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RELATIONS BETWEEN THE OBJECT UNDER CONSIDERATION, DIALECTICAL SYSTEM, SYSTEM AND MODEL OF IT AS A BASIS FOR THE REQUISITE HOLISM AND REALISM OF MODELING AND ITS RESULTS*

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ABSTRACT

Modelling is a crucial tool in research and development, but models simplify one's perception of systems as mental pictures of reality, maybe too much. Therefore one must be aware of the addressed relations, typology of models, and apply 'USOMID – 6 Thinking Hats' method of creative cooperation to attain requisite holism of approach and requisite wholeness of outcomes.

KEY WORDS

object, system, dialectical system, model, USOMID, 6 thinking hats

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THE SELECTED PROBLEM AND VIEWPOINT OF WORKING ON IT HERE

Humans live in the given reality and deal with it by behavior (i.e. observation, perception, thinking, reflecting, conclusions making, decisions making, communication, and action). The given reality is too complex and complicated for the human behaviour to have a full, i.e. really **holistic** basis, i.e. ability to consider **totally all** attributes of reality without limitation to one's single selected viewpoint reflecting one's specialization/interest. Thus, actions have a poorly reliable basis, because there are (many) **oversights**. One strives at a better insight by making and using models, all way from pre-conceptions, e.g. stereotypes that a nation or profession has typical attributes covering everybody, to scientific **models**. Though: models are created by **simplification** of reality that is supposed to be represented and presented; one might **over-simplify**, thus creating a **poorly reliable** basis for practical behavior. This is the selected problem of this contribution. The selected viewpoint is the response offered by Mulej's Dialectical Systems Theory.

HOLISTIC THINKING VERSUS NARROW SPECIALIZATION (MODELING INCLUDED)

A good half a century ago, right after the end of the 'World War I & World Economic Crisis & World War II (1914-1945)' period, scientists such as L. von Bertalanffy, N. Wiener and their colleagues (from several disciplines and in interdisciplinary creative co-operation!) found a new response to the terrible consequences of one-sidedness visible in events of that period, again: holistic rather than fragmented thinking, decision-making and action. They established two sciences, growing into one over time, gradually and more or less, to support humankind in the effort of meeting this end – holism – as a promising alternative to the world-wide and local crises. These were (General) Systems Theory and Cybernetics. Rightfully they are called the **science of synthesis** [1]. System is the word entitled to represent the whole. One fights one-sidedness in order to survive. Bertalanffy wrote very clearly [2; Ch.VII] (exposure of crucial words by bolding is ours, authors):

> "Systems science ... is predominantly a development in engineering sciences in the broad sense, necessitated by the complexity of 'systems' in modern technology ... Systems theory, in this sense, is pre-eminently a mathematical field, offering partly novel and highly sophisticated techniques ... and essentially determined by the requirement to cope with a new sort of problem that has been appearing.
>
> What may be obscured in these developments – important as they are – is the fact that systems theory is a broad view which far transcends technological problems and demands, a **reorientation** that has become necessary in science in general and in the gamut of disciplines ... It ... heralds a new world view of considerable impact. The student in "systems science" receives a technical training which makes systems theory – **originally intended to overcome current over-specialization** into another of the hundreds of academic specialties. ..." [2; Ch.VII].
>
> "It presents a **novel »paradigm«** in scientific thinking ... the concept of system can be defined and developed in different ways as required by the objective of research, and as reflecting different aspects of the central notion." [2; Ch.XVII].
>
> ... "General systems theory, then, is scientific explorations of '**wholes' and 'wholeness'** which, not so long ago, were considered to be metaphysical notions transcending the boundaries of science." [2; Ch.XX] "... 'Systems' problems are problems of interrelations of a great number of 'variables' " [2; Ch.XX].

> "... models, conceptualizations and principles – as, for example, the concept of information, feedback, control, stability, circuit theory, etc. – by far transcend specialist boundaries, were of an **interdisciplinary** nature.." [2; Ch.XX].

This fact about the Systems Theory itself speaks of the "uncommon sense" Bertalanffy has been speaking for [3]: he was fighting the common current practices of **one-sidedness**, because they were dangerous and still are so increasingly. The great author on creativity, Eduard De Bono might say that Bertalanffy has been using the lateral thinking rather the vertical one [4]. Systems thinking was and is fighting the vertical thinking that only follows rules like e.g. in solving crosswords; instead, it requires creative thinking along an unknown path, i.e. **lateral thinking** to become a normal human habit along and combined with vertical thinking. Let us return to Bertalanffy:

> "What is to be defined and described as a **system** is **not** a question with an obvious or **trivial** answer. It will be readily agreed that a galaxy, a dog, a cell and an atom are real systems; that is, entities perceived in or inferred from observation, and existing independently of an observer. On the other hand, there are conceptual systems such as logic, mathematics (but e.g. also including music) which essentially are symbolic constructs; with abstracted systems (science) as a subclass of the latter, i.e. conceptual systems corresponding with reality. However, the distinction is by no means as sharp and clear as it would appear. ... The **distinction** between **'real' objects and systems** as given in **observation** and 'conceptual' constructs and systems cannot be drawn in any commonsense way." [2; Chs.XXI-XXII].

