

INTERDISCIPLINARY DESCRIPTION OF COMPLEX SYSTEMS

Scientific Journal

<i>S. Petlevski</i>	187	Beyond Identity: the Dynamic Self at the Intersection of Performance Philosophy and the Philosophy of Science
<i>M. Wajzer and T. Staniucha</i>	210	Simon`s Puzzle: Heuristics in the Process of Making Political Choices
<i>J.A. García Ayala</i>	225	Complexity and Sociocultural Urbanization of Spare Time in Magdalena Mixhuca Sports City
<i>G. Mester</i>	245	Design of the Fuzzy Control Systems Based on Genetic Algorithm for Intelligent Robots
<i>I. Bíró</i>	255	Synthesis of some Mechanisms using Natural Coordinates
<i>B. Pešec and Z. Petković</i>	263	Assessing Engineering Students' Ethicality

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TABLE OF CONTENTS

REGULAR ARTICLES

<i>Sibila Petlevski</i>	187	Beyond Identity: the Dynamic Self at the Intersection of Performance Philosophy and the Philosophy of Science
<i>Mateusz Wajzer and Tymoteusz Staniucha</i>	210	Simon's Puzzle: Heuristics in the Process of Making Political Choices
<i>José Antonio García Ayala</i>	225	Complexity and Sociocultural Urbanization of Spare Time in Magdalena Mixhuca Sports City
<i>Gyula Mester</i>	245	Design of the Fuzzy Control Systems Based on Genetic Algorithm for Intelligent Robots
<i>István Bíró</i>	255	Synthesis of some Mechanisms using Natural Coordinates

PRELIMINARY REPORT

<i>Bruno Pešec and Zvonimir Petković</i>	263	Assessing Engineering Students' Ethicality
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BEYOND IDENTITY: THE DYNAMIC SELF AT THE INTERSECTION OF PERFORMANCE PHILOSOPHY AND THE PHILOSOPHY OF SCIENCE

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ABSTRACT

In this article we advocate the methodological feedback loop in the study of the dynamical self at the crossroads of performance philosophy, (artistic) performance, and the philosophy of science. We point to the importance of the dynamics of methodology transfer between arts and sciences and the “interactive continuum” proposed by Newman & Benz in 1998. In the first part of this paper we give a comparative review of the research context relevant for our field of study, and we explain our research hubs in approaching the concept of “performance”. We suggest the possibility to define our field of research in three equally legitimate ways: as philosophy-of-performance, philosophy-as-performance and performance-as-philosophy. In our recent work we are primarily interested in artistic performances that incorporate elements of artistic practice in the methodology of research output (Frayling 1993), as well as in the potentials of performative aspects of scientific praxis and methodology. However, the conceptual background relevant for this paper is in the field of process philosophy and its relation to science (Birkhard’s “interactivist model” 2009; Campbell’s “process-based model for an interactive ontology” 2009). We attribute particular importance to the notion of “autopoietic feedback” (Maturana and Varela 1974; Luhmann 1990). The second part addresses the issue of transcending identity in the representations of the self and the other; the relationship between Theory-Theory (TT) and Simulation Theory (ST), as well as some recent attempts at combining different theories of mind (e.g. Barlassina 2013). We also deal with the notion of “embodied praxis” (Gallagher and Meltzoff 1996); we mention some neuroscientific insights into the similar phenomena, and – commenting on the importance of the dialogue between neuroscientists and philosophers (Changeux and Ricour) – we give an example of an enactive approach to understanding acting (Zarrilli 2007). In the third part of this article, we critique the notion of “interpassivity” (Žižek 1997; Pfaller 2000). In the concluding part we mention the importance of exploring the concept of “expanded self” (Gallagher 2000; Jeannerod 2003; Kim and Johnson 2013). Being aware of the impossibility to reach final conclusions in the scientific approach to the dynamics of the self, instead of a formal conclusion, we offer a quote from Yeats’ poem “Balloons of Mind”.

KEY WORDS

autopoiesis, dynamic self, embodied cognition, enactive intersubjectivity, performance

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IN FAVOR OF METHODOLOGICAL FEEDBACK LOOPS: A BROAD OVERVIEW OF RESEARCH CONTEXT FOR EXPLORING THE CONCEPT OF THE DYNAMIC SELF

Richard Schechner understands performance as an inclusive term, a node on a continuum [1-5]. Not everything is meant to be a performance, but everything, from performing arts to politics and economics, can be studied as performance. It is hard to opt for a singular theory and a single methodology that would offer an ideal approach to such a broad concept. For Schechner [6, 7] what sets performance studies apart, is not necessarily what is defined as performance but the framework surrounding the interaction of behavior and the public space in which the performance is enacted. For example, performance studies scholars' inquiry into ritual emphasizes its dynamic "behavior". He distinguishes between various "nodes" of performance historically and experientially linked in a web and, as they exist in everyday life, as a fan. An example of the recent representation of performance context (for "performance art") is a project, curated by Sinéad O'Donnell in 2012, which investigates an existing map created by the German performance artist Boris Nieslony and Gerhard Dirmoser (1993-2001). The work titled *Mapping' Performance Art in Context*, originally researched and finally produced over a period of fifteen years by Nieslony and Dirmoser [8, 9], describes the layered categorizations, disciplines, methodologies and locations of Nieslony's research toward the origin and definition of performance art.

The last 50 years have seen the increased use of the terms and uses of performance and performativity in non-theatre/stage associated research fields of linguistics, anthropology, ethnography and sociology. "The performative turn" – a paradigmatic shift in the humanities and social science to which the concept of performance is central, took performance-inspired methods and situations as both the subject of research and methodology – focusing on embodied practices as a source for understanding society. The modes of research employed stemmed principally from first person and everyday interactions, observations, and analyses, thus stepping away from representational and symbolic models to engage with the "real" world (see Austin, Conquergood, Goffman, Turner). Performance and performativity – in contrast to the representation models of indexing, archiving, and documentation – both as theory and practice – have increasingly taken on as placeholders of the modality of the knowledge production occurring in the arts and humanities as well as in techno-scientific communities and discourse [10]. This shift can be traced to a general concern for "action," which permeated 20th century culture and science, and which has also been echoed in a variety of disciplines from linguistics, anthropology, sociology, and gender theory, to performance art, music, dance and theatre – marking a turning away from fixed representational documents as "knowledge depositories" towards the investigation of event and time-based structures as a "knowledge flow"¹ The concept of performativity has long been discussed within the social sciences and the humanities (in language philosophy, performance theory, gender studies, ethnography, anthropology, etc.). Performance is a new paradigm, not so much a new art form; it stands less for a new phenomenon than for a new observation of familiar phenomena [11] (see also [12]). Performance here becomes not only a subject for study but also an interpretive grid laid upon the process of study itself, and indeed upon almost any sort of human activity, collective or individual [11]. One salient usage focuses on the value of the non-propositional logical mode of understanding gained through a bodily involvement and speech in the act of doing. With growing interest in the interface between art, science, technology and society, the role of the performative act within scientific practice and knowledge production receives more attention these days. Performative acts operate in the "context of discovery", rather than in the "context of justification" [12] (see

also [13-15]). In the contemporary European context the idea of “performative science” (enriched with new technological approaches and systems science insight into the problem of performance complexity) is being propagated by Hans Diebner’s work on Performative Science, where research outcomes could be shown in a “serious game” model of “installation” [16, 17]. A similar notion, in Croatian context, has its beginnings in Gavella’s idea of “freeing new design” in theatre criticism methodology and delivery of its results [18]. Recently, typical conceptions from the arts like enactment, embodiment and interplay, to name but a few, find applications in different scientific areas – even in the “hard sciences”. An artistic performance is a non-replicable event that changes its ontological status with every act of being recorded. It is falsifiable in every relational aspect and every phase of its development, but it defies the very notion of falsifiability wherever it decides to *create a modal world* (no matter if it was based on the less “engaged” actor-spectator or more “engaged” actor-spect-actor type of social agreement between performers and their “audience”). An artistic performance is precise in its own way. In a work-in-progress type of performance – as well as in a theatrical event or conceptual artistic event with classically organized performance time – performers use bodily enacted “operational definitions” in order to define in live time the variables they have studied and continue to study in the process of preparing the performance. (Here we also include the variables performers continue to study within the course of their actual “public” performance, while they perform, and sometimes improvise live). The principle of parsimony, so-called Occam’s razor that maintains that researches should apply the simplest explanation possible to any set of observations, is generally considered not to be applicable to artistic research-in-practice. However, since the performers are human beings (and taking into account the historical importance of the contested concept of “the natural” in some of the acting techniques based on impersonation) we can approach the problem of parsimony in artistic performance with some insights taken from the field of evolutionary biology. We define performance as a process of communication in social contexts. Our current research incorporates qualitative and quantitative insights into the issue of interaction and its problems (for example, the problem of measuring of interaction strength in nature and in society; different parameters in measuring interaction strength in nature, society and in social media, and the lack of formalization). We are interested in philosophical, scientific, as well as in theoretical-performing research of various aspects of interaction (communicative, ritualistic and artistic interactions, internal dynamism in relations between memory and representation; “constructive memory” and performative use of “relational memory” as a topic dealt with in cognitive philosophy and cultural history [19-31]. One of the crucial points in our research is in exploring how the discursive field limits and produces identity. Here we point to the interaction between identity and the physical world looking into the process of establishing social, temporal and discursive relational spaces. The terms “body”, “personae” and “intersubjects” have been looked upon within the course of the scenic dynamism of interchange conducted in the relational space of culture, for example during the “interplay” [32, 33] which is the topic of the theories of acting based in phenomenology. We are also interested in other types of relational spaces based on identity that have implication in the performing domain (urban spaces of identity, institutional, colonial, postcolonial, national and transnational spaces of identity constructed under the influence of popular culture, marginal and liminal spaces including the related terms of periphery, border, the Other and the Different.) We are taking into the consideration the results of identity theory including the controversy involved in it [34-43], as well as of the cognitive science, e.g. [44-47]. In the course of our project dealing with discursive identity topics² we have introduced in an innovative way the following terms into the context of the theory of performative arts: mental event, intersubjective identity, discursive objectivation, individuation, inter-subject, perception, perceptual synthesis,

perception as a form of a corporeal experience, perceptive anticipation, reception, language ability, communicational, interactivity, corporeality, autoreferentiality, reflexivity, intentionality, emotional meaning, corporeal as a mind dimension, autopoietical system, relational space, dynamism of exchange, interplay, relational memory etc. What we find particularly intriguing in the context of the recent situation in the studied area are performative considerations of art-science relationship. Firstly, we analyze performative artistic practices, philosophical and, broadly speaking, theoretical implications of the corresponding “research in practice” which incorporates elements of artistic practice in the methodology of research output [48]. Secondly, we explore process philosophy and its relation to science [49, 50]; R. Campbell’s “process-based model for an interactive ontology” [26], as well as the concept of autopoietic feedback in performance [51-58]); particularly in artistic performance, where we explore autopoietic and alopoeitic behaviors. Thirdly, we explore the intricate relationship between philosophy and performance, opening up possibility to define our field of research in three equally legitimate ways: as philosophy-of-performance, philosophy-as-performance and performance-as-philosophy. Fourthly, we explore the dynamics of methodology transfer between arts and sciences and the “interactive continuum” proposed by Isidore Newman and Carolyn R. Benz in 1998 and further developed by C.S. Ridenour and I. Newman in 2008. The main purpose of our recent research is in giving new scope to exploring the dynamics of exchange connected to the notion of “performance” applied in artistic “creation”, as well as in the study and representation of lives. An important hypothesis, connected to this purpose is to prove that the dynamics of methodology transfer between arts and sciences, the methodological “interactive continuum” and its “feedback loops” [59, 60] maximizing the strength of both methodologies. In order to contribute to clarification of stated theoretical and methodological problems, collaborators coming from different fields of research³ will try to develop, verify, validate and use in simulations, the formal models for quantification of dynamics of exchanges within performances. The type of research conducted in our research, to some extent, belongs to the historical context of experiments in art and technology initiated at the end of the 60s by artists Robert Rauschenberg and Robert Whitman, and by engineers Billy Klüver and Fred Waldhauer. We acknowledge the historical importance of “Intermedia” concept employed by Fluxus artist Dick Higgins, particularly in its educational application of “Intermedia” which led to university program development based on technology-science-art interplay. Here we can mention “Systems art” that emerged in the first wave of the conceptual art movement (as in Kenneth Noland and Frank Stella’s work), Roy Ascott’s concept of “cybernetic vision”, “generative art” from the 70s that brought artists and scientists together promoting the investigation of scientific-technological systems and their relationship to art and to life in general. Some of the most innovative aspects of our research are connected to the concept of “performative science”. We intend to present our research results in two ways: “objectively” (with methodological rigor within quantitative and qualitative frameworks) and “subjectively” (using our scientifically obtained models in artistic performance). However, it is profoundly erroneous truism – repeated by some cultural psychologists – that the key issue that arises with the recognition of subjectivity is “how it affects objectivity” [61]. The concept of subjectivity, and the nature of experience standing behind contemporary methodological feedback loops, is by far more complex than Ratner would like it to be.

That peculiar feedback dynamism that makes collaboration between arts and sciences methodologically fruitful brings back in focus the issue of the subject and its self-consciousness, as in Bickhard’s “social ontology of persons” from 2000, and his “interactivist model” from 2009 [62-64]. In biological terms, dying is the process whereby an organism no longer adequately regulates its material and energetic exchanges with its immediate environment, such that its identity eventually disintegrates into the thermodynamic equilibrium [65, 66]. The enactive⁴; self-directed, perception-action based approach to experience elucidates the

way mental life relates to bodily activity in terms of bodily self-regulation, sensiomotor coupling and intersubjective interaction [55]. As Nicholas Humphrey rightfully claims – *there can be no hope of scientific progress so long as we continue to write down the identity [mental state m = brain state b] in such a way that the mind terms and the brain terms are patently incommensurable* [67; p.7]. Enaction in the philosophy of mind tries to see how perception and action combine to allow humans to perceive, and to have consciousness. It is our aim in this article to argue in favor of the concept of the dynamic self. We define that concept from the perspective of an inter-enactive approach to agency, at the intersection of performance philosophy and the philosophy of science.

In the context of recent development in the field of systems science applied to performance phenomenon, it is important to point to some contemporary attempts to reevaluate ontological and phenomenological considerations of art and science, particularly the relevance of philosophers like Merleau-Ponty, but also M. Heidegger [68], H. Bergson [69]). Merleau-Ponty's bio-philosophy is particularly interesting in the view of the philosophy of neuroscience that attempts to clarify neuroscientific methods and results using conceptual method of philosophy of science. It is important to mention that the importance of some early phenomenological insights into the problem of perception, have been recognized both in conceptual art practice and in systems theory and cybernetics. Minimalist art acknowledges the viewer, whose physical interaction with the work produces ever-shifting viewpoints over time, through a kind of feedback loop. This phenomenon bears striking similarities with developments in cybernetics at the time, particularly the notion of reflexivity. Here the observer, in a kind of synthesis between the organic and the mechanical, becomes part of the system observed, without an outside from which to survey the whole [70, 71].

In *The Autopoiesis of Social Systems* [58] Luhmann distinguishes a general theory of self-referential “autopoietic” systems and a more specific level at which we may distinguish living systems (cells, brains, organisms, etc.), psychic systems, and social systems (societies, organizations, interactions) as different kinds of autopoietic systems⁵. In *Essays on Self-Reference*, he makes analogy between conscious systems and social systems pointing to the necessity in a system to produce its own decay. He speaks of the “fundamental fact of vanishing events, disappearing gestures and words that are dying away” [72; p.9]. Such “events” (for example, thoughts and communications) cannot be saved, because their loss is at the same time a condition of their “regeneration” (recurring integration of disintegration and reintegration). Memory does not preserve events as events, but their “structure-generating power”. Luhmann further explains: “A conscious system does not consist of a collection of all of its past and present thoughts, nor does a social system pile up all of its communications. After a very short time the mass of elements would be intolerably large and its complexity would be so high that the system would be unable to select a pattern of coordination and would produce chaos. The solution is to renounce all stability at the operative level of elements and to use events only. Thereby, the continuing dissolution of the system becomes a necessary cause of its autopoietic reproduction. The system becomes dynamic in a very basic sense. It becomes inherently restless. The instability of its elements is a condition of its duration” [72; p.9].

The general theory of autopoietic systems postulates a clear distinction between autopoiesis and observation. This condition is fulfilled in the case of social systems as well. Without using this distinction, the system could not accomplish the self-simplification necessary for self-observation. Autopoiesis and observation, communication and attribution of action are not the same and can never fuse. Nevertheless, self-observation in this specific sense of describing itself as a chain of clear-cut and responsible actions is a prerequisite of autopoiesis as such. Without this technique of using a simplified model of itself, the system could not

communicate about communication and could not select its basic elements in view of their capacity to adapt themselves to the requirements of autopoiesis in the sense of adaptation to the partially resolved dynamics of environment. This particular constellation may not be universally valid for all autopoietic systems, claims Luhmann. In view of the special case of social systems, however, he thinks that the general theory has to formulate the distinction of autopoiesis and observation in a way that does not exclude cases in which self-observation is a necessary requirement of autopoiesis as such. Luhmann defines functionalism as a theory of a self-referential system applied to “observing systems” as well, where the notion “observing system” stands here in the double sense implied by Heinz von Foerster⁶. Constructivism – such as Foerster’s – argues that there are no observations independent of observers. The lawfulness and certainty of all natural phenomena are properties of the describer, not of what is being described. The logic of the world is the logic of the description of the world. As Paul Watzlawick says in the foreword of Lynn Segal’s book on Foerster: “The realization that the observer, the observed phenomenon, and the process of observation itself form a totality, which can be decomposed into its elements only on pain of absurd reifications, has far-reaching implications for our understanding of man and his problems – especially of the ways in which he literally ‘constructs’ his reality, then reacts to it as if it existed independently of him ‘out there,’ and eventually may arrive at the startling awareness that his reactions are both the effect and the cause of his reality construction. This ‘curved space’ of human experience of the world and of himself, this closure – as Heinz von Foerster calls it – finds its symbolic expression in the Ouroboros, the snake that bites its own tail, or its poetic expression in the words of T.S. Eliot, for whom ‘The end of all our exploring will be to arrive where we started and know the place for the first time.’” [73; pp.xi-xii].

What we find particularly useful in our current research is applying systems theory to performing arts. Von Bertalanffy’s introduction of systems theory [74-76] changed that framework by looking at the system as a whole, with its relationships and interactions with other systems, as a mechanism of growth and change. This led to a new language, popularizing terms such as *open and closed systems*, *entropy*, *boundary*, *homeostasis*, *inputs*, *outputs*, and *feedback*. What intrigues us most in the context of cultural performance research is person-in-environment interaction and the adaptation process analysis. Given the dynamic nature of interactions in person-in-environment relationships, adaptation is the central (socio)ecological concept. Adaptation relates to the cause-and-effect relationship between the person and the environment, with change as the inevitable outcome of the interaction. In particular, the additional notion of “complex adaptive systems”, as formulated and developed in 1980s by Gell-Mann and the group related to the Santa Fe Institute [77] incorporates processes that we focus onto in our current research. The complex systems approach to cognitive science invites a new understanding of extended cognitive systems. According to this understanding, extended cognitive systems are heterogeneous, composed of brain, body, and niche, non-linearly coupled to one another. This view of cognitive systems, as non-linearly coupled brain–body–niche systems, promises conceptual and methodological advances [78]. The fundamental interdependence among brain, body, and niche – according to Silberstein & Chemero [78] – makes possible to explain extended cognition without invoking representations or computation. They also claim that cognition and conscious experience can be understood as a single phenomenon, “eliminating fruitless philosophical discussion of qualia and the so-called hard problem of consciousness”. What they call “extended phenomenological-cognitive systems” are relational and dynamical entities, with interactions among heterogeneous parts at multiple spatial and temporal scales.

BEYOND IDENTITY: REPRESENTATION OF THE SELF AND THE OTHERS

When Heinz von Foerster [79] speaks of “*curved space*” of human experience of the world and of himself, he does that as a cognitive constructivist – a Piaget’s disciple – who illustrates the topic of self-reflexivity with the mythic symbol of Ouroboros. The ancient time-serpent eating its own tail – the alchemical symbol of the circular nature of the alchemist’s work – is depicted in Foerster’s book alongside mathematical formulas. Foerster’s Ouroboros is an illustration of the alchemy of human knowledge and at the same time it is an illustration of the theory of cognitive development. Foerster’s theory is based on the belief that human beings cannot receive a ready-made knowledge given to them in such way that they can understand and use it right away. Humans construct their knowledge; they build it through experience, and that experience enables them to create mental models. Heinz von Foerster’s concept of *eigenform*, explained in *Understanding Understanding: Essays on Cybernetics and Cognition* (in the chapter on “Objects: Tokens for (Eigen-)Behaviors”) [79, 80] illustrates the relationship of an observer and the world around him both mathematically and from the phenomenological perspective: “Apparently, only when a subject, S1, stipulates the existence of another subject, S2, not unlike himself, who, in turn, stipulates the existence of still another subject, not unlike himself, who may well be S1. In this atomical social context each subject’s (observer’s) experience of his own sensori-motor coordination can now be referred to by a token of this experience, the ‘object’, which, at the same time, may be taken as a token for the externality of communal space. With this I have returned to the topology of closure where equilibrium is obtained when the Eigenbehaviors of one participant generate (recursively) those for the other where one snake eats the tail of the other as if it were its own, and where cognition computes its own cognitions through those of the other: here is the origin of ethics” [80; p.261].

Co-creative relationship between the world and the observer, the alchemical illustration of the dynamics of “eating the tale of the other as if it was our own”, opens up some space for speculation in the field of moral philosophy. At least Foerster wants to make room for ethics when he defines the relation between Thou and I as identity. “According to the principle of relativity, which rejects a hypothesis when it does not hold for two instances together, although it holds for each instance separately (Earthlings and Venusians may be consistent in claiming to be in the center of the universe, but their claims fall to pieces if they should ever get together), the solipsistic claim falls to pieces when besides me I invent another autonomous organism. However, it should be noted that since the principle of relativity is not a logical necessity – nor is it a proposition that can be proven to be either true or false – the crucial point to be recognized here is that I am free to choose either to adopt this principle or to reject it. If I reject it, I am the center of the universe, my reality is my dreams and my nightmares, my language is monologue, and my logic monologic. If I adopt it, neither I, nor the other can be the center of the universe. As in the heliocentric system, there must be a third that is the central reference. It is the relation between Thou and I, and this relation is identity: reality = community.

