In memoriam GRIGORE C. MOISIL (1906-1973)

Information Society Technologies - The four waves of information technologies

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Abstract

Human society development is accomplished (achieved) by knowledge and learning. Roger Bohn's concept "Learning is evolution of knowledge over time" is based upon the development and evolution of information technologies and communications. This paper presents in a systematic way the development and evolution in the field of Computer Science and approaches the principles in building applications and software products. The technologies that impelled the European and international research programs are highlighted by a systemic and methodical approach. There are presented the four waves of information technologies.

Keywords: Computer Science, Information Technologies, Knowledge Society

1 Introduction

Computer Science is characterized by the most spectacular evolutions of the impact on human activity. *Computer* includes *technologies* of which man has never dreamt. Although at the beginning the use of computer was regarded with reservation, nowadays most of the people are convinced by the performance and utility of computer in all activities. Today, starting from primary school children find out about the impact of computer in their lives. Because of these reasons, the educational systems of many countries are conceived to implement developing strategies oriented to computer utilization for both initialisation and continuous *learning process*. At the beginning of the 21st century it may be said that *information* and *knowledge* are found on the base of scientific, technological, economical, social, cultural processes/events. The economist *Roger E. Bohn* shows that now it is important to understand technological knowledge, and more specific, the way of producing goods and services. Knowledge depends upon the learning process. It is worth reminding Bohn's concept "*Learning is evolution of knowledge over time*" ([6]).

Human society development is achieved by *knowledge* and *learning*. Today, the specialists working in a certain field, face different complex problems, many of these requiring the use of computer and software products. The complexity of activities, competitions of all kinds, efficiency require the use of the best software and hardware

products. The explosion of tools and methods offered by information and communication technologies (IT&C) can be easily seen, by computing systems, by peripherical equipments with different functions. There are more and more research, development and innovation programs and results do not delay to appear. At the same time, continuous learning, the use of new knowledge in the activity field must be major goals of every specialist.

From this point of view, computer science and information and communication technologies provide *e-Learning technologies* and *educational software*. "*Scientific research, technological development and especially, innovation, represent beside the educational system and information and communication technologies, one of the pillars of building the society based on knowledge. Being in a process of restructuring and reorganization, the Romanian research reduces dramatically, in the last 14 years, both the number of institutes and researchers but also the annual budget. More, these factors have led, indirectly, to a decrease of international scientific cooperation, to the lost of some inter-institutional and inter-human contacts and reduced the capacity of participation with concrete scientific research projects in international programs which offer funds for these activities*." (acad. Florin G. Filip, 2004, project ROINTERA, *Romanian Academy*, www.rointera.ro [2])

2 Computer science development and evolution

Research, development and innovation in Computer Science and Information Technologies and Communication – (IT&C) have evolved especially after 1971 when the "jewel" of the 20th century, *the microprocessor*, was invented as a result of successes recorded in three top directions: *cybernetic systems*, *integrated semiconductor circuits* and *micro-programming*.

The most significant evolutions are presented below.

2.1 The 70's

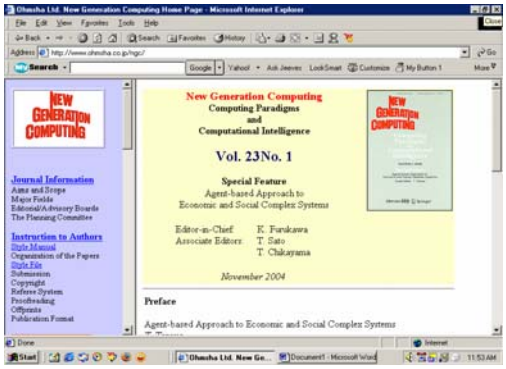
The 7th decade of the 20th century was one of great changes in Computer Science [14,17]:

