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EDITORIAL

This editorial contains necessary details for initiating the INDECSA 2005, the process of evaluation of the best article published in INDECS in year 2004, i.e. in volume 2.

Propositions for INDECSA are given in the document INDECS-DD-005-1, which is available from the INDECS web page, and are written in the INDECS 2(1).

The Commission for choosing the best article for INDECSA 2005 is the following:

1. Josip Kasač, President,
2. Petra Klarić-Rodik,
3. Katalin Martinas,
4. Michel Moreau,
5. Armano Srbljinović.

The President of the Commission is responsible for alignment of the evaluation process with the stated propositions. He prepares the final report which includes the title and the name of the corresponding author of the award winning article, as well as relevant details of the evaluation process. The report will be available from INDECS web pages and will be included in the issue INDECS 3(1).

The award will be given to the corresponding author of the award winning article during International Workshop Decos 2005 (http://decos.znanost.org).

The money sum for INDECSA 2005 is 400 EUR.

Zagreb, 15 December 2004 Josip Stepanić

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COMPLEXITY AND INNOVATION IN BUSINESS SYSTEMS WITH FOCUS ON TRANSITIONAL COUNTRIES

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SUMMARY

This paper is a review from a business analyst's perspective of innovation and complexity concept and their impact upon the paths of business systems and organisations as wholes. Its task is also to catalyse a broader discussion on innovation segment that is by itself complex and its importance to business in a growing complex environment. The argument is that innovations should be the main driving force of business and other social systems due to their path-dependent and positive feedback features that provide for faster growth. Innovation is not limited solely to businesses and should also be viewed in respect to other social (public) systems whose segment often lack innovative approach. Innovation may be found to possess emergent properties like other events that appear in social systems that influence their change and adaptation. It determines path-dependency of such systems because it is considered an event arising early in the history of the system that determines its ultimate end state. Thus, understanding, managing and accepting innovations and its importance is crucial for recognition of complex processes of path-creation, dependence and emergence of forces that drive social systems. Viewed from aspect of transitional countries, it is crucial for judging the future stability of their social entities striving for development and recognised change.

KEY WORDS

complexity, innovation, business system, path dependence, feedback

CLASSIFICATION

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INNOVATION DEFINED AND SOCIETAL CHANGE

Along with the function of knowledge and technique increases, scientists, engineers and managers have increasingly focused on innovation. Innovation is a powerful weapon in competing with other business enterprises, and pushes the society forward endlessly through positive feedback process. In the past, many scientists have put continued effort to understand questions of defining innovation and conditions under which it is facilitated.

The idea becomes an ***innovation*** only when it can be replicated reliably on a meaningful scale at practical cost [1; p.6]. In reference to innovation, there are two factors complementary to individual's ability to innovate: (1) the ability to differentiate between objects that seem to be similar and (2) the ability to find similarities between seemingly unrelated matters [2]. Innovation may also be discussed in the general context of learning. In this respect, innovation can be understood as a novel way to solve a problem. Here the word **"**novel**"** is understood in a qualitative way: Any type of behaviour can show a large variability and still be categorized into a discrete number of qualitatively different classes of behaviour. A technical innovation involves a qualitative different method of solving problems and is not just an improved way of performing a previously existing process. This definition of innovation can be applied at a multitude of levels and often involves the creation of new, specialized problems that need to be solved in order to improve the solution of a more general problem. The concept of learning as a persistent change of behaviour is more general in the sense that it does not require novelty in the method of problem solving. In most cases learning will lead to a gradual improvement of the performance within the class of one existing strategy or behavioural pattern [3].

Innovation represents scientific, technological, organizational, financial and business activities leading to the commercial introduction of a new (or improved) product or production process. Innovation strategy can be defined as the plan of action that determines the type and magnitude of innovation activity that the organization must undertake to meet its strategic and operational objectives. The innovation strategy links technology and product strategies to the corporate strategy. It is shaped by the organization's dynamically changing knowledge and skill sets embedded within the organization's core competencies.

Significant innovation depends on the "long line": the ability to go beyond cut-and-try recombination of well-known building blocks to the more distant combinatorial horizon. Constraints and bottlenecks set the directions of innovations in sciences. The bottlenecks imposed by technical difficulties (constraints) make some combinations difficult or impossible [4]. If the source of innovation is in the past or even in current technology levels, it is said to be an evolutionary technological innovation since it evolved from what came before. If, however, it does not build on past technologies but represents a significant shift from the past, it can be said to be revolutionary technological innovation. If a company believes that technological innovation will be evolutionary, it will look to the leaders in that technology to develop new products and processes. If a company believes that technological innovation will be revolutionary, however, it may wish to seek out the research efforts of smaller companies, specialized research companies, and university researchers [5]. Just as there are many ways of defining innovation, there are also many ways of describing innovation. Each approach is important because it is

derived from a specific strategy to pursue that innovation path, therefore, requires a different focus of management activity in order to be successful.

Many scientists regard innovation as complex process. It is due to it being a result of interaction of a number of components, or agents according to sets of rules that require them to examine and respond to each other's behavior so as to improve their behavior and thus behavior of the system which they comprise. Many papers and reports introduced experimental programs that utilize knowledge of the creativity process in order to enhance innovation in business organizations.

Various innovation programs have evolved in numerous countries as a response to the growing complexity of the innovation process as a prerequisite for sustained development and progress. Thus, transitional (European) countries, like Croatia, are striving to establish a culture of innovation capable of supporting sustainable economic development, and thus to successfully manage its complexity.

In industrially developed countries innovations are the basis for the economic growth whereas innovations are amongst the main tasks of the bearers of economic policies. The introduction of new manufacturing processes, products and services improvements to them are preconditions for survival on the world market not only for developed countries but also for transitional economies.

The lack of national scientific programs is often a neglect of innovation in the public administration segment. Not only that the innovation acts in a complex environment but it is becoming a growing complex process itself. Innovation process is recognized as a complex process due to involving interactions among many players, including ones not acting in innovative fashion (public segment, city and state administration). In fact, increasingly, the real innovation dilemma is not only the emergence of new knowledge and ideas but also their feasibility in an environment surrounded by complexity of administrational and bureaucratic complexity and complicity (external factors) that suppress the idea of innovation of others in its own backyard. In fact, innovators and innovations in any aspect of social systems are forced to face, in the very process of transfer of knowledge, the very limits of public administration that suppress the very drive for change in any social system.

All too often, well-intentional efforts to solve pressing problems lead to policy resistance, where our policies are delayed, diluted, or defeated by the unforeseen reactions of other people or nature. Many times our best efforts to solve a problem actually make it worse [6; p.3]. Improved access to enormous quantities of data of all kinds is an inherent feature of the information society. But, many companies, especially small and medium-sized enterprises, those emerging in the transitional societies, are simply overwhelmed, and experience information overload. Having access to the right information at the right time is a key factor in a company's ability to integrate change successfully. Managing information overload, social acceptance of new technologies, environmental concerns, and the basic logistics of introducing change often pose a far greater challenge to businesses than the underlying technologies themselves.

Transitional countries should essentially be focused on building innovation support infrastructures such as science parks, and on the promotion of specific transfers of technology. They need to look more carefully at the global context in which innovations take place – at the management of the obstacles and risks imposed by external (administrational) or organizational (internal) factors. Bureaucratic

organizations, in general, which can both be public social institutions as well as private enterprises usually have lots of data and little knowledge. The key knowledge in a bureaucracy is in the systems and procedures used to process data and generate information. There is typically little innovation in bureaucracies. Entrepreneurial organizations, however, reward the spontaneous generation of new knowledge that adds value, and allow their members considerable freedom to innovate [7]. The main issue of transitional countries is still a costly, non-innovative and inefficient public administration that slows the progress of innovative organizations. Also, often income tax incentives in such countries do not provide for positive climate that will encourage people to invest in their own education and learning.

The acceleration of scientific progress, globalization, and the advent of the information society have all contributed to the growing complexity of our societies. Companies' ability to manage this complexity along with public sector that follows it will be a determining factor for future innovation capacity of any society as a whole.

Europe, not just European Union, should be viewed as a whole, systematically. An innovative and open Europe is a prerequisite for its overall long-term global competitiveness. Namely, the transitional, yet non-EU nations should not be left aside from EU (i.e. financial) support to boost innovation processes since the innovation, an event early in the history of the system will determine these nations' ultimate end state. Ultimate end-state may be disappointing if "the early history" (that is, today) is neglected and may thus have negative impacts once these countries are planned to enter European Union. Such uncoordinated action of Europe as a whole today may cause significant time delays and result in Europe slowly lagging behind competitive world markets (i.e., the U.S.A.).

But this goes beyond economic considerations. Technological development is essential for economic growth, but the innovative dynamics which is necessary to make it sustainable must also integrate considerations of social justice and environmental protection. Social awareness is what often lacks in transitional countries overwhelmed by bureaucracies and administration constraints that often work only in favor of interest of individuals indeed employed by public domain but who often act to promote their private speculative interests rather than public ones.

The responsibility exercised by enterprises (and other publicly/socially significant institutions) towards their employees, customers and partners, and towards society in their city or region, makes innovation acceptable. Thus a framework for sharing of knowledge can be created, not only on the scientific content of technology transfer, but also on its relationship with the socio-economic and environmental context. It seems clear that this helps all stakeholders to assume greater responsibility, contributing to the growth of a distinctive innovation culture in transitional countries.

There have always been inadequacies of prevailing ways of managing private and public sectors. Private companies have been building new types of organization – decentralized, nonhierarchical ones – dedicated to the well-being and growth of employees as well as success. Some had crafted radical corporate philosophies based on core values of freedom and responsibility. Others had developed innovative organization design. All shared a commitment and capacity to innovate that was lacking in the public sector. Why business is the focus of innovation in an open society? Business has a freedom to experiment missing in the public sector

and, often, in nonprofit organizations. It also has a clear "bottom line", so that experiments can be evaluated, at least in principle, by objective criteria [1; p.15].

INNOVATION AND ECONOMIC EVOLUTION

The importance of sharing knowledge, and the need to find solutions based on co-operation and consensus, are becoming increasingly evident. The very concept of sustainable development and development itself in transitional countries, a key factor in the pursuit of long-term economic and social progress, is based on the principle of consensus building. Innovation's success increasingly relies also on non-technological factors, and businesses are gradually acknowledging the benefits of integrating all the stakeholders in the innovation process. Small and medium-size companies, too, could benefit from greater awareness of the growing importance of social and environmental factors in ensuring long-term competitiveness.

The economy is an adaptive evolving system comprising of multiple agents diverse in abilities and capabilities, interacting, adapting, reacting and constantly modifying the patterns and structures that they help create. And they do so on the basis of sets of internal rules that are modified and refined in the process of interaction. It is believed that this approach offers the promise of new theoretical insights on economic processes, suggests new focus for empirical enquiry and also, new opportunities for the modelling of adaptive processes.

