ON THE NATURE AND PURPOSE OF MEASUREMENT*

I. INTRODUCTION

This paper consists of two main parts, the first being a critique of a currently widely held view as to the nature of measurement, and the second being a sketch of an alternative view which I hope to show is more adequate to the actual practice of measurement in science. The theory of measurement which I will criticize is what might be called the 'representational' theory: namely that measurement consists in assigning numbers to things in such a way that certain operations on and relations among the assigned numbers come to 'correspond to' or 'represent' observable relations and operations on the things to which they are assigned. This view is associated with such writers as N. R. Campbell [4], and more recently B. Ellis [8] and P. Suppes [28], [29], though its main ideas were fairly clearly stated earlier by H. Helmholtz [11] (and one can make a case that Euclid's axioms about addition of equals, etc., constitute a non-numerical statement of many of the fundamental assumptions of this doctrine). Much recent work on measurement theory in the field of mathematical psychology has taken the representational view as its point of departure (see, for example, Luce and Tukey [18], Krantz [15], Davidson and Suppes [6], Pfanzagl [22], Eisler [7] and Tversky [31]). I will try to show that, though the work of Campbell and others in the representational tradition has contributed to our understanding of measurement, the proponents of this approach have neglected to consider what it is that measurements are made for, and in so doing have been led to conclusions as to what measurement ought to be which are in serious disagreement with what scientists do. The alternative view which I sketch in the second part of the paper is based on the assumption that at least

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one of the principal reasons for making measurements is to provide objective *indices* of phenomena. This leads to a kind of *informational* account of measurement, and to the view that measures of a quantity are not so much ‘true’ or ‘false’ as they are more or less informative about the phenomena which they are supposed to be indices of. Without going farther into the consequences of this change in viewpoint, let us proceed directly to the discussion of the representational theory.

II. CRITIQUE OF REPRESENTATIONAL MEASUREMENT THEORY

There are five basic assumptions which seem to me to be associated with the representational theory. These are:

1. Measurement is the assignment of numbers (perhaps numerals) to objects or phenomena according to rule.
2. At least in the case of fundamental measurement, the numbers assigned to objects according to a given procedure are assigned in such a way that certain operations and relations among the objects measured come to correspond to or be represented by operations and relations among the numbers.
3. The problem of the foundations of measurement, as it is concerned with a particular kind of measurement, is to determine “the conditions under which measurement is possible”, which requires determining the empirical laws which the objects must satisfy in order that it should be possible to assign numbers to them such that the empirical operations and relations can be made to correspond to numerical operations and relations.
4. Any given kind of measurement system determines the numerical measures to be assigned in it only with a specified degree of uniqueness, and the remaining arbitrariness of the measurement determines the *scale type* of the system, and its class of permissible transformations (Stevens, [26], [27]).
5. The permissible transformations of a system of measurement determine what can legitimately be done with measurements of the system: what statistical treatments are ‘appropriate’ to them, and what can ‘meaningfully’ be said about them.

Of the above 5 assumptions, the first three might be regarded as basic to pure representational measurement theory, while the last two are