- *the appearance of microprocessor*, followed by building and spreading on a large scale of the PCs (in 1975 Bill Gates founded Microsoft Company), the development of the computer networks, the appearance of the new operating systems (UNIX, RSX-11M, CP/M), improved performances of the I/O devices.
- *the supremacy and propagation of control structures in algorithmic and programming*; the appearance of the pseudo-cod language for algorithm representation; the conceiving of the first programming languages which implement control structures (*Pascal* and *C*), continuous adaptation of programming languages by implementing control structures, data structures and facilities of OOP (*Object Oriented Programming*);
- *spectacular successes in the field of Artificial Intelligence by creating expert systems*; the appearance of the first logic programming language (*Prolog*) which offers the support for *declarative programming*; developing of inference engines for solving difficult problems;

- *sharing the problems solved by computer (decidable problems) in two distinct classes*: problems solved by imperative (procedural) methods and problems solved by *declarative methods*; delimitation of problems that are *not decidable*.

2.2 The 80's

The 8th decade of the 20th century was one of great successes in *Artificial Intelligence*, development of the computer networks and spreading of the modern programming languages:



- *the launching of the Japanese Project* [1,14] in 1981 for building the 5th generation computer at the beginning of the 90's; this foresaw a revolution in the field of computers through the so called *Knowledge Information Processing Systems* (KIPS); with one billion dollars governmental financing and cooperation of many important Japanese companies, a special institute was established (*Institute for New Generation Computer Technology*) which edited the international review "*New Generation Computing*" (www.ohmsha.co.jp/ngc), becoming one of the most important journal in the world; the project had a deep impact worldwide; *Artificial Intelligence* begins to be taught as a discipline of *Computer Science in higher education*;
- *the appearance of the operating system MS-DOS* and of *the graphical interface Windows* – conceived and written especially for PCs by Microsoft, produced an unprecedented utilization of computers in many fields of activity; the window concept was used in 1985 to build the *graphical user interface* (GUI) *Windows version 1.0*, which will contribute to the appearance of the operating system *Windows 95* in 1995; in this field, history registered cooperation and competition between Steve Jobs from Apple-Machintosh and Bill Gates from Microsoft;
- *the appearance and development of the first generation of network computers* – building and utilization of microprocessors Intel 80286, 80386, 80486 on 16 and 32 bytes made possible the appearance of *microcomputers* and *minicomputers* as well the development of Ethernet computer networks; *these networks represent the base structure of Internet* [14, 17];
- *the development of the programming languages using OOP technology* – utilization on a large scale of *object oriented programming* in modern languages *C++, Pascal, Modula, Simula, SmallTalk, TCL, Prolog, Visual Basic, SQL, Oracle* [14, 17, 18].

2.3 The 90's

The 9th decade of the 20th century was one of great accomplishments in *Information Technology and Communication* (IT&C) through the development and the spreading of

the *Web Technologies* and *Internet*, the improvement of the operating systems and programming environments:

- *the appearance of Linux operating system* – in 1992 appears the first free operating system with facilities for Internet which uses *communications protocols* (TC/IP, FTP, IPX etc) for *E-mail*, *informational areas* (WWW, Gopher, FTP), Newsreader, the appearance and development of Web-sites [17];
- *the appearance of Java Technology* – in 1995 is launched Java programming environment which offers support for distributed, platform independent applications; produced by Sun Microsystems, it inherits object oriented programming concepts from *C++*, *SmallTalk*, *Lisp* [14, 17];
- *launching Windows as an operating system* – in 1995 it appeared the operating system *Windows 95* followed by versions 98, 2000; for computer networks it appeared in 1992 *Windows NT* Workstation/Server; it developed operating systems Netware, OS/2;
- *improvement and utilization on a large scale of Microsoft Office package* containing *Word*, *Excel*, *Access*, *Outlook*, *Power Point*;
- *building hardware-software platforms* – design of the 3D integrated circuits, optical components, parallel architectures for inference processing, high capacity *optical fibre networks*, *neural networks*, operating systems with advanced user interface, *concurrent languages*, *symbolic processing* (natural languages, pattern recognition: images/ voice), Databases Dbase, Foxpro, Oracle; Prolog, knowledge databases, expert systems, CAD, CAM, CAE, Multimedia Technologies, Virtual Reality(VR), Web Technologies.