Therefore, first, it is imperative to stress that enterprise is the primary driver of modern capitalist trade economies. To treat enterprise seriously requires the tools and methods of an adaptive, evolutionary approach to economic growth. And, second, it is important to depict innovation as an emergent phenomenon that drives economic growth through positive feedback in which the focus is on the creation of patterns through interaction, with these patterns being created at different levels of interaction.

It is suggested that it is transformation that enables growth and that the process of economic transformation is an evolutionary process. This process is driven by behaviour of innovative agents (often employees aware of importance of learning and adaptive organization), process of selection that transforms diversity into pattern of change and process of development that generates and regenerates that behavioural variation. It is the manner of interdependence between these three elements that defines any particular process of economic transformation.

Economic transformation has qualitative and quantitative dimensions and the interaction between the two is central to the evolutionary endeavour. The qualitative dimension is closely connected with the process of innovation and is reflected in the introduction of novelties and the withdrawal of old economic activities. The quantitative dimension is inseparable from ongoing processes of structural change in the economy.

But evolution and adaptation cannot be reduced simply to a question of variation and selection. Process of development is significant as to have innovation in products and methods of production, and through the selection process, the continual change in the relative importance of the different activities. The link between transformation and growth then depends on whether better ways of satisfying economic needs increase in relative importance over time requiring dynamic monitoring of the process.

Novelty or more precisely the creation of novel economic activities plays a particularly prominent role. The primary dynamic element in economic transformation is the generation of new business conjectures, theories and models of profitable activity that are to be tested in the market place. It raises questions of how creative the product or service is, or, what properties does it have as an experimental (novel) system?

The institutional framework of the economy is extremely important in this approach. The institutions of the market are not given naturally. Markets are costly to establish and operate, they operate by sets of rules in relation to standards and conventions for doing business and they are regulated either by law or informal practice. Most markets reflect the interaction between public and private interest. The growth of knowledge depends on the interaction between organizations in the public and private domains that generate, store and communicate knowledge. These systems reflect the division of labour in the growth and application of knowledge between organizations and disciplines and, within these distributed processes of innovation, firms play the unique combinatorial role of gathering and bringing together multiple kinds of knowledge to practical effect. Competition is essential to this story in terms of the way that institutions are constructed and in terms of the innovation-growth dynamics. But, it is competition as a process of change not competition as a market structure that matters in the evolutionary viewpoint.

DIVERSITY, INNOVATION, COMPLEXITY AND ADAPTIVE STRATEGIES

Diversity is the integral to complexity. The innovation of complex technologies is normally accomplished by accessing or creating new knowledge, decoupling from existing knowledge, and/or reconfiguring knowledge. Innovation occurs in two ways, with the creation of new trajectories and through innovation along those trajectories. In most cases, commercial success comes with innovation along trajectories [8].

Over the past decade a new approach to science, called complexity, has been addressing various kinds of paradoxes in natural systems. What has been learned has useful implications and tools for businesses. The concepts that the scientists concern themselves with have a familiar ring in business: Adaptation, evolution and co-evolution, fitness, interactions of agents, the nature of environments, and the dynamic environment in which such systems adapt or die. We can extend the scientists' understanding of how natural adaptive systems function in comparison to businesses and their unique problems. In that sense our knowledge of adaptive and emergent phenomena in ecosystems is powerfully suggestive about how businesses function.

Concepts and universal principles of complex adaptive systems can be found in a large number of scales and areas of application. One of them is related to evolution and can be interpreted as "innovation" on different hierarchical levels both in natural as well as in artificial, and social systems. Complex systems can provide a general framework for exploring the phenomenon "innovation" and within which innovation in the more traditional sense can be embedded as one specific manifestation.

But that picture is also incomplete and can therefore be dangerously misleading. Businesses are more complex than "natural" systems because of their explicit social and financial goals. Those goals are embodied in ideas. Ideas represent the cognitive frameworks and provide the coherence that allows creative, independent people to

work toward common goals. The cognitive framework is the way to resolve the paradox of consistency and innovation. To manage and lead the business, one must understand that framework. When the framework is muddy, or interpreted in widely differing ways, the business is in trouble. And when a business is successful, it is so because a clear cognitive framework guides people as businesspersons.

Businesses both conduct day-to-day operations and adapt continuously guided by that unifying framework. Today's profits come from finely honed operations; tomorrow's profits will come from innovations. The purpose of business strategy is to fuel innovation (new ideas and new benefit from them), and by that definition strategy must be adaptive and dynamic. The major challenge facing a business today is to create organizational environments in which adaptive strategies can emerge. The spread of rumours and new ideas, the adoption of new technologies, and the growth of new products can all be viewed as "epidemics" spreading by positive feedback as those who have adopted the innovation "infect" those who have not. The concept of positive feedback as a driver of adoption and diffusion is very genera and can be applied to many domain of social "contagion" [6; p.323].

In a very general way complex adaptive systems, both natural and social, can be characterized by their capability of evolving in terms of adapting to a changing environment. During evolutionary processes selection mechanisms favour those systems that have a higher rate of survival.

Strategies will emerge naturally in a **"**well tuned" organization. But how do we know if an organization is well tuned, and how can we tune it better? Our diagnostic processes are built around the relationships among fundamental four elements of any business cognitive framework, which comprise [9]:

- Abstract principles that define it,
- Models for implementing those principles,
- Temporary rules that enable predictable operations and
- Behaviour of the participants.

The achievements of strategic managers with long-established credibility and track records show that sustained strategic success comes neither from process alone, nor from simple checklists or isolated initiatives. Rather, it depends on a deep and thoughtful understanding of exactly how their firm functions, and interacts through time with the industry in which it operates. If strategy methods are to be of any value, then, they must help managers understand and steer this complex system into the future, with some indicators of scale and speed of progress [10].

Our diagnostic process point toward what is possible and effective for a particular company to do, that is, what its cognitive framework will permit and support. The goal of a diagnostic inquiry is to understand and align the company's operations and its fundamental principles. But rarely does a company frame its concerns at that relatively abstract level. Rather, it is likely to focus on patterns of sales, or difficulties with production or suppliers, or a slow pace of innovation, or whether to expand into a new market or to acquire another company.

For example, problems in operations, at the smallest or the largest scale, can almost always be traced to a misalignment among some of those four elements. Very often the problems stem from the way in which different people, or different parts of the organization, interpret the principles. The solution lies in understanding the broader

context, because it is almost always cognitive discrepancies that are at the heart of the perceived problem. This inquiry process is also effective in assessing the viability of new plans that a company is contemplating because it leads to a clear understanding and description of how new activities fit the company's fundamental mindset, or cognitive framework.

These inquiries enable companies to step back and look at themselves in a fresh way. The result is development, by the company, of new processes to provide a sharper cognitive focus and of processes to enhance adaptation of strategy to needs. The process is idiosyncratic for each company and cannot be done by formula. But once done, and once adaptive processes are established, the process for emergent corporate strategy can continue to provide benefits for a long time.

Although there are numerous questions that refer to complex systems, in the sense that a great many independent agents are interacting with each other in a great may ways, in every case, moreover, the very richness of these interactions allows the system as a whole to undergo spontaneous self-organization. Self-organizing complex systems are adaptive, in that they don't just passively respond to events. They actively try to turn whatever happens to their advantage [11; p.11]. Although there is no universally accepted definition of complexity, the following definition is offered by the Santa Fe Group: "Complexity refers to the condition of the universe, which is integrated and yet too rich and varied for us to understand in simple common mechanistic or linear ways. We can understand many parts of the universe in these ways but the larger and more intricately related phenomena can only be understood by principles and patterns – not in detail. Complexity deals with nature of emergence, innovation, learning and adaptation" [12].

Some authors argue that complexity theory has only a limited use as a paradigm against reductionist approaches and that it has a much richer potential as a comparable property and that it is unlikely to have any useful value if applied to "real" objects or systems. Furthermore, some may argue that complexity is usefully differentiated from the concepts of size, ignorance, variety, and minimum description length and order [13].

What sustains organizational continuity and what makes for creative change are central questions, and how we think about these matters is of major significance. It is this conviction that lies behind the desire to explore ways of thinking and complexity related to business systems and how they come to be what they are; that is, how they come to have the identities they have and what the role of managers is in that process. In other words, my key questions are as follows [14; p.6]:

1. What causes a company to take the form it takes and what causes the pattern of its evolution into the future?
2. Can that future be known and therefore predicted?
3. Can that future be chosen in a rational way?
4. Or, is the future under perpetual construction and hence unpredictable to a significant extent? If so, what are the processes of perpetual construction?

Understanding and managing complexity led to systems and matrix ways of thinking. It can be said that in the background of systems thinking lies the complexity itself which appeared as requisite when previous thinking ways were unsuccessful in explaining complex emergent phenomena in company as a whole and relations it has with its environment [15].

This way of thinking makes managers look for the causes that will produce the outcomes they need in order to succeed. It is also a way of thinking that focuses on design. Some thinkers in domain of judging causality suggest that interaction itself has the intrinsic capacity to yield coherent patterns of behaviour. They propose that the entities of which nature is composed interact locally with each other, in the absence of any blueprint, plan or program; and through that interaction they produce coherent patterns themselves.

But, interaction in nature takes place not primarily in order to survive but as the creative expression of identity. It is only when the interaction between entities has a critical degree of diversity, emerging as conflicting constrains on each other, that there arises the internal capacity for spontaneous novelty. In other words, creativity (innovation), and destruction, order and disorder are linked in the creative process. The process is self-referential in the sense that interaction causes patterns in it-self in a way that both sustain continuity in, and potentially transform, those patterns.

Intrinsic properties of connection, interaction and relationship between people would be the cause of emergent coherence and that emergent coherence would be unpredictable. That coherent pattern might be creative or it might be destructive but it would still be a coherent pattern that emerges. People would still be understood to be choosing and acting intentionally, but this would apply to particular, local responses to others in ordinary, everyday organizational life. It would be the interaction itself that has caused the emergent pattern, and plans and procedures would feature in these interactions without determining their pattern. Instead of people interacting selfishly with each other, instead of their organization interacting selfishly with each other simply in order to survive, they would be understood as interacting with each other for the sake of emerging identity and difference in the present living. In this paradigm, an organization comes to be what it is because of intrinsic capacity of human beings, individually and collectively, to express their identities and thereby their differences. Identity and difference emerge through self-organization; that is, relationship of a cooperative and competitive kind. What an organization becomes would be thought of as emerging from the relationships of its members rather than being determined simply by global choices of some individuals [14; pp.7-8].

