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Control, Activity, Personality

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Abstract: The paper presents the view of a control theoretician on the theories of personality and activity, in search of their results necessary for the formulation and solution of control problems for systems with active elements (man). The constructions proposed below can be treated as an "interface" that establishes a correspondence between the approaches and results of personality psychology, control methodology, and control science.
The paper is intended for control theoreticians, who may read it for getting initial ideas about the theories of personality and activity as well as about their connection with control of social and organizational-technical systems. In turn, psychologists may observe not only the prospects of using their results in the above-mentioned branches of control theory, but also a number of new challenges.

Keywords: control theory, complex activity, personality psychology, structure of activity, structure of personality

1. INTRODUCTION

Control[1] is an impact on a controlled *system* with the *goal* of ensuring its required *behavior*. A *control system* (CS) consists of three components, namely, a *controlled system*, a *subject of control*, and relations between them (see Fig. 1).

As a rule, a controlled system has its own internal *structure*, including different (e.g., causal) relations between all *elements* of the system. Knowing the cause-effect relations, one can influence some elements ("causes," often called *subject matters* or *objects of control*) for changing the *states* of other elements ("effects"). The general *control problem* is to find admissible impacts on the objects of control that will ensure the required dynamics of the states (behavior) of a controlled system.

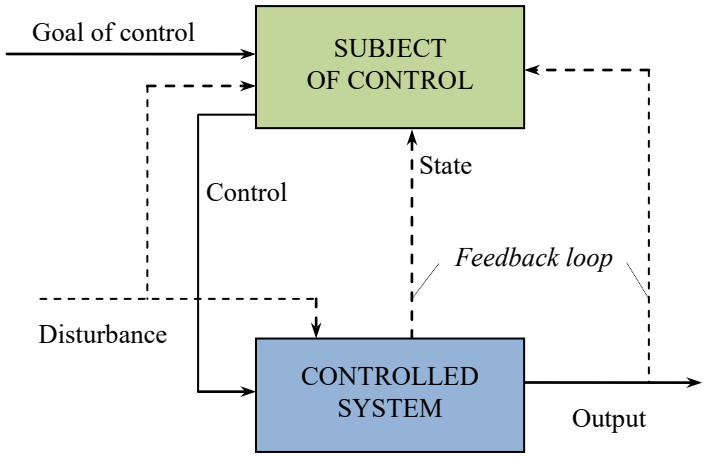

Fig. 1. Basic structure of control system

[1] *Main terms, when first mentioned, are marked by italic font.*

Over a century and a half of its development, control theory has encompassed many classes of controlled systems [13]. For the effective development of the corresponding branches of control theory and the acquisition of knowledge about a controlled system, a close cooperation between mathematicians (experts in control) and the representatives of other relevant branches of science is required. For example, historically, "mechanical" systems (then technical systems) were the first classes of mass controlled systems studied in theory; moreover, precisely for these classes of systems, the most profound and extensive theoretical results on the solution of control problems were obtained in the 20th century, which found many applications in practice (control of moving objects, production systems, etc.). This was due to the progress of physics and mechanics in the 19–20th centuries, which yielded well-developed models of controlled systems.

Over the past half century, the mathematical theory of control has been actively considering new classes of controlled systems (from the 1950s–1960s, economic systems; a little bit later, ecological-economic, living, and other systems), following a current progress in the description of the corresponding control systems in economics, biology, and other sciences. In recent decades, social systems have increasingly been in the focus of this theory.

Any science is determined by its subject matter and methods [15]. Man and social systems are the subject matter of many sciences and scientific fields. Each of them highlights its own subject of research, including the one considered below (see Fig. 2), as follows: the psychology of personality, the mental attributes of a man and the corresponding phenomena and processes; *methodology* (as the science of activity organization), *activity* [1, 15]; mathematical control theory, control processes.[2]

The objective reality, indicated by a dotted ellipse in Fig. 2, is reflected differently in each of the sciences exploring this reality, which all form the "world of models"; see the dotted arrows there. Each of the sciences highlights its own aspects of interest, abstracting from certain "details," as well as introducing certain assumptions and hypotheses about the subject of research. In other words, each science (and each individual researcher) studies its own subject matter and constructs its own *model* of a controlled system.

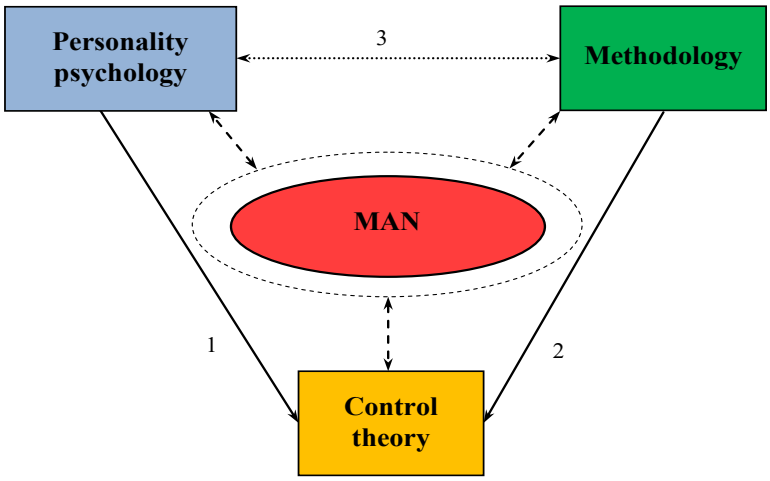

Fig. 2. Subjects of research

Developing in parallel, different sciences enrich each other, "sharing" their models with each other, introducing and extending the results of other sciences, and resulting in more complete and adequate models of reality. For example, over the past two decades, there has been an active use of the results of methodology (see arrow 2 in Fig. 2) as a foundation of the