2.4 After year 2000

The first decade of the 21st century started by the consolidation of the great achievements in *IT&C* [3-9, 14-18]:

- *the appearance of the operating system Windows XP* – the version from 2001 has brought important facilities regarding Internet, multimedia, USB services; Microsoft Office Professional XP package is launched and it includes Front Page 2002 created for Web pages design [17];
- *the diversification of technologies for creating and maintaining Websites* – CGI (*Common Gateway Interface*) programs, ASP platform (*Active Server Page*), PHP (*Hypertext PreProcessor*) platform; Languages XML (*eXtensible Markup Language*), Perl, TCL, VBScript, JavaScript, My SQL; graphical editors for Web pages development (Netscape Composer, Macromedia Dreamweaver/Flash, Adobe GoLive, ContentWare, Content Management Server), Oracle9i platform [14, 17, 18];
- *significant achievements regarding Virtual Reality* [13, 15], *e-Learning* and *educational software technologies*, electronic trade, electronic libraries.

2.5 Principles

There have been established a series of principles regarding building, programming and utilization of computer:

- **the sequential principle** stated by the American scientist *John von Neumann*, considered to be the architect of modern computer; classical computing systems

work based on the "*step by step*" processing principle; this principle dominated both the conception and the elaboration of the operating systems and of the programming languages; in software and hardware development they searched to exceed the sequentially limits; the goal of the Japanese project [1] was to build the *non John von Neumann* fifth generation computer, which was to make the change from data processing to knowledge processing in problem solving; this is how software products which include human intelligent behaviour in solving problems and making decisions appeared; the so called expert systems which implement human reasoning in solving problems at an expert level has been elaborated and used in different domains (*N. Nillson, Artificial Intelligence: A New Synthesis, Morgan Kauffman, 1998*);

- **interactivity principle** – human-computer interaction is a field that always concerned the design and building of hardware and software products; the goal is to study and to improve the factors that influence effective, convenient and efficient use of computer;
- **object oriented principle** is a programming principle which has imposed in designing, elaboration and implementation of the problem solutions by describing them in term of objects, relations between objects and processing operations of these objects; the object oriented programming technology is the only one that satisfies the actual requirements of software products; the modern programming languages (*C++, Java, Visual Basic*) offer the concepts of object oriented programming which have their roots in *SmallTalk, Lisp* and *Prolog* languages;
- **the client server principle** – interaction between the applications of a computers network is realized according to the client server model; in this model, the working in a system is structured into cooperative processes called servers, which offer services to clients; the server executes a request from a client and can initiate a dialog with the client process; this principle offers portability to the hardware platform, multitasking execution, multiprocessor execution, multithread execution; Web applications conform to the client server model;
- **Hypertext principle** –the term *hypertext* was proposed by *Ted Nelson* in 1965 and represents an organizational form of interconnected information in a complex way which conventionally can not be represented on paper [17]; this is on the base of the most important Internet service WWW (*World Wide Web*) which administrates HTML (*HyperText Markup Language*) documents; normally, irrespective of the storage method, the main forms of organization are: linear organization, hierarchical organization, associative organization (similar to human memory);
- **WYSIWYG** – *What You See Is What You Get* principle – this is the characteristic of text/images editors/processors where the document looks on the screen the way it looks in its final representation (on Web, CD, or other media). The programs from *Microsoft Office Professional* package respect this principle. On international plan, computer science, (France- *Informatique*, Germany- *Informatik*) and *IT&C*- (*Information Technology & Communication*) offer diverse research and innovation fields. For instance, the international journal "*New Generation Computing*" (www.ohmsha.co.jp/ngc) has the following objectives: "*The journal is specifically intended to support the development of new*

