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Comment to: L. Mari "Is our understanding of measurement evolving?"

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ABSTRACT
The present contribution is a comment which addresses the paper published in this Journal "Is our understanding of measurement evolving?" and authored by Luca Mari. This Technical Note concerns specific parts of that paper, namely the statements: "doubt: isn't metrology a 'real' science? … Metrology is a social body of knowledge", "Measurements are aimed at attributing values to properties: since values are information entities, any measurement must then include an informational component" and "What sufficient conditions characterise measurement as a specific kind of property evaluation?", and discusses alternatives.

Section: TECHNICAL NOTE

Keywords: Metrology; measurement science; measurement process; informational component

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1. INTRODUCTION

After having read the recently published paper [1], I am feeling, dictated perhaps by being a long-since metrologist, a compulsory need to write the Comments below, more from some sense of surprise than for a less appreciation for its Author. The comments concern the following quoted parts (where added Section numbers are the ones used here below):

(2.) – "*doubt: isn't metrology a 'real' science ? … Metrology is a social body of knowledge*" (original italics);

(3.) – "*Measurements are aimed at attributing values to properties: since values are information entities, any measurement must then include an informational component*";

– "*Listing some necessary conditions that characterize measurement, and that plausibly are generally accepted, is not a hard task: measurement is*

…

(iv) *that produces information in the form of values of that property. Indeed,*

(iv) *characterises measurement as an information process*".

(4.) – "*However, not any such process is a measurement, thus acknowledging that not any data acquisition is a measurement. We may call "property evaluation" a process fulfilling (i)-(iv). What sufficient conditions characterize measurement as a specific kind of property evaluation? The answer does not seem as easy"*

(blank lines added for clarity)

…

"*The possible evolutionary perspectives of measurement can be considered along four main complementary, though somewhat mutually connected, dimensions:*

– *measurable entities as quantitative or non-quantitative properties …;*

– *measurable entities as physical or non-physical properties;*

– *measuring instruments as technological devices or human beings*;

– *measurement as an empirical or an informational process, and therefore the relation between measurement and computation …*".

2. "ISN'T METROLOGY A 'REAL' SCIENCE?"

My position is that metrology is a part of measurement science, a process intended to share common ways to transmit the knowledge to the Community that is not limited to a single generation of scientists and practitioners, and to obtain the necessary consensus.

It is metrology the part that defines the meaning of the terms "precision" and "accuracy" by introducing the concept of uncertainty, otherwise not necessarily embedded in the meaning of measurement, as it happened, e.g., in times anterior to modern science.

Another mandatory requirement of metrology is the need of a multiplicity of the measurements in order to obtain data comparable with each other, so requiring that they are

traceable—to a common denominator— to each other, in order to ensure that all the scientists are "on the same page". The reason for this is that data, numerical or not, are certainly to be considered *facts*—as opposed to inferences—but not necessarily and usually as *un-equivocal* as one would ask for. Restricting the case to numerical data—e.g., rarely the published ones are the "rough" instrumental indications (as recognized, e.g., by the VIM [2])—metrology is the science dealing with correctly setting rules for their *elaboration*.

Metrological competence is also necessary to implement the increase in precision of the measurements, the latter being a normal goal of science as one of the ways for increasing knowledge.

Yet, in order to allow sharing the results, "good-practice" rules must be installed, eventually ordered in protocols and conventions, only apparently a non-scientific stage of the measurement process. The latter requires instead scientific competence and *sharing meanings* and, consequently, a *language* (also across local ones). At the end of this process, language is stored into *written rules* ("*scripta manent, verba volant*") —notation being a specific symbolic language—a feature common to every frame of shared knowledge, called *consensus* ("*pacta sunt servanda*"), in the lack of human possibility of knowing truth. On the other hand, consensus cannot replace or contrast current knowledge, but its function is merely a notary one (an issue becoming today more and more critically important and subject to misuse).

In the above respect, my opinion is that measurement science may be compared to the DNA of the observational science, i.e. the body of knowledge, with metrology its RNA as presently interpreted in biology, i.e. the *tool for implementation* of its basic principles and rules.