EVOLUTION OF BUSINESS SYSTEMS FROM STATIC OR DYNAMIC TO ADAPTIVE

Static Organizations can be defined as those having a fixed practice, a fixed size. Like static equations, these organizations have no variables - time does not change them significantly. They persist until some new organization occupies their niche. Dynamic Organizations can be defined as those with fixed practices and variable size. Like dynamic equations, these organizations vary in size over time, even though their underlying practices do not change much. They go through a single life cycle, each growing rapidly as it occupies its niche, then declining as its competitors implement better practices that steal away its clients. Adaptive Organizations can be defined as those having variable practices and variable size. Like complex adaptive systems, these organizations vary their practices, seeking the constant improvement that launches life cycle after life cycle, creating new products, services, and processes that hold on to clients' generation after generation [16].

The capabilities and decisions rules of the agents in complex systems change over time. Evolution leads to selection and proliferation of some agents while others

become extinct. Adaptation also occurs as people learn from experience, especially as they learn new ways to achieve their goals in the face of obstacles [6; p.22]. A key question often asked in business organizations is how do we know if an organization is ready to change? There are several key variables that may have a significant effect on an organization's readiness and ability to change. The variables are as follows [9].

1. Stability – a system that has too much stability will be unable to change, it will need a certain amount of randomness.
2. Connectivity – a stable system can move towards the edge of chaos if its agents are better connected.
3. Diversity – this refers to the diversity in the agents themselves or the nature of the relationships between them.
4. Information Flow – if the amount of information transferred is increased the system moves towards the edge of chaos.
5. Level of contained anxiety – this is particularly relevant for human systems. The readiness for change and creativity are inhibited if the level of contained anxiety within an organization is too high.
6. Power differentials – if there is too much control due to power differentials within the organization, then change is unlikely to occur.

In response to changes in the environment an organization may undergo a process of self-organization so that it may cope with its environment in a better way. New properties (such as new ways of working, new roles and responsibilities) may emerge. Complex systems are said to self-organize onto an attractor. Attractor is a set of points toward which complicated time paths starting in its neighbourhood are attracted. In fact, attractor is used because the system's temporal evolution appears to be consistently "pulled" to identifiable mathematical points [17]. We know that we cannot dictate the attractor, but can organization influence the choice of attractor in some way?

Adaptive organizations will displace dynamic and static organizations in economic competition, so that within a generation, most people will have learned to expect continual improvement in their life experience. The fact that their ancestors once worked at the same job in the same way for an entire lifetime will seem almost as incredible as the fact that people used to stay at jobs they have not thoroughly enjoyed. But, how strong is the impact of the past times?

PATH-DEPENDENCY, RETURNS AND CHAOTICS

Path-dependency represents a pattern of behaviour in which small, random events early in the history of a system determine the ultimate end state, even when all end states are equally likely at the beginning. Path-dependence arises in systems whose dynamics are dominated by positive feedback. Path-dependence is a pattern of behaviour in which the ultimate equilibrium depends on the initial conditions and random shocks as the system evolves. In a path-dependent system, small, unpredictable events early in the history of the system can decisively determine its ultimate fate. Path-dependency can, therefore, be strongly influenced by ability to innovate successfully in an innovative-friendly environment thus providing for a strong driver early in the system's history.

The eventual state of a path-dependent system depends on the starting point and on small, unpredictable perturbations early in the history. Even when all paths are initially

equally attractive, the symmetry is broken down by microscopic noise and external perturbations. Positive feedback processes then amplify these small initial differences until they reach macroscopic significance. Once a dominant design or standard has emerged, the costs of switching become prohibitive, so the equilibrium is self-reinforcing: the system is locked in [6; pp.349-350]. Lock-in persists until an architectural shift of large external shock renders the dominant design obsolete. A wide range of positive feedbacks drives the growth of business systems. The evidence suggests that the profitability of individual firms and the evolutions of the economy as a whole is strongly influenced by these positive loops and exhibits path-dependent behaviour. Successful firms are able to strengthen several of the positive loops that can drive growth to create synergies that lead to cumulative success.

In positive feedback, also referred as reinforcing feedback and process, a small change builds on itself. These processes are defined as engines of growth. Innovation can be considered a small action, a "snowball" with more and more and still more of the same, resembling compounding interest. But, reinforcing (amplifying) processes can also have a character of "vicious cycles", in which things start off badly and grow worse. If we are in a reinforcing feedback system, we need to be aware of how small actions (i.e. innovation) can grow into large consequences – for better or for worse. Seeing the system often allows us to influence how it works [1; p.81]. It is not intention the oversimplify the definition of positive feedback but rather to provide for an essential understanding of its terminology in context of understanding innovation as an initial step that can grow further into an positive outcome.

Business systems derive their systemic feature precisely from elements that are inter-locking, producing path-dependence. Path-dependence defines historical dependency namely taking one road often precludes taking others and determines where you end up [6; p.22]. Innovation can hardly provide for an initial action that would grow into large negative consequence, but wrong steps, less effective solutions and their social and environmental impacts are essential parts or concerns of every inner, self-organising innovation process. The point is how the system can recognise evolutionary mistakes and at what speed the system can correct them.

Conventional economic theory is built on the assumption of diminishing returns. Economic actions engender a negative feedback that leads to a predictable equilibrium for prices and market shares. Such feedback tends to stabilize the economy because any major changes will be offset by the very reactions they generate [18]. Such an agreeable picture often violates reality. In many parts of the economy, stabilizing forces appear not to operate. Instead, positive feedback magnifies the effects of small economic shifts; the economic models that describe effects differ vastly from the conventional ones. Diminishing returns imply a single equilibrium point for the economy, but positive feedback – increasing return – makes for many possible equilibrium points. There is no guarantee that the particular economic outcome selected from among the many alternatives will be the best one. Furthermore, once random economic events select a particular path, the choice may become locked-in regardless of the advantages of the alternative. If a product or a nation in a competitive marketplace gets ahead by "chance", it tends to stay ahead and even increase its lead. Predictable, shared markets are no longer guaranteed.

Path-dependency in the economy is common because the growth of business systems and enterprises is driven by a host of positive feedbacks. These feedbacks involve scale economies, learning, network effects, market power, and many other

processes. The most successful companies are able to create synergy by using ensembles of the feedbacks to create a mutually consistent strategy. However, success with one set of these positive loops can lead to inertia and rigidity that prevent a firm that dominates in one regime from maintaining its dominance as the technical, economic, political, or social environment changes [6; p.406].

For a company as a complex adaptive business system, a condition of increasing returns means that bigger is better - it can produce goods at a lower average cost as its own output increases. Increasing returns can also be understood to occur when products become more valuable to each consumer as more consumers use the product. So, for example, in a network like the telephone system, the advantage of having a phone increases as more people get phones. For a given technology, the payoffs to a user may increase as the number of other users of that technology increases. It has been claimed that for typewriter keyboards, videotape recorders, microprocessors, or word processors, the advantage of using a particular design seems to increase with the number of users of that design.

The concept of path-dependency can be used to challenge the widespread view that the corporate governance systems of the major advanced economies are likely to converge towards the economically best system at a rapid pace [19].

The important thing besides studying path-dependent organizations and segmental technologies is to observe the actual living economy as a whole; it is path-dependent, complicated, evolving, open and organic. It is apparent that the economy and thus its business entities are locking themselves in to an unpredictable outcome. If the world can organize itself into many possible patterns, and if the pattern that it finally chooses is a historical accident, then: how can anything be predicted? [11; p.39].

It is essential that the path-dependency and hence increasing returns be understood as the features of the exponentially growing economic environment as a whole, however, predominantly as a derivate of innovation. Innovation may be defined as the “small” starting point or “small random event” early in the history of the system, the initial condition that provides for sustainable and path-dependent growth of business. This innovation in the later phase may grow to the stage of customer brand-dependence, in fact, their locking-in with the innovative product brand. This is a key fact that should seriously be considered in the emerging and developing markets such as the ones of transitional countries. But, how much chaos is linked with path dependency and complexity?

When we look at the changing world that we are living in, we can categorize the types of changes into a few fundamental categories: growth and recession, stagnation, cyclic behaviour and unpredictable, erratic fluctuations. All of these phenomena can be described with very well developed linear mathematical tools. Here linear means that the result of an action is always proportional to its cause: if we double our effort, the outcome will also double. Only recently do we have access to methods and compute power to make significant progress in the field of non-linear systems and understand, for example, seemingly simple things. One whole class of phenomena, which does not exist within the framework of linear theory, has become known under the word of chaos. This fact makes the role of humans and their attitudes crucial. The complexity and chaos theories do not tackle this, but the Dialectical Systems Theory does.

The Dialectical Systems Theory impacts the human attitudes in order to make the staring point of a work process oriented to creativity and cooperation rather than routinism [20, 21]. This starting point may be called subjective (as opposed to material) initial condition that influences future paths of business. However, one does not need to be confirmed evangelist of dialectical materialism to acknowledge that the economic well-being conditions most of our activities, including our intellectual endeavours, and is impacted by them. Usually, the economic well-being measures our actual progress. Following the post-Second World War boom, which lasted for some 30 years, nourished on sustained economic growth, en masse innovation and an information and population explosion, the world has been through nearly two decades of slowdown, stagnation, even regression here and there, amid widespread frustration and scaled-down expectations. The big issue is how to regain the lost momentum, how to get mankind moving forward again and, by the same token, ensure more equitable worldwide sharing of the fruits of expansion and social progress?

For things to improve all around, significantly and durably, it is not too difficult to point out a few prerequisites for success in material terms. Clearly, a first imperative is to produce more, and better-quality, goods while using fewer resources, by recasting some production processes and organisation. This is done by creative, innovation oriented people. The second basic condition is to increase the efficiency of management at both the macro- and microeconomic level, possibly inventing a new managerial culture that will lie upon ideology of systems thinking and approach to battle with the hitherto prevailing reductionism approach. Inasmuch as science and technology are changing more rapidly than ever, there is a pressing need to improve the tools and methods of technology forecasting to avoid costly failures. This, too, is done by creative, innovation driven people, and seen in economics as a material result. Of course, there is a lot of complexity and chaotics on the way from the starting points to final results.

It is an interesting phenomenon that the degree of chaos in the environment itself can lead to adaptive changes. Deterministic chaotic dynamics can sometimes be actively used in strategies to simulate stochastic environments: Learning of patterns by neural networks can be accelerated using chaotic learning strategies. The performance of such a strategy can sometimes even be better than the stochastic strategy itself (simulated annealing) if the chaotic dynamics has been adapted to the intrinsic dynamics of the system using the concept of “dynamical key”. In the context of organizational learning strategies including a limited amount of chaos can reduce the degree of predictability for competitors.