This supports our understanding of the term system [5]: **Systems are mental pictures of real or abstract entities as 'objects' of human thinking; they are concepts that 'represent' something existing from a selected perspective/viewpoint/aspect**. Thus:

> In **mathematical** formal terms, a system is a round-off entity consisting of elements and relations, which makes it **holistic**. In terms of **contents**, a system depends on its **authors' selected viewpoint**; hence, it does not comprise all attributes of the object under consideration, but only the **selected** part of them. This fact makes a system both **holistic** (formally, with no contents, or inside the selected viewpoint only) and **one-sided** (due to the unavoidable selection of a viewpoint). Therefore **models are also one-sided**.

See Table 1 for brief presentation of these relations:

- **objects** exist, and humans watch and manipulate them with different levels of holism. Total holism makes the object and the system as someone's mental picture of the object totally equal, but it reaches beyond human natural capacity,
- this is why humans are specialized and limited to single viewpoints causing humans' limitation of consideration of any object to a **one-viewpoint system**,
- by co-operation, normally by an inter-disciplinary one that includes several essential professions in a (creative) synergetic effort, a team can attain more holism – by a **dialectical system**,
- both a system and a dialectical system exist inside the human mental world, in human thinking and feeling; they can be expressed in **models** for other humans and other living beings to receive information about humans' thinking and feeling.

Why is **requisite holism** important? There are scientists attempting to say that their discipline offers the **only** unique and unifying basis for dealing with systems. They do not speak of worldview, like Bertalanffy does, but of professional/scientific disciplines. Can they be right? Yes, in their own **perspective/viewpoint** they can. Can they be sufficient for holism? They can be so rarely, exceptionally. **Nobody can be really, i.e. totally, holistic**: teams can perhaps

Table 1. Relation between reality and holism/realism of human consideration of it.

Level of humans' realism of consideration of the selected topic	**Level of humans' simplification of consideration of existing objects**	**Viewpoints of consideration taken in account by humans**	**Components taken in account in consideration by humans**	**Relations taken in account in consideration by humans**
Existing object to be dealt with	None	All existing	All existing	All existing
Dialectical system	Small – requisite	All essential	All essential	All essential
One-viewpoint system	Big due to specialization	Single – selected by specialization	Selected inside the boundaries set by the selected viewpoint	
Model of/about the one-viewpoint system	Big due to specialization and modeling aimed at clear presentation	Single – selected by specialization and simplified to be clear	Selected inside the boundaries set by the selected viewpoint and shown in a simplified – modeled way	

be requisitely holistic with interdisciplinary creative co-operation.

Bertalanffy – as you see – stresses the **whole, wholeness, and interdependencies**, rather than parts and independencies or dependencies. This necessary worldview **fights reductionism**, which has been very **helpful** over the recent centuries, but causing **oversights** as well, with consequences causing World Wars, climate change, and economic and social crises. Table 1 states that **models are permanently in danger of reductionism** leading to **over-simplification** with dangerous consequences:

- **viewpoints** from which an object is looked at, **select** the attributes to be found crucial among many. They do not erase other attributes, but **forget** about them, find them (fictitiously and wrongly, sometimes) unimportant or even non-existent, at least "belonging to another discipline" rather than to the same nature, biosphere, organization (in Bertalanffy's terms). Holism becomes rather **fictitious**, if a **single viewpoint** is selected, in terms of the requirement that e.g. the entire biosphere should be considered,
- **interdependence of viewpoints** is in this way forgotten about, so are synergies that result/emerge (also) from the **overseen** impacts over each other resulting from interactions based on interdependencies of the fictitiously separated attributes of reality,
- **complexity** of the real life tends to be forgotten about, too. **Generality** is emphasized; this seems to be a version of understanding of the so-called trans-disciplinary approach by several later authors. But generality is unavoidably **limited** to the general part / subsystem of the entire system of attributes, thus leaving aside the group-specific and individual subsystems of attributes (Table 2). This is a serious **simplification**, based on admitting (realistically!) the definition that science simplifies and is based on reductionism.

