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# Autopoietic Information Systems in Modern Organizations

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## Abstract

In this paper we argue about the possibilities of applying the concept of autopoiesis to modern organizations information systems. Modern organizations today in a rapidly changing, turbulent and complex environment are virtual, open, heterarchic and autopoietic. The main question in this paper we try to address is how to support such organizations with an adequate information system? We show that it is possible to develop autopoietic information systems which should be able to respond to the chalanges of modern organizations.

**Keywords**: autopoiesis, information system, organization

## 1. Introduction

Modern organizations are today very liable to often and fundamental changes that come not only from their environment, but also from their internal need for change. Every day we witness many organizational structures and forms that radically change the basic premises of organizations. Organizations in today's dynamic circumstances are virtual, networked, autopoietic and open (Žugaj and Schatten, 2005:1). The concept of organizational architecture is maybe a good metaphor for a holistic view of an organization. Organizational architecture states that the organization should be perceived in its

entirety as an open, complex, chaotic system which influences and is influenced by its environment (Žugaj and Schatten, 2005:21).

The environment is the main factor that determines new trends in organization, as well as organizations by implementing these trends influence the environment. In such a context we can define the main forces which drive organizations to change. According to Nadler these forces include (Nadler et al., 1992:1-3): technology, competition, oversupply, globalism, customer expectations, government participation, ownership and work force dynamics.

We can conclude that only those organizations that will be able respond to the above mentioned challenges will survive. . In order to survive, organizations develop and create new organizational forms like[1] (Nadler et al., 1992:5-8): (1) autonomous work teams, (2) high performance work systems, (3) strategic unions and alliances, (4) organizational satellites and spinouts, (5) networks, (6) self-organizing organizations, (7) fuzzy boundaries and (8) team work on the top of the organizational pyramid.

The fundamental question is how to support these modern dynamic organizations with information technologies, in other words, how to design, implement and maintain an adequate information system in these dynamic conditions.

## 2. Modern Organizational Forms

Many new organizational concepts, structures, architectures and forms have been described in modern organization theory literature. The basic concepts on which we base our further elaboration are: (1) heterarchic or networked structures, (2) *ad hoc* structures, (3) process and project approach, (4) organizational openness and (5) the concept of autopoiesis from organizational chaos theory (Schatten and Žugaj, 2005:217).

### 2.1. Heterarchies

The concept of a *heterarchic* organization (or network organization) is based on the following: an organization consists of organizational units (which in this context can be individuals, teams, departments, divisions and even entire organizations or groups of organizations by the fractal organization principle (Žugaj and Schatten, 2005:149-151)) which are mutually connected through information links (mostly based on modern information technology), are mutually independent, heterarchically organized (as opposed to hierarchy), and they operate internally and externally (with their environment) in most cases sharing some common goal (Žugaj and Schatten, 2005:106). The idea of a

[1] It should be mentioned that these organizational forms are most common in services and information sector organizations. Examples of such organizations are consulting, software engineering, architecture, marketing etc.

heterarchical organization comes from the neuropsychological research of the human brain which were conducted by Warren McCulloch in 1945 (Reihlen and Rohde, 2004:3). He concluded that the human brain must have a heterarchical organization as opposed to previously defined hierarchical models, and described this organization as a neural network which is specifically designed for parallel information processing. If we apply such a concept to an organization, we get a structure which interrelationships are not strictly defined, but rather activated, or self regulated depending on the particular situation (Žugaj and Schatten, 2005:106).

A good example for this kind of organization is the fishnet organization, shown on figure 1. If we observe a fishers net on the coast, it seems completely nonhierarchical. But if we take one node and lift it up, we get a hierarchical structure. Lifting further nodes and putting down the old ones, we can see the dynamical creation of the new and the destruction of old hierarchical structures.