[2] *Control theory, methodology, and psychology are not completely "parallel." Control theory does not study human beings, just as it does not study the motion of a rocket—this is the task of physics. Methodology is the foundation of the theory of any activity, including control. Psychology explores the human psyche, and control theory uses the methodology paradigm and the results of psychology to control human beings. In other words, the user's position of control theory dictates: "Provide a model!"*

theory of control in organizational systems (see [1, 18] and Sections 3–4 below). There are long-standing and stable relations between methodology and the *personality psychology* (the subject matter of methodology—activity—is one of the basic categories of psychology); see dotted arrow 3 in Fig. 2. However, the relation between the personality psychology and control theory (see arrow 1 in Fig. 2) is still very weak.

Precisely this relation will be considered below: this paper is a "navigator" across the psychological aspects of the control problematics in systems that incorporate man. The main goal of this paper is not to contribute to the psychology of personality, but to establish an interface between the needs of control theory and the concepts and approaches of the existing psychological theories.

Making a small digression, let us discuss the differences and relations between a real CS and its model: how control theory "reflects" the reality; see Fig. 4. (Here the vertical dashed line indicates the boundary between the real world and the "world of models," between the real CS and its model.) Also, see Fig. 2.

Assume that the problem is to design and create some real control system that consists of a controlling system and a controlled system. The corresponding activity has the structure shown in Fig. 3.

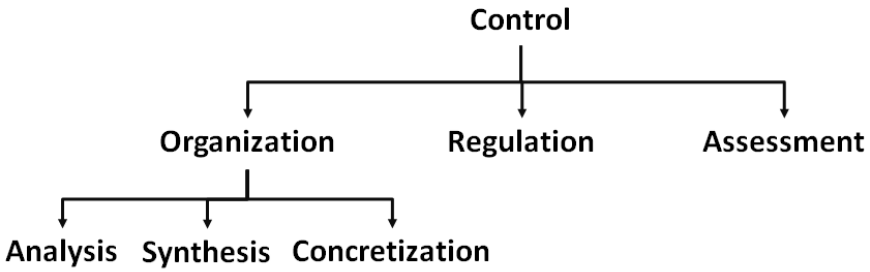

Fig. 3. Structure of control and organization [1]

First (see Fig. 4), *analysis* (I) is carried out: a *model* of the controlled system is constructed, and the controlled system and its model are studied (dynamics, sensitivity in parameters, initial and external conditions, etc.). Also, the corresponding properties of the control system are examined.

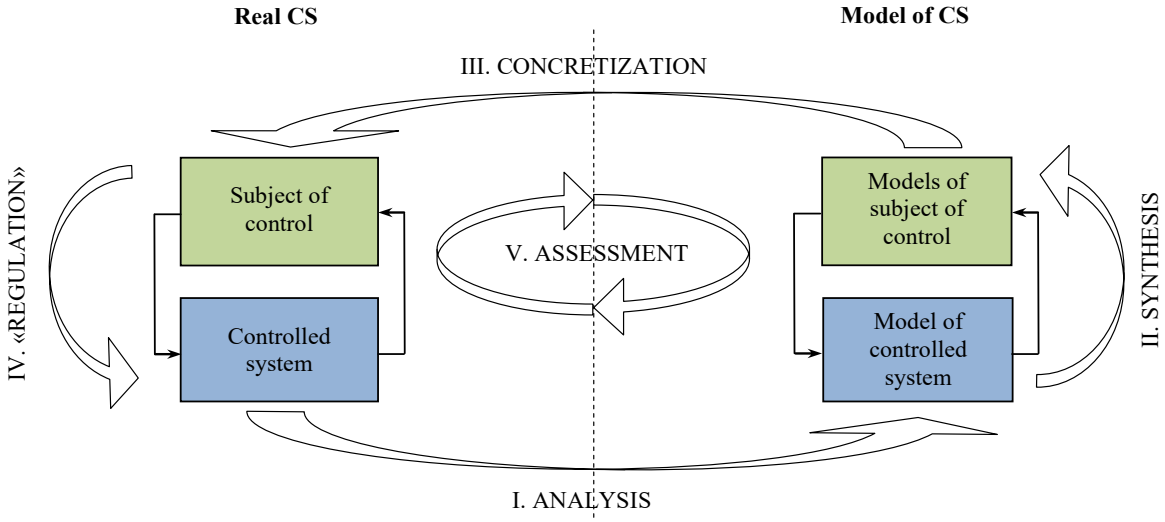

Fig. 4. Real systems and their models in control problems

Then *synthesis* (II) is carried out: a control law or algorithm that ensures the required properties of the control system and the behavior of the controlled system is designed. Note that this stage is implemented in the "world of models."

In the process of *concretization* (III), the synthesis results are implemented in a real control system that performs "*regulation*" (IV) of a real controlled system.

