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INFLUENCE OF INTERNET METROLOGY ON ADVANCES OF MEASUREMENT SCIENCE

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Abstract – Aim of the paper is
1. to present different definitions of measurement
2. to prove, that measurement science is metrology
3. to illustrate the advantages of Internet-metrology
4. to show the influence of standpoints on definitions
5. to define measurement paradigms for practical use.

Keywords: metrology, measurement, Internet

0. INTRODUCTION

For 30 years there has been an interest to speak and write about measurement science:
Measurement Science Conference MSC [www.msc-conf.com, 10.04.04].
IMEKO TC 7 Measurement Science [www.imeko.org, 10.04.04].
International Vocabulary of Basic and General Terms in Metrology VIM [www.xs4all.nl/~mlbroens/vim.htm, 10.04.04].
Handbook of Measurement Science [www.wiley.com/WileyCDA/WileyTitle/productCd-0471100374.html, 10.04.04].

The aims of IMEKO TC 7 since its foundation in 1973 are:
to promote measurement-related theories on international scale to increase efficiency:

- in research, by allowing easier solutions of problems as a result of their deeper understanding
- in education, by rationalization of teaching as a result of objective generalization
- in production, by allowing easier quality control as a result of greater measurement reliability

[www.imeko.org, 10.04.04]

An increasing interest is in asking the questions:
1. What is measurement?
2. What is the difference between measurement science and metrology?

Therefore, the following topics will be discussed:
1. different definitions of measurement,
2. identity of measurement science and metrology,
3. the advantages of Internet-Metrology,
4. the influence of standpoints on definitions,
5. selected measurement paradigms for practical use.

1. DEFINITIONS OF MEASUREMENT

1.1 Selected definitions of "measurement" in books

Selected definitions of "measurement" in books in alphabetical order of the authors are:

Measurement is the assignment of symbols to properties of objects and events, and is thus the description of properties of objects or events and not of the objects or events [1 Finkelstein] p.41. Further definitions of measurement are given by Finkelstein in [1] pp.39 and 41

Measurement is an origin of sciences and technologies crossing wide fields and is common base of human activities from the problems of high technologies to the problems of our daily life [3 Kariya] p. 201

Measurement [M] is the process of experimental determining the value of a quantity X for mapping X as X = N[x], where N is a number N and [x] is an appropriate unit of measurement [2 Kneller] p.1120,

Measurement is a specific kind of evaluation, i.e. it is an operation aimed at associating an information entity, the result of measurement, with the state of the system under measurement in reference to a given quantity, the measurand. [1 Mari] p.17. Further definitions of measurement are given by Mari in [1] pp.20, 22 and 27,

Measurement consists of a sequence of operations with the purpose of obtaning experimentally a quantitative information concerning certain properties of an object or a system [2 Millea] p.65´. Further definitions of measurement are given by Millea in [2] p.68

Measurement is a principal tool of empirical domaines of science [2 Morawski] p.1116,

Measurement is the process of assigning numbers (numerals) for representation of elements of a given empirical system such that relations between these numbers are closest to relations in the reference empirical subsystem belonging to a suitable scale [3 Muravyov] p.38.

Measurement can be thought of as an operation leading to selection of symbols from the set of all possible measurement results [1 Urbanski] p.32. Further definitions of measurement are given by Urbanski in [1] p.36

Measurement of a quantity is a mapping of the space of events (objects, phenomena, things) into the

mathematical space which represents the results of measurement (values of physical quantities) [1 Urbanski] p.68.

1.2 Selected definitions of "measurement" in web

Selected definitions of "measurement" in web sites in alphabetical order of the web addresses are:

Measurement is a set of operations having the object of determining a value of a quantity.
NOTE: The operations may be performed automatically.
[www.cornnet.nl/~mlbroens/vim.htm, 10.07.2003].

The word ***measurement*** has only one sense:
Measurement > noun (*act*) .
Meaning: The act or process of measuring.
[www.hyperdic.net/dic/m/measurement.shtml, 07.04.04]. HyperDic is a *hyper-dictionary of English*, based on WordNet, a semantic web of English words.

1.3 Frequency of "measurement" in the Internet

For "measurement" the Internet searching machine www.google.de offers **13,700,000** results in 0.16 seconds (10.04.04).

For "measurement" the Internet book shop www.amazon.com offers **66,451** books (10.04.04).

Google offers for "definition of measurement" **1,940,000** results in 0.17 seconds (13.04.04).

Amazon offers for "definition of measurement" **45,806** books (13.04.04).

