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EVALUATION AND MEASUREMENT OF TECHNOLOGICAL FUNCTIONS

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Abstract. Technological transfer is an important factor of technological development and requires assessment and measurement of effects. Evaluation and measurement can be done with the use of models, the most important being the model of the technology, i.e. of the object being transferred. In the paper, a version of technological function's model is developed, starting from the models of interaction, establishing links, choosing the mechanism and forming the interaction interface, forming the technological function by modifying the internal functions of the objects in interaction and modifying the properties them. The modifications of the properties of the object subjected to the action, of the object carrying technological tasks and of the object-interface serves as the basis for the evaluation and measurement of the technological function in all its complexity. It is shown that technological task bearers can be of two categories: physical-technical (materials, energy, processes, etc.) and immaterial (theories, concepts, data, knowledge, etc.). Both the mechanisms and the measure of manifestation of the technological functions for the two categories are different.

Keywords: *technological function, internal function, property, interaction, link, interface, physical-technical object, immaterial object, carrier of technological task.*

Rezumat. Transferul tehnologic este un factor important al dezvoltării tehnologice şi necesită evaluare şi măsurare a efectelor. Evaluarea şi măsurarea se pot realiza cu utilizarea de modele, cel mai importat fiind modelul tehnologiei, adică al obiectului ce se transferă. În lucrare este dezvoltată o versiune de model al funcţiei tehnologice, pornind de la modelele de interacționare, de stabilire a legăturilor, de alegere a mecanismului şi formării interfeţei interacţiunii, de formare a funcţiei tehnologice prin modificarea funcţiilor interne ale obiectelor în interacţiune şi de modificare a proprietăţilor acestora. Modificarea proprietăţilor obiectului supus acţiunii, obiectului purtător de sarcini tehnologice şi a obiectului-interfaţă serveşte ca bază pentru evaluarea şi măsurarea funcţiei tehnologice în toată complexitatea sa. Este arătat că purtătorii de sarcini tehnologice pot fi de două categorii: fizico-tehnici (materiale, energetice, procese etc.) şi imateriali (teorii, concepte, date, cunoștințe etc.). Atât mecanismele cât şi măsura manifestării funcţiilor tehnologice pentru cele două categorii sunt diferite.

Cuvinte cheie: *funcţie tehnologică, funcţie interioară, proprietate, interacţiune, legătura, interfaţă, obiect fizico-tehnic, obiect imaterial, purtător de sarcină tehnologică.*

1. Introduction

Technological transfer is an important aspect of technological development. It is often treated as an act of using a newly acquired technology, from which some positive results are expected. It is true that in many cases this approach manifests itself positively, but for short periods of time. The reality is more complex, because the sources of modern technologies increasingly represent not only physical-technical systems, but especially physical-technical-informational systems. Without knowing well what a technology represents, what are the sources and carriers of technology, how a source, a carrier of technology is manifested, it is difficult to carry out the assessment, especially based on measurement [1,2].

Technology and technology models. The term technology comes from the Greek language (tekhnë - craft, art and logos - word) with the initial meaning of "discourse on crafts, arts", being currently treated as "the sum of techniques, skills, methods and processes used in the production of goods or services or in achieving objectives, such as scientific research" [3]. In some works technology is treated as the totality of tools, machines, systems and processes used in practical activities and in engineering [4,5]. It is observed that the mentioned totality includes components of different origins (artifacts and processes), a fact that generates certain problems of perception. It goes without saying, however, that all components are interacting processes.

Technologies are process entities intended to reproduce artificial functions [6]. In this statement, the key words are "artificial functions", thus emphasizing the human role in selecting the process and its implementation. "The artificial" shows that the entities are either created by man, or are natural but are used differently than "natural". "Function" refers to how things are used.

The relationship between technology and applied research is one of asymmetrical reciprocity. Technology is not limited to applied sciences, because knowing how to reproduce a useful effect does not mean knowing how and why this effect is produced [6]. This distinction leads to the definition of technology in terms of artificial functions, which generate the necessary results. Often, based on observation and knowledge, the functions are artificially reproduced and understanding is not mandatory. At the same time, understanding serves as an active and organizational element for the next step in technological development.

Technological development activities are amplified by the need to solve certain problems. The observation, knowledge, understanding, research focus on the problem to obtain a predetermined result. Thus, technologies are process entities resulting from solving problems, which produce transformations and changes based on a preconceived idea, a plan or a project to give rise to the desired artificial functions [6].

The evaluation, in general, and the evaluation of technologies is done with the use of models, which reflect a connection between inputs and outputs, between cause and effect. Namely, the models make possible a structured understanding of the technologies and their effects.