Assessment (V) is intended to identify the system, to compare the results of its activity with the goals, to make corrections if necessary (when the expected and observed behavior of the controlled system does not match one another), and to proceed to the next cycle.

Fig. 4 illustrates the significance of distinguishing between two worlds, i.e., the real world in which the systems (the controlling system, the controlled system, etc.) objectively exist, and the "world of models" in which the systems exist "subjectively."[3] Note that the researchers operate the systems in the "world of models." Therefore, the interaction of control theory, modern psychology, and methodology is discussed in the "world of models"; also, see arrows 1 and 2 in Fig. 2). In particular, the matter concerns the information about the "internal structure" of the controlled and controlling subjects, which are necessary for the formulation and solution of control problems.

One of the classification bases for control systems is the type of control, determined by the degree of automation of control *functions*. Depending on whether the elements of a control system include a man or not (who is always a *subject*!), there are three (out of four logically possible[4]) combinations—the types of control presented in Table 1. A controlled system may have technical, natural, biological, social, and other components.

Automatic control corresponds to the case when both the controlling system and the controlled system are technical or cybernetic *objects*.

Automated control corresponds to the case when the controlling system is a subject, for example, man-machine systems in which the most important and responsible decisions are made by people. The controlled system is a technical or cybernetic object.[5]

Table 1. Types of control

Type of control	Subject of control	Controlled system
Automatic control (object–object)	Control device, controller	Controlled object
Automated control (subject–object)	Controlling subject	Controlled object
Organizational control (subject–subject)	Controlling subject	Controlled subject

Organizational control corresponds to the case when both the controlling system and the controlled system are subjects, i.e., when people control people.

In this paper, automated control and organizational control will be considered. Both this types of control involve man.

If a man is included in a controlled system, then control of a human is nothing more than control of his behavior; see the definition of control above. In turn, behavior is an external reflection (manifestation and *result*) of his *activity*. Therefore, the goal of control can be formulated as the desired result of the activity of a controlled subject.

[3] *System analysts are used to say, "Any system is a model."*

[4] *The fourth type of control is the subject–object one, when a controller "operates" a human being. It also occurs, but will not be considered separately. Some examples are simulators (control devices guiding the learner's activity), pacemakers, traffic lights (control devices regulating the behavior of drivers at crossroads), etc.*

[5] *An automated control system generally includes both "automatic" and "human" components. For example, in industrial process control, information about the state of a controlled object can be acquired and processed automatically. This information is used by a human operator to makes an appropriate decision (perhaps, in combination with some "advising" information, which is automatically generated by a decision support system). Then the decision is brought to the controlled object "automatically." If a human being controls an object without automation, then such control is called manual (e.g., cycling).*

It's almost impossible to control human behavior directly (the army is the ultimate example here). However, one can affect the activity of a man by indirectly influencing his behavior. Activity is a nontrivial process with its own internal structure (an objective one as well as the one within the existing scientific principles). Hence, the description and analysis of this structure, the identification of different subject matters of control (the components of activity that can and should be purposefully influenced), are necessary for formulating solving control problems for the systems involving people.

Moreover, activity is performed by a *personality*, who also has its own internal structure. The attributes of this structure significantly affect and often predetermine the process and results of activity. They have to be taken into account, since the components of personality structure can also be the subject matters of control.

Well, considering a personality in the role of a controlled system, for influencing its behavior one should analyze the interconnected structures of the personality and its activity. Indeed, behavior is the "result of activity" - see Fig. 5 and Fig. 14.

In the case when a man performs control himself (being an element of a control system, or the entire control system, see Fig. 1), he implements control activity [16]. His personality influences both the process and results of this activity.

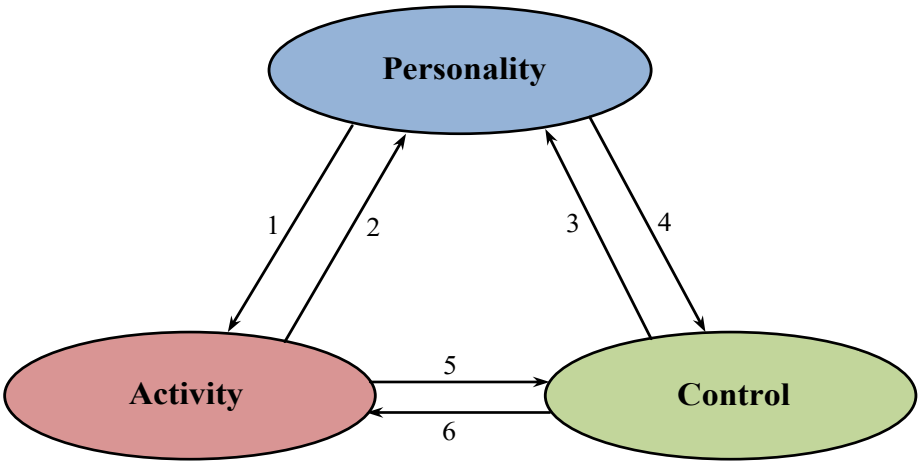

Fig. 5. Basic categories: personality, activity, control

Due to the aforesaid, it is necessary to consider the relations between the following categories: personality, activity, and control. In this paper, six aspects (see arrows in Fig. 5) will be identified as follows:

1) The influence of personality attributes/traits on its activity (see section 7).