Table 2. Interdependence of the general, group specific and individual part of attributes

(1) The general part or subsystem of interdependent attributes, common to all considered objects					
(2) Group specific subsystem (1)		(2) Group specific subsystem (n –1)		(2) Group specific subsystem (n)	
(3) Individual subsystem (1)	(3) Individual subsystem (2)	(3) Individual subsystem (3)	(3) Individual subsystem (m –1)	(3) Individual subsystem (m –1)	(3) Individual subsystem (m)

Bertalanffy's concept of organization involves interdependence and interaction of **components** of the same entity and different from each other. It **should** imply the same **interdependence** concerning the **viewpoints** (which have evolved, among other effects, to many specialized scientific disciplines and professions). Consideration of the real complexity can hardly be done without a lot of (the **requisite**) **interdisciplinary** work, which enables specialists to be what they are **and** to attain the requisite level of holism, too. Which level is the requisite one, depends on the **decisive persons**; they unavoidably take the risk of success versus failure.

Our concept of 'the law of requisite holism' may lead the way out from the blind alley [6].

REQUISITE HOLISM IN BRIEF

Systems thinking as the practice of **holistic** (Table 3) rather than **one-sided** behavior had been many millennia old practice of the **successful** humans, before systems theory as its theoretical generalization was created. Like most other human capabilities, the practice of systemic behavior was **informal**, first, and then received the form of theory for transfer of good practice through teaching to be easier to make.

Inside an authors' (usually tacitly!) selected viewpoint, one tends to consider the object dealt with (**via models**) on the basis of **limitation to one part of the really existing attributes** only. When specialists of any profession use the word system to call something a system inside their own **selected viewpoint – it makes a system fictitiously holistic**. It does not include all existing attributes that could be seen from all viewpoints and all their synergies. See Table 3.

Thus, summary of the law of requisite holism (Tables 4a and 4b) reads: one needs always to try and do, what many, but not all, have the habit to do in their behaviour – **avoid the exaggeration** of both types:

1. the **fictitious** holism, which observers cause by limiting themselves to **one single viewpoint** in consideration of complex features and processes,
2. the **total** holism, which observers cause by trying to include **totally all attributes** with no limitation to any selection of a system of viewpoints in consideration of complex features and processes.

Instead, the **middle ground** between both exaggerations should be covered, which can be achieved via "**dialectical system**", made by the author/s as a system (i.e. network) as an entity or **network of all essential and only essential viewpoints**.

For the requisite holism to be achieved three preconditions, at least, matter:

1. both **specialists and generalists** are needed, working in **teams** that feel **ethics of interdependence** and co-operate,
2. they include professionals from all and only essential professions/disciplines,
3. their **values** are expressed in their ethics of interdependence and practiced in a creative teamwork, task force, session(s) based on an **equal-footed cooperation** rather than top-down one-way commanding.

Requisitely holistic **behavior, e.g. concerning modeling,** cannot include the **global/general** attributes only, because they make **a part** of the really existing attributes only, although they matter very much and tend to be subject to oversight by specialists. Neither can requisitely holistic thinking include the **parts' attributes** only, although they matter very much and tend to be focused by specialists of single disciplines and professions. **Oversight** of relations,

Table 3. Dialectical system of basic attributes of requisite holism/realism of human behaviour.

Interdependent actual general groups of real features' attributes	**Interdependent attributes of the requisitely holistic consideration of real features**	**Considered attributes of thinking about real features**	**Attributes of participants of consideration at stake**	**Surfacing of all these attributes in a given case**
Complexity	Systemic	Consideration of the **whole's attributes** that no part of it has alone	Interdisciplinary team	The final shared model resulting from research as a dialectical system of partial models
Complicated-ness	Systematic	Consideration of the **single parts' attributes** that the whole does not have	One-discipline team/group or individual	Partial models resulting from one-viewpoint based investigation
Relations – basis for complexity	Dialectical	Consideration of **interdependences of parts** and **viewpoints** that make parts unite into the new whole – emerging (in process) into synergy (in its outcome)	Ethics and practice of interdependence – path from one-discipline approach to the interdisciplinary teamwork	Shared attributes and complementary different attributes, which interact to make new synergetic attributes, i.e. **from systematic to systemic** ones
Essence - basis for requisite realism and holism of consideration	**All** essential	**Consideration** that selection of the **systems of viewpoints** must consider reality in line with the law of requisite holism for results of consideration to be applicable – by reduced reductionism	Capability of researchers to **deviate from reality as little as possible** in order to understand reality, including systemic, systematic and dialectical attributes of it	Findings applicable in practice, due to/ although resulting from theoretical considerations

especially **interdependences** causing influences of parts over each other, may not be forgotten about in (requisitely) holistic thinking/behavior; especially specialists, who have not developed the habit to **consider specialists different from themselves**, tend to make crucial oversights in this respect. This experience makes them **not realistic enough**. See Tables 1-4.

