INFORMATION AND DECISION SYSTEMS
MATHEMATICAL MODELLING AND STATISTICS

SCIENTIFIC COMMITTEE

INFORMATION AND DECISION SYSTEMS; MATHEMATICAL MODELLING AND STATISTICS

ENVIRONMENTAL DECISION SUPPORT SYSTEM

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Abstract

This paper presents, briefly, a new concept, the concept of decision support system. It also, defines the environmental decision support system and describes its architecture.

The authors describe, further, the environmental data processing techniques in an organization.

In the end it is presented the model of an environmental decision support system that we have been developing in our university.

Introduction

The environmental protection is now a very important concernment all over the world. People are taking a greater interest in current and future state of the environment and many are adapting their way of life accordingly [8].

The companies are enforced more and more by governmental institutions, non-profit organizations, international institutions, clients, suppliers and public to consider the environmental management problems as one of their priorities. For this reason, in the last years, many companies have implemented environmental management systems and certified them accordingly with the ISO 14000 international standards series and with the Eco-Management and Audit Scheme.

The amount of information this type of environmental management systems must manage is very large so that the manual management of the system is inefficient. Therefore, the environmental specialists must use computerized solutions to fulfill in optimum conditions their objectives [11].

In this paper they are presented, on brief, the decision support system and the environmental decision support system concepts. They are, also, described the

environmental data processing techniques and, in the end, the authors present the model of an environmental decision support system.

Decision support system

The decision support system concept is extremely large, its definition being different from the viewpoint of the person defining it.

Decision support systems (DSSs) *represent interactive information systems that help managers in solving some semi structured problems using, in this purpose, models and databases specialized in defined problems* [1, 9, 16]. DSSs do not formulate decisions but support managers in the decision making process.

Decision support systems contain software modules for data management, for models management and, respectively, for dialog management (user interface). The more advanced decision support systems also include a component for knowledge management that is based on an expert system and that confers it the intelligent attribute or the knowledge based decision support system attribute [1, 10].

Environmental decision support system

The environmental decision support systems (EDSSs) represent a concept arisen from the effort to integrate new tools that are able to process more complex systems.

The environmental problems field to which EDSS have been applied is large and varied such as: used water top management, risk assessment, forests management. The activities that an EDSS must fulfill, also, are varied from the monitoring and data storage to prediction, decision analysis, control planning, remediation, management, and communication with society [12, 13].

There is a wide range of opinions about what constitutes an environmental decision support system. It can not be formulate a single, consensual definition because this term is relatively recent and integrates multiple tools.

However, even though one may argue that a database management system could be used as a decision support system, today all the specialists are agree with the fact that EDSSs must adopt a knowledge-based approach, which includes the steps of knowledge acquisition, representation, and management [12, 13].

The fact that different tools can be integrated under different architectures makes EDSSs difficult to define. It also means that different design and implementation methods coexist.

EDSS is an intelligent information system that helps reduce the time in which decisions are made, and improves the consistency and quality of the environmental decisions [6, 12, 13, 15].

The decisions are elaborated when an expected or desired system state is observed or predicted. This implies problems field awareness based on the information, experience and knowledge about the process.

The conceptual components that can integrate an EDSS are presented in figure 1.

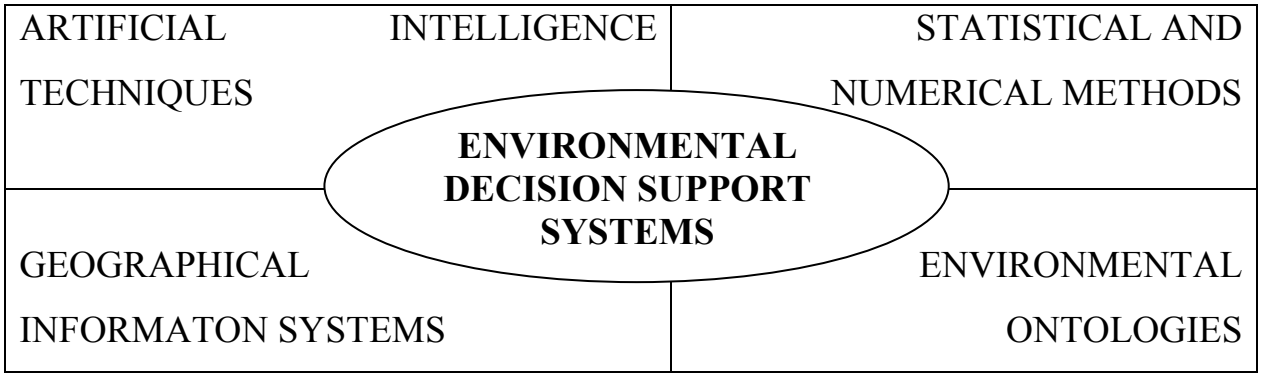

Figure. 1. The conceptual components of an EDSS [12, 13].

The EDSS design approach is depending on the type of environmental problem and the type of information and knowledge that can be acquired. With these constraints in mind, and after an analysis of the available information, a set of tools can be selected. These are represented not only by the numerical models but also by the artificial intelligence (AI) methodologies such as knowledge management tools. The artificial intelligence tools and models use provides direct access to experience and their flexibility makes them capable of supporting learning and decision making processes. Their integration with numerical and/or statistical models in a single system provides higher accuracy, reliability and utility [12, 13].

Once implemented an EDSS, like any knowledge based system, has to be evaluated for the experience stored in it, for how it uses this knowledge, for how fast it can learn something new and, last but not least, for its overall performance.

Due to the field literature [12, 13] the architecture of an EDSS is made of five levels (figure 2):

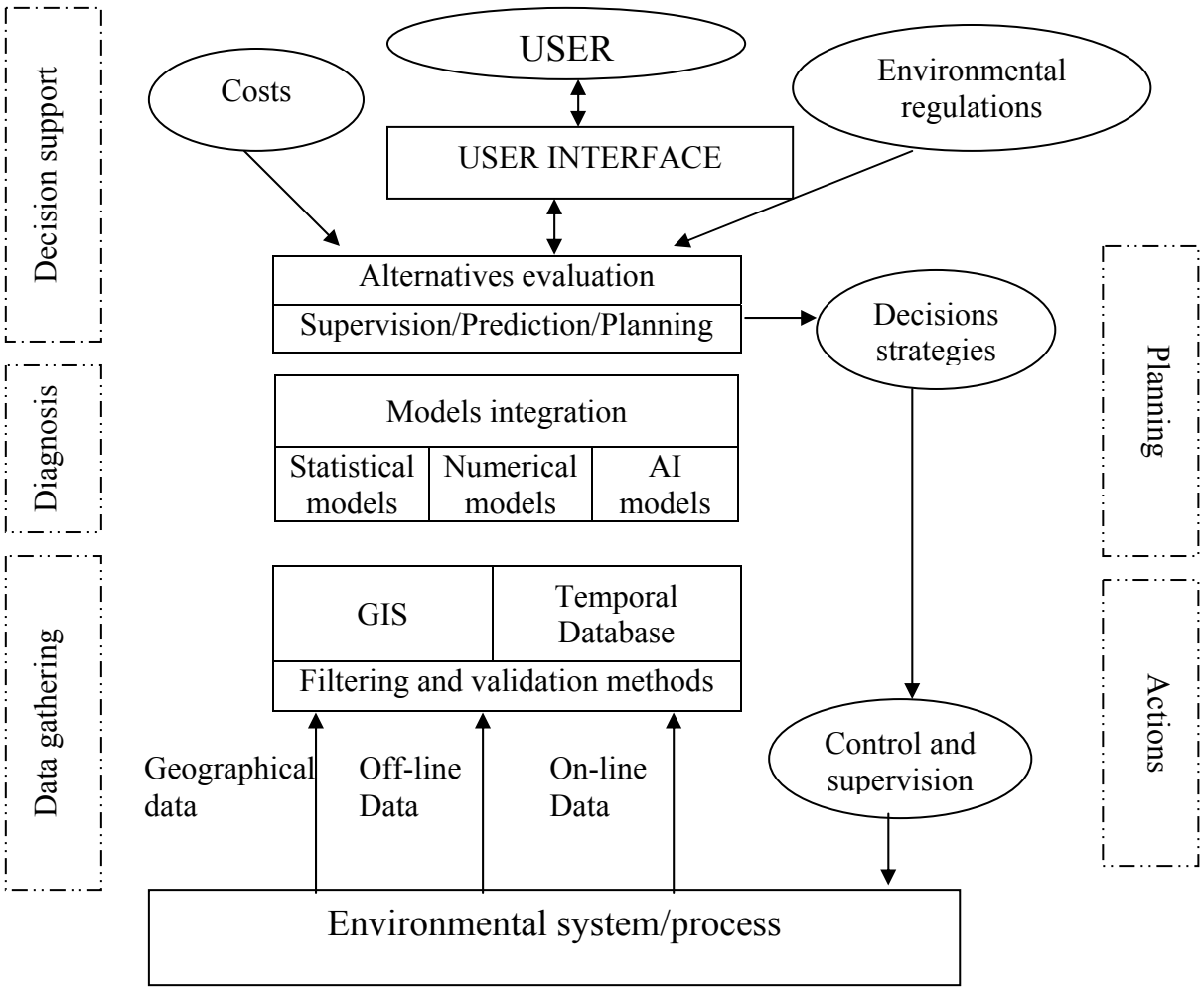

Figure. 2. EDSS architecture [12, 13].

- *first level* contains data gathering and registration into database activities;
- *the second level* includes the reasoning models that are used to infer the process state so that a following action can be established;
- *the third level* establishes a supervisory activity that consists in gathering and merging the conclusions derived from knowledge based and numerical

techniques. This level also ensures the interaction of the users with the computer system through an interactive and graphical user machine interface.

- *in the fourth level*, plans are formulated and presented to managers as a list of general actions suggested to solve a specific problem;.
- *the fifth level* is represented by the set of actions to be performed to solve problems in the domain considered. . The system recommends not only the action, or a sequence of actions (a plan), but a value that has to be accepted by the decision maker.

The environmental data processing techniques

The flow of data that are manipulated by an EDSS is similar with the data flow in the classical business applications. This flow can be structured into four phases: data capture, data storage, data analysis and metadata management [8]. Each phase is characterized by some techniques.

The *environmental data capture* consists in gathering and processing of environmental raw data. In this step the great variety of environmental objects is mapped onto a collection of environmental data objects, which, usually, have a structure that is much simpler and more clearly defined than the original raw data [8, 17].

The collecting data methods are various and the most frequent described by literature are: census, statistical surveys, monitoring, teledection [7, 8, 14].

For the *data storage phase* it has to choose a suitable database design and appropriate physical storage structures that will optimize overall system performance. Because of the complexity and heterogeneity of environmental data it is, often, necessary to extend substantially the classical database technology.

The most used environmental data storage methods are: geographical information systems [2, 3], database systems for environmental management that are based on complex data models (relational, object-oriented and distributed), data warehouses etc.

In the *data analysis phase*, the available information is prepared to be used in the environmental decisions making process. This may require simultaneous access to

data that are geographically distributed, stored on heterogeneous hardware and organized using a wide variety of data models.

The data analysis is based on data mining techniques, on environmental monitoring, on complex statistical methods, scenarios, simulation tools etc [8].

Metadata are collected and aggregated throughout the above three phases. They are stored in appropriate data structures and used, mainly, in the data analysis phase to support search and browsing operation.

The proposed conceptual model for the EDSS

The application design had the following objectives [4, 5]:

- the application has to be used both in the design and implementation phase of the environmental management system and in its current exploitation phase;
- the application has to be cheap so that even the companies with lower financial resources could afford to buy it;
- the application has to allow storing and manipulation of the environmental information accordingly with the ISO 14000 standard [18, 19].

In this purpose, the authors have chosen the following conceptual structure for the entire application (figure 3).

The proposed structure allows a progressive modular development of the application in conformity with the design and implementation process structure of the environmental management systems recommended by the ISO 14000 standard.

Additionally to the ISO 14000 requirements, the authors have added a module that allows the waste management, an activity that, even it is not enforced by the ISO 14000 standard, has a big importance in the environmental management system.

The application modules are independent from the functional point of view, the only integration possibility being provided by the coordination and control module. This solution allows using some different data modules, the coordination and control module having the task to convert the data from one format to another one. Certainly, it is recommended to use a unique data model but the high heterogeneity level of the data manipulated by the system does not allow this. Therefore, the integration possibility of some different data models and format become a necessity.

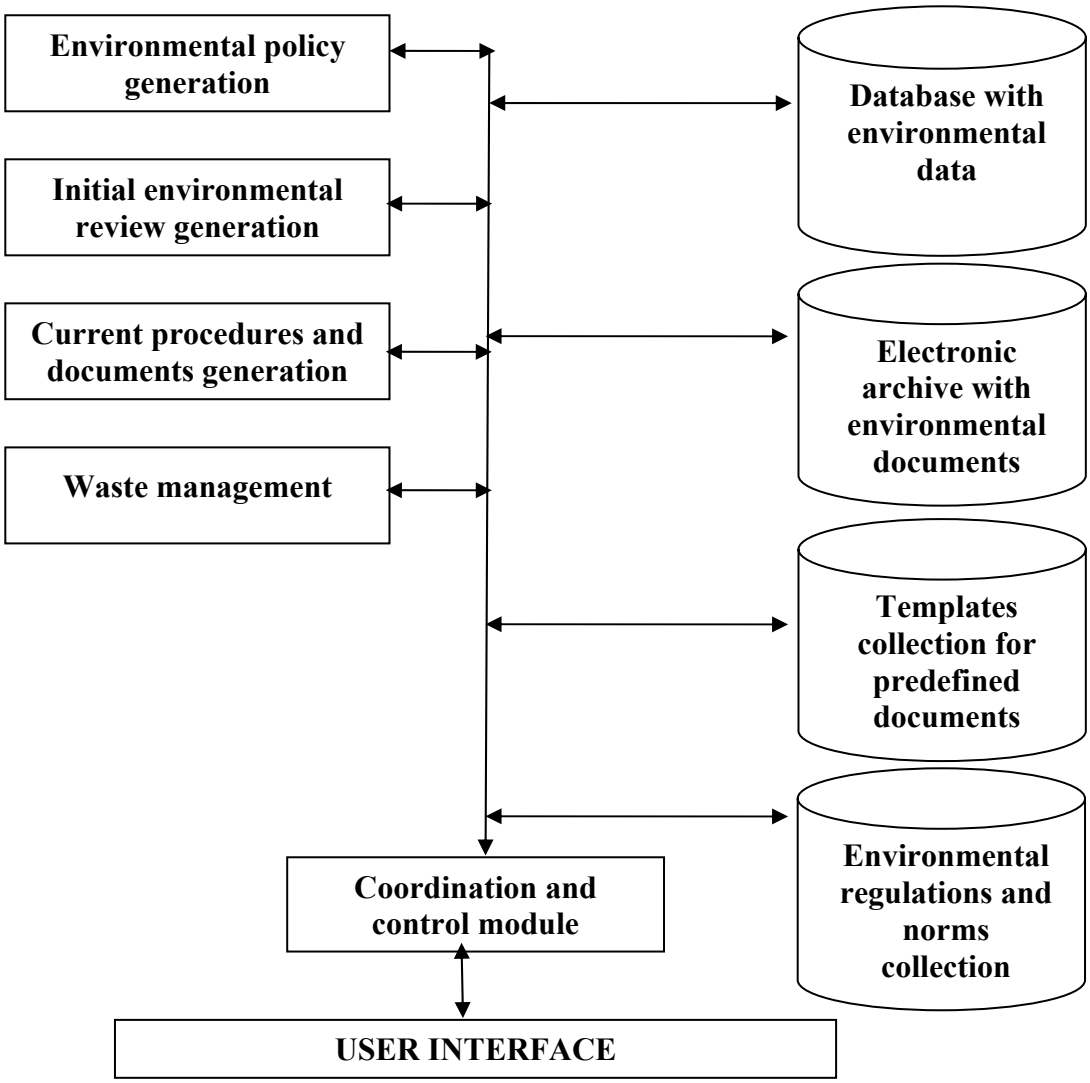

Figure. 3. The EDSS proposed structure accordingly with the ISO 14000 [4, 5].

Conclusions

The EDSS term is a new concept that integrates many tools, inclusively, artificial intelligence techniques.

The model presented in this paper represents the conceptual model of an application that it has been building and implementing in our university.

The authors consider that the application could be easily used by all the companies that wish to implement an environmental management system accordingly with the ISO 14000 standard because it ensures a simple development of an environmental management system and an easily maintenance of it.

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Risk Management Holds the Key to Security and Trust

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Keywords: security risks, manage risks, risk analysis

A security policy framework is necessary to support the security infrastructure required for the secure movement of sensitive information across and within national boundaries. To ensure the secure operation of this kind of infrastructure, it is necessary to have some well-founded practice for the identification of security risks (as well as the application of appropriate controls to manage risks). This practice can be formalised and (semi)-automated by the use of formal methods and tools which increase the reliability of the system specification (and therefore users' confidence in it). This is important since the security of a system is largely dependent upon the accuracy of its specification. To be truly beneficial, the risk analysis framework must be granular enough to produce a customisable roadmap of which problems exist, and to rank them in order of severity, which facilitates making decisions about which ones to deal with first.

CORAS (A Platform for Risk Analysis of Security-critical Systems) is an EU/IST project within the 5th framework programme, the basic idea for which was proposed and initiated by the author in an attempt to meet the requirements mentioned above, among others. Its main objective is to develop a practical (the word practical emphasised) framework for a precise, unambiguous and efficient risk analysis, by exploiting the synthesis of risk analysis methods with object-oriented modelling, (semi-)formal methods and tools, in order to improve the security risk analysis and security policy implementation of security-critical systems. Since the critical infrastructures of, for example, medical services, banking and finance, gas

and electricity industries, transportation, water, and telecommunications are making use of the public Internet for communication, not least for the exchange of business, administrative and research information, it must be our aim to make these critical infrastructures totally secure and unassailable.

What are the ranked goals for security?

1. Data security
2. Intrusion prevention
3. Abuse prevention
4. Auditability Security Mechanisms

What physical security mechanisms will be used?

- Servers will be kept in a locked room with door code known only to administrators.
- Servers will be kept in a locked equipment rack.
- Server case itself has a security cable that prevents the case from being opened (so the hard-disk with sensitive data cannot be removed).
- Backup tapes are stored in a locked cabinet in a locked room.

What network security mechanisms will be used?

- A firewall device limits access to specific network ports (e.g., port 80 for web server access).
- Firewall software limits access to specific network ports (e.g., port 80 for web server access).
- Only the front-end machines are accessible over the Internet. Other machines in the server cluster communicate over a private LAN only.
- Users can only connect to the server from specific ranges of IP-address (e.g., university-owned computers in networks on campus).
- Certain users (e.g., administrators) can only connect from specific ranges of IP-addresses.
- All network communication takes place over a virtual private network (VPN) that is encrypted and not accessible to outsiders.
- All network communication takes place over a LAN that does not have any

connections to the Internet.

What operating system security will be used?

- Operating system user accounts will never be created on the servers, other than those needed by the application itself.
- Different components in the application execute as different operating system users, have only the least possible privileges, and may only access the particular files needed by that component.
- Operating system permissions on files and directories are set to prevent undesired access or modification.
- Intrusion detection software will be used on the server to detect any modifications made by hackers.
- Administrators will monitor security mailing lists for announcements of security holes in any components that we use and security patches and upgrades will be applied quickly.
- Data on disks and backup tapes is stored using an encrypted file system so that the data is protected if the media itself is stolen or somehow accessed.

What application security mechanisms will be used?

- Values input into every field are validated before use
- Usernames and passwords are required for access
- Passwords are stored encrypted
- Verification of user email address
- The quality of passwords is checked
- Users must have certificate files on their client machine before they can connect to the server
- Users must have physical security tokens (e.g., hasp, dongle, smartcard, or fingerprint reader)

What are the ranked goals for persistence in this system?

1. Expressiveness
2. Ease of access

3. Reliability
4. Data capacity
5. Data security
6. Performance
7. Interoperability Central Database

What is the logical database design?

The logical database design is described in this UML model or this ER diagram.

What database access controls will be used?

A database user account has been created that has access to the needed application database tables. The username and password for this account is stored in a configuration file read by the application server. The database limits login by that user to only the IP-address used by the application server.

What file format will be used?

- The XYZ standard file format.
- A java .properties file.
- A window's .ini file.
- An XML file using this DTD file.
- A simple text file with the following format: ...
- A custom binary file in the following format: ... Distributed Storage

What information (if any) will be stored on client machines? For how long?

- A cookie will be stored on the user machine for the purpose of identifying a user session. When the user logs out or closes their web browser, the cookie is deleted. Most browsers will not even write this cookie to the disk.
- The a cookie is stored on the user's computer that is equivalent to their password (but it is NOT actually their password). This cookie is needed for the auto-login feature. The cookie lasts a maximum of 30 days, and it can only be used from the same IP address.
- User preferences for color scheme are stored in cookies in their browser. This information is not at all sensitive, so it is kept indefinitely.

What are the usability requirements?

- Our main criteria for making the system usable is the difficulty of performing each high-frequency use case. Difficulty depends on the number of steps, the knowledge that the user must have at each step, the decisions that the user must make at each step, and the mechanics of each step (e.g., typing a book title exactly is hard, clicking on a title in a list is easy).
- The user interface should be as familiar as possible to users who have used other web applications and Windows desktop applications. E.g., we will follow the UI guidelines for naming menus, buttons, and dialog boxes whenever possible.

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A comparison of Bulgaria's and Romania's information infrastructures for EU accession

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Abstract

The European Union completed a massive expansion in 2004. Bulgaria and Romania are slated for accession in 2007 and negotiations have started with Turkey for later accession. Joining the EU is expected to promote the candidate country's economic growth, provide access to western technology, increase employment and attract foreign investments. EU accession requires the fulfillment of a list of requirements relating to social, judicial, economic, information and social infrastructures. The detrimental impact of corruption on achieving national goals must also be addressed. This article examines linkages between information infrastructures and social development in the candidate countries of Bulgaria and Romania. Financing and investment needs were examined in order to improve National Information Infrastructures (NII), expected payoffs from NII improvements were identified, and the role of foreign direct investment was investigated.

Using statistical methodology the status of information infrastructures and social development in Bulgaria and Romania were compared to those of the Visegrad 4 countries admitted into the EU in 2004. Through cluster analysis comparisons were made with the original thirteen EU member nations on social and information infrastructure variables. As was with Portugal for the original EU it is concluded that the accession of Romania and Bulgaria will be a costly burden for existing EU members when considering these candidate counties' infrastructure improvement needs. Foreign direct investment, traditionally the source of investment funds for infrastructure improvements is shown to be a mediocre player at best. Recommendations are made regarding priorities for meeting EU standards.

Introduction

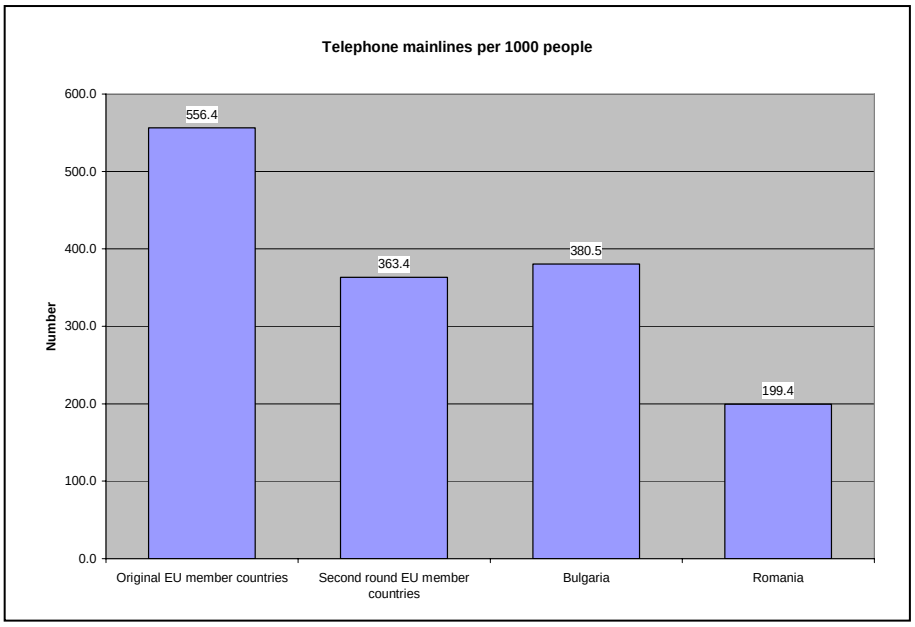
The information and telecommunications industry has become the backbone of the information society, both present and future. Electronic commerce has served to open opportunities to small and large businesses alike while fostering the evolution of electronic governments to ease and speed up the business of government. The information and telecommunications industry created world wide networks interconnecting societies and individuals alike influencing social development and knowledge acquisition. At the heart of the information and telecommunications industry is information and communications technology (ICT). ICT may be viewed as consisting of traditional information media such as newspapers, fixed line telephones, radios, and television. Less traditional components include PCs, Internet, and mobile phones. While building national information infrastructures (NII) remains important nationally, regulation of components of the NII gained center stage in most EU member and accession countries. In addition, availability of a functioning and improving NII has become an important driving force at facilitating social development and, as a corollary, forces working to hinder the efficient development of NII and local ICT, such as corruption, must be identified and rooted out.

The following discussion will first address ICT factors describing Romania's and Bulgaria's ICT industries and NIIs as they compare to the original EU15 as well as the second round EU10 countries' factors. Next liberalization measures instituted by the two candidate countries will be discussed. Thirdly, observations will be made regarding relationships between information technologies and social development and between information technology development and prevailing measures of corruption.

Bulgarian and Romanian ICT measures vs. the EU

Comparing fixed line telephone penetration in Romania and Bulgaria to the EU15 countries Figure 1 shows both candidate countries trailing behind, though Bulgaria is ahead of the recent entrant EU10 averages. Romania is a little better than half of the EU10 average.

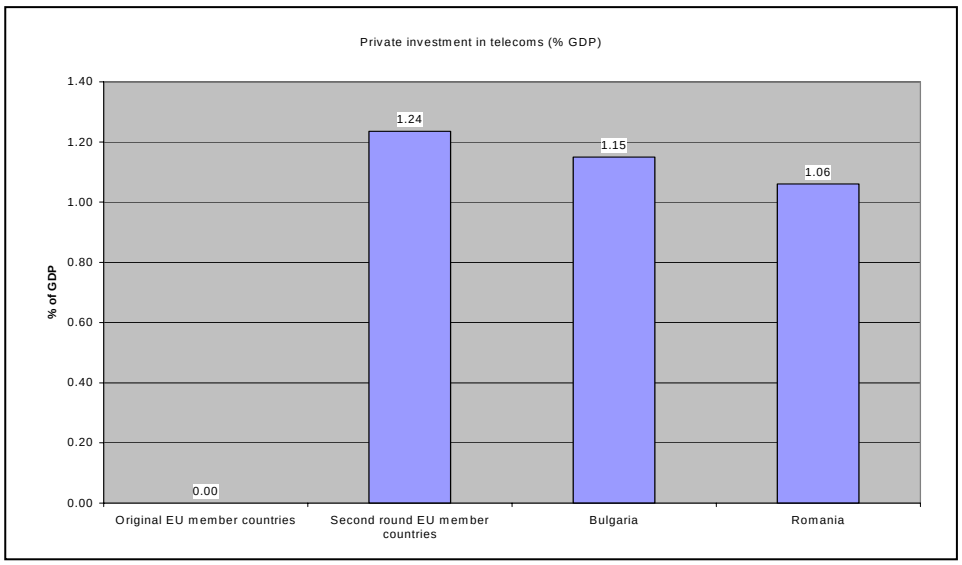
Figure 1. Fixed line telephone service



Data: ITU 2006b

Private investment in telecommunications in Bulgaria and Romania, Figure 2, is on par with that of the second round accession, EU10, countries, suggesting that these two countries should be able to improve fixed line penetration without need for drastic changes. Regarding the availability of Voice over IP calls, EU15 and EU10 countries are making the service available by allowing PC to PC VoIP, PC to Phone VoIP, and Phone to Phone VoIP communication. Romania recently made these services available (ITU, 2006a); data are not available on Bulgaria at this time.

Figure 2. Investment in telecommunications



Data: ITU 2006b

Table 1 compares traditional ICT services among EU nations and the candidate countries of Bulgaria and Romania. It suggests that the two candidate countries are on par with both the original

EU15 and newer EU10 countries on all measures except telephone mainlines as suggested above. On some factors the candidate countries surpass penetration rates of both EU15 and EU10 countries.

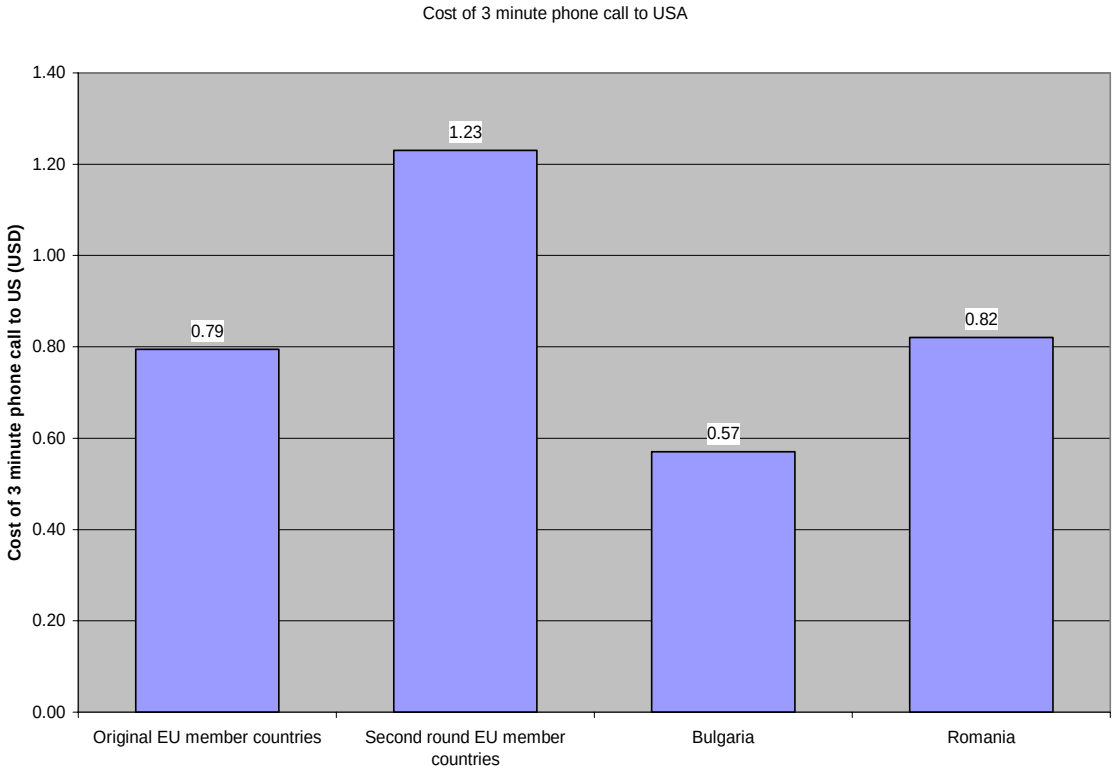
Table 1. Summary of traditional ICT technologies

	Original EU member countries	Second round EU member countries	Bulgaria	Romania
Telephone mainlines per 1000 people	556.4	363.4	380.5	199.4
Television setes per 1000 people	672.5	480.4	448.8	697.4
Radios per 1000 people	820.0	592.7	477.4	305.7
Daily newspapers per 1000 people	249.4	169.8	261.9	271.5

Data: World Bank 2005

Relative costs of communication are best measured by the cost of a three minute telephone call to the USA. Figure 3 illustrates that with call rates of $0.57 and $0.82 Bulgaria and Romania both are competitive in their long distance rates with recent EU10 entrants, $0.79, and are considerably less expensive than the original EU15 average of $1.23. Bulgaria's and Romania's situations are no doubt attributable to their national telephone companies being partially privatized yet their rates still being regulated.