2) The influence of activity on personality. This phenomenon has been known for a long time and has been deeply studied in philosophy and psychology (the *development* of personality, first of all, its *experience* and *volitional* components) [19]. Therefore, it is beyond the scope of the paper.

3) Control of the components of personality structure (for their formation and development, see section 5). It is reasonable to distinguish between two cases:

3.1. *Self-development* of personality (the subject controls these components himself);

3.2. The development of personality structure of one subject controlled by another subject, which is often implemented through education (the development of personality experience; see [17] and below).

4) The influence of personality attributes on the control activity performed by it or on the controlled activity. These phenomena are the subject matters of the psychology of management and organizational psychology, respectively, and are beyond the scope of the paper.

5) The specifics of control activity, which are the subject matter of control methodology [16] (also, partially considered within the methodology of complex activity [1]). They are beyond the scope of the paper as well.

6) Control of activity components (see Section 8). Like in item 3, it is reasonable to distinguish between two cases:

6.1. self-control (the subject controls these components himself);

6.2. the activity of one subject controlled by another subject.

The goals of this paper are to systematize:

- the structures of personality and activity;
- the influence of personality attributes on its activity;
- control of the components of the structures of personality and activity,

as well as to harmonize the ideas about them among personality psychologists, methodologists, and control theoreticians.

This paper is organized as follows. First, the psychological theories of personality (Section 2) and the theories of activity (Section 3) are discussed in brief. Then, the methodology of complex activity (Section 4) is sketched. Such an approach makes it possible: to suggest the systemic structures of personality (Section 5) and activity (Section 6); to establish the correspondence between the components of personality structure and the structural components of the performed activity (Section 7). The problematics of control are studied in the concluding part of the paper (Section 8).

2. PERSONALITY STRUCTURE: HISTORY

In Soviet and Russian psychology and philosophy, first the approach introduced by S.L. Rubinstein and K.K. Platonov should be mentioned. It will be adopted below to describe the components of personality structure and their relation with the components of activity structure.

S.L. Rubinstein [21] (the 1930s–1940s) proposed a personality structure that includes personality *directivity*, experience (*knowledge*, *competences*, *skills*) and individual *typological characteristics* (manifested in *temperament*, *character*, and *capabilities*).

K.K. Platonov [19] (the 1960s–1970s) suggested a four-level personality structure with the following substructures: personality directivity, experience, features of psychic (mental) processes, and biopsychic attributes. He reflected this structure in the system (!) of psychological concepts; see [19]. Platonov's system is the most structured one to date.

The existing psychological approaches (in particular, the ones mentioned above) focus on various aspects (such as consciousness, attitude, etc.), are mainly conceptual in nature, have little appeal to experiment, and are weakly structured. In other words, the relations between the basic categories are not analyzed at the general systemic level, the completeness and redundancy of their set are not justified, and their operational use is awkward.

For the sake of justice, note that these problems are typical not only for the Soviet and Russian psychology of personality, but also for any psychological research schools. In any monograph or handbook on the personality psychology (for example, see [4, 9, 10, 12, 22–24]), the following four groups of personality theories are distinguished:

1) psychoanalytic/psychodynamic theories (S. Freud, A. Adler, E. Erickson, C. Jung, and others);

2) humanistic/phenomenological theories (A. Maslow, C. Rogers, and others);

3) theories of character traits (G. Allport, H. Eysenck, R. Cattell, and others.);

4) social cognitive theories (G. Kelly, A. Bandura, and others).

(In some of such books, the theories of learning, etc., are also included.)

The approaches of American and European authors are more oriented towards experimental data; however, they are even less systematic and, in the final analysis, are mostly limited to the networks of correlations between personality traits measured in weak scales.

The psychology of personality considers, among other things, individual characteristics, cognitive and motivational processes, volitional and emotional components, personality development, biopsychic grounds, social impact, and interaction. The psychology of personality has close ties with physiology, psychiatry, and sociology.

3. ACTIVITY STRUCTURE: HISTORY

Consider in brief the development of activity theories in psychology and *methodology*.

S.L. Rubinstein [21] (the 1930s–1940s) proposed the following structure of activity:

$$\text{“}need \rightarrow motive \rightarrow \text{activity.”} \tag{3.1}$$

(Hereinafter, the sequence of components reflects the logical and/or causal relations between them.)

A.N. Leontiev [12] (the 1950s–1960s) added the goals, *tasks*, and *conditions* of activity to the chain (3.1). In addition, he emphasized that the activity has a hierarchical structure “activity–*action*–*operation*.”

K.K. Platonov [19] (the 1960s–1970s) considered the following structure of activity:

$$\text{“goal} \rightarrow \text{motive} \rightarrow \text{method} \rightarrow \text{result.”} \tag{3.2}$$

A.M. Novikov [15] (the 1990s) introduced the structure of activity:

$$\text{“need} \rightarrow \text{motive} \rightarrow \text{goal} \rightarrow \text{methods and means} \rightarrow \text{result.”} \tag{3.3}$$

Also, A.M. Novikov’s idea was to consider the process of *self-control*/*self-regulation*, in which the subject corrects the procedural components of the activity by comparing the goals and results of activity, as well as by performing *self-appraisal*. In the 2000s, he added to the consideration the process of assessing/reflecting the results of activity, as well as the *conditions*, *norms*, and *criteria* of activity [15].

