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Socio-Cognitive Engineering Scenarios for the Reinforcement of Global Business Intelligence: TOGA Approach

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Abstract

The presented paper is an introduction to the new global conceptualization scenario of the business intelligence improving from the perspective of meta-systemic knowledge and socio-cognitive values involved in the management of large complex heterogeneous real-world systems integrating human, technological and environmental components. The socio-cognitive perspective, as a complementary to the techno-economic vision of humans activity, is here considered. On the other hand, the paper demonstrates how an application of the modern systemic approach TOGA (Top-down Object-based Goal-oriented Approach), its top-ontology, and artificial intelligence software technologies enable together to define meta-modeling frameworks and to indicate why, where and how business intelligence can be constructed and reinforced. This approach should lead to the indication of critical factors of business organizations, and, as a consequence, to the development of intelligent business decision support systems. Conscious applications of socio-cognitive engineering paradigms and models, being integrated together with strongly automated business tools should also dramatically improve quality, efficiency and efficacy of the design, planning and management of business enterprises. Two concrete examples illustrate possible applications of the presented scenarios.

1. Introduction: Context and Methodological Scenario

This article is a continuation and refinement of the study of the business intelligence improvement being presented on the Special Session of the 5th Business Information Systems International Conference– BIS 2002, Poland, April 24-25 [Gadomski, Straszak 2002a].

The current analysis is focused on the vague and not yet sufficiently investigated interrelation between the concept of **business intelligence** (BI) and nowadays emerging systemic methodological framework of **socio-cognitive engineering**.

Numerous publications and brochures dealing with BI (seen as a specialized organizational intelligence or corporate intelligence) are widely diffused over the world. They describe concepts, techniques, methods, and tools, and include domain-dependent case studies of how industry and commerce organization are developing and applying new technologies towards building (see the web) their own intelligence. On the other hand, BI is considered as a very useful metaphor for the commercialization of modern software technology in the business ambient, as well as for meta-business socio-politic and socio-economic activities.

From the practitioners perspective, numerous solutions available on the market represent low level of usability and always insufficient reliability for their potential clients. For the reason of their weak structure and lack of an unified commonly accepted theory, they represent rather toolkit boxes with instructions how each one instrument works but without their allocation in an integrated generic global business scenario. One of the most advanced software tools in the BI domain is Wisdom Builder package [www.wisdombuilder.com], it is a preliminary approach to an integrated solution of information management and analysis methodology in the business field [Libowitz 1999].
In parallel yet, all the modern business managing and developing actors are deeply convinced that the science and technology progress have to drastically improve and support human intelligence involved in business enterprises management.

In this paper, taking under consideration the complexity of the problem, its heterogeneity and its novel character, we use the TOGA meta-theory as a basic problem conceptualization framework [Gadomski 1989], [Gadomski 1994], [Gadomski 2001]. The TOGA meta-theory objective is to provide a systemic and cognitive methodological approach for goal-oriented knowledge ordering and problem specification. The top-down conceptualization in frame of this theory means that all definitions and rules introduced on higher specification/identification levels are mandatory for every lower subsequent level [Gadomski 1998].

One of the key aspects of TOGA is its meta-systemic ontology and incorporation of an abstract intelligent agent into every specification and identification of any complex real world problem.

The main simplified steps of the TOGA heuristic methodology are the following:

1. identification of the *key concepts* involved in the problem definition.
2. identification of main intelligent components
3. identification of their contexts objects
4. identification of goal-oriented interrelations
5. top-down problem modeling encompassing to the level satisfying the problem requirements.

In this paper we accept intuitive definitions of the above used meta-concepts: problem, identification and modeling.

The **problem** here is to present the socio-cognitive engineering paradigms, a meta-methodological framework, and to indicate why they should be employed to the modeling and reinforcement of BI.

Identification of the key concepts relies on their goal-oriented systemic refinement on such abstraction /generalization level when their definitions can be independent of: the type of business, business specific domains, intelligent agent/actor role, and particular situation-dependent attributes.

Modeling is a construction of a conceptual/abstract system that is a product of the goal-oriented projection (with an assumed accuracy) of selected properties of a modeled system/process repetitively recognizable by the modeler (an intelligent agent) in its environment.

Identification of complex problems of an intelligent agent, assumes its recognition as a property of the real world and also, for this reason, includes *ontology building*, where *ontology* is a recognized set of "what exists" for a particular problem. The identification process leads to the construction of a model being valid for a requested class of problems.

2. Global Business Intelligence – What is it?

The key top concepts of our problem are easy to recognize, they are: *business*, *intelligence*, *socio-cognitive engineering methodological scenario* and *global-BI reinforcement*.

Let's start from identification of business intelligence.

2.1 Business

Business is a complex goal-oriented activity distributed in time and space and performed by autonomous intelligent entities/agents in their society.

Business goals, among other attributes, have to have one integrated attribute *value* that can be mapped on a measurable well ordered one-dimension scale commonly accepted and considered mandatory by a human society.

In general, business is every material or abstract activity which produces the above value.

According to such definition, the classical business activity is based on rational reasoning processes and does not include emotional, ethical goals related to the human life, unique cultural historical objects, and preservation of human ecological environment which may not be reconstructed by economical and technological investment.