Take a look at experience around you and discover (again): **Success** has always resulted from absence of oversights with crucial impact. And **failure** has always resulted from crucial oversights, be it in business, scientific experiments, education, medical care, environmental care, invention-to-innovation-to-diffusion processes, etc., or wars, all way to World Wars of the 20th century, or the world-wide economic crises.

Any level of holism depends on information and provides information.

Table 4a. The selected level of holism and realism of consideration of the selected topic between the fictitious, requisite, and total holism and realism.

⟵		⟶
Fictitious holism/realism (inside a single viewpoint)	Requisite holism/realism (a dialectical system of all essential viewpoints)	Total = real holism/realism (a system of all viewpoints)

Table 4b. Law of requisite holism (Table 4a) in some details.

Approach to dealing with an object as a topic of behaviour	One-sidedness by a single viewpoint	Requisite holism by co-operation of all essential professionals and only them	Total holism by consideration of totally all viewpoints, insights from all of them and synergies of all of them
Type of approach	(Too) Simple	Requisitely simple	Very entangled
Type of system as a mental picture of the object dealt with	Single-viewpoint based system	Dialectical system	Total system
Attributes of object included in system	(Very) Few	All essential	All
Result of approach	Fictitious holism (in most cases)	Requisite holism (good in most cases)	Total holism (ideal)
Focus made possible	(Too) Narrow focus (in most cases)	Requisitely holistic focus	Lack of focus
Number of professions	One single	Requisitely many	Literally all
Type of work	Individual	Mixed team of requisite and different experts	All humankind in co-operation/synergy
Consequences	Complex due to crucial oversights, dangerous	No problem due to no crucial oversights	Simple due to no oversights
Availability	(Too) Frequent in real life	Possible in real life	Not possible in real life

THE ROLE OF INFORMATION IN SYSTEMIC BEHAVIOUR (INCLUDING MODELING)

In the daily life, the word information tends to be used in many different **contexts and contents** without a clear definition. We see the same reality concerning the words system and model. This is far from being the only attribute they may have in common.

Information must, first of all, be **delimited** from the notions of data and message:

- **data** exists when signs are **ordered** into a **syntactic** entity, such as a word, an organ of a body, a leaf of a tree, a picture, piece of music, etc,
- **message** shows up when data is ascribed a **meaning**, thus receiving its **semantic** dimension,
- **information** shows up when a message makes an **impact** by coming to be understood, accepted and causing an action. This is called the **pragmatic** dimension of information.

From such a definition, one can see that it is problematic, if the making and application of computer is called informatics, even less so to let it monopolies the notion. The same would

apply to ordering data in book keeping, in libraries etc. One can find something, which all of them have in **common**:

- information is an influential relation,
- there is no system, hence, without information,
- there is no entity, hence, without information,
- there is no order, hence, without information,
- information is a natural phenomenon, which is not limited to humans and their relations and organizations,
- information is, potentially, but not unavoidably, supportive of holism,
- information is an expression of interdependence in general,
- information can be a physical (e.g. in a stone, in a machine), biological (in a living cell, organ, organism), and/or human (in a group, organization, society, humankind) relation,
- information can be linked with evolution (e.g. of a cell of an embryo, developing into lever, of another cell of the same embryo becoming the eye, etc.) and with development (of e.g. a society from a nomadic one to a postindustrial one over many steps in the process),
- information can be a tool against entropy, a tool of negentropy, because (and if) it induces order, evolution, development, holism, interdependence, relations etc., keeping or transforming an identity of an entity under impact of/by information,
- information can (also, but not only!) be a product of consciousness in terms of knowledge, data interpretation, learning and other experiencing, indeterminism and determinism,
- information can be insufficient and/or exceed the information requirement/needs,
- information can be subject to individual subjective understanding of given data and messages. It depends on the **selected viewpoints**,
- **information is also the essence of modeling**.

The viewpoints in which the **traditional** sciences were specializing did not focus on information – but rather on **energy** and **matter** and their flows. The issue, e.g., was how much energy, food, etc. an embryo may need to become able to be born and survive. The issue from the viewpoint of cybernetics and systems theory results from a different viewpoint: **why** will an embryo become a dog or an elephant rather than a tiger? The answer is: **information**.

In dealing with e.g. **modeling**, humankind of today may still have to come across a similar change of questions put from different viewpoints. As long as only the traditional question was asked, only (!) the basic process (the one of production of products and/or services, its supplies and their sales) was found worth consideration. Cybernetics found (1) **information** and (2) **management** processes to be (interdependent and interactive) preconditions of the (3) **basic** process (and impacted by it, too, of course). Hence, consequence in the form of e.g. a model, do not come from the basic processes only, even less from them alone or in isolation from anything else, but they also/rather come from the information and management processes, involving both the humans and the other nature.