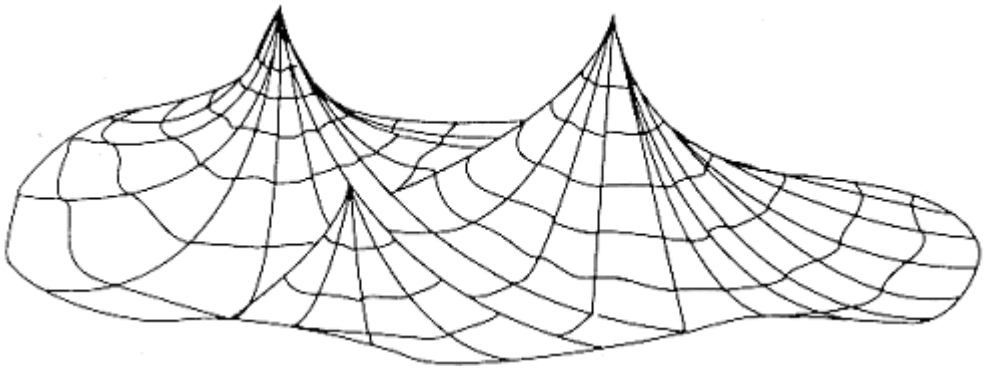

**Figure 1.** The fishnet organization (Johansen and Swigart, 2004:on-line)

### 2.2. Ad-Hocracies

*Ad-hoc* suprastructures are concepts which built on top of the existing organizational structures and they emerge as a response to some problem or change in the immediate environment of an organization (Žugaj and Schatten, 2005:119). Ad hoc organizations are characterized by adaptability, readiness, individual initiative, desire for experimentation, creativity, and outside growth and support (Baker and Branch, 2005:7). They usually disappear when the environment problem is solved. A Virtual organization[2] is a target oriented suprastructure of geographically separated entities (organizational units) which are specialized for a predefined area of activity, are interconnected through space, time and organizational limitations, mostly using information, communication and network technology for efficient

[2] Virtual organization is one of the most widespread examples of ad hoc organization in expert literature. Barnatt (2004) says that these organizations exist in cyberspace, that they develop proportionally with the development of information and communication technology and that they can be found in conventional organization structures. Under cyberspace he understands the media in which electronic communication and computer programs exist, and he argues that the understanding of the term is essential to the understanding of the virtual organization.

and flexible cooperation and exchange of knowledge. Figure 2. shows the concept of a virtual organization.