Main domains of business activity are industrial enterprises, commercial services and banking.

From the organizational foundation-goals perspective [Gadomski 1994] the goals are represented by the generic:

production goal, economy goal, and safety goal,

while the **business kernel activity** has always been focused on meta-attributes of organization products and its economy goals. In the explosively developing market economy, it had to lead to the necessity of the growing multilevel continuity strategic management and to the searching for new more efficient organizational structures adopted to such purposes [Mintzberg 1989].

On the operational research strategic level, business and business intelligence are seen in the context of such concepts as market and enterprise growth , business requirements and environmental changes, what is briefly illustrated in Fig.1.

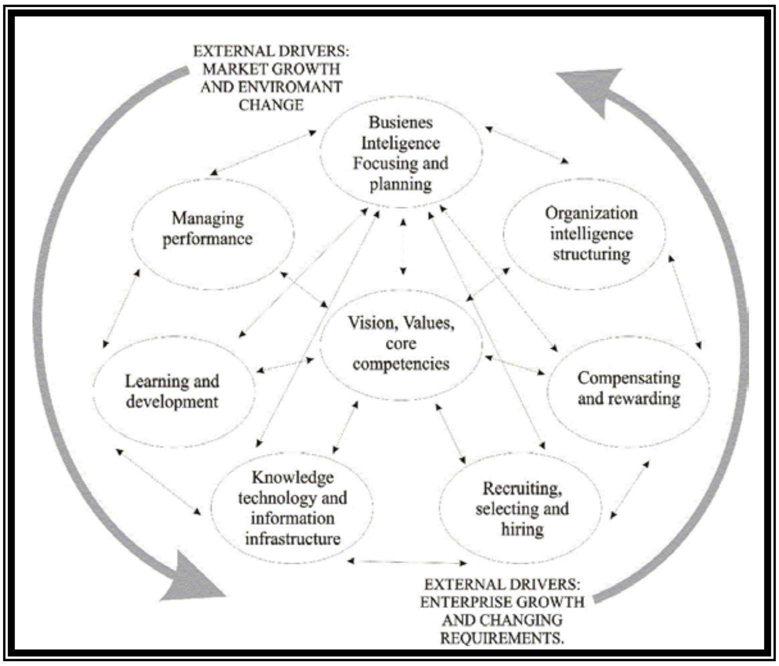

Figure 1. An informal illustration of the "business mechanisms" on qualitative abstraction levels in the context of the operational and system research [Gadomski, Straszak 2002].

The competitive modern society, government policy makers and stakeholders tend to transform social activities, products of human culture and technology in business enterprises in order to give them the measurable market values. This critical tendency influences the sustainable society development, causes clash with traditional and subjective humans axiologies and generates the stressed and neurotic societies already studied by Erich Fromm [Fromm 1992] and Horney [Horney 1968].

On the other hand, we should notice that business activity produces values and means which enable people and their organizations, such as different types of voluntary associations, to preserve and practically apply their individual non-business values.

Taking under consideration the increasingly acutely conflicting interests among social, political and business parts, as well as painful organizational changes and mismanagement in large and middle enterprises, traditional decisional approaches are not any more sufficiently efficient in coping with the always more choosy and assertive customers, instructed citizens and legislative systems. As a result, in modern global society, business need to be more "intelligent" [R.Amann,2000].

2.2 Intelligence Model: the TOGA Framework

There are many more or less incongruent definitions of intelligence in psychology, social sciences, as well as, recently, in the computer science and system engineering [see, for example, on Internet]. The denotation of this vague concept is also extended on the software artifacts called agents [Klopotek 2001], [Ning Zhong 2001] as well, in business ambient it is considered as a **capability of a system/organization to be more efficient, especially under the unexpectable real-world circumstances.**

This "very goal-oriented" intuitive definition is currently promoted by stakeholders and in the webwide publicity of software vendors but it is not sufficient for the development of new innovative organizational structures and, from the technological perspective, it does not enable formal and scientific specifications required for the intelligence simulation and building.

In the subject matter literature, apart from the numerous functional intelligences, we may distinguish two, more general but not congruent interpretations of the intelligence concept. The primary, more diffused, is a behavioral intelligence, the second is the structural one.

2.2.1 Behavioral and structural intelligence.

In order to confront these two notions of intelligence we assume the point of view represented by the TOGA meta-theory. In this approach the concept of intelligence is founded on a structural pattern of an abstract agent [Gadomski 1990,1994]. The definition of structural intelligence is different from the behavior based intelligence but it is more useful for the development of multi-purpose intelligent systems.

The behavioral intelligence of an agent is observable, by definition. The structural one, if knowledge or individual preferences/intentions are not adequate to the problem or not sufficient for the task execution, it is not visible for agent's external observers.

An important advantage of the structural intelligence is that all agents with structural intelligence, independently of their roles may be constructed using the same repetitive architecture modules.

Therefore the structural definition of intelligence seems to be more efficient for the design and reuse intelligent software architectures. It is important to notice that while modeling of the structural intelligence, TOGA also enables explanation of the meaning of behavioral intelligence.

2.2.2 TOGA Model.

The essential TOGA concepts employed in the modeling of intelligence or more precisely, of an abstract intelligent agent (AIA), are: information, preferences and knowledge (IPK). These relative functional (= goal-oriented) abstract entities are defined formally as a specialization of the components of the generic data processing operation:

result = processing_operation(data),

and an application of the choice operator dependent on generic preference relations: **A** is **better than B** .

