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SYSTEMS INQUIRY AND INFORMATION TECHNOLOGY

The systems inquiry is a conceptualization method of ways for informational-integrative and communication based cognitive reality understanding and imaging. It supports interactive investigation and micro-macro integration in complex human activity systems design.

Informatics is the set of concepts and principles that enable human being to apply information to the communication activities of daily life, e.g. human affairs, where computer science represents one area of such application through specific forms of technology.

Arne Collen

1. CONCEPTUAL INFORMATION SYSTEMS TRANSFORMATION

The interpretation of the concept *system* is inseparably accompanied by the terms *information and inquiry*. This is because of the nature of information which can be identified, from the emotional and physical point of view, with attributes of the energetic factor, which actuates the interactively intellectual and genetically intentional synergy of evolutional behavior of the man and of groups of any societies and of systems. As a model, information exists in very differentiated forms and values. It constitutes an *inflammatory* kernel of any kind of motivation and activities of interactive human beings (as living organisms) which are capable to interact with the surrounding reality and with their environment. Each information received by the man generates in his mind a kind of network and process form of the model, this model representing images (framework) being in interaction with the man an its environment (these images are considered to be alive). These images create semiotically communication platforms (set of frames) of logic constructs which also are a composition of contents (facts and rules) and categories (criteria) of ethical-cultural values emerging with the transformations taking place, during the acquisition of knowledge on the evolutional behavior and decision judgments of a determined community of the man. The evolution of such interactive information-intellectual behavior has the character of auto-regulation processes and auto-creation (selforganization), generally directed onto adaptative conceptualization and on a more or less conscious transformation of the so far used functions of behavior, appearing in the human organism and in the surrounding community.

A global composition in the platform of the logical map of the information activity systems architecture, based on hierarchical values of semiological transformations of the environment, and layered dimensions of conceptual interactions, methods, communications and knowledge representation tools, is presented in Tab.1.

The evolution is characterized by a specifically systemized purposefulness of behavior categorized by values of time and space and measures of matter, energy and information. An aspect of such categorization of evolution values can be such measures as the level of the dynamic character and of the activeness of behavior equilibrium, and the intensivity of the cyclic character and the scale of transformations taking place in the nature of the communitarily and systemically perceived world, or in its subsystems (Tab.1). Thus, any kind of systemic-evolutionaly transformations refers to the behavior of living organisms, to innovative technology processes, to the artifacts and various components arising as their result, to the nature of phenomena and values of phenomena of the human life and its images, to knowledge and interactive information processes of the human being, to decision making processes categorized by the degree and efficacity of the decisions made. However, on the other hand, these transformations are decisive for the interactive and integrative values of the systemic-creative evolution of the intellect, culture, morality, ethics, rationality of activities, co-operation, interhuman collaboration, and particularly creative-developmental evolution of the world. The duality paradigm of the creative socio-technological transformation is presented on Fig.1.

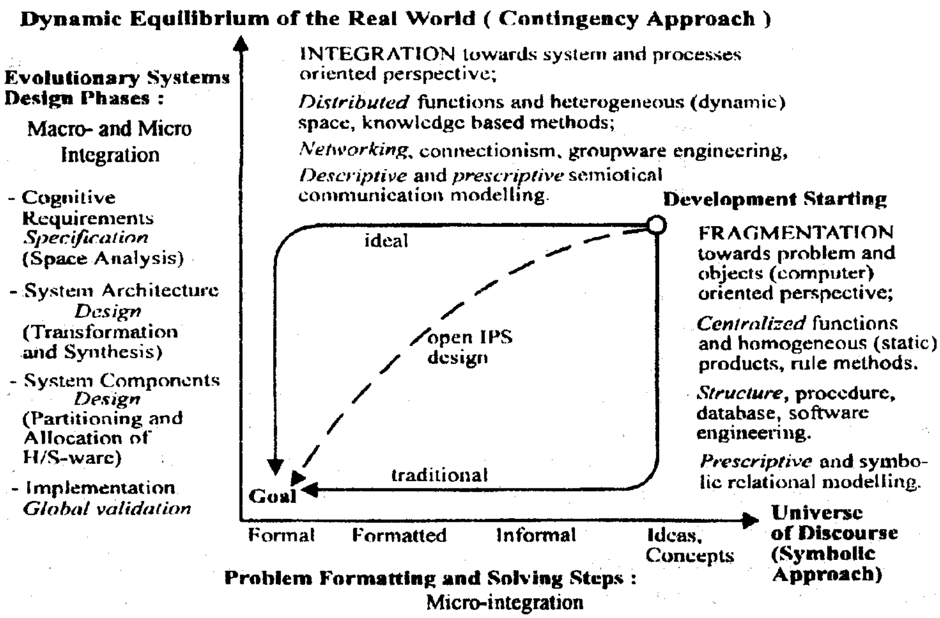

Fig. 1. Methodological reasoning of systems inquiry and technological knowledge based transformation processes paradigms