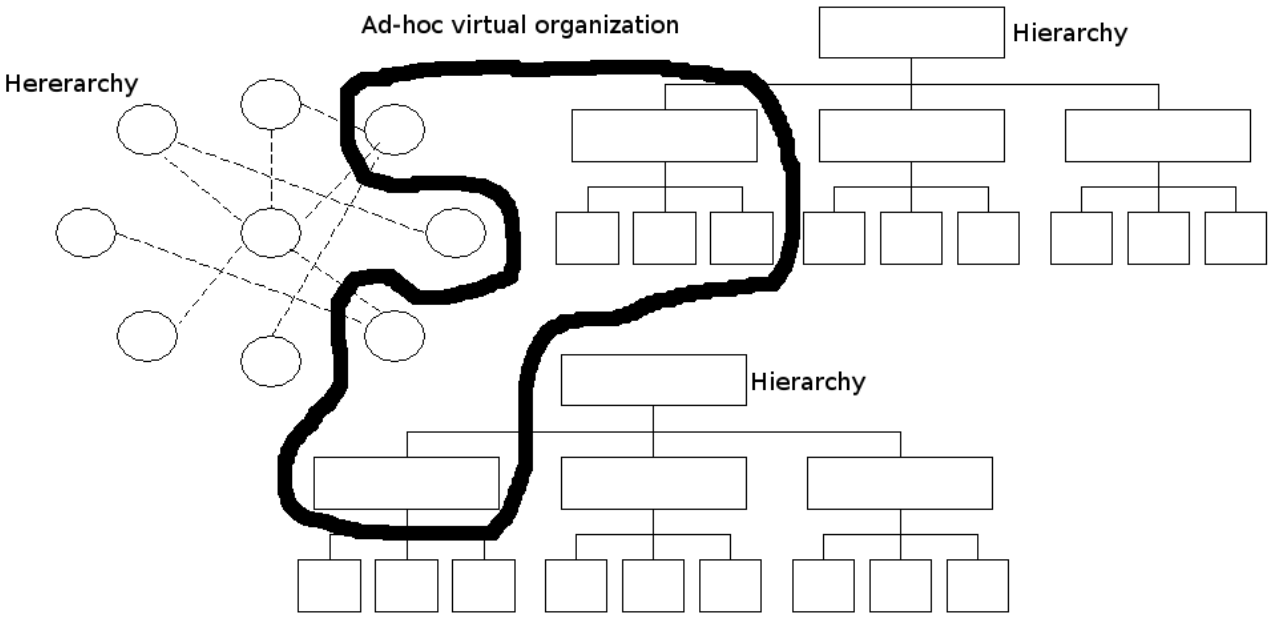


**Figure 2.** The virtual organization (Barnat, 2004:on-line)

### 2.3. Process and Project Orientation

*Process and project orientation* put an organization into a different perspective. They approach an organization as a system of processes instead of departments and hierarchy, an they analyze a series of ventures or projects instead of continuous business operations respectively. In the process approach[3] grouping is performed by simultaneously applying all the principles which evolved from classical management theory, which means that work broken into pieces by the *scientific management* is being reintegrated (Buble, 2003:80). The project approach to organizing subsumes task or project orientation and interdisciplinary team work. Projects are always time limited, so a project organization is time limited from the beginning of the project until its ending (Dulčić et al., 1996:44).

At a first sight, it seems impossible to combine these two approaches together[4], but their mutual benefits, with elimination of their disadvantages can be useful in the hypertext organization introduced by

[3] Which is very important due to the business process reengineering and similar paradigms that enable business system management through business processes and their support through information technology.

[4] The process based approach is oriented to everyday operations, while the project based approach is oriented to certain ventures which generally are not repeatable and are time limited.

Ikujiro Nonaka (1995). This kind of organization consists of three layers – a business layer, which in essence is performing everyday bureaucratic tasks; a project team layer used for executing the multidisciplinary activities which increase the total knowledge of an organization; and a knowledge based layer that is imaginary and in which the knowledge accumulated in the previous two layers is once again categorized and put into new contexts (Žugaj and Schatten, 2005:165-168).

**2.4. Openess**

Modern organizations must permanently be in contact with their clients and are forced to be more open. This behavior makes the boundaries which separate the organization between its surrounding become fuzzy[5]. The most important factor apparently seems to be technology. When a client can "enter" the network and interact directly with organizational tools and when the client becomes a part of the business process helping in the products and services design; it will be hard to determine who is and who isn't a member of an organization. The development of mechanisms for managing such unclear boundaries would enable organizations more positive interaction with its surrounding . One of such mechanisms is the open organization concept[6] as a result of using the open source concept in organizations (Nadler et al., 1992:1-3).

**2.5. Autopoiesis**

The word autopoiesis comes from the old Greek word *autos* which stands for self and *potein* which means create. In context of autopoietic systems it can be said that the product of an autopoietic system is the system itself (Žugaj, 1996:59). The term autopoiesis was first introduced by Humberto R. Maturana who published an article in the year 1980: *Autopoiesis and Cognition: The Realization of the Living*[7] and gave the basic ideas of autopoietic theory in cognitive biology in collaboration with his student and associate Francisco J. Varela (Whitaker, 2001:on-line).

They noticed that organisms have the ability to adapt to their environment, while being able to keep their own identity inside that environment. That dual capability is called autopoiesis. In cybernetics, autopoiesis is a special case of homeostasis in which the critical system constant variable is the organization itself.

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[5] Architectonic elements like strategic unions and alliances, organization satellites and networks accent this unclearness even more.

[6] Open organization is an „organization which is in constant interaction with its customers, which attentively listens and respect their opinions, an organization without strict hierarchical relations in which their members network together in order to achieve their common goal. It is a project, fully process oriented, transparent and autopoietic organization" according to Žugaj and Schatten (2005:921-922).

[7] Which is actually a combination of two earlier works published in 1970 and 1973.

Niklas Luhmann, a German sociologist whose work is fundamental to social system theory, found autopoiesis in social systems. The main basis of his theory is communication, since social systems are systems of communication. Every system is determined by the border between the system and its environment. This border is in the case of social systems complex (chaotic) in nature. Therefore, the internals of the system is an area of reduced complexity. Communication inside the system is performed by choosing only limited quantities of information outside of the system, while the process of choosing information is called reduction of complexity. The criterion on which information is chosen from the surrounding is called a sense (germ. *Sinn*). Every social system has its distinctive identity that is constantly reproduced in its communication, and depends on what is considered to be of sense or to be senseless. If a system is unable to reproduce its identity, it looses its sense and disappears back into the environment. Luhmann called this process of reproduction of filtered elements from a complex environment autopoiesis (Wikipedia, 2005:on-line).