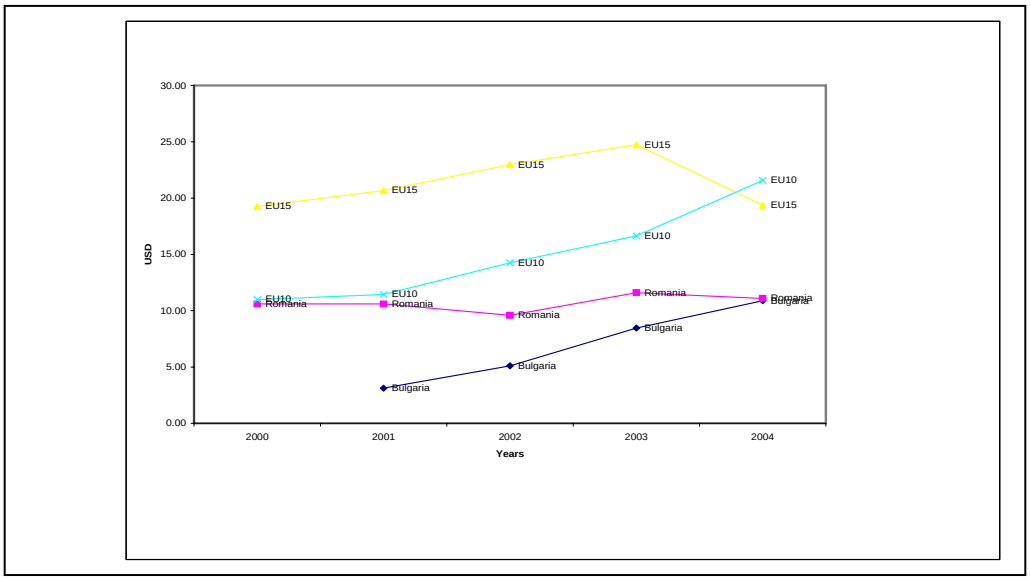
Figure 3. Cost of three minute phone call to the USA



Data: World Bank 2005

Liberalization of telecommunications services in the EU15 did not begin to drive down fixed line telephone prices until 2003, in the EU10 they were still increasing as of 2004. In Bulgaria they were rising through 2004 while in Romania they remained roughly unchanged through 2004 (Figure 4). While the accession countries of Bulgaria and Romania may benefit from the

Figure 4. Price basket of fixed line phone calls

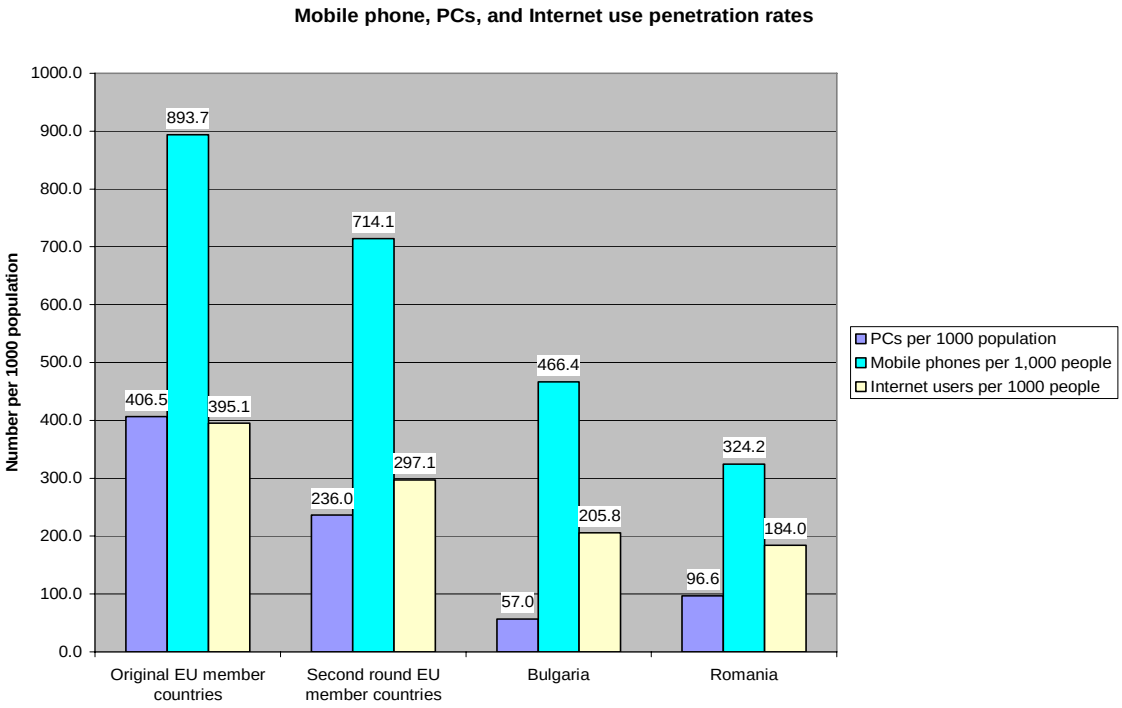


Data: World Bank 2005

recently dropping rates and improving service in the EU15 countries, their immediate neighbors' rising fixed line rates may pose long term problems.

Examining ICT's high technology components such as mobile phone, Internet and PC penetration rates, Figure 5 reveals that mobile phone penetration rates of Bulgaria and Romania are not comparable to that of the new EU10 countries; neither are Internet use and PC penetration rates quite as prevalent as in the EU10 group. With 57 PCs per 1000 population in Bulgaria and a somewhat higher 96.6 PC per 1000 in Romania they lag

Figure 5. Mobile phone, PCs, and Internet penetration rates



Data: ITU 2006b

behind the EU10 average of 236 per 1000 and the EU15 mean of 406 per 1000 population by a considerable amount. The relatively low numbers of PCs in the candidate countries here may be explained by the slow rate of acceptance of PCs as information and communications devices

Table 2. Secure Internet servers

	Original EU member countries	Second round EU member countries	Bulgaria	Romania
Secure internet servers	3827.7	176.0	46.0	65.0

Data: World Bank 2005

due to low rates of broad-band Internet links and secure Internet servers as shown in Table 2. However, given the approximately 30 million combined populations of Bulgaria and Romania, these figures represent a large market for mobile phone and PC makers in the EU and beyond.

Competitive structure of the telecommunications industry

Bulgaria opened up its data, DSL, VSAT, leased lines, fixed satellite, paging, cable TV, and Internet services to full competition, keeping local and domestic long distance, international long distance, fixed wireless broadband, and mobile services only partially open to competition. The Bulgarian Telecommunication Company BTC is partially privatized. Romania has opened all its telecommunications services to competition; S.C. Romtelecom S.A. is partially privatized.

The National Regulatory Authority of Romania (ANRC) was created in 2002 by Government Emergency Ordinance No. 79/ 2002 on the general regulatory framework for communications, approved, with amendments and completions, by Law No. 591/2002, with later amendments and completions. The ANRC is financed from regulated telecom operators, 79% and 21% from regulated postal services. Liberalization of the telecommunications market became effective on January 1, 2003 by canceling the incumbent operator's remaining exclusive rights to offer fixed voice telephone and leased wire line services. Other network operators launched their operations on the newly opened fixed line telephone market and more companies are likely to enter into the market (ITU 2006b). Recent review of Romtelecom's price structure further opened the market to new fixed network entrants (see Figure 3). In 2005, measures were introduced relating to carrier selection, number portability, and the minimum set of leased lines (EU 2004).

Bulgaria's regulatory authority is the Communications Regulation Commission (CRC), created in 2002 by the Telecommunications Law. The CRC is financed according to the formula: 57.6% from awards and auctions of mobile license, 1.6% from license fees, 2.6% from numbering fees, 22.7% from spectrum fees, 0.2% from penalties, and 15.3% from regulated telecom operators (ITU, 2006b). In 2004, 65% privatization of Bulgarian Telecommunication Company was achieved and a third GSM license, making use of unused spectrum, was issued. Furthermore, an action plan for the implementation of Bulgaria's e-Government strategy was adopted in 2004. It envisions measures to ensure high-quality, effective and easy-to-access public services by electronic means (EU 2004).

Table 3 provides a comparative picture of Bulgaria's and Romania's telecommunications profiles and funding mechanisms. Indications are that both countries' profiles meet EU expectations and internal practices (ITU, 2006b).

Relationship between ICT, corruption, and social development

Examination of international data provides interesting insights into the relationship between information technology and social developments. Using data from 203 countries a national information infrastructure index, NII, and a social development index, SDI, was constructed.

Components of the NII were PCs per 1000 population, telephone mainlines per 1000 people, television sets per 1000 population, mobile phones per 1,000 people, radios per 1000 people, and number of daily newspapers per 1000 people. Components of the SDI were per capita GDP, percent GDP per capita, infant survival rate, primary school enrollment rate, literacy rate, access to health care, access to improved water source, and life expectancy in years. From Figure 5 it can be seen

Table 3. Telecommunications profiles of candidate countries

	Bulgaria	Romania
Universal services available	Fixed line private residential service, fixed line public payphone service, emergency services, special services for the impaired or elderly, directory services, transmission speed requirements of 2400 b/sec	Fixed line public payphone service, emergency services, directory services, telecenters
Operators under the obligation to provide universal access/service	Incumbent fixed line operator(s)	None specifically, though obligations are allocated on a competitive basis
Financing of universal access, service or universal obligations	Universal service funds	Universal service funds
Operators required to contribute to the operational Universal Service Fund	All operators contribute who provide voice telephony services.	Providers of public electronic communications networks and the providers of publicly available telephone services with a turnover for the previous year equal to or higher than EUR 3 million

Data: ITU 2006b

that the lower the NII ranking of a country the lower the SDI ranking as well. However, the relationship is highly non-linear, suggesting a growth curve relationship with an R2 value of 0.593 at an F = 233 and significance of 0.0005. Both Bulgaria and Romania are on the rapid growth portion of the curve suggesting that less and less amounts of improvement in social development will improve NII by ever increasing amounts. This was shown by Pook and Pence (2005) suggesting that the non-linear "… model does make logical sense since it suggests that as capital earmarked for social projects is freed up, it can move into national information infrastructure development and improve it at increasing rates."

When comparing Bulgaria's and Romania's national information infrastructures to those of the original EU15 and the later EU10 countries as in Table 4, one may conclude that both countries have some improvement left to accomplish. Figure 6 shows Bulgaria and Romania on the steep portion of the NII-SDI curve, the EU15 group with a group mean of 50.09 can be found a considerable distance above the accession countries with NII's of 28.8 and 26.1. On the other hand the recently admitted EU10 group mean is not far away at 35.8, indeed, with a minimum value of 24.5 for Poland and 28.9 for Lithuania, hence, Romania is well within the new EU10 group range. While the gap to reach EU15 NII's does not appear great, the movement along the curve in Figure 6 requires some time and investment.

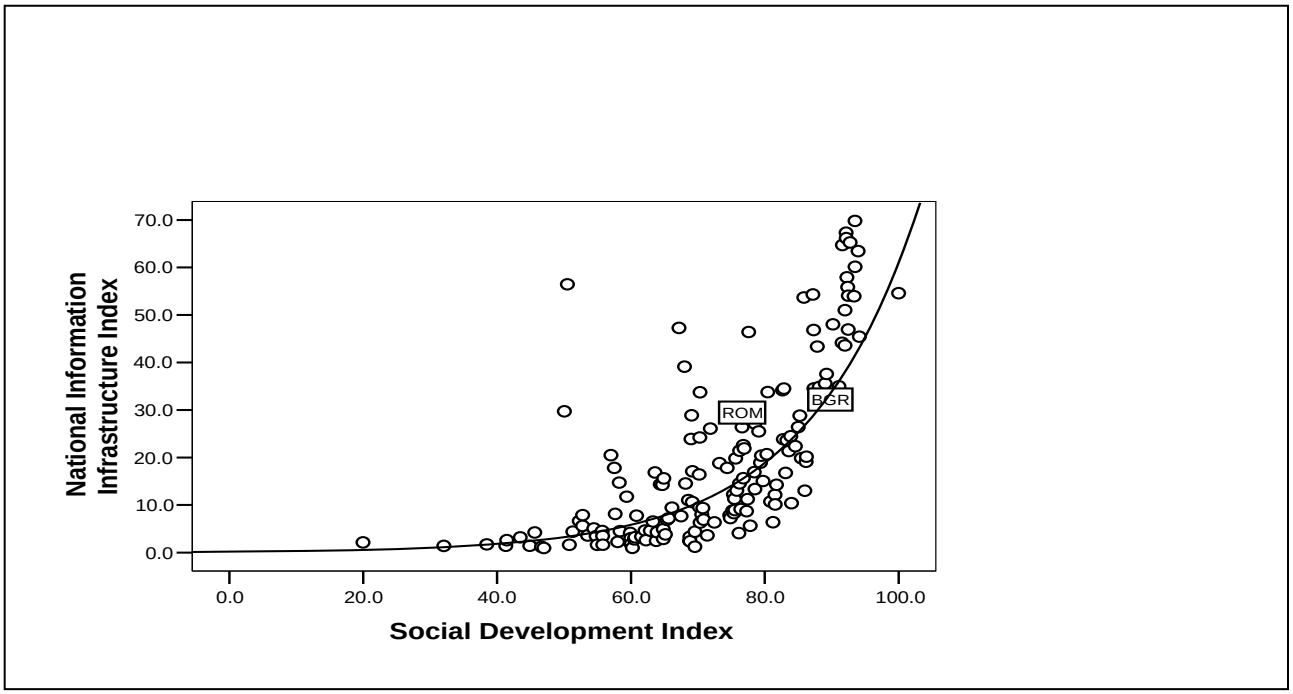
Table 4. Information infrastructure indexes in for EU countries

	Original EU15 member countries	Second round EU10 member countries	Bulgaria	Romania
NII Index	50.09	35.8	28.8	26.1

Data developed by the author from WB and ITU sources

As shown in Figure 2 and related discussion above investments in telecommunications are on track and comparable to the EU10 group; heavy reliance on foreign direct investment is at best tenuous as shown by Pook and Pence (2005). Local private investment funds would serve Bulgaria and Romania best at achieving parity with their EU neighbors.

Figure 6. Relationship between social development and information infrastructure with Romania and Bulgaria



Data developed by the author from WB and ITU sources

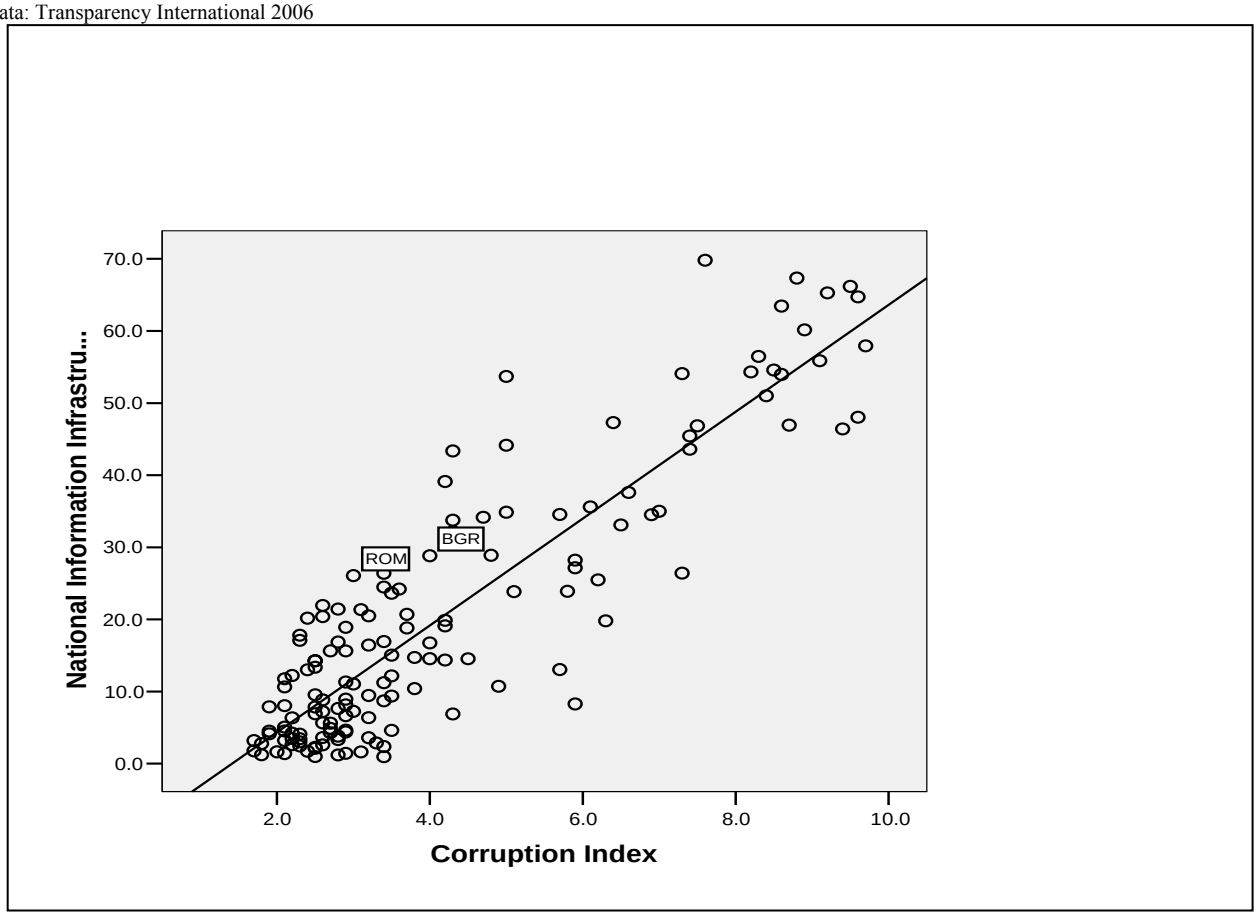
It is important to note that developing nations need to guard against allowing resources earmarked for infrastructure development to be siphoned off by corrupt activities. In a recent speech to the EU Foreign Affairs Committee Ollie Rehn commented that, "…Romania has made progress in the fight against corruption. Sound and solid structures have been set up for this purpose, and investigations into high-level corruption cases have been launched" (Rehn, 2006). While that statement displays hope in the future, it is discouraging in that it also points at a long progress of evolution to eradicate the detrimental effects of corruption on the government level. To illustrate the damaging affect of corruption on the development of national information infrastructures NII was regressed on the corruption index developed by Transparency International (2006).

The corruption index used in Figure 7 runs from 0.0, most corrupt, to 10.0 which is least corrupt. This is survey based data. The regression model displays an R^2 of 0.792 which is surprisingly high level of correlation with F = 551 and with a significance of 0.0005. While regression does not prove causality it does indicate a strong apparent relationship, warning us of the detrimental effect of corruption on resource depletion. In Bulgaria business persons do not hesitate

to make unofficial payments under the table in order to get things done. In fact the mechanism of bribery works quite well. Survey based studies show that corruption spreads to virtually all occupations and to most institutions such as customs, judicial systems, ministries, agencies in charge of issuing permits, tax systems, municipal administrations, big business, and education system (Transparency International, 2004). In a survey conducted by Transparency International,

Figure 7. Impact of corruption on national information infrastructures, NII

Data: Transparency International 2006



corruption ranked ahead of all identifiable problems in Bulgarian society. Regarding Romania, corruption, if left un-checked, will threaten its markets, the proper functioning of EU policies and EU funded programs such as the expansion of needed ICT and NII infrastructures (CEC, 2005).

In order to examine the relative importance of ICT, social development and corruption on GDP a regression model was tested where GDP per capita (2000 international $s) was regressed as the dependent variable on national information infrastructure (NII), social development (SDI), and corruption (CI) for all 203 countries in the world Bank database. The results of this step-wise regression indicated that only NII and corruption were significant contributors with a combined R^2 of 0.826 at F=315 and a significance level of 0.0005. The model is estimated, using beta coefficients, as:

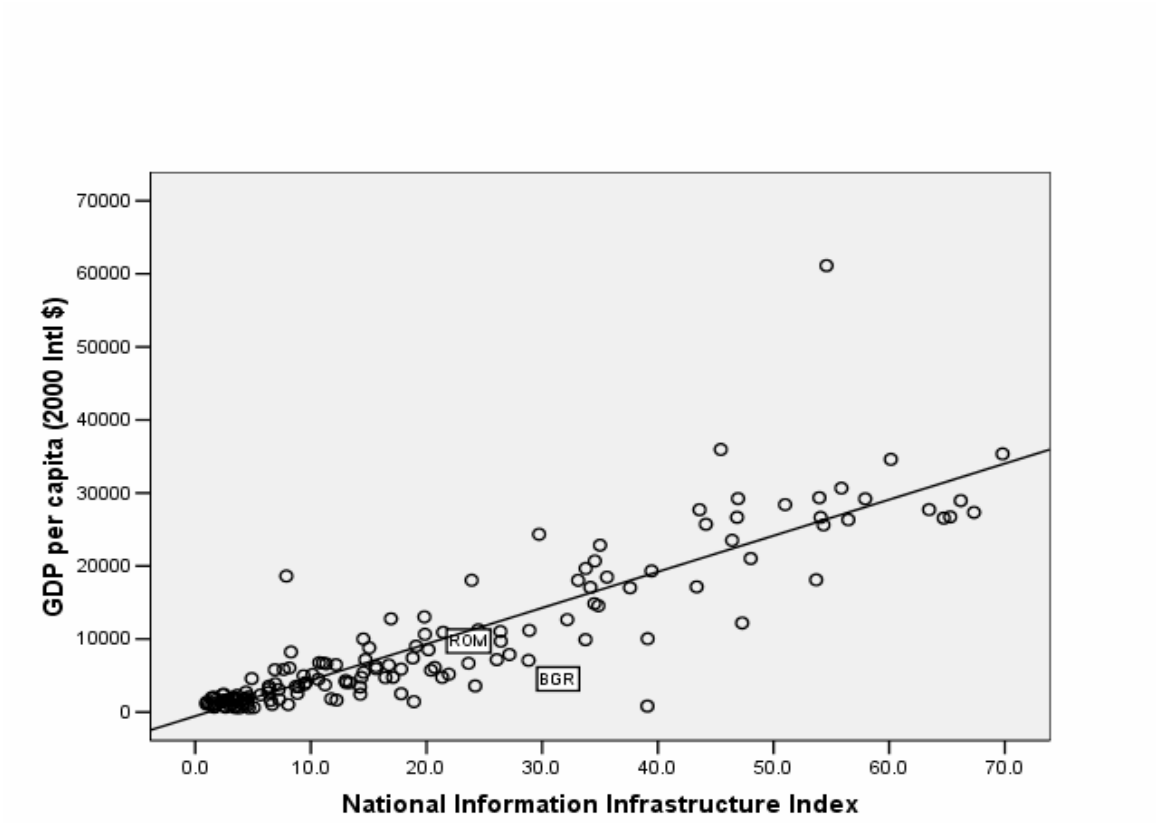
GDP per capita = 0.896 + 0.598 NII + 0.335 CI (significance of 0.0005)

SDI proved not to be a significant contributor. However, the above result, without SDI, is all the more significant illustrating the power of NII with all its components, as well as corruption (CI).

It is informative to further examine the relationship of national information infrastructure regarding per capita GDP of the countries in question using graphical means as in Figure 8. It can be seen that both Romania and Bulgaria are located in the lower one-third of the graph suggesting that there is plenty of room for improvement. However, when considering the strong apparent

interaction between corruption and NII and consequently GDP there should be strong impetus for controlling corruption.

Figure 8. Relationship between NII and GDP per capita with Romania and Bulgaria



Data: World Bank 2005

Conclusions

In their report the Commission of the European Communities recommends Bulgaria and Romania for accession. Examining these two countries' performance in the ICT sector and their national information infrastructures overall they compare favorably to the original EU15 as well as the second round EU10 countries. Fixed line penetration in Romania lags behind both the EU15 and EU10 norms. The availability of investment funds for telecommunications, however, will likely remedy the situation. Other traditional ICT technologies are on par with EU norms in both countries. Pricing of long distance telephone calls in Bulgaria and Romania reflects influences of partial privatization and consequently vary rather broadly, however; so does pricing among other EU members especially the EU10 recently entered. The situation is further highlighted by varying trends over the past 5 years of the price basket of fixed line phone calls among EU members and candidate countries.

High technology components of NII e.g. mobile phones, Internet and PC penetration rates, lag behind both EU15 and EU10 norms and need attention on the government level. The mobile phone markets of both countries have been mostly, though not completely, deregulated and attention paid to limiting legislation and corruption controls will likely bare fruit. As pointed out earlier installation of secure Internet server sites and the establishment of PCs as information delivery machines by sponsoring e-government programs could be the impetus needed by this industry segment.

As indicated in Figure 6 national social development, measured by the Social Development Index (SDI), forms the foundation of national information and technology infrastructures. That is, without an appropriate level of social development it would not make any sense to talk about

developments in telecommunications and information technologies. It was demonstrated through cross-national analysis that not only is there a high correlation between the National Information Infrastructure Index (NII) and SDI but that the relationship is non-linear (see Figure 6), indicating that as a nation fulfills its social obligations less and less investment in SDI related projects will result in ever increasing pay-offs in NII. Furthermore, as corruption worsens its detrimental influence on NII, and ultimately on GDP, it can defeat national efforts to improve development by siphoning off badly needed investments earmarked for development.

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ECONOMIC DATA ANALYZE USING NEURAL NETWORKS

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Abstract: Financial and economic forecasters have witnessed the recent development of a number of new forecasting models. Traditionally, popular forecasting techniques include regression analysis, time-series, analysis, moving averages and smoothing methods, and numerous judgmental methods. ANN (Artificial Neural Networks) are members of a family of statistical techniques, as are flexible nonlinear regression models, discriminant models, data reduction models, and nonlinear dynamic systems. They are trainable analytic tools that attempt to mimic information processing patterns in the brain. Because they do not necessarily require assumptions about population distribution, economists, mathematicians and statisticians are increasingly using ANN for data analysis.

Keywords: *Artificial Neural Networks*, *supervised learning, prediction of data series.*

1. INTRODUCTION

Neural computing represents an alternative computational paradigm to the algorithmic one (based on a programmed instruction sequence). Neural computation is inspired by knowledge from neuroscience, though it does not try to be biologically realistic in details [4].

An artificial neuron has several inputs, say n. Each input arrives from another neuron, having a connection strength associated with it. For a given neuron, call it neuron j, the connection strength on the input coming from neuron i is written as w_{ji}.

The artificial neuron performs the following operations [3]:

➲ a summation of weighted inputs: $\sum_i w_{ji} \cdot x_i$

➲ a non-linear threshold of this sum: $f\left(\sum_i w_{ji} \cdot x_i\right)$

➲ the output of this neuron j, is: $y_j = f\left(\sum_i w_{ji} \cdot x_j\right)$

These neurons can be connected together in many ways. The particular manner of interconnection is called ***architecture*** of the network.

We will deal with neural networks organized in layers, where the information is transmitted from the first layer until the last layer. These types of feedforward multylayer neural networks are called MLP (MultiLayer Perceptrons) [3]. Some important fact about artificial neural networks:

➲ the first layer of neurons is called input layer, it is a simple buffer to store the input data.

➲ the input signal is transmitted to the connected (hidden) neurons.

➲ the last layer is the output of the system, and is usually called output layer.

MLP learn in a supervised manner [10]. Learning represents the process in which input patterns are presented repeatedly and the weights are adjusted according to the learning algorithm, which in this supervised case, take the difference between the desired output and the current output into consideration.

2. MATHEMATICAL ASPECTS OF SUPERVISED LEARNING

The training set used for supervised learning has the following form:

$$T = \left\{\left(\mathbf{x}_i, \mathbf{z}_i\right) \mid i = 1,2,\ldots,N\right\} \qquad (1)$$

where $\mathbf{x}_i \in \mathbf{R}^n$ is the n-dimensional input vector, and $\mathbf{z}_i \in \mathbf{R}^m$ is the m-dimensional target vector that is provided by a trainer. $N \in \mathbf{N}$ is a constant that represents the number of training samples. Usually the training set T is obtained from a probabilistic known distribution**.** In the classical supervised learning strategy [5], [10], the trainer is a static agent. Using the probabilistic distribution he selects a certain input vector $\mathbf{x}_i$, and provides the appropriate target vector $\mathbf{z}_i$. The learning algorithm will compute the difference between the output generated by the neural network $\mathbf{y}_i$ and the desired target vector $\mathbf{z}_i$, which will represent the error signal:

$$e_i = y_i - z_i, i = 1,2,\ldots, N \tag{2}$$

The signal error is used to adapt the synaptic weights w_{ji} using a gradient descendent strategy [7]:

$$w_{ji} = w_{ji} + \eta \frac{\partial E}{\partial w_{ji}} \tag{3}$$

where $\eta \in (0,1)$ is the learning rate, controlling the descent slope on the error surface which is corresponding to the error function E [8]:

$$\mathrm{E} = \frac{1}{2}\sum_{i=1}^{N}\left(y_i - z_i\right)^2 \tag{4}$$

3. DATA SERIES PREDICTION WITH NEURAL NETWORKS

3.1 General problems

Economic problems have an important role in the society life, activity of companies and people. To better understand these problems and to find the desired solutions, economists try to build models that describe the investigated problems. Using some developed models and predictions, studies are made to find the optimal solution.

Usually, data accessible to the economists are sets of numeric values that describe the situations about the investigated problem in a certain moment. Numeric data sets are called *data series*, and their analysis and values prediction is called the *analysis*

respectively the *prediction of data series*. Examples of data series are: the value of monthly unemployment, the value of monthly / annual inflation, the value of different stocks and the value of daily exchange between different currencies. To develop those economic models we have to study the analysis of economic time series, and for the decisions process we have to make the prediction for those series, using the developed models.

An important class of economic data series is represented by financial data series. These series contain data that represent monetary values of some economic objects or reports on some monetary values of economic objects. In this way, these series play an important role in monetary decisions of the central bank, in the investments made by companies and private people, in stock exchange transactions.

3.2 The analysis and prediction of data series

A simple model for data analysis is based on the auto-regressive model of *order p*, noted by *AR(p)* and the average sliding model of *order q*, denoted by *MA(q)*. In the auto-regressive case the model is written [1]:

$$X_t = a_1 X_{t-1} + \ldots + a_p X_{t-p} + Z_t \qquad (5)$$

where a_i are the coefficients of the model, and Z_t are the probabilistic variables that follow the same normal probabilistic distribution with 0 average and σ^2 variation.

The probabilistic average models have the following formula [1]:

$$X_t = b_0 Z_t + \ldots + b_q Z_{t-q} \qquad (6)$$

where *bi* are the parameters of the model, and Z_t is following the same normal probability rule $N(m, \sigma)$.

The combined model of *AR(p)* and *MA(q)* is the model *ARMA(p,q)* that contains both components, having the following formula:

$$X_t = a_1 X_{t-1} + \ldots + a_p X_{t-p} + Z_t + b_0 Z_t + \ldots + b_q Z_{t-q} \qquad (7)$$

The prediction of data series is based on the supposition that there exists a functional relations between past, present and future data series values. Usually the

supposition is that the functional relation is not completely deterministic, but also contains a stochastic component. In several cases, especially in the case of financial time series, it is assumed that the deterministic component is not dominant, the stochastic component being of great importance.

The idea of applying neural networks has its origins in the observation that functional relations between time series values are in most cases non-linear. Thus, for the approximation of these non-linear functional relations neural networks are very efficient [2], [15].

3.3 Predictions at microeconomic level

A large usage of predictions using financial data series is at microeconomic level. In this category we can consider predictions regarding exchange rates, predictions regarding different financial products, predictions regarding the value of products and commercial products (gold, aluminum, etc.). The usual users of these predictions are investors and brokers.

The problem of prediction at microeconomic level is the presence of the stochastic components. In this case one can observe relatively frequent shocks produced by more or less independent events, independent from the data series object (quick changes of values caused by wars and in general by political events). Another special phenomenon of these series is the presence of short or medium time trends that can disappear in short time.

3.4. Data processing

Data processing represents the process of data transformation before building the models. These transformations are conversions, classifications, filtrations or other similar processing.

Many times data are not properly structured to build predictive models. In these cases it is important to remove components that represent redundant or irrelevant information [16].

Another important aspect is the necessity to validate the proposed models. For this reason we need to have data to build the model and data to validate the model. Thus, it is necessary to divide data for training data and data for validation.

3.4.1. Processing methods

The general purpose of preprocessing is to remove the observable deterministic relations. Theoretically, the purpose is to obtain some data series with mean 0 and a small variation.

The first step in data preprocessing is to make comparable the components of the data series. For this purpose it is necessary to rescale the data so that the values of the data series components to have values in the interval [0,1] or [-1,1].

The second step is to remove the primary deterministic components, that are easy to be observed. Examples of these types of components are trend and seasonality [12].