The relativity of IPK relies on two fundamental assumptions:

- IPK bases are always referred to a common, arbitrarily chosen and distinguished domain of mental/physical/social activity of AIA,
- IPK depend on the AIA conceptualization system, it means, they have to be expressed using the same AIA conceptualization tool.

According to the above assumptions, and less formally:

Information, I, is/are data which represent a specific property of a preselected domain of human or artificial agent's activity (such as: addresses , tel. numbers, encyclopedic data, various lists of names and results of measurements).

Knowledge, K is every abstract property of human/artificial agent which has ability to process/transform (quantitatively/qualitatively) information into other information (such as: rules, instructions, procedures, manuals, scientific materials, models, theories).

Preferences, P, are ordered relations among two coupled properties/states of the domain of activity of agent which indicate states with relative higher utility. Preference relations serve to establish an *intervention goal* of agent.

Goal, G, is a hypothetical state of the agent's domain of activity which has maximal utility in a current situation according to the preferences relations available for the agent. Goal serves to the choice of knowledge which should be activated for the processing of new information.

Less formally yet, information answers to the question what concretely exists in a specific domain for the preselected agent/actor.

Knowledge enables to transform information into the new one, useful for the achieving of a current AIA goal in a predefine situation of an **Intelligent Agent World**.

These, very highly abstract definitions are included in the TOGA ontology. They are referred to an abstract intelligent agent, that is - to any, self goal-oriented, human and human-like entity, such as: individual person, human group, organization, nation and humanity supported by adequate technological tools. All of them are goal-driven and their intelligence carriers can be concentrated or distributed in different manners.

The second paradigm of AIA claims that its generic conceptual framework is valid in every specialized domain of human society and … business activity.

We should notice that TOGA is an intelligent-agent-based rather then an agent-oriented approach. The discussed approach has evolved from the TOGA theory (proposed and being developed since 1989). As the consequence, TOGA includes a general functional architecture of an abstract intelligent agent, called personoid.

A clear distinction between an abstract simple agent (called monad) and an abstract intelligent agent is made. Using a biological metaphor, a monad can be seen as an abstract "cognitive cell" of a mind which represents an essence of "intelligence". The AIA architecture is a main idea of a personoid, it does not depend on its physical realization and its specific IPK load.

Contrary to humans, where only the behavioral intelligence is observable, computer intelligent systems, by definition, enable not only to see structural intelligence but also to modify and design it.

Anyway, if we assume that an abstract intelligence can be considered as a common property of humans and advanced highly autonomous software systems, then a structural intelligence model should be valid also for interpretation of human behavioral intelligence. Even then, though the structural intelligence of human decision-makers remains invisible.

Let us assume the TOGA model of intelligence that is based on the concepts of domain-dependent hierarchical meta-level structures of the IPK triangles and a domain-independent reasoning "mechanism" [Gadomski, 1994].

Fig.2 illustrates the basic multi-level functional IPK architecture of AIA.

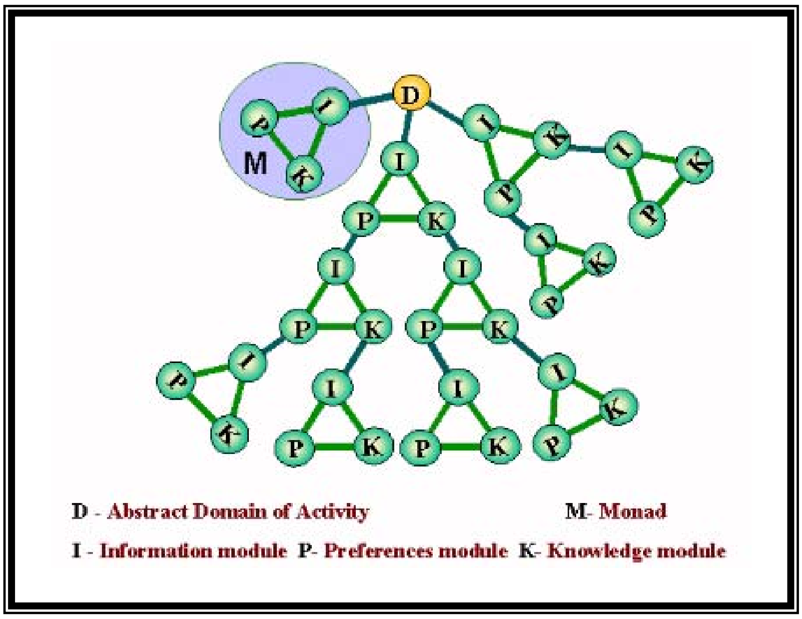

Figure 2. Multi-meta-level functional architecture of AIA [Gadomski 2001].

The information, preferences, knowledge (IPK) triangles represent abstract bases of information, preferences and knowledge rules/relations related to the pre-selected domain of activity of an abstract intelligent agent.

According to the structural intelligence hypothesis, behavioral intelligence is the result of three conceptual components: **IPK bases**, **Structural Intelligence** (build-in intelligence), and **Reasoning Methods**. All of them can be supported by computer systems interacting with their human users.

