NEED OF EDUCATION AND TRAINING FOR INFORMATION SCIENCE

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ABSTRACT

Today, information, rather than labor or capital, is becoming the key factor in production. Thus, the "Post-Industrial Society" is the ***Information Society, whose fundamentals are Information Science and Information Technology****. In this paper, an attempt is made to outline* ***the need of university education and training in Information Science****, in the hope that it might provide the basis for appropriate decisions and action.*

1.Concept of Information

Information is today a central concept of our live and work. For organizations, information is one of the most valuable and important resources [1].

The concept of **"information"** could be defined as a *collection of facts* (as answers given to basic questions what?, where?, when?, who?) *organized in such a way that they have additional value beyond the value of the facts themselves*. Concept 'information' should not be confused with other concepts like **"data"** (relating to raw facts or events) and **"knowledge"** (which relates to answers given to other basic questions, like: why? and how?). Thus, "information" can be defined as *organized data* and "knowledge" as *understood information*…

In order to be valuable, for example for managers and other decision makers, information should be more or less *accessible, accurate, complete, economical, flexible, reliable, relevant, secure, simple, timely, verifiable*, etc. Each of these information characteristics is to be appropriately measured and compared with some pre-established accepting/rejecting criteria…

2.Opportunities and Challenges of the Information Society

USA and Europe – as well as other developed countries and regions throughout the world – are creating their *own information societies*, as parts of a **future Global Information Society.** It is obvious that the first countries to enter the information society will reap the greatest rewards because they will set the agenda for all who must follow. By contrast, <<*countries which temporize or favour half-hearted solutions could face disastrous declines in investment and a squeeze on jobs*>> [2].

The concept of "information society" could be defined very simple as being the *society where most of people work with information* (by creating, processing, distributing and/or using it) *rather than produce goods* (in agriculture, forestry, industry, etc).

In his world-wide known books *Megatrends* and *Megatrends 2000* (translated too in Romanian), the American John NAISBITT points to the year 1956 as the beginning of the information society in USA. That year, for the first time in American history, white-collar workers outnumbered blue-collar workers!

New information and communication technologies – mostly developed during the last two decades! – are generating a new industrial revolution based on information. Every day, somewhere, new *information products and services* are offered to the market. This happens because the progress of these technologies enables us now **to generate, process, store, retrieve and communicate** - electronically or optically - **information** (in **what ever form it may take: texts, sounds, or images) unconstrained by distance, time and volume** [2].

This revolution is adding **huge new capabilities** to human inherently limited skills and even began to change *the way human beings are living and working together*!

We are certain that the widespread availability of new information tools and services will offer new opportunities to build a *more equal and balanced society* and to foster *individual accomplishments*. Thus, the **information society has the potential to improve the quality of citizens' life and the quality of environment, to raise the efficiency and the effectiveness of organizations and to promote new forms of work organizations as well as the creation of new jobs, to strengthen industrial competitiveness and to reinforce social cohesion.**

But the information revolution presents a major challenge: **the risk to create – within a country or a region – a society of "have" and "have-nots",** in which only a part of the population has access to the new information technology, is comfortable using it and can fully enjoy its benefits. Consequently, the part of the population which does not have access to this technology, *will ignore these benefits or, worse, will even reject the new information culture as well as its tools.*

Analyses made in Japan, USA and Western Europe made clear that **the investments costs required for creation of the information society are *considerable.***

According to the High-Level Group on the Information Society – which elaborated Recommendations to the European Council – **creation of the information society in Europe** << ***should be entrusted to the private sector and to market forces****.(...) Public investments will assume a role (...) rather by refocusing of existing expenditure. Some of the investment that public authorities have to undertake to develop applications in areas of their responsibility, will generate productivity gains and an improvement in the quality of services that should, if properly handled, lead to savings*>>.

This Group called for **specific actions** dedicated to *the promotion of public awareness of opportunities and challenges of information society.* <<*Particular attention should be paid* ***to the small and medium sized business sector, public administrations and the younger generation***>>.