1.4 Conclusion

It is obvious that the confusing multitude of formally different definitions for the same word is counter-productive.

An old proverb says:
The fewer the words, the better the prayer.
[http://creativeproverbs.com, 11.07.2003].

2. DEFINITIONS OF METROLOGY

2.1 Selected definitions of "metrology" in books

Definitions of metrology in the International Vocabulary of Metrology VIM and in the Hyper-Dictionary of English HYPER-DIC are:

Metrology is the science of measurement.
NOTE Metrology includes all aspects both theoretical and practical with reference to measurements, whatever their uncertainty, and in whatever fields of science or technology they occur
[www.xs4all.nl/~mlbroens/vim.htm, 2.2; 10.04.04].

The word ***metrology*** has only 1 sense:
Metrology > noun (*cognition*)
Meaning: The scientific study of measurement.
[www.hyperdic.net/dic/m/metrology.shtml; 10.04.04].

2.2 Definition of legal metrology of the OIML

Legal Metrology is the entirety of the legislative, administrative and technical procedures established by, or by reference to public authorities, and implemented on their behalf in order to specify and to ensure, in a regulatory or contractual manner, the appropriate quality and credibility of measurements related to official controls, trade, health, safety and the environment
[www.oiml.org/information/presentation.html 03.04.04].

2.3 Frequency of "metrology" in the Internet

For "metrology" the Internet searching machine www.google.de offers **516,000** results in 0.09 seconds (10.04.04)

For "metrology" the Internet book shop www.amazon.com offers **927** books (10.04.04).

2.4 Conclusion

Metrology and measurement science are synonymous words. They have the same meaning.

3. ADVANTAGES OF INTERNET-METROLOGY

3.1 Networking and Internet-Metrology

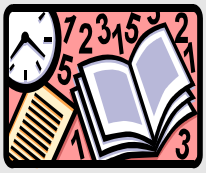
The working conditions of Internet are tremendous due to the co-operation and functionality in real and virtual networks (TAB.1).

TABLE 1. Co-operation by web

Typical production structures in societies		
agricultural	industrial	informational
solo work	**team work**	**net work**
		

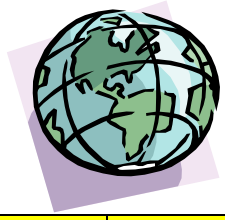
The working conditions of Internet are tremendous due to the standardization and affordability of tools for knowledge workers (TAB.2).

TABLE 2. Standardization by web

language	**storage**	**protocol**
		
unified ENGLISH	unified WWW	unified TCP/IP
⬇	⬇	⬇
global unified human-machine-interface		

The working conditions of Internet are tremendous due to the convenience for knowledge workers (TAB. 3).

TABLE 3. Convenience by web

CONTENT every what	LOCATION everywhere
	
TIME every time	USERS everybody

3.2 Internet-Metrology

Internet-Metrology includes all aspects both theoretical and practical with reference to measurements, whatever their uncertainty, and in whatever fields of science or technology they occur, applying the Internet.

3.3 Conclusion

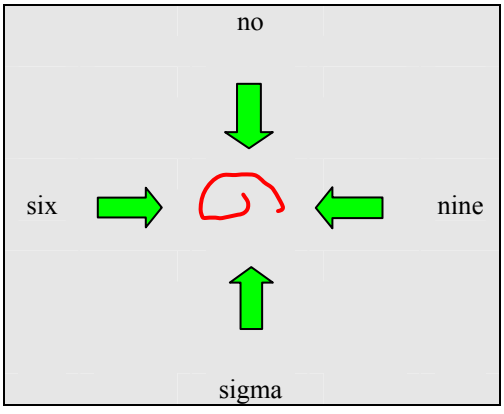
Internet-Metrology is the method of choice for the comparison of measurement definitions.

4. THE INFLUENCE OF STANDPOINTS ON STATEMENTS

4.1 The role of standpoints in discussions

Looking on a sign, the standpoint is essential concerning the meaning of the sign. Discussions about the meaning of words or signs are becoming endless, if the individual standpoint is not mentioned (TAB. 4).

TABLE 4. Influence of individual standpoints on the meaning of signs



4.2 The role of standpoints in metrology

Looking on the different definitions for "measurement" in part 1 it might be possible that the differences are smaller concerning the contents than concerning the individual standpoints (TAB. 5).