Main element of intelligent agents' mental activity that causes goal-directed human behavior is a decision-making process. Therefore, every IPK refers to abstract or physical domain of activity of the agent, i.e. domain of decisions.

In the IPK conceptualization, abstract IPK bases are basic necessary carriers of decisional process (D-M), and D-M can be represented as follows:

$$I'' = \textbf{Complex\_Choice\_Operator}\ [\mathbf{I,P,K}]\ I',$$

where I' is an information which activates D-M, and
I" is an information which includes decision.

We may intuitively accept that independently of the assumed representation of D-M, its efficacy depends on the quantity, quality, allocation and management of the problem oriented **I**, **P**, **K** related to the different real and abstract domains involved in the problem specification.

More formal and detailed specification of the IPK architecture is in the recent SOPHOCLES report [Gadomski 2002]. Here, we should only mention that the computer implementation of the meta-levels of AIA reasoning, involving knowledge about knowledge, preferences of preferences, and so on, requires meta-programming tools, i.e. "refers to the ability of writing programs that have other programs as data and exploit their semantic" [Apt 1995].

An advantage of the abstract personoid model is its applicability to
- natural and artificial agents,
- one separated intelligent unit, as well as the distributed organization with hierarchical management,
- unified heterogeneous corporate systems with human and technological components (large intelligent-based systems).

2.3 Global Business Intelligence Reinforcement

In the context of business activity, **business intelligence** is intelligence focused on business objectives, more precisely, business intelligence is closely referred to the business-oriented decision making. It is equivalent to **organization intelligence** in business organization.

Business intelligence is a **corporate intelligence** of intelligent actors.

In contemporary information society, business intelligence is continuously increasing by the application of the ever more advanced technology support to the business decisional processes. Fig. 3. illustrates a generic classical isolated Business World of a decision-maker without influence of socio-cognitive ambient.

Let us allocate conceptually the generic frame: Structural Intelligence, Reasoning Methods and the IPK bases to the components of Intelligent Business System (IBS). We can notice that every actor role is describable by IPK bases, which are individual or shared among the different task-oriented work groups on different hierarchical levels of the organization.

The primary hypothesis of the BI improvement is that some improvement of the available IPK bases has to reinforce human decisions and, as a consequence, this operation increases “behavioral intelligence” of organization and it’s managers.

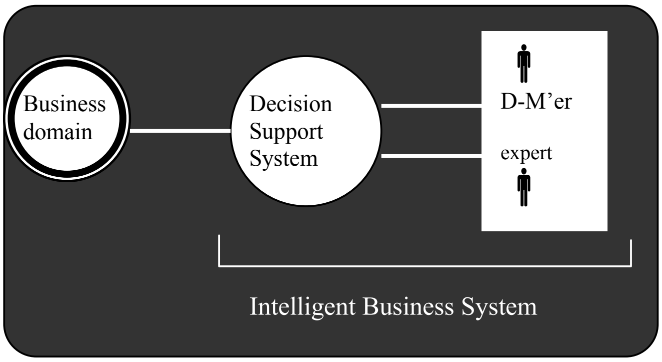

Figure 3. Generic Business World without socio-cognitive component.

Therefore, we argue that to reinforce behavioral business intelligence of Intelligent Business Systems is necessary:

- to develop some networked and intelligent Decision Support Systems
- to take under consideration interactions and constraint of the D-M’ers with their organization and socio-cognitive environment.
- To develop learning-organization frameworks for efficient organizational knowledge application and management.

The above objectives require an adequate top-down models building and a bottom-up IPK acquisition from all domains which may influence organization efficacy in the positive or negative sense.

In general, the strategic intervention of the BI improvement should be concentrated on supporting, increasing or autonomous realization of the Intelligent Business Systems components.

3. Socio-Cognitive Scenario

3.1 Intelligent Socio-Cognitive Systems (ISCS) Engineering

In the field of cognitive researches the major results come from new interdisciplinary collaborations. The importance of studying the cognition in integrated manner is now generally accepted.

“Cognitive science is concerned with the analysis of natural information processing systems (such as animals and humans). Its main concern is the **investigation and modeling of human cognitive competences “**

[Anand Rao 1997].

"The main concern of cognitive science is the construction of models of human thinking - models which detail the processes intervening between environmental stimuli and behavior. A shared assumption is that the mind is representational in nature and that cognitive processes can be described in terms of their function, without reference to a neural substrate… "

[the Web: Peter Gärdenfors 1999]

"At present we can say that AI contributes to psychological research and reciprocally psychological models are going to be goal-oriented applied to the user modeling in engineering systems "

[The Web: P.J. Laird].

Therefore this approach requires an integration of :
-*Engineering perspective*, in which IPK is applied to the construction of useful artifacts - this leads to the questions of the utility and efficiency of "intelligent" problem solving mechanisms;
-*Psychological perspective*, in which a systemic and ecological knowledge is involved in the identification of mental processes of real acting beings.
This last approach tends to explain, forecast and modify human intelligent behaviors.