In the next step we can proceed a data filtering. The purpose of the filtering process is to remove non-trivial periodical components that have dominant effects in data series. To determine those periodical componets we can apply a Fourier transformation of the data series. To filter these componets we can build linear filters. The most common filters are the the low-pass filters, high-pass filters and band-pass filters. By combining those filters can be filtered outside non-trivial periodical componets existing in data series [10]. These filters usually have the following form:

After removing the deterministic observable componets we have theinput data vectors that contains relevant information. On one side this is done by removing the componets of data vectors that are not meaningful according to the known knowledge, on the other side data vectors are combined to obtain new vectors with more complete informational content. The question is, which are the previous data that influences the values of the data series in a future moment. This doesn’t mean to

search for functional relations but also to the search for relevant information. This problem is also called the problem of *determination of data dimension*.

Finally, input data vectors are analised to determine possible clustering [9], [13]. This is done through simple classification of data. If we can group the data in precise distinct classes, separate models are built for those classes. It is possible, that after clusterization the models to be equivalent. We must verify model equivalence, and in case of equivalation relations, we must build simplified data general models [14].

3.4.2. Data for training and validation

Analising the data corresponding to a problem it is possible to build predictive models. It is very important to test the accuracy of the generated model. Through validation we understand the testing of the model and the measurment of its performance using a measure of performance [6].

A method for spliting data in training data and in validation data is the simple division based on data feature. We can consider the data x_t with $t <= T_0$ as training data and data x_t with $t > T_0$ as validation data.

A practical observation is that the selection of the model depends on the validation set. A way to select the best model is to use more than one set of validation, for example the validation data are grouped in many validation sets. After that, the generated models are verified with every validation test and is a balanced validation is generated. Theoretically, it is desired that the validity of the models to be tested for every possible validation set. But this is not possible practically, because of the necesity of excessive calculation.

3.5. Performance measurment

The performance measurement of predictive models is crucial for their practical application. A common measure regarding predictive models, including neural networks, is the use of square average error. Many times prediction errors are

too large in the context of real applications because of the stochastic components present in the financial series. For this reason it is necessary to use additional performance measures to test the validity of the predictive models. Examples of additional performance measures are: the measure of generated profit, the measure of correct prediction of different value, the measure of correlation between the real values and the predicted values, the measure of percentual error towards the real value of predicted value and other similar measures [11].

In conclusion, we can say that neural networks are efficient tools to detect nonlinear relations that rule, at least partially, the behaviour of time series. As the majority of financial data series contain nonlinear components, neural networks are good candidates to predict this type of series. Because financial data series have important stochastic components, is very important to build minimal models, that estimate sufficiently well nonlinear relation, and in the same time, it doesn't incorporate the stochastic noise.

4. PRACTICAL IMPLEMENTATION OF THE NEURAL NETWORK

The practical part of this paper is related to the implementation of a neural network that offers the possibility to analyse and predict data series. In this simulation we have tried to approximate and to predict some financial data series.

The parameters that are influences the learning process are: the training data set, the number of ephocs (number of the presentation of the training data set), learning rate, the activation functions for the neurons contained in the hidden layer, the number of neurons in the hidden layer.

We have built a practical application, based on a MLP neural network, in order to test the prediction capabilities of neural networks [3].

The architecture of the neural network used in our simulation is corresponding to a MLP neural network with one hidden layer [4]:

- The input layer contains n input neurons, *n* representing the dimensionality of the input space $x_i = \left(x_i^{(1)}, x_i^{(2)}, \ldots, x_i^{(n)}\right) \in \mathbf{R}^n$. The bias can be considered explicitly or implicitly.
- The hidden layer having a number of hidden neurons equal to the dimension of the training set $T = \left\{\left(\boldsymbol{x}_i, f\left(\boldsymbol{x}_i\right)\right) \middle| i = 1,2,\ldots,N\right\}$. The activation functions of the hidden neurons are Green functions $G\left(\boldsymbol{x} - \boldsymbol{x}_k\right)$ [13]. The dimension of the hidden layer can be reduced using an unsupervised clustering algorithm;
- The output layer contains one single output layer having as activation function a linear function or a special weighted functions of the output values generated by the neurons in the hidden layer [6];

Synaptic weights:

- The weights between the input layer and the hidden layer are included in the form of the activation functions of the hidden neurons. The vector $\boldsymbol{w} = \left(w_1, w_2, \ldots, w_N\right)$ represents the weights between the hidden layer and the output layer.

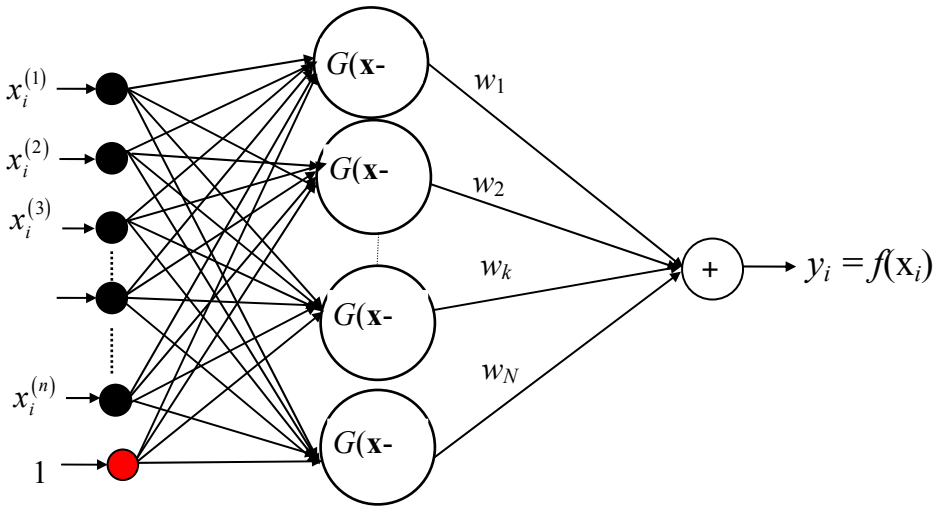

***Fig. 1*: Architecture of the neural network used for simulations.**

The nerural network was trained using an original learning algorythm, based on the backpropagation learning strategy. For learning we have used a training set containing financial data series, like the exchange rate between RON and EUR or

RON and USD. The learning set, corresponds to the time frame January 2004- June 2005, and was obtained from the official Web-site of the National Bank of Romania http://www.bnr.ro (Banca Nationala a Romaniei). After learning we have performed a testing phase, in order to measure the accuracy of the trained neural network.

Number of ephocs	Learning error
10	0.0289682211941586
50	0.0135544478100808
100	0.00669238729756063
500	0.00268232311020435
1000	0.00192883390014049
5000	0.00163946058914474
10000	0.00157560371972362

Table 1.: Results of the learning phase: the learning error obtained for different number of epochs.

In the following ghaphics we have presented the ability of the neural network to approximate and to predict the finnancial data series corresponding to the exchange rate of RON versus EUR. The red curve represents the real exchange rate and the blue curve represents the result generated by the neural network.

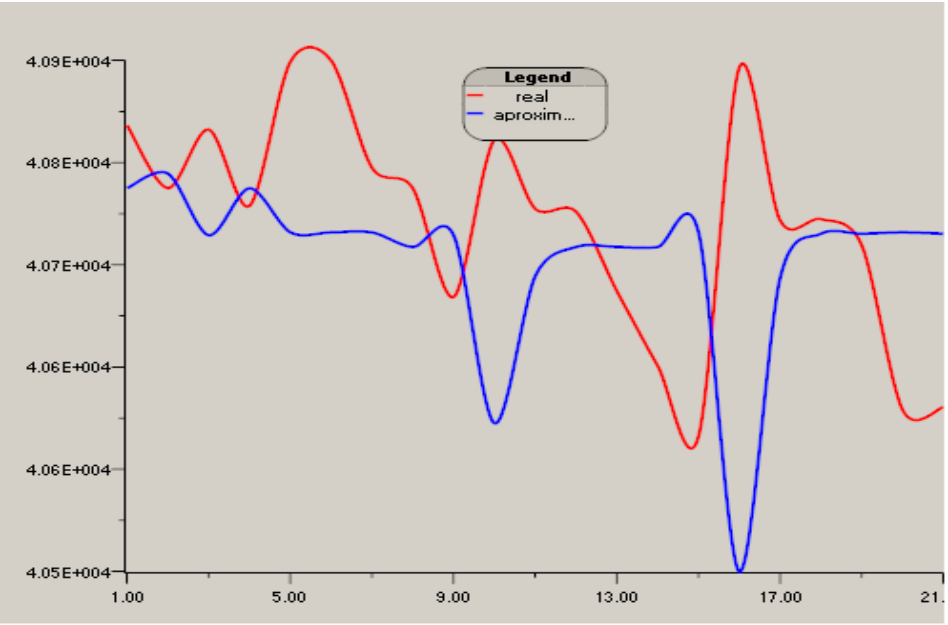

Fig.2: Results of the approximation and prediction made by the neural nework, after a learning process of 10 ephocs.

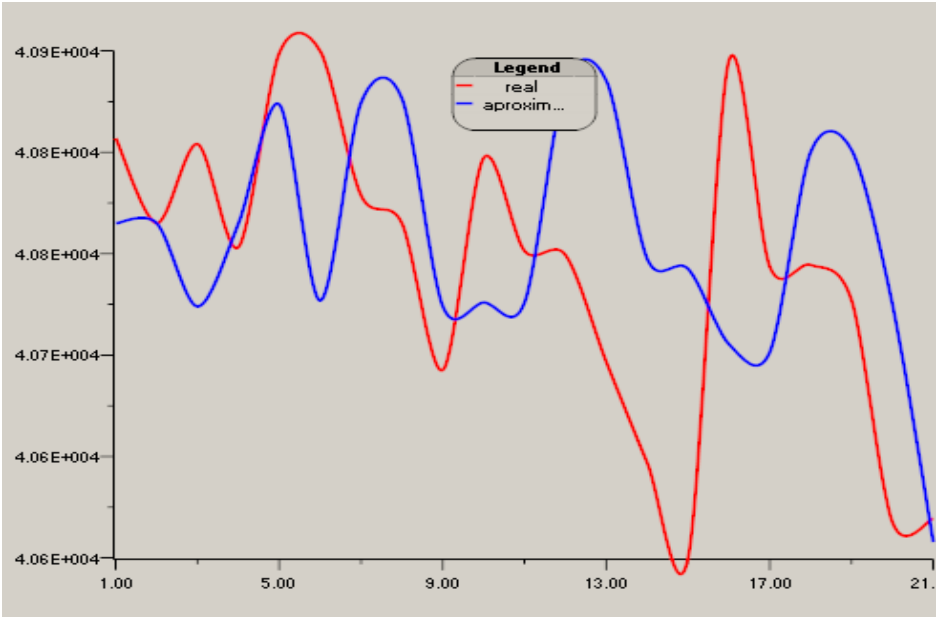

Fig.3: Results of the approximation and prediction made by the neural nework, after a learning process of 100 ephocs.

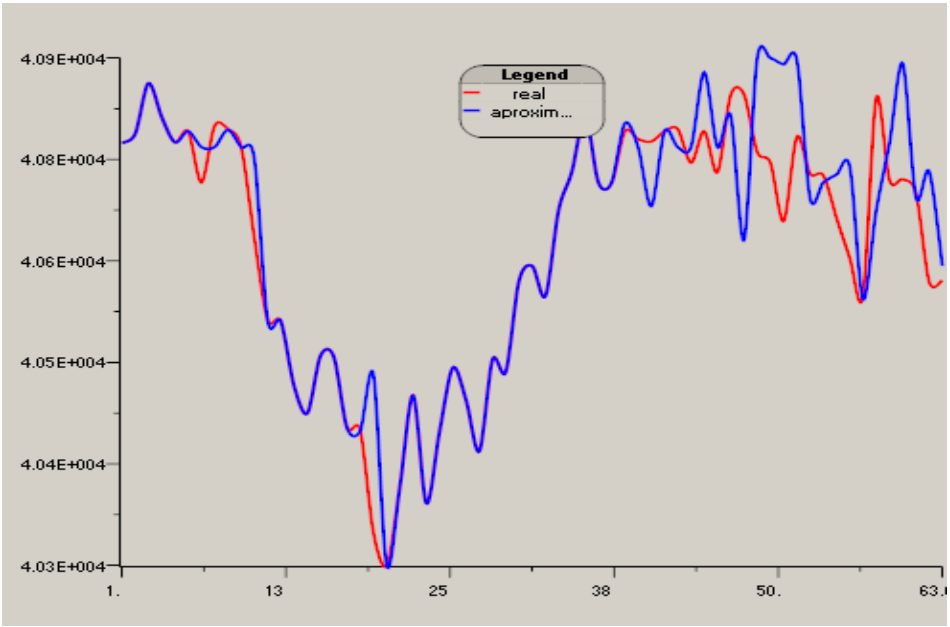

Fig.4: Results of the approximation and prediction made by the neural nework, after a learning process of 500 ephocs.

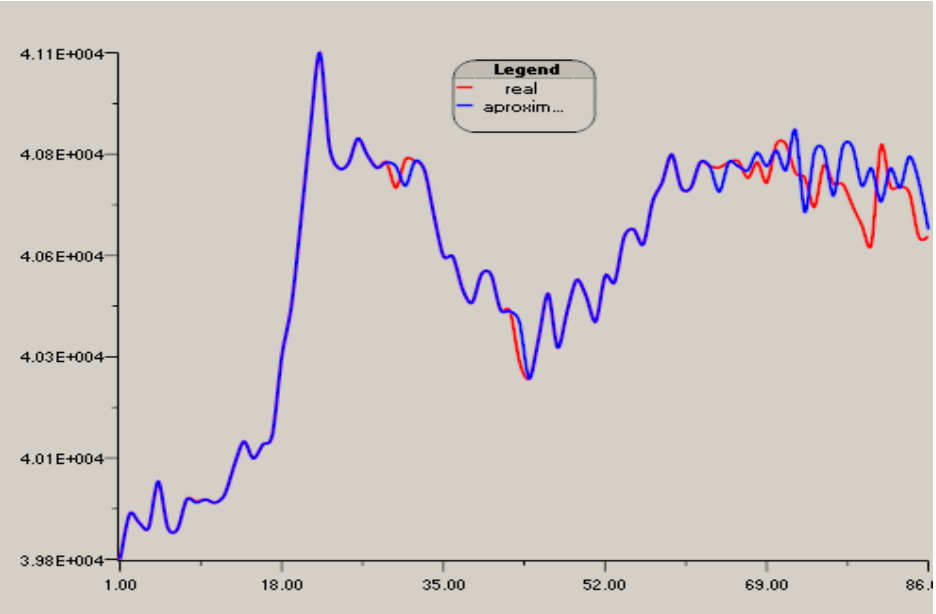

Fig.5:: Results of the approximation and prediction made by the neural nework, after a learning process of 5000 ephocs.

5. CONCLUSIONS

The technology of ANN has existed theoretically for decades. ANNs are revolutionizing statistical computing in many fields as they not only "learn" autonomously, but they also are ideal for noticing non-linear relationships in data. ANN models are becoming highly desirable statistical tools for statisticians and economists who, having internalized the hallmark of rational expectations, now firmly believe that people react to one another and to policy rules in strategic and dynamic ways.

The ability to deal with many processing elements makes neural computing faster than conventional computing. In addition, parallelity makes it robust and fault-tolerant in the sense that performance does not degrade significantly even if one of the nodes fails. Researchers are concluding that most economic and financial problems are non-linear; that simple cause-and-effect relationships rarely exist; that, instead, most problems encountered are fuzzy patterns, which relate to multiple variables. There are many useful neural network models for nonlinear data analysis,

such as the MLP model, and there is room for many more applications of statistics to neural networks, especially in regard to estimation criteria, optimization algorithms, confidence intervals, diagnostics, and graphical methods.

As they do not require an exact specification of the functional equations, emulative neural systems can be applied to predict economic phenomena - especially unrecognized, unstructured, and non-stationary processes. Thus, ANNs are highly suitable for analyzing economic systems. ANNs have proven themselves to be adequate also for searching out and identifying non-linear relationships and for pinpointing those variables that hold the highest predictive value. After extensive training, ANN are able to eliminate substantial amounts of ambiguity in economic forecasts, although never completely overcoming indeterminacy.

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MODERATE GROWTH TIME SERIES FOR DYNAMIC COMBINATORICS MODELISATION

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Abstract

Here, we present a family of time series with a simple growth constraint. This family can be the basis of a model to apply to emerging computation in business and micro-economy where global functions can be expressed from local rules.

We explicit a double statistics on these series which allows to establish a one-to-one correspondence between three other ballot-like strunctures.

Keywords: Time series, Complex system, Growth constraint, local rules, Dyck words, Permutations, Codes.

1. Introduction

In this paper, we are interested with time series with moderate growth but possibly sudden decay. We will focus ourselves on a very simple model (a “toy model” as physicists may say), the combinatorics of which is completely mastered. This feature is important as one may use simulations and estimates over “all the possible configurations”, as it is the case, for example, for other combinatorial models (Cox-Ross-Rubinstein, for instance). The model is that of sequences with integer values and growth bounded by a unit (local rule). Surprisingly, there is one-to-one correspondences between the possible configurations and planar combinatorial objects which are endowed with a special dynamics which we describe here. The structure of the paper is the following. Section 2 presents an applicative economic problem which leads to generate the studied growth time series from local rules. On section 3, we propose a non exhaustive review concerning emerging computation in economic domain and how our work relates corresponding of this body of knowledge. Section 4 develops the dynamic combinatorics computation which leads to establish one-to-one correspondences between three other ballot-like structures. We conclude on section 5.

2. From Micro-Economy Local Rules To Dynamic Combinatorics

Our aim is to describe here a **toy-model** of the benefit in the following situation. A capital owner possesses two accounts, say **P** and **R**, **P** is the account where the principal (untouched) capital is deposited. This capital produces a constant return (one unit per unit of time) which is sent to a reserve **R**. From the account **R** can be with drawn arbitrary amounts of money and the account must stay positive.

The possible configurations are described the sequences such that

- $a_1 = 0$
- $a_{i+1} \leq a_i + 1$

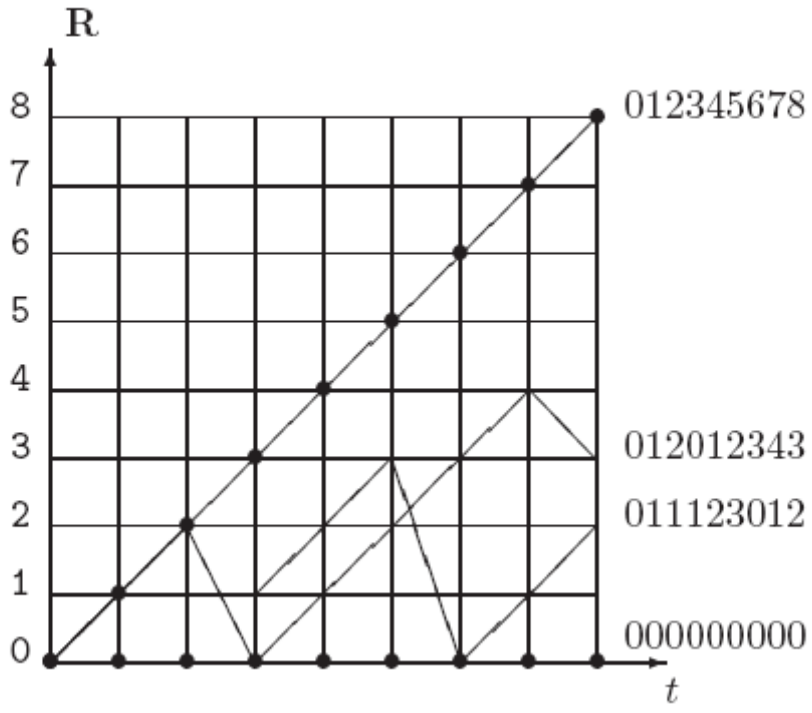


Figure 1: Maximal, minimal (dotted) and two intermediate trajectories. Their codes are on the right

In this paper, we build combinatorial structures that allow to modelize and to compute the global behavior of the reserve **R** by some specific functions. We can consider this result as an emergent function from the basic local rules.

3. Emerging Computations

Emerging computation is nowadays a thrilling topic which concerns many developments in complex systems modeling. A brief review can allow to classify these emerging computations concerning economic domains in 3 spaces.

The first space is composed of emerging computations which lead to some universal laws. Per Bak's sand pile is concerned by this class [6]. In such model called Self-Organized Criticality, the phenomenon is crossed by transformation which make it evolve by avalanche. The Coton market trade follows such a law. For 1000 small price variations, there are only 100 middle price variations and only 10 major price variations. The general law which characterize such criticality phenomena is an exponential law.

The second space of emerging computation leads to some pattern formations without a complete knowledge of any law. Thomas Schelling's segregation model for urban development is concerned by this class [7]. In such model some local interactionbetween neighbours can lead to self-organized patterns which emerge from the whole interaction systems. Some areas become specialized to some people categories while other areas are devoted to others ones.

The third space of emerging computation described here, leads to some global functions expressions. It is typically what we will describe in our problem. The local rules concerned by the proposed economic toy-model will lead to define

combinatorics structures allowing to compute a functional global approach. The detailed computation is describe in the following

4. Dynamics Combinatorics Computation

4.1 Trajectories and Codes

We can define the trajectories of our model by sequences (codes) $a_1a_2a_3...a_n$ such that

- $a_1 = 1$
- $a_{j+1} \leq a_j + 1$

Example : For n = 4, we have 14 codes as described in the following table.

numbers	codes
1	1111
2	1112
3	1121
4	1122
5	1123
6	1211
7	1212
8	1221
9	1222
10	1223
11	1231
12	1232
13	1233
14	1234

We remark that we have 5 codes which end by 1 or 2, 3 codes ending by 3 and one code ending by 4. Now if one sets $l(n,k)$ to be the number of codes ending by $k-1$, one can check that

- $l(n,0)=l(0,n)=0 \ \ (\forall n \geq 1)$
- $l(0,0)=1$ (the void sequence)
- $l(n,k)=\sum_{j \geq k+1} l(n-1,j)$

whence the easy computed table of the first values

N\k	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
0	1	0	0	0	0	0	0	0
1	0	1	0	0	0	0	0	0
2	0	1	1	0	0	0	0	0
3	0	2	2	1	0	0	0	0
4	0	5	5	3	1	0	0	0
5	0	14	14	9	4	1	0	0
6	0	42	42	28	14	5	1	0
7	0	132	132	90	48	20	6	1

The values for $n,k \geq 1$ can be even more easily computed with the (subdiagonal) local rule described by **West** + **North** = **result**. For instance, we remark that 9 + 5 = 14.

1	0	0	0	0	0	0
1	1	0	0	0	0	0
1	2	2	0	0	0	0
1	3	5	5	0	0	0
1	4	**9**	14	14	0	0
1	**5**	**14**	28	42	42	0

Remark that the preceding table gives the mirror images of the lines of the previous double statistics.

4.2 Permutations

We say that a permutation π of n letters has an increasing subsequences of length k if there are positions

$$1 \le i_1 < i_2 < i_3 < ... < i_k \le n$$

such that

$$\pi(i_1) < \pi(i_2) < \pi(i_3) < ... < \pi(i_k)$$

For example

$$\pi = \begin{pmatrix} 1 & 2 & 3 & 4 & 5 \\ 5 & 3 & 4 & 1 & 2 \end{pmatrix}$$

has increasing subsequences of length 2, at points $\{2,3\}$ as well as at positions $\{4,5\}$. Let $\pi_2(n)$ be the number of permutations of n letters that have no increasing subsequences of length >2. By direct enumeration we obtain the following table.

n	0	1	2	3	4	5	6	7	8
$\pi_2(n)$	1	1	2	5	14	42	132	429	1430

Proposition 1. $|\pi_2(n)| = C_n$, where $\pi_2(n)$ the number of permutations of n letters that have no increasing subsequences of length >2 and C_n is the n-th Catalan number.

$$C_n = \frac{1}{n+1}\begin{pmatrix} 2n \\ n \end{pmatrix}$$

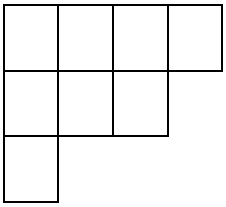
4. 3 Young Tableaux

Definition 1. A **partition** of n, written $\lambda \triangleright n$, is a sequence,

$$\lambda = (\lambda_1, \lambda_2, \lambda_3, ..., \lambda_k)$$

such that the λ_i are decreasing (weakly) and $\sum_{i=1}^{k} \lambda_i = n$.

Let $\lambda = (\lambda_1, \lambda_2, ..., \lambda_n) \triangleright n$. Then the **Ferrers diagram**, or **shape**, of λ is an array of n-squares into k left-justified rows with row i containing λ_i squares for $1 \le i \le k$. For example, the partition (4,3,1)



Let λ be as above. A **Young tableau** of shape λ, is an array obtained by replacing the squares of the shape of λ by a bijection with the numbers 1,2,...,n. A tableau T is said to be a **standard Young tableau** if the rows and columns are increasing sequences. For example below the tableau is standard

1	2	3	5
4	6	7	
8			

A **standard Young tableau of two lines** is of the shape $\lambda(l_1, l_2) \triangleright n$ where $l_1 \ge l_2 > 0$. Let $f^{(l_1, l_2)}$ be the number of standard tableaux of two lines. We have

$$f^{(l_1, l_2)} = \frac{l_1 - l_2 + 1}{l_1 + 1} \binom{l_1 + l_2}{l_1}$$

Proposition 2. If $l_1 = l_2$ then

$$f^{(l_1,l_1)} = \frac{1}{l_1+1}\binom{2l_1}{l_1}$$

which is th n-th Catalan number C_n.

In general, we can represent a Young tableaux of two (equal) lines as follows :

.	.	.	.	2n
1	.	.	.	k

Then

$$2n - k = h$$

will be the second parameter of the tableau.

Example : A Young tableau of size six and height two

3	5	6
1	2	4

Then

$$6 - 4 = 2$$

we remark that 2 is the last letter of

$$\sigma_2(3) = 312$$

4.4 Dyck Words and Dyck Paths

Let **w** be a word and **a** a letter, the length of **w** will be denoted by $|w|$, and the number of occurrences of **a** in **w** by $|w|_a$. We denote the empty word by ε. If **w = uv** , then **u** is a prefix of **w**.

Definition 2. A Dyck word **w** is a word over the alphabet $\sum = \{0,1\}$ with the following properties :

- For each prefix of u of w, $|u|_1 \geq |u|_0$
- $|w|_1 = |w|_0$

A Dyck path is a path in the first quadrant, which begins at the origin $(0,0)$, ends at $(2n,0)$. A Dyck path consists **North-east** and **South-east** steps. The number of Dyck paths of length 2n is the Catalan number

$$C_n = \frac{1}{n+1}\binom{2n}{n}$$

and thus,

$$\sum_{n\geq 0} C_n x^n = \frac{1-\sqrt{1-4x}}{2x}$$

Now, we can refine the number of Dyck words with respect to a parameter like k which is the number of factors in Dyck words. The number of Dyck words of length 2n which decompose into k (irreducible Dyck) factors is exactly $l(n,k)$ and their sum (over k) equal to the Catalan numbers. For example

aaaabbbb

is a Dyck word of length 4 which has one factor.

4.5 Bijections

In this chapter we will describe the links between some combinatorial famillies and we try to give certain properties that help us to understand the connection.

$$Codes \leftrightarrow \sigma_2(n) \leftrightarrow Youngtableaux \leftrightarrow Dyckwords$$

Theorem 1. Let $\Phi = \{a\} \cup \Phi^+$ be a data structure with a bi-variate statistics

$$l : \Phi \to N^2$$
$$s \to l(s) = (n,k)$$

such that

$$l(\Phi^+) \subset N^+ \times N$$

Suppose that

We suppose that there exist a function $d : \Phi^+ \to \Phi$ such that

1. $d : \Phi_n \to \Phi_{n-1}$ $(\Phi_n = (pr_1 \circ l)^{-1}(n))$
2. $\phi : \Phi_n \to \Phi_{n-1} \times N^+$

   $s \to (d(s),k)$ is injective
3. define $\pi = pr_2 \circ l$. For all $s \in \Phi$ we define his code by

   $$\chi(s) = (\pi(d^{n-1}(s)), \pi(d^{n-2}(s)), \cdots \pi(d(s)), \pi(s))$$

   then χ is injective.

For example to pass a code 1122 to $\sigma_2(4)$, $f^{(4,4)}$ and Dyck word of length 8 which decompose into one factor.

$$\sigma_2(2) : 1 \to 12 \to 312 \to 3412$$

Dyck word : ab → aabb → abaabb → aabaabbb

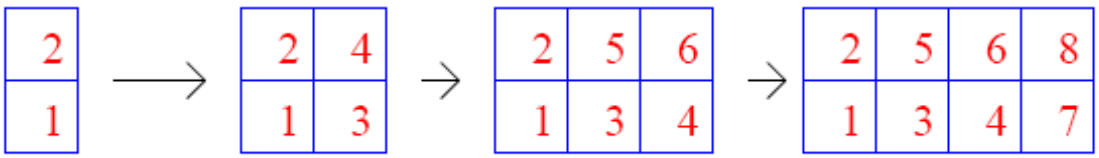


Figure 2: Young tableau

5. Conclusion

We have presented an toy-model economic behaviour based on local rules and we propose some global function expression which can be also described by three combinatorics structures. By this application, we point out a one-to-one correspondence between three other ballot-like structures. The innovative aspect of this paper deals with a constructive development of the involved bijections.

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A 3-DIMENSIONAL TRANSPORTATION PROBLEM WITH FRACTIONAL LINEAR OBJECTIVE FUNCTION

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Abstract: This paper presents solving the three-dimensional transportation problem, a double sum model and fractional linear objective function by using Dantzig Wolfe decomposition method and also with the help of simplex method.

Theoretical preliminaries

I am proposing now to solve the 3-dimensional transport problem – a double sum model - with the fractional linear objective function and linear constraints:

$$\min \frac{\sum_{i=1}^{m}\sum_{j=1}^{n}\sum_{k=1}^{p} m_{ijk} x_{ijk}}{\sum_{i=1}^{m}\sum_{j=1}^{n}\sum_{k=1}^{p} n_{ijk} x_{ijk}} \tag{1}$$

$$\sum_{j=1}^{n}\sum_{k=1}^{p} x_{ijk} = a_i \qquad i = 1, m \tag{2}$$

$$\sum_{i=1}^{m}\sum_{k=1}^{p} x_{ijk} = b_j \qquad j = 1, n \tag{3}$$

$$\sum_{i=1}^{m}\sum_{j=1}^{n} x_{ijk} = c_k \qquad k = 1, p \tag{4}$$

$$x_{ijk} \geq 0 \qquad i = 1, m \qquad j = 1, n \qquad k = 1, p \tag{5}$$

$$a_i, b_j, c_k > 0 \tag{6}$$

$$\sum_{i=1}^{m} a_i = \sum_{j=1}^{n} b_j = \sum_{k=1}^{p} c_k = T \qquad (7)$$

Requiring the following specifications:

m – the number of sources

n – the number of destinations

p – the number of means of conveyance

a_i – the available quantity in each source i = 1,m

b_j – the necessary quantity in each destination j = 1,n

c_k – the quantity with must be transported by means of conveyance k = 1,p

$$\sum_{i=1}^{m}\sum_{j=1}^{n}\sum_{k=1}^{p} m_{ijk} x_{ijk} \geq 0\,,\ \sum_{i=1}^{m}\sum_{j=1}^{n}\sum_{k=1}^{p} n_{ijk} x_{ijk} > 0$$

Matrix $X = \{x_{ijk} \setminus i = 1, m; j = 1, n; k = 1, p\}$, which satisfies constraints (2) (3) (4) (5), is called a transportation plan and plan X is called optimum if it satisfies (1).

When the condition (7) is satisfied, the resulting formulation is called a balanced transportation problem. Condition (7) is the necessary and sufficient condition for the existence of the solution: the level of the matrix of the constraint system is m+n+p showing that a non-degenerated transportation plan of problem (1-7) contains at least m+n+p-2 non-null components; the problem admits endless solutions and at least one optimal.

The objective is to establish a transportation plan with minimum total expenses.

The function (1) is explicit quasi concave in S i.e.:

If $x_1, x_2 \in S$, $x_1 \neq x_2$, $f(x_1) \neq f(x_2)$, $\lambda \in (0,1]$ and $x_0 = \lambda x_1 + (1- \lambda)x_2$ then $\min[f(x_1), f(x_2)] < f(x_0)$ holds.

For such function, a local minimum is not necessarily a global minimum.

Thus with the help of the Simplex method the possibility of obtaining a local minimum exists.