Sharif N. [7] structured technology into four tools or forms of technology: technical (technoware), human (humanware), informational (infoware) and organizational (orgware). The technical form of technology (technoware) includes facilities in the form of capital resources, products, machines, machine-tools, robots, transport and storage units, physical equipment, tools, physical-technical processes, etc. The human form of technology (humanware) includes skills of understanding, applying knowledge, know-how, solving problems, working in design, manufacturing, organizing, managing, etc. The informational form (infoware) is the form of technology incorporated through open or coded records about physical, technical, scientific relationships and principles, about standards, technical information, computer programs, etc. The organizational form of technology (orgware) is the form of technology that contains techniques for organizing work and processes, techniques for using, maintaining and controlling manufacturing factors.

The Sharif model is simple and clear, but it emphasizes components, tools, aspects, which makes them, in a way, static. It is important that these tools are effectively used [7], which can be achieved by considering them as correlated processes.

The evaluation of transfer technologies must be based on quantities that can be clearly identified, measured, and compared. In this sense, the notion of ownership is very attractive. In the field of machine building, to design and manufacture, is worked with many properties of the objects. For example, materials are characterized by properties classified into: physical, chemical, mechanical, technological, thermal, optical, electrical, magnetic, radiological, toxic hygienic-sanitary, etc. [8-11]. In the transfer process, the notion of property of the technology becomes a fundamental one, because the property is the vizible cause of the initiation of the transfer, it is also the main element for evaluation and measurement.

2. Properties of objects and their manifestation

In any object there is something "for itself" (the object in itself), something that is found within its limits (of the object) and does not depend on anything else. Simultaneously, in any object there is something "for someone else" (object for another object), something that is conditioned exclusively in relation to something else [11]. The property is not only an external manifestation, but also a unity of appearance and essentiality, being a messenger to the outside about the internal quality [12]. Thus, the property is born inside the quality of the object, in the sphere of its essence, and the genotype of the property is determined by the totality of all internal links.

According to [12] the property represents a moment of the own qualitative determinability of an object, which through the interaction with another object detaches from its own foundation, penetrates into that other object, acquires in it and through it visibility and already exists on a foreign basis, on a foreign carrier (Figure 1,a).

The interaction is reciprocal, so that in the eyes of the analyst both the property of the object A in the base B (Pr_B^A) and the property of the object B in the base A (Pr_A^B) are manifested. The interaction is, as a rule, multiple, it occurs through different physical channels (for example, mechanical force, mechanical friction, thermal, etc.), so the sets of properties of both objects ($\{Pr_B^A\}, \{Pr\, B\}$) are simultaneously manifested and observed. Interactions can occur simultaneously with several objects, so that each couple of objects generates properties, the multitude of the latter becoming very large [14,15]. Moreover, the interaction of object A with the set of objects B, generate interactions within this set with very varied effects for properties (Figure 1,b).

A property is a quality, a potential reflected in an object, it is a quality from the realm of the possible. A possible property is revealed externally in the interaction with another object and through this other object. Interactions are produced by establishing links between objects. Linkage is a way of the presence of one object in another, a means of the existence of different objects in their unity [12].

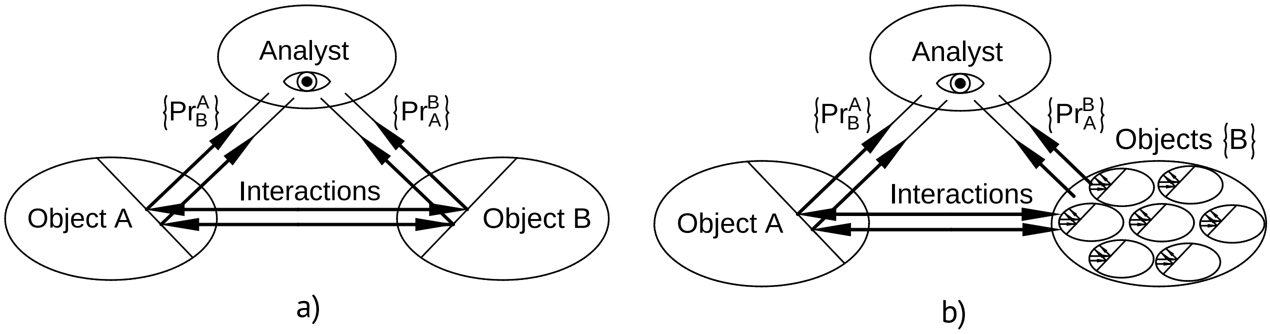

Figure 1. Formation of object's properties in the "mirroring" interaction: a) between objects A and B, b) between object A and the set of objects $\{B\}$.

There are two main types of links (Figure 2): 1) external link through force (energetic) contact of objects with mutual maintenance of the force effect in space and time; 2) the abstracted external link of the internal inherent essences of the objects, such as, for example, the connections "cause - effect", "general - particular", etc. The first type of links has a real character based on physical-technical laws, and the second has a virtual character, representing, in fact, the directions of change and oriented development.