3. "ANY MEASUREMENT MUST THEN INCLUDE AN INFORMATIONAL COMPONENT"

I agree that a measurement result, numerical or not, is additional *information*, assumed to be useful for increasing the knowledge level—otherwise there would be no reasons to perform measurements. However, after Shannon having extended the scientific meaning of the term *measurement*, and especially in the present times dominated by *informatics*, I suggest that assigning a specific further meaning to the term *information* becomes necessary, as I do not consider it anymore a generic or un-equivocal one.

I consider it sufficient here to point out that one meaning of *information* is the one carried by a value measured according to the scientific definition of measurement, i.e., a "material" information concerning the "external World" as perceived by the humans and their built apparatuses—made to supplement the human limited (standard) sensorial capabilities. Instead, I consider a different meaning of *information* what scientists (and anybody else) elaborate or communicate (the information born from) thoughts of *their mind*. The difference is the usual one, between the case of becoming informed by our senses about a feature of a World's phenomenon, and the case of having a *personal thought*—or based on an inter-subjective one, basically without difference when concerning this issue.

In other words, in all cases "information" is a *concept from human mind*, while a "measured value" for a human is an *external fact*, then assimilated through subsequent mind inference.

This difference is substantial and does not produce, in my opinion, any "*evolutionary perspective*" (italics added) in measurement science— at least, when the perspective does not concern the human mind.

In this sense and meaning, I respectfully disagree with the above clause (3.) (iv), because it is *not* an information process in the current sense, and especially not according to the procedures used today in information science.

Let me introduce here a bit of humour, by citing an extreme case that recently occurred to me in this subject matter. It is popular in this period for an author to pretend to have found an information method to check if the current scientific evaluation of measurement uncertainty leads to correct estimates, e.g., in the case of the uncertainty associated to the value of the universal constants of physics (for the Planck one see [3]). His method is said to be based on the information content. I had a short correspondence with him to understand the way he implements the information process and gets his results, until I discovered that he is considering as the information content of a given physical constant value the number of times that the value is cited in the reference document of the SI, that being the "firm" basis of the rest of his computations …

4. "WHAT SUFFICIENT CONDITIONS CHARACTERIZE MEASUREMENT AS A SPECIFIC KIND OF PROPERTY EVALUATION?"

The author indicates as "evolutionary perspective" basically an extension to a wider meaning of the term "measurement", namely to categories of observations that historically were not comprised in the current definition of measurement, namely the *non-quantitative* and the *informational* ones, a goal having attracted more attention in recent times.

It seems to me that, for that purpose, it would be simpler to use a *term different from "measurement"*, e.g., the one used by the author itself, "evaluation" for the non-quantitative case. It does *not* seem to me a *diminutio*, being used simply for indicating a previous stage of the process, even in the quantitative case [4]—or "representation", if one prefers to avoid any misunderstanding about the existence of a possible quantification.

Concerning instead the issue of measurement *vs.* computation, I think that "computation" has *always* been in modern science part of the elaboration of the numerical (or logical) data obtained from observations (here the theoretical case is not considered), and that recently the elaboration is done prevalently via automatic computing. This fact has induced the development of a new discipline in science: *informatics*. Arising from its nature, its most important influence in science has been an exponential increase in time of the development of new (machine) languages, obviously having for their roots in the human ones, thus also concerning the organization of the numerical knowledge for it *elaboration and use*. In that sense, I see informatics as a marginal *follow up* of the measurement process, *not* an integral stage of it—as also "simulation" and "extrapolation" are, both based on models, so actually pertaining to the theoretical frame.

5. CONCLUSIONS

I conclude by saying that I am aware and I had direct experience long since that there are gaps between disciplines—I contributed, since 30 years ago, to start a Conference Series just with the main goal, at that time, to "increase the extent of co-operation by calling scientists from both the mathematical and

the metrological fields to meet and exchange experiences" [5], later extended to computational science.

These gaps include language: metrology has developed its own idiom that, in my opinion, is satisfactorily summarized in [2]—for a more extended discussion on this issue see [6].

Different meanings may be assigned to terms in other discipline idioms, namely those of philosophy of science, or different terms may be used. Consequently, it may easily happen that it becomes hard to overcome basic misunderstandings in inter-discipline conversations. On the other hand, this diversity is a richness of science. [7]

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