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# SYSTEMIC STRUCTURE OF THE KNOWLEDGE ON TECHNICAL OBJECT MAINTENANCE

**Leszek Powierża**
*Warsaw University of Technology*
*ul. Łukasiewicza 17, 09-400 Płock, Poland*
*tel.: +48 24 3675995, fax.: +48 243675995*
*inzsyst@pw.plock.pl*

***Abstract***

*Against the background of mentioned semantic, methodical and essentials flaws and errors in articulation and generating of the maintenance and operating knowledge, transferred in education, scientific and popularizing literature as well as in realization of the maintenance activities, a proposal concerning systemic configuration of this knowledge was presented in this paper. Taking into account that the semantic aspects of essence articulation in presented proposal make the substance of these considerations, the names of scientific disciplines and the terms of specific notions are given in Polish language.*

***Keywords:*** *action, exploitation, knowledge, maintenance, methodology, operation, system, science, theory*

## 1. Introduction

For effective realization of activities ensuring the technical systems to be set in motion – including the main systems of ship driver – apart from material, energy and time resources, the adequate knowledge on operating and maintenance is necessary. However, the effectiveness of such activities depends not only on essential correctness of this knowledge but also on its practical usability. First of all the knowledge ought to be configured and drafted correctly and clearly, in essence, methodology and semantics.

From the systematic view point the operation and maintenance knowledge is a market product and the demand for it depends not only on its essential correctness but also on its semantic and methodological "wrapping". Systemic configuration of the maintenance and operation knowledge increases the communicativeness of its articulation and perception.

## 2. Problem

Within the limits of this pronouncement it is possible only to relate to some subjectively selected principal questions.

Quite large group of flaws to be noticed in texts fixing the knowledge – not only on the operation and maintenance includes the semantic – methodological flaws which consist in occurring inadequacy of the terms and ideas a well as some methodological deficiencies. As an example may be mistaking the notions such as "thesis" and "hypothesis" or using "thesis in situations where it should not be used. It deals also with the following relations: *działanie – funkcjonowanie, działanie – proces, zależność – związek, równanie – teoria, wielkość – wartość, liczba – cyfra, wyznaczanie – określanie, pojęcie – termin, masa – materia* ( action – functioning,

action – process, relationship – connection, equation – theory, magnitude – value, number – figure, determining – qualifying, notion – term, mass – matter ).

To frequent cases belongs also unperceiving the defferences between a physical quantity and its symbol and – consequently – mistaking "equation" as symbolic structure with the relationship between physical quantities, or the errors consisted in personification of the things though attributing them the causative power.

### 3. Basic notions

Postulated usability of systemic formulation ought to be revealed beginning from the remembrance of necessary basic notions, starting with the key notion of "system" important for further considerations. In accordance with Wintgen`s [6] set theory we assume that system (S) is a functional whole, or the set of determined elements (E), provided to of determined relations (R), what may be written as:

$$S = < E, R >$$

Consequently, it may be assumed that generator of subject knowledge – in this case the knowledge on maintenance and operation – is adequate subjective "scientific discipline", treated according to Greniewski [1] definition, as "relatively individual informatic system" (fig.1).