What are the consequences of all this in ethics and aesthetics?

The ethical imperative: Act always so as to increase the number of choices.

The aesthetical imperative: If you desire to see, learn how to act” [80; p.227].

Thinking about another mind by using one’s own mind as a model – “mindreading” as an ability of assigning mental states to others – is an important issue in the theory of mind, but it also has potential practical implications for medical science, e.g. in understanding and

treating autism. A *theory-theorist* explains the mechanism of using “folk psychology” in order to reason about others’ minds. This is considered to be an innate cognitive capacity developed automatically, though instantiated through social interactions: represented and exemplified by social relations conducted over centuries of human history. Unlike theory-theorist, a *theorist of mental simulation* does not believe in an innate folk-psychological conceptual scheme, but rather in a kind of mental modeling in which the simulator uses her own mind as an analog model of the mind of the simulated agent. Predicting and anticipating behavior of other living beings is indispensable for survival of human species. An effective and fast-acting *mindreading* system provides us with information on other people’s intentions. However, in spite of many differences in Theory-Theory versus Simulation-Theory, there are some new attempts at combining TT and ST theories of mind as in Barlassina⁷ [81]. The confrontation between opposing groups of TT-supporters and ST-supporters – this prolonged philosophical “quarrel” – waits to be settled by an experiment conducted in a laboratory. Neuroscience research has demonstrated common neural mechanisms between executed and observed action at the neural level. Neuroimaging experiments in humans have showed the activation of a fronto-parietal neural network that is involved in the observation and imagination of action. There are also new insights into the problem of *the self*, representing *the other*, with the new cognitive neuroscience view of psychological identification⁸. Contemporary research in developmental science, cognitive psychology, and neuroscience provides cumulative evidence for a view of similarities in the construction of representations of the self and others. Trevarthen’s theory of coupled rhythms in infant’s coordination with the parent as a partner, and his intersubject sympathy – a predisposition to be sensitive and responsive to the subjective states of other people [82, 83] – gains in relevance in the light of the newly conducted experiments with neonatal imitation. These findings have led Gallagher and Meltzoff to propose that the understanding of the other person is primarily a form of embodied practice [84-86]. The perception of others’ action, explain Buccino et al. activates the premotor cortex and the parietal cortex in a somatotopical manner; watching mouth actions activates the cortical representation of the mouth, while watching hand or foot actions activates their respective representations [87, 88]. Decety and Chaminade continue the line of the previously made research indicating that we are from birth not only acting and thinking selves, but we also express an intuitive need to relate ourselves to other people [89-91].

An impressive example for an open-minded collaboration across different fields of research is a book-length discussion about ethics, human nature and the brain between Jean-Pierre Changeux, a French neuroscientist, and Paul Ricoeur, celebrated French philosopher⁹. In the 3rd chapter, in the section titled *The Human Brain: Complexity, Hierarchy, Spontaneity* [92], Changeux calls attention to the notion of spontaneous activity arguing that our nervous system is not active only when it is stimulated by sensory organs. The brain functions in a projective mode. It is the permanent seat of important internal activities – when one thinks, when one plans a movement, when one hears, perceives, imagines, or creates. These activities occur when we are awake, but also while we are asleep. Changeux explains how these activities play a fundamental role in the sense that they serve as the basic material for constructing, elaborating, and organizing the representations that will be projected onto the world, thereby making it possible to anticipate the future – to anticipate events that will occur in both the external and the internal world [92; p.88].

Commenting on Changeux’s remarks, Ricoeur points to Husserl’s last writings, highlighting his thesis that human agent does not content himself with being informed about his environment in order to modify it afterward; from the beginning he interprets it and shapes it, or better – to use Husserl’s formulation – he constitutes it as the world that surrounds him by

projecting onto it the aims of his action and his demands for meaning. Changeux notices that both Ricoeur and himself rejected the input-output model of cerebral function common to cybernetics and information theory in favor of *the projective schema*. He partly agrees with Ricoeur, saying that we project husserlian “aims of action and demands of meaning” onto a world that has neither fate nor meaning, and that it is with our brain that we *create categories* in a world that – according to his opinion – possesses none, apart from those already created by human beings. Changeux points to the experiments that have shown that distinct cortical (and subcortical) regions are mobilized by the sight of the moving hand, the mental image of the movement of one’s own hand, and preparation for executing this movement. He explains that when brain interacts with the external world, it develops and functions according to a model of variation-selection that is sometimes called Darwinian. According to this hypothesis, variation – the generation of diversity of internal forms – *precedes* the selection of the *adequate* form. Representations are stabilized in our brain not simply by “imprint”, as it were a piece of wax, but indirectly via process of selection [92; pp.90-91].

One of the rare theatre practitioners keenly interested in embodied acting and cognitive foundations of performance is Phillip B. Zarrilli. In *Acting (Re)Considered* [93] he argued that every time an actor performs, he or she implicitly enacts a “theory” [93; p.3] – a set of assumptions and styles that guides an actor through performance, the shape that those actions take (as a character, role, or sequence of actions as in some performance art) and the relationship to the audience. In an essay on “An Enactive Approach to Understanding Acting” [94; pp.635-647], inspired by recent developments in phenomenology, cognitive science, and anthropological ecology, he explores an enactive approach to meta-theoretical understanding of acting as a phenomenon: “In contrast to representational and/or mimetic meta-theories of acting that construct their views of action from a position as an outside observer to the process/phenomenon of acting, an enactive view provides an account of acting from the perspective of the actor as enactor/ doer from “inside” the processes. Acting should not be viewed as embodying a representation of a role or a character, but rather as a dynamic, lived experience in which the actor is responsive to the demands of the particular moment within a specific (theatrical) environment” [94; p.638].

Perceptual, *sensiomotor knowledge* is vitally important for an enactive view of acting. Zarrilli promotes the perspective of *the actor-as-(human) doer enactor* inside the performance of an acting score. Acting is here considered as an extra-daily skilled mode of embodied practice requiring the performer to negotiate “interior” and “exterior” via perception-in-action in response to an environment. The type of spontaneity Zarrilli advocates (the one that “allows one to become an animal, ready “to leap and act”, “embodying the lion’s fury”) is based on daily training of actor-as-perceiver. He thinks that in the moment of enactment we are utilizing their perceptual and sensory experience and cumulative embodied knowledge as skilled exploration in the moment of the specific theatrical “world” or environment created during rehearsal process. [94; p.647].

INTERPASSIVITY – A “SHARP-DULL” TERM FOR A MISSING CONCEPT

In *The Plague of Phantasies*, Slavoj Žižek draws on Robert Pfaller’s intervention at the symposium *Die Dirge lachen an unsere Stelle* (Linz, Austria, 8-10 October 1996) and supplements “the fashionable notion of ‘interactivity’ with its shadowy and much more uncanny supplement/double, the notion of ‘interpassivity’” [95; pp.151-152]. The phenomenon that provoked Žižek and Pfaller into supplementing the notion of interactivity in arts and culture with the notion of interpassivity¹⁰, is the situation on the postmodern cultural scene where “at the moment when in art an ideology of interactivity appeared predominant, the example of canned laughter pointed into an opposite direction: it was an artwork that

contained its own observation. Here, the artwork did not leave some creative activity to the observers; on the contrary, it kept all for itself, even the “passivity” of the observers” [96; p.47]. Žižek criticizes ideological implications of the contemporary “paradox of interpassivity, of believing or enjoying through the Other” [95; p.147]. The core of Žižek’s interpretation of cultural interpassivity of the (post)modern times is in the psychoanalytical notion of “transference”. In the first approach to that notion, Freud defined it as a displacement of affect from one idea to another. Later on he described transference as an unconscious redirection of feelings from one person in the past to another, e.g. to a therapist during the process of psychoanalysis. Lacan described the dialectics of transference in *An Intervention on the Transference* [97] as a pure mechanism that – although it mimics emotional relation and manifests itself in the guise of strong affects like love and hate – actually has nothing to do with emotions and acquires meaning solely by virtue of the dialectical moment in which it is produced. From the repetitive symbolical nature of the transference, which brought this notion close to “speech-act” theory, Lacan enriched the concept of transference with the concept of “sujet supposé savoir”. Different shades of interpretation in Lacan’s approach to the concept of transference consolidated in the sixties around the central problem of analysand’s phantasy of the subject that is supposed to know his or her innermost thoughts. The analyst as a supposed subject of knowledge is imagined as somebody who knows the innermost thoughts of the analysand. The projection of self into the other is a phantasm that strips the object of supposedly perfect knowledge from its personality and transfers it into a mere function. Lacanian “Objet (petit) *a*” sets desire in a circular motion around what is unattainable. From the theoretical point of view, Žižek’s approach to transference is clearly Lacanian: “Transposing my very passive experience on to another is a much more uncanny phenomenon than that of being active through another: in interpassivity I am decentred in a much more radical way than I am in interactivity, since interpassivity deprives me of the very kernel of my substantial identity. Consequently, the basic matrix of interpassivity follows from the very notion of subject as the pure activity of (self-)positing, as the fluidity of pure Becoming, devoid of any positive, firm Being: if I am to function as pure activity, I have to externalize my (passive) Being – in short I have to be passive **through another**. This inert object which ‘is’ my Being, in which my inert Being is externalized, is the Lacanian **objet petit *a***. In so far as the elementary, constitutive structure of subjectivity is hysterical – in so far, that is, as hysteria is defined by the question ‘What for an object am I (in the eyes of the Other, for the Other’s desire)?’, it confronts us with interpassivity at its purest: what the hysterical subject is unable to accept, what gives rise to an unbearable anxiety in him, is the presentiment that the Other(s) perceive him in the passivity of his Being, as an object to be exchanged, enjoyed or otherwise ‘manipulated’. Therein lies the ‘onto-logical axiom’ of Lacanian subjectivity: the more I am active, the more I must be passive in another’s place – that is to say, the more there must be another object which is passive in my place, on my behalf (this axiom is realized in its utmost simplicity in the proverbial senior manager who, from time to time, feels compelled to visit prostitutes to be exposed to masochistic rituals and ‘treated as a mere object’). What psychoanalysis is looking for in an active subject is precisely the fundamental fantasy which sustains his disavowed passivity” [95; pp.151-152].

The problem with Žižek’s use of the concept of interpassivity is – contrary to what he would like to make his readers believe – not in supplementing *the fashionable notion of ‘interactivity’ with its shadowy and much more uncanny supplement/double, the notion of ‘interpassivity’*. The real uncanny, hazardous supplement of interactivity, is transference. Žižek’s “interpassivity” – at least the one exemplified in his book with a number of concrete examples from everyday life and politics – is based on the pure functionality; on the repetitive mechanism of the dialectics of transference. The problem is in the (re)interpretation of an old psychoanalytical term, or rather in the lack of any substantially new interpretation.

The more one reads Žižek, the more one gets impression that the Greek word ὀξύμωρον – “sharp dull” (that makes the etymology of the Latin *oxymoron* as a figure of speech based on juxtaposition of seemingly contradictory elements) lies at the very basis of Slavoj Žižek’s “style” of philosophical thinking. Rober Pfaller, a professor from Linz University of Art and Industrial Design, masterly defends Žižek’s theory as a philosophy that proceeds through examples. In his eulogy of Žižek’s philosophical “toolbox”¹¹, the paper presented at the annual conference of the British Society of Phenomenology in 2006, Pfaller explains that a typical Žižek’s example is not a concrete illustration of an abstract idea; it fulfills the completely different – Pfaller says “paradoxical” function. The idea which Žižek in his elaboration points at is far from being there at the beginning. On the contrary, Žižek uses his first example in order to dismiss the idea usually connected with the chosen example. He suggests an alternative reading and in such a way he “estranges” the common practice of approaching the chosen concept. Pfaller – in appraisal of the “strictly logical function” of telling jokes in Žižek’s philosophical narrative, claims the following: “Only by ‘estranging’ and problematizing our own practice, i.e. by recognizing its strangeness and by transforming its previous evidence into a question, we get a key for replacing our astonishment and the respective assumptions about foreign phenomena by theoretical concepts” [96; p.37].

However, we are not quite sure that Pfaller’s appraisal of the logic of Žižek’s joking – in spite of the strictness of the logic that makes Žižek’s points in philosophical narration so rhetorically effective – succeeds in convincing the reader of Žižek’s huge body of work that every single estrangement-effect this author uses, automatically leads to a deeper insight into the chosen philosophical (or broadly speaking cultural) concept. The problem is not in Žižek’s philosophical system whose relevance is undisputable, but the real danger lies in the possible missuses of his “toolkit”. The term “interpassivity” – since it was established by Žižek in the nineties – has assumed a meme-like potency. For example, it is theoretically naïve to reduce the problem of “interpassivity” to examples such as the example of the internet, “reified as an object, taking on our political values, intentions and goals so that we can remain passive, a reversal of the familiar rhetoric that the internet offers greater participation and activity”¹² [98]. A huge mass of miss-interpretation and theoretical banality circles around it. The key concept of “transference” is completely lost in the meantime. There is an army of young meta-readers whose chief subject of expertise is reading what said “the significant other” about books they are too lazy to read themselves. The interpassivity of reading Lacan through Žižek seems to be yet another symptom on the list of symptoms of postmodernity. A typical meta-reader of today asks himself: Who cares now about the development of the notion of transference in the Lacanian system of thought? Who cares about its Freudian legacy? Who cares about the problem of transference connected to the relational self in the context of an interpersonal cognitive theory¹³?

Dynamical, “situated” approaches to cognition have resulted in the reinterpretation of the distinction between so-called *external* and so-called *internal* representational formats of memory “storage”. Merlin W. Donald suggests in *Origins of the Modern Mind* [99] and in *Précis of Origins of the Modern Mind with multiple review and author’s response* [100] that the increasing reliance on external memory media in “technology-supported culture” (as the third stage in the development of “human capacity through culture”) may have deep effects on human cognitive development and behavior. The externalization of memory has changed the way humans use their cognitive resources, what they can know, where that knowledge is stored, and what kinds of codes are needed to decipher what is stored [99; p.362]. The main Donald’s thesis is that each translation in human cognitive evolution depends on culturally mediated changes to the structure of memory. In Donald’s view, mimesis – as a human-specific ability to reenact bodily previously experienced events – is the basis for the

translation to the first humanlike culture. What makes mimesis different from imitation, in Donald's account, is that mimesis adds a representational dimension to imitation, so that it may be used intentionally to represent both physical and social events such as in the act of engaging in certain forms of dance, communicating to others about past events, practicing social roles observed in others, coordinating personal behavior in group activities and teaching skills¹⁴. In the circle of Žižekians, the reification of objects of technology seems to be fatally connected to the "interpassive" transference mechanism of "enjoying through the other". However, the process of transferring human memory to external memory disk of media and new technology looks entirely different, and certainly "more natural", when we look upon it from the evolutionary perspective. It seems to us that the dialectical, repetitive nature of transference described by Lacan – its pure functionality and its capability to mimic emotions in spite of being devoid of them – gets an unexpected supplement in the new research of the neurological basis of empathy¹⁵.

A POEM INSTEAD OF A CONCLUSION

The notion of the extended self – the concept that refers to the idea that people incorporate self-relevant others or objects into one's sense of self – has been recently tested. The previous experiments by Gallagher [85] showed that the minimal sense of self is grounded in the moment-to-moment mapping of intentions to act with the sensory and proprioceptive feedback that accompanies the actions. Thus, we have a sense of owning the body and the ability to author actions with that body [101]. The recently obtained results provided neural evidence for the idea that personally relevant external stimuli may be incorporated into one's sense of self [102].

W.B. Yeats wrote a short poem in 1919 titled *The Balloon of the Mind*. His poetic "interpretation" of the problem of the body-mind relationship is the following:

"Hands, do what you're bid: // Bring the balloon of the mind //
That bellies and drags in the wind // Into its narrow shed."

The research of the dynamics of the self could not reach a conclusion, but luckily, the poetic insight into the mystery of ourselves could provide an objective correlative, a shortcut to the reality that we cannot approach by other means – at least not yet.

REMARKS

¹Lamontagne, a new media artist and curator interested in fashion studies and body-based technologies used by cyborg performer Stelarc, claims in the aforementioned context that a coupling of wearable objects technology and performativity is not only crucial to an understanding of the materiality of the wearable object and its social practice, but also offers new grounds for a repositioning of research within the broader field of performance.

²Scientific project titled *Discursive Identity in Performing Arts; Bodies, Personae, Intersubjects*, led by S. Petlevski, financed by Croatian Ministry of Science, Education and Sports (2007-2013).

³The project we started and intend to continue – with or without institutional financial backup – under the title *Interactive Continuum: Performative Approaches in Art & Science*, includes researchers coming from different fields of art and science. Senior researchers: D. Lukić [103], O. Markič [104], Ž. Paić [105], S. Petlevski [32, 33, 106, 107], J. Stepanić [108, 109] and young researchers G. Pavlić and L. Potrović [110].

⁴Evan Thompson [111] traces the development of the concept of enactivity back to phenomenology in the article titled "Sensorimotor subjectivity and the enactive approach". The enactive approach – says Thompson – offers a distinctive view of how mental life

relates to bodily activity at three levels: bodily self-regulation, sensorimotor coupling, and intersubjective interaction. He further explains: *The name “the enactive approach” and the associated concept of enaction were introduced into cognitive science by Varela, Thompson, and Rosch (1991) in order to describe and unify under one heading several related ideas.1 The first idea is that living beings are autonomous agents that actively generate and maintain their identities, and thereby enact or bring forth their own cognitive domains. The second idea is that the nervous system is an autonomous system: it actively generates and maintains its own coherent and meaningful patterns of activity, according to its operation as an organizationally closed or circular and re-entrant sensorimotor network of interacting neurons. The nervous system does not process information in the computationalist sense, but creates meaning. The third idea is that cognition is a form of embodied action. Cognitive structures and processes emerge from recurrent sensorimotor patterns of perception and action. Sensorimotor coupling between organism and environment modulates, but does not determine, the formation of endogenous, dynamic patterns of neural activity, which in turn inform sensorimotor coupling. The fourth idea is that a cognitive being’s world is not a pre-specified, external realm, represented internally by its brain, but a relational domain enacted or brought forth by that being’s autonomous agency and mode of coupling with the environment. This idea links the enactive approach to phenomenological philosophy, for both maintain that cognition bears a constitutive relation to its objects. Stated in a classical phenomenological way, the idea is that the object, in the precise sense of that which is given to and experienced by the subject, is conditioned by the mental activity of the subject. Stated in a more existential phenomenological way, the idea is that a cognitive being’s world – whatever that being is able to experience, know, and practically handle – is conditioned by that being’s form or structure. Such “constitution” on the part of our subjectivity or being-in-the-world is not subjectively apparent to us in everyday life, but requires systematic analysis – scientific and phenomenological – to disclose [111; p.2].*

⁵Autopoiesis is here understood as the capacity of a system to reproduce the components of which it is composed [53, 112]. The evolution of that concept is interesting in itself, especially in the aspect where it is critically evaluated in relation to the complexity of self-reference. On the other hand, there are some recent attempts at revisiting the concept of autopoiesis in relation to cognition and life [113]. They present a mathematical model of a 3D tessellation automaton, considered as a minimal example of autopoiesis. This leads them to a number of new theses. Thesis T1: “An autopoietic system can be described as a random dynamical system, which is defined only within its organized autopoietic domain”. They propose a modified definition of autopoiesis: “An autopoietic system is a network of processes that produces the components that reproduce the network, and that also regulates the boundary conditions necessary for its ongoing existence as a network.” They also propose a definition of cognition: “A system is cognitive if and only if sensory inputs serve to trigger actions in a specific way, so as to satisfy a viability constraint. They claim that the concepts of autopoiesis and cognition, although deeply related in their connection with the regulation of the boundary conditions of the system, are not immediately identical: a system can be autopoietic without being cognitive, and cognitive without being autopoietic. Finally, they propose a thesis T2: “A system that is both autopoietic and cognitive is a living system.” [113; pp.327-345].

⁶Luhmann refers to Foerster book of essays titled *Observing systems* [114]. In an article *Cybernetics on Cybernetics* first published in 1979, Foerster distinguishes the cybernetics of observed systems we may consider to be first-order cybernetics; while second-order cybernetics is the cybernetics of observing systems [80; pp.283-287]. Foerster gives theoretical homage to Maturana’s article “Neurophysiology of cognition” [115]. In 1958 Foerster founded the Biological Computer Laboratory (BCL) at the University of Illinois, in

which mathematicians, neurophysiologists, epistemologists, physicists, logicians and computer scientists worked cooperatively on problems of cognition.

⁷Barlassina [81] recognizes “mindreading” as the ability to attribute mental states to other individuals both to the Theory-Theory (TT) and the Simulation Theory (ST). According to the Theory-Theory (TT), mindreading is based on one’s possession of a Theory of Mind. On the other hand, the Simulation Theory (ST) maintains that one arrives at the attribution of a mental state by simulating it in one’s own mind. She defends a two-folded claim: on the one hand, she defends Goldman’s idea that face-based disgust recognition is underpinned by simulation; on the other hand, she maintains that simulation is not enough to account for the attribution of disgust from non-facial visual stimuli, and that this latter capacity should be explained in terms of the possession of theoretical knowledge about disgust. Barsallina proposes a ST-TT hybrid model of the ability to attribute disgust on the basis of visual stimuli such as facial expressions, body postures, etc. Her model is grounded in evidence from individuals suffering from Huntington’s disease. While defending Goldman’s thesis that the ability to attribute disgust based on observing disgusted facial expressions stems from a mirror-based simulation process [116], Barlassina argues that ST is unable to account for the ability to attribute disgust based on non-facial visual stimuli. She proposes that this latter ability is theory-based.

⁸Cf. [89, 90].

⁹*Ce qui nous fait penser* [92] was translated into English under the title *What Makes Us Think. A Neuroscientist and a Philosopher Argue About Ethics, Human Nature, and the Brain*.