In the above contexts, Intelligent Socio-Cognitive Systems (ISCS) Engineering is a new sub-field of Socio-Cognitive Engineering (SCE) especially focused on the intelligence as the most advanced computational property of socio-cognitive systems. Socio-cognitive engineering has started, as every new human technological and engineering activity, bottom-up from the design of human-computer interfaces, cognitive ergonomics and available software engineering tools/technologies, but today from new systemic and unified interdisciplinary perspective, it should be reconceptualized and may be seen as an internal interactions' engineering between cognitive components and their structures into highly complex large aggregates of intelligence-based systems embedded in the real-world environment.

Taking under consideration the complexity, large and mobile scale, heterogeneity, and always-insufficient IPK, in order to cope with the problems of understanding and design together:

- human organizations,
- computer networks and
- human-technology culture,

in the framework of one intelligence-based system, it is necessary to follow the paradigms of:
- systemic conceptualisations (top-down approach, unified and integrated),
- engineering (goal-oriented/driven/directed/based), and
- cognitive perspective (human-like, mental functions modeling).

The key research domains of ICSE are related to the computational modeling and simulation of:

1. Socio-cognitive and cybernetic knowledge on business/governative/social organizations
2. Motivations, preferences and risk-benefits based distributed cognitive reasoning
3. Individual and collective cognitive decisions
4. Human reasoning errors, meta-reasoning, stress, emotions
5. Intelligence kernel: Cognitive abstract intelligent agents
6. Human and Computer role sharing in human-computer systems (using tasks analysis)
7. Survivability of intelligent entities in hostile environments
8. Human components in a Virtual Business Enterprise
9. Socio-cognitive usability (an evaluation of organization - technology interaction)
10. Sustainable organizations and cognitive sustainability (criteria, indicators and measurement).

Summarizing, we may define Intelligent Socio-Cognitive Systems Engineering as an engineering of highly complex large aggregates of intelligence-based systems in the real world environment.

3.2 Two Socio-cognitive perspectives in Business Intelligence

Modern business demonstrates, as never before, that human components, business organization management and their socio-cognitive interactions are crucial for the business success.

“ There is a growing gap between the complexity of these societal problems and the human capacity to deal with them. There is a need for better methods and tools, more knowledge and imagination. Scientific knowledge is needed to survive amidst these problems”. [DeTombe 2002]

Therefore not only technology but methodology or implementable methodologies for complex human, societal and business problems, have become a new field in the focus of scientific attention.
The socio-cognitive perspective takes under consideration that the business decision problems are not seldom defined, change during their development and solution, many actors are involved often with a different view on the problem, with different interest and with different ‘solutions’ in mind.
Societal reasons for this systemic approach is the importance of these problems for society, organization, and individuals, the impact they have on people, and the large amount of money involved.
Combining existing business, cognitive and organizational knowledge, and creating new insights with methods and tools for supporting real-world decisional problems is a challenge for scientists from different fields involved in business intelligence research.
From the top-down perspective, two socio-cognitive IPK are involved in the improving of IBS.
The first regards the conceptualization of business domain, the second is focused on the cognitive modeling of decision-makers and their collaboration in frame of human organization.
The **external** perspective is related to socio-cognitive domain of activity and requires monitoring of client and public reactions, and a generic public utility.
The **internal** perspective is related to the competences and individual motivation of employers of business enterprise. Here**,** the monitoring of satisfaction, motivations and initiatives plays a crucial role.

4. Socio-Cognitive BI Modeling Paradigms

Fig.4 presents an extended vision of the Generic Business World. It is complex, with variable dynamics, heterogeneous, with incomplete, unsure knowledge and information. It includes:

- human decision-maker
- human organizations,
- computer intelligent support
- human-technology culture.

In order to cope with its understanding, modelling and design it is necessary to begin its identification effort from an integrated congruent set of paradigms.

Taking under consideration the definition of ISCS engineering, and its meta-systemic perspective, the following TOGA proposal of paradigms seems to be acceptable:

Physics paradigms: the simplest solution is better/"true", necessity of observability/ measurability, and repetitiveness.
Systemic paradigm: top-down approach, completeness and congruence of description on any generalization level, unified terminology.
Engineering paradigm: construction activity has always to be planned and goal-oriented/driven/based, and always to use available: knowledge, technologies and materials.
Cognitive paradigms (an unified cognition theory): user/(human-agent) must be modeled, mind is abstracted from human brain and it has to have a computational intelligence which does not depend on specific knowledge, preferences (also ethics) and available information. Human emotions and bounded rationality have to be taken under consideration [Edmonds 1999].
Social paradigms: intelligent cognitive agent is a basic component of a human society, i.e. has to satisfy constrains, which result from the society's structure, in order to satisfy better own preferences. Every human agent is a member of many formal and informal organizations (numerous social roles).