Clearly, the “chains” (3.1)–(3.3) of the procedural components of activity were sequentially complicated, a next chain based on a previous one. Following the development of methodology, more and more complex “activity models” were constructed, taking into account an increasing number of factors. (Also, see (6.1) below.)

Control methodology and the *theory of control in organizational systems* (the 1990s–2000s) involve a scheme presented in Fig. 6 (for details, see [1, 15, 18]).

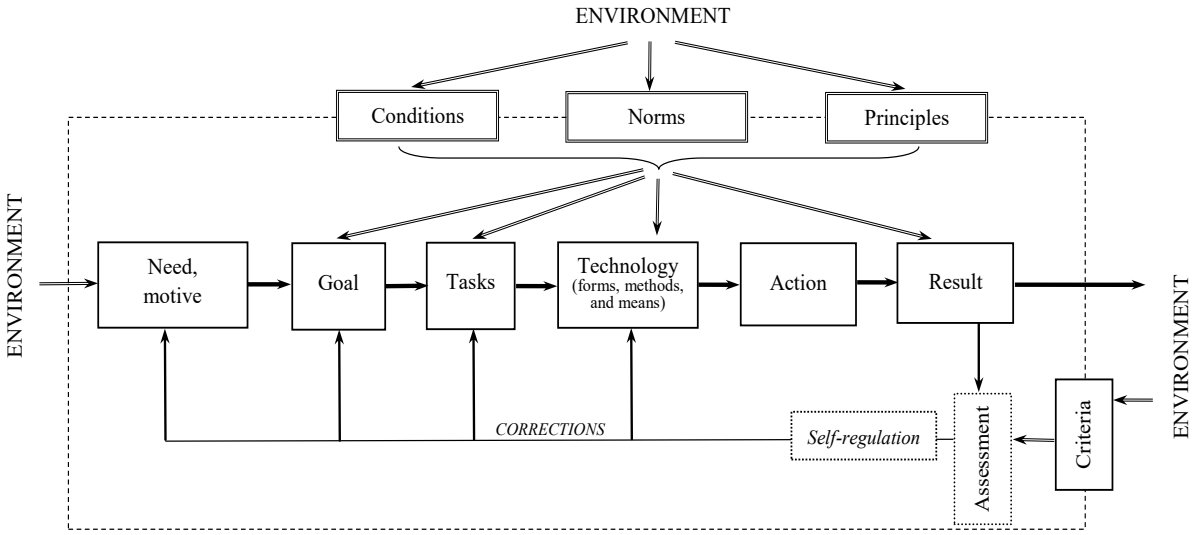

Fig. 6. Activity structure [15]

Within organizational control (Table 1), when both the controlling system and the controlled system are subjects, each of them performs the corresponding activity. Their interaction is a control activity. (Recall that control activity is an activity to organize (and regulate) another activity [15, 18].) A direct combination of Fig. 1 and Fig. 6 gives the structure of control activity shown in Fig. 7.

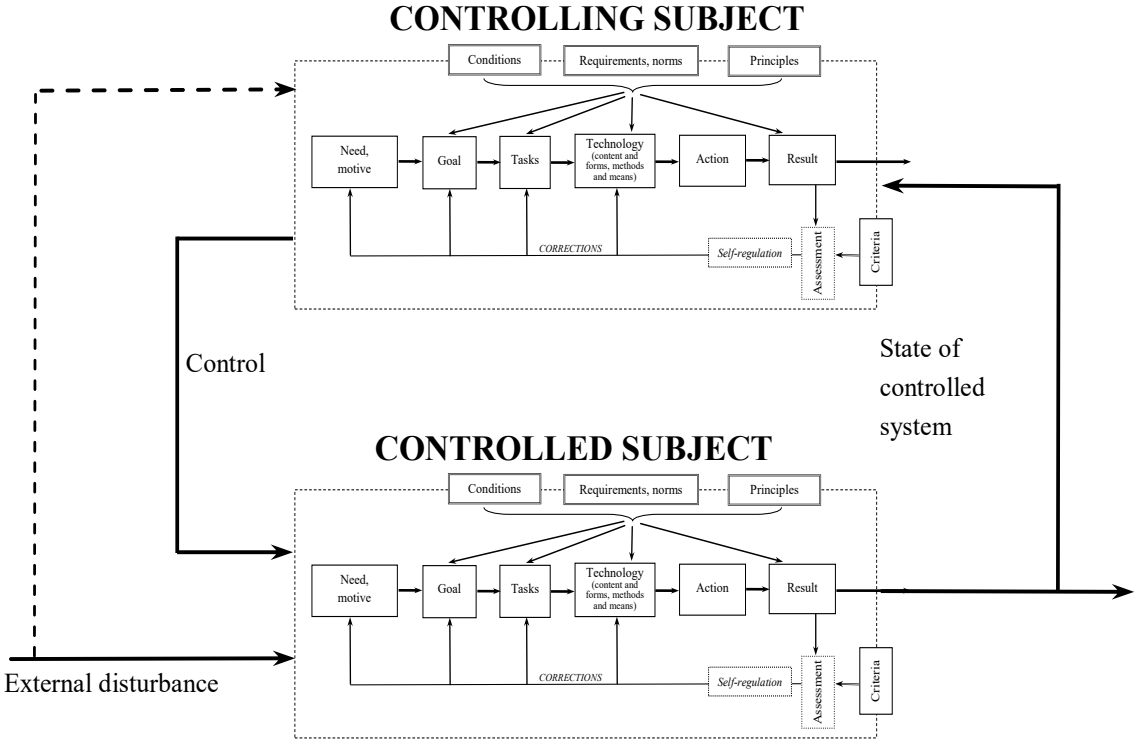

Fig. 7. Structure of control activity [16]