Further practical examples are published in [3 Hofmann] pp.67-68 and [www.measurement.sk/2003/S1/Hofmann.pdf]

TABLE 5. Individual standpoints (ISP) in metrology

	Medical ISP **Medical Instrumentation** security comparability operability	
Physical ISP **Measurement Science** signals systems information	**Metrology**	**Industrial ISP** **Measurement Instrumentat.** design applicability reliability
	Legal ISP **Legal Metrology** standards uncertainty traceability	

4.3 Conclusion

The individual standpoint concerning metrology is crucial for the definition of measurement.

5. MEASUREMENT PARADIGMS FROM PRACTICAL STANDPOINT (PSP)

5.1 Definition of measurements from PSP

Measurement is the comparison of an unknown measurand (object or event; product or process) with a known measurement reference standard (object or event; product or process).

5.2 Definition of measurement standards

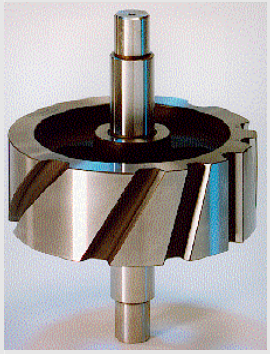
Standardised measurement standard is a SI-based measurement standard under supervision of an institution for legal metrology. Typical examples are etalons for m, kg, s, A, K, mol, cd. [www.bipm.org, www.ptb.de, www.nist.gov, www.npl.co.uk 09.04.04] (TAB. 6)

TABLE 6. Simple measurements with standardised measurement standards and measuring methods

Simple measurements with standardised measurement standards and measuring methods		
Length measurement	Mass measurement	Time measurement
		
Measurement Standard Ruler	Measurement Standard Weight	Measurement Standard Clock

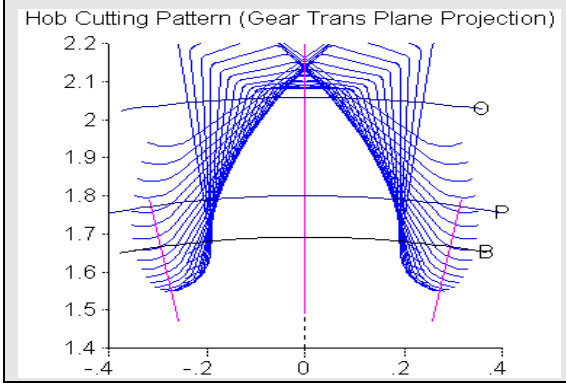
Particular measurement standard is a reference hardware with defined and reproducible characteristics supervised by an authorized institution (TAB. 7)

TABLE 7. Particular measurement standard

Particular measurement standard	
Helix Slope Standard www.ptb.de	
	Size: d = (60…200) mm Calibration uncertainty: U ≥ (0,5… 1,3) µm Purpose: Correction and inspection of gear measuring devices.

Objective virtual measurement standard is a virtual reference tool (software) with defined and reproducible characteristics supervised by an authorized institution (TAB. 8)

TABLE 8. Objective virtual measurement standard

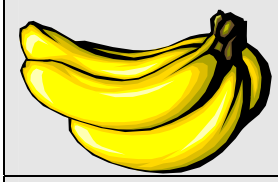
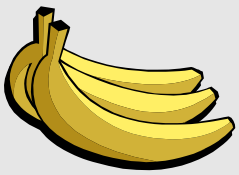
Objective virtual measurement standard
Software programme package


Subjective virtual measurement standard is a virtual image of a reference tool in the brain of a measurement person which is defined and reproducible characterised by experience and expertise (TAB. 9)

5.3 Conclusion

Selected new measurement paradigms have been published in chapter 5. They may be discussed in the portals, workshops and symposia of IMEKO TC 1 and IMEKO TC 7 [www.imeko.org] concerning their helpfulness and praticability.

TABLE 9. Subjective virtual measurement standard

Subjective measurement	
Virtual measurement standard (image)	Measurement system (experienced person)
	
No-Go Banana	
	
Measurement by experience and expertise	

6. FINAL CONCLUSIONS

Using the innovative working method of Internet-Metrology we recommend to collect personalised definitions for measurement in the web-based IMEKO TC 7 "Questionnaire on Measurement Science" [www.liuc.it/imekotc7, 10.04.04].

The personalised definitions of measurement should be analysed for a systematisation of measurements.

First results of these investigations should be published in papers for the International IMEKO TC 1 Symposium "Education in Metrology and Measurement" in September 2005 in Thueringia/Germany.

REFERENCES*

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[3] Komyo Kariya & Ludwik Finkelstein (eds): Measurement Science. A Discussion. Amsterdam, Oxford, Tokyo, Washington DC, Ohmsha and IOS Press 2000

*Web sources are included into the text in square brackets, for example [www.imeko.org]

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