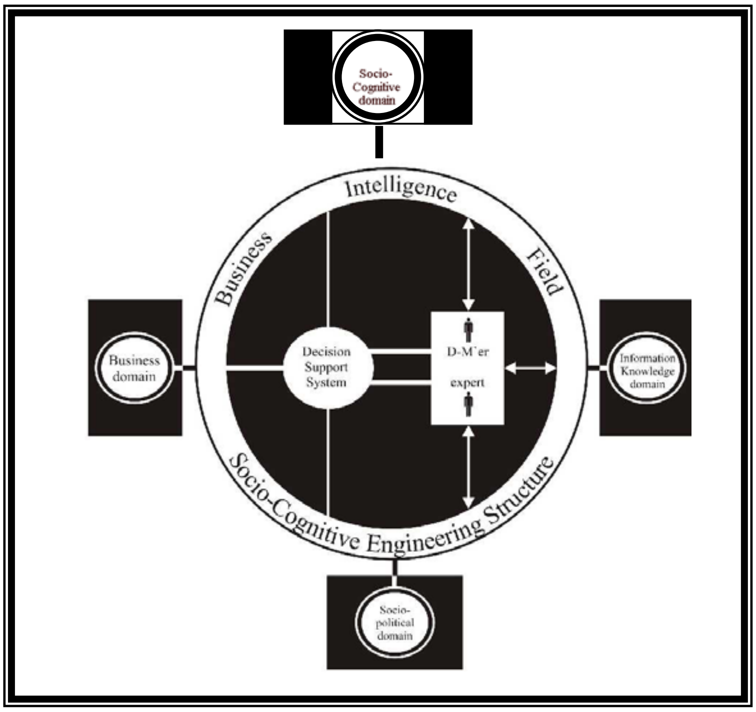

Figure 4. Informal representation of the business world where the socio-cognitive IPK and socio-cognitive engineering are taken under consideration [Gadomski 2002a] .

In practice, these paradigms indicate a sequence of required modifications of the BI model, especially related to the organizational functional IPK bases.

Information – increasing of numbers of information sources which are supervised.
Knowledge – employing new socio-cognitive knowledge in decisional processes, permanent organizational learning and preservation of historical knowledge of the organization.
Preferences – follow the generic rule "I use and others knows that I use business ethics". More precisely, the preference rules should indicates:

- what should be taken under consideration,
- on which level of importance, and
- which methodological approach can be applied (is better).

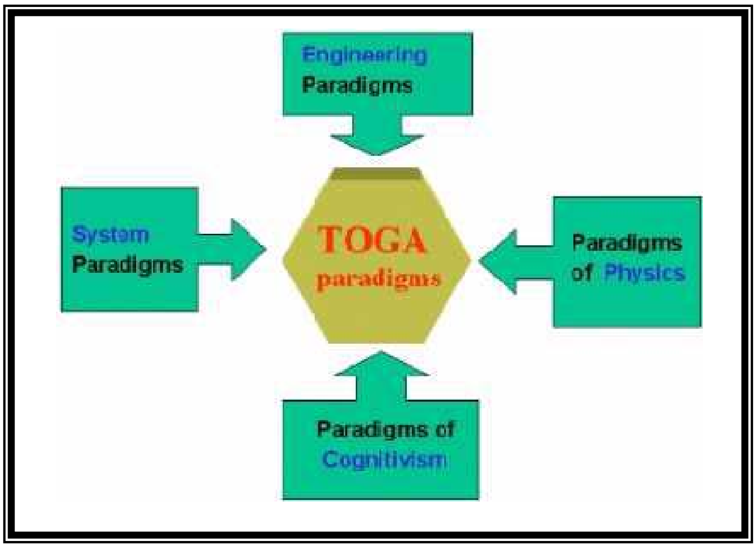

Figure 5. TOGA integrates different paradigms of the scientific method defined in [Kuhn 1977].

At the end of this paper we mention yet the permanent preference dilemma of the business managers. It relies on the conciliation of:

- Current business objectives
- Personal employer objectives
- Ethics preferences, which also includes business ethics.

In the paper of three distinguished American managers [Evans 1996] dealing with what ought to be integrated into the production business process, in the lists of 20 Key Elements, professional ethics is indicated as the 5th. They write:
"Follow the Golden Rule: Treat others as you would have them treat you.
Over the years, the focus of published professional Canons of Ethics have changed:
in 1912, the focus was protection of a client's or employer's interest (AIEE)
in 1947, the focus was concern for the safety, health, and welfare of the public (ECPD)
in 1990, the focus is on fair treatment of all persons (IEEE)."

5. Conclusions: Meta-systemic perspectives on the Development of Highly Intelligent Systems

In the real world business, the socio-cognitive factor has been not yet sufficiently represented. For an integrated vision of business enterprise, from the perspective of global systemic modeling, a socio-cognitive engineering framework is necessary. It will enable to reinforce behavioral business intelligence and to increase efficiency of business organizations. Its development is based on: modeling and knowledge dissemination effort and an application of new advanced technologies.

5.1 Modeling and knowledge dissemination effort

The theoretical research and modeling activity leads to the better understanding of BI processes, theoretical contexts and socio-cognitive factors. Their construction are related to such basic ontological concepts as: society, organization, manager, environment, decision-making, cognitive processes, technology and decision-making. The reciprocal static and dynamic interrelations network should be designed, implemented and applied to the design of IBSs and to the conscious management of business decision-making. The above approach requires to lift a modeling platform on a higher abstraction level using some generic unified meta-modeling frames. In order to integrate:

- physical, social, cognitive and normative constrains of the business ambient,
- business knowledge and mental decision-models
- architecture of individual and distributed BI,
- permanent organizational learning and knowledge management,

the TOGA meta-theory with the IPK architecture of the abstract socio-cognitive system frame has been employed in this study. Dissemination and diffusion of the developed theoretical frameworks on the global scale in the information society, requires the application of modern e-learning and Internet infrastructures.