Despite the worldwide fame of his work, A.N. Leontiev has only one notable follower among Western psychologists, Finnish psychologist and teacher J. Engeström [7]. His first monograph [5] was published in 1987, and its second edition [6] appeared in 2012. Almost all modern studies on activity theory refer to the non-hierarchical (!) structure of activity (chiefly, educational activity) described by Engeström in [6, p. 78]; for example, see [20]. Today, activity theory is widely used and developed, probably, only in the models of human-computer interaction. For example, see a special issue of the Scandinavian Journal of Information Systems (2000, vol. 12). The other concepts of activity in the Western psychology of personality (e.g., see the fundamental reference book [10]) are weakly structured in the sense discussed above.

4. METHODOLOGY OF COMPLEX ACTIVITY

Presented in Fig. 6, the structure of the procedural components of activity does not imply any decomposition of the goals, technology, and result of activity (and does not contain appropriate procedures). The description of the result or technologies in the form of non-detailed and unstructured objects significantly restricts the applicability of methodology for the study of practically interesting non-trivial examples of activity in complex social or organizational-technical systems.

Therefore, the *methodology of complex activity* was developed in the monograph [1] as follows.

First, the concept of a *structural element of activity* (SEA) was introduced therein (see Fig. 8); in addition to activity (2), this element includes its *subject* (*actor*) (1) and *subject matter* (3).

Second, the concepts of elementary and complex activity were introduced therein: an elementary activity is an activity whose goals, technologies, and result have no non-trivial internal structure.

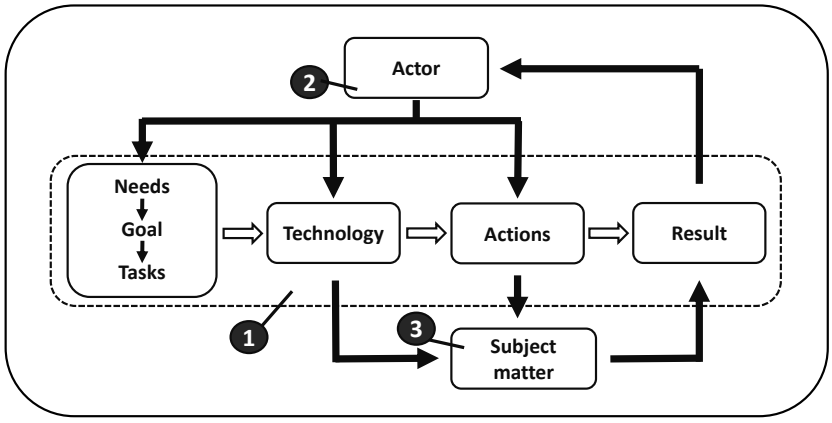

Fig. 8. Structural element of activity [1]

In particular, elementary activity is characterized by the three conditions as follows:

1) The technology does not change in the course of activity, and the activity itself has clear limits for the observer (researcher, subject of activity, consumer of its results).

2) The subject matter is single and changes in the course of activity according to the technology (which is actually the goal of activity); however, the subject matter does not change its place and role in the context (the requirements applied to the subject matter of activity remain the same).

3) The subject performing activity is single, clearly defined and limited, and also undergoes no transformations in the course of activity.

In the case of elementary activity, the structure in Fig. 6 suffices to describe the activity itself; there is no need to consider the subject matter and subject together with the activity itself. Really, they play the role of a clear context: during the period of activity, only the subject matter evolves in accordance with the technology used by the subject.

In contrast, a non-elementary activity was called complex in [1]. In other words, a *complex activity* is an activity with a non-trivial internal structure, with multiple and/or changing goals, subject, technology, and the role of the subject matter in its goal context.

Third, the temporal structure of any activity (elementary or complex) was proposed and considered in [1]; see Fig. 9.

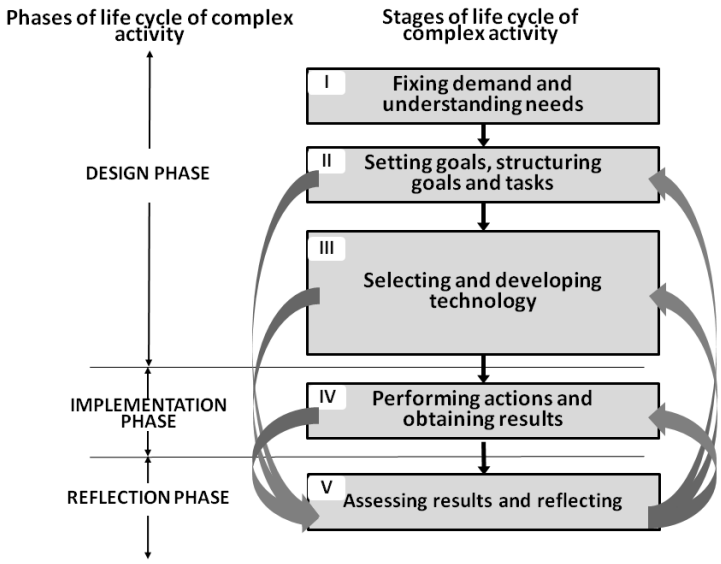

Fig. 9. Phases and stages of life cycle of complex activity [1]

Fourth, the logical, cause-effect (causal), and process structures of complex activity (including a hierarchy of SEAs and elementary operations) were constructed in [1].

