

## FOUR EXPRESSIONS OF FUNDAMENTAL STRUCTURE OF MEASUREMENT SCIENCE

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**Abstract** – This paper is a discussion of a simple structure of “MEASUREMENT SCIENCE” to use on education process to rise up the scientific knowledge of all people who live in science and technology and information oriented society. An act of measure is a fundamental act of a man and people take action to getting information and knowledge by the act, and the people live a life in society, perform the social activity and contribute to the development of society. At the age of science, technology and information oriented society, a science that all people able to learn at each education stage according to each level is wanted. When an act of measure is arranged systematically as the fundamental act of human action and discuss about its social role, “MEASUREMENT SCIENCE” becomes just very appropriate science. In this paper, a structure of MEASUREMENT SCIENCE is arranged by the four definition-functions.

**Keywords:** Need of action, an act of measure, definition-function

### 1. FUNDAMENTAL FOUR CONCEPTS OF MEASUREMENT

The society we live is constructed by gathering individual a man, and the society is going to develop with the growth of civilization, the development of economy and the upkeep of order by law. Here, there is “Action of a man” in basis. And the action takes by a man is started as “An act to measure the things”.

There are some definition to a learning designates “MEASUREMENT SCIENCE”[1],[2]. Here next definition appropriates on the purpose of this paper.

#### Definition of MEASUREMENT SCIENCE

An act of measure takes a man is basic act of action of a man. By measuring, a man gets information and acquires knowledge by analysing the information. Then people take the action individually and socially by applying the knowledge. MEASUREMENT SCIENCE is an important Science to discuss the action of a man and the birth - development process of society by setting the view (theory) of measurement, which is a basic act of a man and the practice method (technique) in the discussion centre.

It is not saying that “Engineering” related deeply with “MEASUREMENT SCIENCE” is “MEASUREMENT ENGINEERING”. Here, the methods to measure, the tools and the devices to measure, the methods to analyze the measurement results, the devices and the instruments to analyze and the systems to how measure are studied and practiced. In the first time, the “MEASUREMENT ENGINEERING” had developed every engineering field and every measurement object as the measurement techniques related with the growth of a man and the development of society as like.

#### Every engineering field,

- Electric measurement,
- Electronic measurement,
- Civil measurement,
- Mechanical measurement,
- Chemical measurement,
- Medical measurement,
- Optics measurement,
- -----,
- -----,

#### Every object,

- Temperature measurement,
- Radiation measurement
- Photo measurement,
- Radio measurement,
- Infrared measurement,
- Ultraviolet measurement,
- Force measurement,
- Hardness measurement,
- Length measurement,
- Area measurement,
- Volume measurement,
- -----,
- -----.

But now the “MEASUREMENT ENGINEERING” is concerning as a system over the boundary of learning and technique. Is learning with “Measure” or “Measurement” and “Engineering” or a “Science”? This is a question and there are some discussions in the academic associations. But it is appropriate that since the basis of an action of a man is an act of measure like indicated in above-mentioned definition the measurement should be discussed as “SCIENCE” by its sociality.

Fig.1 shows a conceptual diagram of “MEASUREMENT SCIENCE”. As clear from this figure, the process of an action of a man is classified in four process (1)(2)(3)(4) based on an act of measure (0), and these become “Four concepts of measurement”.

- (0) A basis of an action of a man is ”An act of measure”.
- (1) The first process is an act of measure by the need of an action of a man, that is, a process to detect the signal included information. This is **First concept of measurement “An act of sensing”**
- (2) The second process is an operation to analyse the signal, that is, a process to get the analysed signal to extract the knowledge. This is **Second concept of measurement “An act of analysis”**.
- (3) The third process is an act to extract the knowledge from the analysed signal, that is, a process to get the knowledge to practice the need of action of a man. This is **Third concept of measurement “An act to get knowledge”**.
- (4) The fourth process is a social operation of a social action by utilization of the knowledge. This is **Fourth concept of measurement “An act for individual and social activity”**.

These four processes and concepts are fundamental functions of a man on individual and social activity, and the functions contribute to the development of society by progress and expansion of the functions. Here the discussion of the functions of measure-

ment as “SCIENCE” becomes very important, especially on the discussion of the process from second to fourth (regard the “Study” in Fig.1).

## 2. BASIS OF AN ACTION OF A MAN “An act of measure”

An act of measure starts by the need (desire) of action a man move on. The Basis of an action of a man, that is “An act of measure”, is practiced for the purpose to get information. The information is classified in effective one and non-effective one. Now indicate an act of measure of a man as  $M$  and indicate the need of action of a man as  $N$ , then a relation  $N$  and  $M$  is given like next, and it is expanded to practical measurement.

$$N \Leftrightarrow M, f : N \rightarrow M \quad (f ; \text{mapping}) \quad (1)$$

Generally, the  $M$  is practiced as some acts of measure, and it is appropriate to classify in to four processes. And the need of action becomes the condition for each process. The relation indicates like next.

$$(M|N) \rightarrow M_p \quad (2)$$

where,  $p = 1,2,3,4$  are four process for the practice of  $M$ .