Table 1. Socio-Technological Platform of Human Information Functi... HAS Architecture and Communication System

Systems Hierarchy in Environmental Interchangeability (Transformations)	Layered Architecture Dimension and Logical Levels of their Interactions	Tools for Interactive Communication and Knowledge Representation of Systems	Services and Standards, Interfaces
HUMAN ACTIVITY SYSTEM (HAS) Intellectual and Biophysical Interactions in Imagination, Knowledge, Consciousness, Decision, and Transformation of their Values - Ethic, Culture, Morality, - Education, - Responsibility, Creativity, - Inventiveness, Rationalism - Categorisation of values - Visibility, Imagination	**EVOLUTIONARY LOGISTIC - contingency phenomena and methodologies of multidimensional transformations** *Dynamical Equilibrium* and *Associative Morphology* of Socio-Technolog. Layering for the Communication Levels and Services - Systems Inquiry Dimensions: Information (KPS), Processes (IPS,DPS), Structures (CCS) - Knowledge Levels: Elicitations, Representation, Formalization and Communication Interfaces and Protocols of Dimensional Levels	- Cognit. identify/Deduct. validate and Descr. /Prescr. **Modelling** of evolutional systems - Systemic/Synergic/Axioms **Imagination** and **Categorization** of environment, - Multimodal, Fuzzy-value, Multimedial, **Interactive** Tools for **Heuristic** Knowledge Representation, - Functions/ Processes/Interactions/ Behavior- Structures for System **Transformation**, - KB - Cooperative Guidance, **Reasoning** of Decision-making Process and System Design	**Integration and fragmentation** of ISO/OSI for aiding of interhuman activity, **System concepts**: terminology - categorizing principles of knowledge and imagination, Environmental artefacts, performance, validation, ...
KNOWLEDGE PROCESSING SYSTEM (KPS) Visibility and Intellectual Processes - Knowledge, Information, Decision - Communication, - Morphology, - Efficiency of Purposes - Evolutions and Strategy - Arrangement - Creativism and Constructivism - Transactionality	**INTERACTIVE -INQUIRY - pragmatic** Methods, Strategies, Metaclasses for Communication, Imagination and Embeddedness of Behavior, Connectionists. - Interations for Decisions and Tasks, - Spatial Composition/Decomposition, - Transitiveness of Heuristic Structures and Processes and Transaction Services, - Many Valued Logical Transformations of Information Models - Hierarchical Orderlines of Functions and Values in Services and Tasks	- Distributed knowledge based expert engine, - Inferences declarative/procedural mapping of concepts and decision processes, frames and semiotics communication interactions, - Groupware services for associate reasoning, - Computer Supported Cooperative Work, - Visual/Logical Knowledge Representation	Telecommunication and computers-multimedial interhuman services of communication: Fax, E-mail, EDIFACT, CATV, Windows, Hypertext, LOTUS NOTES
INFORMATION PROCESSING SYSTEM (IPS) Transaction on the Level of Tasks and Services - Transformation of Imagination, Vision, Entities (data and semiotical information), - Validation of Knowledge and Images (facts and rules)	**INFOLOGICAL - semantic** Distribution, inferences, function/process structures - Semiotical representation-components, - Syntactical relationships and axiomatic network, - Transformation of symbolic/semiotic representation for Knowledge-Bases/Allocation	- Management of transactional processing, - Communication protocols, interfaces, servers and services, - CASE, CAD/CIM graphic, Tool Box, - Connectionist structured information networks (entities, token, primitives, relationship-structures) and simulation	EDI, Teleconferencing, X.400; X.12; ISDN services (data, word, speech, images), Audio-VISUAL services and interfaces
DATA PROCESSING SYSTEM (DPS) - Data Base-Domain, - Files and Programs, - Entities, Relationships	**DATALOGICAL - syntactic** - Management and operational software-structure and functions, - Distributed relational Data Bases and symbolic representation	- Formal-deductive logic/symbolic specificat., - Prescriptive modelling (ERM) and procedural programming, compilers, ..., - Computational tools for structural verification and simulation	TOP, CIM, CAM, CAD, PASCAL, C++, PROLOG, LISP, DML/DDL, FTP, RJE
COMPUTING COMMUNICATION SYSTEMS (CCS) - Functional and Signal Processing, - Multi-media Communication Processes, - Inter-Networking Communication	**TECHNOLOGICAL** - Infrastructure of hardware and software systems, - Instrumental connectionism and non-linear communication services	- CAD tools and firmware (soft/hard) products, - Operating systems software (Bytes, Bits, Digits, Routines), Algorithms, - Multimedial, analog, digital, networks integrated services structure, Measurement	Assembler, CHILL oriented progr. language, TRANSPUTER, OCCAM, bioprocessors, CATV - interactiv, VLSI; physical parametric