These two processes govern the basic process – in a way of the **choice made by the owners of the management process**, e.g. the **model authors**. Its owners, of course, must consider the basic process very carefully in order to place the right instructions into it, but this is their choice anyway. This set of findings lets us see the growing complexity of managing an organization (of any size) and of its consequences. Let us, hence, take a look at possibilities to **simplify** management processes, which may let us have more time to deal with the crucial open issues of the dialectical system of all three processes.

INFORMATION NEEDS – FRAMEWORK TO REQUISITE HOLISM, INCLUDING MODELING

The very practical issue is open to decision and opinion: what is **really requisite**? Which **information** provides the **requisite holism**?

The common denominator of all the (very many) possible cases and examples as well as of all different contents of systems, all of which in one way or another meet criteria of the law of requisite holism, are the **information needs/requirements**. The latter are addressed by the **content** of the system(s) as mental/emotional pictures of reality (both mental and/or physical), which are tackled from the (dialectical systems of) viewpoints that are selected by those, who introduce systems to (re)present the selected attributes of the selected parts of reality. Once authors match information needs with **all crucial information and no overburdening with unnecessary data**, the law of requisite holism is met. **Simplification** is around, but may **not** become **over-simplification** all the time anyway for human abilities to be either good enough rather than overburdened or sufficiently informed rather than be misinformed or lack crucial information.

SOME TOOLS USABLE FOR SIMPLIFICATION IN COMPLEX PROCESSES AND SITUATIONS, INCLUDING MODELING

First of all, we should never forget the sentence by Albert Einstein: Let us simplify as much as we can, but no more.

What can be simplified? Reality is as it is, it cannot be simplified; this would reach beyond the human scope. The **human image of reality** can be simplified; this generates dialectical systems, systems, and models. They are used as the **bases of the human action, not insight only**. If the basis is over-simplified, the **action** will tend to have a too **unrealistic** background. Hence, this simplification may be helpful and dangerous, both at the same time, even. **Object** exists and has all attributes it has by its nature (Table 1). **Dialectical system** allows for a requisitely holistic presentation of the object. **System** allows for a one-sided presentation of the object from a single selected viewpoint. **Model** allows for a rather understandable **presentation of the system, not of the object**. In human interaction models are used; hence the basis of human interaction is **very simplified**, compared to the reality that humans try to comprehend and master; if there is not enough of the **creative interdisciplinary co-operation**, success is rarely possible.

If simplification is **unavoidable**, **reduction** from the object level to the model level is so, too. The reductionism, which Bertalanffy was fighting rightly under the label of over-simplification (and we are as well), is back, for natural reasons. The issue, which shows up, reads:

> in which ways can one simplify / reduce the total amount of attributes to the requisite one, in order **not to exaggerate**, but to rather comply with the law of the **requisite holism**?

Modeling can be based on several different **principles** and apply several related methods/tools:

- **hierarchy**, if it is not limited to a commanding hierarchy of subordination with no creative co-operation between bosses and their co/workers, is a useful tool of simplification of management. It allows for parts **different** from each other in the same process to be considered as **relatively independent** entities on which specialists can work. The interdependencies and interactions among members of such a sub-entity (e.g. finance department in an organization, etc.) are more frequent and important than the ones among different sub-entities. Acknowledging the differences among parts of the process is the

basis for **division/distribution** of labor and even more for **co-ordination** of work processes into one entity. Specialization does not make e.g. departments special only, but also **interdependent**: they are **complementary** rather than self-sufficient. The same applies to organs of a body, parts of nature, products, etc. **Models** may reflect this hierarchy,

