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PAUL'S COLUMN ON MIC

"Quality of a measurement result" is established by means of metrological criteria

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"Quality" has become one of the buzzwords of our time. Just look at the number of times that "quality control" and "quality assurance" can be found in the literature.

What is quality? Several attempts for definitions circulate. A few examples: quality is said to mean:

- degree of excellence [1],
- the totality of features and characteristics of a product or service that bear on its ability to satisfy stated or implied needs [2],
- the property of a product or service being proven correct by subsequent evaluation [3], and
- any of the features that make something what it is [4].

In the context of measurement, "quality" obviously refers to quality of measurement results obtained for the measurand (entry 2.3 in [5]) as decided by the analyst (obviously prior to the measurement). This specification of the measurand is essential to subsequently enable to talk about "quality" of results obtained for this measurand.

Two main questions immediately do come to the mind: where does the result come from (i.e., what is its metrological traceability?) and: how doubtful should we feel about the result? (i.e., what is its measurement uncertainty?). In communication worldwide, quality of a measurement result must be understood in the same way in the main cultures of that world. It therefore requires *common understanding* of the concepts "metrological traceability" (entry 2.41 in [5]) and "measurement uncertainty" (entry 2.26 in [5]) as properties of a measurement result. Common understanding by means of mutually agreed definitions of these concepts is simply a condition sine qua non.

Fortunately, such commonly accepted definitions are available—since 2008—in an "International vocabulary of metrology" (VIM) [5], patronized by eight international organizations (BIPM, IEC, IFCC, ILAC, ISO, IUPAC, IUPAP, and OIML). After 10 years of study work, two periods of 6 months of formal consultation and a formal vote according to previously established procedures, these definitions were unanimously approved in the final version and are available/downloadable for free on the Internet [5]. In the very recent version (released in 2012), various editorial and typographical corrections were published [5].

When considering the property "metrological traceability," the question automatically arises: to what are these results trace-able? In other words: what are references for this trace-ability? They are given in the VIM in entry 2.41 Note 1 in [5]:

1. a measurement unit (entry 1.9 in [5])
2. a "reference measurement procedure" (entry 2.7 in [5])
3. a certified reference material (entry 5.14 in [5])

Metrologically speaking, it is difficult to see how values can be trace-able to anything else than values. That is consistent with the definition of reference given under concept 2.6-1 in [6], a 10 years' IUPAC study having been subjected to formal examination procedures similar to those given above. We note that *values* are indeed central in this definition:

"specification of kind-of-quantity and description of how to obtain one or more quantity *values* of that kind-of-quantity" (not italicized in the original).

The author is a member of the Joint Committee on Guides for Metrology (JCGM), Working Group 2 (VIM). The opinions expressed in this Column do not necessarily represent the view of the Working Group or of ACQUAL.

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The three references given in entry 2.41 in VIM, Note 1 can now be interpreted as:

1. a value of a measurement unit (usually, but not necessarily "1"),
2. a value obtained by a reference measurement procedure, or
3. a value embodied in a certified reference material.

It would constitute a great leap forward if every measurement laboratory institute, organization, research group, university, and especially National Measurement Institutes would use these commonly agreed references for metrological traceability: they create the very basis for establishing metrological comparability of measurement results (entry 2.46 Note 1 in [5]) on a regional, national, international, global (intercontinental) scale, or within an association of professionals in the same field. Such common references should always be agreed *before* measurements are carried out the results of which are intended to be compared. They should also be accessible to all parties involved. "Comparability" enables us to validly compare results other across time and space, the very purpose of measuring, and the very reason for the requirement "metrological traceability."

The other property "measurement uncertainty" of a measurement result presupposes an established metrological traceability chain (entry 2.42 in [5]), and for evaluating measurement uncertainty, we also have an international guide [7]. We will not dwell on that here, but rather look at a related matter.

In the practice of measurement, we like to distinguish "good" results from "medium" and "bad." That requires setting a goal (prior to the measurement) for the maximum permissible measurement uncertainty to quantify the fitness-for-intended-use [8] of that result. A tool for that is available from the VIM: "target measurement uncertainty" (entry 2.34 in [5]). After the measurement has been performed, it enables to draw the conclusion about a result as being.

- "good": measurement uncertainty somewhat smaller than the target measurement uncertainty, and therefore, fit-for-intended-use,
- "medium": measurement uncertainty somewhat larger than the target measurement uncertainty, and therefore, unfit or maybe still just fit-for-intended-use,
- "bad": measurement uncertainty really larger than the target measurement uncertainty, and therefore, unfit-for-intended-use of the result.

From all of the above, it seems useful—and possible—to derive a possible definition of quality of a measurement result:

> quality of a measurement result is the fitness-for-intended-use of that result, expressed by its metrological traceability including a comparison of the ensuing measurement uncertainty to a pre-set target measurement uncertainty.

Maybe a definition of "quality of a measurement result" should be considered and included in the next VIM?

As usual, any comment, question, or amendment is welcome, preferably as a contribution to the Discussion Form of this Journal.

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