CONCLUSIONS

Business is successful because of a clear cognitive framework that guides people as businesspersons. Today's profits come from finely honed operations; tomorrow's profits will come from innovations. The purpose of business strategy is to fuel innovation (new ideas resulting in new benefit), and by that definition strategy must be adaptive and dynamic. The major challenge facing businesses of transitional countries today is to create organizational environments in which adaptive strategies can emerge. Sustained strategic success does not come from process alone, nor from simple checklist or isolated initiatives; it depends on a deep and thoughtful understanding of exactly how their firm functions, and interacts through time with the industry in which it operates. Self-organizing complex systems are

adaptive; they don't just passively respond to events. Hence, complexity deals with nature of emergence, innovation, learning, and adaptation.

The aspect of innovation has a far wider role especially in transitional countries referring to both private and public segment. It means a new innovation culture should be naturalized in the entire social culture of these countries so that the innovation can be activated in the business system too.

A wide range of positive feedbacks drives the growth of business systems. The evidence suggests that the profitability of individual firms and the evolutions of the economy as a whole is strongly influenced by these positive loops and exhibits path-dependent behaviour. It is essential that the path- dependency and increasing returns, too, be understood as the features of the exponentially growing economic environment as a whole. However, predominantly as a derivative of innovation since the innovation may be defined as the "small" starting point or "small random event" early in the history of the system, the initial condition, that provides for sustainable and path-dependent growth of business.

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KOMPLEKSNOST I INOVACIJE U POSLOVNIM SUSTAVIMA S NAGLASKOM NA ZEMLJE U TRANZICIJI

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SAŽETAK

Ovaj rad predstavlja pristup konceptu inovacije i kompleksnosti s perspektive poslovnog analitičara te njihov utjecaj na putanju poslovnih sistema i organizacija kao cjeline. Zadatak ovog rada je kataliziranti širu raspravu o inovacijskom segmentu koji je sam po sebi kompleksan te naglasiti njegovu važnost za poduzeće u sve kompleksnijem okruženju. Tvrdi se da bi inovacija trebala biti ključni poticaj poduzeća i ostalih društvenih sistema s obzirom na njena obilježja ovisnosti o putanji i pozitivne povratne veze koji potiču brzi rast. Inovacija nije ograničena samo na poduzeće te ju treba sagledati i u odnosu na ostale društvene (javne) sisteme kojima često nedostaje inovativnog pristupa. Može se reći da inovacija posjeduje pojavna (emergentna) obilježja poput ostalih događaja koja se javljaju u društvenim sistemima a koji utječu na promjenu takvog sistema odnosno njegovu adaptaciju. Inovacija određuje ovisnost o putanji takvih sistema upravo stoga što se ona smatra događajem koji je emergentan rano u povijesti samog sistema te utječe na njegovo konačno stanje. Stoga je razumijevanje, upravljanje te prihvaćanje inovacije i njena važnost krucijalna za prepoznavanje kompleksnih procesa stvaranja putanje, ovisnosti i pojavnosti sila koji vode društvene sisteme. Promatrano pak s aspekta tranzicijskih zemalja, to je važno upravo radi adekvatne prosudbe buduće stabilnosti njihovih društvenih entiteta koji teže razvoju i prepoznatljivim promjenama.

KLJUČNE RIJEČI

kompleksnost, inovacija, poslovni sustav, ovisnost o putu, povratna veza

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ACCUMULATION AND CONSUMPTION IN MICROECONOMIC SYSTEM

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SUMMARY

Two main processes are common for an economic system. They are consumption and accumulation. The first one is described by utility function, either cardinal or ordinal one. The mathematical model for accumulation process can be constructed using wealth function introduced within the frame of irreversible microeconomics. Characteristics of utility and wealth functions are compared and a problem of extreme performance of resources exchange process is solved for a case when both the consumption and accumulation exist.

KEY WORDS

irreversible microeconomics, accumulation, consumption, wealth function, maximum income determination problem

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INTRODUCTION

Investigation of resources exchange processes using irreversible microeconomics methods is based on introduction of wealth function is an extensive parameter of an economic agent[1] [1]. Arguments of the wealth function are resources stocks in the agent at issue. So, it is postulated that welfare of the economic agent is monotonous dependence on the stocks. The higher level of the wealth function the agent can reach the more successful the agent is from the economic point of view. But there is consumption process besides stockpiling in any economic process. And utility theory emphasises the consumption process influence on prosperity of the agent. A. Smith wrote [2]:

> *The revenue of an individual may be spent either in things which are consumed immediately, and in which one day's expense can neither alleviate nor support that of another, or it may be spent in things more durable, which can therefore be accumulated, and in which every day's expense may, as he chooses, either alleviate or support and heighten the effect of that of the following day.*

So, because there are two main processes influencing the well-being of the systems, we should consider both of the processes simultaneously.

UTILITY FUNCTION

Let us consider features of wealth and utility functions. These functions describe welfare effects of accumulation and consumption processes correspondingly. Let us start from the utility function. Existence of the utility function is the basic principle of neoclassical microeconomic theory [3]. Utility function associates each point in space of the resources consumption intensities with a number. It is a definition of the utility function. The more value of this number the more welfare of the system is. The important feature of the consumption process is that any voluntary process in an economic system should increment the utility function. It means that *all consumption processes are not reversible ones*.

Another feature of utility function conception is that the system started from an arbitrary point will reach the equilibrium instantly.

It happens due to the model of time using in neoclassical theory. The crux of this model is following. The axis of time is divided onto several intervals so that intersection of any two intervals is equal to empty set and conjunction of all these intervals is equal to whole time axis. The point at each interval is selected and all processes in the system at issue concentrate to this point. That is why it is hard to understand whether arguments of the utility functions are either fluxes of consuming resources or stocks of the resources to be consumed in this time interval. That is why in the most of textbooks one can find "a basket" instead "a flux" or "a stock" and dimensions of arguments of the utility function as "kg", "items", etc. An example of this model is Edgeworth box - a model of resource exchange - where exchange of the resources is assumed to pass until a no trade equilibrium point at a contract curve would be reached. Then consumption occurs (this process is not considered in the model) and new turn of the process begins from the same initial point.

There exist three main concepts of utility function. They are cardinal utility, ordinal utility and a theory of revealed preferences. Cardinal utility function is postulated to be measured, the second partial derivatives are determined for it, Hessian is

negatively defined, utility of sum of the subsystems is equal to sum of the subsystems utilities. Ordinal utility and concept of revealed preferences, which is close to ordinal utility, are very useful for description of resource exchange. It is connected with impossibility to measure either utility or increment of utility. Both of these concepts are used in economic theory. Cardinal features of the utility function are sufficient in the theory of risks, where some assumptions are made about the second derivatives of the utility function. Concept of revealed preferences is the basement of the microeconomic theory of consumption.

As the cardinal utility can be measured the unit of this function should be introduced. This unit is called "util" [4]. Why economists did not use units of money to measure the utility of economic agents? A possible reason is following one. The only optimal basket of goods corresponds to each value of the agent's income. Then it is possible to consider the agent's income as a argument of the utility function. This transformation is made in the theory of risks to determine propensity of the economic agent to run risks. It means that the same value of money income can correspond to different values of the utility functions for different agents. That is why another unit, common for all economic agets, is necessary for cardinal utility function.

WEALTH FUNCTION

Let us consider an economic agent characterised by stocks of resources X. Let X_0 be base resource namely money. Then any resource exchange process can be considered as superposition of process of exchange resource to money. For example, barter exchange is represented as two processes proceeding simultaneously. They are buying of the first resource such that amount of money gained from the selling process should be spent for buying. A value of each resource v including the base one is introduced [1]. It allows one to consider the wealth function as a state function of the system. This function was introduced in [1, 5, 6]. State function means that when the system changes its state the increment ΔS depends on change of the stock ΔX only and for any cyclic process in a space of resources stocks increment of the wealth function is equal to zero, because initial and final states in such a process coincide.

Let us formulate an additional restriction for the wealth function $S(X)$. This function for the system consisting of several agents should be equal to sum of the wealth functions of all agents. It other words the wealth function should be extensive variable of the system. It means that function $S(X)$ should be homogeneous of the first order [1].

Let us discuss the units of the wealth function. In a case when a value v_ν does not depend on X we can measure the wealth function in units of the ν-th resource. Then we accept $v_\nu = 1$.

In the opposite case when all values depend on X then the measuring unit of S has to be selected, it is similar problem to the selection of the measing unit for physical entropy. There is a special case, at least as theoretical possibility, the introduction of "ideal money". This resource does not take part in resource exchange processes. Ideal money has to fulfill the following conditions:

- value of this resource $v_{\mathrm{im}} = 1$. It does not depend on the resources stocks,
- values of other resources does not depend on ideal money stock,
- the change of stock of ideal money is equal zero for all subsystems,

and measure the wealth function in units of ideal money. It means that one can use units of some currency in the only case when no exchange process including this currency flux is in the system at issue. In the case when all stocks are used in exchange processes one should introduce ideal money or some kind of "utils" (non-monetary units as it was mentioned in [8] to measure the wealth function.

One could see that features of the wealth function are very close to features of cardinal utility function. But there are some significant differences [7]. They are

- the wealth function is a state function of an economic agent,
- the arguments of the wealth function are stocks and the values of resources determines the flows of the resources. It allows to use a model of continuous time of processes in a macrosystem consisting of different agents,
- the wealth function determines a value of the base resource. It allows to describe either voluntary or compulsory processes.

More detailed description of the wealth function features can be found in [8].

In a consumption process the wealth function is decreasing. If q_i is the consumed quantity, then $\Delta S = -\Sigma_i\, v_i \cdot q_i < 0$. Incorporating the utility concept gives a possibility to consider the consumption as a no loss process too. The wealth decrease is compensated by the utility increase, that is $S(X - q_i) - S(X) + U(q_i) \geq 0$.

In an "equilibrium process" the equality can be used, then $-S(X - q_i) + S(X) = U(q_i)$, the utility of a consumption bundle is the wealth decrease caused by the consumption. In non-equilibrium situation the wealth decrease must be smaller than the utility produced by the consumption.

DESCRIPTION OF THE SYSTEM

Let us consider a system consisting of two subsystems namely a seller and a buyer. The seller is an active subsystem [9]. The aim of this subsystem is to maximise its stock of the base resource (money). This subsystem can fix the price p for resource exchange process. The buyer is characterised by existence of processes of accumulation and consumption in the subsystem. It has resources stocks $X = (X_0, ..., X_n)$, where X_0 is the base resource stock. Resources stocks increase because of exchange processes with environment and decrease because of consumption process $q(t)$:

$$\dot{X} = g(p, v) - q(t), \tag{1}$$

where $g(p, v)$ is intensity of resources exchange depending on difference between the value v of resource by the buyer and price p fixed by the seller, $q(t)$ is intensity of consumption.

RESOURCE EXCHANGE PROCESS

To determine the behavior of a subsystem with consumption let us consider a problem on minimal capital dissipation for the system [10]. The problem at issue is following:

To determine price dependency with respect to time corresponding to the maximal income of the seller while it sells the given amount G of the resource during the given time period $[0, \tau]$.