¹⁰The term “interpassivity” coined by Slavoj Žižek, and further developed as a concept by Robert Pfaller and Gijs van Oenen, was originally developed for the discourse of contemporary art. Gijs van Oenen’s “interpassivity” [117] has been developed as a notion in reaction to the so-called *Actor-Network Theory* (see, e.g. [118, 119]). ANT is an approach to the research in social theory developed in the eighties. It originated in the field of science studies that treats objects as part of social networks. Questions about “what things do” and about “evocative objects” pop up in philosophy and theoretical sociology with increasing frequency. They direct our attention to an important phenomenon: the agency of objects. Gijs van Oenen [117] contrasts Bruno Latour’s and ANT’s view on the agency, or actancy of objects with his own view of the “interpassive” role of objects. In reaction to traditional interactivity, van Oenen claims, interpassivity indicates that our contribution to the realization of a work of art, or an institution, is now taken over by the artwork or institution itself. He sees it as a consequence of the success of emancipation. Our emancipatory privilege to live only in accordance with norms we have interactively subscribed to, is now starting to turn into a burden – says van Oenen: we feel an obligation to always live up to our emancipatory promise. Interpassivity, the inability to act according to norms we ourselves subscribe to, is a form of resistance to the pressures exerted by successful emancipation. In contrast with Latour’s view that objects can become “actors” but not for particular reasons, van Oenen argues that objects become actors because our interactivity is increasingly being “outsourced” to them. Paradoxically, we need objects to relieve us from our emancipatory burden, in order to sustain our emancipatory ambition. In turn, the condition of interpassivity (see [95]) implies that objects may acquire a more emancipatory status: as carriers of interactive responsibilities, they now interact with us on a more equal footing [117].

¹¹Pfaller’s article was later published in *International Journal of Zizek Studies*. Volume One, Number One – Why Žižek? Under the title “Interpassivity and Misdemeanors: The Analysis of Ideology and the Žižekian Toolbox”. See also other Pfaller’s texts on the aesthetics of interpassivity [120-122].

¹²From The blog of Philosophical Reflections and Speculations written by Mike Bulajewski who defines himself as “a 34-year old user expertise designer and graduate student at the University of Washington’s Human Centred Design and Engineering program”.

¹³For the problem, and each linkage of transference in social cognitive theory see for example: “The authors propose an interpersonal social-cognitive theory of the self and personality, the relational self, in which knowledge about the self is linked with knowledge about significant others, and each linkage embodies a self-other relationship. Mental representations of significant others are activated and used in interpersonal encounters in the social-cognitive phenomenon of transference (S.M. Andersen & N.S. Glassman, 1996), and this evokes the relational self. Variability in relational selves depends on interpersonal contextual cues, whereas stability derives from the chronic accessibility of significant-other representations. Relational selves function in if-then terms, in which ifs are situations triggering transference, and thens are relational selves. An individual’s repertoire of relational selves is a source of interpersonal patterns involving affect, motivation, self-evaluation, and self-regulation” [123; p.619].

¹⁴We have already discussed Donald’s mimetic representation elsewhere [106-107].

¹⁵The evolutionary role of empathy for pain is an interesting topic. In 2005, Tucker, Luu and Derryberry [124] pointed to the role of regulation of pain in the development of empathy. They claimed that the evaluative mechanisms engaged in some complex forms of self-regulation are “extensions of mechanisms that evolved for evaluating and responding to pain”. They also speak of “sympathetic resonance” as an emotional response that ranges from contagion to more complex intersubjective reasoning. In that view, empathy would involve reasoning to integrate visceral emotional contagion and somatic sensiomotor mirroring. Decety and Lamm [91] suggested that empathy involves both emotion sharing (bottom-up information processing) and executive control to regulate and modulate this experience (top-down information processing) aimed at controlling the experience, underpinned by specific neural systems that interact. Decety and Lamm in “Human Empathy Through the Lens of Social Neuroscience” discuss data from recent behavioral and functional neuroimaging studies with an emphasis on the perception of pain in others, and highlight the role of different neural mechanisms that underpin the experience of empathy, including emotion sharing, perspective taking, and emotion regulation. We are interested in the connection between empathy and creativity. Usually, creative persons show greater awareness of the surrounding. It is obvious that the higher quality of incoming information needs a mind that is capable of dealing with it, and in that context it seems that a creative person should have lower level of latent inhibition. Some recent experiments showed that highfunctioning individuals with high IQs (in that particular case, Harvard students) decreased Latent Inhibition associated with increased creative achievement [125]. LI (Lower Inhibition) reflects the brain’s capacity to screen from current attentional focus stimuli previously tagged as irrelevant [126]. Is there any relationship between empathic responses automatically activated by the perception of certain emotional cues and latent inhibition as an automatic protective selection of stimuli? Our hypothesis is that there could be a relationship between latent inhibition and empathy. This is a poorly covered area of research and it needs extensive gathering of material before even getting such a hypothesis an adequate frame for testing.

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NADILAŽENJE IDENTITETA: DINAMIČKO SEBSTVO NA RAZMEĐU FILOZOFIJE IZVEDBE I FILOZOFIJE ZNANOSTI

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SAŽETAK

U ovom radu zagovaram metodološku petlju povratne veze u istraživanju dinamičkoga sebstva na razmeđu filozofije, (umjetničke) izvedbe i filozofije znanosti. U komparativnom pregledu relevantnoga konteksta istraživanja objašnjavamo istraživačka čvorišta našega bavljenja konceptom "izvedbenoga": to je prvenstveno, analiza izvedbenih umjetničkih praksi koja inkorporira elemente umjetničke prakse u metodologiju istraživanja (Frayling 1993); ali i izvedbene aspekte u znanstvenoj istraživačkoj praksi i metodologiji. Kao podloga ovoga rada bitni su uvidi u procesnu filozofiju i njen odnos prema znanosti (Birkhardov "interaktivistički model", 2009), Campbellov "procesno utemeljen model za interaktivnu ontologiju", 2009) kao i "autopoietički feedback" (Maturana i Varela 1974; Luhmann 1990). Naznačujemo tri mogućnosti u složenom odnosu filozofije i izvedbe (filozofiju izvedbe, filozofiju-kao-izvedbu i izvedbu-kao-filozofiju); zagovaramo metodologiju transfera između umjetnosti i znanosti ("interaktivni kontinuum" Newman i Benz 1998, Ridenour i Newman 2008). U tekstu je pridana pozornost važnosti koju za naše istraživanje ima razvoj koncepta autopoietičkih

sistema. U drugome dijelu teksta bavimo se “nadilaženjem identiteta” u reprezentacijama Ja i Drugoga, odnosom Teorije-Teorije (TT) Simulacijske teorije (ST) u teoriji uma (ToM), te najnovijim pokušajima da se pristupi objedine (Barlassina 2013). Bavimo se i pojmom “utjelovljene prakse” (Gallagher i Meltzoff 1996), bilježimo recentna istraživanja srodnih fenomena u neuroznanosti, komentiramo značaj dijaloga neuroanatomika i filozofa (Changeux i Ricour), a dajemo i primjer osnaživanja izvedbene teorije i “istraživanja-u-praksi” osvješćivanjem enaktivnih procesa u tijeku glumačke izvedbe kod Zarillija (2007). U trećem ulomku dajemo kritiku pojma “interpasivnosti” (Žižek 1997; Pfaller 2000), a bavimo se i pojmom “transfera” vezanog uz Lacanovo ishodište Žižekova pojma interpasivnosti. U završnome dijelu rada, naznačavamo važnost istraživanja pojma “proširenog sebstva” (Gallagher 2000, Jeannerod 2003, Kim & Johnson 2013), da bismo, utvrdivši nemogućnost konačnog sumiranja rezultata istraživanja dinamičkog sebstva ponudili navod Yeatsove pjesme “Balon Uma”.

KLJUČNE RIJEČI

auto-poiesis, dinamičko sebstvo, utjelovljena kognicija, enaktivna intersubjektivnost, izvedba

SIMON'S PUZZLE: HEURISTICS IN THE PROCESS OF MAKING POLITICAL CHOICES

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ABSTRACT

In this article we analyse one of the most fascinating paradoxes of mass politics. Based on the data from the studies of neurobiologists, neurologists, social psychology, cognitive and evolution studies we answer the question specified in literature as the Simon's puzzle: How is it possible that citizens have their opinions about politics, if they know so little about it? We began our analysis from the criticism of the economic rationality approach. To do this, we referred to the Allais paradox, cognitive dissonance theory, Ellsberg paradox, the concept of bounded rationality, conjunction fallacy and prospect theory. Next, we described the evolutionary processes shaping the minds of Homo sapiens and characterised cognitive mechanisms, thanks to which people can make political choices, especially in view of the shortage of time and information. The following heuristics are referred to herein: affect, recognition, judgment and imitation.

KEY WORDS

Simon's puzzle, heuristics, political choice, voting behaviour, somatic marker hypothesis

CLASSIFICATION

APA: 2340, 2820, 2960, 3040

JEL: D81, D84, Z19

INTRODUCTION

A professor from one University was struggling over whether to accept an offer from a rival university or to stay. His colleague took him aside and said "Just maximize your expected utility – you always write about doing this". Exasperated, the professor responded "Come on, this is serious" [1; p.3].

Axiomatized theory of expected utility, established by John von Neumann and Oskar Morgenstern [2], became the foundation of game theory and model of rational market behaviour, and heavily influenced modern social sciences. Since its conception, it has been inspiring enough to produce many theoretical concepts in economics and political sciences. Some of them, in spite of their axiological and normative characteristics while being explicitly incompatible with data were held in high esteem by a distinguished group of scientists. Main examples of this approach are the works of rational choice theory proponents [3-6]. We would like to present the description of rational decision makers by Anthony Downs. He hold a view that (1) a rational human being is able to choose from many alternatives and (2) constructs a ranking of these alternatives by individual preference; (3) the ranking of preferences is transitive (if $A > B$ and $B > C$ then $A > C$); (4) the choice is made between the alternatives with the highest position in the preference ranking; (5) finally, *ceteris paribus*, the individual always chooses the same alternative [4; p.6]. In other words, rational human being makes decision based on the highest utility.

Where should we look for the origins of this view defining humans as *Homo oeconomicus*? The answer should be: in the age of the Enlightenment. During that time the need to create rational social order led quite often to the rise of amusing anecdotes. As an example we would like to present an advice given by Benjamin Franklin to his undecided nephew who was looking for a candidate for wife. He told him to draft a worksheet which would list all arguments for and against a candidate and then make a calculation. In this way the decision process would be optimized [1; pp.4-5].

Today, in time of great developments in the fields of neurosciences, social psychology and cognitive psychology, we know that most people do not make decisions based on the arithmetical calculation of profits and losses, as mathematicians and economists would like us to. Humans are not broadly informed beings who have indefinite quantity of time. This observation also applies to the human activity defined as politics. Therefore, we have to ask about the strategies and cognitive mechanisms which enable making decisions and judgments in political matters. The crucial point of our reflections is the problem defined in literature as the Simon's puzzle [7; p.70]. It is a problem which is expressed in a question: How is it possible that citizens have an opinion on politics while they do not know much about it?

CRITIQUE OF ECONOMICAL APPROACH TO RATIONALITY

Before we answer the abovementioned question, we are going to present several examples undermining the logic of choice based on economical axioms of rationality.

The Allais' paradox. In 1952 French economist Maurice Allais made an experiment which proved that even the most distinguished economists of his times make decisions by referring to certainty effect, therefore, their behaviour brakes the fundamental assumption of the von Neumann-Morgenstern theory. During a meeting in Paris he asked his colleagues to solve a puzzle. They had to answer a question: what would you choose in problem 1 and 2?

Problem 1

A: 33 % probability of winning 2 500 \$

66 % probability of winning 2 400 \$
 1 % probability of failure

B: 100 % probability of winning 2 400 \$

$N = 72$

A [18] B [82]*

Problem 2

C: 33 % probability of winning 2 500 \$
 67 % probability of failure

D: 34 % probability of winning 2 400 \$
 66 % probability of failure

$N = 72$

C [83]* D [17]

It is important to notice that in both examples the probability of success differed by only 1 %. In the first problem most of the answers showed that people are more inclined to decide on the basis of the probability of success, in the second problem the prize amount was deciding. The results do not make logical sense; however they can be explained by psychological factors. The probability of success in the first problem made greater impression then the analogous chance in the second problem [8, 9; pp.265-266].

Cognitive dissonance. Leon Festinger’s theory is based on two crucial concepts: dissonance and consonance. Dissonance means a contradiction between two cognitive elements e.g., opinions, attitudes, judgments or between cognitive element and behaviour. Consonance, on the other hand, means accordance and equilibrium. The consequence of dissonance is a troubled state of mind which can be alleviated in a number of ways: by changing the behavioural cognitive element, changing the environmental cognitive element or adding a new cognitive element. In a post-decision situation this reduction may lead to the so-called “freeze effect”, in other words, to change in cognitive processes which in effect greatly increases the appeal of the decision taken after the decision was made. To conclude – all discrepancies and inconsistencies are going to be rationalized [10].

The Ellsberg’s paradox. Daniel Ellsberg, long-time employer of RAND Corporation constructed an experiment based on probability. Let’s say there are 90 balls in a box, 30 of them are red, and 60 are either black or yellow. We do not know how many of them are black or yellow, but we know their total number. We have two lotteries to choose, Tables 1 and 2.

Table 1. Lottery I. Source [11; p.654].

Balls	Number	30			60		
	Colour	Red	Black	Yellow	Black	Yellow	Black
Option	A	100 \$	0 \$	0 \$	0 \$	0 \$	0 \$
	B	0 \$	100 \$	0 \$	100 \$	0 \$	0 \$

Table 2. Lottery II. Source [11; p.654].

Balls	Number	30			60		
	Colour	Red	Black	Yellow	Black	Yellow	Black
Option	A1	100 \$	0 \$	100 \$	0 \$	100 \$	0 \$
	B1	0 \$	100 \$	0 \$	100 \$	0 \$	100 \$

Analyzing the values of the balls in the Lottery I we can see that the scenario A is better than B, under the assumption, that we imagine a higher chance of getting a red ball than the black

one. This also applies to the lottery II. Scenario A1 is better than B1 if we think that there is a higher probability of getting red or yellow ball rather than a black or yellow. Therefore, if getting a red ball is more probable than getting a black one, then getting a red or yellow ball is more probable than getting a black or yellow. Many studies however show that majority of people would take scenario A over B, while choosing B1 over A1 [11; p.654].

Bounded rationality. While researching business organizations, Herbert Simon noticed that managers and decision-makers do not possess complete knowledge of the most essential aspects of their actions and, moreover, they lack specified knowledge, which others would see as broad enough. He also witnessed that many of them are unable to foresee the consequences of their own decisions and they do not use adequate system of their evaluation. As of the consequence he advised that most of the economic decisions should be made under precisely defined procedures [12-14].

Conjunction fallacy. Amos Tversky and Daniel Kahneman presented this short description to their students: "Linda is thirty-one years old, single, outspoken, and very bright. She majored in philosophy. As a student, she was deeply concerned with issues of discrimination and social justice, and also participated in antinuclear demonstrations" [15; p.297]. Afterwards they asked the following question: Which of these options is more probable: (1) Linda is a cashier; (2) Linda is a cashier and an activist in feminist movement?

In accordance to the basic laws of logic there is higher probability that Linda is only a cashier. It comes from the fact that all cashiers create a set within which feminists are only a subset composed of feminists. However, most of the responses (about 85 % to 90 %) implied that option 2 was more probable. How did we get such a fundamental error? The most reasonable answer is that Tversky's and Kahneman's students made a judgment based on their stereotypes, abandoning laws of logic for consistency and credibility of description [15; p.297].

Prospect theory. Inspired by Allais' paradox, Kahneman and Tversky conducted a series of experiments upon which they identified the following effects: (1) certainty, consistent with choosing of prognoses leading to inevitable gain; (2) reflection, that gives information on different interpretation of gain and loss prognoses; (3) isolation, showing that people focus mainly on the difference between alternatives and not on the aspects connecting them. This leads to a situation in which different approaches yield different decisions [9].

To sum up, the above examples are only a small, but sufficient part of studies that falsify the hypotheses defining people as "econs" [16] – beings who logically and consistently maximize their expected utility. Therefore, a few questions arise: Why are we so different from economists' imaginations? Where should we look for origins of processes that created our nature of the cultured animal? In our opinion, this should be explained by looking into the evolution of our species.

EVOLUTION OF HUMAN MINDS

One of the most profound moments in the evolution of hominids was the emergence of a conscious mind. Since then the extent of life processes' regulation has widen, and this has enabled evolutionary success, as chances to survive and raise offspring have grown significantly. However, *H. sapiens* was first to have a conscious mind combined with memory, reason and speech, use of which enabled submission of other species [17]. A question must be asked: what is a human mind? According to Steven Pinker "the mind is a system of organs of computation, designed by natural selection to solve the kinds of problems our ancestors faced in their foraging way of life, in particular, understanding and outmaneuvering objects, animals, plants, and other people" [18; p.21].

The above definition has two aspects we would like to point to. First, according to the computation theory, one of the main features of human mind is processing information, having its material reflection in the brain. In other words, neuronal networks which symbolize existing objects. Perception of these objects leads to the activation of material elements symbolizing them, and then this activates symbols related to them, so in turn it is finalized by specific behaviour¹. Secondly, our mind is not adapted to function within complex societies. We must emphasise that for ninety-nine percent of time from its evolutionary beginning, humans lived in small hunter-gatherer groups. This is why humans are not well-adapted to facing challenges of modern industrial civilization, such as anonymous crowds, written language, government, police, courts, armies or modern medicine [18; pp.41-42].

We may observe that facing requirements of ever changing reality is beyond processing limits of our “neuronal computers”, which were shaped in the Stone Age. We do not have complete knowledge nor do we have full information about the surrounding world at our disposal. It is also difficult for us to foresee consequences of our actions. Therefore, we would like to return to our main point: which cognitive mechanisms support mind in the process of making political decisions? How is it possible that we have an opinion on politics while we do not know much about it?

One of the possible answers can be found in the research on heuristics, and that means general rules, which instead of focusing on “economical” equations look for the most important information and ignore the rest [1; p.18]. In the next part of this article we are going to analyze the types of heuristics catalogued by Tversky and Kahneman and Gigerenzer². The main reason for making a decision is judgment of cognitive and emotional value of an impulse. The main criterion to distinguish the following heuristics was the somatic marker hypothesis. Efficiency of these heuristics is determined by the ability to feel secondary (social) emotions. Without this adaptation, the below listed rules would have no explanatory value for a decision-making process.

AFFECT HEURISTIC

In a world which values time as one of the most important resources, our decision-making is based upon a rudimentary view of reality. This is strictly inherent to the mode our minds operate, and this heuristic is an example of our inability to calculate all arguments for and against and use advanced statistics techniques (such as multiple regression) like a mathematical machine. In this chapter we will focus on neurobiological function of emotions and feelings which underlay our cognitive mechanisms and effective decision making.

First, we would like to focus on Damásio’s research on accords of extraordinary symphony which takes place when human senses are stimulated by certain impulses. To simplify, let us assume that objects are to be processed visually and aurally. We would like to present two cases: a man coming out of darkness, whose exterior is far from falstaffian one, and getting in the middle of an angry crowd. In one moment, and to be precise – in microseconds, we are going to experience visual and aural representations of these objects. Our brains activate neural connections which store previously experienced images of what we are hearing and seeing. As a result, signals activate these regions of the central nervous system responsible for reaction to certain impulses (namely: ventromedial prefrontal cortex, amygdala and brainstem). From these regions impulses are directed to other parts of brain (e.g., somatosensory cortex, cingulum) and to body (e.g., viscera and endocrine system). After a while we can experience changes our body undergoes. In the above examples, it can be excessive sweating, higher or lower blood pressure, change of respiratory rhythm or muscle cramps. Due to increased demand for energy, cortisol is released to blood. Facial muscles

take shape to show fear and the mind produces emotionally driven images of action plans. The fact of feeling emotions, in this case – fear, enables us to make the most suitable way use of distress. If it is an escape, impulses from the brain to the body will increase blood flow in leg arteries to provide additional oxygen and glucose in order to prepare leg muscles for sudden exertion. Last accord of that symphony is played by periaqueductal gray (PAG), which orders production of natural opioids blocking the transfer of pain signals to brain. In this way our pain tolerance is radically increased [17, 20].

Importantly, the presented mechanism also works in other, more complex situation e.g., when we are in a position to make a judgment based on social norms. Let's assume that we have been asked in a street to sign a list endorsing a candidate for a public office. What conditions influence our decision to endorse that candidate? We know that it is highly improbable that we are going to do that basing on rational calculation of gain and loss. This strategy would involve creation of a spreadsheet with all arguments for and against with mathematical values attached to them. Presumably, it would take several hours and it is possible that it would not yield expected results. According to hypothesis formulated by Damásio, the accuracy and effectiveness of decision-making is increased by special kind of emotions, which he calls somatic markers [19]. They originate from socialization and education, and they allow us to match certain impulses with according body reactions. This is why a candidate from party X, which evokes more positive feelings in our mind than his/her opponent, assuming little or no knowledge of their political values, can gain our support. This can also work the other way, e.g., if we are not interested in politics our decision of not endorsing anyone may be rooted in envy, contempt or discouragement.

In a heart of heuristic affect lies a process which changes the scope of the “right question”: do the candidate's qualifications suit him/her for office? to a really “heuristic question”: do I like him/her? What emotions do I attach to this person? Psychologists stress that negative inclinations are displayed more often [21]. This, according to Damásio's hypothesis, is a result of our brain's selection of impulses under one criterion lying beneath others: biological value. The more important for survival the image is the higher and more intensive are the emotions attached. Individuals who adopted this strategy are better adapted to changes, environmental conditions and increased their evolutionary chances for both survival and reproduction. For example, small hunter-gatherer tribes exploring African savannahs or areas of both Americas were unable to sacrifice resources (such as time) in order to analyze all phenomena they experienced. In order to survive, their minds had to be concentrated on one the most important information while ignoring the rest. It could be fear of predator or fear for the offspring left with no supervision [22, 23].

RECOGNITION HEURISTIC

Neuronal representations function as a storage for pictures of surrounding objects, they enable recognition of their names and recollecting events tied to them. This adaptation also enables to confront past events with the present ones, and serves as a fundament for planning [24]. In uncertain conditions most often the only ground to make a decision is a simple recognition of one of the options. However, this simple strategy turns out to be very effective.