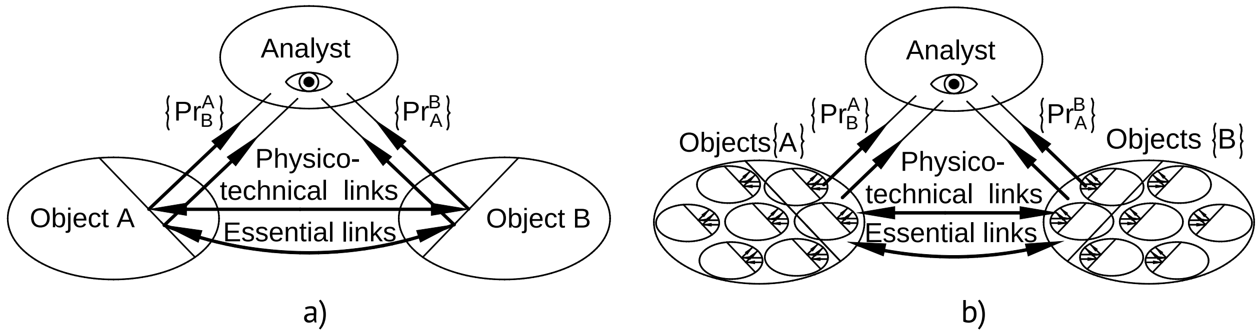

Figure 2. External physical-technical links and abstractized essential links: a) between objects A and B, b) between the sets of objects $\{A\}$ and $\{B\}$.

A link is understood as a mutual action of objects, so that, each of them changing quantitatively in alliance with the other, it nevertheless continues to clearly maintain its qualitative determinability.

Objects manifest their properties in interaction with other objects through the changes that produced. However, only the presence or absence of changes can be observed by comparing what was and what is. Thus, the property can be defined as the inherent ability of the object in certain interactions to produce (not to produce) some changes in another object and/or to change (not to changed) under the influence of other objects [11]. The change or lack of change in its essence is the property. There is no contradiction here, because at least two objects participate in the interaction and for each of them individual criteria and requirements for change or non-change and the measure of these phenomena can be formulated.

The properties can be internal and external [13]. An internal (intrinsic) property is one that the given object has by itself, a priori, independently of other objects. An external (extrinsic or relational) property is one that depends on the given object's connections with other objects.

If an object is something specific, different from what other objects are, then it has other properties. And vice versa, if an object manifests other properties than other objects manifest, then it is something specific, different from what other objects are. In many cases, the identity of the objects is important. Two objects are identical, they have similar identities if they show the same properties.

It can be said that objects are made up of a nucleus, of an individualized substance, and around the nucleus is formed a cloud of interaction links, a cloud of properties, due to which the object preserves its identity.

Objects exist, interact and manifest through properties over time. Time represents a framework for carrying out interactions, for establishing links, a condition for changes, a measure of the existence of objects, a characteristic of the change of states of objects and their development. As a result, properties are the result of processes quantified over time and, in general, are variable. The state of an object, in this context, is nothing but the multitude of properties manifested by this object in the given amounts of time and space.

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Interaction of objects. The properties of the objects are manifested if there is interaction with the establishment of links, that is, if there is a task of sufficient size (physical and/or informational) capable of producing a state of mutual request [14,15]. As sources of the properties are both objects from the couple. In another couple other properties will be present. The same couple of mutually requested objects in another interaction will manifest other properties. From what has been reported, it follows that the interaction does not represent a source of appearance of the properties of the objects, but only a condition for their manifestation. This condition includes three elements: the presence of the actual interaction as a phenomenon, the selection of the interaction mechanism and the selection of the interaction interface.

The interaction can be defined as a specific material and/or energetic and/or informational impulse produced by one of the objects of the couple and perceived, supported by the other object of the couple. The effect of the perception, of the support of the impulse by the second object is also a reaction impulse perceived and supported by the first object.

The realization of an interaction between the objects of the couple is determined by the manifestation of compatible properties and relevant behaviors of the objects. At the same time, conditions, limitations, quantification of space and time, operating scenarios, compliance with which favors interaction must be specified.

The interaction mechanism qualitatively and quantitatively characterizes the specific impulse, the modes and parameters of the interaction, thus representing the concrete form of the interaction, a variety of the many possible ones.

In machine building, in mechanical engineering, the real interactions have a physical-technical character and are produced based on several physical laws. A physical-technical interaction is realized if a physical effect and an appropriate geometry are selected (for example, the physical effect of rolling the profiles of the teeth of the involute wheels).

Interface of the interaction. The notion of interface is common to the fields of mechanical engineering, systems engineering, and has a universal use, common to everyone.