3.Function, Objectives, Nature and Content of Information Science

Information Science ***function*** is represented by knowledge transfer from an individual to another and from a generation to another one, with the ***final goal*** to **facilitate humanity evolution** [3]

Information Science was developed essentially from Library Management, Archival Science, Documentation and Journalism. Its origins are recent: **1968**, birth year of ASIS – the *American Society for Information Science (& Technology* , since 2000 !), the first professional organization in this field, in the world, and an offshoot of *American Documentation Institute* [3].

The Information Science is one of the fundamentals of the Information Society…In opposition to its above mentioned "ancestors" – mainly dedicated to processing and transfer of information material carrier (especially paper) -- Information Science is taking into consideration the previous and subsequent processes of the *information transfer ("communication")* process. Those are *information creation/generation* process and *information use* process. Obtaining *the highest efficiency and effectiveness* of these processes as well as *the optimum accessibility and usability of information* are the main ***objectives*** of Information Science researches.[3].

One of the first and the most detailed **definition of the Information Science** was the definition given in 1968 by BORKO [3] According to him, << *Information Science is that discipline that investigates* ***the properties and behavior of information***, ***the forces governing the flow of information*** *and* ***the means of processing information***, *for optimum accessibility and usability. It is concerned with that body of knowledge relating to its origination, collection, organization, storage, retrieval, interpretation, transmission, transformation and utilization of information.*

This includes ***the investigation of information representations*** *in both natural and artificial systems,* ***the use of codes*** *for efficient message transmission and* ***the study of information processing devices and techniques*** *such as computers and their programming systems. It is an* ***interdisciplinary science*** *derived from and related to such fields as mathematics, logic, linguistics, psychology, computer technology, operations research, the graphic arts, communications, library science management and other similar fields. It has both a* ***pure science*** *component which inquires into the subject without regard to its application and an* ***applied science*** *component which develops services and products*. >>

BORKO stated that the Information Science will be able to lead to improvements in the various **institutions and media** dedicated to the knowledge accumulation and transmission,: *books, schools, libraries, movies, television, radio, journals, conferences,* etc. In this opinion, all these were, in 1968, **inadequate to meet the communication needs of society**; consequently, a *duplication of effort* was necessary and a *slowing of progress* was determined. These weaknesses are still actual, ***especially for developing countries***; so it is useful to know *the factors* that – in his opinion – contributed to this inadequacy:

1.The tremendous *growth in science and technology* and the *accelerated pace* at which new knowledge becomes available and old knowledge becomes obsolete

2.The fast *rate of obsolescence of technical knowledge*, so that the old graduate must go back to school and update their skills.

3.The *large number of working scientists and the large number of scientific and technical journals*, which exist today

4.The increased *specialization* which makes communication and the exchange of information between disciplines very difficult.

5.The *short time lag* between research and application that makes the need for information more pressing and more immediate

A. Relation of Information Science to other Information based Disciplines

Information Theory is the outgrowth of an attempt to measure whatever can be transmitted over a communication channel of given measurable physical properties. In information theory, information is a *probabilistic quantity*, a measure of an expectation value: the probability of occurrence of an event prior to its observation. Information is viewed as the result of stochastic selection process; hence, the measurable quantity is named 'selective information'. Consequently, **Information Theory deals with only one specific aspect and type of information: the quantitative one!** It does not deal with many other – particularly semantic – forms that we generally refer to as information. Most important, it does not provide a theory ***for*** information as it is used and valued by man in his daily actions. [5]

But the common concept of 'information' is ***qualitative*** and can be distinguished from the 'selective information' concept as that of 'semantic information'. Ultimately, semantic information would have to be measured in terms of the conceptual system of the man, as information user. Linguistics and semanticists are in search of a measure for semantic information but have not as yet succeeded in finding one.[5]

Various ***mathematical theories*** have received impetus from the rapidly developing information technologies and have resulted in the branching of specialized information-oriented disciplines of mathematics.