Let us formalise this problem for linear dependence of intensity of resource exchange process and scalar resource:

$$g(p, v) = \alpha(v - p), \tag{2}$$

where v is value of the resource determined by the buyer, p – price fixed by the seller. The objective functional is the total income of the seller

$$\int_0^\tau p\alpha(v-p)\mathrm{d}t \to \max_p . \tag{3}$$

Restrictions for the set of possible solutions are total amount of transferred resource

$$\int_0^\tau \alpha(v-p)\mathrm{d}t = G . \tag{4}$$

and balance equation for the resource stock of the buyer

$$\dot{X} = \alpha(v-p) - q(t), \quad X(0) = X_0 , \tag{5}$$

where $q(t)$ is intensity of consumption.

Hamilton function for Problem (3 – 5) can be written as following

$$H = \alpha(v-p)[p - \lambda + \psi(t)] - \psi(t)q(t) . \tag{6}$$

Here λ and $\psi(t)$ are undetermined multipliers; λ is a constant and $\psi(t)$ is a function of time such that $\psi(\tau) = 0$. Note that v is a function of stocks of the buyer. That is why necessary conditions of optimality $\partial H/\partial p = 0$, $\dot{\psi} = -\partial H/\partial X$ have the following form:

$$p = \frac{v + \lambda - \psi(t)}{2} , \tag{7}$$

$$\dot{p} = -\alpha \frac{\partial v}{\partial X} \frac{v - \lambda + \psi(t)}{2} . \tag{8}$$

Comparison of (9) with (6) gives

$$\dot{p} = \frac{\partial v}{\partial X}[\dot{X} + q(t)] . \tag{9}$$

If v is linear function of X: $v = A\text{-}c\cdot X$, then, taking into account (9) solution can be found from the linear differential equation

$$\dot{X} = -\alpha c X + \xi(t) , \tag{10}$$

where

$$\xi(t) = -\frac{\alpha c}{2}\int_0^t q(\theta)\mathrm{d}\theta + \frac{\alpha}{2}[A - \lambda] - q(t) + K ,$$

with λ determined from (4) and K from the condition $\lambda(\tau) = 0$. Solution of (10) is

$$X(t) = \mathrm{e}^{-\alpha c t}\left[\int_0^t \xi(\theta)\mathrm{e}^{\alpha c\theta}\mathrm{d}\theta + X(0)\right]. \tag{11}$$

For constant value of q function $\xi(t)$ is linear

$$\xi(t) = at + b ,$$

where a and b are constants dependent on λ.

Equation (11) can be rewritten as

$$X(t) = X(0)\mathrm{e}^{-\alpha c t} + \frac{\alpha}{c}\left[t - \frac{1}{c} + \frac{b}{a}\right]. \tag{12}$$

CONCLUSION

Process of consumption significantly influences the resource exchange. Pure exchange of resources is not a real process. There should be a reason why an economic agent needs the resource. One of the reasons is accumulation of the resource. Another one is consumption. Intensity of the consumption is determined by utility function of the agent. But the determination of this intensity is a secondary problem. In a general case the economic agent should solve a multicriteria problem where it takes into account increments of welfare due to accumulation, consumption and all other processes motivating exchange of the resource. But the driving force of the resources exchange process is the difference between vectors of values determined by the wealth function of corresponding subsystem and prices independently of the reasons motivating the economic activity.

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REMARKS

[1]That wealth function, introduced by K. Martinás is not the welfare function of traditional microeconomics.

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AKUMULACIJA I POTROŠNJA U MIKROEKONOMSKIM SUSTAVIMA

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SAŽETAK

Dva glavna procesa su uobičajena za ekonomski sustav: potrošnja i akumulacija. Potrošnja je opisana funkcijom korisnosti, kardinalnom ili ordinalnom. Matematički model za akumulaciju konstruira se pomoću funkcije bogatstva koju se uvodi u okviru ireverzibilne mikroekonomije. Značajke korisnosti i funkcije bogatstva su uspoređene. Problem krajnje mogućnosti procesa izmjene resursa riješen je za slučaj kad postoje i potrošnja i akumulacija.

KLJUČNE RIJEČI

ireverzibilna mikroekonomija, akumulacija, potrošnja, funkcija bogatstva, problem određivanja najveće dobiti

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TOWARDS QUANTITATIVE TOOLS FOR ANALYSING QUALITATIVE PROPERTIES OF VIRTUAL COMMUNITIES

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SUMMARY

During the last decade, the advance of Internet has enabled the emergence of previously nonexistent type of human social structures - virtual '*online*' communities. As compared to the traditional communities, online communities are distinguished by the drastic reduction of the requirement for the physical proximity and geographical clustering of their members. The primary cause of this shift away from 'physically concentrated' communities to dispersed virtual ones is new long distance communication tools that Internet has provided. Along with the increase in quantity of communication that the new technology brought about, it also strongly influenced its quality. The paper suggests two simple mathematical tools for analysing the 'soft' (qualitative) sociological internal properties of virtual communities. The suggested tools are applied and their utility discussed on the example of one such virtual community, Croatian NGO 'Society znanost.org'.

KEY WORDS

mailing list analysis, online communities, scale-free distribution, quantitative analysis of qualitative properties, social energy

CLASSIFICATION

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INTRODUCTION

VIRTUAL COMMUNITIES

Emergence of virtual communities

During the last decade, the advance of Internet has enabled creation of previously nonexistent type of human social groups - virtual 'online' communities [1]. As compared to the traditional geographically highly condensed communities, online communities are distinguished by the complete eradication of the requirement for the physical proximity and geographical clustering of their members. As the basic ingredient of community is the existence of reliable communication channels among its members, the primary causes of this shift away from 'physically concentrated' communities to dispersed virtual ones are the new long distance communication tools that Internet has provided.

Certainly, tools and services for long distance communication themselves are not novelty. Couriers and mail have existed for centuries, telegraph has been with us for almost two hundred years and during past century telephone and fax have joined this arsenal. However, the emergence of the community from the group of previously unrelated individuals requires the possibility of engagement of these individuals in a number of frequent and intensive formal and informal communication. 'Classic' communication tools mentioned earlier just could not support these requirements. Couriers and mail are relatively slow, as they both require physical transport of the message between geographically remote destinations and hence intensity of the information exchange is strongly compromised. Telegraph, telephone and fax have managed to drastically cut down on the message transmission time by using fast electromagnetic signals. They are the 'real time' communication tools and hence could possibly support the required intensity of the discussion. However, they also have two limitations. First, their extensive usage is relatively expensive for average consumer - and usually the price grows with geographical distance between users - and hence is mostly used 'in emergency' and only for important formal discussions. As such, they don't provide the possibility of frequent and informal communication. Second, they are 'one-to-one' means of communication and do not support multi-party discussions involving more than two participants at the same time. Hence they cannot convey the feeling of participation in real 'community' discussion to their users.

The affordability of home computers, the rapid spread of global computer network - the Internet - has cut down the price of real-time long-distance communication to just a small percent of its cost some ten years ago. Also, development of 'user friendly' communication software (web browsers, e-mail clients, internet telephony tools) has eliminated the need for acquiring any particular expert knowledge in order to be able to use these services on Internet. Hence, the new technology has opened the door to growth of new kind of physically dispersed global communities, as well as provided a new means for sustaining and reinforcing the 'classical' physically concentrated ones. As one of the greatest media theorists, Marshal McLuhan, would put it, our planet has indeed become a 'global village'. Further, not only did the technology make available new efficient 'broadband' communication channels and hence enabled the massive increase in the quantity of communication, but it also had far-reaching impact on the quality of our relation with fellow humans, physical environment we inhabit and even our own inner mental landscape [2].

Research into virtual communities

Social researchers have been interested in virtual Internet communities from their very beginning in the early 90s [3, 4]. This interest was supported by the fact that the very nature of the new communication tools made the communication itself amenable to quantification. The digital data format of the new online communication made it feasible to archive, retrieve, classify, sort, backtrack and analyse massive amounts of this communication in many different ways. During past century, scientists analysing quantitative mathematical aspects of networked structures - including human networks such as online communities - have discovered a surprising regularity that these seemingly completely random structures possess, commonly referred to as **Pareto's law** or **Zipf's law** [5 - 7]. Recently the deep relation between Pareto's law and dynamical rules governing the emergence and evolution of the various types of natural (e.g., ecosystems and crystals), social (e.g., companies and cities) and artificial (e.g., computer networks and power grids) networks has been established [8 - 10].

Research aim

This somewhat surprising encounter of strict mathematically expressible regularities and rather ‘soft’ world of social science research gives a hope that a precise mathematical toolkit is foreseeable which could be used to study the new sociological dimension of communication that emerged along with the virtual communities. The primary aim of the work presented in this paper was to present and discuss some rough-cut and simple, yet potentially useful quantitative tools for analyzing the quality of communication within the virtual communities.

ZNANOST.ORG SOCIETY

Brief history of znanost.org

Society znanost.org (in Croatian, *znanost* translates as *science*) is a Croatian non-government non-profit organization (NGO). It was initiated in early 2002 by the group of recently graduated physics students from Zagreb University. During past two years the membership has spread both to other natural sciences, as well as to social and technical ones. The mission of the **znanost.org** is to organise, promote and support activities that would help Croatia towards becoming the knowledge-based society. More information about the **Society znanost.org** and its activities can be found on the official web pages, http://www.znanost.org.

The main activities of the society are not directed towards amassing the membership, but rather towards fostering various projects aimed at promoting and disseminating knowledge as a tool of choice in Croatian society at large. Any interested party - whether member or non-member of **znanost.org** - that wants to start a project whose goals are in line with the overall mission of **znanost.org** can submit a project proposal to **znanost.org** Projects Board asking for the support. If the project is accepted, **znanost.org** provides the supporting infrastructure for the project - web space on society's server, financial administration services and network of contacts that society has developed with Croatian scientific and journalist community. Society, however, does not provide immediate financial support for the projects, as it has no sources of income of its own. Rather, it provides 'branding' that can help supported projects in finding commercial or charitable sponsorship.

Internal structure of znanost.org

The real structure of **Society znanost.org** is highly non-hierarchical. However, to be registered as an NGO in Croatia, the society has to have all the necessary formal structure elements required by the current Croatian law: President, Vice President, Secretary and Advisory Board with 3 members and Board of Members with at least 11 members. Due to strong inclination towards project-based activities, the society has also established a 3-member Projects Board which on the behalf of the society examines the submitted project proposals and declares its decision to the Board of Members.

Although in the first days of its existence great majority of the society's members were located in Croatian capital, Zagreb, in the following years this changed drastically. This change came about due to two reasons. First, some of the new members that were 'recruited' in the meantime were at the time already abroad. Also, significant number of initial members that are currently active in the society's activities has since left Croatia. All of these members that are currently abroad left the country exclusively for educational and professional purposes - they are now PhD students at various highly-rated scientific research institutions around the world, including Italy, Germany, Switzerland, United Kingdom and USA.

