NEW CHARACTERISTICS OF VIRTUAL PHENOMENA, ESPECIALLY OF VIRTUAL ORGANIZATIONS

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Abstract

Virtuality is the property of computer system with the potential for enabling a virtual system (operating inside the computer) to become a real system by encouraging the real world to behave according to the template dictated by the virtual system. Virtual phenomena like virtual memory, network switching, virtual teams, virtual reality and virtual organization may change our way to work and perceive. Hence it is important to understand virtual phenomena, especially the virtual organization.

In this paper we shall classify those virtual phenomena into some classes of dynamical systems. Our analysis will show that all the phenomena do not belong to one class only, but to the several classes. An outcome of our classification is that a certain class will give some new information about a particular virtual phenomenon; e.g. the virtual organization can be kept as a self-steering system where the same state never returns.

Mowshowitz' (1997) extreme definition of virtual organization played an important role as a motivator of our analysis. It, for example, raised a question: Does virtual organization have its own production/service or not? After showing that it had to have its own core competence, we succeeded also to find a new category of interdependency between co-operating organizational units. This new category, called parallel dependency, may have a lot of useful applications in the future.

Keywords: Virtual organization, systems theory, interdependency

Introduction

Recently Mowshowitz (1997) defined his view on the concept of virtual organization. The main idea is as follows: "The virtual organization approach makes explicit the need for dedicated management activities that explore and track the abstract requirements needed to realize some objective while simultaneously, but independently, investigating and specifying the concrete means for satisfying the abstract requirements." Mowshowitz characterizes *virtual organization* in terms of four basic management activities that

depend on separating requirements from satisfiers:
I. Formulation of abstract requirements (e.g., requests of information);
II. Tracking and analysis of concrete satisfiers (e.g. information services);
III. Dynamic assignment of concrete satisfiers to abstract requirements on the basis of explicit criteria; and
IV. Exploration and analysis of the assignment criteria (associated with the goals and objectives of the organization).

We must immediately note, that Mowshowitz' definition above is very clear and abstract. We could even call it as Weberian ideal type, and hence it seems to form the good basis for further analysis and comparisons. Mowshowitz himself applied his virtual organization construct with the first three features (I ... III) into disparate phenomena, including virtual memory, network switching, virtual teams and virtual reality by demonstrating abstract requirements, satisfiers and criteria. His purpose was to show common characteristics, i.e. how close to each other those rather different constructs are from virtual point of view.

To our mind, Mowshowitz purposefully or by accident forgot the fourth feature. It is therefore interesting to identify that those virtual phenomena are not similar, when the fourth criteria is taken into account. The differences are already implicitly expressed when Mowshowitz describes criteria used in assignment of satisfiers to abstract requirements in each phenomenon.

By referring to this subproblem, our research approach can be called conceptual research (Stohr and Konsynski 1992, 302-307), because we shall conceptually criticize Mowshowitz's conclusions. All the phenomena (virtual organization, virtual memory, network switching, virtual teams and virtual reality) can be considered as a dynamic system. We are going to use Aulin's (1989) exhaustive classification for dynamic systems, and as the first contribution to show that all the phenomena do not belong to the same class of dynamic systems. This will make the differences between virtual phenomena even clearer.

According to Mowshowitz (1997) the virtual organization will assign satisfiers to requirements by using "cut-and-paste"-method. This may be the valid approach, when the number of requirements is small. But when it is large, some other method is needed. As the second contribution we shall propose some operations research approaches for the latter.

By referring to Mowshowitz´ (1997) key features we can say that some organizations, say customers, will present particular requirements or tasks to the virtual organization, and the latter will try to find some satisfiers, say suppliers or partners, to perform those tasks. The suppliers, the virtual organization and the customers then clearly constitute a value chain (Porter and Millar 1985). Kumar and van Dissel (1996) found that the value chain is one of the Thompson´s (1967) three types how organizations can co-operate. Mowshowitz seems to keep the virtual organization as a broker between customers and suppliers. To test Mowshowitz theory of a virtual organization, we shall in the similar sense as Lee (1989) make an attempt at its falsification. The broker role does not seem to be long-lived, because Benjamin and Wigand (1995) with good reasons forecast that the brokers would disappear. Hence, the theory of virtual organization in the Mowshowitz form should be falsified.

In order to be constructive, reasoning above put us to ask: What is the minimum requirement for the virtual organization to exist? We shall therefore analyze the position and future of the virtual organization and we shall show that the virtual organization necessarily needs own core competence and it can organize its co-operation with partners in a new way. Actually our analysis will produce the new fourth category to the Thompson´s (1967) typology as the third contribution of this paper.