Examples are ***Coding Theory*** (evolving from set and function theories in response to needs in the field of communication) and the ***Theory of Finite Automata*** (evolving from the theories of computability in response to needs of designers of software, in particular of programs simulating human recognition functions).

Other examples can be derived from the various ***system theories.*** Theories describing the behavior of dynamic systems have evolved in response to the need for full control over the design of electric signal processing systems. These theories serve as the link between physical characteristics of system components and system responses to signals and allow the *analysis and the synthesis of systems*. Since electric signals are carriers of information, **any form of signal processing is an operation on information**!

B. Relation of Information Science to Information Technology

Human desires and needs lead to the development of technologies: the advancement of these technologies requires explanations to technological questions that arise.

Hence, the advancing technologies stimulate research and lead to the development of sciences.

As the technologies progress, research and, correspondingly, the resulting sciences become more and more specialized. More and more sciences evolve, sciences that become narrower and narrower in specialization. As a result, **the chances for fertile and productive communication between related specialized sciences decrease**.

In response to trends of higher and higher specialization, usually, a counteraction takes place: the need for *communication between sciences* leads to a re-evaluation of the foundations of related specialized sciences.

These re-evaluations stimulate the formulation of new *simplifying and unifying theories* that subsume the *main concepts* of the original theories of contributing sciences. **These unified theories may be considered as the body of a new science, which may be named the *metascience*** for those sciences for which the metascience provides the unifying foundation.[5]

C.Functions of a metascience

Metasciences provide the common language and the means for translating concepts among divergent fields and, as such, assist in *unification of knowledge in general*. Metascience serve **three important functions** [5]:

1.They permit the description of the *common basis of related disciplines at a higher level of abstraction* than possible within the framework of the individual contributing disciplines.

2.They provide a *common language for scientists and technologists* in divergent fields of specialization

3.They establish the means for translating knowledge gained in one field to other related fields.

Metasciences require precise and abstract formalizations and definitions of the foundations of all related sciences, thereby strengthening the foundations of the sciences under unification through metascience.

The specialization of sciences in our century has led to the evolution of several metasciences in the sense of *unifying base sciences*, even though they are usually not identified as such. Such examples could be:

-***Systems Theory*** , developed from the general theories of *linear* and *nonlinear dynamic* systems, based on parallel developed specialized theories of analysis and synthesis of *mechanical, acoustical, optical and electrical* systems

-***Formal Mathematics,*** which is the metascience of mathematics (or '*metamathemaitcs*') evolved in response to the divergence and growths of specialized mathematical disciplines

-***Linguistics,*** which can be regarded as the metascience for the body of knowledge on languages and their use for communication

Information Science could be seen too as a metascience of information (or '*Informatology*') developed in response to the need for a critical reevaluation of the foundation upon which (too!) many information disciplines and technologies are based today. It could be defined as <<*the study of the fundamental principles underlying the structure and use of information*>> [5].

D. Information Science as Metascience of Information

The **needs** for the existence of such a metascience of information are obvious [5]:

1.There is a need to provide a *common basis* upon which all information-oriented specialized sciences and technologies can be understood and studied

2.A *common framework and language* must be established to serve technologists concerned with information

3.There is a need *to build bridges* between the abstract theories attempting theoretical explanations of the phenomena of information, on the one side, and between the predominantly empirical theories describing man's relationship to information phenomena, on the other side

Information is generated, processed and used by man. Computers and other machines involved in handling information generate, process and use information only **under the control by man and for man**….Man sets the limits to what can be done with information. As ultimate user – and ,in many cases, as generator of information – his *information processing capabilities*, obviously **limited**, are very important and have to be augmented (for example, by means of the so-called 'information systems'). The evolution of artificial intelligence in the sense of intellectual or information generating power exceeding that of the man is conceivable. Yet, it always has to be under the control and submission to man as its originator and user [5].