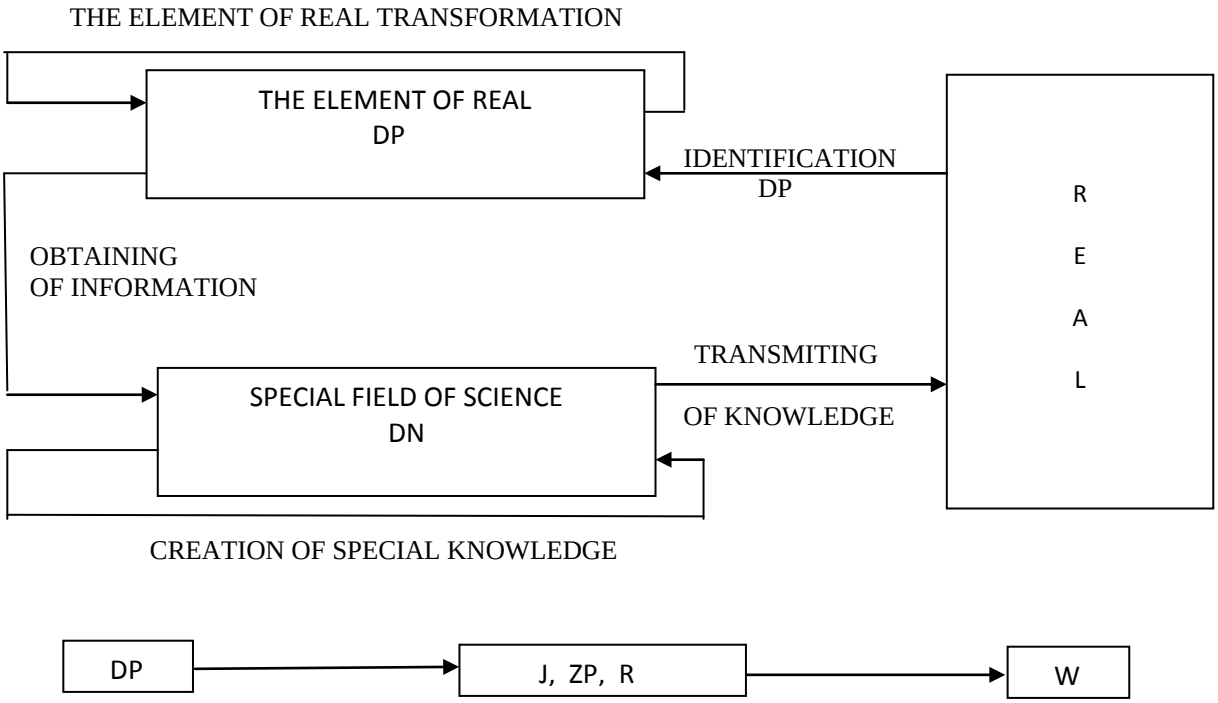


*Fig. 1. Model of special field of science as a systems*

$$DN = < DP, J, ZP, R; W >$$

where: DN – scientific discipline,
DP – subjective domain, J – language, ZP – laws, R – rules, W – knowledge.

During gaining applicable knowledge numerous circumstances may occur which threaten its credibility, quality and finally – its practicability. The reason of such a situation consists in

ambiguous identifications included into given system of elements.

From the systemic view point the language of scientific discipline creates a set of elementary systems TPD (fig. 2) called the Ogden – Richards triangle [6]

$$J = < T, P, D : RI >$$

where: J – language, T, P, D – term, notion, designation, RI – relations among: T, P, D.

The source of many diversities in meaning at interpretation of the maintenance and operations knowledge is lighting the univocal character requirements of relations occuring among the TPD system elements, i.e. among the term, notion and designation.

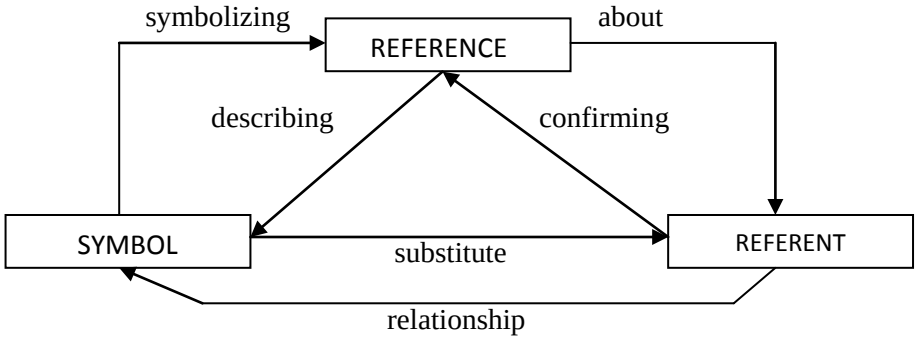


*Fig. 2. TPD System [5]*

Resigning the wider descripion of mentioned flaws, it is still necessery on selected exaples, to explain - as: *hipoteza, teza, teoria, równanie, zależność, związek korelacyjny, czy współwystępowanie ( hyphotesis, thesis, theory, equation, dependence, correlation or joint appearance ).*

Thus, *„udowodnienie hipotezy" ( proof of a hyphothesis )* – as often may be read – is an methodological error; the hyphothesis is not a theorem, but only an assumption, the rightness of which may be doubtful and its configuration would be needful.

A mistake is also to make use of the "theasis" in empirical sciences as it a theorem which needs to be confirmed, what is possible in the formal sciences only. Commonly used term "równanie teoretyczne" ( theoretical equation ) is also a redundancy what may be easily proved on the basis of systemic formulation. Both, the "theory" and "equation" are the systems. Equation, as an element of the theory, is used to its formal articulation.