computational paradigms stemming from the cross-fertilization of various research fields. These fields include, but are not limited to, programming (logic, constraint, functional, object-oriented), distributed/parallel computing, knowledge-based systems and agent-oriented systems. It also encourages theoretical and/or practical papers concerning all types of learning, knowledge discovery, evolutionary mechanisms, and emergent systems that can lead to key technologies enabling us to build more complex and intelligent systems." (www.springeronline.com). The sections of this journal are the following. *Computing Paradigms*: Soft Computing, Quantum Computing, Molecular Computing, Foundations; *Programming and Architecture***:** Computational Logic, Constraint Programming, Concurrency and Parallelism, Programming Systems; *Network Computing***:** Grid Computing, Web Computing, Mobile Computing, Ubiquitous Computing; *Intelligent Systems***:** Intelligent and Adaptive Agents, Communicative Intelligence, Ontology, Semantic Web, Knowledge Management; *Learning***:** Computational Learning Theory, Inductive Logic Programming, Statistical Learning Methods, Bayesian Networks, Reinforcement Learning, Knowledge Discovery and Data/Text Mining; *Bio computing***:** Evolutionary Computing, Genetic Algorithms and Programming, Biologically – inspired Systems, Biochemical Modelling and Simulation.

3 European research and development projects

The ages through which humankind has passed are presented by James W. Michaels (*James W. Michaels, How New is the New Economy? Forbes, October 11, 1999*): the stone age, the iron age, the agriculture age, industrial age, technology age and knowledge age. "*James W. Michaels' considerations represent probably the first conceptual classification of the knowledge society during human history. The missing of the informational age that does not appear explicitly could be surprising, but it divides itself between the technology age and the knowledge age, which is the superior part of informational age. Actually, in our opinion, humankind is in an informational age having as sequential phases information society, knowledge society and conscience society .... Both knowledge and conscience are information"* (M. Drăgănescu - www.racai.ro/~dragam).

Before approaching the joining between the knowledge society and the conscience society, we will talk about the joining between the *information society* and the *knowledge society*.

If in the 70's, the predominant expression was that of Informatics Society (the main pursuit being the realization of a national informatic system with ideas and trends that refer to an *information society*), gradually, the concept of information society gained ground and became a reality after 1990 as *Internet technologies* propagated. This happened in the last decade of the 20th century. For the first part of the 21st century the problem of knowledge society appears. Regarding the Internet technologies there were invented the information conveyance through communication lines, radio, satellites and packet switching [3]. The *packet switching technology* proved to be fundamental for the development of the Internet network. The *Web Technology* is the most exciting transformation and extension for human society. *e-Mail*, *e-Book* and *Web Technology* established a self-organizing process on global scale, which continues

today. Everything must self organize: *people, organizations, institutions, countries, regions, continents, etc*.

In time, European countries have reacted to the great American or Japanese challenges in many activity fields. For instance, the reaction to the Japanese project (1981) was immediate: Great Britain initiated a 500 million $ project for 5 years for researches in all technological domains concerning the *5th generation computer*. The *European Economic Committee* has launched the ESPIT (*European Strategic Programme in Information Technology*) program having the same objective and it was financed with 1,5 billion $ for the first 5 years by the participant governments and 12 important companies (*ICL-England, Bull-France, Siemens-Germany, Olivetti-Italy, etc.*). In the European countries, the research in the field of Artificial Intelligence gained new dimensions. After 1985, in high education institutions they started to teach the *Artificial Intelligence* discipline. Also, the languages of *Artificial Intelligence* – Prolog and Lisp – began to be taught and used in the expert systems elaboration. Maybe it is not accidental the fact that one of the most important and successful Internet services WWW was created at CERN (*Centre Europeen pour la Recherche Nucleaire*) in 1989 by *Tim Berners-Lee* and *Robert Callau* from Geneva (Switzerland). In 1990 CERN becomes the most developed Internet centre in Europe. In 1994 was constituted the *World Wide Web Consortium* (W3C-www.w3.org), an international non-profit organization having *Tim Berners* as general manager under the direct guidance of MIT (*Massachusetts Institute of Technology*) and INRIA (*L'institute National de Reacherche en Intelligence Artificielle*). Today, W3C has more than 500 members, both academic organizations, commercial corporations and physical persons [3, 4].