The paper objective is to present how to obtain optimum with Simplex method as well as by using Dantzig Wolfe decomposition method.

Simplex method

The considerations concerning the three-dimensional problem are valid.

An initial feasible solution can be obtained by using the north-west corner rule.

We denote $I_x = \{(i,j,k) / x_{ijk} > 0, x_{ijk} \in X\}$

Due to (7) each nondegenerate solution will contain m + n + p – 2 positive components.

We consider the dual variables:

$u_i^1,\ u_i^2,\ (i = 1,m), \qquad v_j^1,\ v_j^2,\ (j = 1,n), \qquad w_k^1,\ w_k^2,\ (k=1,p)$

and $\quad m_{ijk} = u_i^1 + v_j^1 + w_k^1$

$$n_{ijk} = u_i^2 + v_j^2 + w_k^2 \qquad \text{for } (i, j, k) \in I_x$$

If $\quad V_s = \sum_{i=1}^{m} a_i u_i^s + \sum_{j=1}^{n} b_j v_j^s + \sum_{k=1}^{p} c_k w_k^s, \qquad s=1,2$

$$m'_{ijk} = m_{ijk} - (u_i^1 + v_j^1 + w_k^1)$$

$$n'_{ijk} = n_{ijk} - (u_i^2 + v_j^2 + w_k^2) \qquad \forall (i,j,k)$$

the optimum criterion for the fractional linear problem yields a relation:

$$\Delta_{ijk} = m'_{ijk} V_2 - n'_{ijk} V_1 \geq 0 \qquad (8)$$

for all non basic variables of the studied solution.

Dantzig Wolfe decomposition method

The initial problem (1-7) with m + n + p constraints and m·n·p unknown values is reduced to a problem with p constraints and much unknown values. The new linear fractional problem obtained is resolved by the inverse matrix method which is a variant of the Simplex method by adding the estimation generalized operation:

$$\min \frac{\sum_{s=1}^{N} \gamma_s z_s}{\sum_{s=1}^{N} \mu_s z_s} \qquad (9)$$

$$\sum_{s=1}^{N} \rho_s^k z_s = c_k \qquad k=1,p \tag{10}$$

$$z_s \geq 0 \qquad s=1,N \tag{11}$$

In the set on N columns $(\rho_s^k)_k$, s=1,N only p sufficient are explicitly necessary for forming a base. One works only with the basic matrix inverse.

One comes to the optimum solution in a finite number of steps because the number of bases is finite.

To construct the initial base B of size p x p for reduced problem there are resolved p 2-dimensional linear fractional transportation problem.

$$\min \frac{\sum_{i=1}^{m}\sum_{j=1}^{n} m_{ijt} x_{ij}}{\sum_{i=1}^{m}\sum_{j=1}^{n} m_{ijt} x_{ij}} \tag{12}$$

$$\sum_{j=1}^{n} x_{ij} = a_i \qquad i=1,m \tag{13}$$

$$\sum_{i=1}^{m} x_{ij} = b_j \qquad j=1,n \tag{14}$$

$$x_{ij} \geq 0 \tag{15}$$

for t = 1,p

Conclusions

The big volume of calculus generated in the solution by classic method [1] leaves three-dimensional transportation problem unsolved.

The Dantzig Wolfe decomposition method [2] known in linear programming for solving problems of big dimensions allowing a decomposition into smaller problems – for the transportation problem having a particular structure [3],[6]. The advantage of the decomposition method is obvious for problems of great dimensions.

Some works [4], [5] have been done concerning the transportation problem with the fractional objective function.

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STATISTIC MODELS CONCERNING THE ECONOMIC FORECAST SURVEY OF TURNOVER

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In the present state of things, when market's factors are having priority in the system of variables which explains business enterprise results, it is essential the forecast analysis of turnover to give an estimation of enterprise place in its area, of its position on market, of its qualifications of launching and developing in profitable manner different activities. Depending on turnover level, it may be specified if the enterprise is sufficiently important , if its results reference to line of business ones has importance, respectively if its share on market is a neglijable quantity , in consequence taking on startegical decisions.

PROPOSAL OF A SIMULATION MODEL STRUCTURE FOR STUDYING THE ECONOMIC BEHAVIOR OF THE POULTRY SUPPLY CHAIN UNDER SANITARY CRISIS

Scientific Context of the Research

This paper will thus consist in proposing a behavior analysis of this particular system by presenting a generic model of food production for industries manufacturing and distributing fresh foodstuffs. The poultry industry represents at best the actual constraints met in the fresh foodstuffs industry and then has been chosen as an application field for this study. The model worked out starting from the principles of System Dynamics developed by Forrester (Forrester 1961) will aim to study and to explain the behaviors and instabilities which could be met by this type of industries with short processes and short DOC. These latter require a high reactivity and a very flexible organization, another difficulty being added on the management of the inventory levels often undergone in the short run despite being subject of medium-term forecasts (for instance, the poultry breeding launched several months while basing itself on forecast of consumption). This latest case enables us to pose the complex problems of space and multi-temporal integration of logistics.

THE RESEARCH FIELD, THE OBJECTIVES AND THE THEORETICAL BASES

Specificity of the Chicken Carving Industry

This work was primary based on a qualitative and empirical research via various interviews and then on investigations by questionnaire near 17 companies followed of a multidimensional analysis of the data (Thiel 1997). In the poultry industry, the logistic chain breaks up into successive phases which are the breeding, the slaughtering, the carving, the packaging and the forwarding (see figure 1).

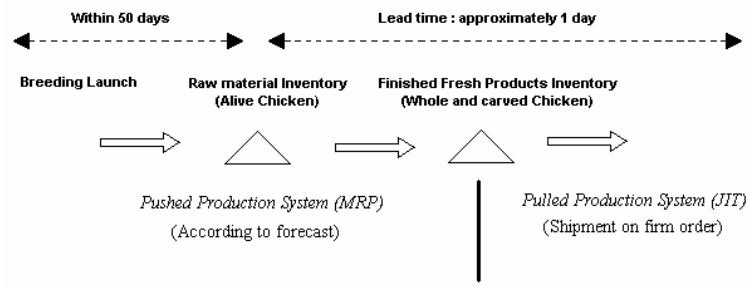


Figure 1. Logistic supply chain of chicken production

Firstly, the breeding launch must be considered several weeks early. Then as the upstream works in pushed production system, all launched products must be slaughtered after approximately fifty days for chicken, therefore on a precise date (at more or less a few days) ; actually, too early the product has not reached a sufficient weight and an organoleptic quality and too late, the ratio [weight on production cost] decrease, the weight being stabilized and the breeding costs continuing to increase. After this breeding phase in upstream followed by the slaughtering, the carving and the packaging are launched only on order. The first complexity (C1) comes then from the synchronization between the work-in-process volume of alive chicken ready to be processed and the volume of the customers orders, with however a great constraint in comparison with others industries: the stocks are perishables.

Moreover these companies buy the poultry to the stock breeders exclusively belonging to the same group and being near its factories. This poultry farming production in the upstream activities is managed in an irreversible way according to the forecasts of consumption established on more than fifty days which can harm the flexibility of the company in the event of unforeseen orders of finished products. The sale in hypermarket of

these more or less elaborated fresh foodstuffs (for instance, chicken legs or cooked dishes) currently represents the main part of their turnover. These customers orders are recorded from 9 a.m. and are distributed along the day according to the local stockists. These orders must be carried out on the day D for a delivery at the final customers on day D+1. Then the second complexity of the industrial management (C2) comes from a continuous adjustment between a daily planning developed from forecasts and the real orders arriving regularly during this same day.

Finally, it is also to be noted the existence of a reversed nomenclature which could be met usually in food and chemical industries. Indeed, from a raw material i.e. the alive chicken, it is indeed possible to obtain simultaneously various finished products: thighs, wings, and more elaborated products. So the third complexity (C3) is met at the level of the appropriateness between the manufactured volumes of these various finished products coming from one even raw material (in accordance with the reversed nomenclature) and the real volumes of the orders which inevitably do not respect the equation of the products structuring.

By the way, in the event of an anticipated and unsold production at the end of the day owing to a lack of orders, these enterprises have to resort to deep freezing which lead them to develop a marginal activity with very low profitability. From these difficulties of piloting, the solutions usually implemented in others industries to ensure a better control of the upstream activities according to the downstream orders, consist in making flexible all the chain, in working in Just-In-Time production system as possible in the upstream and in reducing the delay. However in this particular case, it is quite difficult to put a whole pull production system into practice owing to a very long required breeding time to reach an optimal quality.

Objectives and Theoretical Bases

The two scientific objectives that have been fixed are, on the one hand to highlight the problems of coordination between variables controlling the production in the upstream activities (pushed flow with a time of six weeks breeding), the piloting of the slaughtering and the carving (system pulled by the customers orders with a need for reactivity lower than a day); and on the other, to formalize the cybernetic mechanisms allowing to control the whole integrated logistic chain, met in the poultry production system.

The objective of the model of simulation that has been proposed is turned to the study of the system behaviors, the identification and the modification of the symptoms of instabilities met in this particular production system, rather than to the true causes. This model does not seek to represent the physical reality of the industrial activities in factories ; in the same way, it is not a question here to seek an absolute precision in the quantitative results of simulation, but to understand the qualitative behavior of the studied system.

GENERIC MODEL PROPOSAL

Causal Diagram of a Fresh Foodstuff Production System

According to Radzicki and Sterman (1993), the dynamic behaviors emerge to the structure of the systems and consequently, their comprehension requires the identification and the representation of this particular structure. In practice, the progressive development of “dynamic” models proceeds by a first qualitative phase of formalization of the causal relations in the systems, starting from our preliminary investigation. Taking as a starting point the graphs of signals flows, Forrester proposed to describe the feedback structure by a causal diagram to make the visualization of this organizational networks easier (Forrester 1969 and

Roberts 1984). The functioning of this particular causal diagram (see in figure 2), composed of eight cybernetic loops, is as below :

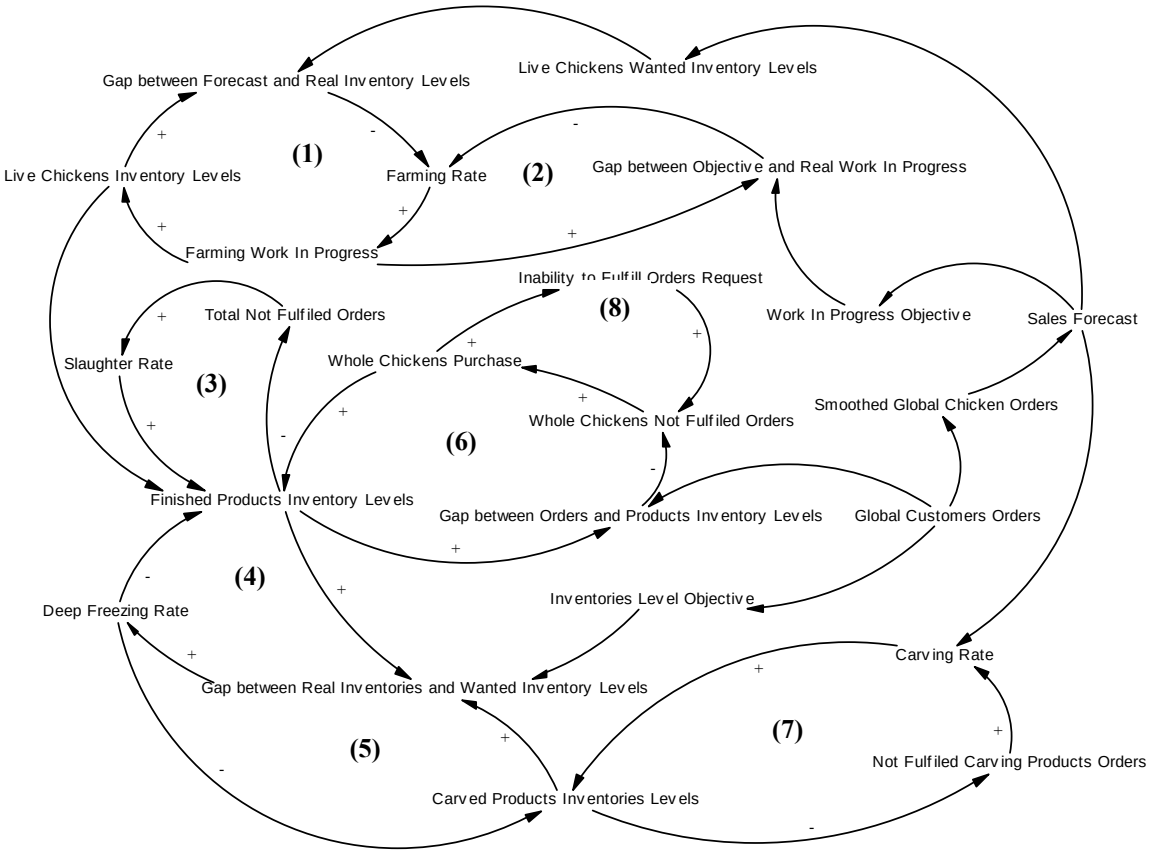


Figure 2. Causal Diagram of fresh foodstuffs production system
(model of a poultry carving enterprise)

The program of the poultry breeding is defined by an estimated planning of sales, itself based on a history of sales. One of the principal causes of imbalance comes from the difference between the real orders of finished products and the volume of chicken put in breeding fifty days before, on a basis of a dubious data. The forward program is fixed by an exponential smooth of the sales. Loops [1] and [2] allow then a long-term adjustment of the breeding work-in-progress and the number of available and desired mature poultry at the slaughtering center. The other control loops are short-term actions: the slaughtering rate, also defined by an estimation of sales, is corrected by the real orders observation [7]. The adjustment of the inventory levels of finished products (whole and carved poultry), following the stock outage or the overstocks, take shape by external purchases or deep freezing of surplus, according to the variation measured between the effective orders and the inventory levels of the products in question (loops [4], [5], [6]).

The principal fragility of the system comes owing to the fact that the main part of the variables is controlled by an estimated planning of sales. For that reason, these enterprises are not able to react in the short run towards important errors of forecast. It is to be noted that owing to the “pushed flow” system in upstream, the control in the very short term on the slaughtering rate (loop [3]) is to be avoid because of instabilities which could be result and because of a too great uncertainty on its effectiveness (Minegishi 1999).

The system is then controlled on the level of two essential points: the breeding center (breeding launching rate) and the carving center (Finished products carving rate). The corrections in the variations observed in comparison with the objective in the variables are done in the medium and long terms, which all the more justifies the choice of simulations over a very long period (several years). This progressive step of modeling leads us to continuous simulations which makes possible to visualize stabilized behaviors and to analyze characteristic phenomena of instabilities of certain real systems.

Mathematical Formalization of the Customers Orders

The behaviors of the studied system will be analyzed by adopting various approaches on the variations of the customers orders. The time series coming from the latest sales are useful to test the validity of the model compared to the known past. But the correspondence between the latest behaviors and the results of the model is not enough to only ensure the validity of the model and its future behaviors. In accordance with the recommendations of Forrester (1961) and Lyneis (1988), it is thus necessary to test new assumptions on the orders which consist of a combination of four types of entries i.e. steps, pulse, hisses and seasonal components. The variation of the orders is thus expressed by the following configurable equation:

$$Of_x = Rorders_x * MPS * [1 + Flu_x + Normal(NDh_x, SDh_x) + Step(Hs_x, STs_x) + Pulse(Hp_x, STp_x, Fp_x)] \quad (1)$$

Of_x : *Fluctuating orders of the product x (qty),*
$Rorders_x$: *Product x orders/Total orders ratio,*
MPS : *Master Production Schedule (qty),*
NDh_x : *Normal Distribution of hisses for the product x (%),*
SDh_x : *Standard deviation of hisses for the product x,*
Flu_x : *Unforeseeable orders fluctuations compared to the initial sales forecast of the product x (%),*
Hs_x : *Height of the "step" for the product x (%),*
STs_x : *Starting time of the "step" for the product x (day),*
Hp_x : *Height of the "pulse" for the product x (%),*
STp_x : *Starting time of the first "pulse" for the product x (day),*
Fp_x : *Pulse frequency for the product x (day $^{-1}$).*

In this model, the tendency of the orders is considered as following qualitatively and quantitatively that of the MPS, except for exceptional and definable variations (step, pulse and hiss).

SIMULATION RESULTS AND ANALYSIS

Some results underlining the causes of instability of type (C1) and (C3) described in the previous paragraph 2 are presented. The problems of the type (C2) of the food industry concern rather problems of sales forecasts and production scheduling which are not the subject of this research. The experimental scenarios of simulations were based on the following elements : some factors of inaccuracy have been integrated in certain data of the model which correspond to the modifications of the population food practices, therefore of the customers' demand.

The simulation phase proceeded in two successive stages: (a) firstly, the validation of the results from the view of their stability with respect to the low or high variations of the model entries, i.e. the checking of the coherence of the general behavior of the modeled

system; (b) then, a proposal for an example of case study whose results interpretation would have to take account of the information brought by the precedents stage.
After having evaluated the coherence of the model behavior (Minegishi 1999), a simple case study is presented to show an example of application. Two assumptions on the request have been chosen and correspond respectively to:

- Event 1: A modification of the diet practices (more orders of chicken legs compared to the wings during a first period, then conversely during the second period),
- Event 2: A quantitative variation of the chicken consumption following unforeseeable phenomena (for instance, brutal increase in the chicken consumption following the crisis of the insane cow).

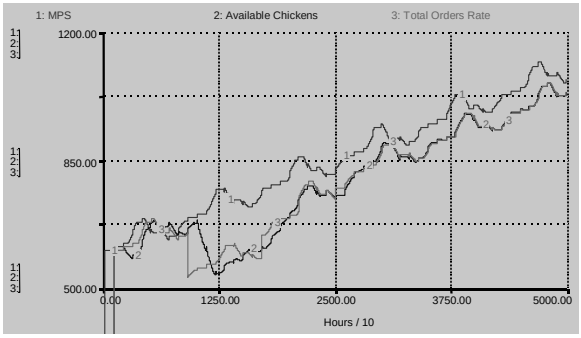


Figure 3

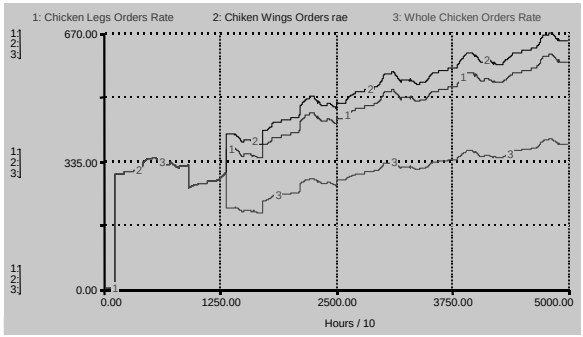
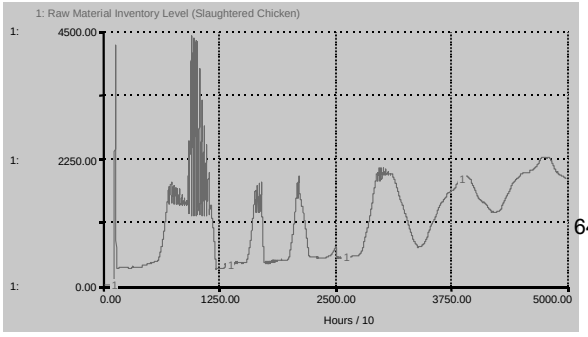


Figure 4

The figure 3 illustrates the evolution of the total orders rates, corresponding to the sum of the orders of the three types of finished products (figure 4). The dioxin intoxication event takes place at time T=10000 hours. The curve 2 in the figure 3 represents chickens coming out of the slaughtering center in pushed flows production system according to a Master Production Schedule, based on a trade forecast of more than fifty days. Following the dioxin intoxication, the company could only undergo, at the beginning, these falls of orders with an intensive deep freezing of the slaughtered surpluses (figure 6). The Master Production Schedule has been of course corrected but the effects are only visible fifty days after the beginning of the crisis. The adaptation of the production system to these new conditions is carried out only on the level of the breeding rate and is successful but very difficult owing to a very long breeding time and a configuration of the market parameters intentionally very severe (action of the positive feedback loop which slow down the system adaptation, figure 5 and 6, T= ~25000). Nevertheless a stabilization of the losses related to the whole chicken deep freezing (curve 3, figure 6) and a stabilization of the recourse to subcontracting (curve 4, figure 6 and figure 8) could be noted.

At time T = 15000 hours, on the figure 4 the second event could be observed with variations in the volumes of the orders for whole and carved chickens. This event affects the carving MPS. This latter is actually based on the maximum of the orders rates of the various carved finished products, then involving an inevitable surplus of one of the two products and thus its loss by deep freezing as it could be see on the figure 6 (curve 1). The deep freezing rule consists in comparing the real inventory levels of the various products with the desired levels corresponding to a maximum volume of one day, the latter being determined by a moving average of the daily rates of observed orders, and freezing the surpluses.



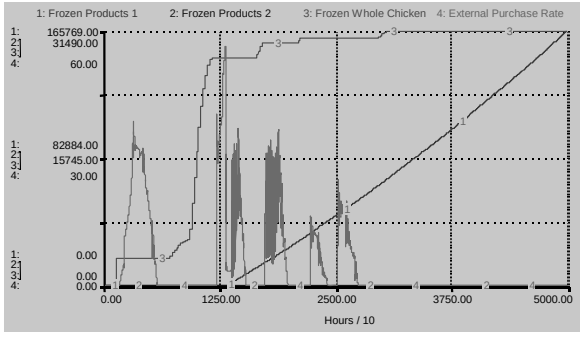


Figure 5 Figure 6

In addition, because of a brutal and not foreseeable increase of chicken legs (product1) and chicken breasts (product 2) (10% and 20% respectively) to the detriment of a fall of whole chicken orders, the system is at the beginning of the event 2 in stock outage condition because of a necessary adaptation of the carving capacity to these new conditions (curve 2 and 1, figure 7 with T = ~ 14000 hours and T = ~ 17000 hours). Indeed, the latter was initially fixed at 10% above the forecast production rate. The regulation of the carving capacity to these new orders rates require a time which causes delays in the deliveries. It is interesting to note that the adaptation is carried out over two relatively distant periods (interval of ~ 3 months) which could be explained by the play of the shifted actions of the other control loops.

Figure 7 Figure 8

Finally, it is to be noted that the quantitative variations for the event 2 in the orders of the various finished products has any consequences, neither on the Master Production Schedule nor on the stability of the whole chicken inventory level, insofar as the fall of orders of one of the products is compensated equitably by the rises of the other products. It is not the case for the quantitative variations of the event 1 since the system required more than 7 - 8 months of adaptation phase (figure 5).

Other interesting results of simulation were obtained and confirm the possibility of using this type of generic model as a decision-making aid tool for piloting these complex logistic systems (Minegishi 1999).

CONCLUSION

This work has permitted to understand and to explain the complex behavior of a particular type of food industry which is confronted with two strongly dependent situations but positioning on different horizons of decision. Firstly, at short term, the company operates by using a material flow which is pulled by the customer orders, the short delivery times (below 24 hours) and the good products quality. Secondly, on an irreducible horizon of fifty days, the company has to produce, in the downstream activities, the raw material which is necessary for the chicken carving process. This type of company is “vertically” integrated in its chain level and has therefore to manage the coherence of decisions at two scheduling levels. The generic model simulations show the phenomena of instabilities and the system controls confronted to important hazards in their customers demands. In the future works, we suggest a mixed approach which could improve our short term vision of the shop floors activities by superposing a discrete events model for the operating system and a continuous model for the control and decision model. This work will also require to be completed by thorough investigations on the logistics of the fresh foodstuffs industry.

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A STUDY ON ICT IMPLICATION IN GLOBAL SUSTAINABLE DEVELOPMENT

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The purpose of this paper is to present some connection that we have identified through our research between Information Society and global economic development. A sustainable development cannot be achieved without the implementation of a solid infrastructure and ICT it is a very interesting component. Influencing personal and organizational culture, knowledge proves itself to be one of the main resources of the modern economic system, a resource that can substantially modify economic parameters, and eventually the life at a global level.

In the modern society the importance given to information is crucial and for understanding its implication we should firs have a look on some concepts[1] :

- *Information* refers to facts, data, instructions in any form and on every media, including the meaning that people give to them using conventions in their representations.
- *Informational Process* is a succession of steps through which information is collected, analyzed and disseminated in every

[1] Hammil, T; Deckro, R; Kloeber J., "*Evaluating information assurance strategies*", Elsevier, Information management, 2004, p.4

environment and in every form in order to add value to the decision process by specific functions and providing anticipate services;

- *Information System* includes the entire infrastructure that collects, works on it, stores, presents, transmits and act upon information. Information system includes informational process too.

We can find a few approaches on information as a source of power even long time before the dawn of the management science. Confucius, consultant of the Chinese imperial court, was presenting 2500 years ago the elements of a moral order which have generated a philosophic and religious movement that has a perennial life[2]. In his systems of values Confucius draw a central axis named the sense of humanity that relies on three directions: central values, excellence values, and complementary values. Among the 18 Confucian values at least 5 can be considered dependent on information:

- ZHI – knowledge of things and people;
- HUE – intense and detailed study;
- XIU SHEN – self improvement;
- JIAOYANG – teaching, pedagogy;
- JING, MIN, REN – implication, decision, perseverance.

Another interesting approach, somehow opposite with the Confucian philosophy of balance, is the "conflict world", where we are confirmed thal competition an forms of conflict have generated a kind of development.[3] There are a lot of arguments to affirm that human society evolved under the sign of force, and power essentially depends on information use. We think that it is ethical to distinguish some examples of information use in less noble purposes, often violent ones. The history of mankind confirms that a lot of technological wonders we are using today were developed in military laboratories and first were used by secret services. There are some voices from many fields that accuse the "pseudo-freedom" of the information, meaning that in fact it conceals a big cultural manipulation.

[2] Faure, S., *Manager a l,ecole de Confucius,* Les editions d,organisation, Paris, 2003, p.79
[3] Rotariu, I., *Globalizare şi turism,* Continent, Sibiu, 2004, p.18

Because the main purpose of this paper is to present some implication of ICT in global development we will be concerned by economic, social and cultural macro trends.

The mankind knew a continuous evolution trough its existence. We can identify waves of social development, represented in the graphic below, that accentuates a causal factor.[4]

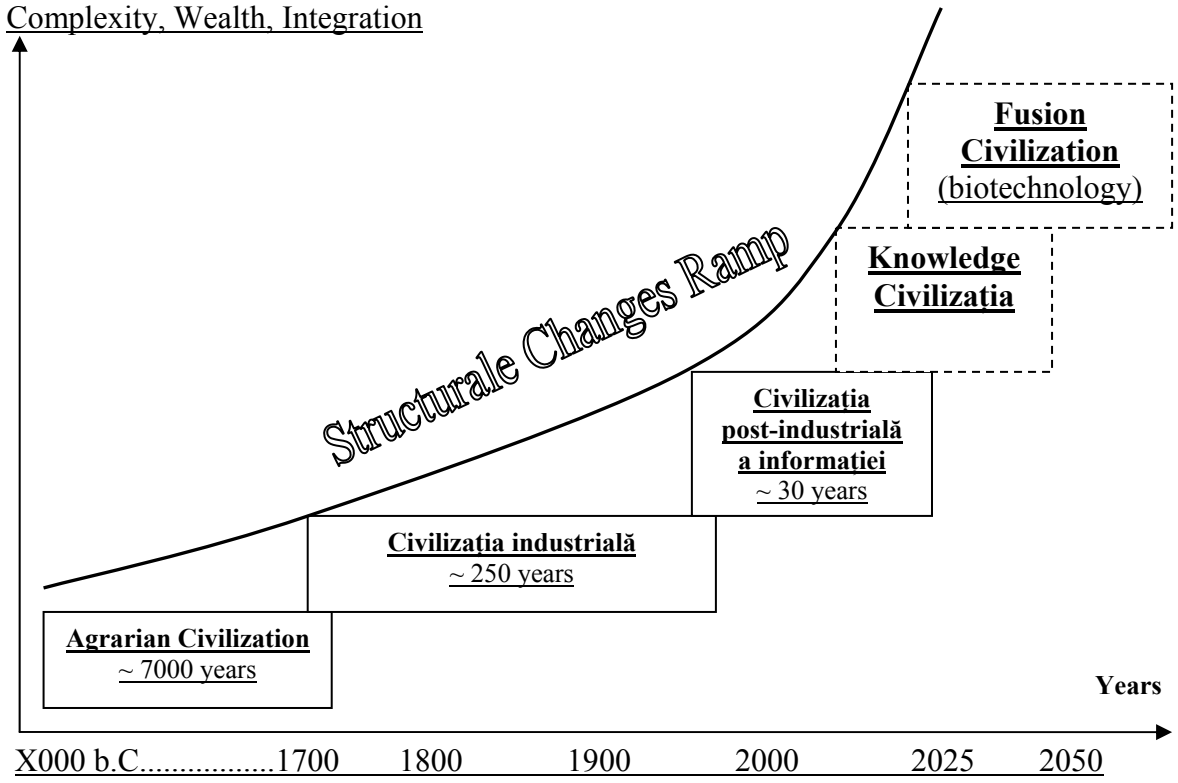

Fig. 1. Human society evolution

The development of *National Information Infrastructure(NII)* and the assurance of individual and organizational access to information by using ICT are proven to be factors that bring dynamism to economical evolution. Pook and Szabo demonstrated in their researches that there is a strong correlation between NII investments and the wealth of nations and countries.

In contemporaneous society heading to the Age of Knowledge, ICT consolidates its position as a factor that contributes to increasing productivity, to

[4] Ahlqvist, T.,"*From information society to bio-society? On societal waves, developing key technologies",* Elsevier-Technological Forecasting and Social Change, 2004, p.503

creating value trough sustainable development so that countries could provide their citizens with the much desired prosperity. One nation competitiveness depends more and more on the presence of a solid ICT sector, on the "Technology Readiness" of all national stakeholders: public administration, businesses, individuals.

The World Economic Forum[5] brings us an image of the digital world, presenting 117 countries, ranked by an aggregated indicator, similar with the NII, where level 1 means the break-point to consider the society ready to take advantage of ICT. Only 24 countries overpass that limit. (Fig. 2.)

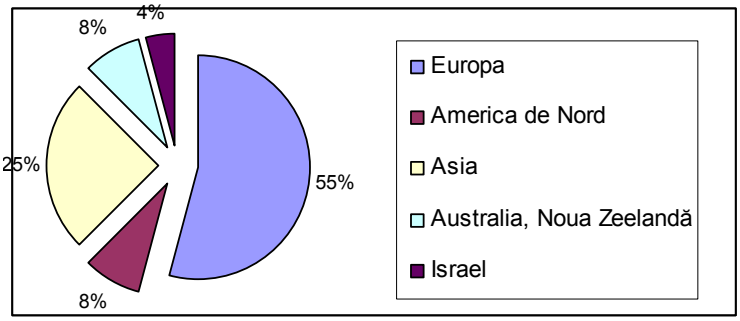

Fig. 2. Repartition of contries „ready" for Information Society

Source: *Global Technology Report* al World Economic Forum

The evaluation scale spreads within the limits of 2,02 – USA and -1,39 – Ethiopia. Romania is ranked 60th, with a grade of – 0,23, in decrease with 5 places related to 2004. The WEF top confirms a situation that researchers call "digital divide"[6] between countries. But form of this informational inequity can be found in developed countries too. In the US, 26 states invest in high-tech 14 times more than the rest of the states.

A very useful approach appeared to us to extract a top of best evolutions, dynamic countries that improved their rank significantly.

[5] ***, Technology Readiness WEF Report, http:www.weforum.org/

[6] Azari, R; Pick, J., *"Technology and society: socioeconomic influences",* Elsevier-Information management, 2004, p.25

Best ICT evolution Top 2005/2004 Table 1.

Contry	Increase *(steps)*	Position	Grade
Poland	19	55	-0,09
El Salvador	11	61	-0,24
South Korea	10	16	1,31
Bulgaria	9	66	-0,31
Taiwan	8	9	1,51
Czech Republic	8	34	0,36
Slovakia	7	43	0,19
Ukraine	6	78	-0,49
Latvia	5	53	-0,03
Mexico	5	57	-0,14
Argentina	5	73	-0,38
Romania	**-5**	**60**	**-0,23**

Source: *Global Technology Report* - World Economic Forum

These evolutions confirm the preoccupation of developing countries to invest in the NII to take benefits from ICT use, to reduce gaps between them and developed countries, some of them with a strong rate of growth.