5.2 An application of new advanced technologies: prostheses of mind

An application of specific information systems, expert systems and active problem solving decision support systems increases in the incremental manner business intelligence of organizations, but more promising temptation of the modern computer technology is a opportunity to use really artificial intelligent tools to the support of mental processes of managers.

Such challenge requires yet:

- a better cooperation between socio-cognitive theory developers, meta-logic specialists and, on the other hand, an application of AI software agents technology
- a conscious application of meta-systemic integrated perspective to highly intelligent system design
- a development of software components, automated reasoning methods and techniques validated on the level of prototyping and pilot applications for selected critical decision types in business domains.

In the figure 6, a meta-systemic vision on the application of different knowledge domains, technologies and engineering approaches, in order to design a highly intelligent decision support are presented. There are many RTD projects, especially bottom-up developed, which are going in this direction. We would like mention only two, which have been planned from the meta-systemic perspective and which are in the focus of the current activity of High-Intelligence and Decision Research Group, the ENEA's Unit CAMO. The primary is Cog-SOPHOCLES, sub-project of the ITEA Sophocles project, 99038, 2001-2003 [http://www.itea-office.org/projects/sophocles_fact.html]. The objective of the Cog-SOPHOCLES contribution is an experimental (prototype-based) elaboration and validation of a methodology and architecture for the development of an intelligent advisor. It should provide an intelligent support for e-design of, so called, Systems-On-Chip in frame of the networked Cyber Virtual Enterprise. The validated architecture of this intelligent cognitive agent is based on the IPK framework of personoid [http://erg4146.casaccia.enea.it/SOPHOCLES].

Second one is the EC ITS Project SAFEGUARD, 2001-2004: Intelligent Agents Organization to Enhance Dependability and Survivability of Large Complex Critical Infrastructure. Its research objective is a validation of intelligent cognitive agent architecture and the structure of intelligent artificial organization which should be able to supervise and protect against hacker attacks on the national energetic and telecommunication networks [http://www.ist-safeguard.org].

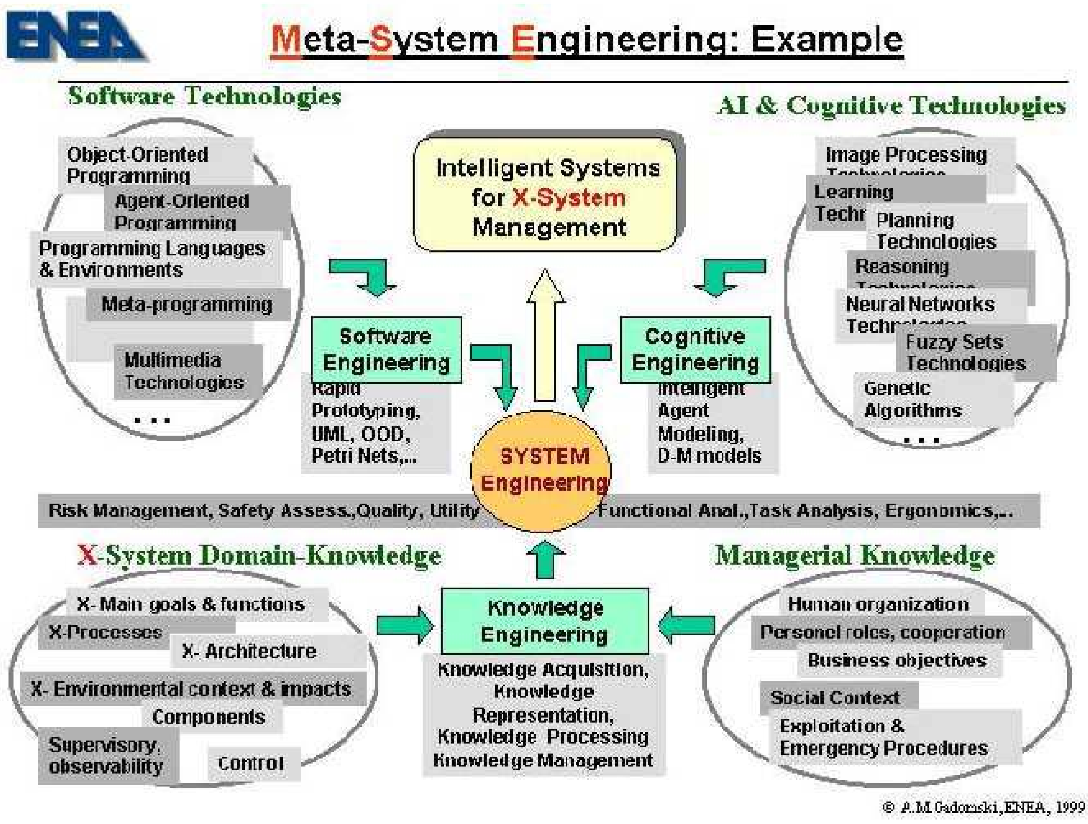

Figure 6. An illustration of the domain of meta-systemic approach to the design of highly intelligent systems which should support human management of complex real-world systems [Gadomski, the Meta-knowledge Engineering Server's web pages, 1999].

Both mentioned projects are focused on the improvement of human intelligence by the supporting and automation of human mental decisional processes which are responsible for the behavior of complex engineering systems and large industrial infrastructures in unexpected situations.