Each field leaves a specific mark, thus mechanical engineering formulates the interface in several variants [11,14,15]:

- the place of passing the interaction beyond the spatial limits of the object;
- a physical or functional mating relationship between two objects through which the interaction are produced;
- a facilitating means that makes possible the interaction between two objects;
- an intentional relationship of interaction between two objects;
- the place where the properties appear, the means by which the object can be designed to fulfilling certain functional requirements;
- any physical or logical relationship necessary to bring together the boundaries of objects, including the object with its external environment.

At least two objects are simultaneously interacting, both having portions of common borders - interfaces. Each of the objects of the couple has its own portion of the common border, that is, it has its own interface. This one is an approach to define simple interfaces

Another approach considers that the interface is an object in itself, which at the same time unites objects and separates them. Being something separate, the interface is made up of the interacting objects and is complex [11,14,15].

In many cases, the originally intended interaction mechanism is supplemented with derivative mechanisms, so that additional interactions appear, new interfaces appear, possibly other objects are involved in the interaction. Derived interactions can be the reaction result of the mechanism of the intended interaction, they can also be a consequence of the mechanism of an already defined derived interaction. The mechanisms of intentional and derivative interactions and their physical-technical phenomena are all manifested together, so the analyst's task consists in establishing the order of manifestation of the phenomena and the objectivity of the "cause-effect" links of the interactions.

3. Technological function

The interactions between objects can be natural with useful effects or without them, but they can also be initiated, organized, carried out intentionally by humans, being artificial. Namely, these last interactions represent the beginning of any technology. Chronologically, this process includes the following actions: selecting the objects, initiating the interaction, choosing the interaction mechanism, forming the interaction interface, establishing links and observing the properties of the objects.

Once many properties of the objects are known, their degrees of compatibility are also known and this fact represents a potential for interaction. In the context of practical engineering activities, there is the possibility not only to select but also to oriented way create objects with compatible properties for certain interaction mechanisms and formed interfaces, so as to obtain a result, an anticipated effect. In this case, the chronology of actions changes: selection of compatible properties, choice of objects bearing such properties, choice of interaction mechanism and interface, initiation of interaction, establishment of links, observation and recording of anticipated formulated result (properties), verification (testing) of manifested properties.

It should be mentioned that mutual compatibility is necessary for both properties and interfaces. The lack of an element of compatibility leads to the non-formation of the link and the result, the expected effect is not obtained. To satisfy a need, an object with an appropriate set of properties is required. If such an object exists and is available, the need is satisfied.

More frequently, objects have sets of properties that do not satisfy the need, but can be modified oriented way for this purpose. Initially, the technological objective is formulated.

The technological objective represents a state of some (yet unspecified) object, a set of its properties $\{Pr^V\}$ that can be obtained or achieved through action directed at the object (Figure 3). The character of the objective is imaginary, virtual, not yet real, it corresponds to the question "what the?" and does not provide answers to other questions such as "how?" and "from what?" [11].

It is found that there is an object with a set of real initial properties that do not fully correspond to the need, but which can be modified up to the size of the set formulated by the technological objective (Figure 4).

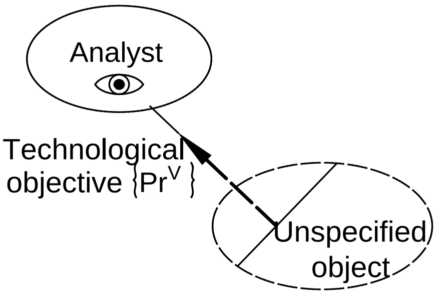

Figure 3. Formulation of the technological objective $\{Pr^V\}$.

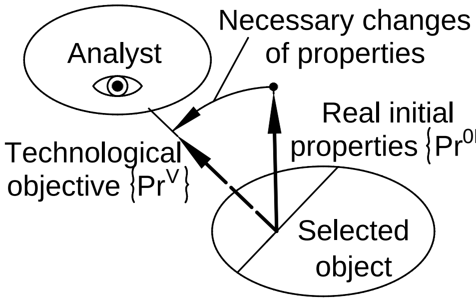

Figure 4. Object with real properties $\{Pr^{0R}\}$ that can be brought to the sizes formulated by the objective $\{Pr^V\}$.

Thus, to the question "from that?" an answer is given. Next is the selection of the method of action on the object to modify its properties. There are several modes of action, but only one is chosen, thus the answer to the question "how?" becomes concrete and unequivocal. The action, in turn, can be performed by several objects carrying technological tasks and follows the choice of only one. Once the actions are defined, the carrier of technological task is chosen, the mechanism and the interface of the actions are chosen, the actions are initiated, the links are established, the changes in the properties are observed and recorded, the real final properties are verified by testing (Figure 5).

The carrier of technological tasks realizes a continuous concretization of the way to modify the properties, is it a transformation system "how?" of entries "from what?" in outputs "what the?" [11]. The carrier of technological tasks has the capacity for the necessary transformations to achieve the objective.