We think that between ICT use and wealth there is another important factor – the productivity. It is considered one of the most useful indicators to measure performance in organizations, allowing researchers to make comparative studies inter and intra organizations.

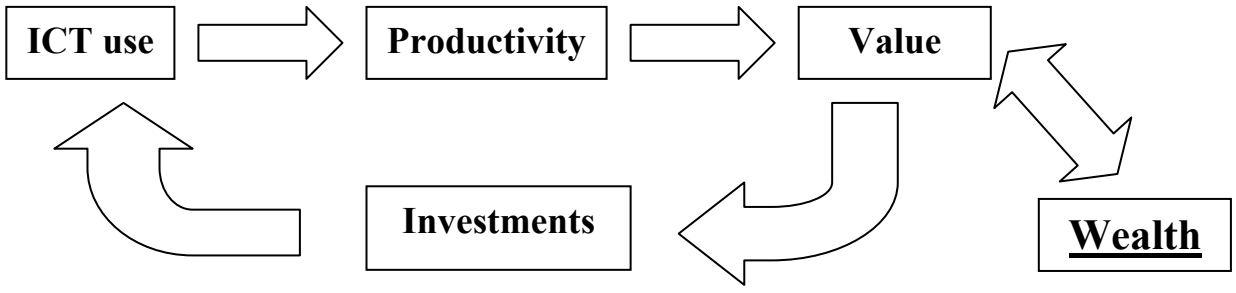

Fig. 3. The positive circle of value

In the table below we can see only some exceptions from a positive evolution of productivity and we can affirm that one of the causes of this is the adoption of ICT continued with the change of economic philosophy to value knowledge. Know-how and automation brought by ICT in organizations lead to a work environment change, conducting personnel, both managers and executants, to work better, to improve results.

Productivity index in OECD countries **Table 2.**

	1998	1999	2000	2001	2002	2003	2004	2005	trend 2006
Australia	4,0	2,8	0,6	1,7	1,6	0,9	2,1	2,0	1,8
Austria	2,8	2,2	3,0	0,2	1,5	1,0	1,5	1,8	1,8
Belgium	0,4	2,1	1,9	-0,9	1,6	1,4	2,4	1,8	1,7
Canada	1,5	3,0	2,9	0,7	1,5	0,1	1,4	2,2	2,3
Czech Rep.	-0,2	3,7	5,3	2,8	0,4	3,4	4,9	4,7	4,4
Denmark	2,8	2,1	3,1	1,7	0,9	2,1	2,9	2,6	2,4
Finland	3,1	0,5	3,5	-0,6	1,8	2,6	3,8	2,7	2,7
France	2,2	1,2	1,5	0,2	0,4	0,8	2,8	1,8	1,6
Germany	0,8	0,8	1,0	0,3	0,7	0,9	1,0	1,1	1,3
Greece	-0,9	3,8	5,2	5,2	4,0	3,4	2,5	2,4	2,5
Hungary	9,2	0,5	3,5	3,8	4,4	1,6	3,0	2,8	2,8
Island	1,3	0,4	4,1	0,6	1,2	4,6	6,8	3,4	2,1
Ireland	0,2	5,1	5,4	3,2	4,8	2,1	3,5	4,1	3,7
Italy	0,7	1,1	1,5	0,1	-1,0	-0,2	0,3	0,6	1,4
Japan	-0,8	0,6	3,2	0,8	0,9	2,9	4,0	2,0	2,1
S. Korea	-1,1	8,3	4,4	1,9	4,2	3,3	3,3	3,1	3,3
Luxemburg	2,7	3,0	3,4	-4,3	-0,8	1,0	2,1	2,1	2,0
Mexico	2,2	2,7	4,7	-0,3	-2,0	0,1	2,6	1,3	1,7
Netherlands	1,9	1,5	1,4	-0,7	0,2	-0,6	2,6	0,7	1,1
N. Zeeland	0,5	3,0	2,0	-0,1	1,9	1,3	2,5	1,3	1,9
Norwey	2,3	3,3	2,2	2,3	1,7	1,8	4,3	2,6	2,3
Poland	4,1	9,6	6,4	3,7	5,2	5,6	5,4	3,9	4,1
Portugal	2,5	2,8	1,3	-0,4	-0,2	-1,2	1,6	1,5	1,5
Slovakia	5,2	5,8	3,9	2,7	4,5	1,6	4,2	3,1	3,2
Spain	0,1	0,6	0,8	0,4	0,7	1,0	0,7	0,8	1,0
Sweden	2,4	2,4	1,2	-1,0	2,4	2,5	4,5	1,8	1,9
Switzerland	1,7	0,1	2,5	-0,7	-0,2	-0,3	1,8	1,1	0,9
UK	2,0	1,7	2,8	1,7	1,1	1,7	2,7	2,4	2,5
SUA	2,1	2,8	2,3	1,0	3,7	3,4	3,7	2,0	2,2
OECD avg.	**1,4**	**2,0**	**2,5**	**0,7**	**2,1**	**2,2**	**3,0**	**1,9**	**2,1**

Our supposition about the relationship between productivity and ICT is confirmed by another OECD study, about the gains of productivity due to ICT use.

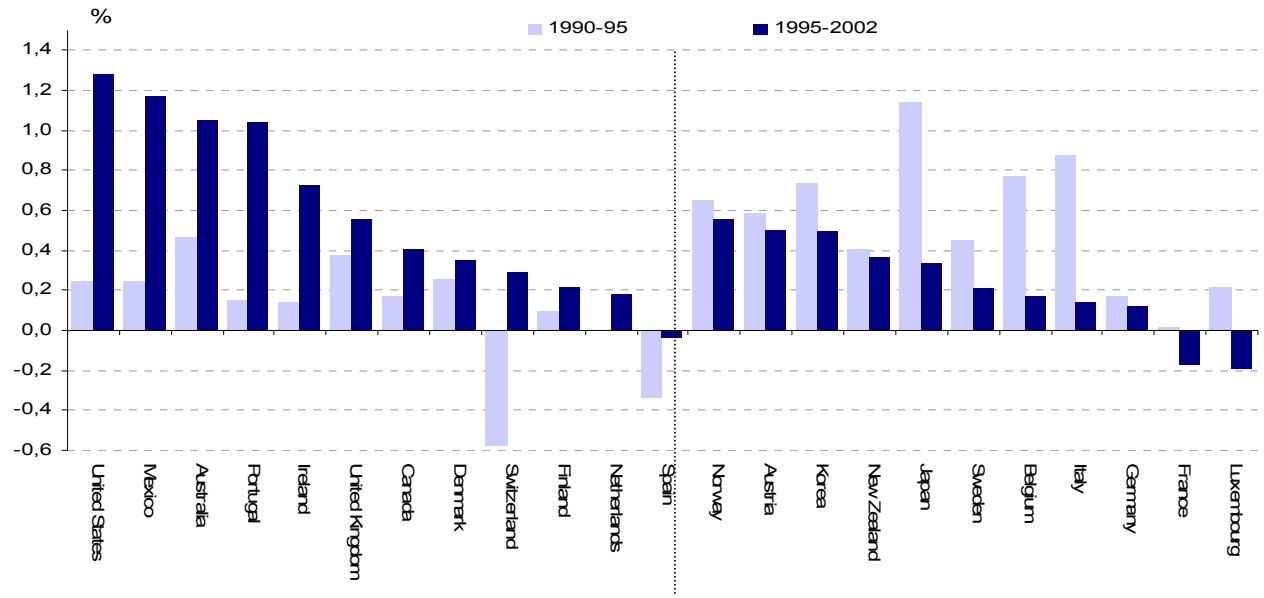

Fig.4. ICT Contribution to productivity in OECD countries

Source: OECD Fact book 2005, IT Outlook

Comparing with the table above, we can see that in many countries ICT is confirmed as a great contributor to the increase of productivity. There are very few countries whose evolution is negative or stable, most of them EU countries with a solid NII. A similar situation we can see in the next graphic regarding the impact of ICT investments to creating value worlwide.

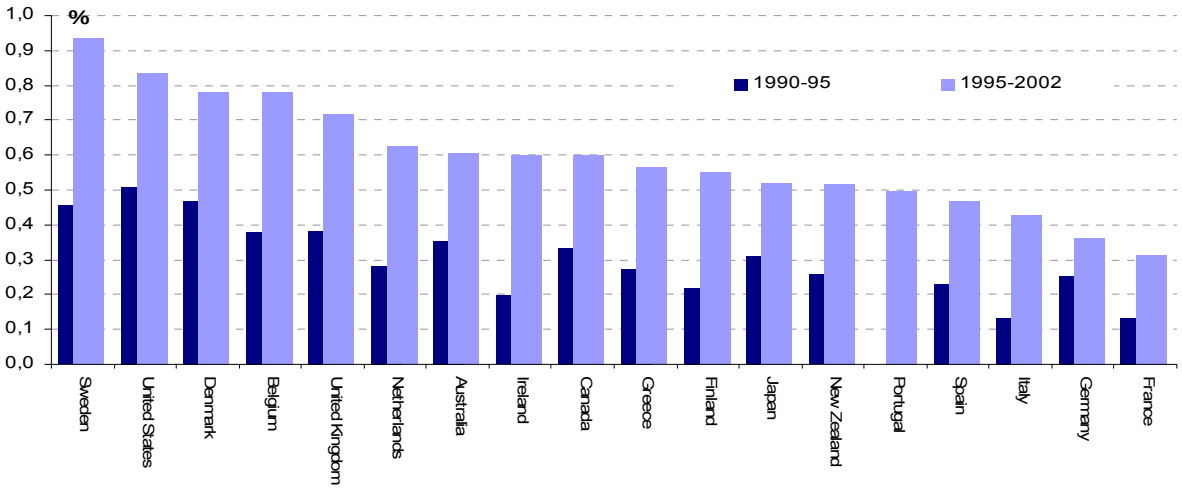

Fig. 5. Contribution of ICT investments to GDP growth in OECD countries

Source: OECD Fact book 2005, IT Outlook

OECD experts identified that the average value of this indicator has increased more than double – from 0,288 to 0,595 - in the last ten years compared to the previous period. It proposed a new top of countries, with leaders which create value for theirs inhabitants by investing intelligently in ICT solutions.

Another confirmation of ICT implications in economy is provided by the graphic of population occupied in ICT related jobs

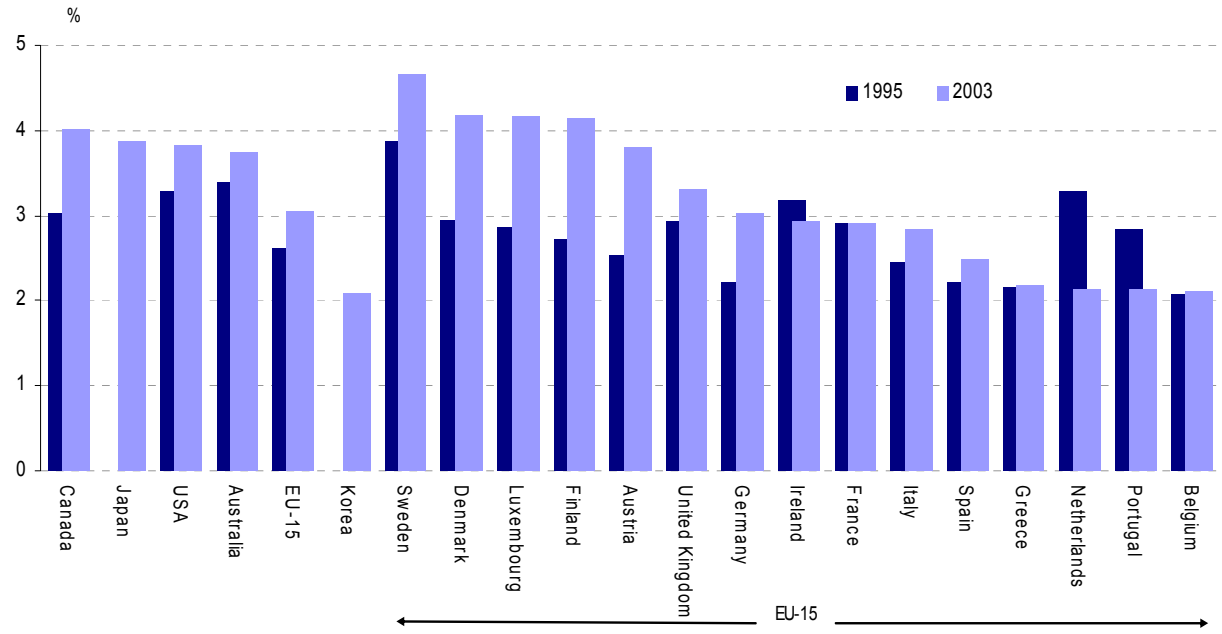

Fig. 6. ICT related jobs in labor force OECD countries

Source: OECD Fact book 2005, IT Outlook

In ten years there was an average increase of 15% among OECD countries. EU evolved slower than other countries, one of causes could be considered the development of outsourcing. But there are exceptions (North European Countries) where ICT jobs reach almost 5% from occupied population.

In these conditions it is obvious that the consequence is a solid, often spectacular development of ICT market. A very suggestive indicator, showing the quantitative trends of ICT market is the contribution of these investments to non-residential fixed capital formation.

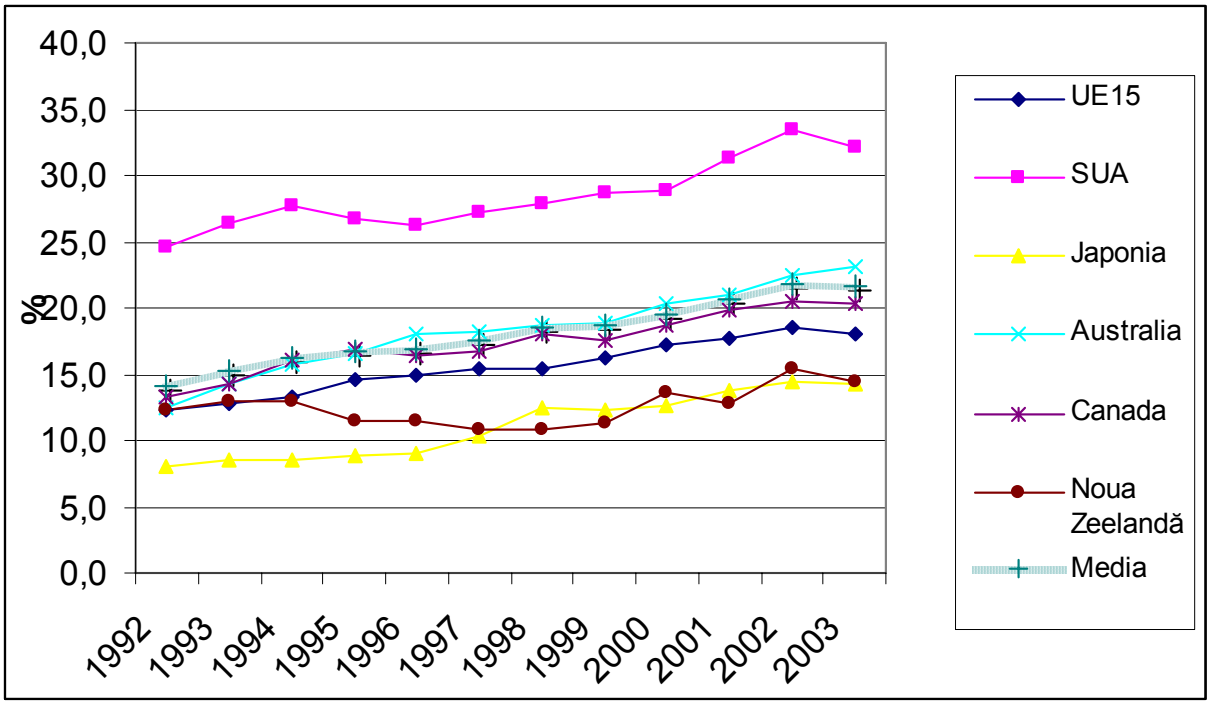

Fig. 7. Evolution of ICT investments in non-residential fixed capital formation

Source: OECD Fact book 2005, IT Outlook

If we start with the concept of investment[7] – operation of allowance of available capital to get a tangible or intangible asset in order to generate a growth of patrimony in the future – we can affirm that ICT became a priority in developed countries because of its positive effects inducted in economy and society. As we see in the graphic above, US ranking in tops that we have presented is explained by the sustained growth of ICT capital expenses. It is impressive to observe that more than 1 from 5 dollars is invested by OECD countries in products related to knowledge.

As a consequence of ICT spread worldwide, we can see a new phenomena growing: a freedom of information, a new "cyber-culture" related to ICT use, facts that promote the idea of globalization. We have tried to draw a graphic that should unite the main flows that support the globalization process.

[7] Cistelecan, L., *Management Investitional – curs universitar,* Univ."Petru Maior", Tîrgu-Mureş, 2005

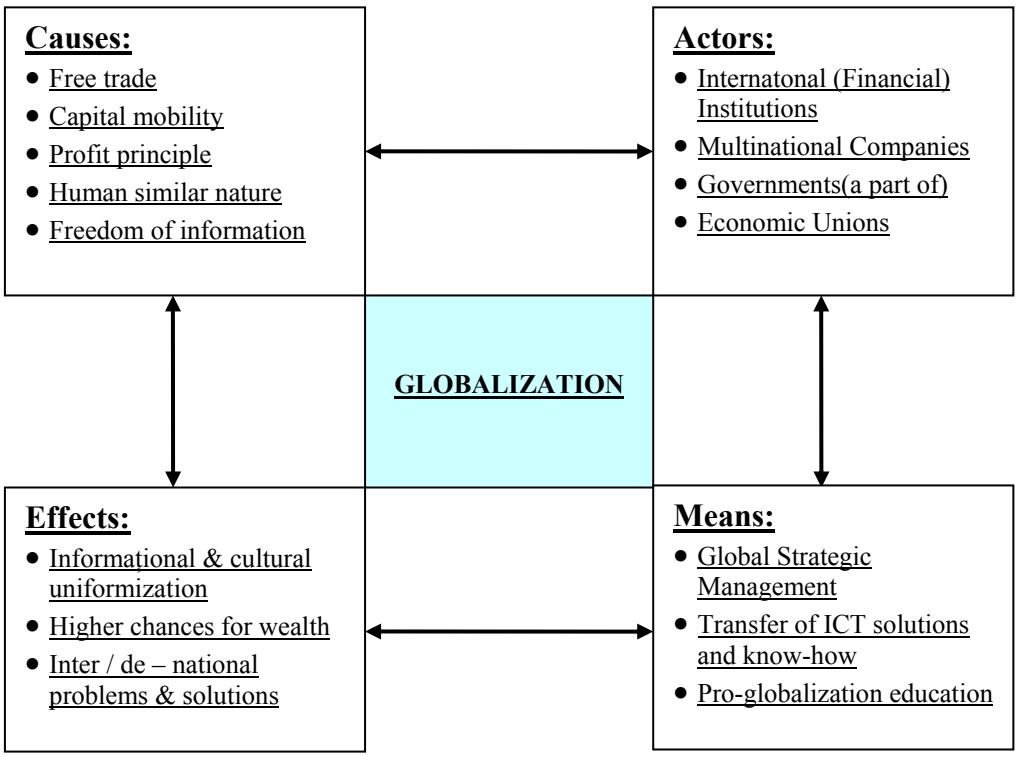

Fig.8. Globalization Flows

A very useful argument in our approach is offered by Peter Drucker in his book *Post-Capitalist Society* [8]*:* „If the personification of middle age was the feudal cavalier, and in capitalism was the bourgeoisie, the educated person will represent the post-capitalist society, and knowledge will make main resource." We are living a process of gathering of knowledge and we can state that the cultural phenomena involved way that information is collected, stored, transmitted and valorized, individually or in organizations. We are specially interested by the relationship of interdependence built between ICT, culture and globalization. It is an infrastructure meant to confer to the intelligence the capacity of fruit. The revolution of Information Society impose a "new global order of mobility" based on the triangle: computerized production dynamics, education progress and the perfection of human creative forces.

We are living the evidence of a cultural globalization, accelerated by the presence of universal human values and by the standardization of the methods to accede to them. We think that it is for the first time in history at a global level that this new form of "E-culture", in spite of its limits, transform IS freedom in axiom and

[8] Beatty, J., *Lumea în viziunea lui Peter Drucker,* Teora, Bucureşti, 1998, p.130

can be capable to contribute to the spread and to the persistence of true values, to sustain true leaders and managers able to consolidate economic systems in order to provide the inhabitants of our planet with the joy of living.

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EMERGING DECISION SUPPORT SYSTEMS FOR GEOGRAPHICAL INFORMATION SYSTEMS

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Abstract

Geographical Information Systems are widely used today
and within the next significative evolution concerning their use
for territorial management but also for economic and politics
purposes. They can be used as the basis of decision support systems where a great amount of data (geographical data but also their semantic) must be connected. For a specific problem, we must deal with the interaction of the concerned data and often some additional dynamical aspects must be considered (like in traffic management). We place our studies within the complex systems theory and we propose to review

some self-organization processes well-suited for our purpose. We propose an automata-based model which can produce adaptive solutions for decision support system. The outputs of the decision support system produces feedbacks on the GIS itself by the need of updating. The paper will show how we manage also this step into an integrated conceptual approach which finds its roots in complexity and dynamic combinatorics sciences.

Keywords: Complex systems, Decision support system, Agent-based modeling, Geographical Information Systems.

1. Introduction

The current world is nowadays deeply assisted by new technologies. Huge data bases and high performance computing allow to develop efficient tools for management. Satellites and information technology allow both to obtain accurate representation of the world and to develop world-wide communication networks. Today, everyone needs to be informed of events everywhere in the world, the information dynamical fluxes has increased in an impressive way since the last decade. New challenges are proposed about geopolitics and world-wide economy. All these news technologies and these new challenges make the geographic information systems, the supports of the major decision support systems for the future world, but we need to be able to manage them relatively to the complexity of the current world.

2. A Multi-Scale Modeling for Decision Making and Updating within GIS

Our purpose is to use GIS to build efficient decision support systems as we will explain in the following. These decision support systems (DSS) have the goal to give some new development for urban area for exemple, for road networks or for economic or industrial areas. In this way, the DSS which we project to implement over GIS will contribute to update the real world by all the realization of the development proposed by this DSS. From this reality updating, we will have to update in return the GIS which are supposed to represent this reality. And by the

updating with the reality, the forecoming DSS to implement will have to change. This feedback processus have to manage 2 time scales. The first is described inside the simulation and the DSS and is able to represent the evolving real world. The second scale concerns the reality updating and GIS updating for which the time step if many times greater that the previous time.

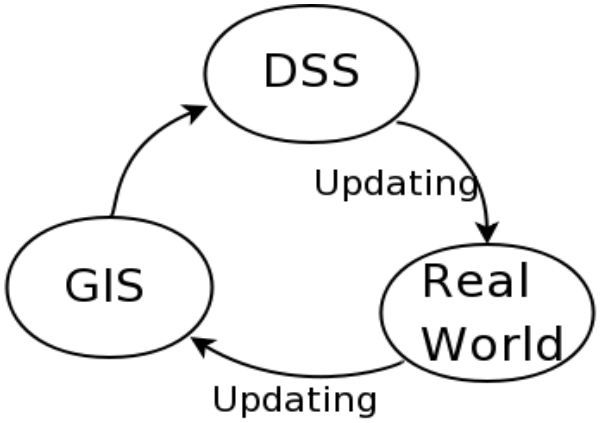

Figure 1: Decision support system and updating

3. A Conceptual Evolution of GIS Within Complexity

Our purpose is to locate with accuracy the complexity concerning GIS. A general formalism to describe a GIS is proposed in [6] and is based on a feature-based approach, where features are the fundamental concepts for the representation of geographical phenomena.

A Geographical Information System (GIS) is a computer-based tool using a Geographic Data Base (GDB) with applicative operators which allow getting, stocking, verifying, manipulating, analyzing and representing the spatial data of the GDB. The formalism considered to represent the GIS is composed of a quadruplet

$$(V, D, R, C)$$

where

- V is the set of classes used in the GDB. Each class gathers features which have

common characteristics;

- D is the definition domain of the variables of V. It is the set of the objects of one GDB instance;
- R is the set of the relations that connect the elements of the GDB, corresponding to a connection graph. In [kad05], three kinds of relations are proposed, *compositions* relations, *dependence* relations and *topological* relations;
- C is the set of constraints defined between the variables of V and/or between values of V. In [6], two kinds of constraints are proposed, *structural* constraints and *non structural* constraints.

This quadruplet corresponds to the GDB modelisation to prepare it to be used with different kinds of applications which can use the support of the connection graph to build some kinds of interactive networks generated by these applications.

All these structured information which define a GIS introduce a great number of static dependence but each layer can be generally understood alone or some parts of each layer can be isolated to better understand the dependence between involved objects. Generally the applicative operators can be computed on each of these parts. In that way, we can consider classical GIS as complicated systems in the terminology proposed by Le Moigne [11]. We can consider that the Geographical Data Base in association with the previous applicative operators which constitute the GIS, is a closed system.

Today, the complexity of the world needs to use or to add additional functionalities on GIS. Geographical information deals also with human-landscape interactions. The simulation of social aspects and of ecological processes seems to be more and more linked to the better understanding of the geographical data and its evolution inside its all social, geopolitical and ecological environment. To integrate these new aspects,

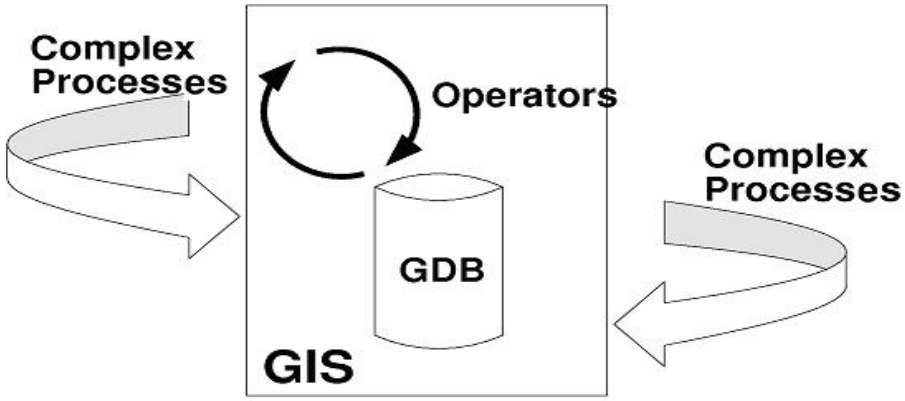

Figure 2: GIS under complex porcesses is an open system

we have to manage some complex processes like some energetic fluxes that cross the standard GIS (see figure 2).

These complex fluxes transform the standard GIS in an open system, which confer to some properties linked to complexity. Self-organization and multi-scale organizations can emerge from these complex processes. The expected evolutions of GIS can be considered as the transition which will transform the standard GIS into complex GIS.

4. Emergent Computation for GIS

In this section, we discuss about emergent computations which can be of interest for GIS.

4.1 Schelling's segregation model

Thomas Schelling contributed to enhance the understanding of conflict and cooperation about social institutions. He proposes a simple model of spatial segregation which can lead to self-organized phenomena. This model illustrates how spatial organizations can emerge from local rules, concerning the spatial distribution of people which belong to different classes. In this model, people can move depending on their own satisfaction to have neighbours of their own class. Based on this model, a city can be highly segregated even if people have only a mild preference for living among people similar to them.

In this model, each person is an agent placed on a 2D grid (in his original

presentation, a chessboard was used by Thomas Schelling). Each case can be considered like a house where the agent lives. Each agent cares about the class of his immediate neighbours who are the occupants of the abutting squares of the chessboard. Each agent has a maximum of eight possible neighbour, the exact number depending on the agent's position on the chessboard (straight edge, corner, or interior). Each agent has a "happiness rule" determining whether he is happy or not at his current house location. If unhappy, he either seeks an open square where his happiness rule can be satisfied or he exits the city .

- An agent with only one neighbour will try to move if the neighbour is of a different class than his own;
- An agent with two neighbours will try to move unless at least one neighbour is of the same class as his own;
- An agent with from three to five neighbours will try to move unless two neighbours are of the same class as his own;
- An agent with from six to eight neighbours will try to move unless at least three neighbours are of the same class as his own.

The exact degree of segregation that emerges in the city depends strongly on the specification of the agents' happiness rules. It is noticeable that, under some rule specifications, Schelling's city can transit from a highly integrated state to a highly segregated state in response to a small local disturbance. We can observe some bifurcation phenomena which lead to chain reactions of displacements.

4.2 Ant-based systems

Another method for self-organized system computation is based on a bio-inspired method from social insects colony and especially ants. The basic ant system algorithm describe and explain how it can be used to transport optimization, and especially for the traveler salesman problem.

P. Grassé proposes the concept of stigmergy when he studies the termites building activity (pillars, arks for nest building for example). It is the result of a sequence of stimuli-reply process. The insects perceive a previous state of a building. This perception makes them contribute to this building and so by this way, they will stimulate themselves other insects.

The ant foraging is a nice example of natural self-organization based on stigmergy. J.-L. Deneubourg has built a practical experiment to study this phenomenon. In this experiment, some artificial multi-paths bridges join a ant nest to a food source. The ants go out their nest and they find the optimal way from nest to food source in a collective way by the usage of pheromones. As soon as some ant finds some food, it comes back through the same path to its nest and deposits some pheromone on the path to incite other ants to discover this winner path.

5. A model for Cooperative-Competition Economic Management of Services over Urban GIS

Our purpose is to explain in this section, how we can use agent-based programming to simulate complex systems and how genetic automata-based description can give powerful operators for complexity.

5.1 Multi-scale description of complex systems modeling

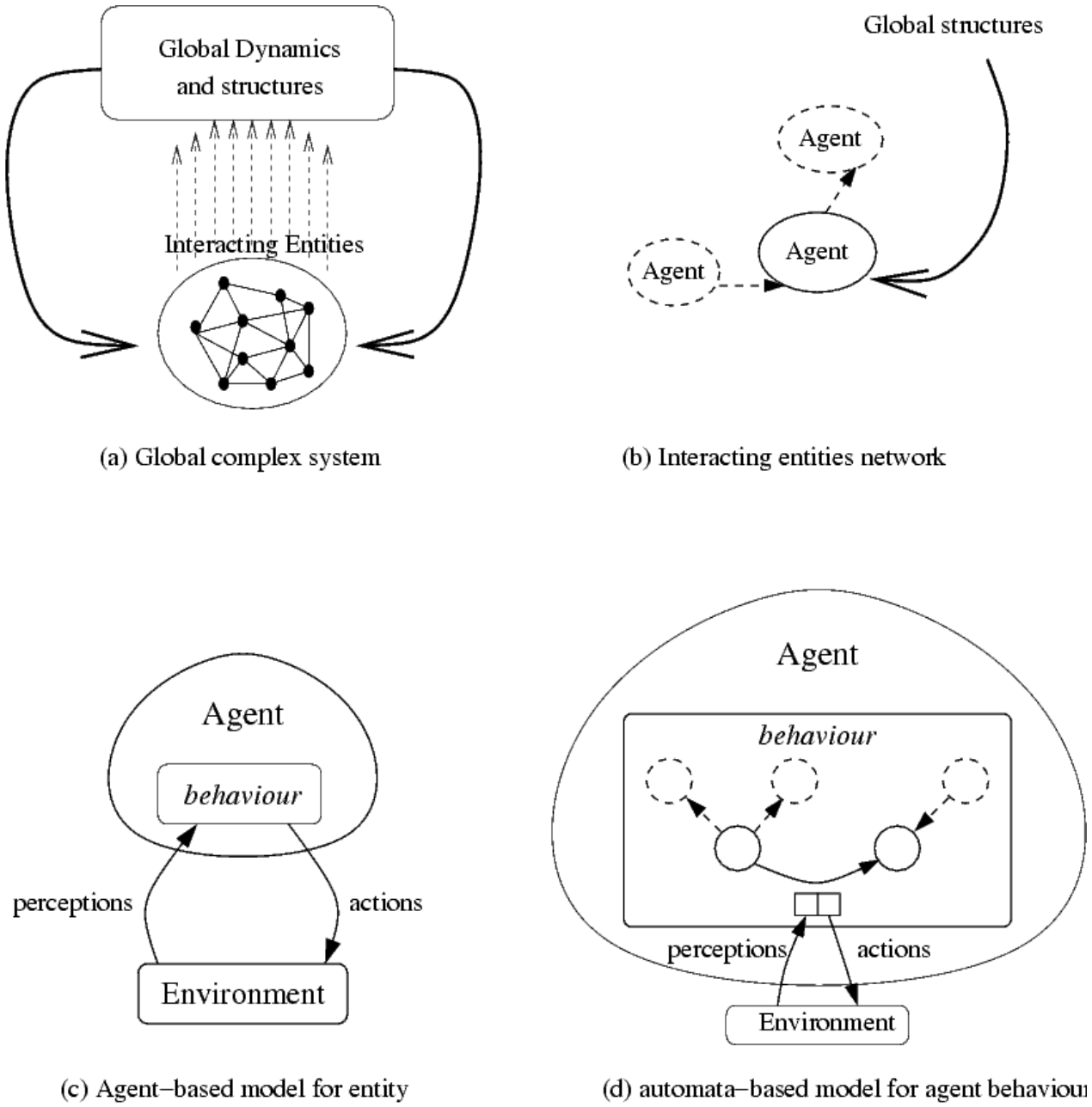

Figure 3: Multi-scale description of complex system

Complex systems are usually presented as some systems of interacting entities which can be represented as a kind of networks, as we see in part (a) of Figure 3. From these interacting entities, some emergent processes happen and will consist in constituting some kind of organisations. These organisations act on their constitutive entities by the way that they are able to structure the interacting network. This kind of phenomenon is usually called feed-back process and has been initially introduced in the domain of Cybernetics. Emergent process and feed-back of the system over its entities are respectively schematised using dotted line arrows and large around arrows in the part (a) of Figure 3.