We shall next classify the different virtual phenomena to classes of dynamical systems. We then present better assignment methods for pairing requirements and satisfiers. We finally analyze the position of the virtual organization in the value chain.

Analysis of assignment processes of different virtual phenomena

Our starting point in this section is the Mowshowitz´s claim that virtual organization, virtual memory, network switching, virtual teams and virtual reality resemble each other as systems. His arguments were based on the first three features (I ... III) of his definition. We shall show that those virtual phenomena, however, have some differences and then use Aulin´s (1989) classification of dynamic systems as a yardstick. The classification is based on exact mathematical considerations, which to our mind may give a more firm basis for analysis than some empirical cases. At the end of this section we shall consider the assignment problem in a virtual organization from the operations research point of view.

Aulin's classification

According to Aulin (1989, 18-27) the dynamical system can have either nilpotent or full causal recursion. The system with nilpotent recursion has the rest state. The initial state is called the rest state and the nilpotent dynamical system has the property that it comes back to its initial state after the finite number of units of time. We can say that an external disturbance (or stimulus) occurring at the beginning throws the system out of its rest state to a perturbed state, after which the nilpotent causal recursion conducts the system back in the rest state. During its return journey the system gives response to the stimulus. If the same stimulus is offered again, the system gives the same finite total response. Thus it is a memoryless system that does not learn from experience. (We shall here describe Aulin's classification verbally – you can find the mathematically exact expressions in Aulin (1989, 18-27).)

If the nilpotent system contains feedback, it is called a cybernetic nilpotent system. If a computer is programmed to solve a finite problem, i.e. a problem that can be solved in a finite number of steps of computation in the machine, it is the cybernetic nilpotent system. (But computers can also be programmed to simulate systems that have a full causal recursion.)

A dynamic system with a full causal recursion does not have any rest state to be reached in a finite number of steps (during a finite time). The causal systems can be classified into two categories: nilpotent systems with a constant goal function (in time) and systems with a full causal recursion with a continuous goal function in time.

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causal systems
  |
  |--- nilpotent systems
  |
  |--- systems with a full causal recursion
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The causal systems with full causal recursion can be divided into four classes depending on whether the system will disintegrate after a certain disturbance and its trajectory disassociate from the path of its old goal function, or the system is steerable from outside and its path goes in the constant distance of the path of its old goal function or it comes closer to the path of its old goal function in time. The latter can be either finite (self-regulating systems) or infinite (self-steering systems).

```
causal systems
  |
  |--- nilpotent systems
  |        |
  |        |---mechanistic
  |        |
  |        |---cybernetic
  |
  |
  |--- systems with a full causal recursion
          |
          |--- self-steering systems
          |
          |--- self-regulating systems
          |
          |--- systems steerable from outside
          |
          |--- disintegrating systems
```

It is important to note that Aulin´s classification of dynamic systems is exhaustive, i.e. it covers all the types of dynamic systems. In order to get definite views on the classes above we shall show, which real system belongs to each category. If the uniqueness of the states of mind, along with the goal-oriented nature of thought processes, is typical of human consciousness, the only thinkable causal representation of what takes place in human mind in an alert state is the self-steering process. According to Aulin (1989, 173) it is, however, necessary to limit the interpretation so that what is self-steering in human mind is the *total* intellectual process. All the partial processes needn't be self-steering.

Real-world examples of self-regulating systems are: a ball in a cup that has the form of a half-sphere, a room equipped with a good thermostat (self-regulating equilibrium systems); some living organisms like a heart (periodically pulsating self-regulating systems); etc.

A flying ball (the resistance of the air is negligible), a frictionless oscillator and a robot are examples of systems steerable from outside. A radioactive atom and a dead organism are disintegrating systems.

Application of Aulin’s yardstick

We are now ready to analyze the virtual constructs presented by Mowshowitz (1997). He describes that "*virtual memory* works by dynamically mapping virtual storage, or requirements, to primary storage cells, or satisfiers. Assignment of physical cells to virtual ones are made according to the explicit criterion of using the physical memory as efficiently as possible; these assignments are then tracked by the operating system." The subroutine taking care of virtual memory in the operating system has a constant goal function and it follows the rule: "If the same stimulus is offered again, the system gives the same finite total response", that is, if the initial state in the computer is same as sometimes earlier and if the same program must be run again, the operating system uses physical memory in the same way as earlier. Hence that subroutine in the operating system is a nilpotent system.