- **recursion** is a different way of simplification, although quite closely linked with hierarchy in a number of cases. The point of this simplification of management is not in the differences, but rather in the **similarities**, which show up again and again. Specialization to a specific profession is such a case: it is easier to become a good boss inside the same specialized department and industry than in a different one. Repetition of the same features (i.e., recursion) allows for routine and requires creativity to be employed to the remaining, non-repetitive, non-reoccurring, non-recursive features. **Standardization** is enabled e.g., if attributes of products, processes etc. are built into automatic machines, in decision making (at least on a framework basis), etc. Today, recursion is often called **fractal** structure/attribute,
- **'black-box'** can also help simplify the management. Car drivers need not to know the **functioning**; it is enough, if they know only the **behaviour** of their cars, so do TV-viewers, users of kitchen appliances, persons cooking their own tea, coffee etc., who are no profound professionals. Frequently it is not necessary to know the inside, the "hidden processes", to manage, these cases say. Sometimes these processes are impossible to know but on the level of behaviour, i.e. on a (**more superficial**) black-box level, such as processes in a brain. In business, democratic bosses may have much less work to do, because they are capable of trusting, hence of considering their subordinates as black-boxes and concentrate on the remaining variety,
- **feed-back** may help such bosses to control the process well enough. But feed-back is not only a type of input-output relation between human beings and/or other part of nature. It is a basic attribute of artefacts based on first order cybernetics. All automata are self-regulating due to feed-back, but the level of temperature of a water-heater etc. is predetermined by feed-forward information installed. This is called regulation rather than self-regulation, for this reason. Nature applies self-regulation as well,
- in nature, there is a lot of **self-regulation**, if humans do not intervene too much. Harmony arises from **interdependence and interaction** of different parts making the same eco-system; it is a process of a dynamic stability. A trusting boss with trustworthy co-workers may use a black-box approach and self-regulation much more than other bosses. This can be called autonomy,
- **autonomy** can be found in nature and in organization. It can be called a way of **using the black-box approach, hierarchy and recursion/fractals combined**, as well as **regulation and self-regulation combined**, or even **all of them combined,**
- **standardization** is another way of simplification of management. Standardized parts of machines are **easier** to replace. Standardized rules of conduct are easier to follow. Programoteque is such a case on a framework level. Standardization of decision making is also possible, but it is easier to attain in terms of methods than in terms of contents [7].

Models can be classified from other viewpoints, too.

TYPOLOGY OF MODELS

There are no models about objects, but models **about system's** state, behaviour or functioning/working and models **for** it. The first ones are **descriptive**, the latter ones are **prescriptive**. Both types are influential as the **basis** for analysis and for synthesis, decision, and action. Therefore they **may not be oversimplified** pictures of systems, which in their turn may not be oversimplified pictures of objects dealt with.

- Models must therefore be **usable and useful**; this attribute depends on the **analogy and similarity to the system**, which can be made understandable with a legend (like in the practice of geographic maps, etc.). The level of simplification must be clear and match the purpose. Otherwise **disinformation** results and requisite holism of approach and wholeness of outcomes cannot be attained. Consequences may be fatal.
- As a type of **similarity**, *isomorphism* is more precise than *homomorphism*. The latter is not requisitely reliable in e.g. engineering blueprints as models for building a house or making a car, bridge or another technical artifact. But isomorphism is hard, if not impossible, to attain in social sciences.
- Models bring **mathematics and verbal expression** closer. In mathematics, a model means coming closer to reality by introduction of concrete data in formulas. In other sciences a model means reduction of concrete data under consideration.
- **Simulation** is another word meaning **model building** aimed at discovering of attributes of the system, which in its turn is aimed at **mastering** the object. This means that models provide feed-forward information as the basis for action. Hence, models are also tools of influence.
- Thus, *information* is a model that serves *management*, *regulation* as well as *self-regulation*. It can be a **hypothesis, a decision, or supportive feed-forward information**.
- Due to the influential role of models as *partial* sources of information, which may meet requisite holism or miss it, one must pay attention to **dangers of exaggeration** in making and using models. **Too much or too little mathematics** might cause a lack of requisite holism (market situations and trends are less well expressed with mathematics than attributes of technical artefacts, such as engines, hydro-power stations, airplanes, houses, etc.). Too many or too few **details** are another case of danger. Too much or too little attention to the **limitations** of the model may make it unrealistic. So, conclusions from models can be over-drawn.
- From the viewpoint of the **way of expression** models can be verbal (such as books), physical (such as prototypes of engines), graphic (such as pictures, diagrams, maps), or formal (such as quantitative models, e.g. formulas).
- From the viewpoint of **analogy** of the model **with the system** to be expressed, models can demonstrate *functioning/working* (such as electric network), *structure* (such as models of molecules, hierarchies in organizations), or *behaviour* (such as models of inputs and output in black boxes, mathematical equations).
- From the viewpoint of **purpose** model can serve *demonstration* (such as teaching or marketing materials), *experiments* (such as in laboratory research, field experiments in agriculture, practicing in sports and teathar), or *decision making* (such a constitutions and other legislation, decision trees). All three purposes can also be *combined*, of course, e.g. per phases of the same process.
- From the viewpoint of **research** models run through several **phases**: (1) modelling of **requirement** the systems under research should meet as attributes of objects in real life; (2) modelling of **hypotheses** about attributes of such systems to be met; (3) development and integration of such **systems** in tangible and intangible forms; and (4) evaluation of the system in terms of **suitability** or need to return to phases (1)-(3). Inside every phase one needs (a) **development** of models in several steps, (b) **collection** of research information, and (c) **synthesis** of information inside models.