Andreas Ortmann and Gerd Gigerenzer tested that strategy. In 2000 they have entered into a contest organized by “Capital” magazine. During 6 weeks, the contestants could buy and sell stock of 50 multinationals to generate the highest possible profit. Among 10 thousand of contestants was also “Capital's” editor-in-chief, whose portfolio was treated as a benchmark. Professional stock traders mostly used a strategy of gathering information about stocks and using computers with huge computational power. Ortmann and Gigerenzer selected a

different approach. They asked one hundred pedestrians in Berlin, 50 men and 50 women, if they have ever heard of enterprises listed by contest organizers. When they obtained this information they created two portfolios: first, with the most recognized brands, and second, for control purposes, with 10 least recognizable ones. The first portfolio generated a profit of 2,5 %, and was a better result than 88 % of all contestants, while the second took a loss of 18,5 % which was as huge as loss of Capital's editor's-in-chief portfolio [25].

The results of this experiment became a part of heuristic research and provided valuable data on decision-making. It turned out that partial ignorance represented by Berlin pedestrians may bring the same or better results than broad knowledge of specialists. Gigerenzer explains why: "Recall that in an uncertain world, a complex strategy can fail exactly because it explains too much in hindsight. A portion of the information is valuable for the future. A simple rule that focuses only on the best reason and ignores the rest has a good chance of hitting at the most useful information" [1; p.163].

Producers, marketing leaders and politicians are perfectly aware of the significance of the above. The latter, especially in modern democracies, which are tightly connected to the media, are going at great lengths to be present in television, radio, press and the Internet, simply because that way they become recognizable by citizens. They advertise themselves and use marketing tactics assuming that if voters do not recognize them, they will not receive votes from them³. The same fear arises when a new political formation is created. At that point not only financial resources or friendly journalists are keys to success, but also symbolical name connecting the new party to traditional expectations of electorate. This strategy has been grasped by Lithuanian politicians of Order and Justice party and Polish politicians of Law and Justice party.

These names are of symbolical nature because people gave them sense, value and meaning for communication and cognitive purposes. The same rule may apply to each word, phrase, gesture, place or object as they also may become symbols [27; pp.28-29]. There are two types of definitions in literature regarding "symbol": (1) Conventional signs – letters, numbers, coats of arms, flags, trademarks, road signs, mathematical signs; (2) Images, representations, notions, objects, and experiences connected to other notion or object [28; p.5].

Emotional attachment to conventional signs, images and notions facilitate socialization and education, and also bear huge mobilization potential. This potential enables modification and synchronization of contrary motivations of various individuals, which in turn strengthens the functionality of a political system [29]. However, it is possible under the condition that signals encoded in symbols can be understood. For an American, a Russian or a French, national flag and national anthem usually generate deep emotional reaction, while other flags and anthems can symbolize nothing but colorful sheets and more or less agreeable melodies [30]. The same observation applies to perception of other political symbols. The typology presented by American political scientist can be used as an example: (1) Symbols connected to a political community – the flag, America, "Constitution"; (2) Symbols associated with structure, norms and characteristic functions of a political regime – "Congress", presidency, "one man, one vote"; (3) Situational symbols, (a) associated with current political power – Reagan's administration; (b) associated to non-governmental political entities – Ralph Nader, NRA; (c) related to politics and political matters – "right to life", gun control [27; pp.36-37].

Capability for symbolic thinking, as Mircea Eliade pointed out, is an immanent attribute of human life, it predates language or discursive mind. Symbols reveal certain aspects of reality "which defies any other means of knowledge. Images, symbols and myths are not whimsical creations of the psyche; they respond to a need and fulfill a function of bringing the most hidden aspects of being to light" [31; p.12]. Evidence of symbolic thought, which is a

prerequisite for creativity and language capability, can be dated several dozen thousand of years. One of them is a 75 000 years old ochre tile, covered with geometrical signs found in Blombos cave in southern Africa. Another evidence was found in central Africa – a harpoon ended with barbs made of bones, dated back to ca. 80 000 years ago [32, 33]. According to one of the hypotheses our hominid creativity started to flourish thanks to natural selection which favored individuals with greater quantity of neural connections. Fossil records show how many changes occurred in prefrontal cortex, which are responsible for plan realization and coordination of thought processes e.g., Brodmann area 10 which takes part in abstract thinking has grown two-fold since our ancestors split from evolutionary line leading to chimpanzees [34]. However, it worth noting that not only biological transformations enabled modern humans to manipulate the surrounding world in an unprecedented manner. Among other factors, amplifying abilities of human minds were processes accompanying population growth e.g., necessity to function within more complex social relations [35, 36].

JUDGMENT HEURISTIC

Apart from recognition, there is another activity that our brains do – we make judgments. Simple judgments are made on everything that has an effect on an organism and within organism itself e.g., state of health or images recalled from memory. Even smallest aspect of a situation which we experience becomes a subject of analysis by nervous system. This simple mechanism allows humans to detect danger and act accordingly; it is also not exclusive to humans⁴. We have inherited it from our distant ancestors, when ability of fast recognition between friend and foe greatly increased chances of survival in a habitat more dangerous than the one we live in today [38; pp.89-90]. Improvement of cognitive mechanisms allowing the judgment of opponent's strength and fighting skills was determined by high level of aggression which shaped social relations of our predecessors. Paleo-anthropological, anthropological and ethnographic evidence shows that it was mainly males competing for food and sexual partners that were under such a selective pressure [39, 40]. Natural selection favored those males who were able to predict their rivals' intentions and select the best way out of peril. Research made by evolutionary psychologists and anthropologists suggests that the ability to decode signals appearing on top parts of a body, and especially face, was essential [40].

This mechanism did not lose its value in modern societies. People try to read intentions and predict events from expression and shape of strangers' faces. Usually lowered lip corners and/or wrinkled brows make us uneasy; meanwhile self-confident smile and/or square jaw are associated with inclination to domination and competence. The same rule leads us to perceive someone's attractiveness, which influences our behaviour towards the person. Moreover, this adaptation mechanism also relates to political phenomena. We would like to mention research on making voting decisions which has shown that we can make an immediate decision based on perception of pictures of candidates' faces used in the electoral campaign [41, 42]. In the same way our actions are determined by unconscious prejudices towards gender, age, ethnic origin, height, weight, accent or clothing [17, 43].

Intuitively we judge the left-right inclinations of political parties. As Gigerenzer points out, "The political Left-Right division is a simple cultural cue that provides many of us with an emotional guide for what is right and wrong in politics. It is so emotionally overwhelming that it can also structure what is politically acceptable in our everyday lives. People who think of themselves as politically left-wing may not want to be friends or even talk with someone who is politically right-wing. Similarly, for some conservatives, a socialist or communist is almost an alien life form" [1; p.138].

In the face of insufficient knowledge and lack of time, one of the key reasons for voting on a specific party is its position on a left-right scale. The closer the party is to the optimal preference, the greater is the chance of achieving electoral success by winning human perceptions. Taking part in elections does not necessarily require knowledge about complex issues such as: social policy, immigration policy, family policy, nuclear power, in vitro, stem-cell research, abortion, secular state or foreign policy. Subjective perception on left-right scale and ability to estimate distances between parties is sufficient. This strategy reduces multiple levels of political landscape into one dimension [1, 44].

IMITATION HEURISTIC

Developmental and animal psychologists, as well as primatologists and biologists, have conducted research, showing that humans are the only species that imitates others' behaviour consciously and on a large scale [45, 46]. Imitation can be observed even in few-days-old new-borns. They reproduce mimics of adults such as smiling, opening and closing mouth or put out tongues if mother performs analogical gesture. Due to brain structures responsible for registration of movement and recognition of faces (and their expressions), humans can participate in a world of social interactions [47, 48]. Later, as they mature, children use imitation techniques that have a certain aim – adaptation to conditions of ecological and cognitive niche they populate. Their behaviour stops being exact reflection of adults' and becomes a purposeful actions which indicates intentional manipulation of surrounding objects [49].

Reproduction of behavioural patterns in a life of an individual and whole societies fulfils a number of essential functions: (1) It provides behavioural patterns compliant with the ethics of the reference group; (2) It considerably improves social acceptance while satisfying community instinct of the individual; (3) It enables self-identification; (4) It is a shortcut which enables fast decision-making, especially while having insufficient amount of time and information; (5) It is a *sine qua non* condition for cultural evolution [1, 49-51]. Relating to the subject of this article, we would like to focus on the last two functions which we explain further in the text.

It would be very hard to imagine transmission and internalization of cultural patterns without the ability to learn behaviours, adopt attitudes and use speech. Thanks to these adaptations, cumulative development of knowledge, transmission of ideas and social institutions exist. L.L. Cavalli-Sforza distinguished two directions of culture transmission: vertical and horizontal. The former encompasses inter-generational flow of cultural patterns in a family or a group bound by strong social ties. The latter one is similar to a spreading wildfire. It references to the relations between unrelated individuals who do not come into deep, relevant and intensive social relationships [36; pp.179-187]. As an example of vertical transmission we would like to point to multigenerational transfer (both written and oral) of holy books. Fast spread of technological innovations and political institutions of the first municipal civilizations, as well as mechanization processes, which started in the 10th century, are examples of horizontal transmission.

Cognitive mechanisms specifying cultural transmission also play a significant role in a world of politics. Evolution of what is political within the social context would not be possible and politics itself would not emerge. Individuals would not be able to adopt attitudes, norms, values and behavioural patterns, which would lead to difficulties and prolonging of political socialization process. In this case people imitate according to a simple and practical rule: to do what the majority of others do and do what successful individuals do [1; p.217]. People use this heuristic from a very early childhood and it enables internalization of opinions and

beliefs which dominate in their respective groups such as: family, school, companies, social and political organizations or public institutions [52-59].

Significance of this adaptation is best presented when we look at the evolution of human species. About 60 000 years ago first representatives of *H. sapiens* left Africa and got to south-west Asia and southern Eurasia. After about 20 000 years they expanded towards Australia in the south and Arctic Ocean in the north. When they passed Bering Strait, they quickly colonized the area of both Americas, as well as many of the Pacific islands. This odyssey would be impossible without transmission of knowledge and technology, whether it would be simple tools, ideas, social institutions, values and so on, which did have to be reinvented but were ready to use, since it was much easier to copy them from individuals who had already benefited from them. We would like to give few simple examples of skills that were crucial during human journey from Africa, which had to be copied by following successful generations: sewing warm clothes, construction of shelters, creating light, warmth and arms, hunting, cooking or building boats with floats [32, 51, 60-62].

CONCLUSIONS

In the second half of the 20th century ideas which assume a priori that a rational human is guided by rules of logic to maximize the expected utility of his/her actions gained noticeable influence on economics and political science. This strategy was also used to explain election decision-making. The rational voter hypothesis states that a human facing many alternatives can make a decision based on a transitional ranking and casts a vote on the highest-rated options. Under non-changeable circumstances the choice will be the same. It is important to note, that a being would have to possess knowledge of all possible options and also would have indefinite quantity of time. We asked a question about explanatory values of hypotheses which describe humans as *H. oeconomicus*. Below is the conclusion list of our analysis: (1) conditions of ecological niche populated by humans require fast decision-making. It would be impossible for our brains to function like accounting machines gathering all arguments for and against and use advanced statistical tools such as multiple regression. In reality we do not take all the options into account. Most commonly we focus on some chosen processes with higher emphasis on these ones which have crucial value for our survival. The main reason for that is the evolutionary history of our species; (2) in constantly changing and uncertain reality the strategy of focusing on one, most important premise, while ignoring the rest, might be the most beneficial. This observation is also applicable to politics; (3) facing the deficits of time and information citizens are making political decision not by arithmetical calculation of profit and loss but by heuristics. Voting decisions are determined by emotions which are initiated by politicians within electorate and environment. Their decisions can be influenced the fact of knowing a candidate or his/her political party affiliation. Sometimes the appearance of a candidate may influence the decision, especially shape and expression of his/her face. In this context unconscious biases related to age, gender or ethnical background play important role. People also judge the position of the candidates on a left-right scale.

Conclusions of this article can be considered a discussion point in the field of theoretical approaches in the social sciences. As of now economical schools and normative schools and ideas have a great influence over them and dominate academic discourse. In our opinion the need to employ life sciences becomes more apparent as the hypotheses built on their grounds can produce better answers to the key questions regarding human nature.

REMARKS

¹A.R. Damásio proposed a very similar hypothesis. According to him, knowledge which we need to reason and make decisions has a form of perception pictures locating their material reflection in neuronal representations [19].

²It is worth noting that Tversky and Kahneman analyze heuristic in categories of dysfunction and irrationality, while Gigerenzer points to challenges of ecological niche we populate and see them as cognition mechanisms quickening and optimizing decision-making.

³Recognition by others alone does not guarantee electoral success, it is crucial to use proper manipulation techniques. Without them it is very easy to discredit oneself [26].

⁴In a world of animals other than *H. sapiens* the stake is much higher. The animals which cannot detect and judge danger fast enough have much lower chances to survive and pass their genes. Biologist R. Dawkins concludes: “The whole point about behaviour, on the other hand, is that it is fast. It works on a time-scale not of months but of seconds and fractions of seconds. Something happens in the world, an owl flashes overhead, a rustle in the long grass betrays prey, and in milliseconds nervous systems crackle into action, muscles leap, and someone’s life is saved-or lost” [37; p.55].

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SIMONOV PROBLEM: HEURISTIKA U ODABIRU IZMEĐU POLITIČKIH MOGUĆNOSTI

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SAŽETAK

U radu analiziramo jedan od najfascinantnijih paradoksa politike masa. Na temelju podataka iz neurobioloških, neuroloških, socijalno psiholoških, kognitivnih i evolucijskih istraživanja odgovaramo na pitanje, u literaturi uobičajeno nazivano Simonovim problemom: Kako je moguće da građani imaju mišljenje o politici, ako znaju toliko malo o njoj? Analizu započinjemo kritikom pristupa ekonomskog racionalizma za što koristimo Allaisov paradoks, teoriju kognitivne disonance, Ellsbergov paradoks, koncept omeđene racionalnosti, pogrešku konjunkcije i teoriju očekivanja. Zatim opisujemo evolucijske procese koji oblikuju um homo sapiensa i kognitivne mehanizme zahvaljujući kojima ljudi se ljudi mogu odlučivati između političkih opcija, posebno u vidu ograničenosti dostupnog vremena i informacija. Pritom se rabe ove heuristike: afekt, prepoznavanje, prosudba i oponašanje.

KLJUČNE RIJEČI

Simonov problem, heuristika, politička mogućnost, ponašanje glasača, hipoteza somatskih markera

COMPLEXITY AND SOCIOCULTURAL URBANIZATION OF SPARE TIME IN MAGDALENA MIXHUCA SPORTS CITY

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ABSTRACT

This article derives from my thesis research project “Fragmentation and sociocultural urbanization of spare time. High-significance places in Magdalena Mixhuca Sports City”. Its purpose is to concisely present those considerations that allowed integrating transdisciplinary epistemological and methodological frameworks. An analytical method was designed to integrate epistemological considerations for cultural and deep hermeneutics analysis, and the principles of complex thinking and complex systems theory, with the purpose of explaining the spare time sociocultural urbanization that is taking place in this fragmented public space that is characteristic of Mexico City.

We present here some of the results of the implementation of this analytical method based on hologramatic, recursive and dialogic principles, that allowed interpreting Magdalena Mixhuca Sports City (at first sight considered fragmented, disarticulated and chaotic) as a fractal space, integrated by symbolic forms, socially and historically structured in this public space, from its origin, in 1958, up to the 21st century. We can conclude that these symbolic forms, located within a complex system, are condensed in high significance places such as Juan Escutia Sports Palace, Rodríguez Brothers Racetrack, Foro Sol, Gates 3 and 2, and Agustín Melgar Olympic Velodrome Esplanade, all of which have their own cultural dynamics that determine the characteristics, as a whole, of this sport centre.

KEY WORDS

complexity, deep hermeneutics, sociocultural urbanization, public space and spare time

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INTRODUCTION: REFLECTIONS TO *UNTHINKING THE CITY*

This paper is partly based on the results of my thesis research project “Fragmentation and sociocultural urbanization of spare time. High significance places in Magdalena Mixhuca Sports City”, which I presented in 2010 to obtain my PhD in Urbanism at Universidad Nacional Autónoma de México (UNAM) [1], and on other research projects developed by Instituto Politécnico Nacional and published in 2012 [2]. This thesis was an epistemological and methodological study with a transdisciplinary approach, where complex thinking principles were joined to the complex systems theory, as well as to epistemological considerations for cultural and deep hermeneutics analysis, with the aim of explaining, in a more accurate way, the sociocultural urbanization that takes place in a fragmented public space, in the context of the citizens’ spare time (Fig. 1).

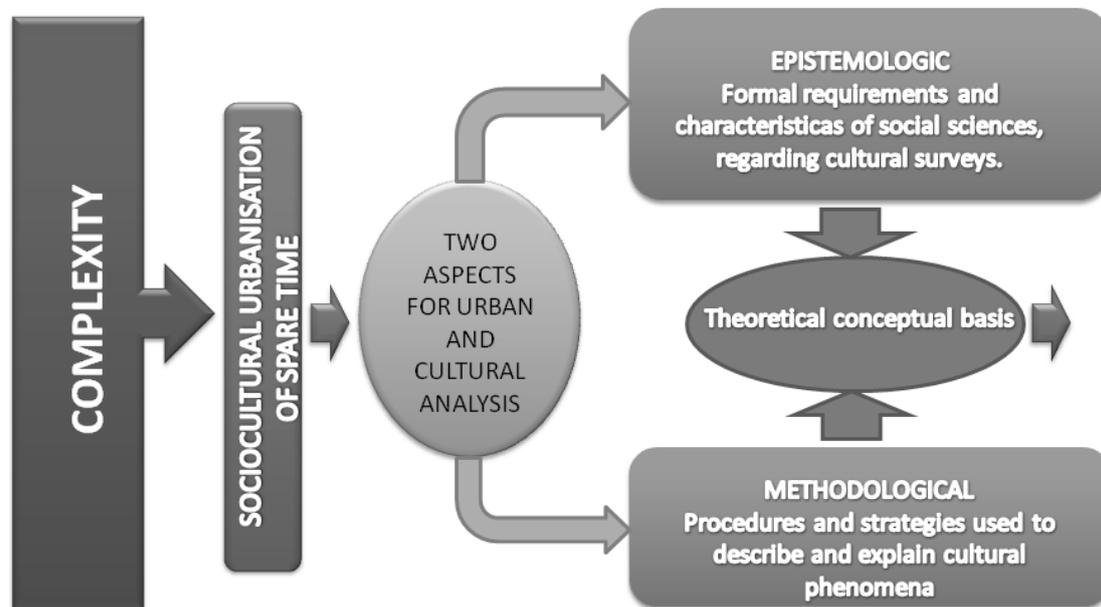


Figure 1. Epistemological and methodological aspects of sociocultural urbanization of spare time from the complexity.

Our aim was to open an analytic door in order to understand the contemporary city in a different way, by looking for new paradigms that, as a whole and in an ecumenical way, would complement themselves within the cognitive surpassing, noted by Rafael Lopez Rangel [3; pp.18-34], that is taking place in urbanism. This shows not only the relevance of undertaking urban research projects starting from their cultural dimension, but also the importance of developing these surveys based on alternative forms of thought, different from those related to the paradigms of modernity and functionalist positivism, that shed light on the explanations given on the phenomena and problems affecting urban environments in the context of global and postmodern fragmenting processes. As it is well known, spatial and sociocultural urban fragmentation is characterised by the dominion of the tertiary sector over urbanization guidelines¹. Such situation has driven apart the processes that structure cities from their subjugation to industrialization guidelines (as it has traditionally occurred in modern metropolis) and has brought them closer to commercial and service activities, to which cultural industry, related to massive communication media, belongs.

These structuring processes have favoured the existence of an informational society, such as the one described by Manuel Castells [4; p.33], that is mainly defined by money and information flows running through certain city enclaves, which disturb the city systems by

fragmenting them on a daily basis, but that also allow interaction with other places, on a global scale, on the understanding that globalisation² and postmodernity³ processes, to which these enclaves belong, do not structure a city in an homogeneous way. This diversity of factors, characteristic of sociocultural and economic processes as the ones described earlier, allow the restructuration of certain properties of city fragments related to leisure or entertainment during spare time⁴, which must be considered as part of urban analyses from a close and inside interpretative position, such as the one presented by Jose Guillermo Cantor Magnani [8; p.14-17].

The field of contemporary urban studies with that close and inside interpretation position seeks to account for the phenomena and internal problems that affect urban environments, taking into account how they are disrupted by extra-local processes that link them with other parts of the metropolis and even with other parts of the world. This type of urban studies start from a local scale and centre the analysis on ordinary citizens who use, on a daily basis or sporadically, the places where they live, by weighing up activities and discourses that arise from their mutual interactions, due to which both city and society are considered active subjects that determine and transform each other, leaving behind those researches in which urban space is only seen as an object, that is, as a container or a location where social events occur, but without paying attention to the analysis of its properties.

The above results from using urban experiences as a way to understand cities lived by their citizens. Cities formed by urban environments, where they concur at the same time remnants of the traditional city, old towns, the modern city in constant transformation and the postmodern city linked to globalisation and technological advances, each with its own dynamics and socio-cultural life forms that point to a spatial and socio-culturally fragmented city where the boundaries between public and private are increasingly blurred and citizenship is under constant construction.

The topic of urban experiences to which citizens are exposed inserts into the debate on the urban condition and its sociocultural determinants in public spaces built by the citizens who are in constant interaction with them through the urban activities they perform and the symbolic representations they comprise, which altogether accounts for the way city urbanises society through a process defined by Ricardo Antonio Núñez Tena as sociocultural urbanization [9; pp.72-78], whose importance lies in thinking the city as an actor that feeds back on itself through the cultural effects it has on the society that created it and continues to transform it.

