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The 'Classification of Science and Technology'

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Description of the purpose, background, features, structure, compilation principle and use of the Japan 'Classification of Science and Technology' (CST) serving for the indexing and retrieval of research projects within the system REGISTER of the Japan Science Foundation as well as various other purposes. It covers the natural sciences and all the technologies and some related problems. It is in use since 1971 and was revised in 1973. (I.C.)

1. Purpose

The *Classification of Science and Technology* (CST) (1) was compiled to standardize tasks for analyzing the subjects of projects on research and development and for organizing them for retrieval. The scope of science and technology here covers all natural sciences and their application to human society (i.e. all technologies such as engineering, agriculture, medicine). Some problems which seem to be relevant to science and technology are also included. Science and technology, especially technology, is expected to become more versatile and more complicated in the future. To cope with this tendency, the classes and divisions of the CST are freed from the conventional framework of existing technical fields such as civil engineering, architecture, mechanical engineering, etc. and are well prepared for the development of future technologies. Therefore the CST can be regarded as a future-oriented classification system.

2. Background

The CST was compiled on the basis of the *Classification of Technology*. The Classification of Technology is a system with a decimal notation devised in 1965 by the Japan Science Foundation. It aims at classifying technical items from various industrial fields in a systematic way. It is based on totally new aspects varying from those adopted for existing classification systems. However, the Classification of Technology deals mainly with industrial technologies and excludes natural sciences from its coverage, especially biological sciences, agriculture and medicine.

In 1969, the development of the retrieval system for general information of scientific and technological research, REGISTER, was started by the Japan Science Foundation (2). REGISTER is a system for operating information exchange services (a clearinghouse function) by collecting information on on-going research projects in Japan and retrieving research subjects being presently carried out in various research organizations.

For the information analysis and retrieval of REGISTER, the basic principles of the Classification of Technology were adopted. A provisional edition of the CST was compiled in 1970 by revising and supplementing the Classification of Technology. This new system, unlike the Classification of Technology, includes natural sciences, agriculture and medicine. It also covers integrated technology which has come to the fore in recent years. On the other hand, it does have some fundamental defects, such as inconsistency of the system, redundancy of added concepts, and inconveniences in classifying (indexing) and retrieving research information. In 1971, the first edition of the CST came into existence after thorough revision of the defects of the provisional edition. Once the inconveniences encountered in the application of the first edition of REGISTER were removed, the 1973 edition was completed by the Committee on Classification of Science and Technology (chairman: Mr. *Yukio Nakamura*) organized by the Japan Science Foundation.

After examining and revising the classification on the basis of experience gained in the application of REGISTER operations and in the compilation of the *Classification of Agricultural Science and Technology* commissioned by the Ministry of Agriculture and Forestry, and the compilation of the *Classification of Management and Economics* commissioned by the Small Business Promotion Corporation, the staff-members of the Japan Science Foundation completed the 1976 edition of the CST with assistance from specialists from outside organizations. The members of the Committee on the CST and others who have participated in the compilation of this classification system are as follows:

Yukio Nakamura (The Nippon Telecommunications Consulting Co., Ltd.)
Haruto Koga (Mitsubishi Development Corporation)
Yoshio Nagai (Tokyo University)
Isao Oshida (Sophia University)
Toshio Sasaki (Tokyo University)
Takahisa Sawamoto (Keio University)
Momotaro Suzuki (Sophia University)
Sakae Yagi (Chiyoda Chemical Engineering Construction Co. Ltd.)
Tuneo Yosimura (Japan Science Foundation)
Hitomi Igarashi (Japan Science Foundation)
Misao Oono (Japan Science Foundation)

3. Features

Since it was decided to carry out subject analysis and processing of science and technology projects on the basis of various "aspects", the CST was compiled by organizing these aspects systematically, different from the way conventional classification tables have been compiled whose intention is to find the most convenient way for users to arrange materials on a certain subject.

The CST firstly established several wide aspects irrespective of existing subject disciplines and divided these into sub-divisions which correspond to narrower aspects of the subjects. Any subject matter in science and technology can be expressed by coordinating these

aspects; thus it is not necessary in this classification system to set up detailed sub-divisions. At present, sub-divisions are only given on three levels, if necessary, more detailed divisions can be established. The CST adopted the decimal system of notation for convenience of use.

As mentioned above, the CST is a multi-aspect post-coordination system using four decimal digits.

4. Structure

The CST consists of a main scheme and a Japanese syllabary index. In the main scheme the classified entries are listed according to the classification notation in up to 4 figures. The meaning of a classified entry is usually not expressed in terms of one-to-one relationships. When terms in the plural are given to express a single entry, the concept indicated by a group of these terms constitutes an entry. In this case, the aspect is defined by the indirectly defining system.

Several terms are given under each entry. These are synonyms and related terms whose meanings shall be expressed in the aspects of an entry. There are many other synonyms and related terms for each entry besides the terms given as examples in the list. Most terms established as related terms are selected ones used in the titles of research projects carried out in Japan in recent years.

In the Japanese syllabary index, entry terms in the main scheme, synonyms, related terms and other terms not included in the main scheme are arranged with the respective classification numbers. In the CST terms are classified according to various aspects, which means, of course, that a single term can belong to more than one entry. Thus a single term can have more than one classification number in the index.

There are 10 entries in the main classes, 74 with two digits, 399 with three digits and 1.858 with four digits. Approximately 8.900 terms are listed in the Japanese syllabary index.