For a **dialectical system of models** most or even all types may be used in **synergy**. This can be supported by some statistical methods, which apply to R&D process modeling better than some others.

QUANTIFIED APPROACHES TO MODELING

Social events and processes are difficult to study scientifically, because they are complex, multidimensional, and linked as causes and consequences. Whatever is the event or process under investigation (e.g. quality of research or education), investigation depends on a set or even a (dialectical) system of **influences**, some of which are **unknown**. Choice of simple research models that do not **respect** the **complexity** of the events or processes under investigation is hence not justified; a **complex methodological approach** is necessary for which the following four basic attributes are typical:

1. a precise, doubtless **definition of content** of the selected events or processes under investigation (e.g. quality of research or education),
2. a multi-dimensional **definition of factors with influence** on events or processes under investigation, both the external (the closer and/or broader social environment) and the internal (subjects under investigation); one must control the working of the tackled factors (under the experimental conditions) and discover differences depending on these factors as the independent variables and showing up in the dependent variables (in the non-experimental investigations),
3. a multi-dimensional definition of **indicators** of the events or processes under investigation (e.g. quality of research or education); indicators help us to investigate the events or processes under investigation in line with their complexity rather broadly (e.g. along with efficiency we investigate the personality changes in the investigated subjects),
4. a **methodological broadening** of investigation of the events or processes under investigation; we apply the requisite holism to add the **quantitative** (see e.g. [8-12]) and **qualitative** methodologies (see e.g. [13-16]) from the viewpoint of the procedures of data collection, data processing and results interpretation, see Table 5.

Table 5 enables us to see that one uses in investigation of the social events and processes the traditional, i.e. **structured** instruments (e.g. knowledge tests, assessment scales, survey questionnaires), and the free, i.e. non-coding scheme forms (e.g. non-coding protocols of observation or interviewing). The data collected with various instruments are processed **quantitatively** (by statistics and mathematics) with uni- and multi-variat statistical methods, and **qualitatively** (structuring of the text material, uncovering of the meaning of the given symbols, explanation of the given text). In **interpretation** of results one avoids the paradigmatic exclusivism by using the requisite holism in **linking** the causal and interpretative paradigms.

If one uses methodological complexity in investigation of the social events and processes,

one can come close to their complexity as much as to minimize the errors that are linked to research results and attain a high reliability of their application.

The next issue reads: how do we cooperate best?

‘USOMID’ AND ‘SIX THINKING HATS’ IN SYNERGY – A FRAMEWORK PROCESS OF MODELING

The point of this new combination emerged from the insight that the Six Thinking Hats (6TH) method mostly covers the **emotional** part of the human personality, while the USOMID-SREDIM procedure covers the **rational** one. About the essence of the ‘hats’ see Table 6. The combination means that in every step in Table 7 the appropriate hats are applied.

The USOMID model of creative co-operation enables smooth work covering **several professional views** and **organized procedures**, thus leading toward the law of requisite

Table 5. The basic procedures of data collection and processing and results interpretation in the quantitative and qualitative investigation.

Investigation phase	Quantitative methodology	Qualitative methodology
Procedures and instruments of data collection	• **Testing** of knowledge – knowledge test • **Assessment** – assessment scale • **Survey** – survey questionnaire (mostly closed questions) • Structured **interview** – coding protocol of interview • Structured **observation** – coding protocol of observation	• Unstructured **observation** – non-coding protocol of observation • Unstructured **interview** – non-coding protocol of interview • **Analysis of documents**
Procedures of data processing	1. Statistical methods for the analysis of nominal and ordinal variables: • frequency distributions, • chi-square test hypothesis about independence and hypothesis of equal probability, • measures of contingency 2. Statistical methods for the analysis of numerical variables: • basic descriptive statistics (measures of central location, variation measures, distribution measures), • statistical methods for the analysis of differences with parametric tests (t-test, analysis of variance) and non-parametric tests (Mann--Whitney, Wilcoxon, Friedman, Kruskal-Wallis, test), • statistical methods for the analysis of relationships (bivariate, multiple correlation, regression, factor analysis).	• **Content analysis** • **Semiotic analysis** • **Hermeneutics**
Interpretation of results	**Causal paradigm** – paradigm of the causal explanation	**Interpretative paradigm** – paradigm of interpretation in the form of comprehension of intentions and behavior

holism. This enables a lot of creativity and a lot of innovation, not invention only. A problem that has remained unsolved over all 30 years is (1) relative **waste of time**, (2) **fight/arguing** and bad feelings. The organizational jobs are supposed to solve this problem, but it does not always work without trouble. This is where the 6TH applies.