Some **questions** to be answered by Information Science (as metascience of information) could be [5]:

1.Can the concept of 'selective information' (of information theory) be extended to permit the measurement of semantic or qualitative information? (*Information Theory and Semantics)*

2.Can the various forms of information processing be analyzed in the form of common elementary processes and can these processes be described by fundamental laws? (*Mathematical Logic, Automata Theory, Computer Science*)

3.How can different methods of information processings, which achieve the same results, be compared and what are suitable quantitative measures that will enable the differentiation of the complexity and efficiency of operations on information? (*Computer Science, Computational Linguistics*)

4.How does man associate meaning with information and what is the relationship between meaning and his established value system? (*Psychology, Philosophy, Semantics*)

5.What are the laws that make natural languages (including in their widest sense music and forms of artistic expression) the universal means of formulating/creating and communicating new concepts and ideas? (*Linguistics, Semantics*)

6.What are the interrelations between the forms of energy, matter and order (or structure) and the use of these forms to represent 'selective information'? (*Information Theory, Physics)*

7.What are the physical limitations of communication, information processing and information storage? *(Communication Science, Brain Research, Storage Technologies)*

8.What are the laws governing the organization of information as it applies to mass information storage and retrieval? *(Experimental Psychology, Library Science, Computer Science, Brain Research)*

9.What are the laws of information dissemination which explain the processes of cognitive perception? *(Educational Psychology, Self-Adaptive Systems Theory, Cybernetics)*

10.Are there properties of information which stimulate creativity and is creativity an information processing function for which laws can be developed ?(*Cybernetics, Artificial Intelligence, Semantics)*

11.What are the laws of information accumulation, updating and assimilation? *(Educational Psychology, Library Sciences, Computer Science)*

The above mentioned questions are not at all exhaustive but are representative and relevant for the information scientists' expectancies in 1970. After 30 years, some questions were answered but a lot of other questions are searching their answers!

These major questions are allowing us to indirectly define the metascience of information and to find its concerns common with other sciences and disciplines.

The Information Science, as metascience of information, has to synthesize the various existing formalistic descriptions into one unified set of theories which is equally applicable to all contributor sciences and disciplines.

E. Relation of Information Science to Other Sciences and Disciplines

There are numerous old and new *sciences and disciplines* concerned directly with some selected phenomena of information, as for example:[3][5]:

-Psychology and Educational Psychology
-Philosophy
-Library and Documentation Science
-Linguistics and Semantics
-Mathematics
-Information Theory, Information Transmission Theory and Signal Theory
-Self-Adaptive Systems Theory and Systems Theory
-Artificial Intelligence and Brain Researches
-Electronics and Telecommunications

-Computer Science, Informatics and Cybernetics

-Economics and Management

Consequently, the Information Science , as metascience of information, is << *a very specific science, concerned only with the foundations of information-related sciences and technologies and not concerned with the content of these specialized disciplines*>> [5] . Information Science **is not a one of 'all-inclusive science'** but a typical 'interdisciplinary science' [3],[5]

F. ADIK-Systems and EATPUTr-Model

Another and more recent definition of Information Science is given in [6]. <<*Information Science could be defined as the scholarly occupation that attempts to establish the principles and laws that govern* ***the augmentation of human capacities through technology***>>

We consider that all *natural organisms* (i.e. individuals) and *social organisms* (i.e organizations) are - in varying degree - **d**ata, **i**nformation and **k**nowledge processing systems ('**DIK-Systems'**) and that data, information and knowledge processing *technologies* (as well as the *institutions* related to them) augment their capacity to acquire, process and use data, information and knowledge. These technologies and institutions are called **'ADIK-Systems'** and have to be analyzed and designed in order to augment the capacity of human beings for awareness (information), enabling the extension of this state to knowledge, namely meaning and understanding.

The central focus of Information Science would be the **DIK-System** which would be represented as consisting of a number of essential components, namely: *events, sensors, transmitters, processors, utilization and transfer/communication devices*.