Table 2 below describes the organizational specifics of activity during different periods of human development, from the Stone Age to the present day. The main conclusions that can be drawn from such a periodization are as follows.

1. Starting from the appearance of man, human activity is characterized by multiple and changing goals and other attributes of the definition of complex activity. In other words, human activity has always been complex and the methodology of complex activity provides a uniform description for complex activity in all periods. Unlike other living creatures acting jointly (a swarm of bees, a colony of ants, a pack of wolves, etc.), man organizes all types of complex activity (*labor*, *learning*, *play*, *creativity*, *communication*), i.e., performs structuring of the subject matter, in accordance with the goals of complex activity, not instinctively but consciously, as the forms of control. The second distinctive feature of human complex activity is the use of *artificial means of activity*.

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Table 2. Organizational specifics of activity during different periods of human development

Social structures (K. Marx)	Primitive-communal system		Slave system			Feudalism		Capitalism		… Communism
Types of organizational culture (V.A. Nikitin, A.M. Novikov)	Traditional			Corporate-handicraft			Professional		Project-technological	Knowledge
Mass types of practical activity	Hunting, fishing, collecting	Cattle-breeding, agriculture			Craftsmanship			Industrial production		Information production
Sources of energy	Muscle force of people and animals				Natural sources (water, wind)			Hydrocarbons (steam, electricity)		Nuclear energy, RES
Dominating types of production			Piece			Batch			Mass	
Methods of normalization and translation of activity	Myths and rituals				Sample and recipe for its recreation			Theoretical knowledge in the form of text	Projects and programs	Information models
Organizational forms of collective activity	Community		State, army		Church		Workshop	Enterprise	Corporation	Extended or virtual enterprise
Dominating links between actors performing joint activity	Kinship	Language		Faith		Property		Capital	Organization	Technology
	…	10000 B.C.	…	5000 B.C.	…	0	500 A.D.	1000 A.D.	1500 A.D.	2000 A.D. **Time**

2. Besides the monotonously growing complexity of activity (the depth and width of its hierarchical logical structure), technologies have been the only evolving factor of complex activity. However, even for technologies, it is difficult to identify certain "historically specific" forms and methods of activity. The means of activity have been evolving! That is, in the course of human development, the means of complex activity and methods for performing "industry-specific" elementary operations (industry-specific technologies) have been created and further developed. At the system-wide level of generalization, the technology of complex activity has been remaining invariant: the target (logical) structure and the cause-effect structure, as well as the process model of complex activity as a universal algorithm for managing and/or implementing the life cycle of complex activity.

3. The maximum complexity of the projects implemented in different historical periods (which can be described, e.g., by the spatial dimensions of objects created and the number of their "elements," the duration of projects and the number of their participants) has been demonstrating a moderate growth over time.

4. The gradually accelerating development of technologies has led to the mass creation of more and more complex artificial systems, which allows achieving results with fewer resources (time, energy, etc.). In fact, "the set of achievable results" over the entire history of mankind has not changed much (a few exceptions are: hydronautics, astronautics, etc.).

Thus, the typical architecture formalized by the methodology of complex activity is universal for any types of activity, throughout the entire past history of mankind. Hence, it can be hypothesized that such universality will hold in the future (at least, until the set of subject matters of activity that is accessible to mankind changes).

5. SYSTEMIC PERSONALITY STRUCTURE

In the previous sections of the paper the history of personality theories and activity theories has been briefly traced. Methodology provides an operational and systemic structure of activity, including the set of its elements with the functional, causal, and other relations between them. Personality theories, however, are still lacking these important properties. This section is an attempt of maximal systematizing of main categories, basing on the personality structure introduced by K.K. Platonov [19]. This will be done by analyzing the basic terminology, i.e., by establishing the cause-effect and particular-general relations between the relevant concepts. The analysis results are demonstrated in Fig. **10**.