The "theory" is an abstract structure ( R ) created to describing the relations appearing among concrete and abstract objects of reality; it forms a functional whole or the system (TE)
of the laws ( P ), rules ( Z ), theorems ( T ) and hypotheses ( H ):

$$TE = < P, Z, T, H; R >$$

Whereas the "equation" is an abstract structure being a notion of relations among the symbols which, together with the relations, create a functional while, i.e the "system".

The fault is also to misinterpret the "eqation" – a formal structure built of the symbols, and the "dependence" on "correlation connections". "Dependence is such an eqation where concrete physical magnitudes are the symbols and it expresses the causative – "correlation connection" means their coexistence described by an eqation in which concrete physical magnitudes are the symbols. An example of wrong interpreting the terms of "process" and "activity" ( działanie ) are controversions around the definition of "maintenance and operation" ( eksploatacja ). "Activity is

a sequence of elementary changes in objective state of reality fragment caused by human influence, whereas the "process" is a sequence of elementary changes in objective state of reality fragment affected by the impact of various factors, where the human participation is not necessary. Thus, the "activity" ( działanie ) consists in creating the process in most possible and expected way. In accordance with Polish language convention the name`s ending for "activities" is "- anie", while for the "process" – cja"[5].

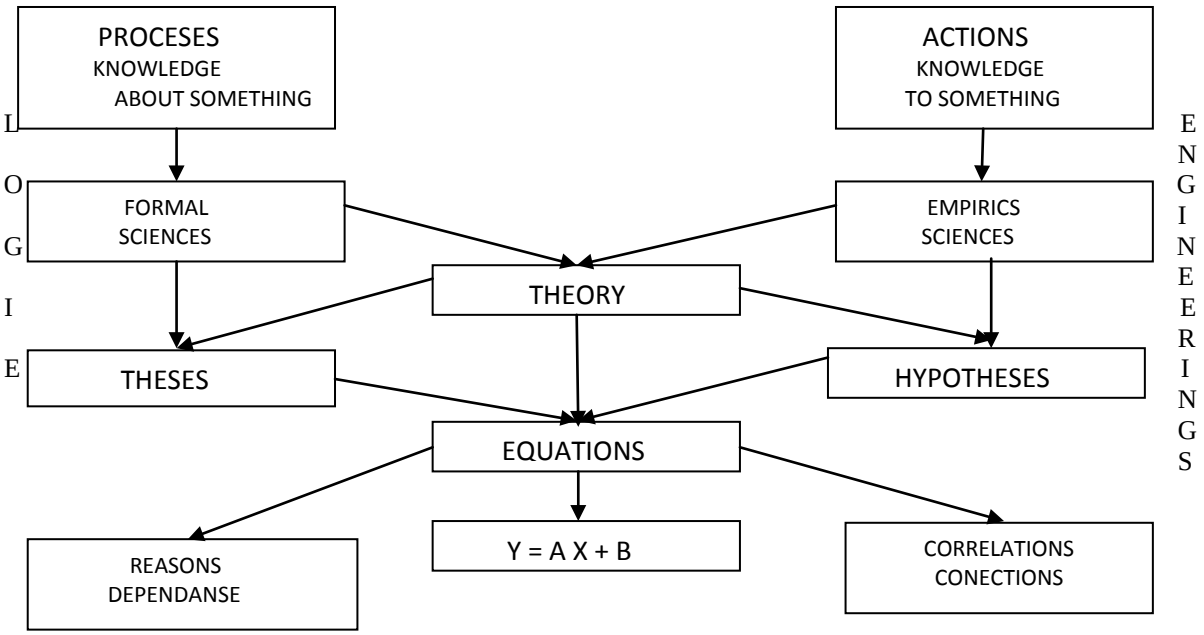


*Fig. 3. The structural model of science*

In the case of systems such as objectively oriented scientific disciplines, their functions – in general formulation (fig. 3) – may consist in shaping and configuration of knowledge:

- about something, i.e. on the processes, phenomena and relations, or on informatively available, existing concrete and abstract objects of the reality;
- to something, i.e. to realize activities consisted in creating the new existences, not appearing in such a shape.

Sciences of the first group, conventionally and according to custom, are determined as the basic sciences, sciences of the second group – as the applied ones. The objective sphere, not fully covering the essential division, is division into "formal" ( formalne ) and "empirial" sciences, based on methodological premises. In semantic convention, the names of basic disciplines – sciences on the processes, phenomena and relations, have in Polish language the ending "- logia". Thus, they may be conventionally named "- logie", as opposed to appleied disciplines, supplying the kowedge necessary for activities, which may be called as "techniques" ( techniki ) or "engineerings" ( inżynierie ). From methodological view point both mentioned groups are distinguished in this, that "- logies" generate knowedge on the basic of information, whereas the "techniques" ( engineerings ) – on the basic of knowledge generated by "logies". Techniques ( engineerings ), generating the knowledge objectively directed, are functioning as the tools useable in practical activities. What are them the sources of interesting us "maintenance and operation" knowledge?