The European references regarding research, development and innovation for building a *knowledge society* are the following (www.ici.ro/ici/revista/ria2004_1/):

- **Global Information Society** – initiative launched in 1997 at the summit of the presidents and the prime ministers of the G7 countries (today is G8 by Russia's joining) which took place in Naples; in 1995, at the Conference for an Information Society in Brussels it was analysed the implementation of an international competitive informational infrastructure;
- **Communications in Information Society** – conference that took place in 1997 in Estonia, where 19 countries participated;
- **The G8 Pilot Projects** – in 1998, the G7 group to which Russia joined, had launched the Pilot Projects for Information Society development in the following fields: education, culture, commerce, environment, health and public administration;
- **EURIDYCE –** Technologies de In'formation et de la communication dans les systemes educatifs en Europe, Paris, 2000 (www.euridyce.org);

- **eEurope and eEurope+** – action programs launched in 2001 at European level for the UE countries, but also for the countries in the process of adherence at UE eEurope+) (www.europa.eu.int);
- **Global Tera byte Recherche Network** (GTREN) – action program launched in 2002 for the development of the communication infrastructures and of a faster, safer and more efficient Internet network;
- **eEurope 2005** – launched in 2002, the action program "*An Information Society for All*" has two major objectives: to stimulate services, applications and the content of electronic information and to develop wideband infrastructure and to increase the information and network security;
- **Sixth Framework Programme** (FP6) (www.cordis.lu/fp6/) – launched in 2002, is one of the most complex research, development and innovation program; "*The objectives of Community action in this field are to contribute to the creation of a European Research Area (*ERA*) by stimulating and supporting programme coordination and joint activities conducted at national or regional level, as well as among European organizations, and thus help to develop the common knowledge base necessary for a coherent development of policies*". Launched for 2002-2006, FP6 has direction 2 of priority: *Information Society Technologies* (IST - www.cordis.lu/ist/) [11]. In Romania, the Romanian Academy has launched the ROINTERA project (www.rointera.ro) in 2004, "which is stipulated to be implemented for stimulating, encouraging and facilitating the participation of the Romanian technical and scientific community to the research, development and innovation programs of the European Committee, focusing on the *Sixth Framework Programme*, as well as on the integration of this Romanian community in ERA". At this moment, the *FP7* program is already launched for the period 2007-2011 with a budget of 72 726 million EUR [10, 11].

The main research and development topics of the priority 2 are: major social and economic challenges; communication technologies, computation technique, software; micro-systems and software; knowledge and interface technologies. Recently, in June 2005, the *Minister of Education and Research* (MEdC) from *Romania* and the *Federal Minister of Education and Research* (BMBF) from *Germany* have signed the protocol regarding the cooperation in the fields of science and technology for the period September 2005 – December 2006, as a consequence of the initiative of BMBF in April 2004 for a bilateral cooperation in education and research with central, eastern and south-eastern European countries.

The priority cooperation domains are:

1. Sciences of life, genomic and biotechnologies;
2. *Information Society Technologies* (IST);
3. Nanotechnologies and nanosciences; materials, production processes;
4. Food quality and safety;
5. Lasting development.

The working tools are: preparations of the missions, individual visits, expert meetings, pilot research, thematic seminars and feasibility studies, both for the preparation of PC6 projects proposal and for the preparation of the national interest projects for both parts. The limit of the grant provided by BMBF is 50000 EUR/

project for the expenses for mobility and organizing events for the mutual accepted projects in the limit of 10 projects in 2005 and 15 projects in 2006, according to the Protocol (source: www.edu.ro).