Communication within znanost.org

Almost from the very beginning - as it can be easily guessed from the very name - **znanost.org** was envisaged as a society with a strong underlying Internet backbone. It is quite questionable whether the society could function at all in its present, physically dislocated form if it did not have the whole range of practically free internet telecommunication tools at its disposal. Hence, during last year **znanost.org** has transformed into a fine example of literally ‘online’ community.

Through several major successful projects - just to mention the website (http://www.znanost.org) and press service of the First Croatian Science Festival - the society has raised sufficient funds to purchase its own web server. Thanks to several of the members' computer administration skills, this server has become the heart of the society's internal communication. Individual communication is done through direct e-mail correspondence, whereas majority of topical discussions are conducted on purpose-made mailing lists. As the server is completely administered by **znanost.org** members, the management of these e-communication resources within the society is very prompt and flexible. Some time ago, the free internet telephony tool, Skype (http://www.skype.com), has started getting some attention as a very useful prospective mean of immediate real-time communication. However, as it requires users to be online at the same time - which can be a bit of a problem having in mind their geographical dispersion - e-mail and mailing lists are still the tools of choice.

The oldest and probably the most influential mailing list of them all (within **znanost.org**) is the list *glavni@znanost.org*. This list is some sort of the society's virtual 'main square' - it serves as a general purpose bulletin board and chat room for the all the members of **znanost.org** administrative bodies. All the projects that at later stages develop their own separate mailing lists necessarily kick of from *glavni@znanost.org*. Also, voting procedure on all the major issues related to **znanost.org** activities is done through this list. Hence, the starting premise of this work was that if any of the society's general socio-dynamical characteristics is to be retrieved from the archived correspondence between its members, it must certainly be found precisely in the archive of *glavni@znanost.org*.

METHODS

SORTING THE POSTS

Two research methods employed in this paper are fully quantitative and actually belong to the realm of the natural rather than the social sciences. Both presented methods are fairly simple and, as will be demonstrated, they greatly differ with respect to their actual usefulness. It should be mentioned that the fully-fledged analysis could and should include much broader range of sociological approaches, primarily to strictly operationally define various elements of - and their respective contributions to - the concept of 'internal social energy' (i.e. the quantity and intensity of actual activities and internal social dynamics) of a particular virtual community. Indeed, some theoretical work on the closely related topic of social thermodynamics has already been done in discussing general social systems [11, 12]. However, this work was envisaged as the first - rather than the final - step towards new quantitative tools for analyzing the qualitative aspects of online communities. In that light, the presented analyses should be accepted as fully justified notwithstanding their obvious limitations.

Daily traffic analysis

The analysed data set comprised of 1634 posts sent by the members of **znanost.org** to the *glavni@znanost.org* mailing list between 2 March, 2003 and 4 November, 2003. The first quite obvious classification aimed at analysing the daily traffic on the list during this period and comparing it with the author's first-hand 'insider' knowledge of society's various activities. Put in other words, the aim was to find out whether there is a correlation between the 'virtual' activity of **znanost.org** society (reflected through the frequency of posts on the *glavni@znanost.org* mailing list) and its internal social energy. The main idea underlying this analysis was that if it was possible to establish some strong correlation between the two, then mailing list posting frequency could be generally utilised as a direct quantitative measure of the internal social energy of the virtual community.

The first set of data - the posting frequency - was extracted directly from the date stamps in the mentioned posts sent to the *glavni@znanost.org* mailing list. The respective set of data about the society's members' activities was based on the author's insider's background knowledge of the society and the range and dynamics of its activities.

Thread length distribution analysis

The second classification was concerned with threads that have emerged on the list. Thread develops in such a way that one member posts a message with some subject, other members reply to that mail with 'reply to' option in their e-mail clients automatically copying the subject line. This type of mailing list correspondence often results in a whole chain of replies and replies-to-replies etc. containing the same subject line. This chain shall be referred to as *thread*. Due to the complete freedom in the choice of initial subject line, thread analysis uniquely and sharply decomposes the mailing list archive into series of disjoint and easily discernible elements. The simplest way to classify threads is by their length, i.e. the total number of posts they contain. The second tool was the analysis of distribution of the number of threads vs. their length.

RESULTS AND DISCUSSION

DAILY TRAFFIC ANALYSIS

During the period from 2 March, 2003 to 4 November, 2003 (248 days) a total of 1634 posts were sent to the *glavni@znanost.org* mailing list by the list members. The resulting daily traffic on the list is displayed in Figure 1.

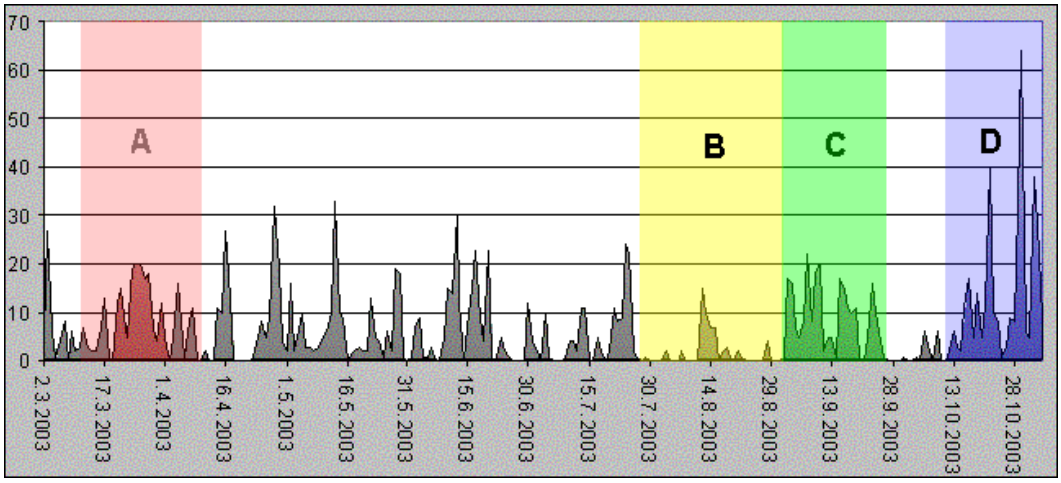

Figure 1. Daily traffic on *glavni@znanost.org* mailing list. Dates are on the x-axis, corresponding number of posts on the y-axis.

One of the characteristics of the society's internal dynamics which is quite notable from the daily traffic analysis is the 'burst mode' of its activities. The reason for this is simple to explain: due to the possibility of high intensity discussion that communication tools used provide, any problem or issue that arises within the society is dealt with very quickly. As all the members of **znanost.org** are volunteers and have their jobs to attend on daily basis, there is no regular daily 'background' correspondence on the *glavni@znanost.org* mailing list. The list is 'active' only occasionally, when there is some issue to be resolved. In this respect it would be interesting to analyse some mailing list which is tied to some more regular activity. One may argue that such a list would exhibit much smoother level of activity.

First Croatian Science Festival

One of the major events that **znanost.org** intensely worked on during the 2003 was First Croatian Science Festival. Festival was held during the week of 12-18 May, but as members of znanost.org were on the organising committee of the event, the activities related to it begun roughly about two and a half months earlier, in early March.

The first relatively extended period of constant activity on the daily traffic graph between mid March and early April corresponds to the various preparations for Science Festival. In Figure 1 it is designated with letter A. Rough content analysis of the posts shows that during this period several other very important things were discussed on the list. Along with the Science Festival related issues, during this period the society was highly engaged in acquiring the server as well as applying for membership with Croatian Research and Academic Network, CARNet. This conundrum of 'big issues' has produced a relatively steady daily inflow of posts to the mailing list, since most of these issues were related to some 'physical' activities

(contact the computer hardware stores, contact CARNet's personnel, etc.) that members had to conduct on daily basis and report back to the list with the results.

However, it is interesting to note that list activity does not show any major systematic increase from this period towards the Festival. One of the probable reasons for this is that members involved in organisation of the Festival diverted the traffic related to the Festival to the separate mailing lists. Hence, the increase in the activity due to the Festival cannot be noted on the 'general purpose' *glavni@znanost.org* mailing list.

Summer break

Summer break is the second reasonably distinguishable period. On Figure 1 it is designated with letter B. It is characterised by the drastic decline in list activity between late July and late August. However, due to the difference in dates when various members went on their summer break - some in early July, others in late July - there is a sharp peak in list activity halfway through this period when they all have briefly 'met' again on the list.

End of the summer break

The second period of relatively sustained activity of the list, somewhat expectedly, started immediately after the summer break in early September. In Figure 1 it is designated with letter C. Rough content analysis of the posts shows that through this period several issues were 'finished off' that were started just before or during the summer break or in the mid August half way through the summer break.

Beginning of the academic year

The last distinguishable span on the daily traffic graph is the one at the end of the analysed period. On Figure 1 it is designated with letter D. It is interesting as it includes several highest peaks of the activity of the list during the whole analysed period. Content analysis shows that these peaks correspond to discussions on some major organizational issues (formulation and discussion of society's projects regulations bill and society's finances regulations bill) as well as the start of the engagement with several new projects.

To conclude: using the insider background knowledge of the **znanost.org** virtual community, hints of correlation between the mailing list activity and society's internal social energy can be glanced. However, it would be a gross overstatement to conclude that using this simple approach allows the full and precise quantification of that correlation. In other words, without the insider background knowledge, applying just simple posting frequency analysis to the other similar virtual communities seemingly does not enable one to firmly conclude on the precise periods of the community's actual activities, or any qualitative features of these activities. It would be a matter of further research to inquire into whether a more sophisticated analysis tool could be developed by somehow 'upgrading' the posting frequency analysis approach. Nevertheless, this method can readily be utilised as a neat 'bookkeeping' tool for analysing, summarizing and presentation of particular virtual community's activity in a given period.

THREAD LENGTH DISTRIBUTION ANALYSIS

The second analysis the data was subjected to is the thread length distribution analysis. Namely it could be argued that thread length distribution correlates in some way with internal structure and actual activities' dynamics of the virtual community composed of all the members of particular mailing list. So, for example, one of the signatures of the existence of virtual community with high value of internal social energy would be that there are some long threads, as long threads necessarily result from a prolonged and coherent exchange of information. To compare the lists with very different number of members, obtained results should be suitably normalised, e.g. by considering not total but relative number of posts per thread, obtained by dividing each thread length with the total number of list members.

Certainly, to prove such an assertion comparative analysis should be conducted using data from whole number of mailing lists. However, from the point of view of introductory research such as this one is, it suffices to focus the attention on a very simple task: to see whether data on thread length distribution from this single virtual community's mailing list provides some firm quantitative parameters. In further research, such parameters could be used as a quantitative measure of internal social energy of the virtual community.