## 4. The maintenance and operation knowledge

The starting point to articulate the range of knowledge useful for keeping the systems moving

is an identification of this action during exiting of the system ( fig. 5 ) as a phase of resource circulation process (fig. 4).


*Fig. 4. Real circulation of the resources*

Perceiving the difference between process and activity, and using terminology in convention of the Polish language, the process of exhausting usable resources contained in the object will be named – "eksploatacja" ( exploitation ) while the activity consisted in extraction of these resources – "eksploataowanie" ( exploiting ).

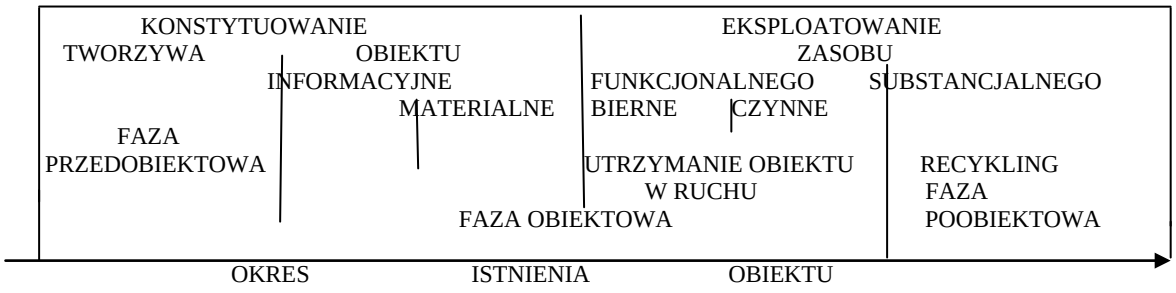


*Fig. 5. Phases of the objects` life*

Fig. 5 shows that the process of object exploitation proceeds since the moment of its arising until the management of substantial resources contained in it ( object and postobject phases ), being in continuous relations with its infrastructure (fig. 6).

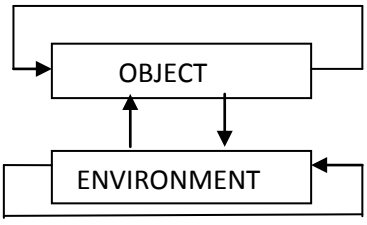


*Fig. 6. Object and environment*

After decomposition of object infrastructure into: technological infrastructure ( everything connected with realization of functions attributed to the object ), exploitation ( maintenance and operation ) structure ensuring realization of these functions by the object, as well the environmented structure ( reminder of ecological and sozological environment ), the maintenance and operation ( exploitation ) situation of the object , in most generalized formulation, will be look on the fig. 7.

During whole exploitation period the object may find itself in the state of passive (fig. 8a) or active exploitation.

At the state of active exploitation, when the object is being exploited it may be in the conditioning (fig. 8b) or functional (fig. 7) stage.

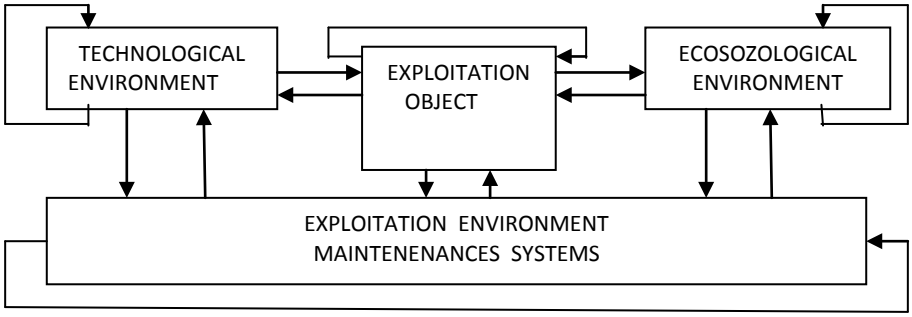


*Fig.7. General configuration of object exploitation. Object in of functional exploitation state [3]*

When the object is not subjected to the effect of technological and exploitation infrastructures, being affected by the environmental infrastructure only, then it is in the state of passive exploitation (fig. 8a).