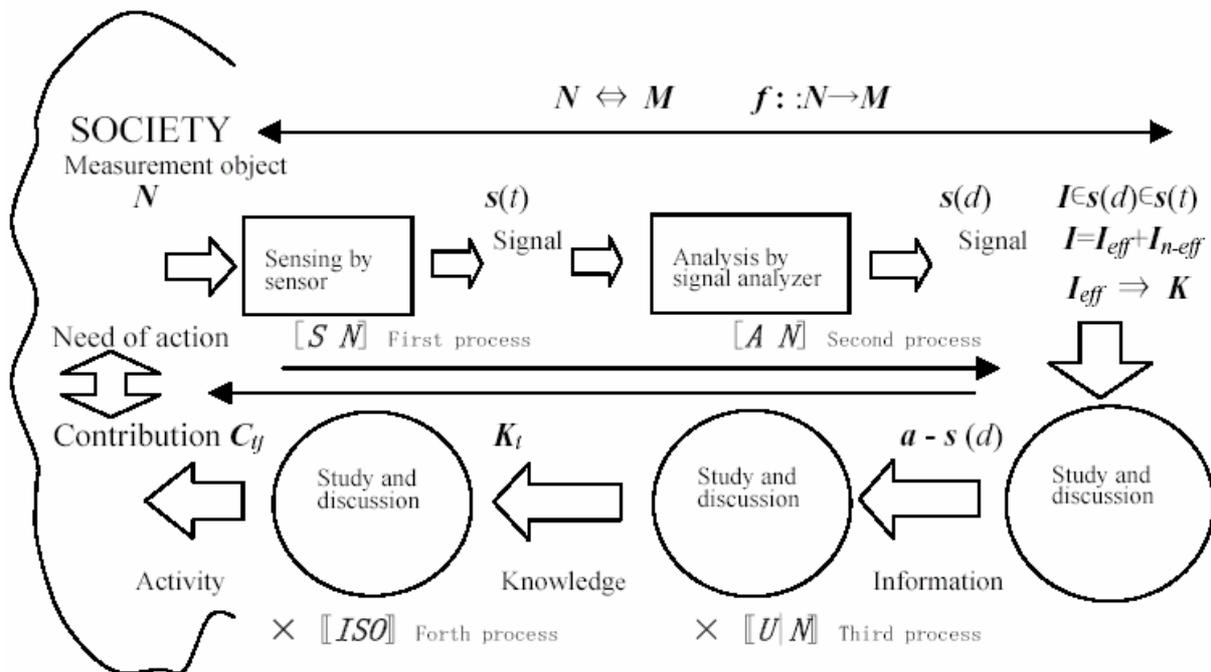


Fig.1 Conceptual diagram of “Measurement Science”

### 3. FIRST CONCEPT OF MEASUREMENT “An act of sensing”

The practical an act of measure of a man  $M_p$  is, in the first process, practiced by sensor. The action is generally called as “Sensing” and this is first concept of measurement, that is, “**An act of sensing**”. And it is proper to classify into two categories, the feeling sensing and technical sensing. Anyway, the result of sensing becomes time series signal  $s(t)$ , and the information comes out oriented the signal. Since an act of measure of a man  $M$  is practiced in the first by getting the information  $I$  which takes practice the need of action of a man  $N$ , the  $M$  becomes to an action  $I \cdot M_p$ . At the first process  $M_p$  becomes an act of sensing  $M_s$  and the action  $I \cdot M_p$  is practiced by sensor  $S$  conditioned by  $N$ . This relation is indicated like next.

$$M \Rightarrow I \cdot M_{p=1} \Rightarrow I \cdot M_s \quad (3)$$

$$I \cdot [SN] \rightarrow s(t) \quad (4)$$

Here, [ ] shows the instrument as technical factor.

### 4. SECOND CONCEPT OF MEASUREMENT “An act of analysis”

The second concept is a process to analyse the signal  $s(t)$  and to get another domain signal  $s(d)$ . Because, more information is embedded in  $s(d)$  related with the need of action. This is well known as “Signal analysis” or “Signal processing”, that is, “**An act of analysis**”. Then, here, it must be memorized that the time series signal  $s(t)$  is a set and has a structure of a stochastic process as like next.

$$s(t) = \{s(t, \omega); -\infty < t < \infty, \omega \in \Omega\} \quad (5)$$

Here,  $\omega$  is stochastic parameter, and the measured signal (detected signal by sensor) is determined by  $\omega = \omega_i$ . Then practical output signal is given like this:

$$s_i(t) = \{s(t, \omega = \omega_i); -\infty < t < \infty\} \quad (6)$$

This signal is analysed by the signal analyser  $A$  related with  $N$  and the result becomes signal  $s(d)$ . This signal is almost case given on the domain  $d$  except time domain  $t$ . This relation is shown in it with the case of sensor

$$M \Rightarrow I \cdot M_{p=2} \Rightarrow I \cdot M_a \quad (7)$$

$$I \cdot [A|N] \Rightarrow s(t) \cdot [A|N] \rightarrow s(d) \quad (8)$$

Here,  $M_a$  is an act of analyzing and the act practiced by signal analyzer  $A$  conditioned by  $N$ . Practical analyzers are Frequency analyzer, Frequency spec-

trum density analyzer, Probability density analyzer, and so on.

