 80, 130, 167).

If we understand 'metrization' as the search for the measure function, then we can meaningfully subdivide it in 'fundamental' and 'derived'. The measuring principle presupposes that, at least for one intensity, a measure function must be known a priori. This will happen only for properties having an intensity which can be mapped according to the function $y = x$, and, indeed, we are justified here to speak about 'fundamental'.

"A common example of a derived measurement is the measurement of density. In this case we establish numerical values of the density of ... bodies by *calculation,* on the basis of their volume and mass, without having to perform any empirical operations" (p. 19). However, if we use a constant volume, then we again get the familiar measure function $D = a\,m$.

Although many magnitudes can be measured "fundamentally as well as derivatively, it is nonetheless incompatible with the theoretical construction of physics in which this classification is still applied. Such relativization is also in conflict with the fact that the discernment of fundamental and derived magnitudes has, at any rate, a principal significance for the construction of coherent systems of measurement units" (p. 76).

This is an untenable position. Berka has forgotten here his correspondence rules. Because of these rules, the difference between empirical and numerical characteristics is repealed, that is, each magnitude (not only "many") must be measurable, both fundamentally as well as derivatively. Otherwise, the one-to-one correspondence stated in these rules would be violated. The fact that computation and measurement can be exchanged characterizes physics as an empirical theory.

In the theory of scales (chap. 7), Berka introduces the familiar nominal, ordinal, interval, and ratio scales, which are characterized according to their transformation function $f$, where $x' = f(x)$ (p. 158-161). Berka gives no clear definition of a scale transformation, nor does he explain what $x'$ and $x$ really mean. If we measure an intensity $y$ by means of an intensity x using the measure function, say, $y = a\,x$, then nothing can be said about the property of $y$, unless that of $x$ is known. Scale transformations can be interpreted, therefore, as a change of the measurement procedure, either with respect to magnitude $x$, or with respect to magnitude $y$. In the latter case, $y$ is measured by means of a new magnitude, say $x'$, causing a new measure function, in general. Hence, the transformation property is characterized by the applied measurement procedure, but not by the magnitude itself.

The discussion of the methodological and philosophical problems of measurement (chap. 8 and 9) are shadowed by Berka's misunderstanding of the measuring principle. We pick up only two points from it, the discussion about rational and irrational values, and the question of measurability in the so-called extraphysical sciences.

The confusion between true and measured value is very common and manifests itself in causing grotesque philosophical problems. "Let us imagine that we have at our disposal a certain body which has the shape of a right-angled isosceles triangle with the sides $a = b = 1$ m, and that we have to measure the length of its hypothenuse $c$". Using the Pythagorean theorem, we get the irrational number $c = \sqrt{2}$ . Thus the length of $c$ cannot be measured by pure operational procedures (pp. 4, 122). However, "if we combine, for instance, a fundamental measurement of length with a derived measurement on the basis of the laws of Euclidian geometry, we obtain irrational values, too" (p. 130).

Note that irrational numbers can never be 'measured' by calculations. It is quite incorrect to identify fundamental measurements with rational and derived ones with real numbers (p. 193). There is no "conflict between empirically measurable values of magnitudes and their numerical values" (p. 121, 196), and it is not true that in practical and theoretical relevant "cases, indirect measurements prevail, for one cannot measure directly the irrational values of magnitudes" (p. 131). The geometrical as well as physical laws are related to the true values. They may but must not be thought of as real numbers. Real numbers are not "of necessity used in the formulation of numerical laws", it is not true that "any theoretically discipline is inconceivable" without them (p. 121). Similar to the concept of true values, Berka introduces so-called actual values (p. 195), but without drawing clear consequences from their state.

The discussion about measurability is closely connected with measurements in extraphysical sciences. In physics, a property is assumed to be measurable, if either a fundamental metrization could be performed, or if at least one measure function has been found as a bridge to an already measurable magnitude. Otherwise, no assertion about its measurability can be made. What could be the reason not to be measurable? Either: (1) the property has no connection to any other property; or (2) there exists no measure function. Case (1) could happen, in fact, but such property would not be observable, because observability implies the ability to come in contact with another object. Case (2) could occur if the measurement system does not reach a stable state. To what extend is it allowed to transfer this conception to measurements in the social sciences? More precisely, does the physical measuring principle hold in the social sciences, too? We answer this question in affirmative, whereas Berka seems to deny it (pp. 15-19, 214, 216), although no clear justification can be found from him. Without any knowledge of the history of physics, Berka maintains that, in contrast to the social sciences, in physics the "situation was facilitated by the existence of the objective conditions of the applicability of quantitative methods". "Physicists did not feel the need to be preoccupied with the methodological questions of experiments, since they had not encountered serious obstacles in this respect" (p. 11).

Again, the fact is of crucial importance that measurement presupposes the knowledge of a law. If such a law between two magnitudes has been established erroneously, then it may happen "that a certain intelligence test ... will not refer to intelligence but to memory" (p. 203). On the other hand, each correct law opens the possibility for a meaningful measurement in whatever discipline. Berka did not understand these fundamental relationships of the measurement procedure: "The transition from classificational to metrical concepts, which on the theoretical level expresses the measurability of the respective property, must be carefully distinguished from a more or less successful attempt to provide a *quantitative explication* of a certain qualitative concept. To give an illustration of this manner of conceptual elucidation, we may mention the exemplification of a certain qualitative concept by means of numerical data; for example, the explication of the concept of a successful theatrical production by the number of reruns, or the discovery of a suitable correlation between qualitative and quantifiable concepts which have a different content, for instance, between the concepts of fear and the adrenalin level in blood" (7 f).

Moreover, purely theoretical quantities like 'accuracy', 'precision', 'reliability' and so on, require likewise a measure; otherwise they will lead to meaningless assertions like "classificational concepts are inexact and indeterminate" (p. 5), or "it is obvious that real numbers offer more precise information than do the whole numbers" (p. 193).

Reviewing the literature on the theory of measurement published in the last decades, one can notice a prevalence of logicians and mathematicians amongst the authors, e.g., Carnap, Hempel, von Neumann, Suppes, Krantz, Pfanzagl, and now, as temporarily the last one in this number, Berka. And, in continuing the tradition, Berka documents with his book that he has never seen a laboratory from inside. Measurement is neither a logical, nor a mathematical, nor a philosophical activity. What is the reason that just those people feel an urge to write on measurement who do not have any practical experience in this area?

http://www.peterjaenecke.de/messtheorie.html 22.08.07