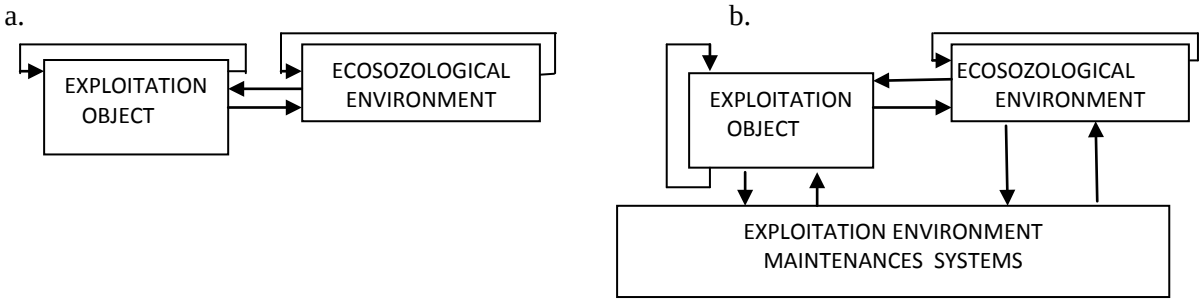


*Fig. 8. Exploitation configurations of the object: a – passive exploitation, b – active exploitation, configuration of conditioning ( treatment ) exploitation*

Diversity of the phenomena processes and activities taking place during exploitation, as resulted from a number of various relations among the object elements and its infrastructure, generates demand for the knowledge necessary to realize exploitation activities, i.e. to keep the technical systems in motion. This knowledge is being obtained from many different scientific disciplines including these phenomena, processes and activities as the subject of scientific cognition.

According to earlier identification of scientific disciplines, the science on exploitation as a process of exhausting the resources of used object, will be called “exploitology”
( eksploatologia ). Exploitology supplies the knowledge on exploitation process, through the compilation of knowledge acquired in many specialistic scientific disciplines engaged in cognition of the phenomena affecting the course of process.

The course of exploitation process is affected, apart from the environmental process, also by

exploitation activities or exploiting and therefore, getting out the useful resources contained in the object. The science supplying knowledge on exploiting will be named “exploitation engineering”. The knowledge on exploiting is formed on the basis of knowledge taken from other, kindred branches of engineering, as well as from the knowledge on “exploitology” and “exploitics”, engaged in exploitation techniques and implements.

The whole of knowledge on exploitation, i.e. exploitation process and accompanied connected process, as well as on exploiting and participating in it activities, may be named “exploitation cognitivistics” ( kognitiwistyka eksploatacyjna ) which may be treated as some scientific “metadiscipline” fed by many subject – directed disciplines [3].

Specification of these disciplines, presented in fig. 9, may be treated as an identification of the state of exploitation knowledge sources, necessary to designing, generating and exploiting the technical objects, as well as to keeping them in motion.

| Procesy | Narzędzia | Działania |
|---|---|---|
| LOGIE | TECHNIKI | INŻYNIERIE |
| EKOLOGIA<br>KWALITOLOGIA<br>MATERIAŁOLOGIA<br>METODOLOGIA<br>METROLOGIA<br>PSYCHOLOGIA<br>PRAKSEOLOGIA<br>REOLOGIA<br>SOCJOLOGIA<br>SOZOLOGIA<br>SYSTEMOLOGIA<br>TECHNOLOGIA<br>TRIBOLOGIA | CYBERNETYKA<br>EKONOMIKA<br>ERGONOMIKA<br>INFORMATYKA<br>MATEMATYKA<br>MECHATRONIKA<br>MECHANIKA<br>METRONIKA<br>PROBABILISTYKA<br>STATYSTYKA<br>TRIBONIKA | INŻYNIERIA EKONOMICZNA<br>INŻYNIERIA ERGONOMICZNA<br>INŻYNIERIA INFORMATYCZNA<br>INŻYNIERIA JAKOŚCI<br>INŻYNIERIA LOGISTYCZNA<br>INŻYNIERIA MATEMATYCZNA<br>INŻYNIERIA MECHANICZNA<br>INŻYNIERIA MECHATRONICZNA<br>INŻYNIERIA METROLOGICZNA<br>INZYNIERIA NIEZAWODNOŚCI<br>INŻYNIERIA PRAKSEOLOGICZNA<br>INŻYNIERIA REOLOGICZNA<br>INŻYNIERIA SYSTEMÓW<br>INŻYNIERIA SOZOLOGICZNA<br>INŻYNIERIA TRIBOLOGICZNA<br>INŻYNIERIA WIEDZY |
| **EKSPLOATOLOGIA** | **EKSPLOATYKA** | **INŻYNIERIA EKSPLOATACJI** |
| **K O G N I T Y W I S T Y K A  E K S P L O A T A C Y J N A** | | |