To represent such conceptual functioning, we can use agent-based programming which allows, as we will see, to represent interactions between entities as communication processes (see part (b) of Figure 3 which zoom up a part of the interaction network, where on each node representing an entity, we place an agent). In this figure, we can see now the edge of the graph as some kind of interaction and especially communications.

In part (c) of Figure 3, we represent a situation quite similar to the part (b) but with another point of view. In this new vision, we choose to centre the description relatively to the main agent of part (b). In part (c), the description is made from the vision of the agent. To better understanding, we will now develop the next paragraph which will explain what the agent is.

5.2 Automata-based computation

On part (d) of figure 3, we have made a zoom on the considered agent behavior. We propose in this figure, to use a model based on states and on transitions systems which may or not allow for the states changes corresponding to some behavior rules. This description, states and transitions, will lead us to represent the agent behavior with a finite state automata. More precisely, we propose to use an efficient data structure called automata with multiplicities [8,9] where each transition is labeled with a couple of values. The first value is from an entry alphabet whose elements correspond to agent perception. The second value is from a set of outputs, the set is a semiring. This algebraic structure allows to represent the agent behavior using matrix formulation. Semiring are efficient structures allowing to define powerful operators . In [7], we have proposed to defined genetic operators over these automata, allowing to describe some adaptive behaviors.

5.3 Common Equipment Allocation Based on Ant-System

As originally described in [4], ant systems can be extended by colored ant systems and be used to automatically compute an emergent distribution of dynamic

communication graph nodes insides clusters of same colored nodes. In the same cluster, we try to aggregate graph nodes which communicate a lot and put them in the same cluster means to allocate these nodes in the same machine associated to the color. With the hypothesis that the communication cost inside the same machine is low comparatively to the communication cost between different machines, the goal of the clustering is to reduce the whole communication cost.

The principle is to manage ant casts which are identified by their associated color. An ant of color c will drop pheromone of color c and will be attracted by the pheromone of color c and repulse by the pheromone of all the other colors different from c.

In practical applications [4], we can represent the clustering obtained after some iteration over graphs evolving dynamically (edges and nodes can appear or disappear at each moment).

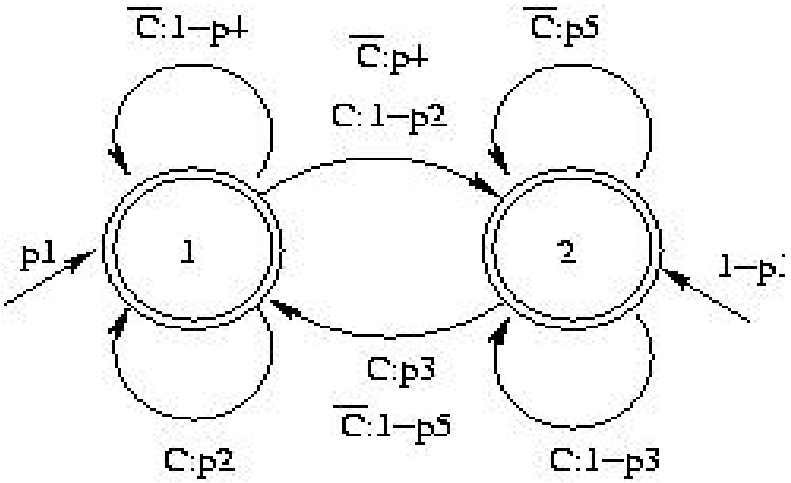

Figure 4: two-states adaptive strategy based on probabilistic genetic automaton

So we propose a direct application of this algorithm to services repartition over a graph which can be a simplified representation of spatially connected elements inside a GIS. In this way, we can compute self-organizations for many kinds of services, like school area repartition, domestic hydraulic distribution, telecom and computer networks equipment placement over urban GIS

5.4 Multi-Participant Strategies for common equipment Allocation

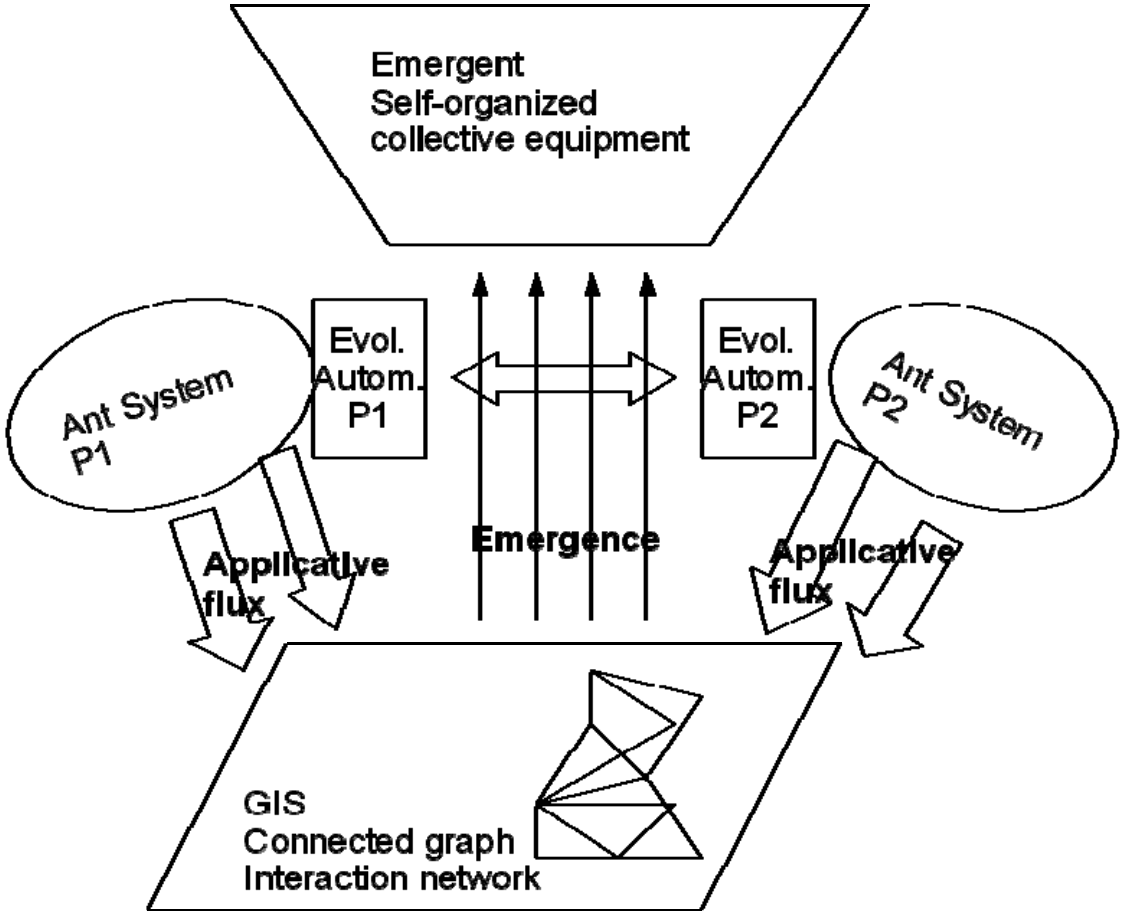

Figure 5: coupling negociative evolutive strategies with emergent computation of common equipment distribution

Our purpose is now to study how many societies must share the development of these common equipments. Do they have to cooperate or compete to find the most efficient way to work? We propose a model based on the prisoner dilemma [1]. This model come from game theory and can be used in spatial computation. We can generate adaptive strategies to use by each participant trying to obtain the maximum of profit. The figure 4 is a example of two-states adapative strategy based on probabilistic genetic automaton.

5.5 A Global Decison Support System by Complex Coupling of Effective Models

In the figure 5, we present a schematic view of the whole process which must link evolutive strategies to each emergent computation managed by each company for the common equipment distribution. The adaptive strategies will act on the complex system. So the complexity of the system is the result of the action of these adaptive

strategies on the whole decision making. The resolution based on the ant system is perturbed by these adaptive strategies which act on it like energetic fluxes. New reorganizations and completely different solutions can appear because of these energetic fluxes. This whole system is the basis of a global environment decision support system.

6. Conclusion

This paper presents the benefit of complex system modeling for geographic information systems. The availability of a great huge of data and the accurate representation of them through computer systems, which allow to manipulate them in efficient way, allow the geographers to develop innovative studies about spatial-temporal phenomena. The connection between GIS and agent-based modeling to manage complex systems allows today to modelize and simulate emergent organizations over interacting components. Multi-scale modelization become available and non linearity can be managed within dynamical systems implementation. The paper aims to applied a general process of complex system modeling for computing emergent decision support system. With respect to complex system modeling, we explain how we can make interact in non-linear coupling two models based on ant systems for urban services distribution and genetic automata for cooperation-competition modeling. These two models interact themselves and on the GIS which is their context of applications. They also interact in non-linear way with the self-organization computation which results of the whole processes.

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THE INTELLIGENCE OF THE EXPERT SYSTEM AGENTS

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Abstract. *Expert systems are used for many difficult problems solving. In this paper, we propose the endowment of the expert systems with agents' capabilities. We call these agents expert system agents. The expert system agents can solve more flexibly and precisely problems than the expert systems. The proposed expert system agents can be used in medical diagnoses. We will present applications of the expert system agents in illnesses diagnosis. At the end of the paper, we will analyze the intelligence of the expert system agents.*

Keywords: *knowledge-based agent, intelligent agent, complex system, cooperative problem solving, agent, multiagent system, expert system, agent architecture, expert system agent*

1. Introduction

The *agents* represent systems with proprieties like [3, 16]: increased autonomy in operation, communication and cooperation capability with other agents and learning capability. The systems composed from more agents are called *multiagent systems* [8, 13]. The informations and data detained by an agent, used in the problems solving, represented using a knowledge representation language, are called *knowledge*. The knowledge of an agent can be retained in one or more *knowledge bases*. The agents that use knowledge bases in the problems solving are called *knowledge-based agents* [16, 8]. The knowledge-based agents can use large quantities of knowledge in their operation [8]. The knowledge based agents can be endowed with capability to help

the humans and other agents in the problems solving. These agents are called *assistant agents* [14, 11].

Expert systems are used in many domains for problems solving [2, 8]. As an example of domain, in which are used expert systems, we mention the medicine. *MYCIN* represents one of the first expert systems used in medical diagnosis [2]. At the creation, an expert system is endowed with an initial set of knowledge. The expert system can learn during its life cycle new knowledge. A human called knowledge engineer is responsible for the endowment of the expert system with the knowledge necessary in the problems solving. The expert system retains the knowledge in the transmitted form by the knowledge engineer. This learning technique is called *rote learning* [1].

2. Expert System Agents

The expert systems as opposite to the agents do not interact directly with the environment. They do not sense the environment with sensors and cannot execute actions in the environment. The exert systems cannot learn autonomously from experience. An expert system cannot solve cooperatively problems with other artificial systems or humans. An expert system cannot share its knowledge with other systems in order to improve the problems solving.

An important research direction represents the endowment of the expert systems with cooperation capability [8]. A system called *FELINE* composed from more expert systems endowed with cooperation capability is described in the paper [17]. The expert systems cooperate in order to identify different illnesses at cats.

We propose the endowment of the expert systems with agents' capabilities. We call these agents *expert system agents* [8, 11, 12, 4, 5, 9].

$$expert\ system\ agent\ =\ expert\ system\ +\ agents'\ capabilities.$$

The expert system agents are knowledge-based agents. The expert system agents can solve more flexibly and precisely problems than the traditional expert systems [8,

11]. The expert system agents can perceive and interact with the environment. They can communicate with other agents and humans that allow the cooperative problems solving. They can learn and execute different actions in the environment autonomously. At the creation, an expert system agent is endowed with an initial set of knowledge. The agent can improve its knowledge in order to eliminate the erroneous and imprecise knowledge. He can learn new knowledge during its life cycle. Figure 1 illustrates the proposed expert system agent architecture. An *agent architecture* is essentially a map of the internals of an agent, its data structures, the operations that may be performed on these data structures, and the control flow between these data structures [16].

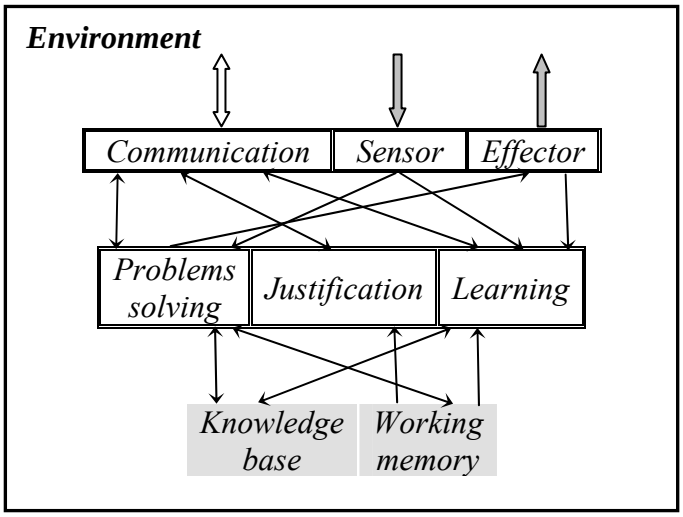

Fig.1. *An expert system agent architecture*

In the following, we analyze the notations used in Figure 1. The environment where can operate an expert system agent may have different computational and physical components. In the same environment may operate humans and other agents.

Sensor represents the agent sensor (sensors). The sensor perceives the state of the environment. An expert system agent may have physical and software sensors. A software sensor may perceive informations about the computational components of the environment. As examples of informations that can be perceived by a software sensor we mention: data about the network where operate the agent (topology,

bandwidth, latency), resources that can be used in the problems solving, a software agent's operation (what it does in the environment) etc. A physical sensor may receive informations about the physical part of the environment. As examples of informations that can be perceived by a physical sensor, we mention a robot operation in the physical part of the environment (what it does in the environment).

The *effector* (effectors) can execute different actions in the environment. An expert system agent may have physical (execute actions in the physical part of the environment) and software effectors (execute actions in the computational part of the environment). As an example of action that can be executed by a software effector, we mention the movement of the agent in the network. The agent migrates from a computational system to another. This may be necessary if the agent doesn't have enough resources at the current computational system. As an example of action that can be executed by a physical effector, we mention, the movement of a physical object.

Communication represents the component capable of communication with other agents and humans. *Problem solving* represents the component responsible for the problems solving. The *problem solving* component solves the problems like the expert systems. The problem solving component may have implemented capabilities like, the cooperation with other agents in the problems solving. *Working memory* represents the memory where are retained different informations and data obtained during the problems solving. *Knowledge base* contains different knowledge used by the agent during its operation. *Justification* is responsible for the elaborations of the different explications during the agent operation. As examples of explications that can be elaborated by the agent during a problem solving cycle, we mention: the motivation of an obtained result, the motivation of an asked question and the motivation of the obtained problem solution. *Learning* is responsible for the learning. At a learning process in the agent's knowledge base can be added, retracted or modified knowledge. Knowledge contained in the agent's knowledge base are used by components of the agent like: *problem solving*, *justification*, *communication* and *learning*.

The components of the agent must be implemented depending on the *role* (purpose) of the agent. The notion the role of an agent is defined in [3, 13]. As an example of role, we mention the *slave role*. An agent with a slave role must solve problems transmitted by agents with *master role*. The arrows used in Figure 1 illustrate the interactions between the components, the informations and data flow between the components, knowledge bases and working memory. For example, the arrows to the learning component illustrate that the learning component can learn from informations communicated by other agents and humans. The learning component may also learn by observing informations transmitted by the sensors and the consequences of the executed actions by the effectors. The observation of the consequences of the executed actions is necessary for an intelligent agent [8]. During a learning process the learning component may transmit informations to other agents. For example, may require informations that must retain.

3. The Expert System Agents Operation

An expert system agent is endowed with a set $S = \{S_1, S_2,\ldots, S_q\}$ of specializations that allows to fulfill its role. The specializations of the agent are detained in its knowledge base.

In the following, we consider specializations implemented as sets of rules of the following form:

$$<No_i, Pr_i> \quad P_1, P_2,..., P_n \Rightarrow A_1, A_2,\ldots, A_m.$$

The precondition of the rule is composed from a set of elementary preconditions P_1, P_2,..., P_n. The postcondition of the rule is composed from a set of elementary postconditions A_1, A_2,…, A_m. Pr_i represents the priority of the rule. No_i represents the rule number.

P_1, P_2,..., P_n may contain knowledge that are:

- transmitted by the sensor;
- communicated by humans or other agents;

– contained in the working memory.

$A_1, A_2, \ldots, A_m$ may contain knowledge like:

– actions that must be executed by the agent;
– informations and data that must be written onto the working memory;
– informations and data that must be communicated to humans or other agents;
– informations and data that may represents the preconditions of other rules.

The algorithm *Problem Solving* describes briefly an overtaken problem *P* solving by the agent *AG* using knowledge retained as rules described before.

Algorithm - Problem Solving

$SELECTED = \varnothing$

Step 1

AG overtakes the problem *P*.

$P = <type, description>$.

Step 2

Based on the informations known about the problem *AG* establishes the specialization S_z necessary for the problem solving.

Step 3

While (are unchecked rules in S_z) *Do*

Begin

AG selects the next unchecked rule R_k.

$R_k = <No_k, Pr_k> P_1, P_2, \ldots, P_n \Rightarrow A_1, A_2, \ldots, A_m$.

If (R_k preconditions are satisfied)

Then

$SELECTED = SELECTED \cup \{R_k\}$.

End

Step 4

From the set *SELECTED* chose the rule R_i with the highest priority.

$R_i = <No_i, Pr_i> P_1, P_2,..., P_q \Rightarrow A_1, A_2,..., A_w$.

AG execute the actions $A_1, A_2,..., A_w$ specified in the postcondition of the rule R_i.

End.

Transmitted problems for solving may consist in informations and data: transmitted by the sensor, communicated by humans or other agents, contained in the working memory. Corresponding to the type *type* of the problem *P* the agent *AG* will select the necessary problem solving specialization S_z. *AG* solves *P* using the specialization S_z represented as a sets of rules. In order to solve the problem *P*, *AG* will select all the rules which elementary preconditions are verified. From the selected rules is choused the rule with the highest priority. The actions specified in the selected rule postcondition are executed. If a rule is selected, the rule postcondition will specify what must be down in the following. For example, a selected rule precondition may consist in a message content transmitted by a human. The selected rule postcondition specify the response that must be transmitted to the message sender human. A rule postcondition may specify preconditions of other rules. In such situations, more rules establishes all the actions that can be executed in order to solve the overtaken problem.

4. Expert System Agents used for Difficult Problems Solving

In the following, we present applications of the expert system agents in medicine. The expert system agents can be endowed with medical diagnosis capability in different medical domains [11, 12, 4, 5, 6]. For example, an expert system agent may have specializations in subdomains of: dermatology, cardiology and general medicine. The expert system agents specialized in medicine, can diagnosis in some

situations more precisely illnesses than the expert systems specialized in medicine [11, 12, 5].

The expert system agents may help the doctors in the diagnostics elaboration [9, 4]. As an example, we mention the situation when an expert system agent and a doctor solve the same diagnosis problem. The obtained solutions are compared. The same solution obtained by the agent and the doctor increases the certitude in the correctitude of the obtained solution.

In the papers [10, 4, 11] a cooperative heterogeneous medical diagnosis system is described. The diagnosis system is composed from doctors and expert system agents with medical specializations. The cooperative illnesses diagnosis by the diagnosis system is partially based on the blackboard-based problem solving [16]. The expert system agents solve cooperatively the problems with the doctors. The diagnosis system is proposed for difficult diagnostics elaborations. As examples of difficult medical cases, we mention the combinations of illnesses (patients that suffer from combinations of illnesses).

In the papers [5, 6, 12] a distributed medical diagnosis system is proposed. Some of the members of the diagnosis system are expert system agents. The problems solving specializations are distributed between the members of the diagnosis system. The members of the diagnosis system can solve cooperatively a large variety of diagnosis problems. Agents may help each other during the problems solving processes by transmitting different useful informations. Transmitted informations may help an agent in the decisions elaboration, like the precise establishment of a diagnostic and the establishment of the best-fitted agent capable to solve a problem.

In the papers [7, 9] a large-scale heterogeneous diagnosis system is proposed. The diagnosis system is composed from doctors, expert system agents and a novel class of mobile agents with medical specializations. The agents' members of the diagnosis system solve cooperatively the overtaken diagnosis problems. At a problem solving, may contribute more members of the diagnosis system. The proposed diagnosis system may have a large number of members. In the diagnosis system, can be

introduced new expert system agents, the inefficient expert system agents can be eliminated.

5. The Expert System Agents' Intelligence

In this paper, we have described a novel class of agents called expert system agents. The expert system agents are more flexible and robust in operation than the traditional expert systems [11, 12]. They can solve precisely difficult problems [5, 9]. We have described applications of the expert system agents in medicine. The presented applications show that the expert system agents can be successfully used in illnesses diagnosis.

The intelligence of the agents cannot be defined uniquely. In the literature exist many definitions of the agents' intelligence [16, 3, 8, 1, 13, 15]. An expert system agent may have capabilities that can be considered components of an intelligent behaviour. As examples, we mention the adaptability and the cooperation capability with humans and other agents. An expert system agent may adapt its behaviour in order to solve more efficiently problems or to solve new problems. The adaptation of an expert system agent can be realized by learning [8, 9]. The cooperative agents' intelligence can be considered at the level of multiagent system where they operate. If the agents cooperate, they can solve intelligently difficult problems [3, 8, 13, 15, 11, 14].

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The Allocation Model in Distributed Database Design

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The fragment allocation design is an essential issue that improves the performance of the applications processing in the Distributed Database systems (DDBs). The database queries access the applications on the distributed database sites and should be performed effectively. Therefore, the fragments that accessed by queries are needed to be allocated to the DDBs sites so as to reduce the communication cost during the applications execution and handle their operational processing.

1. Introduction

Fragment allocation in a distributed database represents a major problem, taking in consideration the per formance of the distributed database. The undertaken experiments verified that the cost formulas reflect the communication cost in a realistic manner.

Optimal distribution of databases implies the following intertwined aspects:

- The way in which the global relationship can be fragmented;
- The number of copies of a fragment that can be replicated;
- The number of fragments that can be allocated to the sites of the communication networks;
- What is the information required in order for the fragmentation and the allocation to take place.

These issues make the distribution of the database more complex. Even though each issue can be considered as a whole, it is related with the others. To simplify the general problem, we will take in consideration only the fragment allocation issue, assuming that the global relationships have already been fragmented. This problem is determined by the number of each fragment and the finding of an optimal allocation of all the fragments, including the replicated ones.

The definition and the allocation of fragments must depend on what the database will be used for. This implies the analysis of the applications. Generally, not all the applications can be analyzed.

It is necessary for the design to use both quantity information and quality information. The quantity data will be used for allocation, while the quality data will be used for fragmentation. Quantity information includes:

- The frequency at which an application is used;
- The site where the application is run from;
- Criteria for the transaction and application performance.

Quality information includes the transactions run by the application (including relationships, attributes and tuples accessed), access types (read or write), and predicates of the read operations.

The definition and allocation of fragments aims to fulfill the following objectives:

1. Local availability of a reference – where possible, it is advisable that the data is stored in the proximity of the site which will use them. If a fragment is used by multiple sites, storing a copy of it at each site might be an advantage;
2. High reliability and availability – these parameters are improved by replication, that is when a site crashes, other copies of a fragment might be available at other sites;
3. Load and cost balancing – availability and storage cost has to be taken in consideration, to permit cheaper storage where possible. Local availability must also be considered;
4. Minimal communication costs – it is necessary to look after the costs of distant requests.

There are several methods that can be used for the allocation process:

- Centralized strategy – consists of one database and one DBMS, both hosted at one site, with users distributed along a network (distributed processing)
- Partitioned strategy – the database is partitioned into different fragments, each fragment being hosted by a site
- Full replication strategy – a complete copy of the database is hosted on every site
- Selective replication strategy – represents a combination of partitioning, replication and centralization.

2. Information requirement

We consider a set of fragments $F = \{F_1, F_{2,\ldots\ldots} F_n\}$ and a network consisting of stations $S = \{S_1, S_{2,\ldots\ldots} S_n\}$ on which a set of transactions $T = \{T_1, T_{2,\ldots\ldots} T_n\}$ are run. The allocation issue implies the finding of the optimal distribution of the fragments F on the stations S. The optimality can be defined depending on cost or performance.

Minimal cost – this function evaluates the cost of storing each fragment F_i on the station S_j, querying F_i on station S_j, updating F_i on every station on which is stored, and the cost of the data transfer. The allocation issue conducts to finding an allocation scheme which minimizes a composite cost function. This implies finding a set I, $I \subseteq S$, which specifies where the copies of a fragment should be stored.

Performance – the allocation method is designed so that it provides and maintains some performances: minimizing the response time, and maximizing the system throughput on a period of a time, on each station.

Database information – it is necessary to extend the concept of minterm predicate selectivity, to the selectivity of a fragment F_i as to a request T_i. This is defined as the number of

tuples F_j which have to be accessed in order to execute the request T_i , and is equivalent in notation to sel(F_j).

The dimension of a fragment F_j is:

$$\text{Size}(F_j) = \text{card}(F_j) * \text{length}(F_j)$$

where length represents the length of a tuple (in bytes) and card represents the number of tuples within fragment F_j.

Application information (transactions: number of read accesses, equivalent in notation with RR_{ij} , which a request T_i makes to a fragment F_j, and the number of renewed accesses, noted with $U R_{ij}$.

Two matrices are defined, UM (update matrix) and RM (retrieve matrix) with the elements:

u_{ij}= 1 if request T_i updates fragment F_j.

u_{ij}= 0 else

r_{ij}= 1 if request T_i makes a retrieval on fragment F_j.

r_{ij} = 0 else

We take a vector O, where o(i) represents the station from where the transaction T_i. was initiated. Also, it must specify the maximum response time allowed for each application. Keeping in mind that not all the fragments are accessed by a transaction, the matrix RM (or UM) can be empty. For example:

RM:

		F_1	F_2	F_3	F_4	F_5
	T_1	0	3	0	0	0
	T_2	2	0	0	2	0
	T_3	1	0	3	0	0
	T_4	3	0	2	0	0

UM:

	F_1	F_2	F_3	F_4	F_5	
T_1	1	0	0	2	1	T_1
T_2	1	0	3	1	0	T_2
T_3	2	1	1	0	0	T_3
T_4	3	0	2	0	1	T_4

In the RM matrix, transaction T_3 retrieves fragment F_1 once, fragment F_3 trice, while in the UM matrix, transaction T_3 updates fragment F_1 twice, F_2 once, F_3 once and F_4 once at every run.

When a transaction accesses a fragment, not all the sequences of the fragment must be retrieved or updated. The number of sequences which are retrieved or updated isn't the same for all the transactions. Thus, we define de selective matrix SEL, which shows the selectivity of a fragment F_j as to a request T_i.

SEL(%)

	F_1	F_2	F_3	F_4	F_5
T_1	0.1	0.1	0	0.3	0.2
T_2	0.1	0.3	0	1	0
T_3	2	4	0.1	1	0
T_4	0.5	0	10	0	4

In the selective matrix SEL, transaction T_3 retrieves only 0.1% of the fragment F_3 and updates 2% of fragment F_1, 4% of F_2, and 1% of F_4.

The frequency matrix FREQ is required to show the frequency at which the transactions run on each site.

FREQ:

	S_1	S_2	S_3	S_4
T_1	0	3	2	1
T_2	3	0	0	1
T_3	2	0	1	0
T_4	4	0	0	2

Transaction T_3, described in FREQ indicates that it is run two times on site S_1 and one time on site S_3.

Network stations information – for each station, the storage and processing capacities must be known. USC_k represents the cost of data storage unit on station S_k, and LPC_k represents the cost of processing a work unit on station S_k. The work unit should be identical with the one for RR and UR.

Network information – we consider a simple network where the communication cost is defined as a data structure. g_{ij} is the cost of communication of a data structure between S_i and S_j, while fsize represents the dimension (in bytes) of this structure.

3. Cost formulas

An allocation model which minimizes the total cost of storing and processing, while at the same time trying to comply with some restrictions imposed over the response time, will be presented. The components required by this model are the information that were previously introduced.

Let x_{kj} be a decision variable, defined as:

$x_{kj} = 1$ if the fragment is stored on the station

$x_{kj} = 0$ else

The total cost function has two components: processing requests and storage. It can be defined as:

$$TOC = \sum_{\forall g_i \in Q} QPC_i + \sum_{\forall S_k \in S} \sum_{\forall F_j \in F} STC_{jk}$$

where QPC_i is the cost of processing query q_i , and STC_{jk} is the cost of storing the fragment on the station S_k.

Storage cost is defined by the formula:

$STC_{jk} = USC_k * size(F_j) * x_{kj}$

Query processing cost (QPC) can be broken into two components: actual processing cost (PC), and transmission cost (TC).

$QPC_i = PC_i + TC_i$

The processing component consists of three cost factors: access cost (AC), integrity constraint cost (IC), and the cost of current control (CC):

$PC_i = AC_i + IC_i + CC_i$

The detailed specification of these factors depends upon the algorithms used for fulfilling these tasks. AC, for example, has the following form:

$$AC_i = + \sum_{\forall S_k \in S} \sum_{\forall F_j \in F} (u_{jj} * UR_{ij} + r_{jj} * rR_{ij}) * x_{jk} * LPC_k$$

The first two terms of the formula represent the number of accesses to the fragment F_j by the query q_i , while UR+RR returns the total number of accesses that execute retrieve and update operations. The local cost of these operations is assumed to be identical. Multiplying by LPC_k returns the total cost of access to the station S_k , and multiplying by x_{jk} shows that the cost values will be selected only for the stations where the fragments are stored at.

The cost access function requires that each request can be split into sub requests that execute on a fragment stored on a station, while the results are returned to the station which emitted the request. This aspect is a plain perspective, that doesn't take into account the complexity of processing the database.

The transmission cost function can be formed analogue to the access cost function. On update queries, notifying all the stations that contain replicas is required, while the request queries need only one copy to be accessed. Also, when an update query is completed, there is no transmission of data back to the station that issued the request (except for a confirmation message), while the request queries can result into a massive data transmission.

The update component of the transmission function can be defined as:

$$TCU_i = \sum_{\forall S_k \in S} \sum_{\forall F_j \in F} u_{jj} * x_{jk} * \sum_{\forall S_k \in S} \sum_{\forall F_j \in F} u_{jj} * x_{jk} * g_{k,o(i)}$$

where the first term is for issuing an update request for the query g_i from the original station o(i) to all the copies of the fragments that need to be updated, and the second term is for transmission confirmation.

The retrieve component is defined like:

$$TCRi = \sum_{\forall S_k \in S} \sum_{\forall F_j \in F} \min(r_{jj} * x_{jk} * g_{o(i),k} * + r_{jj} * x_{jk} * \frac{sel_i(F_i)}{fsize} * g_{k,o(i)})$$

The first term represents the cost of transmitting the request query to all the stations that contain copies of the fragments that need to be accessed, while the second term represents the cost of transmitting the results from these stations back to the original station (which issued the request). The transmission cost function for the query g_i can be defined as:

$TC_i = TCU_i + TCR_i$

The constraint functions will be analyzed in a similar way. For example, response time constraint can be described in the following way: execution time of query $g_i \leq$ maximum response for the requests g_i, $\forall q_j \in Q$, while the storage constraint can be described as:

$\sum STC_{jk} \leq$ storage capacity of station S_k , $\forall S_k \in S$.