To face the epistemological challenges posed by current urbanization processes, such as sociocultural development in fragmented spaces, it is required, according to López Rangel [3; pp.15-17], *to unthink the city*, this implies not only radically rethinking the conventional paradigms of urban analysis, spatial planning, theories, concepts and assumptions of modern science that dominated the 20th century, but also to establish a boundary, certainly wide and winding, between these forms of knowledge, from the apriorism (conviction where knowledge is given and settled since its origin, so that reality must adjust to a particular theory) and positivism (supported by an empiricism in which knowledge is based on a set of datum, facts or sensory experiences that are functionally linked), and the higher forms of knowledge coming from complex thinking, that allow a different understanding of the city, and that by converging with urban studies from the cultural dimension, provide different epistemological elements for profound interpretation of the structuring and restructuring processes.

Complex thinking proposed by Edgar Morin [11; pp.25-164], is a scientific paradigm emerged from natural sciences and mathematics, based on a dialogical constructivism between

theorisations and experience, capable of conceiving a new epistemological environment to explain the properties of a complex system in constant transformation and the interdefinability of their processes, which is ideal to overcome the aprioristic assumptions and the positivist thought. This has led to the belief that knowledge of socio-cultural and urban issues is a broken mirror of deterministic, reductionistic and linear sciences and disciplines (economics, architecture, urban planning, transportation engineering, sociology, ecology, among others), which are useful to analyse separately each part constituting them, and therefore generating within the city separate sectors such as economy, housing, public space, transport, society, environment, etc., aspects that render the city incomprehensible, especially considering that it is in itself a complex system.

This allowed to consider an epistemological analogy posed by Michel Maffesoli [12; p.36] in which there is a possibility that a fragmented urban space works with an overall coherence in the way a fractal⁵ does, and which in turn is presented as a useful tool for spatially analyzing the city, especially considering its most essential sense, which refers to that disarticulated but united, linked with complex thinking and its dialogic, hologramatic and recursive principles⁶, that are useful for interpreting urban space as a complex system, characterised by forms of interdefinable organisation among the relationships of flow and the structuring or restructuring processes that are set through the component parts.

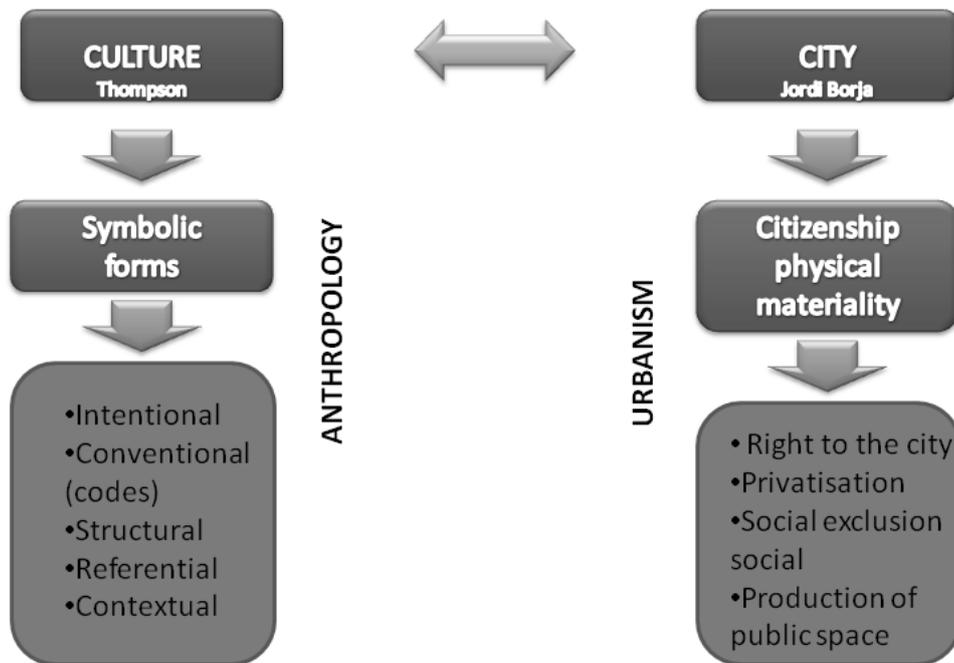


Figure 2. Basic concepts to analyze fragmented urban space from the complex systems theory.

From this approach, fragmented urban space cannot be analysed from partial guidance, but as a whole, where one of the structuring or restructuring processes, one of its flow relationships or any of its elements cannot be modified without modifying the rest of the complex system. This approach laid the foundations for the epistemological and methodological interaction of the principles of the complex systems theory formulated by R. García [14; pp.65-150] and for the considerations of city cultural studies, which start from an interpretive concept of culture⁷ and a relational and evocative city concept⁸ (Fig. 2), framed within the linguistic paradigms defined by G. Giménez [16; pp.33-66], and within the deep hermeneutics method proposed by J.B. Thompson [17].

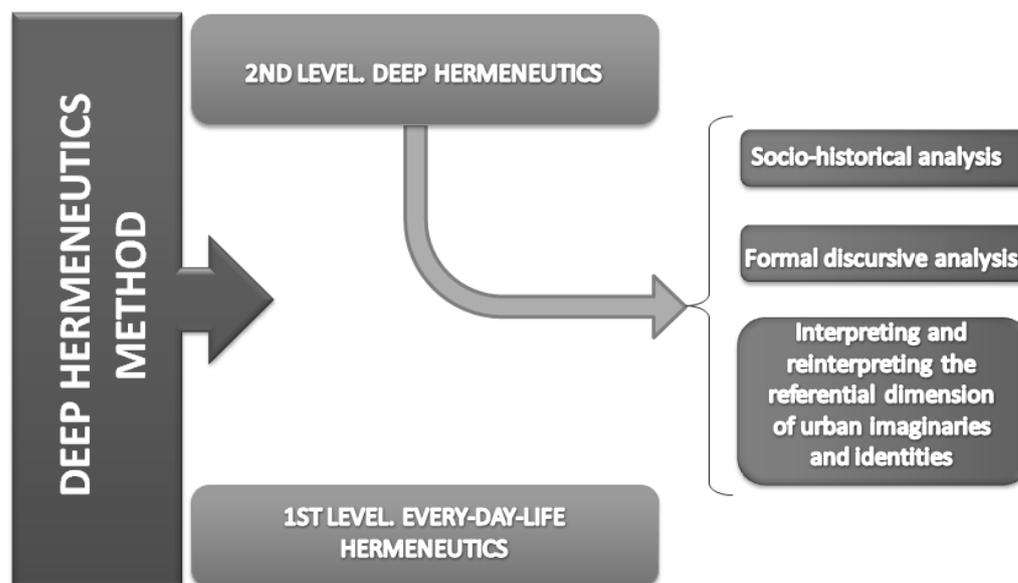


Figure 3. The deep hermeneutics method.

Thompson formulates the deep hermeneutics method in order to study socio-cultural phenomena as comprehension and interpretation activities. We can distinguish two levels in this method: everyday life hermeneutics⁹ and deep hermeneutics¹⁰. Deep hermeneutics is, in turn, divided into three phases or levels: socio-historical analysis¹¹, formal or discursive analysis¹² and interpretation-reinterpretation¹³ of the referential dimension of the symbolic forms (Fig. 3).

An advantage of the deep hermeneutics method is that it does not represent a conjunction of rigid steps that have to be applied in a strict order and that do not allow the integration of other types of analysis within them. This allowed considering Thompson's method as a general framework of analysis to integrate within each of its levels, the principles of organisation¹⁴, evolution¹⁵ and equilibration theory¹⁶ derived from the complex systems theory, where the interaction between the triad¹⁷ and the states¹⁸ allows unravelling the functioning of an urban space as a fractal. By considering its organisation as the stratification at different levels of its components, which interact among each other to articulate themselves internally and with other complex systems, not in a linear way (cause and effect), but through processes of interaction between different levels, occurring in overlapping stages and substages between levels, that take place in structuralising phases that transform this system until it reaches structured phases of relative stability where its features can be clearly identified.

These and other methodological principles derived from the complex systems theory allow detailing the articulation of certain analysis stages within the deep hermeneutics method used for the study of socio-cultural urbanisation of spare time in a fragmented public space, taking into account that the knowledge of the totality of this complex system is not the addition of all that exists in it, but only that which can answer the central research question, which implies a selection within the studied urban area that reveals its behaviour as a fractal space; an epistemological analysis guideline where the whole is more than the addition of its parts, but also less. This is nothing but the application of the hologramatic principle.

SPORTS CITY AS A FRACTAL SPACE

The epistemological and methodological considerations that arose, led to the study of Magdalena Mixhuca Sports City, a public space located between Iztacalco and Venustiano Carranza, devised by Jesus Martinez "Palillo" to meet the need of sports and recreation

facilities, and accessible to popular social classes, but especially aimed at athletes and young people exposed to the dangers of a big city that has few proper spaces for athletic activity that meet the citizens' demand of free time enjoyment.

This idea was appropriated by the Mexican welfare state of the mid-twentieth century, and was used to plan Sports City under the principles and concepts of functionalist modernism, in order to offer society a large public space conceived as an achievement of Mexican Revolution, which aimed to make real the benefits of progress related to sport, recreation and contact with nature. However, since its inauguration in 1958, the eventful life of this public space has always been full of vicissitudes that have disrupted its sociocultural urbanization by going through stages of renovation, but mostly abandonment, that not only fragmented it, but transformed it into an unhealthy and dangerous place where private interests dominated over collective ones.

These features have been transformed through various rehabilitation processes launched since the late twentieth century, when government authorities and the private sector began to reassess the virtues of this sports complex, not only as a place of leisure and athletic training, but as space for entertainment and nature, conforming a public space classified as an urban forest, in which a variety of sports and recreational facilities, combined with great ecological and sport educational facilities and mass scenarios, have become iconic for certain social sectors that considered them sanctuaries of their likings and fondness or heritage sites that account for the achievements of an era.

Places such as the Sports Palace, Agustín Melgar Olympic Velodrome, the Rodríguez Brothers Racetrack and Foro Sol (Figs. 4-6), which with the rest of the high significance places of this sports complex contains, and their physical, socio-cultural and environmental properties, have made Sports City key to understand the ludic history of Mexico's capital city.

In this sense, Sports City turns out to be an interesting analysis laboratory, since it is a public space that contains many of the properties that currently characterise Mexico City in the field of spare time, with the combination of leisure and entertainment spaces that face a spatial and socio-cultural fragmentation that creates discontinuities within the dynamics of the urban activities they promote, which suggests a disruption of them and of the urban spaces they house. But it is also an ideal place to observe the effects of the centres of global entertainment over public spaces, with venues such as Rodríguez Brothers Racetrack, Sports Palace and Foro Sol (Figs. 7-9), that are characteristic of an informational society that articulates to global networks.

Therefore, the functioning of this public space, fragmented by different spatial appropriation processes undertaken by the private sector and by different government entities, has made of Sports City a place primarily seen as disarticulated and chaotic, but that can function as a fractal space that keeps a logical order and an overall coherence and that can be interpreted starting from the sociocultural development of leisure that takes place in it. This accounts for the existence of a high-significance-places system that feeds back on itself by concentrating the primary properties of the dialogical relationship between leisure and entertainment that characterises it.

It should be noted that high significance is a concept developed to designate a place of imagined sociability and/or socialite, that is, an emotional territory with an specific sense intended for daily or occasional social coexistence, in which basic, complex and socialite sociability networks are established depending on whether the encounter point is of local, extra-local or metropolitan nature, producing a relationship that triggers a set of meanings, symbols, values, emotions and feelings.



Figure 4. Agustín Melgar Olympic Velodrome.



Figure 5. Rodríguez Brothers Racetrack.



Figure 6. Foro Sol during Vive Latino Festival.



Figure 7. Vive Latino Festival Graffiti at Rodríguez Brothers Racetrack.



Figure 8. Sports Palace Esplanade during Mexico City Fair.



Figure 9. Red Stage during Vive Latino Festival at Foro Sol.

With the concepts, principles, methods and assumptions referred previously, the sociocultural development of the fragmented Sports City, located within a fragmented Mexico City (which already resembles a fractal), was analysed. To achieve this, the most representative entertainment and spare time high significance places of this public space were identified in order to account for their fractal nature, in which the processes and properties of the high significance places define the state of the public space, and vice versa. Moreover, the dynamics of urban activities in these places were characterised in order to distinguish their continuity and discontinuity within their urban environment.

Speeches of different actors who enjoy leisure and entertainment in this sports complex were interpreted with the purpose of defining the imaginaries built by those representing significant elements of spare time. In addition, the physical properties of high significance places in Sports City were detailed in order to distinguish the spatial determining factors that establish their sociocultural functioning. Finally, the structuring processes and the structured states of public space that have determined the properties of leisure and entertainment in Sports City and in each of its representative points were analysed.

Once this analysis on Sports City was completed, different conclusions were drawn, firstly on the different symbolic forms whose characteristics can be described in view of three complementary theoretical fields. As for spare time, two subsystems were clearly structured from their predominant properties: one related to leisure activities in which recreation is not seen as business, and another made up of those entertainment activities serially produced by the cultural industry capital, with a high economic cost to those who consume them.

Two subsystems such as leisure and entertainment keep a dialogic relationship with each other by competing to occupy people's spare time, and at the same time complement each other to satisfy the citizens' right to recreational enjoyment. Both, leisure and entertainment, have been appropriated and reignified by citizens who attend to this sports complex, creating products, activities and meanings with their own social identities, which are exchanged between social classes, in which those that are in between the dominant class (government and cultural industry authorities) and the subordinate class (athletes, fans and users in general) play an essential role, because they are the link between each other, either as licence holders that optimize the operation of the sports facilities or as artists and professional athletes who are the attraction that allows an entertainment activity to take place and gain significance.

Within citizenship, civil rights and public sphere, it could be seen that public and private space are two elements that establish a dialogic relationship, where one needs the other to exist, and where the boundaries between each other become less clear and precise within the scope of spare time, as they have always been since modernity was established, which has forced to carefully weave their mutual interrelations, especially when private issues override public ones, as in the case of franchised locations in Sports City, which are referred to concepts associated with the interests, values and imaginaries of what is public such as freedom, tolerance, legitimacy and community.

As noted, there are many ways in which you can be a citizen, and public space does not always keeps all the features of the theoretical public space, because it is necessary to think of it as a space made more dynamic by fragmentation and other contemporary processes that intersect in their role of urban life axis. Thus, it is necessary to take into account that public space and citizenship have undergone structuring processes and structured phases mutually defined by each other, that do not allow neither of them to be considered given states, but a condition built every day on the basis of decision making and action taking, with which they were built basic sociability networks (local) and complex sociality networks (extra-local) that

are the amalgamation that permits building different cultural dynamics in a given territory, thus spatialising social issues in the context of spare time.

Regarding public spaces intended for leisure in Sports City, a feature that almost always dominated was that of citizens' freedom of action and choice, associated with a sociability that sets in context the right to "build" city in these scenarios considered by citizens as an extension of their home. On the other hand, the sports complex entertainment options assert the right to the citizens' enjoyment, where citizens share places from a socialite¹⁹ and an expenditure determined by the dynamics of accelerated cultural exchanges characteristic of a mass society immersed in informational flow networks.

Moreover, the symbolic forms of culture showed properties that account for their role within the complex system, which proved to be an effective way to understand the preponderant changes that occur within the main components of this public space, and the sociocultural urbanization they display, which allows to understand how the whole structure of this element and this process will be modified, but also to identify the predominant properties of their cultural environments, in order to see what the determining factors that structure their processes in each high significance place and in the totality of this sports complex are.

Places of high significance are hologramatic elements containing the predominant properties of the leisure and entertainment subsystems of Sports City. Such properties deployed in symbolic forms, feedback on these sites and account for the continuity and discontinuity of sociocultural urbanisation process unfolded similarly to the spatial fragmentation that characterises this sports complex. But not because of it, it stops articulating at different stages and at different levels with a coherence of the whole, where the addition of their high significance places is less and more than the entire sports complex, because these places have more properties and processes with a greater level of detail than those linked to all of this public space.

SPORTS CITY, A MULTIDISCIPLINARY HIGH SIGNIFICANCE SPACE

Within these high significance places, there are scenarios of entertainment that maintain properties and processes with local and extra-local impacts, important for the functioning of Magdalena Mixhuca Sports City and of the cultural circuits articulated outside it. Its vitality is a circumstance that would make possible to increase the strength of the leisure scenarios, but mostly the entertainment subsystem to which they belong, as accounted for by the series of symbolic forms they house at certain times of the year, but whose viability and convening power are constrained to metropolitan, national and global circumstances, making them weak as public spaces under concession, because they require sound economic investment from the private sector managing them and an efficient interest negotiation among public and private actors, that allow boosting the development of mass events, but without forgetting to diminish their affectations on the rest of Sports City, as well as further encouraging the use of open spaces as public spaces through activities that create continuities.

These entertainment scenarios in Iztacalco are the key to building the meanings that root citizens living in Mexico City to this sports complex, especially since they are high significance places with a more intimate relationship with different interests on artistic and sport shows, which concentrate significant properties related to diverse metropolitan identities.

Within these entertainment scenarios, it can be found Juan Escutia Sports Palace (Fig. 10), which can be considered the core of Sports City (next to Agustín Melgar Olympic Velodrome), a heritage site, headquarters of global entertainment and geosymbol of rock and of the 1968 Olympic Games, which articulates with entertainment circuits at all levels, whose territory extends to every corner where there is a basketball court, skateboarding is practiced,

a concert is held or there is a place complementing the activities it houses, which in addition assembles commercial establishments, service and entertainment activities, but that requires a better preservation of its heritage assets which are deteriorating, as it is happening to the dome and to Mathias Goeritz' Polar Bear, as well as the rescuing of some of its parking lots and the elimination of certain barriers that limit continuity of urban activities that it houses or could possibly house.

Rodriguez Brothers Racetrack is another scenario of entertainment (Fig. 11), which can be seen as a historic site of global entertainment that encloses magical places with a reputation that allows it to be considered "the Mexican Cathedral of Motor Racing", and that articulates with other Sports City entertainment and leisure scenarios, displaying cultural dynamics that extend to its immediate environment. It is also a scenario that fulfils a function as a place of leisure by housing a number of sports and recreational activities that demand negotiating public and private interests in order to preserve the versatile use of this scenario, however, it also encloses problems resulting from the mismatch of its technical properties to the global quality standards necessary for it to host again international motor races, a fundamental condition to avoid it falling again into underutilization and abandonment, which at different times have been very harmful since they reduce its vitality and its symbolic power.

Another scenario is Foro Sol (Fig. 12), which can be appreciated as a versatile place, characteristic of global entertainment, which is building its own legend, but that already houses iconic events which display a continuity of urban practices that articulate through different cultural dynamics at different entertainment places of Sports City and its vicinity. However, it is necessary to continue improving spaces intended for the public, in order to provide a better service during the shows held there.

On the other hand, there are those high significance places classified as leisure scenarios that maintain properties and processes with a more local impact but that not because of it are less important for the functioning of Sports City. Its optimal maintenance is a condition that would allow a better functioning of entertainment scenarios, but mostly of the leisure subsystem itself, as shown by the number of symbolic forms they contain, but that are exposed to outside disturbances, which makes it fragile as public open space, since they require great economic investments from local governments, and a better negotiation of interests, that would encourage public practices that articulate spare time dynamics at the sports complex, with the objective of discouraging those practices that create discontinuities.

These scenarios are essential for building leisure meanings that root citizens who inhabit the surroundings of this sports complex, especially because they are high significance places with a closer relationship with these inhabitants, but also because they concentrate significant properties related to different local identities which articulate to metropolitan identities.

Among these leisure scenarios, three scenarios stand out in Venustiano Carranza. The first one is the Agustín Melgar Velodrome Esplanade (Fig. 13), part of the core of Sports City, but that shows the leisure and open public aspect of it, due to the versatility and accessibility of its esplanade, which concentrates practices and emblematic events that unfold cultural dynamics that articulate this public space with other leisure scenarios of Sports City and its surroundings. Here, the role it plays regarding global entertainment scenarios surrounding it is critical, because it is an encounter point that complements these places, so, there must be a negotiation of interests between public and private actors to optimize its use and to preserve the spare time practices it host.

This is the reason why its underused "Cathedral of Mexican Cycling", the Olympic Velodrome (Fig. 14), a historic space that has to be rehabilitated to regain enough power to



Figure 10. Mexico City Fair at Sports Palace.



Figure 11. Mexican Grand Prix Pits at Rodríguez Brothers Racetrack.



Figure 12. Foro Sol Stage during Vive Latino Festival at Foro Sol.



Figure 13. Fronton game at Olympic Velodrome Esplanade.

trigger cultural dynamics that accomplish to retrieve various public open spaces (in its esplanade and parking lot), co-opted by the City Government and different private concessionaires, which creates discontinuities within the spare time practices, and conflicts for citizens who see them as limitations for physically and symbolically appropriating them as places of sociability and encounter, facing the need for parking areas to help meet the parking demand for events hosted in this scenario and in the surrounding places.

The second stage of leisure is Gate 2 (Fig. 15), which is seen as an open public space with a variety of facilities that allow to host various cultural practices that connect it with other sports, leisure and entertainment facilities of Sports City, as well as with the surroundings, but it must also be considered that the internal cultural dynamics that it houses are important enough to form a local historical and identity space, despite some facilities in poor maintenance condition. They need to be rehabilitated in order to encourage their use by citizens, as it happens with the facilities that are in good condition, because they need to be preserved in this state, for which proper management from concessionaires and local governments is required.

The third scenario is entertainment Gate 3 (Fig. 16), another public open space that concentrates leisure, sports and training places, which allows hosting the cultural practices that connect with other sport and leisure places of Sports City, as well as with other sites nearby. It is also a local historical and identity space, because of the cultural dynamics that unfold its sports facilities, however, the conditions of its recreational and socialisation facilities are not the best, since they require to be renewed so that they can once again become a space for family and child sociability, attractive enough for citizens of the surroundings.

Therefore, one must consider that to lessen the effects of fragmentation on the sociocultural development of Sports City, it must be considered the rehabilitation of the places that are still in unfavourable maintenance conditions, considering the opinion of the various actors with interests in them, in order to integrate public policies and management programs that take into account the properties and processes that are currently structuring this sports complex as a whole, as well as those related to high significance places in particular, so that more profound scopes can be reached, and the future of this public leisure space, emblematic of Mexico City, can be guaranteed in order to satisfy citizens' legitimate right to enjoyment.