Since organizations are a special case of social systems it was expected that the concept of an autopoietic organization would also emerge (Bakken and Hernes et al., 2003). Autopoiesis in organization can be metaphorically explained as a fact that organizations survive as independent entities, although the people inside them are changing due to constant employee fluctuation.

**3. What is an Autopoietic Information System?**

After defining autopoiesis in biologic, social and organizational systems, we try to define it in the context of information systems. To be able to define an autopoietic information system we need to answer a few other questions, such as: how should an autopoietic information system for modern organizations look like? Is it possible that such systems already exist, and if they don't exist, is it possible to utilize some familiar concepts taken from existing information systems in order to create such a system?

Autopoietical information systems must support heterarchical relations and if possible enable the establishment of a fishnet organization in order to express the necessary potentials on an individual at the right time. Such systems must be able to support an ad hoc or virtual organization which means that it has to be adaptable and enable quick changes. They must enable process and project approach to organization management and should be open to enable customers to constantly interact with the organization. The system must be autopoietic, but the question is what does it mean that an information system is autopoietic?

To answer this question, we must set up the following definition: *Autopoiesis in the context*

*information systems denotes the ability of an information system to continuously adapt to the needs of its current users and also to keep all the characteristics that make it unique and recognizable as an information system*. Using this definition we can define an autopoietic information system as: *a system that continuously adapt to its users and the surroundings in which it operates, by collecting, storing, keeping, processing and disseminating information important for the organization and society, in order to make it accessible to everyone who wants to use it*.

According to these definitions, we could state that all information systems are autopoietic in a higher or a lower degree[8]. But are today's information systems able to satisfy the needs of modern organizations. Information systems implemented in today's organizations are mostly inflexible because they represent a data snapshot of reality at a given moment and they hardly adjust to dynamic circumstances. We can conclude that there is no such information system today that would be able to solve the problems of modern organizations.

Are there concepts which would enable the construction of such system and if they exist, what are they? The definition of autopoiesis in context of information systems reminds of the open source paradigm. Information systems which are developed in an open source manner become more and more adjusted to its users needs. The necessity to network and the necessity to be adaptable reminds of modern WEB2.0 technologies which we shall address at once.

### 3.1. Open Source Paradigm

The approach of building information systems and applications based on open source is used by many very successful systems[9] like Apache, Perl, Wikipedia, Mozilla and Linux, as the most popular example. The concept of an open source project[10] functions in the following way: a programmer (or few of them) start an information system or application development project. All the source code they produce, the application and the documentation is publicly accessible, usually via Internet. Users play an important role in the system development process, they test it, check it, make suggestions, report bugs, criticize functionality etc. If the application or information system is widely used, it becomes more and more aligned with the customers' needs and its environment, which by our definition means that the information system or application is developed autopoietically.

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[8] The degree of autopoiesis manifests in degree of adaptability of the system to its users and environment.

[9] Many successful systems, probably much more than open source systems, were developed in a closed source environment using traditional software engineering methodology.

[10] Not to be mistaken with classical (commercial) application development, where a development company in addition to the application sells the customer the source-code of the application.

A question to ask here is how is it possible in such an apparently chaotic development to achieve any results at all, and in some cases even excellent results? One of the fundamental problems with classical software development models is the so called Brooks law which states that "the complexity of execution and communication in a project has a square growth with the number of executors, while the work done has only a linear growth". In other words, with *N* executors on a project, there are:

$$\frac{N \cdot (N-1)}{2} \tag{1}$$

communication lines between them, which would make the communication in a project with thousands of executors (what is the case of open source projects) almost impossible. But Brooks law implicitly resides on the premise that the communication structure among executors is a full graph (everyone communicates with everyone), which isn't the case with open source projects (Raymond, 2005:on-line). Autopoietic information systems for modern organizations could be developed by taking advantage of the open source paradigm. In this manner they could be constantly adopting to the requests and needs of its users and its environment.