The data decomposed in total of 446 threads with lengths ranging from 1 to 34. The plot of thread length distribution is given in Figure 2.

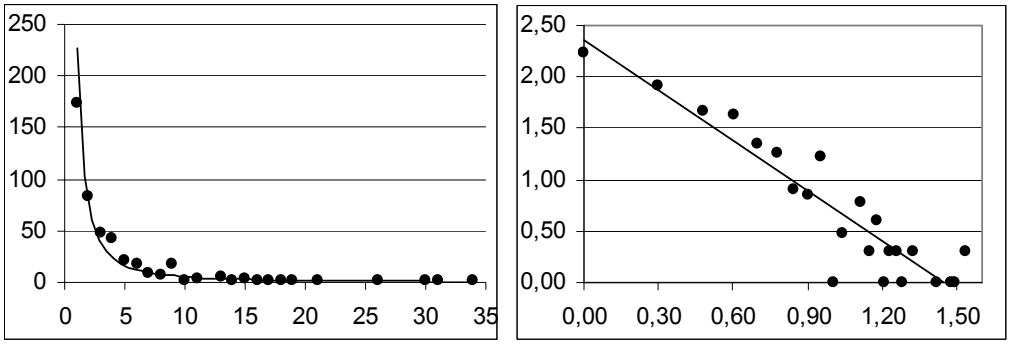

Figure 2. Thread length distribution for *glavni@znanost.org* mailing list. On the left graph, thread length n is on x-axis, number of threads $N(n)$ is on y-axis. On the right the same data are reproduced, but as a log-log plot of thread length distribution. The solid lines are fit to the data using least squares method.

A very impressive characteristic of the obtained distribution is that it is not random but rather highly ordered. Indeed, when data are fitted using the least squares method to the power-law curve of the form:

$$N(n) = A \cdot n^{B}, \tag{1}$$

a high correlation coefficient of 0,86 is obtained, with parameters $A = 227$ and $B = 1{,}6$. This trend-line is also displayed on left graph in Figure 2. On the right graph in Figure 3 the same data is reproduced in the log-log scale from which the fit of data to the trend-line (which in this plot becomes a straight line) is even more evident. Hence, the thread length distribution on the *glavni@znanost.org* mailing list follows the power law.

This finding suggests that thread length analysis could possibly yield some firm quantitative marker of the community's internal social energy. It could be suggested that this power-law distribution relates to the fact that members of the

list actually form a very strong self-organised network. Indeed, it has been shown [9, 10] that principles of self-organisation in social networks do lead to (scale free) power law distributions. However, further research should be conducted in order to fully explore this assertion.

CONCLUSIONS AND FURTHER RESEARCH

As it was stated already at the very end of the Section 3.1., the first of the method of daily traffic analysis is on its own of a very limited value as a tool for analysing the qualitative elements of the virtual community's inner dynamics. Nevertheless, the possibility still remains that if it used in conjunction with some more elaborate sociological methods it can provide some quantitative reinforcement for the conclusions based on pure qualitative observations. In this respect, although this paper offers no conclusive findings, further research on the topic could yield some interesting and useful results.

On the other hand, even in the rough form presented here, the method of thread length analysis seems to offer a very promising quantitative probe of virtual communities' internal social energy. Certainly, further and more elaborate research is required to develop proper benchmarks that would allow the comparison and classification of different virtual communities. First step that should be done along these lines would be to extend the analysis conducted in this work to other mailing lists in order to determine whether some reliable quantitative 'markers' (e.g. like parameters *A* and *B* of the power law distribution (1)) for various qualitative parameters of virtual communities' inner dynamics and sociology can be established. Such markers could be useful as a tool for quickly selecting particular virtual communities on which more extensive (and laborious) sociological, ethnographic or other more in-depth qualitative analysis is to be conducted.

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DOPRINOS KVANTITATIVNIM ALATIMA ZA IZUČAVANJE KAKVOSNIH ZNAČAJKI VIRTUALNIH ZAJEDNICA

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SAŽETAK

Tijekom posljednjeg desetljeća, razvoj je Interneta omogućio nastajanje ranije nepostojećih vrsta ljudskih društvenih građevina - virtualnih '*mrežnih*' zajednica. U usporedbi s tradicionalnim zajednicama, mrežne se zajednice odlikuju gotovo potpunom neosjetljivošću na fizičku udaljenost i geografsku usredotočenost njihovih članova. Prvenstveni uzročnici ovog pomaka od 'fizički usredotočenih' zajednica prema potpuno raspršenim virtualnima jesu nove na Internetu zasnovane telekomunikacijske tehnologije. Usporedo s omogućavanjem povećanja obima komunikacije, nove su tehnologije također ostavile bitan i trajan pečat i na njezinu kvalitetu. U ovom radu su predložene dva matematička alata za izučavanje 'mekih' (kakvosnih) sociooloških značajki virtualnih zajednica. Ujedno, izložen je i primjer primjene ovih alata na jednoj takvoj virtualnoj zajednici, hrvatskoj nevladinoj udruzi 'Društvo znanost.org'.

KLJUČNE RIJEČI

analiza liste e-pošte, mrežne zajednice, bezljestvična raspodjela, kvantitativno izučavanje kakvosnih svojstava

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SPEAKING IN TEAMS: MOTIVATING A PATTERN LANGUAGE FOR COLLABORATION

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SUMMARY

Collaborative work is increasing in frequency and importance in business, academia, and communities. The knowledge behind what makes for a successful collaboration is also increasing but is normally focused on only one aspect of collaboration theory. The understanding of how successful collaborations are built is greatly improved by the creation of a unified framework that organises and transfers knowledge and practices. The framework proposed in this paper is the concept of a pattern language for collaboration. The notion of a pattern language was first detailed in 1979 by Christopher Alexander in his book, A Timeless Way of Building [1]. A pattern language consists of a hierarchy of individual patterns that are used to solve problems associated with the parts in the pattern. When developed, researchers can use a pattern language for collaboration as a tool set to evaluate existing collaborations, repair unhealthy collaborations, and build future collaborations. The core concept is that the structure of an environment guides the pattern of events that occurs. A healthy collaboration is more likely to be responsive to the needs of its community and robust enough to overcome unanticipated challenges. The development and evolution of the pattern language is similar to a genetic process in that quality of the overall language emerges from the interaction of individual and complex patterns. The article applies the pattern language to the real world example of twenty eight different collaborations that are part of the Colorado Healthy Communities Initiative to illustrate the application of the pattern language in context. The article closes with recommendations for future development of the language.

KEY WORDS

Colorado Healthy Communities Initiative, collaboration, pattern language, evolutionary development, complexity

CLASSIFICATION

APA: 3020

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INTRODUCTION

Collaborations are becoming an increasingly common form of work of greater frequency and greater importance. Low cost communication technologies are accessible to more people. Increased travel and communication has shaped a world that is increasingly interconnected. Business, social, and professional relationships are moving from the hallways to online virtual meeting places. Relationships, professional or social, can be maintained at greater distances and with lower effort. As these changes occur the urgency to understand how to build healthy collaborations builds.

The funding of collaboration research and the knowledge base of collaborations is growing every day to meet this need. Individual aspects of collaborations are already known in great detail. These aspects include technology effects, management methods, group dynamics, information sharing, and more. The challenge is that much of this knowledge exists in isolation. As the different research areas develop they start to overlap suggesting underlying similarities. The similarities can be generalised to concepts that are useful to a great variety of applications. The research and experiences with collaborations has developed sufficiently that a framework for understanding the interrelations between these concepts can begin to be formalised through a unifying structure.

The purpose of this paper is to motivate a "pattern language for collaboration" as a framework for understanding this knowledge. The properties of such a pattern language is modelled off the properties of designing buildings and communities that Christopher Alexander describes in his 1979 classic book, A Timeless Way of Building [1]. The characteristics of a pattern can be understood in general as: examining specific contexts that address a specific type of problem and proposing specific solutions. Common ground, distributed work, and models of information are elements of patterns that can be combined together to form the structure of a pattern language. A pattern language consists of a hierarchy of parts that are used to solve problems associated with the patterns.

When developed, the structure of a pattern language provides a network of relationship between patterns that organise, transform, and share knowledge and practices. The knowledge is built through experience and research and provides the motivation for the practices. The practices are actions and methods that build healthy collaborations and repair deficits in existing collaborations [2].

There are precise qualities that are inherent to a healthy collaboration. A healthy collaboration is one that is responsive to the needs of the community it is serving. A healthy collaboration is robust enough to overcome unanticipated difficulties that arise. A healthy collaboration has stakeholders who are willing to risk their own interests for the greater good. A healthy collaboration can also have a significant impact on more than just the intended purpose of the project, frequently building social capital between the stakeholders and strengthening the community [3]. In this paper, we will use the Colorado Healthy Communities Initiative to demonstrate the usefulness of a pattern language for collaboration. [4] The research provides a rich example of a real world application of successful collaboration across various communities.

COLORADO HEALTHY COMMUNITIES INITIATIVE

The Colorado Healthy Communities Initiative (CHCI) started in 1992 with an 8,8 million dollar initiative to empower citizens across the state of Colorado to improve the health of their communities. The CHCI is modelled after the World Health Organization's "Healthy Cities Initiative". Twenty nine communities in Colorado were given planning grants that funded a 15-18 month process to encourage community wide thinking on what health means for a community and to create an action plan to act on this definition. These action plans varied widely depending on the needs of the communities. Examples of actions plans include: building a new medical centre, improving the quality of childcare, and building a region wide transportation program. The twenty eight communities that completed the planning process were then given $100 000 to carry out their action plan with limited restrictions. Later research conducted at the University of Denver evaluated twenty six of these communities on six performance measures.

1. The project accomplished its specific objectives. The goals and objectives of the original stakeholder group were accomplished. 20 of the 26 CHCI projects reported they had accomplished their objectives.
2. The project achieved more than the original goals formulated by the stakeholders group. 18 of the 26 projects exceeded their original goals. Example: In one community the goal was to create a small medical clinic that would serve a few hundred patients a year. After ten years this clinic was serving over 10 000 visits per year and is now a key component of the health care community in the region serving patients from multiple states.
3. The project had a concrete impact on the root problem it targeted. 19 of the 26 projects impacted the root problem. Example: A separate community had the goal of providing transportation through the mountains from outlying communities to health and social services targeting lower income families. The collaboration led to the creation of the second largest regional bus system that serves four million passengers a year.
4. The project was a catalyst for other projects or efforts. 20 of the 26 projects led to other efforts. Example: In a very poor urban community the initial success stakeholders experienced in building a new senior centre has led to the establishment of a community-wide food bank.
5. The project helped change the way the community works together on public issues. Example: One project has a vision of creating a connections group that coordinated the efforts of different agencies to promote community collaborations. Since its inception the agency has fostered highly successful collaboratatives on tobacco awareness, children's literacy and preservation efforts of the regions water supply.
6. The project developed new leaders and increased the engagement of community members. 21 of the 26 projects increased the "social capital" of their community. Example: One community developed an innovative leadership development program for the indigenous populations living in their region. This program had been modelled in several other communities across the United States.