ACKNOWLEDGMENTS

To all the mentors I had through my academic path, especially to Dr. Rafael Lopez Rangel, for urging me along the long and winding road of complexity, full of uncertainties rather than certainties, and who invited me to unthink the city.

REMARKS

¹This process, called by Gustavo Garza [5; pp.178-184] servialisation of developed economies, has nowadays transformed economic specialisation of large cities by significantly reducing their industrial facilities and increasing the tertiary ones.

²Globalisation must be considered, according to D. Harvey [6], as an economic, productive and technological process of temporary restructuration, which is geographically unequal. Globalisation is characterised by the rising of communication and transportation networks, electronic devices and services that favour money flow, organization and accumulation, commerce, available information and time optimization around the world.

³According to David Harvey [7; p.23], postmodernity favours heterogeneity, simultaneity and differentiation of liberating forces in the cultural speech redefinition. Fragmentation,



Figure 14. Velódromo Underground Station, next to Agustín Melgar Olympic Velodrome.



Figure 15. Skateboarding at Gate 2.



Figure 16. Children's Day at Gate 3.

uncertainty and deep disbelief regarding every universal and totalising speech are hallmarks of postmodern thought.

⁴Leisure and entertainment are considered two antagonistic ways of being, in the sense of Z. Muxí [10; pp.98-102], the former is of a not-for-profit nature, linked with sociability, and the later with of a lucrative nature, linked with consumption and socialite. At the same time, these two ways of being complement each other to satisfy recreation and rest needs, by providing pleasures, rest and enjoyment during spare time, which is the time frame in which both take place.

⁵Fractals (from the Latin *fractus*, fragmented, fractured, fractional, cracked or broken) were discovered by the engineer and mathematician B. Mandelbrot in 1975 [13]. According to García [14; p.149], they are objects with sinuous outlines, but with such a structure that when magnifying each fraction of the contour the structure of the whole object appears (principle of self-similarity). In many cases, this can be produced by a recursive process capable of yielding self-similar structures, regardless of the specific scale. Fractals are geometric structures that combine irregularity and structure, where the fragments do not only refer to each other, but also to the whole object.

⁶To help design complex thinking, Morin [15; pp.331-334] suggests three principles: dialogic, recursive and hologramatic. In the dialogic principle, two elements are necessary for each other, that is complementary, but at the same time, antagonistic, with the purpose of generating organisation and complexity. In the organisational recursive principle each product is at the same time producer of itself. In the hologramatic principle, the part is within the whole system and the whole system is within the system part, at the same time, which

allows to go beyond reductionism (which sees only parts) and holism (which sees only the whole system) and thus consider a fraction of reality as a complex system.

⁷We recover the symbolic concept formulated by Thompson [17; p.203], who defines culture as the set of symbolic forms (imaginaries, cultural products and activities, among others) related to contexts and historically specific and socially constructed processes by means of which, such symbolic forms are produced, transmitted and received.

⁸This concept is presented by Jordi Borja [18; p.77], for whom the city is the public space, since it is the location of open places significant for encounters and interactions, in which all kinds of flows converge, and where opportunities for urban contact, action, expression and exchange are optimised.

⁹Daily life hermeneutics, otherwise known as interpretation of the doxa, consist of the opinions, beliefs and judgments that hold and share individuals within the social world. [9; p.4].

¹⁰Deep hermeneutics posed by Ricoeur suggests that every process of scientific interpretation of social and cultural phenomena must be mediated by objectifying and explanatory phenomena, so that “explanation and interpretation” complement each other as part of the hermeneutic circle [9; p.4].

¹¹The socio-historical analysis involves the study of symbolic forms in relation to contexts and processes, historically and socially specified, constructed through and by means of which, these symbolic forms are produced, transmitted and received [17; p.220].

¹²The formal or discursive analysis consists of explaining the structural features and relations of objects and significant statements [17; p.227].

¹³The interpretation-reinterpretation of the referential dimension of symbolic forms, initially recorded as part of the interpretation of everyday life, is the interpretation process built on the basis of socio-historical and discursive analysis, considering the findings provided by these surveys in order to use them as elements of a creative and constructive interpretation [17; p.235].

¹⁴According to García [14; pp.74-76] the principles of organization are: stratification (that determines that complex systems present an arrangement of their elements in levels of organisation, each level having its own dynamics, but interacting with each other), interaction between levels (that determines that in a given complex system level, interactions with other levels can be represented by certain types of influences known as inflows and outflows, which are not necessarily material) and internal articulation (that indicates that within each level of a system, certain kinds of complex elements, processes and phenomena scales can be grouped into subsystems consisting of those elements that have a higher degree of interconnection to each other than to the rest of the system).

¹⁵For García [14; p.78] this principle consists of making successive representations (models) of the empirical reality being studied, in order to reach a satisfactory stage, defined in terms of the ability to explain the functioning of the original empirical complex.

¹⁶This theory explains that the evolution of each complex system is takes place, not through processes that modify themselves gradually and continuously, but from a succession of imbalances and rebalances that lead to successive reorganizations. Each restructuration corresponds to a period of relative dynamic equilibrium, during which the system maintains its previous structures with fluctuations within certain limits until a disturbance exceeds these limits and triggers a new imbalance [14; p.77].

¹⁷The triad is the shorten designation of the succession of steps of intra, inter and trans nature; this is, the going from an intra-operational stage (focused on properties) to an inter-operational stage (focused on relationships), until reaching a trans-operational stage (with the configuration of structures) [14; p.131].

¹⁸The states are periods of organisational forms or stabilised structures that treat evolution by successive reorganisations, comprising two types of alternating phases: structural phases

(periods where structures are built) and structured phases (periods where more or less stabilised structures can be recognised) [14; p.142].

¹⁹Socialite is a concept structured by Maffesoli [12; p.31] that differs from sociability and socialisation by integrating the imaginary, the ludic and the collective oniric from the spaces where moments and experiences of collective vibration articulate.

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KOMPLEKSNOST I SOCIOKULTURNA URBANIZACIJA SLOBODNOG VREMENA U SPORTSKOM GRADU MAGDALENA MIXHUCA

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SAŽETAK

Rad je izveden iz istraživačkog projekta “Fragmentacija i sociokulturna urbanizacija slobodnog vremena. Značajna mjesta u Sportskom gradu Magdalena Mixhuca”. Namjena rada je jezgrovito predočavanje razmatranja koja su omogućila integriranje transdisciplinarnog epistemološkog i metodološkog okvira. Osmišljena je analitička metoda koja integrira epistemološka razmatranja iz kulturne i hermeneutičke analize s principima teorije kompleksnih sustava, za objašnjavanje sociokulturne urbanizacije slobodnog vremena koja se odvija u navedenom fragmentiranome javnom prostoru karakterističnome za Mexico City.

Izloženi su rezultati primjene te analitičke metode, temeljene na hologramskom rekurzivnom i dijaloškom principu, koji su omogućili interpretiranje Sportskog grada Magdalena Mixhuca (koji na prvi pogled djeluje fragmentirano, neartikulirano i kaotično) kao fraktalnog prostora integriranog simboličkim formama, društveno i povijesno strukturiranog u određenom javnom prostoru od svog nastanka 1958. godine do XXI. stoljeća. Zaključak je kako su te simboličke forme, dijelovi kompleksnog sustava, koncentrirane u značajnim lokacijama poput Sportske palače Juana Escutie, Trkaće staze braće Rodriguez, cjeline Foro Sol, Vrata 3 i 2 te Šetališta olimpijskog velodroma Agustina Melgara, od kojih svaka posjeduje vlastitu kulturnu dinamiku koja doprinosi određivanju karakteristika sportskog centra kao cjeline.

KLJUČNE RIJEČI

kompleksnost, hermeneutika, sociokulturna urbanizacija, javni prostor i slobodno vrijeme

DESIGN OF THE FUZZY CONTROL SYSTEMS BASED ON GENETIC ALGORITHM FOR INTELLIGENT ROBOTS

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ABSTRACT

This paper gives the structure optimization of fuzzy control systems based on genetic algorithm in the MATLAB environment. The genetic algorithm is a powerful tool for structure optimization of the fuzzy controllers, therefore, in this paper, integration and synthesis of fuzzy logic and genetic algorithm has been proposed. The genetic algorithms are applied for fuzzy rules set, scaling factors and membership functions optimization. The fuzzy control structure initial consist of the 3 membership functions and 9 rules and after the optimization it is enough for the 4 DOF SCARA Robot control to compensate for structured and unstructured uncertainty. Fuzzy controller with the generalized bell membership functions can provide better dynamic performance of the robot then with the triangular membership functions. The proposed joint-space controller is computationally simple and had adaptability to a sudden change in the dynamics of the robot. Results of the computer simulation applied to the 4 DOF SCARA Robot show the validity of the proposed method.

KEY WORDS

genetic algorithm, MATLAB environment, structure optimization, fuzzy controller, 4 DOF SCARA robot

CLASSIFICATION

ACM: D.1.1.

JEL: Z19

INTRODUCTION

In control engineering there are a number of methods to make robot manipulators work intelligently, they can be classified into: fuzzy methods, neural networks and genetic algorithms.

Genetic algorithm is an optimization technique developed by J. Holland et al. [1-2]. Genetic algorithm is one of search algorithms based on the mechanics of natural selection and natural genetics. Figure 1 shows a flow chart of the genetic algorithm.

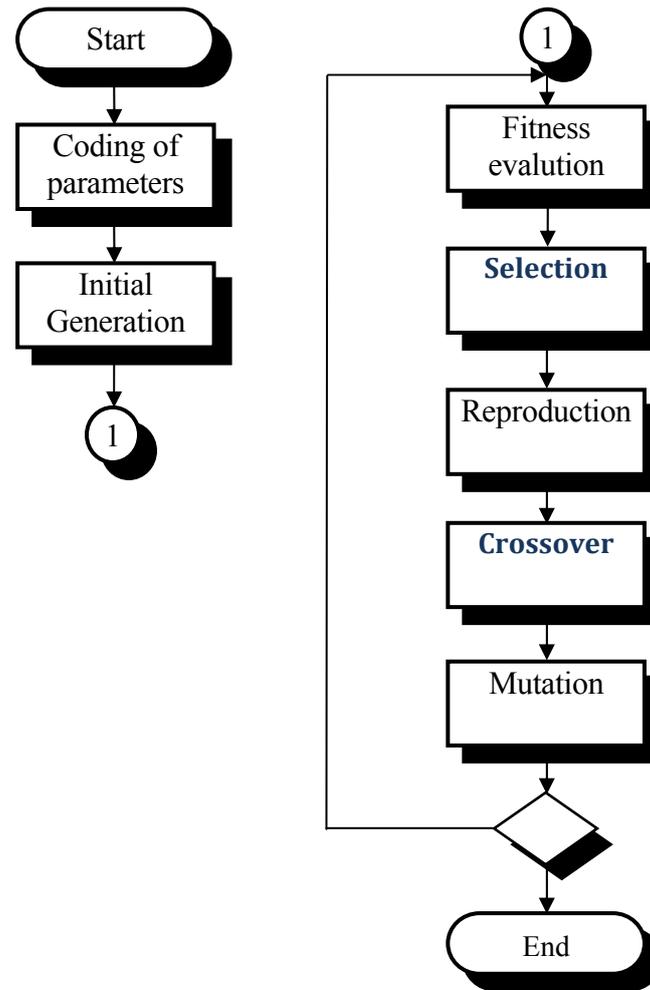


Figure 1. Flow chart of the genetic algorithm.

Genetic algorithms use the operations of selection, reproduction, crossover and mutation to generate the next generation, and they search for an optimal solution from a set of points. Recently, many genetic algorithms have been presented.

They are easy to implement and efficient for multivariable optimization problems such as fuzzy controller design.

Fuzzy systems are an attractive technique for control problems [2-4]. Fuzzy controllers are based on three well-known stages:

- the fuzzification stage,
- the rule base stage,
- the defuzzification stage,

and have been implemented in many experimental cases and in industrial applications because these controllers have advantages such as:

- easy implementation, suitability for complex dynamic systems,
- high flexibility and a
- robust nature.

The disadvantage of a fuzzy controller lies in the following:

- it is hard to obtain optimal fuzzy rules and membership functions, and
- the fuzzy set doesn't have learning capability.

To overcome those problems genetic algorithm is proposed for the purpose of auto-tuning and optimization of the structure of the fuzzy controllers.

The most important fuzzy logic parameters to be optimized are [5-13]:

- location and shape of the membership functions,
- the truth value of each rules, and
- scaling factors.

There are several ways to combine fuzzy and genetic control. Some interesting fuzzy-genetic control methods have been proposed by Fukuda and by Mester [1-2]. The genetic algorithm is a powerful tool for structure optimization of the fuzzy controllers, therefore, in this paper, integration and synthesis of fuzzy logic and genetic algorithm has been proposed.

The characteristic of the proposed system is to obtain the optimal structure of a fuzzy model.

In this article the fuzzy joint-space controller is designed using genetic algorithms without needing the knowledge of the mathematical model or the parameter values of the robot. Simple genetic algorithms are applied for fuzzy rules set, scaling factors and membership functions optimization. The proposed controller is computationally simple. Results of the computer simulation applied to the 4 DOF SCARA Robot manipulators show the advantages and the validity of the proposed method.

The article is organized as follows: Section 1 contains introduction. In Section 2, fuzzy modelling based on genetic algorithm in the MATLAB environment for intelligent robots is illustrated. The simulation results are given in Section 3 while conclusions are given in Section 4.

FUZZY MODELING BASED ON GENETIC ALGORITHM FOR INTELLIGENT ROBOTS

THE FUZZY-GENETIC INTELLIGENT CONTROL ARCHITECTURE

Recently, a new approach that combines the capability of the genetic algorithms with the simplicity of fuzzy logic has been identified as fuzzy-genetic methods. The design of self-organizing fuzzy controllers with genetic algorithm is very attractive, because the fuzzy parameters - membership functions, rules and scaling factors - can be automatically generated and tuned by observation of the process behavior. The genetic algorithm is a powerful tool for structure optimization of the fuzzy controllers, therefore, in this paper, integration and synthesis of fuzzy logic and GA has been proposed. The proposed controller supports the first order Sugeno fuzzy model (J.R. Jang at C.T. Sun) and unity weight for each rule, the single output derived by weighted average defuzzyfication [1-2]. The structure of the genetic algorithm tuned fuzzy control scheme is shown in Figure 2.

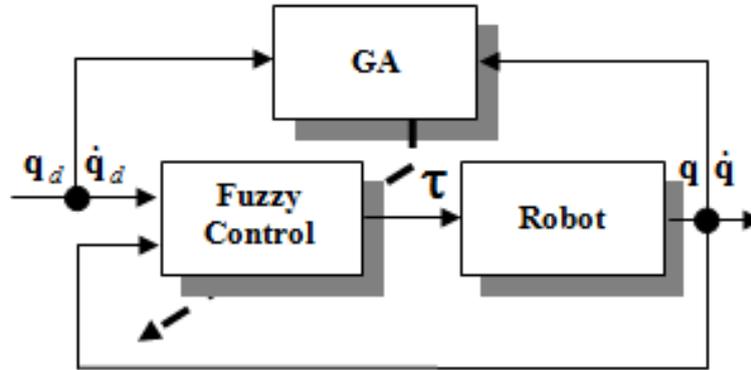


Figure 2. Genetic algorithm tuned Fuzzy Intelligent Controller scheme.

The proposed fuzzy-genetic intelligent control algorithm (FGICA) is a combined fuzzy logic with the genetic algorithm, consist of the three membership functions and nine rules, in each joint used two inputs: joint position error signal $q - q_d$, change of error signal and one output – joint torque τ . FGICA needs neither dynamic models of the system nor control experts for the robot control problem. The proposed joint-space controller is computationally simple, it is capable to compensate for structured and unstructured uncertainty, and had adaptability to a sudden change in the dynamics of the robot system. The FGICA design is initiated by using three fuzzy variables, i.e. the linguistic values NE, ZE and PO and nine rules. Generalized bell and triangular membership functions are chosen to represent the linguistic variables and fuzzy singletons for the outputs are used. The generalized bell membership function depends on three parameters [a , b and c]:

$$f(x; a, b, c) = \frac{1}{1 + \left| \frac{x - c}{a} \right|^{2b}}. \quad (1)$$

where c and a denote the center and the variance of the bell-shaped function, respectively, and the parameter b is usually positive.

SUGENO FUZZY MODEL

Sugeno fuzzy model was proposed by Tagaki, Sugeno and Kang and provides a powerful tool for modelling complex systems. It can express a highly nonlinear functional relation using a small number of rules and has special defuzzifier. The Sugeno fuzzy model has the form:

$$\text{IF } x \text{ is } A \text{ and } y \text{ is } B \text{ then } z = f(x, y), \quad (2)$$

where A and B are fuzzy sets in the antecedent, and $z = f(x, y)$ is a crisp function in the consequent. When $f(x, y)$ is a first order polynomial, than the resulting fuzzy inference system is called a first-order Sugeno fuzzy model. Because each fuzzy rule has a crisp output, thus the time-consuming procedure of defuzzification is reduced.

In this article the genetic algorithm is applied for fuzzy rules set, scaling factors and membership functions optimization. The genetic algorithm starts by randomly generating initial population of strings. The generation, crossover probability and mutation probability are 200, 0,8 and 0,01, respectively. Generalized bell and triangular-shaped membership functions can be parameterized by 3 parameters. First, we optimized the fuzzy controller with the generalized bell membership functions (case 1) and then we replaced those with the triangular-shaped membership functions (case 2). In the next chapter we will compare the simulation results in the case 1 and 2.

The chromosome of the simple genetic algorithm for each robot joints includes two parts: the $3 \times 9 = 27$ consequent variables on the fuzzy control rule base (9 rules) and $2 \times 3 \times 3 = 18$ parameters of the membership functions (3 membership functions for e and 3 membership functions for de). The numbers 0, 1, 2, 3 and 4 on the fuzzy control rule table represent the linguistic values NB, NS, ZE, PS and PB, respectively. The 27 genes in the chromosome are the elements of the control rule table. In this study, the fitness function is composed of the error and the error rate of the systems step response for each joint:

$$\text{Fitness} \leftrightarrow - \sum_{i=1}^4 [k(q_{di} - q_i)^2 + (dq_{di} - dq_i)^2], \quad k = 10. \quad (3)$$

SIMULATION RESULTS

In this section, the simulation of the proposed fuzzy-genetic control scheme is presented using the 4 DOF rigid SCARA Robot. Consider a SCARA like industrial robot actuated by permanent magnet synchronous motors (Mester et al. 1992) with numerical values for parameters of the robot from [1]. Simulations time is 1 s. The desired joint trajectory is chosen to be a simple cycloidal function. Joints move simultaneously from $q_1 = 0, q_2 = q_4 = 0,5$ to $q_1 = 1, q_2 = q_4 = 1,5$ rad, and from $q_3 = 0$ to $q_3 = 0,1$ m, with a peak velocity of $\dot{q}_1 = \dot{q}_2 = \dot{q}_3 = \dot{q}_4 = 2 \text{ s}^{-1}$.

Now, the proposed fuzzy-genetic control scheme was applied to the 4 DOF SCARA robot manipulators. First we optimized the fuzzy controller with the generalized bell membership functions (case 1). In the case 2 we replaced the optimized generalized bell membership functions (case 1) with the triangular-shaped membership functions. In the next paragraph we will compare the simulation results in the cases 1 and 2. Figure 3 shows the optimized generalized bell membership functions for de_1 by the proposed method.

Figure 4 shows the replaced optimized generalized bell membership functions with the triangular membership functions for de_1 in the case 2.

Comparison of the trajectory and velocity errors on joint 1 are shown in Figures 5 and 6.

Finally, Figure 7. shows the control surface of the proposed controller as a function of the inputs for optimized generalized bell membership functions.

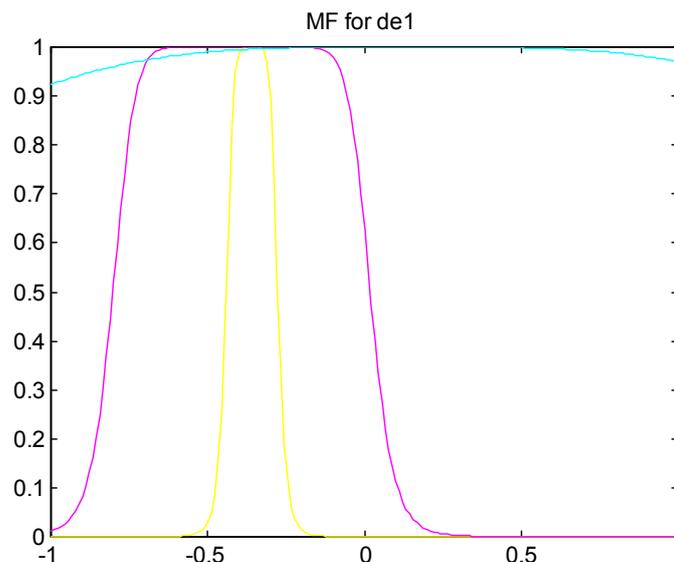


Figure 3. Optimized bell membership functions for de_1 .

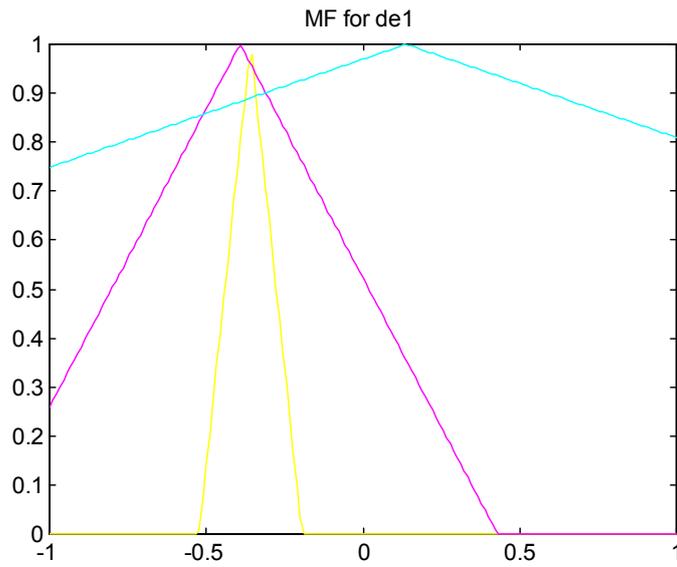


Figure 4. Triangular membership functions for de_1 .