**3.2. Modern Network Technologies**

Modern network technologies are the consequence of the fast growth of Internet, the world's biggest network. The Internet became very popular among organizations that want continuous communication with their clients. It is necessary to describe the most important network technologies in order to understand them better.

A *forum* is a network application which allows its users multimedia communication (most often through text, images, and simple animations) and is organized into subjects and subforums. A forum is hierarchically organized in a way that every user can participate in the communication process by answering previous messages. The communication process of such a system can be thought of as a general tree structure in which nodes are messages and arcs are the essential connections between message and answer.

The concept of *wiki* system operates in the following way: every user or visitor of a wiki service on the Web can change articles and information which he encounters, add new articles and/or information and argue about the existing ones. An additional mechanism that is built into such systems is the possibility to interconnect terms used in articles. In other words, every term which is mentioned in one article of the system can be connected with other articles which elaborate it further. This mechanism allows easier finding and explaining of the unknown terms to its users. A disadvantage of such a system is

the lack of a mechanism for consistent decision making. In other words, such systems are often affected by the so called editor wars, when users are fighting each others by constantly changing some disputable article content.

*Peer-to-Peer* (P2P) is a group of network protocols which, instead of the usual client-server model, enable every participant to simultaneously be both client and server. The concept is based on mutuality in a way that every user shares certain contents at disposal to other users what gives him the right to access their shared content. P2P protocols are not used for interpersonal communication, but for the exchange of electronic data. Their advantages are noted in stability of the system and fast and dynamic dispersion of electronic data. Disadvantages are lack of content organization and inability to determine the trustworthiness of certain electronic data.

*Web services* are modern networking technologies which enable remote procedures or services usage as if they were local. They enable the develop of distributed networking applications without the need to contain all the parts of it on a single computer or server. *Extensible markup language* (XML) is a data description language. It is very simple and intuitive and it is often used in conjunction with web services for interchange of data between the local application and the service. *Business to business* (B2B) communication is a modern communication concept between different organizations, distinguishing it from *Business to Customer* (B2C) communication model used by the organizations to communicate with their customers. B2B often rely on concepts such as web services and XML for the interchange of data.

### 3.3. Additional Concepts

The above mentioned concepts are by far not enough to address all the needs of dynamic organizations. Therefore it is important to examine other concepts for improving the system efficiency and adaptability.

An *Open Source Project Management Systems* (OSPMS) is a system that enables management of open source projects. It is comprised of different communication channels used by the developers or open source application users to communicate with the project leader, or in most cases the programmer himself. It also contains a *Concurrent Version System* (CVS) used to manage concurrent versions of the open source project.

Mind mapping is another modern communication technique. It is used across many different areas which include personal, family, educational and business situations, for making notes, modified brainstorming technique, composing reports, repetition and generally explaining of complex concepts

(Wikipedia, 2006:on-line). This technique can surely find its place in an autopoietic information system for modern organizations because of its versatility and adaptability to human comprehension behavior.

Idea writing and Delphi are creative group-based problem solving techniques. The brainstorming technique, where participants generate a great number of ideas through intensive discussion, is far more familiar. But, brainstorming assumes that all participants are physically in the same room so that they can discuss. In a network environment this is not the case. Of course, it is possible that they communicate on-line; using real time chat applications but the idea writing technique variant is considered more appropriate to implement. Idea writing is used to solve problems that require great creativity and a large number of solution variants for solving them. Delphi applies to problems for which it's hard to find a consensus and a small number of special solution variants is required.

One important question when modeling information systems, if not the most important one, is quality and effective decision making support. Decision making is the process of creating and evaluating solution variants of some problem as well as the process of choosing among these variants. In essence, decision making is a process that can last a longer or a shorter period of time and results with a made decision. This definition implies that the decision making process consists of two phases: (1) decision preparation phase and (2) decision making phase.

The integral decision making process (in a wider context) includes two more phases: (3) decision implementation phase and (4) implementation control phase (Sikavica et al., 1999). By passing through the phases of the integral decision making process, the decision-maker uses certain methods and procedures which ease up the final decision making, and enable him the supervision and control of decision implementation. In the preparation phase, the decision-maker informs himself about the problem and decision goals, possible solution variants are being generated and their evaluation is performed. Preparation phase thus consists of five sub phases:

(1) Problem identification

(2) Tasks and goals definition

(3) Current situation snapshot and analysis (information gathering)

(4) Solution variants generation

(5) Solution variants evaluation.