We must search for heuristic methods that give suboptimal solutions, and test them to see how close they are to the optimal solution. There isn't sufficient information yet to determine how close a solution can be to the optimal solution.

For example, we assume that each site on the network is connected to another site through a logical communication link. Thus, the transmission cost of the data allocated to the site towards the site can be specified with the help of the communication matrix CTR, this being considered a symmetrical matrix (to simplify the problem).

CTR:

	S_1	S_2	S_3	S_4
S_1	0	0,32	0,48	0,16
S_2	0,32	0	0,64	0,32
S_3	0,48	0,64	0	0,64
S_4	0,16	0,32	0,64	0

The data from the above table represents the communication costs in a 50 kbps bandwidth network (ex: 0,16 ms-byte), where each element is a multiple of the value 0.16.

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COMPUTERIZING IN COMPETITOR'S ECONOMIES IN THE COUNTRIES FROM EAST EUROPE
- tendencies and implications -

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Abstract:

Computerizing, modern and necessary process is analyzed by the author through his particularities in the countries' economies recently passed to the market economy, with competitor's relations.

The work presents the modalities, ways and the strategy of computerizing the competitor's economies from East Europe. The analysis refers with predilection to Romania. Privatization, reorganization and companies' computerizing are processes which are determining one another and their effect imbeds reflecting in the evolution's trend of the new organizational structures. The author finds out significant similitude in competitional economies' area from the former socialist countries and tries a generalization of the distinguished aspects. The analysis sets off different tendencies of groups computerizing and ways of organizations with an explicit presentation of the induced causes. Also, there are shown the negative tendencies of computerizing process

used in these economies. Computerizing these economies, in author's opinion, brings many advantages but also social effects which are not sufficiently controlled by the…

The author synthesizes the tendencies and implications of macroeconomic computerizing, phenomenon resulted from the centralization's and generalization's processes.

The work shows strategies and ways of approaching in the future for directing the tendencies and the effects of computerizing in agreement with the needs of market economies' laws.

Key words: *computerizing, competition, software products, computers*

1. Introduction

Computerizing represents a process necessary to the economic activity because of the big volume of information which is necessary to the decisional process and because of the changing frequency of them. The decisional process supposes the next aspects referring to the information:

- Gathering, processing and data analyses
- The decisional process shaping with the elaboration of possible decisions' variants
- Decision elaboration
- Decision implementation at operational level.

Every step presented forward uses as a base information, dates and processing process upon them. It is known that the main objective of 20th century is ***the production of material goods*** and the necessary capital for this goal were ***Money***. The main objective of 21th century is ***the intellectual production***, we are in the century of informational society and the necessary capital for this goal is the ***Information***.

From these results the necessity of using some programs packages or complex informaticss systems. The Technology of Information is the concept who covers all the aspects bounded by the information processing. All the problems bounded by the automatically process of information with the help of software products is included in the concept of computerizing. The types of these software, the way of implementation, usage and inter connecting are influenced by the economical environment, the way of firms' organization and the market relationships. This problem seen through the prism of economies particularities in the countries from Central Europe and North – East (Poland, Czech, Slovakia, Hungary, Estonia, Leetonia, Lithuania, Romania, Bulgaria) which have passed recently to the market economy, represents the main objective of this paper [4]. The presentation and analysis of this problem I will realize approaching the next steps:

1. the computerizing evolution in Romania after 1989;
2. the computerizing' particularities and tendencies in Romania;
3. elements of process generalization in Central and East Europe;
4. the actual and future problem of computerizing in Central and East Europe;
5. conclusions

2. The computerizing evolution in Romania after 1989

The computerizing evolution in Romania after 1989, when it took place the abolition of the centralized socialist economy, covers the next stages (6);

- Disintegration:

The revolution from 1989 abolished the structures from socialist centralized economy and with this the centralized informational structures. The democratization and economy decentralizing leaded to the impossibility of using the old informational structures. An alert revolution took place in informaticss too, all equipments (HARDWARE) and programs, inclusively the operation systems were abandoned

because of the firms' reorganization that had other requirements and other way of organization.

- Reconstruction:

From the year 1990 had appeared the new technologies based on computers, PC, small computers with acceptable power of processing, with new systems of operation and new software technologies. Between the years 1990-1991 appeared application programs which had to replace rapidly what had disappeared and to respond the acute needs of the new firms which were setting up.

In this period, the quality problem of the software products wasn't a prioritar objective. Life forced the adaptation a realization of a huge volume of software application in a small period of time.

The informatics products had been realized as independent programs and packages of programs with generalization elements (6). There weren't a massive penetration of application software on these countries' market.

- Interconnecting:

Because of the inter connecting of material, human, financial fluxes between and at the level of firms had appeared the necessity of establishing of some informational bounds between the software products. This way appeared the first phenomenon characteristic integration and this is inter connecting.

The most used inter connecting methods were: inter connecting through transfer of folders and through concentration of processing on local network servers. Some of the application software products realized in this period of informational revolution is in function today, too.

Once with the growth of the necessary of inter connecting of different application appears on the market of these countries the bigger software's producers (Microsoft, Oracle, SAP, and so on).

- Integration:

The Integration represents a concretization at microeconomic level of globalization phenomenon. The global treatment, unitary, unique and no redundant of data represents conditions of informatics systems performances and specific integration elements.

Integration is not a goal of computerizing, as computerizing is not a goal on the economic point of view. The general tendency of integration the informatics products is determined by the growing needs of efficiency of companies' management.

The real manifestation of integration elements of informatics systems through import of solutions appears once with the big privatizations and with the implementation of an extern management in the privatized firms.

In this stage appears the first tendencies of integration the informatics applications, tendency more pregnant after my opinion in Czech, Hungary and less evident in Slovakia, Bulgaria and Romania.

3. The computerizing particularities and tendencies in Romania, [1, 2]

Computerizing in the transition process of economies in Central and East Europe from centralized socialist economy to the decentralized economy, of market followed a specific road but common to many countries, which sets off the next particularities:

- The necessity of urgent replacement of existent software at the beginning of the year 1990;
- The replacement of equipments, the base software and application software determined an alert revolution specific in computerizing process;
- The cost of informational revolution had to be bearable in record with the low financial availabilities and the priorities of the new founded firms;
- The specialty staff had to bear to this challenge;

- The economic environment is rapidly changing and there weren't implemented the competing economies' rules;
- The preparing level of the new managers class is reduced;
- The privatization of big companies takes national development.

These particularities influenced significantly the evolution of computerizing process from the next few years. Comparing the specific of economic context from the years 1990-1992 we may say that this was similar in all the countries from Central and East Europe. Because of this we may say that the Computerizing as a process which is determined by the needs and economical evolution, followed about the same evolution tendencies in all these countries, named generic in this study the countries from East Europe.

The small and medium size enterprise (SME) follow the computerizing through realization, acquisition and implementation of some less expensive solutions. They install and acquire informatics networks of small dimensions with cheap operating system (Windows NT, Windows XP, NetWare, and so on). Generally, these companies orientates to programs packages and native informatics systems, realized even at demand. After 1999, appears the interest of foreign companies to enter on this market segment. I remind here only the Ciel and Winmentor packages.

There implements applications, packages or informatics systems in these companies' sphere especially to respond to the demands imposed by the legal settlements in a permanent change. The biggest weight has the financial – accountant applications, of wages, staff, only sporadic transaction accountancy and transaction production.

The applications, the packages of programs and the informatics systems implemented in these companies' sphere are badly integrated with viability, generality and the report price/performance low.

As a result of these implementations, the informational fluxes which reach to the firms' management for the operational activity is very low. The processing' results supplies postfactum informative reports, and they respond the demands imposed by the law.

The Internet is a computerizing preoccupation of these firms but for the most of the time used for business' development.

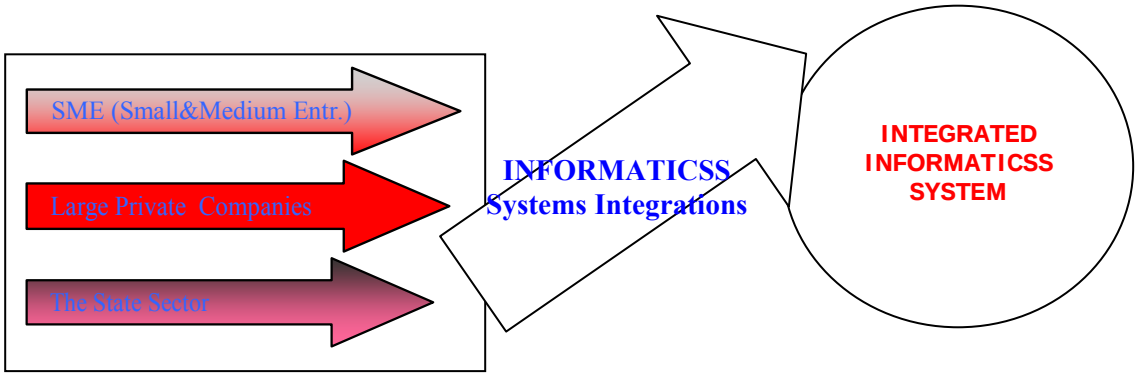

Fig. no. 1 – Developing of computerizing
in the Central and East Europe

■ The big private companies' computerizing

At the big private companies' level we observe the stages of some organizational reorganization of vast proportions, frequently connected with the headquarters of the aquisitional firms. So, there appear on Romanian market, beginning with 1995, software products consecrated on international level: operating systems UNIX, LINUX, informatics systems of Oracle, SAP, Microsoft. It must be said that in this case too, the approached domains with priority are the same: financial – accountant, wages, clients, suppliers, invoicing, and so on.

The main effect for these integrated informatics systems of getting into is that they implements rules of competing economy with the advantages which derives from them. Once with their implementation appears some negative social effects (out of work, the growing of professional demands, job's reconfigurations, and so on), effects who are

determined by the fact that there are not scheduled measures for preventing the negative effects of them.

Internet begins to be used as work environment and develops applications for INTRANET or EXTRANET.

Because of the long period of implementation the integrated informatics systems of such dimensions, the management has to satisfy with the same type of postfactum information and especially reports from financial – accountant sphere. The OLAP (Online Analytical Processing) components are implemented only sporadic although the informatics systems allow this.

Occasionally or almost never, there aren't implementations of informatics systems components which to approach issues regarding the process' optimizations or optimum administration of sources. **Informatics products from this category influence the quality of decisional act through optimum allocation of resources and through mathematical correlation of decisional variant with the settled objective [5].**

- The state sector computerizing

The strategy of the state sector computerizing may partially look like with the tendencies presented in the segment of small and medium size enterprise (SME). At the level of state sector we may implement vaguely integrated applications. Unfortunately, there isn't an efficient strategy at national level of computerizing this sector. On different sectors (finance, administration, school, social field, and so on) are trying different "philosophies" of computerizing that bring unsatisfactory results. The absence of correlation or even integration of these strategies takes to waste of resources, unsatisfactory results and even absence of professionalism in computerizing approach. I can sustain what I have said showing that there didn't realize informatics systems which to connect and concentrate at county level, board and national the data and informational fluxes of the town hall, fiscal administrations, schools, hospitals, and so on.

In this field, after my opinion, I consider that we have an absence of orientation, being left behind towards the other countries East European and even inaccurate realization with the demands of European Union.

- Computerizing in the sphere of residential populations:

At population level we may observe the tendency and preoccupation of computers acquisition, inclusively the investments for knowledge acquisition. The usage of the INTERNET shows the same trend.

All these are at a low level toward de other occidental countries to which we tend. The penetration rate of communication is only of 25-30%toward 50-75% in the Occidental Europe countries.

4. Elements of computerizing process generalization in East Europe

The countries from East Europe who aspire to integrate in European Union had covered and cover the same stages of economical transformations. After my opinion, the stages that are covered in computerizing process follow the evolution of the other economical processes (disintegration, reconstruction, inter connecting, integration).

The particularities identified in ROMANIA referring to the evolution of computerizing process are almost identical in all the countries ex socialist from East Europe. There are still differences in the economies of these countries, differences that don't involve the major influences upon the stages and computerizing strategies. The differences between the states of East Europe who had adhered or will adhere to the European Union consisted of:

- The degree of development from where they left, a degree different from a country to another;
- The different level of social relations and the level of focus of the former socialist economies from these countries;

- The clarity of the defining computerizing strategy and the consistency of application the settled computerizing strategies;
- The type and number of the competing projects used for the attraction of European funds destined to computerizing and professional reconversion;
- The level of allocated investment and used for computerizing.

In the analyzed countries from Europe we may observe an aggressive penetration on the market of big international companies from informatics domain (Hewlett – Pakard – representation, IBM – representation, Microsoft – representation, LASTING Systems supplier for NEC Computers, Romsys Data – supplier for GFi Software, and so on).

5. The actual and future problem of computerizing

Economies' computerizing from East Europe must follow especially the segments of state sectors and of small and medium size enterprise (SME). The big companies will promote the implementation of integrated informatics systems because they dispose of the necessary funds and they are convinced by the necessity, utility and their efficiency.

In **the state sector,** computerizing will meet another period of a few years in which the resistance and opposition of the existent staff who is old and won't be able to make up the renewal processes determined by computerizing. The absence of coherent and consequent strategies in computerizing process will determine an insufficient process. There are many modalities of approaching the computerizing strategy in this field, I remind only the next:

1. the defining of a own coherent strategy of computerizing, financing, realization and its implementation;
2. the take over of an existent model from Occident, financing, adaptation and its implementation;
3. the take over of a model from Occident, financing and its implementation.

The main problem is that a competent organism should define clearly a strategy and to go to its application. Any strategy we adopt, its implementation is absolutely necessary.

In the small and medium size enterprise (SME) , computerizing depends a lot of the management quality, the preparing level of the bosses and of the sustaining politics from the state. Unfortunately, the preparing level of the bosses (education and profession) determines opposition towards the implementation of an efficient computerizing strategy. Here, everything resumes at the capacity of decidents (managers or bosses) to evaluate and understand the necessity of investments in technologies for information processing.

I want to underline the fact that, after my opinion, the implementation of operational research programs is the most efficient way of recuperation the investments made for computerizing [5]. Anyway there aren't significant implementations in this domain and no adequate software offer. The explication is in the fact that there aren't demands.

The integration of existent informatics products or their replacement with integrated informatics systems will be the main trend that will take to the computerizing efficiency. The trend is materialized at the level of the big privatized firms (for example Romtelecom, Petrom, Distrigaz, Sidex, and so on).

If we report ourselves to the other countries from East Europe who orientated towards competing economies we must show that in Romania we have two special problems:

- the absence of a coherent strategy in the domain of state's sector computerizing;
- a deficit in managers preparation in the domain of economical informaticss.

The efficiency of computerizing in companies sectors, administrations or state sectors summarize to the assurance of an electronic processing data flux and of an informational flux that satisfies the minimal demands of management. Major changing in this field will produce only through the application of some coherent and radical strategies in the domain of computerizing.

Because of the shown aspects of strategies we can't improve the potential of information man which we had, the majority looking for work in firms from outside country and in their benefit. If for strawberry gathering in Spain can be found many explications surrogate, for usage the information man in interest of foreign firms there can be said that the reforms in computerizing field are inadequate.

6. C O N C L U S I O N S

Computerizing is not a goal, but the most necessary and beneficial way for solving the informative demands of management at every level.

The macroeconomic analysis of computerizing in the countries from Central and East Europe that had passed to the market economy lead to the next conclusions:

1. Computerizing follow the model of complex transformations suffered in these countries' economies;
2. There were identified implementations modalities for informatics systems on types of companies and organizations grouped according to the nature of majoritar owner: small and medium size enterprise (SME), big privatized companies (generally with foreign capital) and the organizational form in the state sector.
3. The small and medium size enterprise (SME) don't allocate resources for the implementation of some informatics systems efficient from absence of funds, because of the management disability to understand the beneficial effects of computerizing.

4. The usage of small computers network with applications software badly integrated is the dominant of computerizing in the setting of small and medium size enterprise (SME);
5. The implementation of some packages or important informatics systems became almost a fashion, considering that this will solve the problems of the respective organizations. These solutions are in reality very expensive, have an answer deadline for maintenance almost unbearable and solve only partially the aspects of the firms.

For the computerizing to enter a normal line of efficacy, after my opinion, must be undertaken the next actions:

- The elaboration of a national strategy of computerizing that to include all types of companies, organizations and firms;
- The identification of some measures which to stimulate the native producers of soft to produce and implement own informatics solutions with specialists from their own countries;
- The software producers to follow the realization of packages and informatics systems in fields and activities which to assure the penetration on the international market (I will suggest the operative research, the management of clients relations, systems decision support, and so on);
- The Romanian firms to follow, prepare and involve in the process of externalization of informatics services (clients relations, printing – developing, accountant evidence, and so on;
- There must be used and implemented the newest technologies in producing the applicative software. Here, with special restraints bounded by data security I think must be promoted the technologies INTRANET and EXTRANET.

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TABLE OF CONTENTS

ERP in a Networked Society

Abstract. ERP business functions are contained in the typical EIS. EIS contained software support for business processes that are not part of ERP. Can Sales Forecasting, Sales and Operations Planning, Advanced Planning Systems, Supplier Rating Systems and Performance Metrics ERP processes not typical to EIS could with NLS (National Language Support), Local Regulatory Compliance like SOX (Sarbanes-Oxley) in consensus with Basel II, (IFRS) International Financial Reporting Standards and (IAS) International Accounting Standards to unified the national economic frontier in a Networked Society?

Keywords: ERP (Enterprise Resource Planning), ES (Enterprise System), BOM (Bill of Material), MRP (Material Resource Planning), MRP II, APICS (American Production and Inventory Control Society), OM (Operations Management), EIS (Enterprise Information System), BPM (Business Process Management), WFM (Workflow Management), NLS (National Language Support), SOX (Sarbanes-Oxley), LGR (Local Governments Regulation).

1. Introduction

This section provides the context for the topics addressed in the paper identifying the trends and putting them from a historical order. ERP represents a term for the broad set of activities supported by multi-module application EIS that help an organization or other business manage the important parts of its business, including product planning, parts purchasing, maintaining inventories, interacting with suppliers, providing customer service, and tracking orders. Thomas F. Wallace and Michael H. Kremzar in [1] underlines the remark that ERP is not software and try to use another acronym that refer to software ES (Enterprise System) or ES (Enterprise Software). Thomas H. Davenport in [2] defined ES as "packages of computer applications that support many, even most, aspects of a company's

information needs.” In this paper we use the EIS (Enterprise Information System) acronym for ES-Enterprise System or ES-Enterprise Software. In Table 1 and Fig.1 we represent the relation between ERP and EIS.

Table 1. Relation between ERP and EIS

ID	Process	Detailed Processes
1	ERP processes not part of a typical EIS	Advanced Planning System Sales Forecasting Sales and Operation Planning
2	ERP processes found in a typical EIS	Material Requirements Planning Master Production Scheduling Capacity Requirements Planning Distribution Requirements Planning
3	Non ERP processes found in a typical EIS	General Ledger Accounts Receivable Accounts Payable Cash Management Customer Relationship Management Human Resources

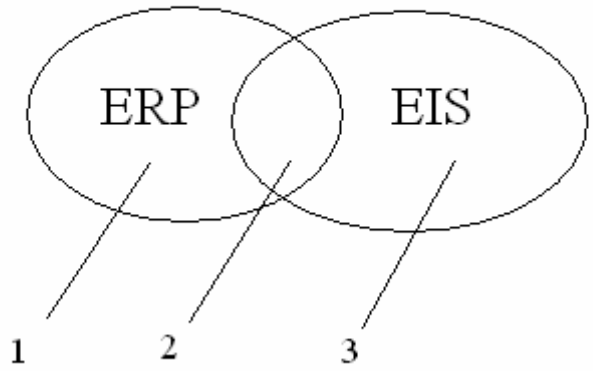


Fig. 1. ERP & EIS, source [1]

1.1 ERP history

The grandfather of ERP is MRP; an early effort in BOM (bill of material describes a product in terms of its assemblies, sub-assemblies, and basic parts). MRP system, at that time intend to simultaneously meet three issues: ensure materials and products are available for production and delivery to customers, maintain the lowest possible level of inventory, plan manufacturing activities, delivery schedules and purchasing activities. These open issues are coming from the questions: What do we have? What are we going to make? What do we have to get? What does it take to make it? These four questions, generic are called the universal manufacturing equation. The father of ERP was MRP II, defined by APICS in [4] as "a method for the effective planning of all resources of a manufacturing company. Ideally, it addresses operational planning in units, financial planning in dollars, and has a simulation capability to answer <what-if> questions." APICS also defined OM (Operations Management) in [5] as "the field of study that focuses on the effective planning, scheduling, use and control of a manufacturing or service organization through the study of concepts from design engineering, industrial engineering, management information systems, quality management, production management, inventory management, accounting, and other functions as they affect the organization". MRP II is made up of a variety of functions, each linked together: Business Planning, Sales and Operations Planning, Production Planning, Capacity Requirements Planning.
Finally ERP (Enterprise Resource Planning) is the successor and extension of MRP II and, as such, includes all of MRP capabilities. ERP is more powerful in then MRP and MRP II because:

- Applies a single set of resource planning tools across the entire enterprise,
- Provides real-time integration of sales, operating, and financial data,
- Connects resource planning approaches to the extended supply chain of customers and suppliers.

1.1.1 CRM (Customer Relationship Management)

CRM is defined in [6], by Jill Dyche, as "infrastructure that enables the delineation of and increase in customer value and the correct means by which to motivate valuable customers to remain loyal – indeed to buy again." CRM in relation with ERP and EIS represents a holistic approach it can not be implemented only by installing and integrated software packages. CRM brings to ERP & EIS the followings needs: create a customer-based

culture, adopt customer-based culture, identify customer success factor, and recommend what questions to ask to help a customer in idea to solve a problem. CRM has three parts of application architecture: **operational** (support the automation to the basic business processes: marketing, sales, service), **analytical** (analyze of customer behavior) and **collaborative** (support the contact with the customers via phone, fax, email, web, in person, post).

1.1.2 SCM (Supply Chain Management)

A supply chain is defined by J. Martin and R. Roth in [7] as "network of facilities and distribution options that performs the functions of procurement of materials, transformations of these materials into intermediate and finished products, and the distributions of this finished products to customers.

1.1.3 BI (Business Intelligence)

The term Business Intelligence (BI) typically refers to a set of business processes for collecting and analyzing business information. BI has three steps: collecting the data, discerning patterns and meaning in the data and the responding to the resultant information.

1.1.4 WFM (Workflow Management)

WfMC (Workflow Management Coalition) defines the Workflow Management System in [9] as "A system that defines, creates and manages the execution of workflows thought the use of the software, running on one or more workflow engines, which is able to interpret the process definition, interact with workflow participants and, where required, invoke the use of IT tool and applications." In [9] workflow is defined as "The automatition of a business process, in whole or part, during which documents, information or tasks are passed from one participant to another for action, according to a set of procedural rules". These two definitions suggest that workflow and WFM systems are very important for any type of organization. Wil M.P. van der Aalst in [8] identified four different categories of WFM from their support point of view:

Table 2. WFM Categories, source [8]

WFM Categories	WFM Description	WFM tools
Pure WFM systems	Are available and used in practice.	Staffware Process Suite, FileNET BMP Suite, i-Flow, FLOWer, WebShpere MQ Workflow, and others
WFM components embedded in other systems	ERP processes found in a typical EIS.	Material Requirements Planning Master Production Scheduling Capacity Requirements Planning Distribution Requirements Planning
Custom made WFM	Organizations choose to build an own solution. They implement only a subset of functionality offered by the first two categories.	Inhouse solution
Hard coded WFM	No generic workflow support. The processes are hard-coded in the implemented application	Built-in

1.1.5 BPM (Business Process Management)

BPM is defined by Wil M.P. van der Aalst in [8] as "methods, techniques, and tools to support the design, enactment, management, and analysis of operational in business processes" an extension of classical WFM, underlining that it has in his life cycle four stages: process design system configuration, process enactment, diagnosis.

2 Research question

We proposed the following research question: Can the sales forecasting, sales and operations planning, advanced planning systems, supplier rating systems, and performance metrics components of ERP systems which are not typical of EIS promote national economic development in today's networked societies?

3 Motivation Scenario

The EIS application helps companies to manage the diversity of international trade. With over three decades of industry experience, EIS enables any kind of organization to streamline and automate the import and export activities according the regulatory compliances, mitigating the financial risk regarding global transactions, giving a holistically approach to manage global activities over heterogeneous landscapes. The open system theory could be a little step in defining a workflow definition for ERP in Network Society.

4 ERP in a Network Society

In 1827, Georg Ohm defines **Ohm's law** in [10] as "the states that the potential difference between two points along a connected path and the current flowing through it are proportional at a given fixed temperature:

$$V = I * R \quad (1)$$

Where V is the potential difference, I is the current, and R is the constant called electrical resistance of the conductor."

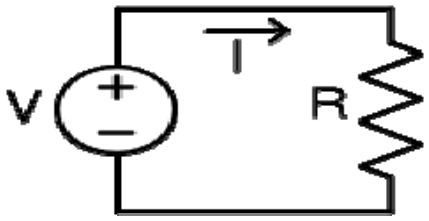


Fig. 2.A voltage source V, drives an electric current I thought resistor R

In 1854, Gustav Robert Kirchhoff, while was a student, defines the current law and the voltage law. The current law, states that the sum of the currents into a specific junction in the circuit equals the sum of the currents out of the same junction. Electric charge is conserved: it does not suddenly appear or disappear; it does not pile up at one point and thin out at another.

$$\sum_{k=1}^{n} I_k = 0 \tag{2}$$

The second law states that around each loop in an electric circuit the sum of the emf's (electromotive forces, or voltages, of energy sources such as batteries and generators) is equal to the sum of the potential drops, or voltages across each of the resistances, in the same loop. All the energy imparted by the energy sources to the charged particles that carry the current is just equivalent to that lost by the charge carriers in useful work and heat dissipation around each loop of the circuit.

$$\sum_{i=1}^{n} U_{ei} = \sum_{k=1}^{n} R_k * I_k \tag{3}$$

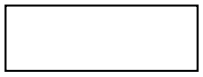
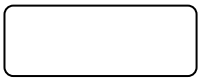
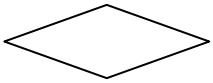
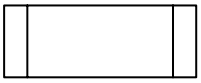
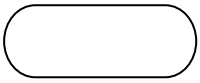
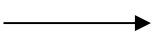
Our approach is that Ohm and Kirchhoff laws could have a "generalization"in ERP system with support for EIS. The graphical representation for electrical circuits in our opinion is isomorphic with the graphical representation for Business Model flavors respective the

mathematical representation of electrical circuits could be with little steps isomorphic with frameworks like .NET Framework, J2EE, and others.

4.1 Shape representation for information flow

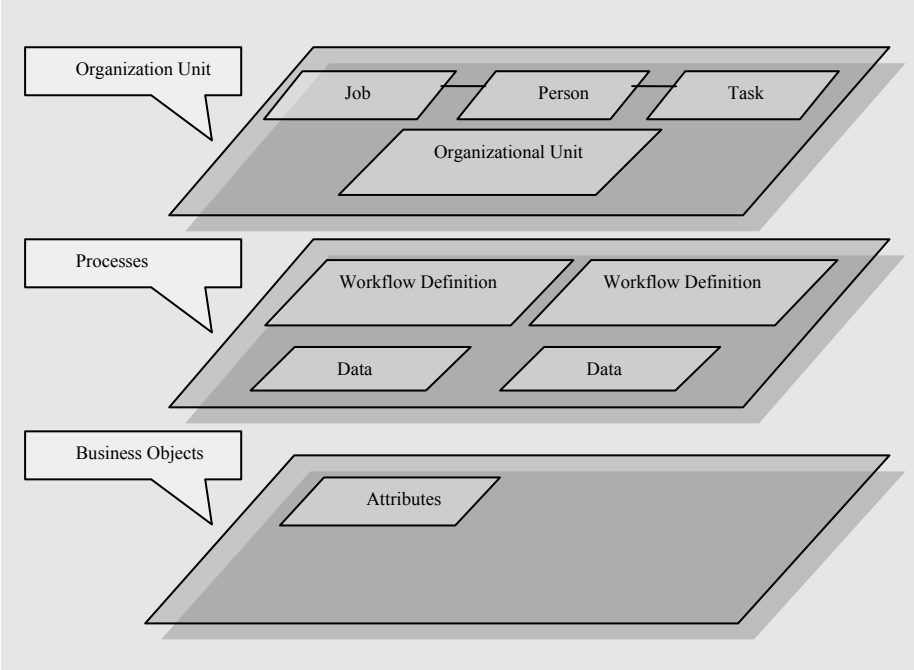
A flowchart is a diagram that illustrates the steps in a process. By allowing you to visualize the process, a flowchart can quickly help identify bottle-necks or inefficiencies where the process can be streamlined or improved.

Table 3. Shape representation for information flow

Shape	Shape Description
	Process
	Subroutine(Alternate Process)
	Decision in Process
	Predefined Process
	Start/End Process
	Connector between shapes
	Arrow between shapes
	Delay

4.2 Business Workflow for ERP system in Network Society

Business Workflow is using the workflow definition to explain the technical issues of the business process. The workflow definition interact the data flow and active control between the process steps



5 Conclusion

In this paper we try to define a Business Workflow for ERP system in Network Society

6 Future work

In our future work, our top priorities are defining the Abstract Syntax for ERP metamodel and Abstract Semantic for ERP metamodel. Concrete Syntax for ERP metamodel and Concrete Semantic for ERP metamodel.

7 Acknowledgement

The authors would like to acknowledge the financial support by SC Sandoz S.R.L, former SC Lek | Pharmatech S.R.L, member of Novartis Group in PNCDI research grant number: 71254-2005 with title “Cost Calculation at SC Lek | Pharmatech S.R.L”

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P.S.

Fig 1 I will change IT, is very difficult with *.ps or *.eps file and insert them in Latex files

USING DATABASES BEYOND DATA ACQUISITION

Lecturer TRAIAN TURC PhD –"PETRU MAIOR "UNIVERSITY OF TG.MURES

Abstract:

This paper contains sum consideration about using databases in order to display and transfer information from Data Acquisition Systems. Acquisitioned data are sending to different users through different networks even through global network Internet using a Data WEB Sever.

The Data WEB Server collects data and generates the WEB page in a standard format or in a client request format.

The server is both data acquisition server and WEB server. The purpose of the WEB server is to prepare data in HTML format or DBF format and then using MIIS to send data at client's request. Clients can make the data displaying using any Internet browser.

Keywords*: Data acquisition, data visualization, data communication, software components and databases.*

Data acquisition and transfer through Internet

For sending acquisitioned data for long distance to a large number of users at low costs it is better to use the public network Internet (see figure 1).

Using this network means a major advantage: the possibility of displaying data using any computer connected to the Internet using any kind of Internet browser.

The users don't need expansive and sophisticated programs for data acquisition and data displaying.