Examples of the *Romania's* cooperation at the *European programms* FP6, FP7:

- **The International Consortium INTUITION (2004-2008)** – INTUITION is a Network Of Excellence focused on *virtual reality and virtual environments applications for future workspaces*- http://www.intuition-eunetwork.net. It is funded by the European Union, and operates under the 6th Framework of the European Commission (IST). The Network includes 58 partners (*15 countries, 248 researchers*; including a number of representatives from Romania: Ovidius University of Constanta -Dr. M.D. Popovici, Polytechnic University of Bucharest -Dr. L.D. Şerbănaţi, University of Bucharest -Dr. M. Vlada, Transilvania University of Brasov -Dr. D. Talabă) and it is being coordinated by the Institute Of Communication And Computer Systems of the National Technical University of Athens in Greece (http://i-sense.iccs.ntua.gr). INTUITION has officially kicked off on September 1st 2004. The EC funding is up to 6 million Euros for a period of 4 years (2004-2008) [12];

- **The bilateral agreement for scientific cooperation (2005-2006)** –signed in July 2005 – between the *Polytechnic University of Bucharest* (PUB – www.pub.ro) and the *Leibniz Institute of Research of Materials and Solid State of Dresden* (IFW Dresden). Owing to this agreement, new research infrastructure will be created, this being attractive to the young researchers. The Romanian-German

mixed teams will have available a new access way to the opportunities offered by the European programs, particularly to the sixth framework programme (FP6) for research and technological development (source: www.edu.ro);

- **The Romanian Office for Science and Technology near by The European Union –** By the decision of the Government to found the Office, approved on July, the 12th, 2005, it is proved the consistency of the reformation principles of education and research in Romania with a view to adhering to the European Union and to creating the European Space of Research and Innovation (ERA); they will support the research centres from Romania for a better access to the European research funds (FP6, FP7); The Romanian research topics will be more visible and they will make lobby to introduce these topics on the research European agenda; the increasing the rate of retrieving of the research funds which Romania provides for the European research (at a level of only 18%); the development of the research management according to the European requirements. At present, in Brussels about 20 Offices are running their activities with a view to preparing and providing support for getting information, contacts, elaborating financing proposals, negotiating research contract, etc for their own scientific communities [source: www.edu.ro];
- **Romania has a representative for the period 2005-2006 at ISTAG** (*Information Society Technologies Advisory Group*), in the person of Irina Socol; the general manager of SIVECO Romania is a part of the Advisory Group in the field of Information Society Technologies (ISTAG) of the European Union; the mission of ISTAG is to direct the IT&C European research. ISTAG (http://www.cordis.lu/ist/istag.htm) contributes to the preparation and implementation of the European programmes for research in IT&C, offering consultancy for the global strategy which applies to the IT&C researchers, for all European community, in Germany, Denmark, Belgium, France, Czech Republic, Netherlands, Switzerland etc. [source: www.agora.ro, www.siveco.ro].

4 The 4 waves of the information technology

We are going to approach the studies concerning the *information technologies* and the *information society* in the way they are presented in the references [7], [8] and [9].

4.1 Defining the information technologies

Generally speaking, there is no unanimity in defining the *information technologies*. However, the most relevant of all consists in understanding the information technologies as collections of technological fields, which develop simultaneously and interdependently. Among the most important fields there are Informatics, Electronics and Communications [9].