### 5. THIRD CONCEPT OF MEASUREMENT “An act to get knowledge”

Third concept is a process to get the knowledge. The information  $I$  is embedded in the signal  $s(d)$  that the detected signal  $s(t)$  by sensor was analyzed by signal analyzer. Then it becomes need to extract the knowledge in the information. This is “**an act to get knowledge**” of measurement. The relation with information and signal is clear from the formula (4) and (8).

$$I \in s(d) \in s(t) \quad (9)$$

Then the information is consisted of effective information and non-effective information, and it is not fixed with the effective and non-effective. As the effective information becomes knowledge  $K$  so that the relation is shown like next.

$$I = I_{eff} \leftrightarrow I_{n-eff} \quad (10)$$

$$I_{eff} \Rightarrow K, K \in I \quad (11)$$

When a man uses effectively the information, the information becomes knowledge. Then some operation becomes need to take out the knowledge  $K$  from the information. Fundamental operation is indicated as like same style with the first concept and the second concept.

$$M I \Rightarrow I \cdot M_{p=3} \Rightarrow I \cdot M_u \quad (12)$$

$$I \cdot [U|N] \Rightarrow K \quad (13)$$

Here,  $M_u$  is an act of use of information, and the action  $I \cdot M_u$  is discussed by  $U$  conditioned by  $N$ . And [ ] shows the scientific factor not technical factor. If  $U$  is practiced by “information processor” or “information analyser” at parallel with “sensor” and “signal analyser” which are instruments as technical factor, the relation is given similarly with formula (4) and (8).

$$s(d) \cdot [U|N] \Rightarrow K \quad (14)$$

But the  $U$  is more strong scientific factor which is discussed at the relate with the need of action of a man  $N$  and the signal  $s(d)$ . Then the relation gives by Cartesian product( $\times$ ) for a  $s(d)$  like next.

$$s(d) \times [U|N] \rightarrow K_1, K_2, K_3, \dots, K_i, \dots \quad (15)$$

For example, when power spectrum and its density, cross spectrum, correlation function and etc

were asked from the frequency amplitude spectrum  $s(d)$  that the detected signal  $s(t)$  was analysed by signal analyser, at the relation with the need of action  $N$ , these become the knowledge  $K_1, K_2, K_3$ , -- support the need of action. And then, similarly, when characteristic function, amplitude probably density distribution transition process and etc. were asked from the amplitude probability density  $s(d)$  that the detected signal  $s(t)$  was analysed by signal analyser, at the relation with the need  $N$ , these become the knowledge  $K_1, K_2, K_3$ , --- practice the need of action.

#### 6. FOURTH CONCEPT OF MEASUREMENT

"An act for individual and social activity"

What purpose a man wants to get the knowledge? The reason is that a man wants every time to be leveled up individual life and to be developed human society. The knowledge is used to the operation, that is, "**An act for individual and social activity**" of measurement. When now indicate the individual and social operation as **ISO** and the contribution as **C**, the relation is shown by scientific factor as next.

$$K_i \times [ISO] \Rightarrow C_{i1}, C_{i2}, C_{i3}, \dots, C_{ij}, \dots \quad (16)$$

where,  $i = 1, 2, 3, \dots$ ;  $j = 1, 2, 3, \dots$ ;  $\times$  is Cartesian product.

Here, the **[ISO]** will becomes to a contribution factor or an accommodation factor and the measurement methods should be studied Generally, the measurement is doing by discussion, and then the **C** must be studied in future adequately.

#### 7. CONCLUSION

**A STRUCTURE** of Measurement Science was shown by four concepts based on **A DEFINITION**, "The mapping of the need of action of a man is an act of measure of a man". And, to express the simple structure of Measurement Science **Four Definition-Functions** are introduced. These functions become easy understandable to compare with each other like TABLE 1.

Here, [ ] shows a definition- function, which is possible to practice by artificial and technical method, and [ ] shows a definition – function that becomes need of the study, the discussion, the decision, and so on of a man. Namely, [ ] is technical function but [ ] is scientific function. The reason that an act of measure is discussed as SCIENCE not ENGINEERING exists in here

We expect that many people in all fields have interest for "MEASUREMENT SCIENCE" and to

be developed the science, technology and information oriented society.

TABLE 1 Definition–functions concern a simple structure of "Measurement Science"

Basis	An action	Defini- tion func- tion	Re- sults	Meth ods
$f:N \rightarrow M$	to get sig- nal	[S N]	$s(t)$	tech- nical
	to analyse signal	[A N]	$s(d)$	tech- nical
	to get knowledge	[U N]	$K_1,$ $K_2,$ $K_3,$ – $K_i,$ – –	scien- tific
	individual and social activity	[ISO]	$C_{i1},$ $C_{i2},$ $C_{i3},$ – $C_{ij}$ – –	scien- tific

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