In a decision making phase one of the previously proposed variants is being chosen. Decision implementation phase is a phase in which the previously chosen decision is being implemented. In

implementation control phase, the decision implementation is checked and monitored. This phase can include monitoring decision results, monitoring correctness of the decision implementation etc.

The integral decision making process shows extremely good characteristics for being supported by modern information technologies. Modern expert systems, decision support systems and management information systems often do not implement all the phases of this process. Similar modern groupware tools are not focused on the decision making process. Therefore the idea of implementing this process into an autopoietic information system for modern organizations emerged.

### 3.3.1. Autopoietic System for Continuous Development

The idea of an autopoietic system for continuous development is very simple and it fits the open source paradigm development framework. Since the system being developed using open source paradigm is constantly under improvement, several methods and techniques evolved to support the upgrade and change of such system. It is possible to modernize that concept by directly integrating the upgrade and change subsystem into the information system. It is necessary to enable that the development of the system can be performed in parallel with operation of the system that includes a decision support mechanism. Therefore, the decision to upgrade or perform a global change should be performed by an automatic procedure which starts the adequate method of the information system which is being changed or upgraded.

### 3.3.2. Autopoietic Filtering System

In order to make the system more heterarchic, we propose the following concept. Every user can be an information moderator, instead of specific, selected individuals. That way, everyone could make his own view of information which is published on the system. Moreover, we are adding the possibility that everyone who wants can acquire the view or filter of another user. In that manner, a list of best moderators is created autopoietically.

### 3.3.3. PageRank/InPrestige

Structural Deep Democracy (or SD-2) is an elaborate (SD-2, 2006:on-line) application of PageRank/InPrestige algorithms in social systems. The PageRank algorithms family serves for web crawler page ranging, which is among others one of the reasons for enormous success of the company Google. PageRank, besides taking only web page contents, takes into account the number of ingoing and outgoing hyperlinks to the page and from it.

Ingoing hyperlinks are hyperlinks from other pages that link to the current page. Outgoing

hyperlinks are hyperlinks to which the current page points. PageRank is iterative and starts from a randomly selected page following its hyperlinks. It can be observed as a Markov process in which states are pages, and transitions (all equally possible) are hyperlinks between pages. If the system encounters a page that has no hyperlinks, or a loop occurs it is solved by randomly choosing another page again and starting over. In order to keep the fairness, because of large number of web pages and long calculation times, to all pages a transition to a randomly chosen page is added with a probability $q$ which is in most cases equal to 0.15. The formula to calculate the rank, which is a probability for a random user to open exactly that page, is shown under (2)

$$PageRank(p_i) = \frac{q}{N} + (1-q) \sum_{p_j \in M(p_i)} \frac{PageRank(p_j)}{L(p_j)} \tag{2}$$

where $p_1, p_2, ..., p_N$ are pages under consideration, $M(p_i)$ is a collection of pages that point to $p_i$, $L(p_j)$ is a number of hyperlinks which are coming from page $p_j$, and $N$ is the total number of pages (Wikipedia, 2006:on-line). It should be noted that although the algorithm looks very dynamic with often changes, page ranks stabilize after a certain period of time, allowing for the simpler processing.

If we assume that every page is an individual in some social system, and every link is a vote which an individual gives to another individual we get the InPrestige algorithm for social networks a concept on which SD-2 is based. If we transfer a modified SD-2 concept into an organization, we get a flexible mechanism to support the fish net organizational structure because rank based data can be a good indicator for capability of a node in certain area.

**4. System Model**

The autopoietic information system model contains the above described concepts. It has to be an open type system in order to support open organizations which imposes a web based interface. As a starting point, the information system framework should be a Open Source Project Management System (OSPMS). That way we are setting up an organizational procedure or rule by which every member of organization can start one's own project. Moreover, from OSPMS we can take version management systems and systems for alerting interested parties about project results. Using this formation we are stimulating the heterarchical structure of organization members.

If on every project a network structure of project participants is formed in a way where PageRank or SD-2 concepts between project members are implemented, we get a fish net structure or specific decision structure for the particular project. That means that as the number of projects will grow, we shall

be able to identify the most competent individuals for certain project types. SD-2 recommends that with smaller groups (up to ten members) three, and with larger groups five members should get the right to make decisions by voting.