In *network switching*, a logical transmission path connecting A and B (abstract requirement) is satisfied with a set of physical transmission channels constituting a physical path between A and B. According to Mowshowitz assignment of physical circuits to logical transmission paths is subject to shortest-path or quality-of-service criteria (if specified). The routing algorithm is pre-programmed and stays unchanged. With the similar arguments as above we conclude that network switching is a nilpotent system.

Mowshowitz describes that "´*virtual team*´ designates an abstract requirement for a group of individuals that collectively possesses certain skills, and it could play the role of concrete satisfier in a particular (virtually organized) task. Assignment of satisfiers to requirements is made according to explicit criteria. Moreover, the criteria used are subject to change. Intense marketplace competition makes continual change necessary. Virtual teams to meet ever-changing task requirements provides the flexibility a business needs to compete effectively." - It is important to note that criteria are changing in time. It means that virtual team cannot be considered as a nilpotent system. The definition of the disintegrating system and the system steerable from outside do not fit with virtual team, because is not like radioactive atom or robot. Virtual team, hence, is either self-regulating or self-steering system.

Virtual reality offers, according to Mowshowitz, a simulated world defined by computer-mediated sensory input. Such worlds may offer, for example, virtual tours of a museum or shopping mall, replete with visual images, sounds, smells, and possibly tactile stimulation. Virtual experiences correspond to abstract requirements and sequences of sensory inputs to satisfiers. Successive assignments of satisfiers to requirements may not differ much, giving the impression of a seamless artificial world, and hence those functions being performed by a computer program. Mowshowitz also described assignment as the system´s responses to user requests or reactions. To our mind a computer program refers to a nilpotent system, but user requests and reactions to self-regulating or self-steering systems. The user is dominating interaction in few time points only compared with computer-controlled creation of sensory inputs. The user can react in boundaries stated by the pre-programmed computerized subsystem. Hence, nilpotent phases are most influential.

Mowshowitz in analyzing virtual reality writes, "all the ingredients of *virtual organization* are present". We understand this citation in such a way that characteristics I ... IV can be found in virtual reality, but their contents or instances are not same both in virtual reality and in virtual organization, because in virtual organization criteria guiding the assignment algorithm are not constant nor pre-programmed as in virtual reality, but they are varying in the course of business context, and some assignments are even manually changed as "cut-and-paste" phrase shows. To our mind, virtual organization is closer to virtual team than virtual reality, and hence it can be considered as either self-regulating or self-steering system.

To summarize, we have shown that all the virtual constructs are not similar, although equivalents in each concept to abstract requirements and satisfiers can be found. To our mind the virtual constructs seem to have the marked differences in assignment process, and hence in the characteristics of dynamic system.

On assignment algorithms

Mowshowitz (1997) described the problem-solving process by phrase "substituting one satisfier for another is akin to a cut-and-paste operation" from one entry to another. Thereafter he encouraged more elaboration and refinement for that cut and paste operation.

The simplest case of virtual organization is that there is one customer with one task or one set of abstract requirements, and there is at least one supplier who can satisfy those requirements. The virtual organization then acts as a broker between the customer and the supplier, and it can be described as a value chain (Porter and Millar 1985) as follows

Figure 1: A virtual organization in the value chain

Normally, there are many customers with different tasks and many potential satisfiers and the virtual organization must assign a particular satisfier to a certain task. This can be presented in a table form where rows correspond to suppliers and columns to tasks. If the number of rows is equal to the number of columns, we the classical assignment problem (Churchman et al. 1957, 343-368), and in its solution each column and each row must have exactly one 1, i.e. every task is carried by one satisfier.

If the number of tasks and satisfiers are not equal or if two or more satisfiers can be assigned to a particular task, then other operations research approaches like integer programming, transportation problem etc. can be applied. - To summarize, we have shown that from operations research literature a practitioner can find new more powerful tools for solving the assignment problem.

The virtual organization in the form described by Mowshowitz is like the broker between customers and suppliers. Benjamin and Wigand (1995) paid attention to the fact that electronic commerce will eliminate wholesalers and retailers in the chain from a supplier to a customer, and customers will do business directly with suppliers. This will take place, if a virtual organization does not have any other function than assignment of customers to suppliers. To this end we shall in the next section consider another type of virtual organization called imaginary organization by Hedberg et al. (1997). The imaginary organization differs from the Mowshowitz´s virtual organization in such a way that it has its own core competence.