The two fundamental technological fields that are the basis of the information technology and communication are: *Informatics* and *Communication*. B.H. Boar [8] considers that the information technologies permit *preparing, collecting, transporting, finding, memorizing, accessing, presenting and transforming the information* in any form (*graphic, text, voice, video and image*). These actions can take place between people, between people and equipments and/or between equipments. The representation model for the *information technologies* is presented in Figure 1. The

British Department of Commerce and Industry gives another definition; the Department says that the information technologies permit collecting, stocking and conveying information as voice, image, text and codes using microelectronics, with technologies offered by Informatics, Electronics and Telecommunications. *Information Technologies* are based upon two components:

a) *information technologies* – hardware and software;

b) *communication technologies* – networks, optical transmissions, satellite transmissions, ISDN, communication standards, etc.

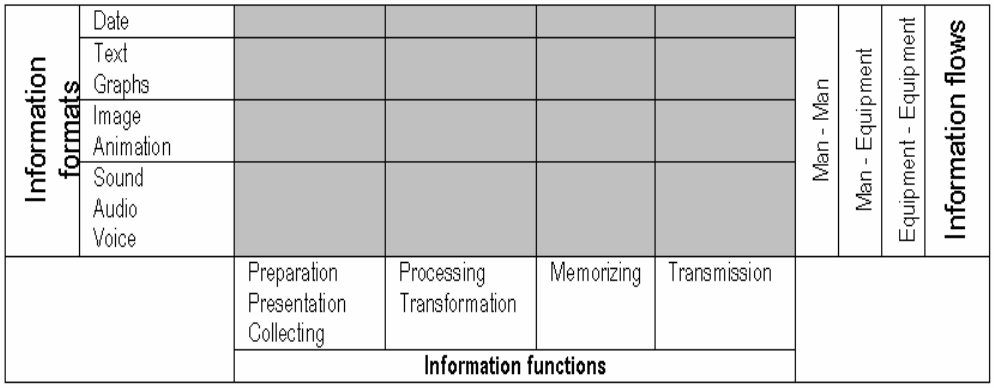


Figure 1. Representation model of the information technologies [9]

4.2 Defining the information society

Generally speaking, the information society can be defined as being the society based upon *information*. In a modern meaning, we can talk about a society based on information since the use of the computers in the economy, in the fields of science and technique etc., and this happened after building the ENIAC computer in 1947, that is in the second half of the 50's.

Today, by the appearance of diverse technologies, programming languages, operating systems, specialized programmes, etc., the wording *"Information Technology and Communication"* (IT&C) is used; including a great variety of information processing and a great utility of these processing in all activity fields. However, at each development level of the human society there was a foundation on information. Information is the primary form of getting knowledge. Among the significant examples, we enumerate the following: *ABAC (Abacus***)** (3000 BC), *paper* (50 BC); *printing press* (1452); *newspaper* (1700); *telegraph* (1837); *photography* (1839); *telephone* (1876); *electricity* (1882); *tabulator* (1890); *film* (1891); *radio - television* (1920-1936); *robot* (1921); *transistor* (1947); *graphic display* (1953); *microprocessor* (1971), *Web Technology and Internet network* (1991). All these contributed to a better utilization of information in society and to an increase of human welfare and knowledge. In other words, it can be said that the global information society is the normal human society of all times with a informational modernism stamp due to the informational and knowledge avalanche. In the period 2012-2030 it is

desired to pass from an *information society* to a *knowledge society*. *European programmes* (FP6, FP7) [10,11] are conceived to fulfil this goal.

4.3 The waves of the information technology

The results and performances in the fields of computer science, telecommunication and information technology have always been spectacular. Today, many computer types are meant to fulfil human dreams about a partial or *integral cybernetic world* and a super library of information. In other words, at the base of the tomorrow society will be information, knowledge and communications. A passing schedule towards the global information society is given by *J.A. O'Brien* [7], who considers that reaching this stage requires passing through 4 stages:

1. the stage of the *computerized enterprises***,** for the period 1970-2012 – *the first wave***;**
2. the stage of the *networked knowledge workers*, which started in 1980 – *the second wave*;
3. the stage of the *global internetworked society* which started in 1991– *the third wave*;
4. the stage of the *global information society* which will start after 2010 – *the forth wave*.