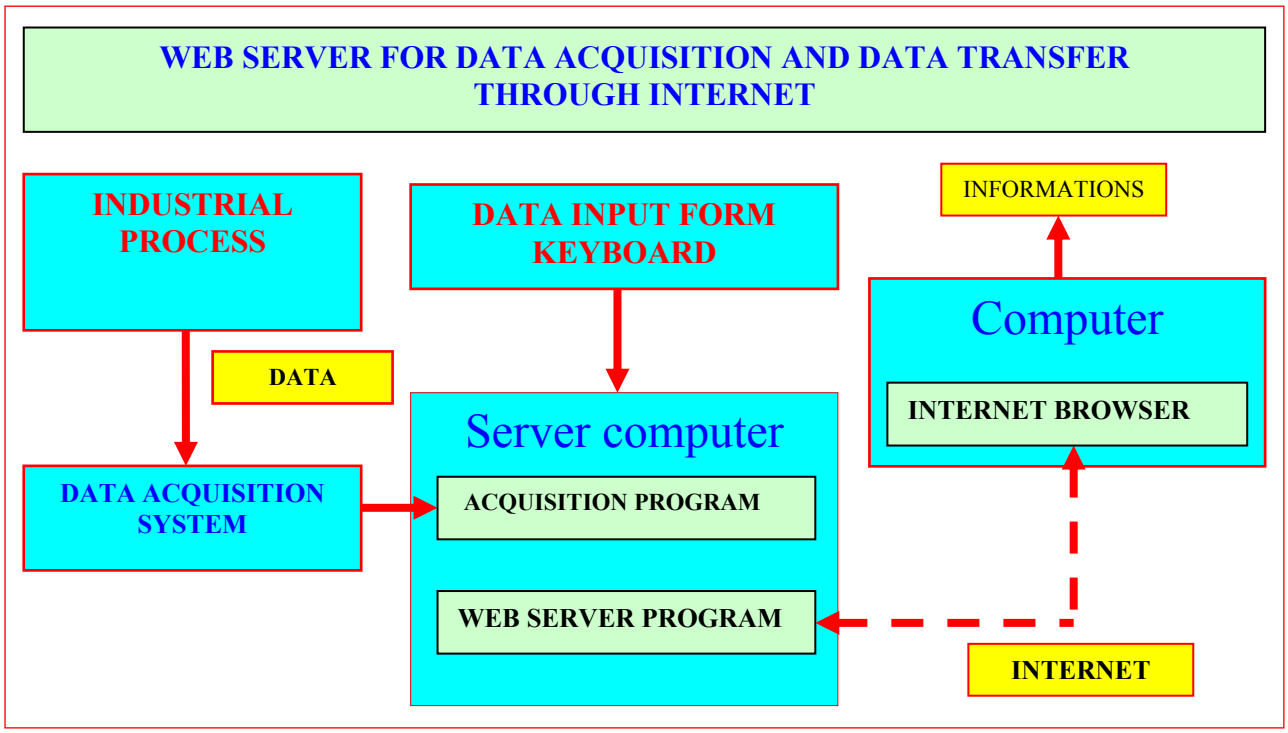

Figure 1

The local computer connected to the data acquisition system, takes data and after data processing makes data display. In figure 4 is shown main screen of remote monitoring and control systems for gas compression stations, data acquisition and data transfer through Internet.

Data sends from every compressor of gas compression stations are centralised and displayed at station office.

The central computer from station office colect dates from compressors and sends orders to every compressor.

Acquisitioned data from gas compress systems can be also exported in different formats (for example in Excel format-figure 2) or sent thought Internet and displayed using any Internet browser (figure 3).

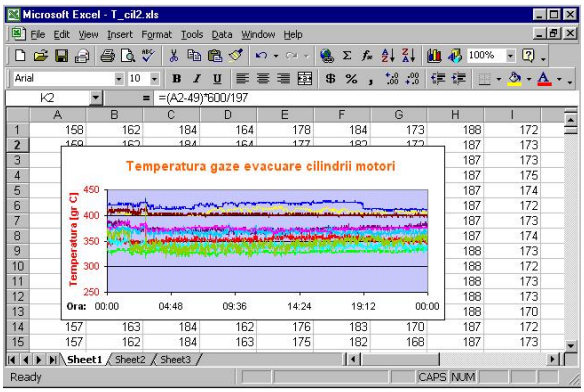

Figure 2

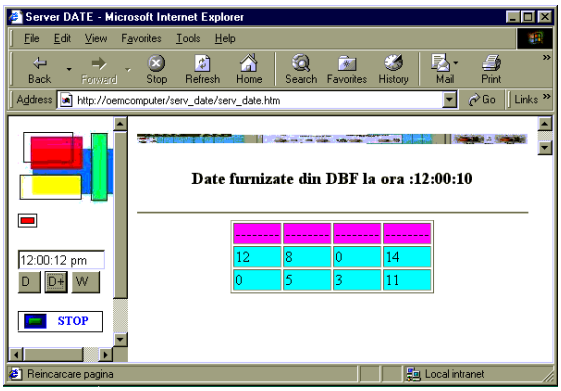

Figure 3

Figure 4

Human Machine Interface (HMI) includes an overview screen list, diagrams and charts (see figure 5).

Figure 5

Acquisitioned data are saved in databases format or in different format from time to time to the local disks for future using.

For data transfer there is generated another special file in HTML format with acquisitioned data and even data brief from the last period. The program, which prepares data in HTML file, is called SERVER HTML application.

The WEB server performs the HTML file transfer at client's URL request.

Users can display data to the local computer connected to the Internet using any available Internet browser simply addressing server that contains the HTML file with acquisitioned data.

The Internet address contains the URL (Universal Resource Locator) of the resource, in other words the name of server and the name oh HTML document.

The content of resource is permanently changing. Any display of this resource means display of new data.

The HTML file generated by the HTML server can contain data and other TAG-s that allow users to request specific data.

If the browser displays repetitively the HTML file we have a real time displaying.

The method described before is very simple, the data access is very fast, and the users number simultaneously connected depend only on WEB server performances.

The users don't access directly the acquisition server and they can't brake down the data acquisition by a large number of requesting.

The disadvantage of this method: the users can't make a particularly request, they can only display data prepared by HTML server.

To solve this problem there must be used a client server application when the client makes some request and the server provides only requested data

Using Internet browser one can display data from server by invoking server address and specific data request (URL). Specific data request includes the name of the script, the process (the application) that must be launched and the method that sends necessary data.

The Internet browser asks for this address (URL) like any other document from server. The server receives the request, understands the fact that URL is a script and runs the script. The script launches the process and invokes the method received in URL.

The method can get data from databases or can make a data acquisition. The data are sent to script in HTML format. The script sends a valid response for the server.

The WEB server sends the response through Internet .The Internet browser displays the response

If we don't use a database, for every client request a new acquisition is necessary. For a large number of requests the system can break down.

To avoid the server break down there must be used use a tampon database (see figure 6).

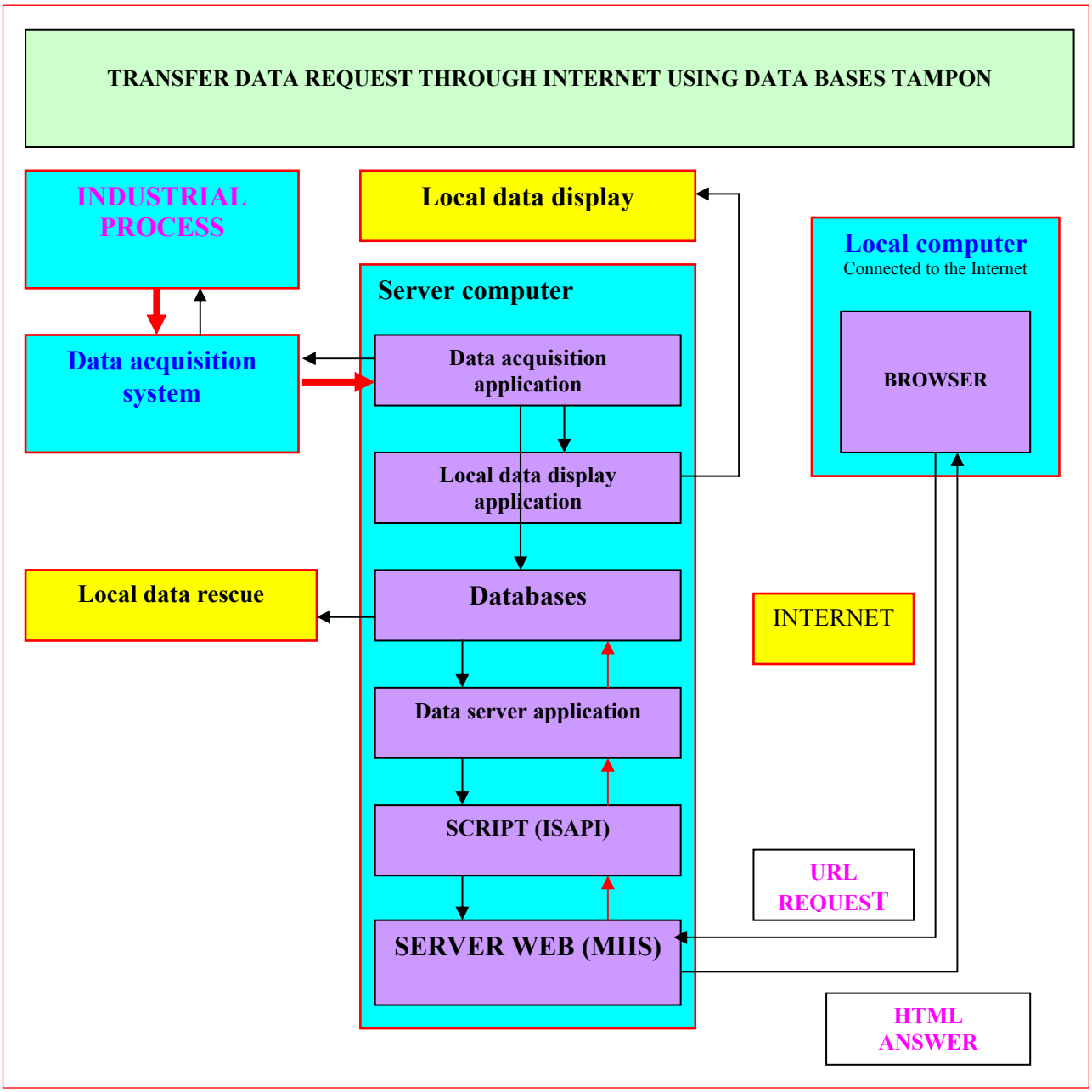

Figure 6

The data acquisition system makes regularly data acquisition and saves data in databases.

A simple implementation of this method is made using WEB server MIIS (Microsoft Internet Information Server).

The script FOXISAPI (Fox Internet Server Application Interface) and the application Server_com.exe that includes the class clasacom1 with paginastart method that asks for data from database valori.dbf (see figure 7)

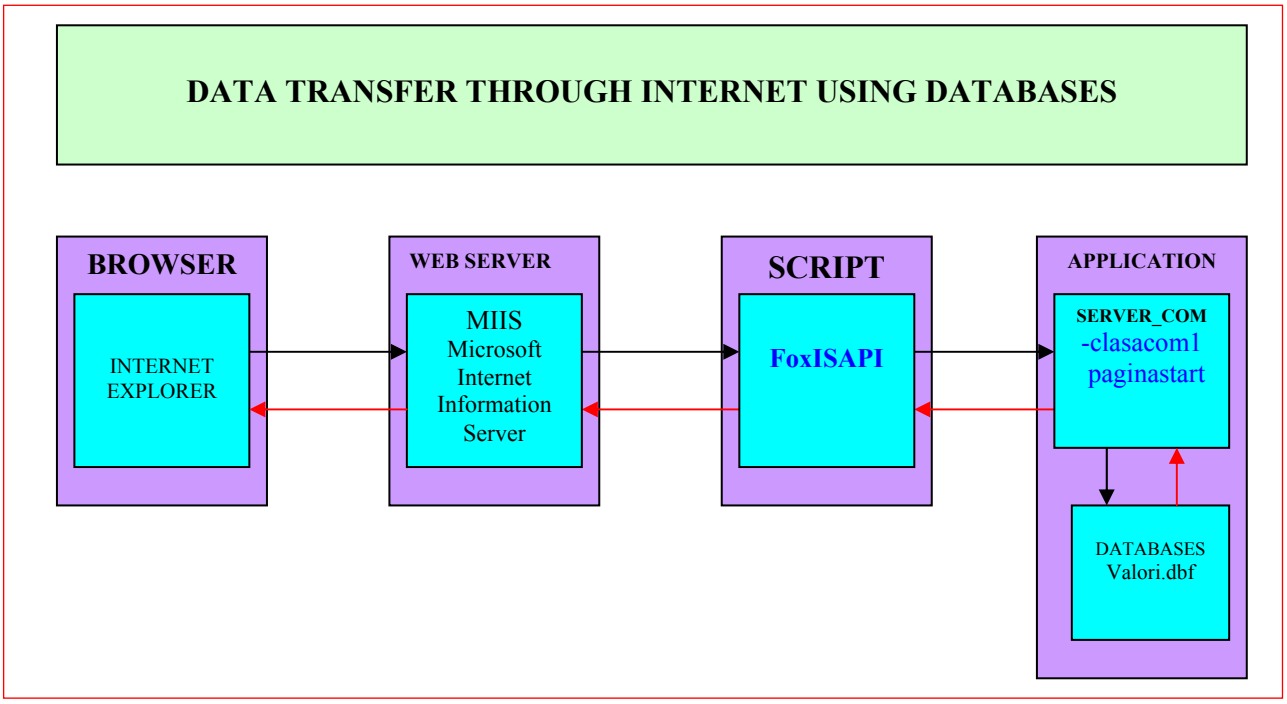

Figure 7

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EVOLUTIONARY REORGANIZATION OF THE CENTRALIZED MULTIAGENT SYSTEMS

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Abstract. *Many difficult problems cannot be solved by a single agent such problems solving require cooperative multiagent systems. In this paper, we propose an evolutionary learning algorithm that allows the construction of organizational rules in a cooperative multiagent system in which the agents are distributed in coalitions of agents. An organizational rule describes how must reorganize the multiagent system its coalitions in order to solve more efficiently the overtaken problems. Using a set of organizational rules, knowing informations about the problems that must be solved in the next problems solving cycle, the multiagent system can reorganize its coalitions autonomously at the beginning of each problems solving cycle.*

Keywords: *intelligent agent, evolutionary algorithm, multiagent system, cooperative problem solving, coalition of agents, multiagent system architecture, multiagent system reorganization*

1. Introduction

Agents that operate in isolation cannot solve many difficult *problems* [1, 19, 9, 10, 5, 12]. These problems solving require the cooperation of more agents with different [1, 9, 12] c*apabilities* and *capacities*. The *capability* of an agent consists in the *specializations* detained by the agent. A *specialization* describes a problem solving [1]. The *capacity* of an agent consists in the amount of problems that can be solved in deadline by the agent using the detained resources. We call *multiagent systems* the systems composed from more agents. *Cooperative multiagent systems* are composed

from agents that cooperate in the problems solving. Cooperative multiagent systems have applications in many domains. As an example of domain in which are used cooperative agents, we mention the medicine [7, 6, 4, 8, 10, 11, 18].

An elementary form of cooperation consists in the problems distribution for solving. If an agent cannot solve an overtaken problem (doesn't have the necessary capability and or capacity) then he must distribute the problem to a capable agent to solve it. This cooperating manner between agents is called *connection problem* [19, 13]: finding an agent to work on a given problem.

The cooperative problems distribution for solving in a multiagent system *MAS* can be described formally as follows:

$$<MAS, PROB, func> ,$$

$$func: PROB \rightarrow MAS ,$$

$$\forall\, prob \in PROB, \exists\, ag \in MAS, \text{ where } func(prob) = ag .$$

PROB represents the set of problems that must be solved by the multiagent system, *func* represents the function that associate to each overtaken problem the agent that must solve the problem.

In a cooperative multiagent system each agent must fulfill a *role*. The role of an agent defines the purpose of the agent [1, 19, 12]. As examples, we mention the manager and contractor role. An agent with a manager role transmits problems for solving to agents with contractor role. An agent with a contractor role is responsible to solve the problems received from agents with manager role. A multiagent system may have more agents with the same role. An agent may fulfill more roles in a multiagent system.

The *organizational structure* (*architecture*) of a multiagent system describes, how the agents' members of the multiagent system are organized [19, 1, 9]. A multiagent system represents an instantiation of a multiagent system organizational structure. As an example, we mention the *centralized multiagent system architecture*. A centralized multiagent system is composed from an agent with manager role and more agents with contractor role.

In a multiagent system the agents can be distributed in coalitions of agents. A *coalition of agents* is composed from a set of agents' members of the multiagent system [19, 12]. We call *centralized coalition* a coalition composed from an agent with a manager role and more agents with contractor roles.

2. The Proposed Multiagent System Architecture

In the following, we propose a multiagent system architecture. A multiagent system endowed with the proposed architecture is composed from a set $MAS = \{Ag_1, Ag_2,..., Ag_j\}$ of agents with different specialization sets. An agent Ag_k is endowed with a specialization set $\{Sp_1, Sp_2,\ldots, Sp_r\}$ that allows the solving of the problems from a set of classes of problems $\{CL_1, CL_2,\ldots, CL_r\}$; where Sp_i represents the specialization necessary for solving the problems from the class CL_i.

$$MAS = \{S\} \cup FREE \cup COAL.$$

FREE represent the agents called free agents. A free agent has a manager and contractor role. A free agent does not belong to any coalition. *COAL* represent the agents distributed in centralized coalitions of agents. *S* represents an agent with the supervisor role. The supervisor of the multiagent system is the manager of the multiagent system. He is responsible for the problems overtaking and transmission for solving to free agents and coalitions of agents.

Figure 1 illustrates a coalition of agents. *Manager* represents the agent with the manager role (the manager of the coalition). $Cr_1, Cr_2,\ldots, Cr_n$ represent the agents with contractor role. The arrows between the agents used in the figure, illustrate the communication and cooperation capabilities of the agents. The manager agent can communicate and cooperate with the contractor agents.

The agents from the set *COAL* are distributed in disjointed *coalitions* of agents,

$$\forall\ i \neq k, \text{ and } Coal_i, Coal_k \text{ two coalitions of agents,}$$

$$Coal_i \subset COAL,\ Coal_k \subset COAL,$$

$$Coal_i \cap Coal_k = \varnothing.$$

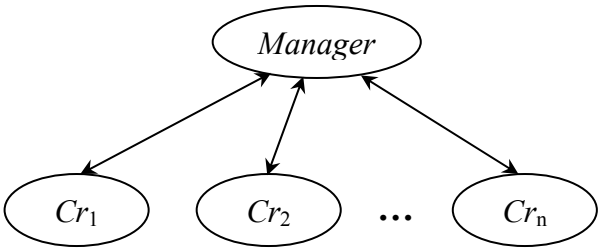

Fig. 1. *A coalition of agents*

Figure 2 illustrates a multiagent system instantiation composed from the coalitions $Coal_1$, $Coal_2$,…, $Coal_n$, the free agents F_1, F_2,…, F_m and the supervisor agent S. The arrows used in the figure illustrate the communication and cooperation links between the agents. S can communicate with the free agents and the coalitions of agents. In the case of a coalition, S communicates with the manager of the coalition.

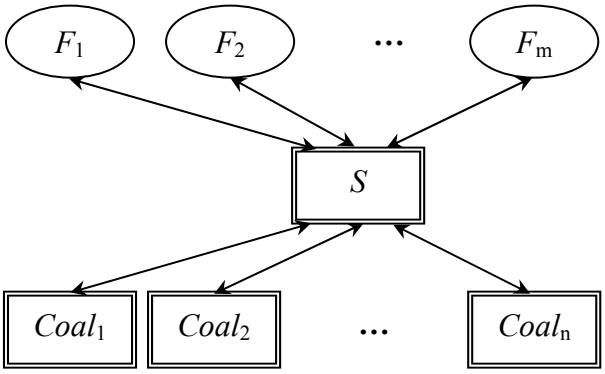

Fig. 2. *A proposed multiagent system*

The agents with contractor role have problems solving specializations. The specializations of a contractor agent are problem-solving methods. The agents with manager role have specializations that allow the problems distribution for solving. The specialization of a manager agent is a knowledge base that contains informations about the contractor agents from the same coalition.

As examples of informations detained by a manager agent about the contractor agents from the same coalition, we mention:

– the number of contractor agents;

- the knowledge detained about each contractor's specializations and capacity;
- the informations detained about the problems that are overtaken for solving by each contractor agent. In the coalition, the problems are transmitted for solving by the manager to the contractor agents. Each contractor agent transmits the obtained problems solutions to the manager agent. However, the manager agent knows in the case of each contractor, when the contractor finishes an overtaken problem solving.

The supervisor agent detains informations about the coalitions of agents and the free agents.

As examples of informations detained by the supervisor agent about a free agent, we mention:

- the agent's specializations and capacity;
- the problems that are currently solved by the free agent. The problems are transmitted for solving to the agent by the supervisor. The agent transmits the obtained problems solutions to the supervisor agent. However, the supervisor knows when the free agent finishes an overtaken problem solving.

As examples of informations detained by the supervisor about a coalition, we mention:

- the number of member agents of the coalition;
- the contractor agents' specializations and capacity;
- the problems that are currently solved by the coalition. The problems are transmitted for solving to the coalition by the supervisor. The manager of the coalition transmits the obtained problems solutions to the supervisor. However, the supervisor knows when the coalition finishes an overtaken problem solving.

In the multiagent system, each coalition and free agent can solve problems transmitted for solving by the supervisor agent. The obtained problems solutions are transmitted to the supervisor agent. In a coalition, the transmitted problems are received by the manager of the coalition. The manager agent will transmit the

problems for solving to the contractor agents from the same coalition. The manager agent also is responsible for the problems solutions overtaking from the contractor agents and their transmission to the supervisor.

3. The Proposed Evolutionary Learning Algorithm

In the following, we consider a multiagent system with the structure described in the previous section. A *problems solving cycle* consist in the solving of a set of overtaken problems. The problems transmitted for solving at a problems solving cycle may match a *problems pattern*. A problems pattern describes how the problems are transmitted for solving during the problems solving cycle. A problems pattern describes the transmitted problems types, priorities, deadlines and numbers. An instantiation of the multiagent system structure can be more or less efficient in the solving of the problems that match a pattern. As an example, we consider a multiagent system formed by a small number of agents. The multiagent system must solve a small number of problems that can be received by a single agent. In this multiagent system, for the efficient solving of the problems a single coalition with a manager agent and more contractor agents must be used.

How must reorganize the multiagent system its coalitions corresponding to different problems solving patterns are described by a set *Rules* of organizational rules.

$$Rules = \{Rule_1, Rule_2, \ldots, Rule_k\}.$$

An organizational rule $Rule_i$ has the following form:

$$Pattern_i \rightarrow Instantiation_i.$$

$Pattern_i$ represents a problems pattern. $Instantiation_i$ defines the instance of the multiagent system corresponding to the pattern $Pattern_i$ (how must be distributed the agents members of the multiagent system in coalitions of agents).

All the organizational rules are detained by the supervisor agent. The multiagent system can reorganize autonomously the coalitions at the beginning of each problems

solving cycle, if the problems pattern is known before the beginning of the problems solving cycle, and in the shared knowledge base exists a rule whose precondition matches the problems pattern. A reorganization determination implies a search by the supervisor in the set of organizational rules. The rule whose precondition matches the known problems pattern is selected. The postcondition of the selected rule defines the new instantiation of the multiagent system. After establishes the multiagent system instance, the supervisor agent announce each agent to which coalition must migrate. Each agent will migrates into the coalition where must belong. The determination of the new multiagent system instance is polynomial in complexity.

In the following, we propose an evolutionary learning algorithm, which allows the construction of an organizational rule. Each rule will be created using the learning algorithm. Different aspects related with the evolutionary algorithms are analyzed in [2, 3, 12, 17, 14, 15]. In the paper [16] is described an evolutionary learning algorithm that allows the construction of organizational rules in multiagent systems composed from coalitions of agents. In each coalition is used the *contract net cooperative problem allocation protocol*. Different aspects related with the contract net protocol are analyzed in [1, 19, 12, 16].

The proposed evolutionary learning algorithm called *Learning* allows the construction of the postcondition of a rule whose precondition is specified. The precondition of the rule specifies the problems pattern. The postcondition of the rule specifies the multiagent system instantiation.

Algorithm - Learning

$t = 1$.

Initialize the chromosome population $P(t)$.

While ($t \leq gener$) *Do*

Begin

Evaluate $P(t)$ by using the fitness measure.

Creates a copy B of the best-fitted chromosome from $P(t)$.

Select chromosomes from $P(t)$ using the *Monte Carlo* linear selection method. Let P^1 be the selected chromosomes.

Choose chromosomes from P^1 to enter in the mating pool *MP*. Recombine the chromosomes in *MP* forming the population P^2.

Replace in the population P^1 the chromosomes used in recombination with their children (the population P^2). Let P^3 be the obtained population.

Mutate the chromosomes in P^3.

Replace in P^3 the worst fitted chromosome with *B*. Let P^4 be the obtained population of chromosomes (P^4 represents the new population).

$t = t + 1$.

$P(t) = P^4$.

End

Selects the best-fitted chromosome *BEST* from the population $P(t)$.

End.

Let us denote by $P(t)$ the population of chromosomes at the generation *t*. *Gener* represents the number of generated populations. The initial population $P(1)$ is generated at random. Each population has the same number *n* of chromosomes. The multiagent system has *nr*+1 member agents (a supervisor agent and *nr* agents that can overtake contractor and manager roles). Each chromosome has *nr* genes. A chromosome $c = \{c_1, c_2, \ldots, c_{nr}\}$ specify an instance of the multiagent system. Except the supervisor agent, to each agent *i* a gene c_i correspond in the chromosome. Each coalition can be identified with a natural number between 1 and *nr*. The value $v \in [1, nr]$ of the gene *i* from the chromosome specifies the affiliation of the agent c_i to the coalition with the identifier *v*. All the agents with the same value associated to their corresponding gene are members of the same coalition, the coalition identified with the value of their gene. A gene that has a value different from all other genes' value means that the corresponding agent to the gene is a free agent. In each coalition from

the coalition member agents, the first agent specified in the chromosome is selected as manager agent, the rest of the agents will overtake a contractor role.

An offspring population is generated by means of *selection*, *recombination* and *mutation* operators. The chromosomes of a population are evaluated by the means of a real-valued *fitness function f*.

$$f : C \to R .$$

C represents the chromosomes' space. A chromosome evaluated value with the fitness function specifies how efficiently can solve the overtaken problems the multiagent system. A chromosome's fitness is evaluated simulating the problems' solving witch matches the problems pattern. The efficiency of the problems solving at a problem solving cycle has meanings like: the precision of the obtained solutions, the number of problems that are solved in the maximum allowed time, the problems solving time.

The *recombination* operator *RC* is used to create new chromosomes by combining the genetic information of the parents. We define the recombination operator *RC* as an application,

$$RC : C^2 \to C^2.$$

The recombination operator realizes a (2, 2) transformation, two parents are combined to obtain two offspring. The recombination operator is applied with the probability *PR*. The *mutation* operator *MC* generates new chromosomes by small variations of the genes values in the chromosomes. We define the mutation operator *MC* as an application,

$$MC : C \to C.$$

The mutation operator is applied to all the genes in a chromosome with the probability *PM*. A gene value that suffers a mutation may increase or decrease. *gener*, *n*, *PM*, *PR* are parameters of the algorithm.

A *survival* mechanism based on the fitness measure is applied to select the chromosomes of the new generation from the offspring and parent populations. In the algorithm two types of selections are used. The selection for recombination operator is used to decide which members of the current population *P*(*t*) will be used as

parents of the new generation. The selection for the replacement operator is used to obtain which chromosomes from $P(t)$ and their offspring will effectively enter in the new generation $P(t+1)$. The best-fitted chromosome *BEST* from the last population $P(gener)$ resents the solution (postcondition of the rule).

A new chromosome *cn* obtained after the application of the mutation or recombination operator must satisfy the restriction:

restr : if in the chromosome *cn* exists a gene with the value *k*, then must exist genes with the following values 1, 2,…, *k*-1.

If a newly obtained chromosome does not satisfy the restriction *restr*, then a transformation *TRANSF* is applied, which will modify the incorrect genes values in the chromosome.

$$TRANSF : C \rightarrow C.$$

As an example, we mention the multiagent system $MAS = S \cup \{Ag_1, Ag_2, Ag_3, Ag_4, Ag_5, Ag_6, Ag_7, Ag_8, Ag_9\}$. *S* represents the supervisor of the multiagent system. Ag_1, Ag_2, Ag_3, Ag_4, Ag_5, Ag_6, Ag_7, Ag_8, Ag_9 represent the agents members of the multiagent system that may overtake a manager or contractor role. The chromosome $c = \{1, 3, 3, 4, 5, 6, 7, 7, 7\}$ obtained after the application of a mutation or recombination operator does not satisfy the restriction *restr*. After the application of the transformation *TRANSF*, will be obtained $c = \{1, 2, 2, 3, 4, 5, 6, 6, 6\}$. Ag_1, Ag_4, Ag_5, Ag_6 are free agents. Ag_2, Ag_3 are members of the first coalition, where Ag_2 is the manager agent and Ag_3 is the contractor agent. Ag_7, Ag_8, Ag_9 are members of the second coalition, where Ag_7 is the manager agent and Ag_8, Ag_9 are the contractor agents.

4. Correctness and Convergence of the Proposed Evolutionary Algorithm

The correctness of the proposed evolutionary algorithm can be demonstrated theoretically. Each chromosome obtained during a learning process represents a valid instantiation of the proposed multiagent system architecture. Only the mutation and

recombination operators can modifies the chromosomes from a population. The transformation *TRANSF* is applied to each obtained invalid chromosome, which guarantees the correctness of the obtained chromosomes. At the end of each run of the algorithm, a correct organizational rule is obtained. The precondition of the rule is the problems pattern that is specified. The postcondition of the rule specifies a correct instantiation of the multiagent system structure. In each newly obtained population, the best chromosome from the old population is transferred, witch guarantees that the best chromosome obtained during the learning is not lost.

We have realized simulations of the proposed evolutionary learning algorithm in a multiagent system composed from a supervisor agent and 300 agents that can overtake contractor and manager roles. In the multiagent system are used 90 problems solving specializations. Each contractor agent may have between 1 and 90 problems solving specializations. During the simulations, the agents were endowed with different specialization sets. The simulations were realized for a large number of different problems solving patterns. The simulations show that the problem solving time in the multiagent system decrease if the multiagent system is organized accordingly with the problems solving patterns. Running the evolutionary learning algorithm, the average problems solving time decrease in more consecutive populations, until there are not obtained significant improvements. The best-fitted chromosome from the last population represents the solution.

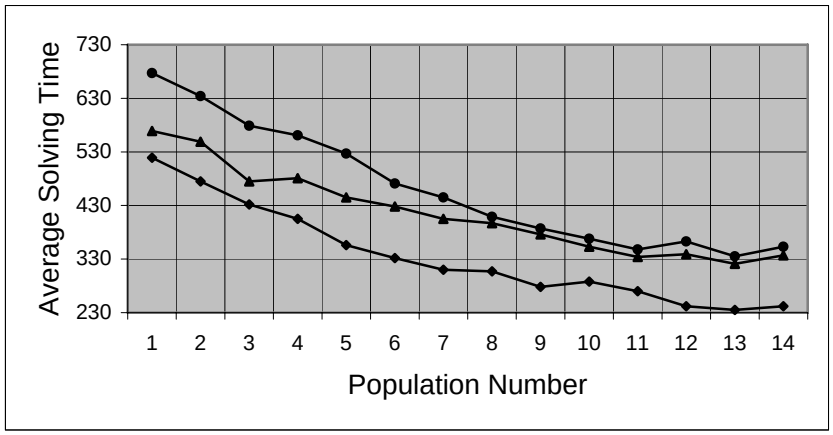

Fig. 3. *Simulation results*

Figure 3 presents the average problems solving time for the construction of three organizational rules in 14 generated populations. The problems patterns used by the algorithm are composed from 50 types of problems. Each newly generated population is composed from 25 chromosomes. Are used a crossover operator with a single crossover point and a strong mutation operator. The probabilities of application of the crossover and mutation operator are 0.33 and 0.08.

5. Conclusions and Future Work

A large number of agents distributed in a network cannot form a centralized multiagent system that can solve efficiently problems. The problems solving efficiency decrease if the agent with the manager role overtakes for solving large numbers of problems and doesn't have enough knowledge to establish the contractor agent that can solve efficiently an overtaken problem. Each contractor agent has problems solving capability and capacity. The multiagent system architecture described in this paper is proposed to eliminate this disadvantage. An instantiation of a multiagent system with the proposed architecture may include a larger number of agents as members then a centralized multiagent system.

An instantiation of the proposed multiagent system architecture can be more or less efficient in the solving of the problems that matches a problems pattern at a problems solving cycle. The multiagent system using a set of organizational rules can reorganize its coalitions of agents at the beginning of each problems solving cycle. The purpose of the reorganization consists in the efficient solving of the problems at each problems solving cycle. A reorganization at the beginning of a problems solving cycle is possible if are known the necessary informations about the problems that have to be solved at the following problems solving cycle. The organizational rules are constructed using a novel evolutionary learning algorithm.

The knowledge collection necessary for the reorganization of a multiagent system may have many difficulties [19]. In a proposed multiagent system, the supervisor

agent detains the knowledge necessary for the reorganization. However, he can coordinate the multiagent system reorganization at the beginning of each problems solving cycle.

The next research includes the development of a technique that allows the generalization of the organizational rules. This supposes the running of the evolutionary learning algorithm in simple cases, for multiagent systems with smaller number of agents and simpler problems patterns. The obtained learning rules have to be generalized. A rule's generalization process supposes the scaling of the rule precondition and postcondition.

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