A wiki system can provide the ability for everyone to participate in content creation and elaboration, advanced content publishing capabilities bound to every single project, as well as the term interconnection system. Mind mapping as creative a presentation method can also find its effective usage. Moreover, every single project can have its own discussion forum.

In order to introduce certain order in potential disorder, we establish the autopoietic filtering system with a modification to use SD-2 instead of ranking lists. We do that by forming a permanent project in which are autopoietically developed guidelines for moderating and moderators themselves using PageRank algorithm are creating a moderators hierarchy.

On a system organized like that, we add the integral decision making process implementation. We set up an organizational procedure by which every decision should pass all the phases of integral decision making process. It is necessary to implement appropriate presentation methods and, if necessary, multimedia content for information gathering sub phase. It is necessary to implement creative problem solving techniques like idea writing and Delphi for solution variants generating sub phase. Also it is necessary to establish a procedure by which everyone involved in a project can participate in generating ideas, if they wish to. In solution variants evaluation phase it is necessary to implement one or more of multicriterial decision making methods (like decision tree, Electre or Promethee) which should be accompanied with the ability for every project member to make its own evaluation and publish it.

In initial OSPMS it is necessary to build in an autopoietical system for further development and administration. We do that by establishing two more additional projects in which we perform (1) the administration of the current system and (2) further development based on the open code principles. By doing that, a system becomes adaptable and enabled for fast changes.

Our system still misses integration features which we accomplish by setting up web services for B2B communication. To make the integration features truly autopoietic, we suggest the usage of a modified P2P protocol for sharing of a data warehouse which emerges during time in an autopoietical information system.

We can state that an information system organized like that would be heterarchical and it would support the fish net structure. Moreover, since it has a web based interface, it enables the establishment of

ad hoc and virtual organization. The system also enables the hypertext organization concept by which it represents the project team layer and knowledge based layer implementation. The remaining layer requires a traditional information system to support a bureaucratized business operation in an organization. At the end, we can say that this system would be extremely autopoietic, unlike existing information systems.

## 5. Partial Solutions

As mentioned earlier, there is no such system which incorporates all the concepts described in this paper. Still there exist some systems which can be considered partial solutions. Open Source Project Management Systems like *Source Forge* (SF, 2007:on-line), *Ruby Forge* (RF, 2007:on-line), *LibreSource* (LS, 2007:on-line) etc. offer their users a lot of functionality like wiki systems, forums, mailing lists, concurrent version and other systems. Still such systems are specially designed for open source application development projects, and not oriented towards organizations. Also they lack decision making capabilities which make them almost useless for modern organizations.

Modern semantic wiki systems add semantics (meaning) to traditional wiki systems. They have the capability to better organize knowledge on a wiki-like system but still lack project management and decision making functionality.

A partial implementation on which the authors work, but which is still work in progress can be found at (TAOPIS, 2007:on-line). The aim of this project is to create a system similar to the described one, but is far from completion.

## 6. Conclusion

In this paper we pointed out that modern organizations need a new kind of information system, a system which will support virtual, heterarchic, open and autopoietic organizations. We argued that such a system, which will fit the need of dynamic organizations, has not been developed yet.

We showed also that the term autopoiesis besides in biologic, social and organizational contexts, can also be considered in an information system context. We propose that an information system is autopoietic if it continuously adapts to the needs of its users and its environment. If an information system is autopoietic enough (since as we argued every information system is autopoietic in a higher or lower degree) it will be able to support modern organizations.

We analyzed modern information technologies (especially concentrating on network technologies) in order to identify concepts that make one information system more autopoietical than others. Open source was identified as a concept which allows information systems to be developed autopoietically.

Forums, wiki systems, Web services, project management systems, the PageRank algorithm implemented in an organizational context allow users to communicate and work in an heterarchical, open and virtual environment. Modern organizational and communicological concepts like the integral decision making process, idea writing, the delphi method, mind mapping allow for creativity and decision making in a turbulent and distributed environment.

We proposed a model of an autopoietic information system which takes advantage of the analyzed technologies in order to support modern organizations. Our future research will be oriented towards the implementation of such a system in order to test our premises.

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