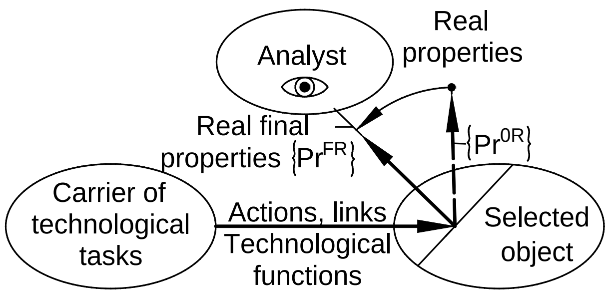

Figure 5. Establishment of technological functions.

When modifying the initial real properties, it must be taken into account that the useful ones must be kept, amplified, highlighted, and the useless ones with a negative influence must be diminished, liquidated, not admitted. The amplification of some properties and the concomitant decrease of other properties is rarely ensured by the same action. The difference between the values of the real initial properties and those formulated by the technological objective is also important. Consequently, the necessary modification of the properties is done through partial technological tasks with the establishment of intermediate objectives (Figure 6).

A technological task represents the difference that must be covered by action between a given real initial state and a virtual, possible, imaginary intermediate or final state [11]. As a result, the modification of properties is done in distinct and non-linear phases, that is, there are no changes only for the "good", there can also be "falls" of properties, which will later be recovered. In some phases, priority is given to actions for "good" properties, and in other phases - actions to combat "bad" properties.

The technological function characterizes the ability of the bearer of technological tasks to carry out the modifications of the initial real properties of an object in its final real properties. Technology, in this context, can be defined as a process structured in space, ordered in time and oriented to change the properties of the object.

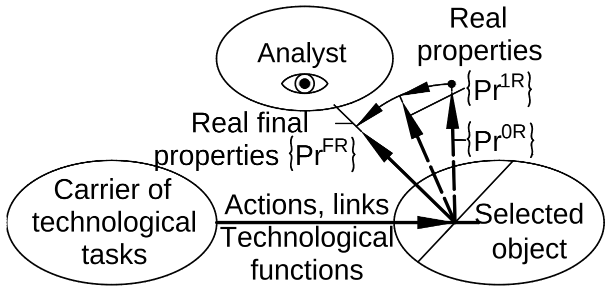

Figure 6. Achieving the objective through partial technological tasks.

For technology, the function resulting from the process is important and not the physical-technical phenomenon used for it. Functions define the essence of technologies, so that technologies represent artifacts, information and knowledge [6]. Because functions are externally oriented, technologies can be multiplied by many physical-technical options appropriate to functional functions and uses. The functional approach of the technological entity positions the technology in a system of values that allow assessments of the quality and efficiency of the technologies.

It is observed that the actions of the carrier of technological tasks have a reaction on the same or on other physical channels, thus becoming an object with properties in the process of modification (Figure 7). In both objects, phenomena with effects occur and the analysis can be focused on one or the other of them.

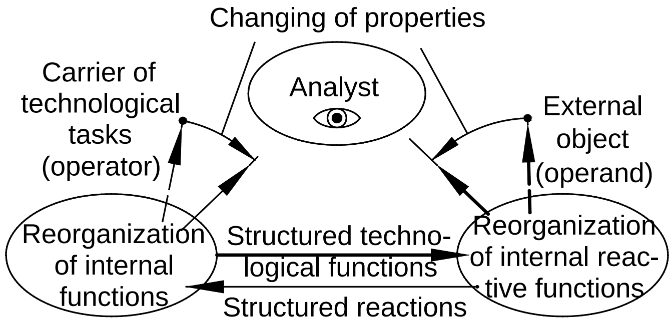

Figure 7. Reactions supported by the carrier of technological tasks.

The technological objective is defined as a set of properties that can be obtained or realized through actions, effort and has an imaginary, virtual character. Having specified an appropriate carrier of technological tasks, the objective from the set of imaginary initial properties is transformed into a set of real final properties. Thus, the technological task defines a requirement, and the technological function defines the reality in which the task is fulfilled, that is, it represents a response to the requirement.

At the base of the technological function are the actions that take place over time, thus the formulation of the technological function as the ability of the task's carrier to effectively give answers to the questions "from what?", "what the?", "how?" the time factor "when?" is also added.

The final performances of a technological function are generated in networks of cause-effect interactions, so that the results of a process represent the launch conditions for the next process. The interactions are not ideal and in order to obtain functional results, the technological components must be of a certain quality and be placed physically, spatially and logically in certain positions to function [6].