The overall project was successful by nearly any standard. What are still unknown are the common factors that lead to the success of the collaboration in these communities. We first proposed applying the concept of a pattern language to collaborations as a method of describing the qualities of collaboration. The fitness of these qualities can

help predict what makes some collaborations successful while other collaborations with nearly identical processes fail.

APPLICATIONS OF A PATTERN LANGUAGE FOR COLLABORATION

The framework is a pattern language that can be used as a tool set to evaluate existing collaborations, repair unhealthy collaborations, and build future collaborations.

As an evaluation tool, a shared pattern language can diagnose where problems exist and predict the expected outcome given the conditions of a current collaboration. The benefit of describing a collaboration using the patterns of the language is the identification of an essential missing factor and a subsequent recommendation of a method to remedy the problem. A trivial example of this point is two people with a shared language of cars discussing why the car will not start. The explanation that the gas tank is empty clearly identifies and communicates the problem. Theses two people do not have to explore the condition of the tires or discuss how the gas will propel the car forward using internal combustion because sharing the language underlying the concepts is enough to organise and share the knowledge of the situation.

A pattern language also provides the framework and tools necessary to repair collaborations with problems. A shared language facilitates the ability to identify problems that inhibit the potential of collaboration. A shared language leads to the transferring of knowledge on how collaborations operate while also providing natural recommendations for mediation strategies of problems until they can be repaired. After the repair the pattern language is applied again to assess the new state of the collaboration in an ongoing evolutionary process.

A pattern language also provides the architectural blueprint for building future collaborations. When stakeholders in any collaboration have a shared language, they are better able to coordinate a shared vision and solve problems that unexpectedly arise. For example, the CHCI collaborations were required to have a 15-18 month planning period before they could start. The first step in this process was to create a community definition of health. The planning process identified the capacities necessary to create novel solutions to increasingly complex social, economic, and public health problems. During this time the collaboratories constructed a shared language. After the initial construction of the collaboration, the language is continually used to assess performance, identify emerging problems, recommend remedies, and again, allow the process to naturally evolve.

EVOLUTION OF A PATTERN LANGUAGE

The evolution of a pattern language and the evolution of an individual process are similar to genetic evolution. The pattern language is composed of many parts and these parts can be configured in countless complex structures. As architects of collaborations start to build multiple collaborations, they learn how one configuration of patterns might work better than a different configuration of patterns in any given context. When they encounter a similar context again they will be more likely to go with the one they know as more viable. Outside of context there is no perfect collaboration. Collaboration is only as successful as its ability to adapt to its environment. Stronger patterns survived through use and weaker patterns are used less frequently. The development of a fully functional pattern language occurs through the growth of many such competitions over time.

The University of Michigan has built a preliminary version of a collaboration pattern language with its Science of Collaborations (SOC) Wizard. The project has studied over 100 scientific collaboratories and has observed qualities across collaborations that are highly suggestive a successful collaboration. The SOC Wizard is a tool that describes collaboration patterns including: collaboration readiness, common ground, technology readiness, and distributed work. For each pattern there is a series of questions that determine if the collaboration will be successful for that pattern. When a question finds a deficiency, the tool both identify the problem and recommends a remedy for success. As this tool and the pattern language formalises, the ability to predict, diagnose, and build successful collaborations improves. The goal is to build stronger collaborations by designing information models that promote quality, healthy cooperation.

Each pattern, because it is part of the larger whole, can help both itself and other patterns to emerge as successful. The interaction of the parts can lead to patterns that co-evolve together as complex combinations of patterns start to form. When conditions change, either gradually or suddenly, the patterns and combinations of patterns that best adapt to the local circumstances will be the ones that survive through use. The interactions of isolated or complex individual patterns are the building blocks for the language [5].

COLLABORATION PATTERN EXAMPLE: COMMUNICATION CHANNELS

The current research will apply the one pattern from the pattern language to a real world situation that is rich in data. Evaluating the language against collaborations with known processes and results provides the necessary feedback to develop the patterns of the language, observe how these patterns interact in practice, and witness the results across situation where various patterns and pattern groups are included or omitted [6]. We will apply an example of an individual pattern to a problem encountered by one of the collaboratories of CHCI to show how this pattern can isolate the problem, provide the means of mediating the problem, and recommend a solution. This will demonstrate how the structure of an environment guides the pattern of events.

CONTEXT

A healthy environment for collaboration naturally leads to more successful collaborations by creating an open and credible process. An interesting finding from the research in Colorado is the observation in practice of the fair process effect. If stakeholders perceive the process as unfair, as treating them with insufficient respect and dignity, they will either abandon collaboratives, or worse will remain and find ways to manipulate the process to garner more resources at the expense of others. They will not, however, see their actions as unethical, but as the natural outcome of the process itself. The result is a vicious circle of selfishness, an eventual loss of legitimacy and the collapse of the deliberative process. On the other hand, we have found that when stakeholders perceive the process as fair they will act cooperatively even when they receive less than what they hoped for. And they will take others' needs and desires into consideration in forming their own convictions. The result is a virtuous circle where the initial emotional, physical and spiritual energy invested into the collaborative fosters greater commitment to the process and stakeholders continue to re-dedicate themselves and their resources to implementing and sustaining joint initiatives.

PROBLEM

While only three of the original 29 projects were not successfully implemented, each encountered obstacles to collaboration. The most common obstacle, as reported by 69 % of the stakeholders, was engaging committed people in sufficient numbers to overcome vested interests and negative community perceptions about the project. Three of the projects failed to engage sufficient commitment to implement their projects. And the ability to foster commitment explained the varying degrees of success among the initiatives as measured along the six performance measures. The only significant difference found between those communities in terms of their ability foster commitment was the stakeholders' ratings of their processes fairness. In those communities where stakeholders perceived the process as less fair success dropped considerably. Described from a game theoretic perspective, each stakeholder has the ability to either cooperate or defect. In this situation cooperation was risking individual resources for the greater good and defecting was not investing resources or protecting ones own interests first. In a situation where one stakeholder defects, the other stakeholders need to know of this defection to appropriately react and punish the behaviour. In the unsuccessful CHCI projects, stakeholders cited a lack of feedback resulting in an equal response from the other stakeholders regardless of if they cooperated or defected. This uniform response provides no incentive to cooperate when cooperation has a cost. Stakeholders also complained of being uninformed of the actions of the other stakeholders and thus were unable to know if others were cooperating or defecting. When negative feedback is sent it deters future defections and also sends a signal to others that defection has direct consequences [7]. Similarly, when a stakeholder makes a sacrifice to the greater good, the feedback should also be immediate and positive.

MEDIATION

The economic theory of trembling-hand perfect equilibrium (THPE) provides a strategy for negotiating contexts with noisy communication channels until high quality communication channels can be constructed. The main idea behind THPE is that stakeholders who are cooperating might be perceived by other stakeholders as having defected (or *vice versa*). When such mistakes are understood to be possible, THPE remains the optimal solution for all stakeholders because is more robust at overcoming mistakes caused by noisy or incomplete communication cannels. The cost of THPE is that the strategy is not an optimum solution, but given the noisy communication channels, it is overall the most stable means of negotiating with the other stakeholders and in the long term provides the most favourable results.

SOLUTION

Improve the communication channels with better technology. Create a community web space that can be accessed by all stakeholders and provides a shared record of events and participation. Standardise the delivery and feedback expectation for actions that require responses. Processes supported by technology are more robust to failures at either level. Technology integrated with a high quality process provides for clear communication channels that transmit a stakeholder's actual intent.

FUTURE WORK

This article is being written at the beginning of this line of research, is forward thinking, and reasonably optimistic by nature. The formalism of the pattern language is a naturally evolving process that will continue to develop. As the framework is

explored, future work can be conceptualised either through extending on the understanding of one pattern in the language, exploring relations between existing patterns or combinations of patterns, or adding a new pattern altogether. A thorough understanding of the language will be able to describe the role of collaboration concepts that are as diverse as:

- social capital
- diffusion of innovation
- communication channels
- information needs
- fair process effects
- communities of practice
- media richness
- network externalities
- resource scarcity
- technology effects
- collaboration readiness
- cultures of helping
- trust
- critical mass
- imperfect information
- reputations
- data sharing
- remote users
- power dynamics
- in/group out/group effects, etc.

The quality of the language is a direct result of the quality of the individual patterns. It is the network of connections between patterns that is responsible for creating the nature of the language. As the individual patterns develop through high quality research, the overall structure of the language will continue to be useful as a framework to organise and share knowledge and practices of collaborations.

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RAZGOVOR U GRUPAMA: MOTIVATING A PATTERN LANGUAGE FOR COMMUNICATION

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SAŽETAK

Učestalost i značajnost suradnje raste u poslovanju, znanosti i zajednici. Znanje o preduvjetima uspješne komunikacije također raste, ali je uobičajeno koncentrirano na pojedini vid teorije suradnje. Razumijevanje izgrađivanja uspješne suradnje znatno se povećava stvaranjem jedinstvenog okvira ta organiziranje i prijenos znanja i vještina. Okvir predložen u ovom članku je koncept jezika obrazaca za suradnju. Pojam jezika obrazaca prvi je razradio 1979. godine Christopher Alexander u svojoj knjizi *A Timeless Way of Building*. Jezik obrazaca je hijerarhija pojedinačnih obrazaca upotrijebljenih za razriješavanje problema povezanih s dijelovima obrazaca. Razvijeni jezik obrazaca za suradnju istraživači mogu koristiti kao alat za izvrijednjavanje postojećih, poboljšavanje nezdravih i izgradnju budućih suradnji. Suština pristupa je da struktura okoline oblikuje obrasce događaja. Zdrava suradnja vjerojatnije će biti odgovorna prema potrebama zajednice i dovoljno robustna da nadiđe izazove suradnji. Razvoj i evolucija jezika obrazaca sliči genetskom procesu jer odlike jezika u cjelini izrastaju iz međudjelovanja pojedinačnih i kompleksnijih obrazaca. U članku se primijenjuje jezik obrazaca na primjer 28 različitih kolaboracija koje su dio Inicijative zdravih zajednica u Coloradu radi ilustriranja njegove primjenjivosti u kontekstu. Članak završava smjernicama daljnjeg razvoja jezika obrazaca.

KLJUČNE RIJEČI

inicijativa zdravih zajednica u Coloradu, suradnja, jezik obrazaca, evolucijski razvoj, kompleksnost

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