As Figure 2 shows, until 2010 the human society will be in the time when the first three waves overlap, which means that there will be a *transition period* with its risks and specific advantages. Thus, as it can be observed, humankind hasn't finished yet the first stage, but has already started another two stages, and in 2010 will start the fourth stage. So, until 2010 the human society will be in a continuous transition process to that *informational globalization* [8,9]. Thus, the modernism stamp becomes more evident as we are getting close to 2010, when the first wave of the simple *computerization* will be surpassed and the fourth wave of "*Global Information Society*" will be more and more visible. In *the first wave* the attention was drawn towards *organizations* as key-elements for getting profit and increase of the productivity. Thus, a reduction of the time and the cost for getting information, as well as a reduction of the cost production was desired. In the *second wave* the *individual performances* in an *computerized environment* is emphasized. The productivity bounce is given, in these conditions, by the *knowledge* the individuals have and by the *interconnection degree*. The purpose of going through this stage is reaching the status of *networked knowledge workers*. In the *third wave* the attention is drawn towards the accomplishment of the connectivity at a global level in the society, in which "*the knowledge workers*" and the *computerized societies* act. Carrying on the activities that create values in such conditions, it will involve a plus of efficiency. The final purpose of this wave consists in obtaining the *globally interconnected society* (*the network society*).

Together with passing to the forth wave, *computerized* of the societies will be considered done, which means that like the telephone or TV, the computer will be an usual tool that everybody will afford at the lowest costs. It will be the stage when the *system-on-chip* concept will be generalized and when its package will be more expensive then the system itself. If we analyse the evolution of the society through classical comparison (*date – information – knowledge*), then we can speak of *knowledge technologies* and *knowledge or intelligent society.*

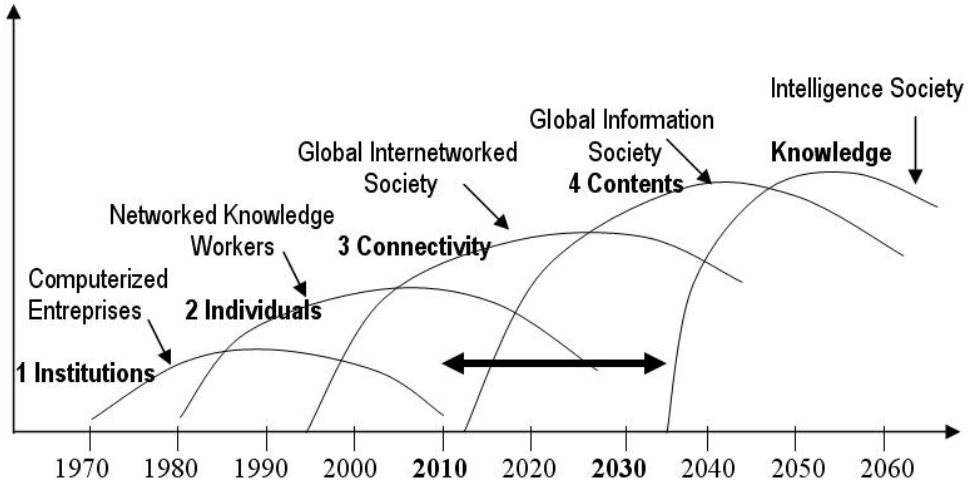


Figure 2. The technological waves of the information society [8,9]

Consequently, the ideas previously presented lead to the conclusion that the next wave could begin around the years *2035 – 2040* and it could be named *the stage of intelligence and knowledge*, representing the *knowledge society*. This stage will place into attention the information operation to reach the desired intelligence level for some entity [9]. It will be the time when the capacities of the human brain will be reached to some degree, when the concept of *bio-techno-system* will be generalised, meaning hybrid systems between biological systems and technical systems through computer science. *Researches concerning* the design and building of the molecular computing have already been started and the *Romanian research* has contributions to that field.

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