The virtual organization in the value chain

To keep Mowshowitz´s vanishing unit, virtual organization, separate from the real one we cite Hedberg et al. (1997) who used term "the imaginary organization" to indicate a particular perspective on companies and other organizations. They define: "the perspective of the imaginary organization refers to a system in which assets, processes, and actors critical to the "focal" enterprise exist and function both inside and outside the limits of the enterprise’s conventional "landscape" formed by its legal structure, its accounting, its organigrams, and the language otherwise used to describe the enterprise." The imaginary organization (IO) is thus a perspective revealing new enterprises, which can utilize imagination, information technology, alliances, and other networks to organize and sustain a boundary-transcending activity.

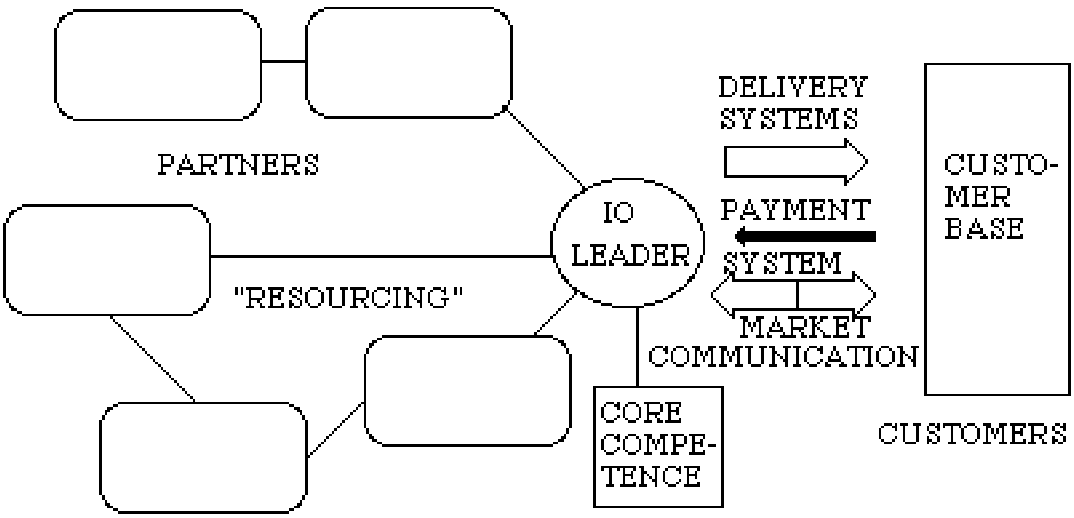


Figure 2: Resourcing in imaginary organization (cf. Hedberg et al. 1997, p. 16)

The IO-leader can be male or female, an individual or a small group, with a will to accomplish something. Consciously or intuitively, the IO-leader creates a strategic map showing how a new business arrangement will be put together in an imaginary organization. The IO-leader also has a conception of the core competence of his own unit. This competence is later supplemented by the contributions of the partners and partner enterprises co-operating in the arrangement. In Figure 2 a customer base, one or more delivery systems, and the methods of communication with customers are defined. The IO-leader designs the production system needed to produce the goods and/or services desired. The leader enterprise, the IO-leader’s own company, performs an essential function.

The imaginary view on organization differs from Mowshowitz´s virtual organization in the fact that the imaginary organization has it own phase of production or service, but Mowshowitz´s virtual organization only assigns tasks to their satisfiers. The relations between customer, supplier and imaginary organization can be as in Figure 3.

Figure 3: An imaginary organization between a supplier and a customer

But it need not to be so, because the imaginary organization can at the same time use more than one supplier. The suppliers used can acts in the sequence, one after another, and hence the interdependency resembles the sequential one. But the suppliers can act parallelly (Figure 4) and the IO-leader assembles their parts together and adds its own core competency-related efforts.

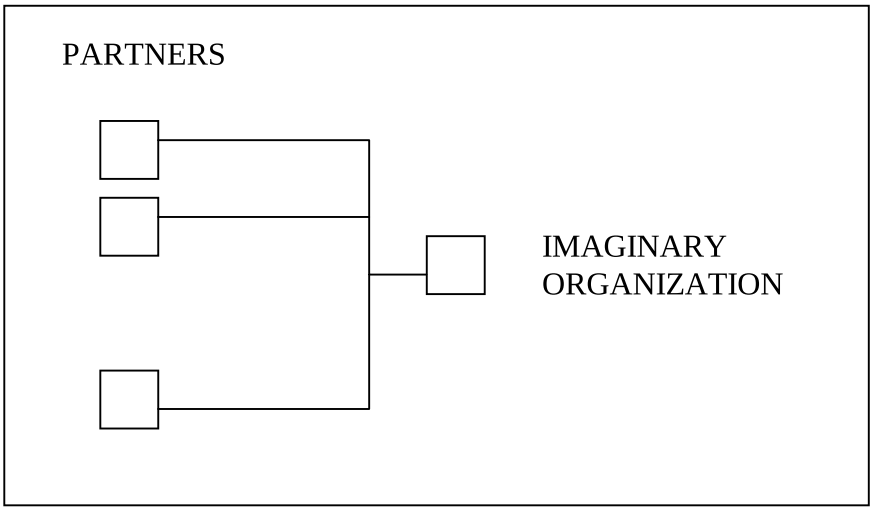
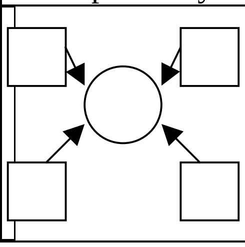
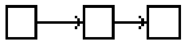
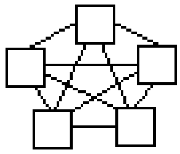