2. SYSTEMS INQUIRY

The process of studying the phenomena of HAS is what is meant by inquiry. This is a methodological concept. The phenomena appearing in different areas of human activity can be a source of search and processes of conceptualizing images of the evoluing reality. Thus, conceptions and constructs of HAS environment transformation and amelioration are emerging. This causes the need of transitions or qualitative changes in the system, these transitions and changes being often accompanied by apparently paradoxical changes of paradigms of acquiring knowledge on the evolution of the environment under consideration. Serious attempt is made to use formalized and agreed upon methods, procedures, and instruments in order to establish the communicationally active and informationally cognitive inquiry founded on scientific bases. Consequently, the phrase disciplined inquiry is used. Many methods of inquiry are discussed; these methods are to a high degree based on informatic technology. A specific method or perhaps a combination of methods (methodologies or metamethods) constitute an expected part of scientific investigations for an informational and communication inquiry into the HAS nature. Inquiry is seeking for truth, information and knowledge.

The methodology of systems inquiry is of a decided integrational and interactive character, and refers to methods and strategies associated with a higher level of knowledge and of intellectual and ethical values. The intellectual and creative processes which are performed on this level of human skills and competence, refer to individuals and multidisciplinary experts. Integration is a primary paradigm of systems science and systems inquiry, being a basis for human valuing. Fragmentation or reduction is a paradigm which serves the achievement of systemic solutions the object of which is to achieve a precision of systems solution - of their constructiveness. From the methodological point of view and research activity, inquiry is carried on various arenas of researches. We can consider here some taxonomy of contextual kind of arenas. An example of three arenas for inquiry is presented in Tab.2.

Table 2. Three arenas of inquiry

Arena I NATURAL INQUIRY	Arena II HUMAN INQUIRY	Arena III CRITICAL, SOCIAL ACTION INQUIRY
research on Acquisition Explanation	research with Collaboration Understanding	research on Advocacy Amelioration
one way exchange from participants to researcher	two way exchange between researcher and participants	three-way exchange among researcher, participants, and other members of the community

Systems inquiry penetrates and integrates, through its modeling methods and techniques, any areas of many disciplines of the universal science. Systems inquiry respects also the usefulness of methods and techniques, both integrational and fragmentational, elaborated and developed in cybernetic sciences and in management. However, a full consciousness and responsibility what concerns limitations of its application and transmission resources on the area of HAS is here obligatory. Cybernetical sciences , indeed, concentrated or restricted till now their fragmentary research and methodology interests first of all on homogenous fields of engineering sciences, and on control rules for physical environments.

The interactive background of systems inquiry is space, being an image of community activities in a form of network, e.g. round-shaped (loop or ring shaped), which bidirectionally connects research processes performed by methods of *systems analysis* and *synthesis*, in four *nodes* or arenas of *interactive* knowledge *extracting* and imagination creating, emerging in an evolutionary way from images existing in the world sciences. Such arenas of science and knowledge are : philosophy, theories, methodologies, applications and technologies, which transform the reality and are incorporated in the HAS. Proceeding around such a loop requires to observe sequence in both directions. *Short-cutting* i.e. proceeding across the loop and omitting one or two *nodes*, leads to methodological and cognitive-systemic simplifications or *denaturalizations* - ref. Fig.2.