5. Compilatiou priuciple

For the overall compilation first of all science and technology were divided into fields of science and fields of technology. Fields of science were then classified as biological sciences and physical sciences, and fields of technology were classified according to their subject matter as materials technology, energy technology and biological technology. Materials technology was subdivided into chemical processing of materials and the technology of industrial processes, transportation and storage. For the interconnection between the above-mentioned divisions, the concept 'information' was handled in the division of information technology. Biological technology was divided into agricultural technology and medical and pharmaceutical technology, and, for convenience of use, life sciences were set apart from agricultural technology.

Two classes have been set up to handle problems common to each division, one for place, time, quality, quantity, etc., and one for related and allied areas to science and technology.

The main classes are as follows:

0. Place, time, quality, quantity, etc.
1. Physical sciences (including mathematics)
2. Materials technology
3. Energy technology
4. Information technology
5. Industrial processes, transportation and storage
6. Biological sciences (incl. agriculture, forestry & fishery)
7. Biological sciences (incl. medicine, pharmacology)
8. Related areas to science and technology
9. Other technologies

The classes are sub-divided according to the subject matter of the technology, adopted techniques, and their results.

6. Use, outline and examples

The CST has been used in subject analysis and retrieval of the on-going research projects in the REGISTER system operated by the Japan Science Foundation. It is expected to be used in research management and technology control and is expected too to find various applications in information processing.

The unit technology consisting of integrated technology and related areas in science can be made clear by analyzing it using an aspect listed in the CST. The CST is also expected to make a contribution to solving technical problems encountered in developing new projects, to drawing up plans for assigning researchers and engineers and facility installations needed for executing those projects, and to providing technology transfer. However, some revisions or additions may be necessary before the CST can be used for various individual applications.
An outline of the CST is shown in Table 1. Table 2 gives a survey on the number of classification digits used at all on every one of the three levels of abstraction.

Class	0	1	2	3	4	5	6	7	8	9	Total
Division (2-digits code)	10	8	7	7	9	8	8	7	9	1	74
Section (3-Digits code)	60	58	24	35	55	39	53	40	34	1	399
Subsection (4-Digits code)	277	352	104	106	136	171	374	203	134	1	1,858

Table 2: Number of CST Classification Digits

In the following two examples are given for the application of the classification in indexing research projects.

Name of research project and Result of subject analysis

(1) Study on highmolecular materials having the catalytic functions for a living body.

1469 (Highmolecular chemistry (others))
1479 (Natural organic substances (others))
2527 (Organic highmolecular)
5116 (Organic substances)
6158 (Fermentation, enzyme reaction (in vivo))
7611 (Drugs (general))

(2) Study on the burning properties of high molecular materials

1372 (Heat)
1412 (Theory of chemical reaction)
1463 (Plastic chemistry)
1499 Chemistry (others))
2512 (Useful chemical properties of materials)
2527 (Products (organic high molecules))
5116 (Materials for mechanical processing (organic substances))
8420 (Fire fighting (general))

Division \ Class	0	1	2	3	4	5	6	7	8	9
	Place, Time, Quality, Quantity etc.	Physical Sciences(incl Mathematics)	Materials	Energy	Information	Industrial Processes (physical), Transportation, Storage	Biology, Agricultural Sciences	Medicine, Pharmacy, Psychology, Veterinary Medicine(incl. every vertebrate)	Related Problems	Other Technology
0	General	General	General	General	General	General	General	General	General	Genera
1	Climatic zone, Land	Mathematics	Resources, Search of Resources	Sources of Energy	Types of Information	Materials	Biology (excl. Morphology)	Morphology(Tissue, Organ, Organ System)	Regional Development	
2	Hydrophere (Sea, River, Lake)	Astronomy, Geodesy, Mesurement of time	Gathering/ Picking of Resources	Energy Conversion	Media of Information	Unit Processing	Morphology (Tissue, Organ, Organ System), Anatomy(excl. Vertebrate)	Diseases	Sciences of Home Economics	
3	Space	Physics	Raw Materials	Waste Energy Treatment	Information Management	Integrated Proceesing	Microbes, Plants	Diagnostics, Therapeutics, Nursing	Prevention of Natural Damage & Pollution	
4	Oceans of the World	Chemistry	Industrial Processes (chemical)	Types of Energy for Use	Systems Engineering	Products(Machines, Buildings,etc.)	Animals	Anatomy	Police, Fire Fighting, Defence, Safety	
5	Regions/ Countries of the World	Crystallography, Mineralogy	Products of Materials	Energy Transfer		Transportation	Products of Agriculture, Forestry, Fisheries	Hygiene, Public Health	Economics, Administration & Management	
6	Regions/ Prefectures of Japan	Earth Sciences, Oceanography	Waste Treatment	Energy Storage	Unit Processing (mechanical)	Storage	Plant husbandry, Soil Science Fertilizer, Agronomy, Horticulture etc. Forestry	Pharmacy, Pharmacology, Drug Therapy, Toxicology	Law, Politics, Sociology, Social Welfare	
7	Time	Meteorology, Climatology			Integrated Processing (mechanical)				Learning, Education	
8	Quality, Quantity				Communications		Animal husbandry, Fisheries		Industries, Occupations	
9	Standards, Reviewing, Tests, Reliability				Others				Others	

Table 1: Classification of science and Technology (CST)

References

(1) The Classification of Science and Technology. (In Japanese). Tokyo: Japan Science Foundation. Science Museum, Div. of System Development 1976. 243 p.

(2) Yosimura, T.: REGISTER and RECRAS: two cases of computer-based information retrieval systems for on-going research projects in the general scientific and agricultural scientific fields. In: Proc. UNISIST Intern. Symp. on Information Systems and Services in Ongoing Research in Science, Paris 27–29 Oct. 1975. Budapest: Hungarian Centr. Techn. Libr. & Doc. Centre 1976. p. 438–450.