Figure 4: Parallel dependency

This new class of parallel dependency is important, because it recommends shortening or speeding up production or service, because the partners´ activities are performed parallel, not sequentially. It shortens the total time, from the beginning to the end. Fulk and DeSanctis (1995) supported this idea, when they saw opportunities to divide design activities to different parallelly functioning units.

To show how important our finding concerning parallel dependency is, we shall analyze interdependencies of firms. Kumar and van Dissel (1996) used Thompson's (1967) classification of different ways in which work of organizational units may depend on one another. "First is *pooled dependency*, where units share and use common resources but are otherwise independent. A within-firm example would be the use of common transportation pool or a common mainframe by different units within the organization. An across-firm example would be the use of a common data processing center by a number of firms. Second, in *sequential dependency* the units work in series where the output from one unit becomes input to another unit. An intrafirm example would be the marketing plan becoming the input to production and/or purchasing plans. An interfirm example would be the various supplier-customer relationships along a 'value system' or a logistics chain (Porter and Millar 1985). Third, in *reciprocal dependency* units feed their work back and forth among themselves; in effect, each receives input from and provides output to others, often interactively. Within-organization examples include a surgical team performing an operation, a group of research colleagues designing a study as a 'think tank' or an executive committee of the firm developing a corporate mission statement and strategy (Thompson 1967). An interfirm example would be a concurrent engineering team consisting of customers, suppliers, distribution centers, dealers, shippers and forwarders, and the multiple within-firm units working together to concurrently design, develop, produce, and deliver the ford Taurus automobile (Mishne 1988, Zimmerman 1991)."

Table 1: Interdependence, Structure, and Potential for Conflict (Kumar and van Dissel 1996, two first rows)

Type of Interdependence	Pooled Interdependency	Sequential Interdependency	Reciprocal Interdependency
Configuration			

The parallel dependency does not fit in any of the Thompson's three categories, but it will form a new non-empty category. To prove that we go through three categories. The parallel dependency cannot be derived from the pooled dependency, because in the parallel dependency is no common resource to be shared. The parallel dependency cannot derive from the sequential dependency, if the requirement of "the output from one unit becomes input to another unit" is fulfilled, because in the parallel dependency two suppliers are working parallelly. The parallel dependency cannot derive from the reciprocal dependency either, because in the parallel dependency are one-directional relations only, not back and forth as in the reciprocal dependency.

Discussion

To shortly repeat our main results we can say that virtual phenomena belong to the different classes of dynamical systems. The virtual organization seems to be the self-steering one, because the people belonging to that unit can change goals in the course of time. The virtual organization can exploit operation research approaches in solving problems to assign tasks to partners. In order to survive the virtual organization must have its own core competence, and when it uses its partners it can sometimes divide its tasks to different partners and they can then be parallelly performed. This parallel dependency is the truly a new category in interdependencies between organizational units. This means that all the studies that used those three Thompson's categories can be now reinvented and maybe new results can be found.

As we know the Aulin’s (1989) classification of dynamic systems is here firstly used in information systems literature. It may help in solving problems where some demarcation line must be drawn between people and computerized systems. Therefore the classification may have many other applications in the future, as well.

Turoff (1997) wrote that Mowshowitz´s concept of the virtual organization is currently the ultimate representation of the third stage, Control System Design, recognizing explicitly that the reprogrammability of the computer can be accomplished in an 'instantaneous' dynamic manner to satisfy a goal-seeking control system that regulates reality. To our mind, our analysis based on Aulin´s classification clearly showed that the virtual organization cannot without a guiding human being act in an 'automatic' way Turoff claimed.

As our use of the imaginary organization (Hedberg et al. 1997) version of an virtual organization concept shows we are not supporting Mowshowitz´ (1997) definition of a virtual organization. The latter played, however, an important role in triggering our analysis and in leading to very important results.

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