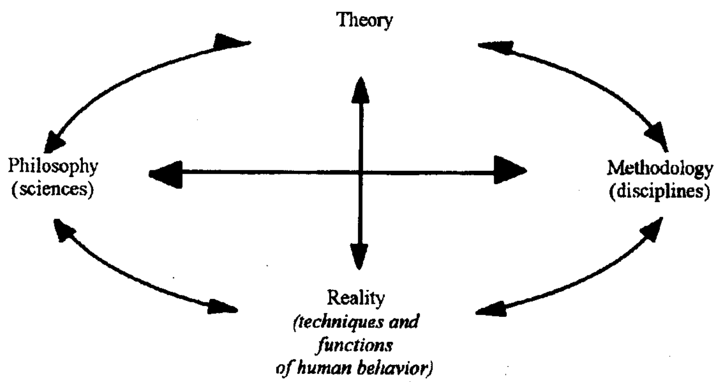

Fig. 2. Cyclic form of the interactive character of multidisciplinary systems inquiry

An example of such a methodological denaturalization is research oriented on object paradigms, on problems, on machine production etc. in a reality perceived by categories of the *universe of discourse*. In systems inquiry bidirectionally realized strategies or approaches are obligatory. For the need of imaginations, they start generally from the outside to the inside of the system (in open and closed systems), from bottom to top, and inversely (in the sense of hierarchy of goals and values).

Thus, systems methods start generally from the analysis of the system architecture, i.e. the micro- and macro-integrated functions and processes with regard to the environment (external requirements), and end with the internal structurization of their functions obtained as a result of the synthesis of the implemented system in a determined environment. So, it is worth enhancing the importance of systems principles and methods and warning against using their naive manipulation - we are, indeed, witnesses (and may-be victims) of such manipulation, particularly now, in the practice of intensively arising transformations. The essence of transformations performed on all the system architecture levels is improving behavior, processes and functions of activities of a determined system, and the choice of a suitable system structure has to follow this behavior, processes and functions improvement. System structure is, indeed, the final transformation result, and the features of the structure should not so much *stiffen* as make more *elastic* an evolutional adaptation of the system to the activities of its environment.

3. PERSPECTIVE OF MICRO-MACRO INTEGRATION METHODS

The principle viewpoint in Tab.1 stems from membership in HAS. These systems are constructed to serve human needs and interests; and therefore, in this general sense, it is useful to note that the four areas tend to collapse within HAS. That is, CMC, DPS, IPS, and KPS tend to become embedded in various ways within HAS. This is a study of not only the interrelations among these areas, but also the embedded nature of these systems within HAS. In other words, the methodolological foundations of HAS and informatics may be importantly described and understood in terms of the collective possibilities combining the areas and dimensions.

The major areas integrating HAS and informatics into a multidimensional communication networks architecture, are presented in Tab.1. This table is a matrix constructed by crossing the communication network areas. The rows of the matrix represent different logical levels for several areas (kind of systems) of communication networks. Where CMC highlights the artificial at one extreme, HAS highlights the natural at the other extreme. Each area of communication designated in the levels of the matrix requires more detail. The colums of the matrix define three dimensions of conceptual emphasis to be crossed with the communication network systems. Each logical dimension level also requires further detail. Although such disection of communication network systems and logical dimensions level seem necessary to articulate the architecture. In practice, the areas and dimensions are inseparable, and the five communication network systems are integrated.

Each cell of the matrix shown in Tab.1 is a focus of conceptualization (various kind) for micro-integration of the whole systems architecture. Each focus may be conceptualized as a subsystem and considered a place to concentrate our attention in a specialized way, while each row level and each column of the matrix constitute more generalized domains of the whole system, respectively. The general subsystems of HAS are complementary to the specialized ones. Additionally, the foci may be considered places in which a person may situate in order to view the whole system. Perhaps, it may be helpful to think of these places much like knotts in a fishnet or intersections in a model of a neural network. We note that there are 15 such foci, as shown in Tab.1. These cells or nodes are termed foci or treat as interfaces of micro-integration, because they are the first and most fundamental combinations that human beings consider meaningful to begin their quest to comprehend the whole system. They also tend to be places within the HAS that a person can comprehend without becoming overwhelmed by the details and complexity of the whole system.

First order micro-integration in its simplest conceptualization is dyadic structure and process. It involves the combination of two basic components of the system and all communications between them. Although there is a tendency to ignore initially the other components and connections comprising the system, it is necessary to link them into this node once the combination has been meaningfully defined, in order to attain a systemic view of the entire communication network. Otherwise, the inquiry remains a limited exercise in analytical activity and thinking. Thus, not only are there 15 choices of possible reference within the whole system for micro-integration, but also there are 15 points in which to wiew the system through macro-integration. Ideally, both emphasizes complement and converge in arriving at a systemic comprehension of the system.

The first order places/points of integration of the architecture serve to set into motion activities toward the macro-integration of the system. There are 5 levels of Tab.1. HAS, KPS, IPS, DPS, and CMC. These are five first order places/points of integration. Dyadic combinations or complets of these five levels constitute the other 10 first order places/points of integration. As various aggregates and subgroupings of these 15 foci are considered, we derive higher order levels toward macro-integration, that is, constructing and strenghten our comprehension of the whole system. We should discuss those of greatest interest in our examination of HAS and informatics.