These components are an analogue of the constituent parts of the human organisms and can be thoroughly examined and explained through the so-called **'EATPUTr - model'**[6]

This model has *six basic components / functions*:

-event (E) , which centralizes the activity of all other system components, defines the objective of the system and set the stage for the analysis and design of the system by specifying the function of overall ADIK-System activity

-acquire component (A), represented by *dedicated human or technological sensors/transducers* used to acquire and capture the energy from events (sensor examples could be : *eye, ear, nose, microphone, video-camera, microwave presence sensor*, etc)

-transmitting component (T) , represented by human or technological information transmission channels used to transfer acquired information (such components could be, for example: *neuronal links, conductors, cables, wave guides, electromagnetic wave links*, etc)

-data processing components (P), which provides the individual (or the organization) with a state of awareness regarding the many dimensional properties of the event. (examples of such components include: *brain, electronic processors, micro-processors*, etc)

-data utilizing components (U), which are providing to individuals awareness for the purpose of general development (as for example, for *problem solving and decision making* processes)

-data transferring components (Tr), which represents the *actions* taken in the response to the event, once the problem is solved, solution is understood and decision is made

This brings the EATPUTr-model full circle and the cycle is complete. From **event** to **awareness** (*information* answering to interrogatives what?, where?, when?, who?), to **meaning** and **understanding** (*knowledge* answering the interrogatives how? and why?) and thence to **action**, this is what we refer to as the **EATPUTr cycle**. This model represents an open, non-linear-feedback loop system and can be applied to the analysis and design of every ADIK-System [5].

Information Science could be considered today as a **mature science**, with its own *concepts, methods, models, laws and theories* [3]

Development of Information Science was accompanied by the setup of specific **information institutions and media** such as: *Information Science periodicals, books, databases, professional societies, universities and departments,* etc [3]

4.The Need of Education and Training for Information Science

For over 40 years, Information Science is a **recognized discipline** in an increasing number of major universities around the world (especially those from USA, Western Europe, Japan, Australia and South Africa).

Over the past ten years were created numerous **Information Science departments** in different universities including those from some developing countries (as for example in the University -Bucharest/Romania).

In these universities and departments, the Information Science *courses content* have been periodically renewed and improved, in order to adapt them continuously to the customers' needs and to the new developments. Consequently, the number of students has increased continuously and substantially. In addition, a lot of these universities are offering too *master's and doctoral programs in Information Science*. Their graduates are **information professionals**, working as *researchers, educators or application specialists* in the field of Information Science (as for example, in **infopreneurship** – as *information consultants, information brokers* or *information analysts*, in **publishing industry** – as *publishers, data-base producers or web designers,* and in **multimedia environment** – as *developers of information products/services, etc*).

The Information Science course *syllabus* COULD BE generally centered, in our opinion, on *four major areas:*

I. Foundations of Information Science: concepts, principles, theories, laws, models

II. Methods of Information Science: tools, methods, etc

III. Information Technology: state of the art

IV. Society and Information Science: roles, functions and impacts of ADIK-Systems; Information Society advances, etc

It has been our observation that **the interdisciplinary education in Information Science is not easy to engage**. Often, the difficulties of interdisciplinary education are not fully appreciated by faculty members or the university. Some of these have the tendency to perceive Information Science as an extension of their field of study! This serves to mitigate the essential interdisciplinary perspective of Information Science.

There are **two views** pertaining to the role of an Information Science course:

A. The first view sees the objective of this course as an exposure of *many subjects matters that are considered to be the domain of Information Science*. Students are asked to provide the synthesis to the respective views….

B. The second view holds that there is *a conceptual framework* upon which the study of Information Science can be pursued..

In our opinion, the *last above mentioned view is the best*, but - as is best discerned - instructors rarely take this view!

CONCLUSIONS

We consider that the information scientist/professional who adopts the view that Information Science is, at its core, **the augmentation of human capacities through technology,** will clearly understand the significance and importance of their work, they will understand the *long lasting effects* their work can have on individuals and organizations and they will be guided throughout their career by *humane motivations and goals*! This, in turn, spells a brighter and safer future for us, our societies, our cultures and indeed our technological civilization. Thus, **the future Information Society will have its well educated and trained experts, the *information scientists/professionals*!**

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