Several special phases can be highlighted in the process of technology operation [11,14,15] (Figure 8):

- ✓ the interaction of the object carrying technological tasks with another external object, thus being initiated a technological function either as an influence from the external object, or as the tendency of the carrier of technological tasks to reach a more preferential state of its own, a tendency that causes action on the external object;
- ✓ the initiation by the object carrying technological tasks of a mechanism structured in space and time by interaction with the external object;
- ✓ the formation of a structured interaction interface between the carrier of the technological tasks and the external object;
- ✓ the mutual adaptation of the object carrying technological tasks and the external object through subordination, that is, through the intensive modification of the properties of the external object, and the modification occurs through the reorganization of its internal functions;
- ✓ perceiving the effect of the structured reaction from the external object by the internal structure of the object carrying technological tasks;

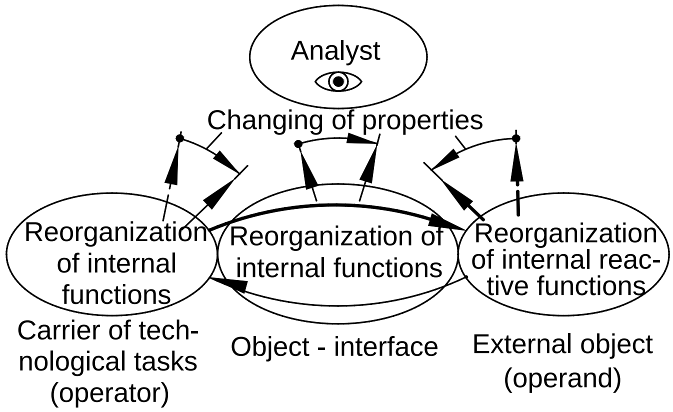

Figure 8. Realization of the technological function by reorganizing the internal functions of the external object, of the carrier of technological tasks and of the interface.

- ✓ the reorganization of the structure of the internal functions of the object carrying technological tasks with the redistribution of tasks on functional elements, with the coordination of actions to ensure its ability to perform the external technological function;
- ✓ the changing of the properties of the object carrying technological tasks (simultaneously with the changing of the properties of the external object) as a result of the reorganization of internal functions.

Thus, the structured technological functions cause structured reactions and the reorganization of the internal functions of both the external object and the carrier of technological tasks. At the same time, the technological functions are manifested through interfaces common to interacting objects and these (interfaces) can be considered separate objects. The act of realizing the technological function includes the reorganization of the internal functions with the modification of the properties of three distinct objects: of the carrier of technological tasks (the operator), of the external object (the operand) and of the interface (Figure 8).

The reorganization of internal functions, the modification of properties are processes that take place over time, so the mentioned objects are objects - processes, i.e. technological objects. Apart from the interactions the object - interface does not exist, the object carrying technological tasks has a defined internal functional structure, and the external object has a defined internal reactive functional structure. These three objects, their properties and variation represent factors for the technological function.

If in an ordinary interaction process, without waiting for a desired result, the establishment of links is conditioned by the compatibility of the properties, then the realization of a technological function is possible if the compatibility of the internal functional structures of the factor objects is respected.

4. Defining and measuring the properties of technological functions

The defining of the properties of the technological functions is done in the form of the observable external manifestation of the reorganization of the internal functions of the operator, operand and interface.

The properties are important themselves, but more important is the extent of their modification, the amplification of the useful ones, the reduction (blocking) of the harmful ones, the formation of new properties, etc. This is ascertained by measurement. Measurement is a set of actions using different types of measurement scales.

The multitude of applications of technological functions is very large, because it is determined by the multitude and variety of objects that manifest themselves through technological functions, by the multiple variants of pairs of objects that can be put into interaction for the manifestation of properties. The interaction conditions, the mechanisms and interfaces, the links installed are also varied. The conditions may change as a result of the interaction. The analyst can change the places of the operator and the operand, if it is in the interest of a special research. Consequently, the number of properties manifested by the reorganization of the internal functions of the object carrying technological tasks, an external object and the interface is large.

A clarification of the notion of object is useful here. In the fields of technology and technique, processes and products, industry and enterprises, the multitude of objects considered and the interactions practiced have a common characteristic - the transfer of matter and/or energy and/or information. The particularities of the analysis will highlight one of the mentioned aspects (material, energetic, informational), and the other two being also imminently present.

Different categories of objects with a real character are manifested through technological functions [11,14,15]:

- *material physical-technical objects* (solid, liquid, gaseous, plasma, machine-tools, devices, tools, blanks, parts, assemblies, mechanisms, machines, products, etc.);
- *energetic physical-technical objects* (gravitational field, magnetic field, electric field, electromagnetic field, laser beam, electron beam, etc.);
- *objects-physical-technical processes* (mechanical, cutting, plastic deformation, welding, thermal, magnetic, electric, electromagnetic, wear, oxidation, cracking, coating, deposition, destruction, technological, manufacturing, production, transport, storage, etc.).