However, the set of foci of Tab.1 is not the only initial basis to commence integration activities within the communication networks architecture. Alternatively, the communication network areas can be combined in various ways and levels of complexity to establish another viable scheme for studying HAS and informatics. To continue in this fashion, the meticulous progression to higher order levels of integration demonstrates the complexity and difficulty of comprehending whole systems and the staggering challenge before humans to exercise systemic thinking. In consideration of first, second, third, and fourth order levels of macro-integration, we transit from micro to macro and specific to holistic considerations of the system. HAS and informatics have been studied in great depth in terms of separate domains of logics, representations, and languages, though the interdependency among them is somewhat obvious. Basic descriptive activities within each domain which spans across the five areas (HAS, KPS, IPS, DPS and CMC) provide foundations for the more difficult undertaking of the dyadic relation between the domains, and finally the more generic triadic interrelations among them, again, across all five areas.

In sum, there are various perspectives on the determination of foci in order to study the system in terms of its parts and their interactions, as well as their integrate into the whole. It is helpful to emphasize momentarily various points of micro-integration. But it is equally important to examine various means to move toward macro-integration, The cognitive activities of working both whole-to-parts and parts-to-whole are essential to systems thinking. Of course, ideally, the three general perspectives on the communication networks architecture will lead those who utilize them eventually to convergence on a more comprehensive holistic conceptualization, comprehension, and understanding of the systems we are part in our technology based environments.

Metaphors provide great assistance to the humble human mind in reaching to grasp at a formulation that does some justice to the awesome complexity of HAS. The use of metaphor is a methodological device for embeddedness of the communication functions and interfaces in HAS. Metaphors help us caste what we know about a system into a form which we can hold up for scrutiny to evaluate our progress toward micro- and macro-integration. By way of illustration, two metaphors can be discussed. The Tab.1 can be described more definitively as a hierarchical multi-layered cone, consisting of five levels (types of communication systems) and three encased (outer, middle and inner) cones (domains of communication interfaces), as a three columns of intellectual and technological tools. The metaphor of stratified cone and cascade presented here are only two examples of metaphors serving the structural and dynamic process aspects of the communication in HAS network architecture. Unfortunately any one system, area, layer, dimension, and metaphor can only convey a delimited snapshot of the dynamic whole, thus one should attempt as much as possible to engage the designer in various impressions about the architecture to foster more systemic thinking about HAS and informatics.

4. CONCLUSION

A knowledge representation in the form of tables does not always facilitate an activation of the imagination and an understanding by the designer of HAS complex architecture. Besides accessible methods, the designer needs to have tools which permit to perform transformations and to identify the communication-evolutional nature of HAS. Tools performing such services in the designer's activity can be achieved by means of hypertext or hypermedial techniques. A non-linear representation of knowledge corresponds, indeed, to the complex and, at the same time, well structured and appearing concepts embedded on different levels and layers of HAS. The embedded concepts are integrated by vertical and horizontal interfaces in the area of HAS platform. The designer, when moving longwise and crosswise the platform, performs a valuing of different solutions in a suitable context, and a confrontation of these values with the user (researcher, student etc.). Communication World-Wide Web (WWW) services enrich the space implementation of hypertext ideas, providing mechanisms appropriate for an communicationally interactive inquiry in the space-time of the user's area. This signifies the possibility of knowledge presentation, asking question, receiving answer, consultation, directing, discussions, observations and participating in evolution of knowledge and ideas, as well as achieving concrete solutions, with their confrontation and validation. A not trivial advantage of WWW in integration with hypertext, hypermedia etc. is also the general access to its services, the facility of manipulation and the fact that it does not demand to know programming.

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BADANIA SYSTEMOWE A TECHNOLOGIE INFORMACYJNE

Badania systemowe, polegające na poszukiwaniu prawdy, informacji i wiedzy są nazywane metodą *inquiry*, której celem jest konceptualizacja postrzeganych wizerunków rzeczywistości. Metoda *inquiry* przyjmuje za podstawę sposoby i paradygmaty poszukiwań informacyjnych ukierunkowanych na mikro- i makro integrowane wizerunki rzeczywistości. Celem tych poszukiwań jest poznawcze zrozumienie i odwzorowanie wiedzy będącej w relacji do tych wizerunków. Wspomaga ona komunikacyjnie świadomość projektanta w pokonywaniu złożoności systemu ludzkiej aktywności oraz dynamicznej integracji środowiska systemu.

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