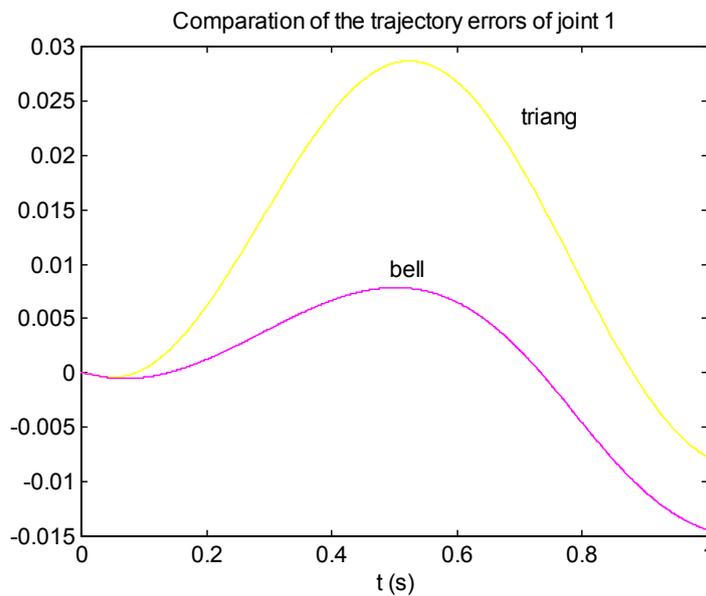


Figure 5. Comparison of the trajectory errors on joint 1.

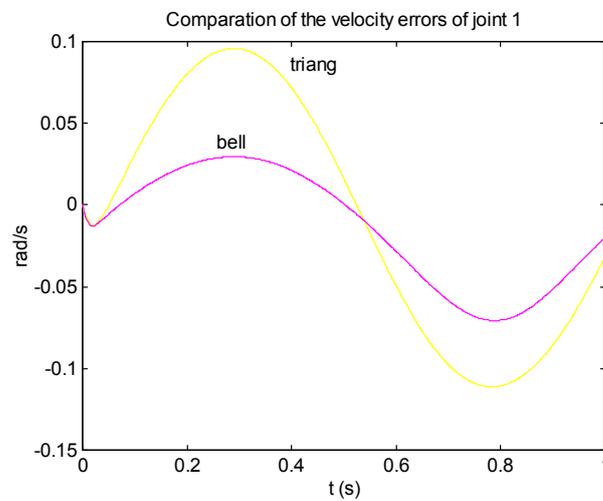


Figure 6. Comparison of the velocity errors on joint 1.

Surface of Fuzzy Controller 1

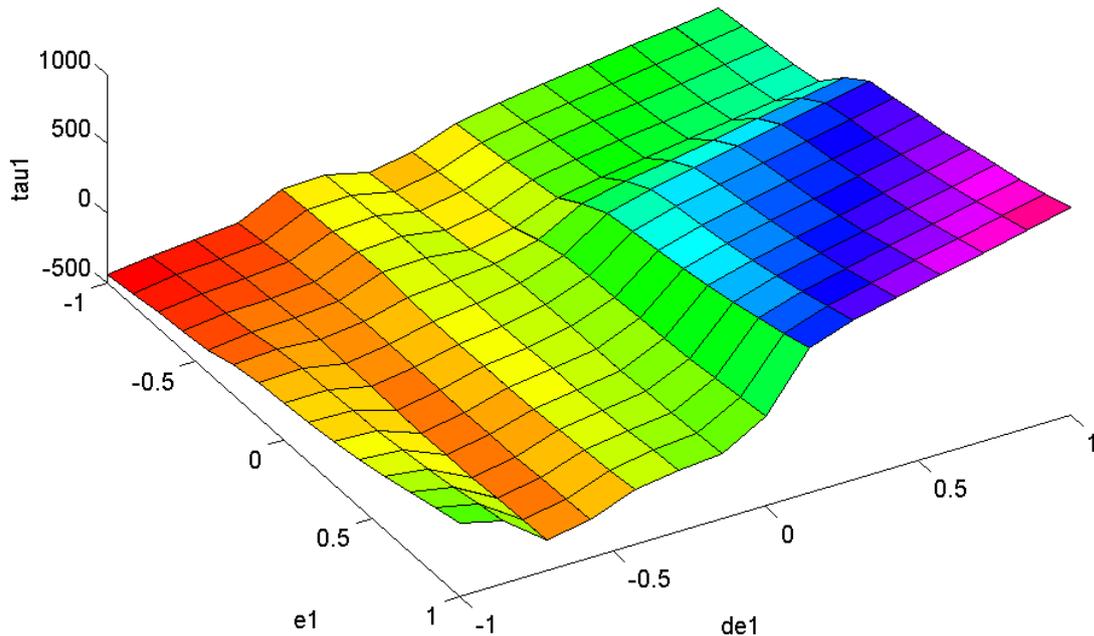


Figure 7. Control surface of the proposed controller.

The Simulink diagram of the 4 DOF SCARA robot control system is shown in Figure 8.

CONCLUSIONS

This article gives the structure optimization of fuzzy control systems based on genetic algorithm in the MATLAB environment. The genetic algorithms are applied for fuzzy rules set, scaling factors and membership functions optimization. The fuzzy control structure consists of the three membership functions and nine rules and it is enough for the 4 DOF SCARA robot control to compensate for structured and unstructured uncertainty.

Fuzzy controller with the generalized bell membership functions can provide better dynamic performance of the robot than with the triangular membership functions. The proposed joint-space controller is computationally simple and had adaptability to a sudden change in the dynamics of the robot.

Results of the computer simulation applied to the 4 DOF SCARA robot show the validity of the proposed method.

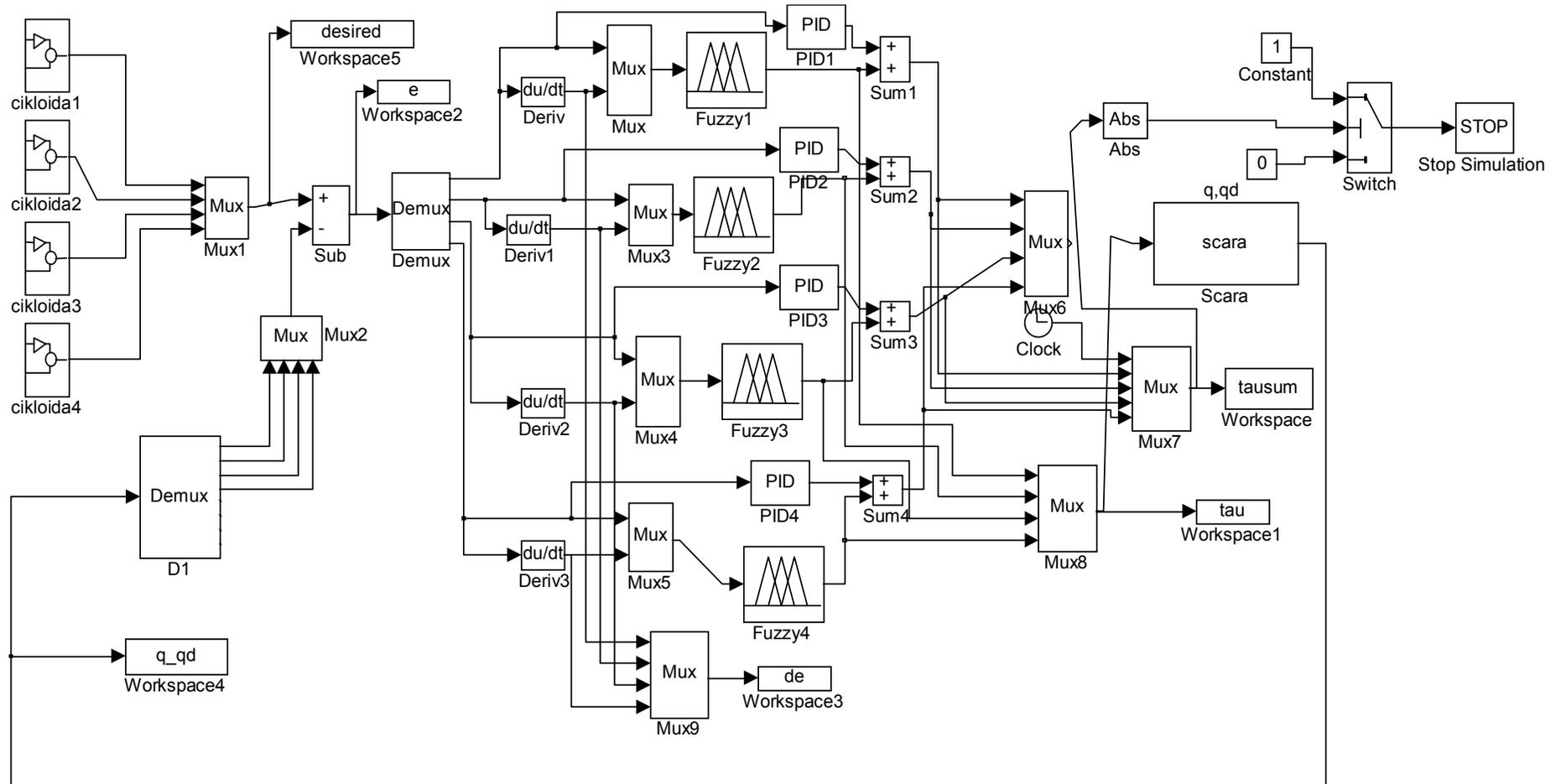


Figure 8. The Simulink diagram of the 4 DOF SCARA robot control system.

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DIZAJN NEIZRAZITOG UPRAVLJAČKOG SUSTAVA ZA INTELIGENTNE ROBOTI, TEMELJENOG NA GENETSKOM ALGORITMU

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SAŽETAK

Rad razmatra strukturno optimiranje sustava neizrazite kontrole. Optimiranje se temelji na genetskim algoritmima u okruženju programskog paketa MATLAB. Genetski algoritam je korisni alat za strukturno optimiranje neizrazitih kontrolera zbog čega je u ovom radu predložena integracija i sinteza genetskog algoritma i neizrazite logike. Genetski algoritam primijenjen je na skup neizrazitih pravila, faktore skaliranja i optimiranje funkcija članova. Početna struktura neizrazitog kontrolera uključuje 3 funkcije članova i 9 pravila. Nakon optimiranja to je dovoljno da u kontroli robota SCARA s 4 stupnja slobode kompenzira strukturne i nestrukturne nepouzdanosti. Neizraziti kontroler s poopćenom zvonolikom funkcijom članova omogućuje bolja dinamička svojstva robota nego neizraziti kontroler s poopćenom trokutastom funkcijom članova. Predloženi kontroler komputacijski je jednostavan i prilagodljiv naglim promjenama dinamike robota. Rezultati računalne simulacije primijenjeni na robot SCARA s 4 stupnja slobode dokazuju validaciju predložene metode.

KLJUČNE RIJEČI

genetski algoritmi, MATLAB okruženje, optimiranje strukture, neizraziti kontroler, SCARA robot s 4 stupnja slobode

SYNTHESIS OF SOME MECHANISMS USING NATURAL COORDINATES

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ABSTRACT

The aim of this article is to demonstrate the kinematical synthesis of some mechanisms applied in agricultural machineries. The applied method based on the use of natural coordinates for this reason the method is simple and efficient.

The mechanical system is described by a set of geometric constraints. The design requirements are handled by a set of functional constraints. By the aid of objective function it can be obtained the values of design parameters of the mechanism.

Finally two characteristically examples are presented that illustrate the application of the method.

KEY WORDS

design parameters, kinematical synthesis, mechanisms, natural coordinates, optimization

CLASSIFICATION

ACM: D.4.8.

JEL: Z19

INTRODUCTION

From the mid 1960s and early 1970s many programs for simulation of multibody systems were developed. These programs are not suitable directly for design because they were developed for kinematical and/or dynamical analysis of different planar and spatial mechanisms. During the investigation the engineer can study only the behavior of the mechanism. Before the investigation all geometrical and inertial characteristics of the multibody system should be defined.

Typical task for engineers is to design a new construction which fulfils certain requirements. From kinematical point of view in such cases the most important problem is to plan the main dimensions (design parameters) of the construction.

For this reason new design tools should be developed which can help the engineer during the design process.

There are some multibody simulation packages involved parametrical design modules for kinematical synthesis which are available for engineers. The efficiency of these program packages depends mainly on the experience of the engineer.

In the agricultural mechanical engineering enormous different type of mechanisms are applied. About 90 % of them can be approached as planar mechanism. The four-bar and the slider-crank mechanisms are the most frequently applied in agricultural machineries.

Kinematical synthesis of planar and spatial mechanisms and different optimization methods lead directly to a design that fulfils all expected requirements or at least is the optimum one considering some desired conditions. Generally the problems of kinematical synthesis are treated geometrically by the methods applied in this field. The tasks are the optimization of mechanisms from different point of views. The expected conditions can be complied by modifying of certain geometrical parameters such as lengths of the rigid bodies, position of no moveable kinematical joints, angles between axes of different joints, and so on.

Some program packages for optimal synthesis have been developed in recent decade. These are applied to many different types of planar and spatial mechanisms. Generally these programs are based on different types of numerical methods for optimization seeking the optimal solution with a minimum level of objective function.

In this paper to describe the mechanism natural coordinates will be used. As you will see the using of natural coordinates leads to a simple system of constraint equations. Therefore the applied method is also simple and efficient.

ABOUT THE KINEMATICAL SYNTHESIS

The kinematical synthesis of multibody systems is basically geometrical problem. About it much has been written by well-known authors [1-3] moreover many methods were developed. In the focus of the majority of this methods were the planar four-bar mechanism. Using these methods the results can be reached mainly on graphical way. Graphical methods in this field are limited to simple and planar mechanisms.

The problems of kinematical synthesis can be separated in three groups:

- function generation synthesis;
- path generation synthesis;
- rigid body guidance synthesis.

The first group is based on transmission functions. The aim of the function generation synthesis is to find (expected) output angles on the driven part that are as close as possible to the desired position in function of the input angle on the driving part.

In this paper the problem of path generation synthesis will be presented. This is a design of a planar four-bar mechanism. There is a specific point on the coupler which draws a trajectory that passes through a series of expected (predefined) points or at least goes as close to them as possible.

Rigid body guidance synthesis: in this case the aim is to create a four-bar mechanism in which a certain specific reference frame connected to the coupler passes through or goes as close as possible to a series of expected (predefined) positions.

THE NATURAL COORDINATES

The attribute “natural” means: coordinates which describe the mechanical system on the basis of the characteristics of the different types of kinematical joints. According to the opinion of Garcia de Jalon [4, 5] the natural coordinates lead to the simplest numerical treating of spatial mechanical systems because the geometrical definition of the mechanisms and the interpretation of the computed results are relative simple.

The creation of constraint equations is also simple because they are line or quadratic equations usually without trigonometrical expressions.

Using natural coordinates the position of a rigid body can be determined by the position of two or more points connecting to the body and the components of unit vector connecting to two or more bodies.

Since the points and unit vectors can be placed in the kinematical joints they can be divided along the kinematical chain. In this way the number of the coordinates of the mechanisms reduces and for this reason the number of the unknown variables in the equation system reduces as well. It follows of this that in such cases less mathematical operations are necessary during the design process.

Unda et al. have made a comparison between the using of natural coordinates and reference point coordinates [6]. The position of a rigid body can be determined by three coordinates of one point and three Euler-angles which are the reference point coordinates [7, 8].

Their investigation proved the above mentioned things. Applying natural coordinates

- the number of coordinates of the mechanism reduces;
- simpler constraint equations can be created;
- and the computation is quicker.

On the basis of above mentioned the applying of the natural coordinates can be proposed.

DESIGN STEPS

The applied method is an improved version of the method presented by Jiménez et al. [9]. Although this method will be demonstrated by path generation problems of four-bar and slider-crank examples, it may be easily applicable to other planar and spatial movable structures.

The following steps have to be taken into consideration in order to find the optimum solution for the investigated mechanism:

- choose the topology of the structure. As a result of this step the engineer should know the number of rigid bodies with their topological description moreover the types of the kinematical joints,
- determine the design parameters. They can be in general geometrical dimensions of the bodies, angles between axes of different kinematical joints, and so on,
- define the design requirements,
- create the geometrical and the functional constraint equations, and
- define and minimize the objective function.

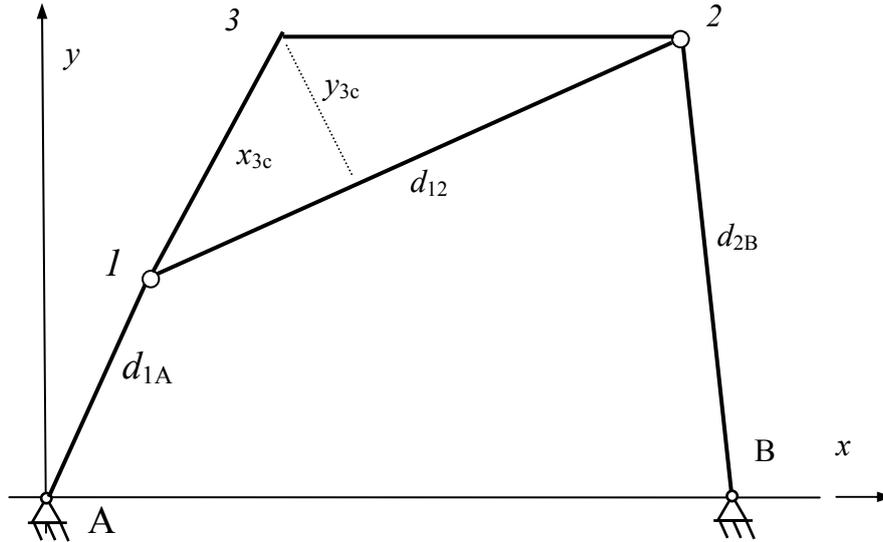


Fig 1. Sketch of the four-bar mechanism.

GEOMETRICAL AND FUNCTIONAL CONSTRAINT EQUATIONS

As an example let us consider the four-bar mechanism in Figure 1. Points *A* and *B* cannot be moved. The design parameters applying the markers in Figure 1 are the elements of the following vector:

$$\mathbf{b}^T = [d_{1A}, d_{12}, d_{2B}, x_{3c}, y_{3c}]. \quad (1)$$

The vector of dependent coordinates:

$$\mathbf{q}^T = [x_1, y_1, x_2, y_2, x_3, y_3] \quad (2)$$

The geometrical constraint equations:

$$(x_1 - x_A)^2 + (y_1 - y_A)^2 - d_{1A}^2 = 0 \quad (3)$$

$$(x_1 - x_2)^2 + (y_1 - y_2)^2 - d_{12}^2 = 0 \quad (4)$$

$$(x_2 - x_B)^2 + (y_2 - y_B)^2 - d_{2B}^2 = 0 \quad (5)$$

$$x_3 - x_1 - \frac{x_{3c}(x_2 - x_1)}{d_{12}} + \frac{y_{3c}(y_2 - y_1)}{d_{12}} = 0 \quad (6)$$

$$y_3 - y_1 - \frac{x_{3c}(y_2 - y_1)}{d_{12}} - \frac{y_{3c}(x_2 - x_1)}{d_{12}} = 0 \quad (7)$$

The functional constraint equations are created on the basis of specific requirements which should be complied. Point 3 on the coupler which draws a trajectory that passes through a series of predefined points or at least goes as close to them as possible. The set of design points (P_1, P_2, \dots, P_N).

Every single design point corresponds to different values of the elements of vector \mathbf{q} , for this reason vectors $\mathbf{q}_1, \mathbf{q}_2, \dots, \mathbf{q}_N$ are different. For the *i*-th position of point 3:

$$x_{3i} - x_{P_i} = 0 \quad (8)$$

$$y_{3i} - y_{P_i} = 0 \quad (9)$$

The constraint equations can be expressed in vector form in the following way:

$$\Phi(\mathbf{q}, \mathbf{b}) = \mathbf{0} \quad (10)$$

As it can be seen in consequence of using of natural coordinates the constraint equations are really simple.

All constraint equations (geometrical and functional) for the i -th design point can be written as

$$\Phi_i(\mathbf{q}_i, \mathbf{b}) = \mathbf{0} \quad (11)$$

THE OBJECTIVE FUNCTION

At this section of the paper the objective function should be introduced. If the number of design points is less than 6, point 3 on the coupler of the four-bar mechanism can go exactly through the design points P_i . In other cases the design parameters have to be computed by minimizing of the objective function. Since there is no exact solution for similar problems, for the optimal solution in the least square sense can be chosen. An objective function can be defined as

$$\Psi(\mathbf{q}_1, \dots, \mathbf{q}_N, \mathbf{b}) = \frac{1}{2} \sum_{i=1}^N \Phi_i^T(\mathbf{q}_i, \mathbf{b}) \Phi_i(\mathbf{q}_i, \mathbf{b}) \quad (12)$$

The kinematical synthesis problem consists in minimizing the objective function Ψ with respect to vectors \mathbf{q} and \mathbf{b} .

EXAMPLE 1

A four-bar mechanism can be seen in Figure 1. Point 3 on the coupler should go through 5 predefined points. Their coordinates and coordinates of points A and B are given in Table 1. Design parameters (elements of vector \mathbf{b}) have to be computed.

Table 1. Coordinates of the predefined points A and B .