They are very important for technological development and immaterial objects with essence content, which are created, formulated by people through observation, analysis and research. Immaterial objects provide a general-methodological foundation for the development of new technologies and industrial products. In other words, these objects represent development environments. Among it are the following categories of objects [11]:

- *geometric objects,* which define the shape of other objects through spatial limits and associate them with graphically represented or mathematically modelled geometric idealities;
- *process-objects* (marketing, conception, constructive design, technological design, machining, manufacturing, logistics, organization, innovation, technological transfer, digitization, computerization, etc.);
- *organizational objects,* which reflect and regulate the existence and manifestation in time and space of objects from any category;
- *soft-objects* - a combination of coded instructions and data that allow a calculation or command system to perform calculations or command functions;
- *time is an object* - a factor that establishes the fact, the measure and the speed of change (unchange) of other objects in interactions with physical-technical effects (physical aging, natural aging of alloys, creep of materials, radioactive half-life t1⁄2, etc.), as well as with essential effects (moral aging, technical level, technological level, etc.);
- *technical-economic-social objects* - major phenomena such as, for example, Kondratiev economic cycles, industrial revolutions, production, marketing, economic strategy, quality, diversification and customization of markets, innovation and technology transfer, industry 4.0, ecology, sustainable development, etc.;
- *concept objects*, which represent generalizations and syntheses of new ideas, based on advanced experiences and forecasts such as:
  - ✓ *concepts of manufacturing technologies* (subtractive, additive, assembly, welding, moulding, punching, casting, injection, cutting at high speeds, dry cutting, etc.);
  - ✓ *manufacturing concepts* (mass, in series, unique, automated, flexible, digital, direct from the computer, advanced, smart, intelligent, etc.);
  - ✓ *industrial concepts* [16]*:* "Industry 4.0" (Germany, 2010), "Advanced Manufacturing Partnership 2.0" (USA, 2011), "Catapult Centers" (Great Britain, 2011), "Intelligent Factories Clusters" (Italy, 2012), "Made in China 2025" (China, 2014), "Intelligent Factories Clusters" (Belgium, 2014), "Industry of the Future" (France, 2015), "Revitalization/Robots Strategy" (Japan, 2015), "Manufacturing Innovation 3.0" (South Korea, 2015);
  - ✓ *concepts of new technologies of Industry 4.0* [17]*:* autonomous and collaborative robots, simulations and digital twins, augmented reality, vertical and horizontal systemic integration, industrial internet of things, additive manufacturing, big data analytics, cloud computing, cyber security, etc.
- *object-theories,* which represent an abstraction and a conceptualization of objective reality, thus becoming a form of rational knowledge and structured knowledge systems for describing and explaining the domains of reality.

These two large categories of objects manifest themselves through technological functions, but through different mechanisms.

Measuring the properties of real physical-technical technological functions. Objects with a real physical-technical character can be put into "live" or virtual interactions. The real properties of technological functions are manifested when both the bearer of technological tasks and the object on which they act are real. These properties are real measured, they are true, but they have a particular character to the interaction couple used. As an example, the mechanical processing of a piece on a machine tool can be given. Both the machine tool and the part are real, but they have individualized characteristics even within the limits of the machine-tool classes and the types of parts.

For generalizations and for reducing the number of properties taken into account until "sufficient and necessary", there is the practice of representative properties evaluated and measured under the conditions of standardized tests. Standardization is necessary to have the possibility to compare the properties starting from a common base. A technological standard is a process of evaluation and measurement of properties, which stably reproduces a structured technological function and a structured technological reaction. A representative property is one that is similar to the real property to a degree of veracity considered acceptable. Representativeness is an evaluation of the similarity of properties starting from the idea that, once the causes and effects are similar, the properties must also be similar.

An example of determining the representative properties of the technological functions of mechanical processing on CNC machining centers is the measurement of the geometric precision parameters of a processed standardized artifact (Figure 9). The piece has surfaces of different shapes and placed in specific positions. If the processing of this part is according to the technical requirements [14], then it is considered that the CNC machining center performs appropriate technological functions for a class of parts with similar geometries and technical requirements. For other geometries, including more complex parts, other artifacts are used and correspondingly by higher complexity.

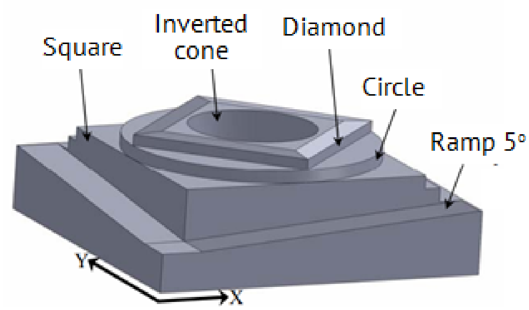

Figure 9. "Square diamond circle" machining artifact for establishing the properties of the technological functions of machining centers [17].