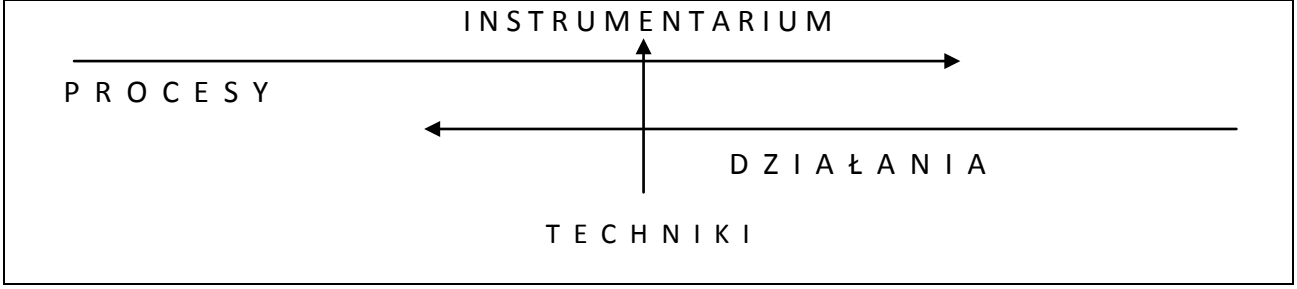


*Fig. 9. Model of exploitation knowledge resources*

In particular it deal with the combustion engines, as well as the machines and devices necessary to keep these engines in motion within the technological structure such as a ship, and also within environmental structure where the ship occurs.

Structural model of exploitation as a process, considering the activities and exploitation states, may be presented in form as given in fig. 10.

There are presented in the model (fig. 10) the states and activities occurring in objective stage of exploitation, thus refered to that, what in exploiting means keeping the system in motion. The feedbecks in particular stages of exploitation were neglected in the figure. It was also necessary to resign the description of post – object exploiting stage, or the recycling phase, including management of usable object resource which left in substancial form after using up the resources for functioning.

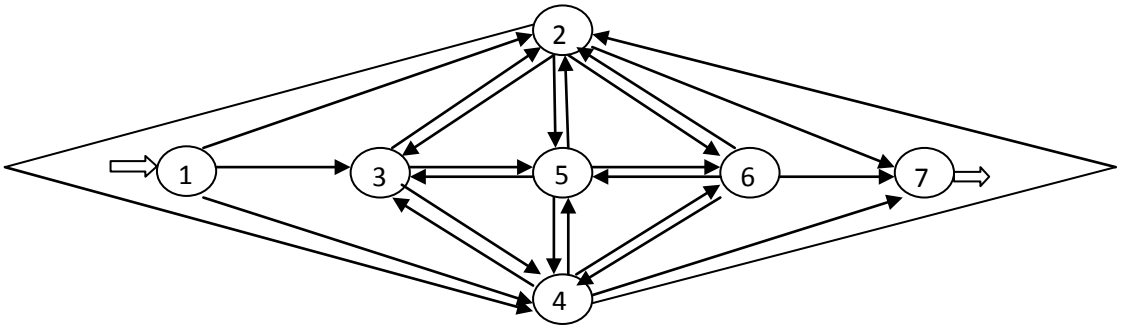


*Fig. 10. Model of objects exploiting. 1 – classification, 2 – operators service, 3 – supplying service, 4 – awaiting, 5 – treatment service, 6 – storage, 7 – removal ( liquidation )[4]*

## 5. Termination

Presented systemic identification of wide spectrum of the scientific disciplines as the knowledge source, showed very strong objective differentiation and wide thematic extension of exploitation knowledge [2]. This multiweft specificity inclines to assumption that the exploitation knowledge is generated in the sphere of some “meta – science”, which may be defined as “exploitation cognitivistics” ( kognitywistyka eksploatacyjna ).

It is rather difficult to expect that on the basis of knowledge from one discipline will be possible to realize the tasks defined in subject matter of this conference: they include designing, production and exploitation with the aspect of keeping in motion the ship driving systems, considering the safety, diagnostics, ecological abilities, energy consumption, functionality, logistics as well as the reliability, serviceability, optimiziation, rationality, controllability and usability.

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