	P_1	P_2	P_3	P_4	P_5	A	B
$x, \text{ mm}$	50	55	70	90	105	0	120
$y, \text{ mm}$	90	100	115	110	95	0	0

The constraint equations for point P_i :

$$(x_{1i} - x_A)^2 + (y_{1i} - y_A)^2 - d_{1A}^2 = 0, \quad (13)$$

$$(x_{1i} - x_{2i})^2 + (y_{1i} - y_{2i})^2 - d_{12}^2 = 0, \quad (14)$$

$$(x_{2i} - x_B)^2 + (y_{2i} - y_B)^2 - d_{2B}^2 = 0, \quad (15)$$

$$x_{3i} - x_{1i} - \frac{x_{3c}(x_{2i} - x_{1i})}{d_{12}} + \frac{y_{3c}(y_{2i} - y_{1i})}{d_{12}} = 0, \quad (16)$$

$$y_{3i} - y_{1i} - \frac{x_{3c}(y_{2i} - y_{1i})}{d_{12}} - \frac{y_{3c}(x_{2i} - x_{1i})}{d_{12}} = 0, \quad (17)$$

$$x_{3i} - x_{P_i} = 0, \quad (18)$$

$$y_{3i} - y_{P_i} = 0, \quad (19)$$

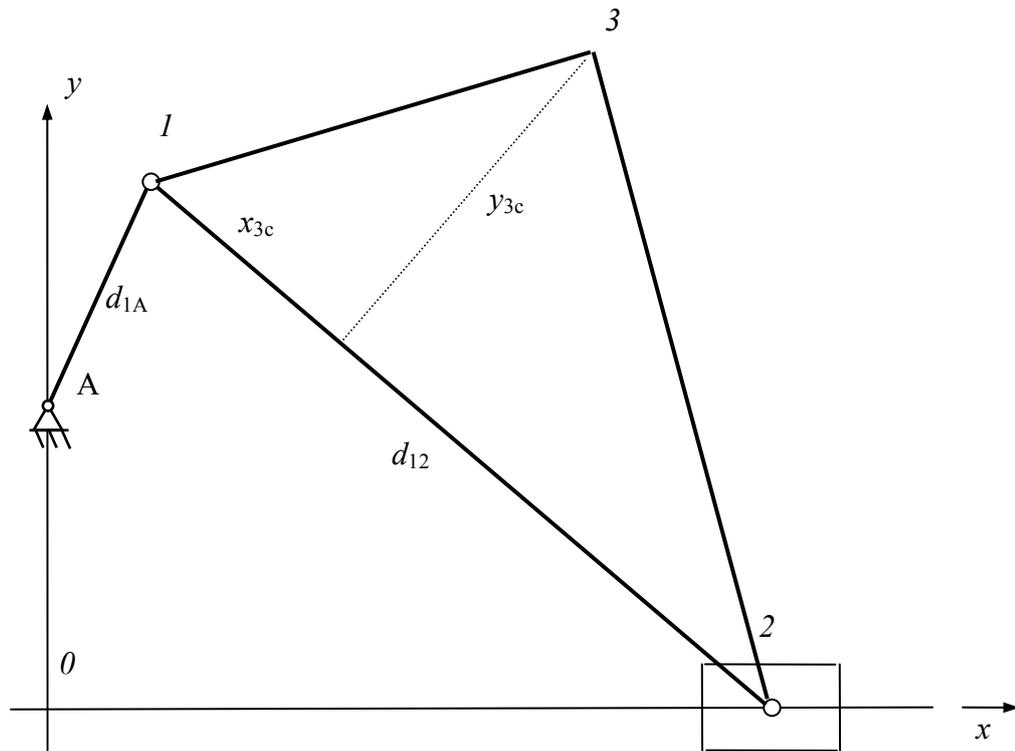
for $i = 1, 2, \dots, 5$. The number of constraint equations and unknowns is 35. With 5 design points, it is possible to construct a mechanism which exactly satisfies the requirements (functional constraints). Using the Solver in program MS EXCEL 7.0 results as shown in Table 2 can be obtained.

Table 2. Computed design parameters.

d_{1A}	d_{12}	d_{2B}	x_{3c}	y_{3c}
91,57	31,63	59,05	-13,20	48,99

EXAMPLE 2

A slider-crank mechanism can be seen in Figure 2. Point 3 on the coupler should go through 5 predefined points. Their coordinates and coordinates are given in Table 3. Design parameters (elements of vector \mathbf{b}) have to be computed.

**Fig 2.** Sketch of the slider-crank mechanism.**Table 3.** Coordinates of the predefined points.

	P_1	P_2	P_3	P_4	P_5
$x, \text{ mm}$	81	162	192	162	86
$y, \text{ mm}$	213	212	181	135	100

In this example $x_A=0$ and y_A design parameter. The design parameters applying the markers in Figure 2 are the elements of the following vector:

$$\mathbf{b}^T = [y_A, d_{1A}, d_{12}, x_{3c}, y_{3c}] \quad (20)$$

The vector of dependent coordinates:

$$\mathbf{q}^T = [x_1, y_1, x_2, y_2, x_3, y_3] \quad (21)$$

The constraint equations for point P_i :

$$(x_{1i} - x_A)^2 + (y_{1i} - y_A)^2 - d_{1A}^2 = 0, \quad (22)$$

$$(x_{1i} - x_{2i})^2 + (y_{1i} - y_{2i})^2 - d_{12}^2 = 0, \quad (23)$$

$$y_{2i} = 0. \quad (24)$$

$$x_{3i} - x_{1i} - \frac{x_{3c}(x_{2i} - x_{1i})}{d_{12}} + \frac{y_{3c}(y_{2i} - y_{1i})}{d_{12}} = 0, \quad (25)$$

$$y_{3i} - y_{1i} - \frac{x_{3c}(y_{2i} - y_{1i})}{d_{12}} - \frac{y_{3c}(x_{2i} - x_{1i})}{d_{12}} = 0, \quad (26)$$

$$x_{3i} - x_{Pi} = 0, \quad (27)$$

$$y_{3i} - y_{Pi} = 0. \quad (28)$$

for $i = 1, 2, \dots, 5$. The number of constraint equations and unknowns in this example also is 35. The obtained values of the design parameters can be seen in Table 4.

Table 4. Computed design parameters.

y_A	d_{1A}	d_{12}	x_{3c}	y_{3c}
70,64	92,08	286,30	69,21	114,04

CONCLUSIONS

A simple and general method for kinematical synthesis of planar mechanisms was demonstrated in this paper. The method is based on the use of natural coordinates for this reason the structure of the constraint equations is simple. The method is suitable for design of spatial multibody systems as well. According to my experience the most difficult part of the proposed method is the choice of the topology of the multibody system. If sometimes impossible to compute the design parameters one should choose another topology in order to find the proper solution [10].

In the agricultural mechanical engineering enormous mechanisms are applied. About 90 % of them can be treated as planar mechanism. The four-bar and the slider-crank mechanisms are the most frequently applied in agricultural machineries. The application of the proposed method has been demonstrated by solving two examples.

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SINTEZA MEHANIZAMA NA TEMELJU PRIRODNIH KOORDINATA

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SAŽETAK

Cilj ovog rada je demonstracija kinematske sinteze nekih mehanizama koji se primjenjuju u poljoprivrednim strojevima. Primijenjena metoda temelji se na uporabi prirodnih koordinata i to je razlog njene jednostavnosti i učinkovitosti.

Mehanički sustavi opisani su skupom geometrijskih uvjeta. Zahtjevi dizajna oblikovani su u skup funkcionalnih uvjeta. Pomoću funkcije cilja mogu se dobiti iznosi parametara dizajna razmatranih mehanizama.

Naposljetku, dva karakteristična primjera ilustriraju primjenu ove metode.

KLJUČNE RIJEČI

parametri dizajna, kinematska sinteza, mehanizmi, prirodne koordinate, optimiranje

ASSESSING HIGHER EDUCATION STUDENTS' ETHICALITY

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ABSTRACT

In higher educational institutions, ethics is the very core of the people that institutions are trying to morally shape. In a few years' time, these students will be assigned to some work place where they will be forced to make decisions which can affect businesses and more importantly – human lives. In that respect, what seems like a simple doubt about right or wrong, becomes alarmingly significant and in times where economics and profit drive the thinking of the society, ethics are often overlooked. Universities attempt to instil ethical principles by providing courses on the topic, and through demonstrated behaviour of professors. This article presents introduction of a new class, devoted to ethics, as an application of stated approaches. The article shows some details of the class, with emphasis put onto the behaviour and decision that students showed during conducting given assignments. Findings have been divided into technical and ethical aspects.

KEY WORDS

engineering ethics, engineering education, metrology

CLASSIFICATION

JEL: Z13

INTRODUCTION

Throughout their career professional engineers encounter a number of ethically doubtful decisions, and situations. With their behaviour they can influence further development of the decision or situation, i.e. they actively shape ethicality of the decision or situation they are participants of.

Although our view of what is and is not ethical is influenced by our families, involved communities, and other layers of society, engineering ethics are taught as part of engineering curriculum. This paper presents assessment of engineering students' ethicality by analysing student behaviour and decision making during their given assignments. Description of the assignment is presented prior to the discussion of the observations, while observations have been divided into technical and ethical aspects. Concluding remarks summarize the paper and findings.

ASSIGNMENT DESCRIPTION

Groups of students were given physical objects that were related to engineering and definitely seen before in their past classes (for example, steel plates).

Each group was given a task to measure some property of a given object to the best of their ability with the tools that were given by the professor and the assistant (Table). To further test their ethicality, a thermometer was also available for use. Temperature was an influential factor to 4 out of 6 laboratories. All of the laboratories were told to write down exact results, truthfully. Assignment organization chart is shown in Figure 1.

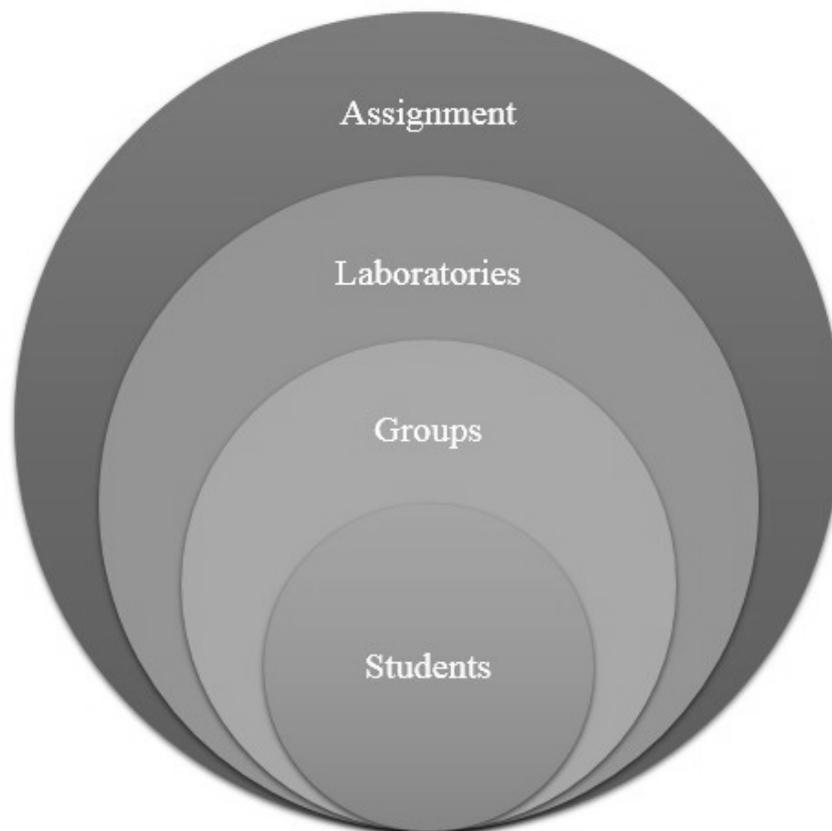


Figure 1. Assignment organization.

Laboratories were supposed to collect all the data from the groups of students that made measurements in the same conditions (same instruments and same objects). With all the gathered raw data, they were supposed to make basic measurement uncertainty calculations, including: expectancy, standard deviation and coverage interval. In addition to those basics, they were also instructed to remove from their calculations groups whose results failed to meet the so called Birge's ratio; commonly used in metrology for testing goodness-of-fit between the laboratories [1].

With all the data processed, laboratories made projector-backed presentations in which they presented calculated values both graphically and numerically. All of the laboratories and their corresponding groups were at the presentation. It was obligatory to present a conclusion to the presented data. After students shared their results with the audience and the professor, they were asked to explain any noticed irregularities.

Table 1. Assignments per laboratory.

Laboratory	Measuring instrument	Measured value
A	Vertical length measuring machine	Outer diameter of the steel ring
B	Toolmaker's microscope	Axial distance between two holes in a cast iron object
C	Vertical caliper	PVC pipe outer diameter
D	Micrometre	PVC pipe outer diameter
E	Coating thickness gauge	Coating thickness on a steel plate
F	Profilometer	Profile height (roughness) of grey cast iron plate

TECHNICAL ASPECTS

Students were supposed to be acquainted with basics of metrology because of the background they should have gotten in courses attended in previous semesters. There were students from different departments of the faculty but all of them had attended at least one metrology-oriented course. Handling instructions for all of the measuring instruments were briefly given by the professor so that the students could remind themselves how to correctly handle the instruments. Professor and assistant were also present in order to help out with any problems that might arise. Therefore, it has been concluded that the technical aspects were sufficiently covered.

However, during the evaluation it was noted that in about 30 % of all the groups, there was complete absence of elementary knowledge of metrology. Students were given comprehensive literature related to measurement uncertainty but still, it was noted that one laboratory and all of their corresponding groups were completely puzzled by the term and didn't understand it because their presented results had not been correct (Figure). Their box plot shows that groups 1, 3, and 4 had perfect measurements and almost non-existent uncertainty (indicated by the narrow band on the box plot). Such results could not be expected even from metrology professionals.

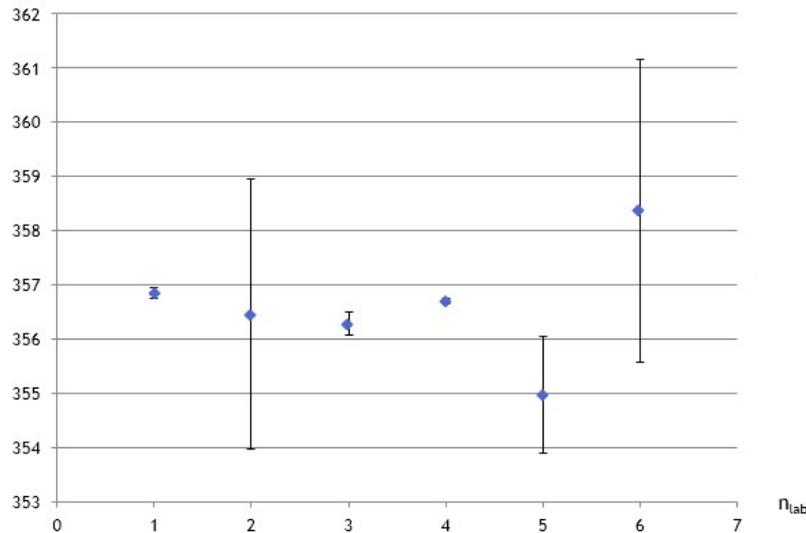


Figure 2. Poor understanding of measurement uncertainty resulting in a bad box plot.

In the case of one laboratory, the results themselves had not been written with respective units of measurement and the results had improper number of decimal places regarding to resolution of the instruments they used, Table 2. That was also noted within other groups that belonged to other laboratories (while the measurement process was being observed) but those mistakes were corrected in a manner that did not affect the results presented in the end.

Table 2. Part of the presentation showing the wrong number of decimal places and missing units of measurement.

Measurement result, D_{SP}	Measurement uncertainty, U
270,5	9,7
272,617	2,331
266,2	5,298
271,4	3,143
279,133	4,344
273,5	4,181

Previously mentioned Birge's ratio rule clearly states that when the ratio of a group of measurements exceeds value of 1, these results cannot be included in the comparison with other groups. It was observed that 50 % of the laboratories decided to ignore Birge's ratio and simply add incomparable results to their charts.

Regarding the handling of the samples, students that used caliper and micrometre (two laboratories and their corresponding groups) showed unprofessional behaviour. Students either had not aligned the samples precisely, or they exerted too much force while they were measuring the samples using the micrometre; all of which resulted in measurements that were not accurate.

Thermometer was purposely integrated into the measurement as a clear indicator of attention and professionalism that students were supposed to show. Only 30 % of students actually used the thermometer to note the ambient temperature of the laboratory. Four out of six laboratories had to include the information about temperature in order for their measurements to be complete and accurate because of the thermal expansion coefficient. However, just 50 % of the laboratories measured temperature and expressed it as an important variable in their measurements. Laboratories that measured objects made from PVC noted the environment's and object's temperature, even though thermal expansion coefficient of PVC is much smaller

than that of steel. Their colleagues, who had objects made from steel, surprisingly, were not worried about temperature and had not noted it. Clearly, that was unprofessional because as future engineers, these students are expected to pay attention to that sort of critical details which could one day be very costly.

All the laboratories considered, it was found that two laboratories obviously fabricated at least some of their results. On the day the presentations took place, it was impossible to hide irregularities because those were obvious when presented graphically (as shown in Figure). This pointed to fabrication and it exactly showed who had and who hadn't been ethical in their work. Presentations themselves demonstrated the amount of time and work each of the team invested in their efforts. It has to be noted that some of teams made excellent and truthful presentations that pointed to teams with good technical knowledge and ethical approach.

ETHICAL ASPECTS

Prior to further assessment whether students' behaviour should be considered ethical or unethical, common understanding of ethics and its relation to the engineering field is established.

According to Merriam-Webster dictionary [2], ethics can be defined as an area of study that deals with ideas about what is good and bad behaviour; a branch of philosophy dealing with what is morally right or wrong; a belief that something is very important. During their professional career engineers encounter various ethically doubtful situations. For example, engineers from the construction industry could find themselves under the duty whether to warn, when to warn, who to warn, and how to warn of any impending disasters [3, 4]. Furthermore, by extrapolating aforementioned example, we could state that engineers encounter following doubts:

- should I report unethical situation,
- when should I report unethical situation,
- to whom should I report unethical situation, and
- how should I report unethical situation?

During assessment of ethical, or unethical, practices and situations, one should take into consideration if included persons had freedom of choice [5]. Additionally, if we try to predict ethical behaviours of the system, one should consider the complexity, chaoticness, and level of discretion of analysed system [6].

Considering technical aspects presented in previous section, and the fact that most students acted similarly, we could state that student group conducted measurement exercise, statistical analysis and data presentation, in ethical manner. But, in order to get the whole picture, we should not look at the study group in isolation. It is safe to assume that study group is a part of larger community, i.e. faculty which includes other students, professors, assistants, administrative staff, etc. Furthermore, faculty is a part of even bigger community, in this case University of Zagreb, which includes numerous other faculties. We could continue to add various layers and communities, but for sake of simplicity, we will put society as all-encompassing layer (Fig. 3). Following aforesaid logic, we cannot assess students' behaviour as isolated community, and we have to take into consideration ethical practices of superimposed layers of community (e.g. The Code of Ethics of the Zagreb University, law, constitution).

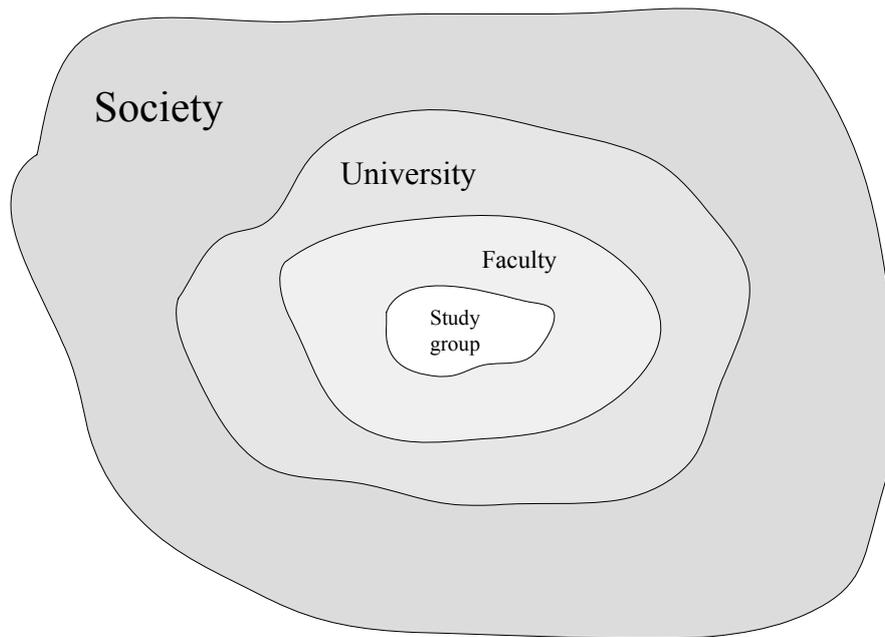


Figure 3. Study group and related communities.

CONCLUSION

This paper assessed ethicality of engineering students, by observing their behaviour and decision making process. Students were given the assignment to conduct various measurements using proper equipment, and perform appropriate data analysis. Later, they had to present their findings, followed by presentation from pilot laboratories. Captured observations were divided into technical, and ethical aspects.

Although the behaviour of the study group could be labelled as ethical, while assessed in isolation (“I did what I had to, and I did it just like everybody else.”), we might not draw the same conclusion if we assessed the group from broader vantage point. Quite the contrary, there were elements that could be labelled as unethical, e.g. students’ failure to conduct given tasks and exercises with due diligence, and several breaches of The Code of Ethics of the Zagreb University. Aforesaid findings do not necessarily imply further unethical decision making of involved students, future professional engineers, but might rather show students’ apathy regarding the assignment or the course itself.

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PROCJENA ETIČNOSTI STUDENATA

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SAŽETAK

U institucijama visokog obrazovanja etika je u temeljima onoga čime institucije nastoje moralno oblikovati studente. Tijekom nekoliko godina nakon studija ti će ljudi na svom radnom mjestu donositi odluke koje mogu utjecati na poslovanje i, što je još važnije, ljudske živote. Time ono što djeluje kao jednostavna sumnja u to što je ispravno a što nije, postaje izrazito važno. U razdoblju u kojemu profit utječe na mišljenje društva etika može biti zanemarena. Sveučilišta nastoje usaditi etičke principe, između ostaloga, pružanjem kolegija na odgovarajuću temu i samim ponašanjem nastavnika. Ovaj rad prikazuje jednu uvođenje novog kolegija, posvećenog etici, kao jedne primjene navedenih principa. Rad navodi neke potankosti kolegija, s naglaskom na ponašanje i odlukama studenata, uočenima tijekom provođenja postavljenih zadataka. Opažanja su podijeljena u tehnička i etička.

KLJUČNE RIJEČI

inženjerska etika, inženjersko obrazovanje, metrologija

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