The systemic socio-cognitive study of the real behavioral business intelligence in human organizations should provide concrete data and generic frameworks to the development and structuring of artificial highly autonomous distributed intelligent agents' organizations, The relations between organization structure, decisional "style" and organization "foundation-goal" seem to be key identificators of Businee Intelligence [Mazzuca 2002]. Summarizing, the both above mentioned projects ought to provide an important experience for the evaluation of various, more detailed methodological and technological solutions for the ISCS engineering.

In order to complete "formally" all currently developed and theoretically possible approaches to the reinforcement of human intelligence and BI in particular, we should mention yet two research directions, the primary is based on the old ideas of genetic engineering and biological computers, and the second on the hybrid integration of human brain with the computer and nano- technology [Kurzweil 1999]. The last hypothetical possibility is only illustrated in figures 7 and 8. Nowadays, an analysis of consequences and socio-cognitive impacts on the culture of the global society of such engineering can only be the domain of an anticipatory science studies.

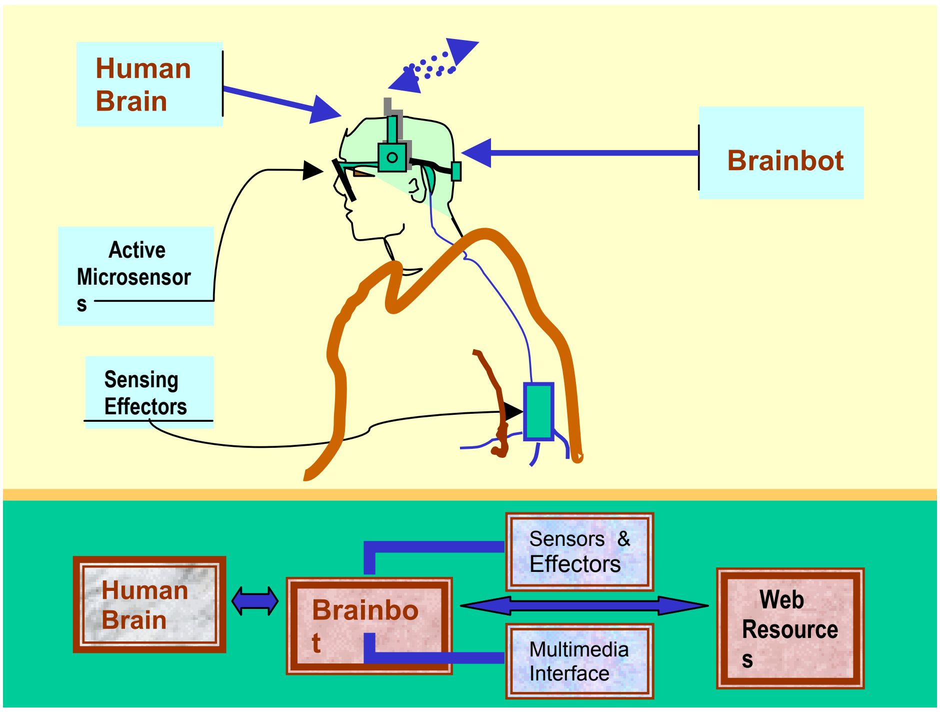

Figure 7. A hypothetical MIND SUPPORT SYSTEM (MISS) [Gadomski 2001a] .

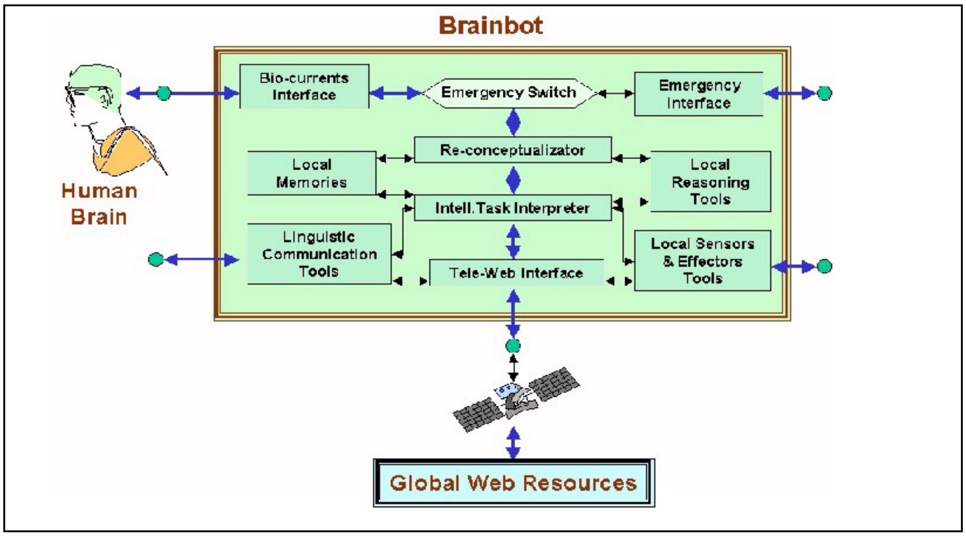

Figure 8. Functional modules of the hypothetical MIND SUPPORT SYSTEM (MISS) .

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