The 6TH enters the scene as **the third dimension** along with SREDIM and the four USOMID steps in every one of them. The 6TH namely enables all circle members to not argue, but to **think from the same viewpoint**, and to do so in terms of the exposed part of values rather than of knowledge. Thus, our tendency toward the requisite holism is not blocked. The six

Table 6. Essence of each of the six thinking hats.

Thinking hat	**Essence**
white	neutral, objective, facts without interpretation, like a computer
red	feelings, emotions, intuition, irrationality, unproved feelings, no justification
black	watching out, caution, pessimism, search for danger, doubt, critique; it all works well against mistakes and weak points of proposals
yellow	optimism, search for advantages of proposals, search for implementation ways, sensitivity for benefit of the idea, constructive approach
green	energy, novelty, creation, innovation, in order to be able to overcome all obstacles
blue	organization, mastering, control over procedure, thinking about thinking

Table 7. Synergy of USOMID/SREDIM and 6TH methodologies in procedure of USOMID.

SREDIM Phases USOMID Steps Inside SREDIM Phases	1. Select problem / opportunity to work on in an USOMID circle	2. Record data about the selected topic (no 'Why')	3. Evaluate recorded data on the topic ('Why is central')	4. Determine and develop the chosen solution/s to the topic	5. Implement chosen solution to the topic in reality	6. Maintain implemented solution for a requisitely long term
1. Individual brain-writing by all in the organizational unit / circle	All 6 hats	White hat	All 6 hats, red, black, yellow, green first of all	All 6 hats, red, black, yellow, green first of all	All 6 hats in preparation of implementation	All 6 hats in preparation of maintenance
2. Circulation of notes for additional brain-writing by all	All 6 hats	White hat	All 6 hats, red, black, yellow, green first of all	All 6 hats, red, black, yellow, green first of all	All 6 hats in preparation of implementation	All 6 hats in preparation of maintenance
3. Brain-storming for synergy of ideas / suggestions	All 6 hats	White hat	All 6 hats, red, black, yellow, green first of all	All 6 hats, red, black, yellow, green first of all	All 6 hats in preparation of implementation	All 6 hats in preparation of maintenance
4. Shared conclusions of the circle	All 6 hats	White hat	All 6 hats, red, black, yellow, green first of all	All 6 hats, red, black, yellow, green first of all	All 6 hats in preparation of implementation	All 6 hats in preparation of maintenance

thinking hats are namely neither used by one person each nor all at the same time, but **all** circle members use **the same hat**, and later on another one, **at the same time**. According to De Bono, this replaces the old western habit that the discussion participants close themselves in their respective viewpoints (like e.g. solicitors or politicians or armies or angry children) and fight for the upper hand rather than for **mutual completion** and **shared and beneficial new solution** [17]. In other words, the 6TH supports well the creative cooperation, but from different viewpoints than the above-summarized attributes of USOMID do: 6TH points more to the **values-and-emotion** part of the human personality than to the **professional** part. Both of them are **interdependent** anyway.

In 6TH **all** circle members think in the frame of the **same hat at the same time**. De Bono calls this manner "parallel thinking" that provides for the same orientation, i.e. looking for **ideas and proofs**. It lets **nobody fight** each other. Hats enter the scene as **phases**, ruled by emotional accents of thinking, thus providing the power of focusing, time saving, neutrality and objectivity, removal of "ego": **one viewpoint in one moment** (by phases – hats). For the essence of hats see Table 6.

SOME CONCLUSIONS

Modeling provides crucial bases for action**,** but often an over-simplified one, which is dangerous. Creative interdisciplinary cooperation with application of the 'USOMID-cum-6TH' method of cooperation and combination of quantitative and qualitative models in a requisitely holistic way can help model authors/users to overcome over-simplification. Understanding and use of (Dialectical) Systems Theory has helped in thousands of cases over close to forty years of its application and evolution.

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RELACIJE IZMEĐU RAZMATRANOG OBJEKTA; DIJALEKTIČKOG SUSTAVA, SUSTAVA I NJEGOVOG MODELA, KAO OSNOVA NUŽNOG HOLIZMA I REALIZMA MODELIRANJA I NJEGOVIH REZULTATA

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SAŽETAK

Modeliranje je krucijalno sredstvo istraživanja i razvoja. Međutim, modeli možda i previše pojednostavljuju percepciju sustava kao mentalnih slika stvarnosti. Zbog toga treba biti svjestan relacija i tipologije modela te primijeniti metodu 'USOMID – šest misaonih šešira' za kreativnu kooperaciju kako bi se postigao nužni holizam pristupa i nužna cjelovitost ishoda.

KLJUČNE RIJEČI

objekt, sustav, dijalektički sustav, model, USOMID, šest misaonih šešira