If in the case of traditional mechanical processing technologies, the physical-technical phenomenon of surface generation is predominantly cutting by various methods, then additive technologies are based on many more physical-technical phenomena with specific problems of creating shapes. For this field, which is developing very quickly, artefacts of geometric shapes specific to the realized technological functions are elaborated (Figure 10). Sometimes testing is done with real equipment on real parts. However, standardized artifacts are predominantly used, so the technological functions are evaluated representatively.

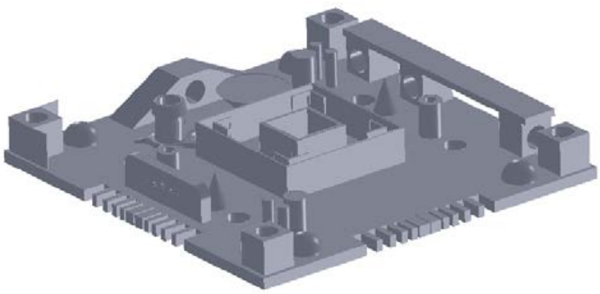

Figure 10. Artefact de testare a unei tehnologii aditive [18].

Modern engineering relies heavily on modelling with systematic parameter variations to map behavior and understand its underlying causes [6]. The properties of technological functions can be defined and measured through virtual interactions (simulations) based on geometric-mathematical models. The models, although they are digital, are based and mirror behaviorally the physical-technical phenomena, objects and real conditions. Models are defined as abstractions that reflect aspects of the entities to which they are similar. Entity properties are also component parts of models. The properties measured in this way are representative and require the determination of the level of veracity.

Measuring the properties of technological functions of immaterial complex objects. Immaterial complex objects are functionally manifested technologically in relation to other technologies through development impulses, through the opening of new possibilities and/or alternatives, through the challenge of technical, economic and social interests, etc. Approaching any technology in terms of a central nucleus around which a vital technology environment is formed means that technology cannot be seen in clear and well-defined boundaries [6]. The vital technology environment is one made up of coherent technologies already adapted to each other that work in a balanced way, but also one made up of new technologies, such as digital ones, which cause imbalance for development. Thus, a technology-environment co-evolution process is generated with incremental improvements in alternation. Technology is the result of this co-evolutionary process in which technological functions, knowledge, artefacts and their living environment adapt and improve each other.

The technological potential of these immaterial objects is multiplied by their own example - they are in permanent modification, change, they are dynamic, they present new and new versions. The properties of the technological functions of the older versions are already evaluated and measured. The effects and problems are well known. The properties of the newer versions have a degree of historical credibility and are qualitatively measured by the interest shown by representatives from industry, research, etc. The greater the interest, the more valuable the properties of technological functions are considered. The measurement is done by scientometry, which is a tool for quantitatively studying the evolution of scientific and technological fields, of industrial concepts through statistics of information published in certain reference time periods (theoretical and applied scientific works, citations, etc.).

The following measurement is made by analyzing successful experiences (so-called "good practices"), with real results of economic agents expressed in technical-technological and economic values. The absolute values are often not significant enough, so the sensitivity measurement is used. Sensitivity reflects the formation of an effect-value disproportionate to the cause-value. Good practices are disseminated, adapted to various concrete conditions, and the measure of properties becomes closer to the real one.

5. Conclusions

Technological transfer is an important aspect of technological development and as any process requires not only qualitative but also quantitative evaluation to appreciate the effects of the transfer. Quantitative evaluation by measurement can be done using different models, the most important being the technology's model, i.e. of the object being transferred.

Models based on the notion of property are very attractive for evaluating transferable technologies, properties being defined as the ability to change other objects, and the change is easy to measure. Based on the models of the manifestation of the properties in interactions with the establishment of physical-technical and essence (substance) links and through interfaces, the notion of technological function was defined.

The technological function model includes the interaction of three distinct objects: of the carrier of technological tasks (of the operator), of the external object on which the action is applied (of the operand) and of the interface. The technological function is defined as the reorganization of the internal functions of the operator, the interface and the operand caused by the interaction and has a character of modifying their properties, a fact that offers the possibility of measuring them.

The technological functions are performed by objects carrying technological tasks of two categories: physical-technical (materials, energy, processes, etc.) and immaterial (theories, concepts, data, knowledge, etc.). The measurement of the properties of technological functions is done with interactions of real or representative objects in real or representative conditions, in most cases the measured properties being representative. The measurement of the properties of the technological functions of complex immaterial objects is done with statistical scientometric tools (theoretical and applied scientific works, citations, etc.) and by analyzing successful experiences ("good practices").

An increasingly widely used field of measuring the representative properties of technological functions is digital simulation with the use of models that reflect the properties of real objects and their behavior.

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