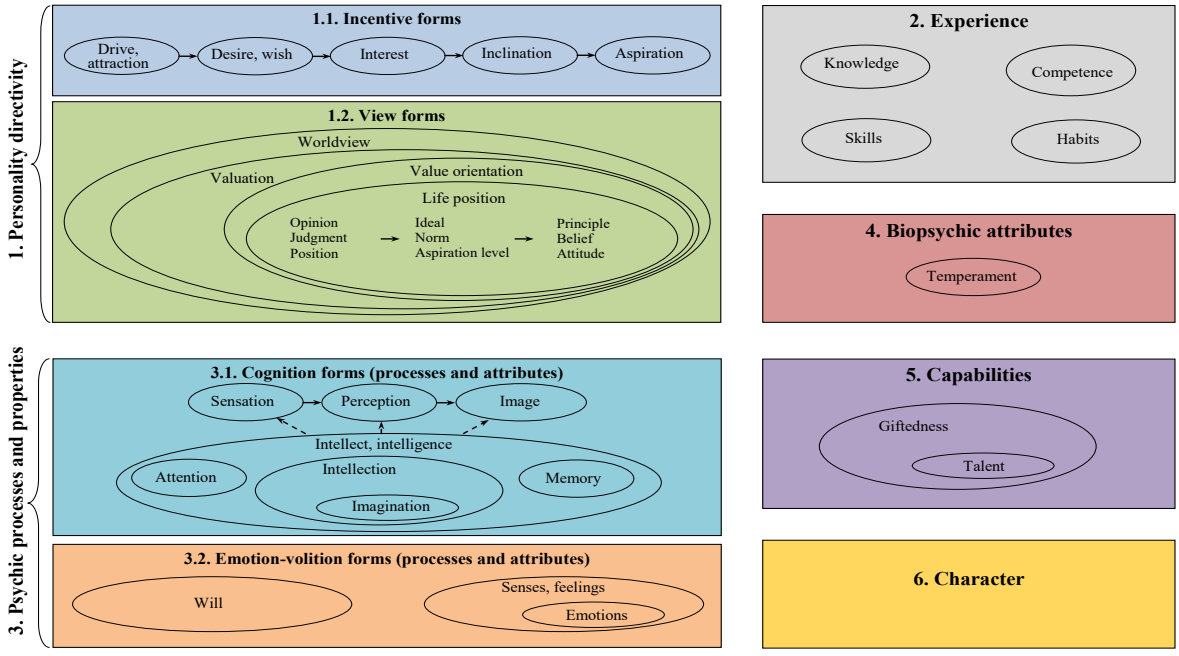

Fig. 10. Systemic personality structure

The resulting structure agrees with K.K. Platonov's hierarchy and has the following form[6]; see Fig. **10**.

1. Personality directivity:
   1.1. incentive forms:

drive, attraction → desire, wish → interest → inclination → aspiration; (5.1)

   1.2. view forms—*worldview*, *valuation*, *value orientation*, *image*,[7] and *life position*, which includes three groups of components (Fig. 11):
   - *opinion, judgment, position*;
   - *ideal,* norm, *aspiration level*;
   - *principle, belief, attitude*.
2. Experience—knowledge, competence, skills, *habits*.
3. Psychic (mental) processes and attributes:
   3.1. cognition forms: processes

sensation → perception → image and capabilities — intellect, intelligence (attention, intellection, memory, imagination). (5.2)

   3.2. Emotion-volition forms: will, *senses, feelings*, and emotions.
4. Biopsychic attributes (*temperament*).
5. *Capabilities* (*giftedness, talent*).
6. *Character*.

Of course, the six groups of components of the personality structure (see the list above) are not isolated. For example, the appearance of inclination requires not only the presence of interest, but also the strong-willed aspiration to implement the latter in activity [19]; images, opinions, and judgements are naturally associated with the experience of an individual, etc. Unfortunately, modern psychology has not suggested any systemic picture of such relations between different components of the personality structure so far, but their relevance is already obvious even to the representatives of adjacent sciences.

Among these six groups of components of the personality structure, additional systematization is needed for the view forms of personality directivity, or rather, the components of a life position. (Indeed, their number is quite large, and the relations between them were not clearly established in the literature; in particular, any "structuring" like (5.1) or (5.2) has not been proposed to date.) To do this, consider the process by which a subject assesses the state of a certain system, as is illustrated in Fig. 11.

The state of this system is described in the state space by some indicators, measured in appropriate scales. The subject assesses the functioning of this system according to some (perhaps its own internal) criteria, also measured in appropriate scales.

Generally speaking, the assessment process consists in the transition from the state space of the system to the criteria space (Fig. 11), i.e., in establishing a relationship between the values of the indicators of the system's state and the values of the criteria (in a special case, the criteria can coincide with the indicators).

An opinion, a position, and a judgement (in a certain sense, all three terms can be regarded as synonyms for subjective appraisals, possibly comparative and multicriteria) are "points" in the criteria space. According to this terminology, a norm is a system of criteria, i.e., a set of their "admissible" values; a principle is a norm of activity (including assessment); the aspiration level is the self-appraisal of a personality (i.e. a special case of self-assessment in relations with the environment); beliefs are a set of criteria, norms, ideals, and assessment results (i.e., opinions, positions, and judgements) in accordance with them;

[6] *Note that genetic, neurocognitive, and many other related aspects remain almost beyond consideration. In recent time, they have been given much attention within instrumental studies at the junction of psychology and physiology, cognitive sciences, etc.*

[7] *Images can be treated as a view form (item 1.2 of the list) as well as a cognition form (item 3.1).*

an attitude is the readiness for a certain activity in a typical (assessed) situation according to beliefs and principles.

As a matter of fact, the representation of the reflection process shown in Fig. 11 is somewhat simplified. It would be more correct to consider the following chain (see also cognitive processes in

Fig. **10** and (5.2)):

"objective state space → sensation → perception → image →
→ subjective state space → criteria space," (5.3)

thereby attributing reflection in Fig. 11 to the last pair of this chain.

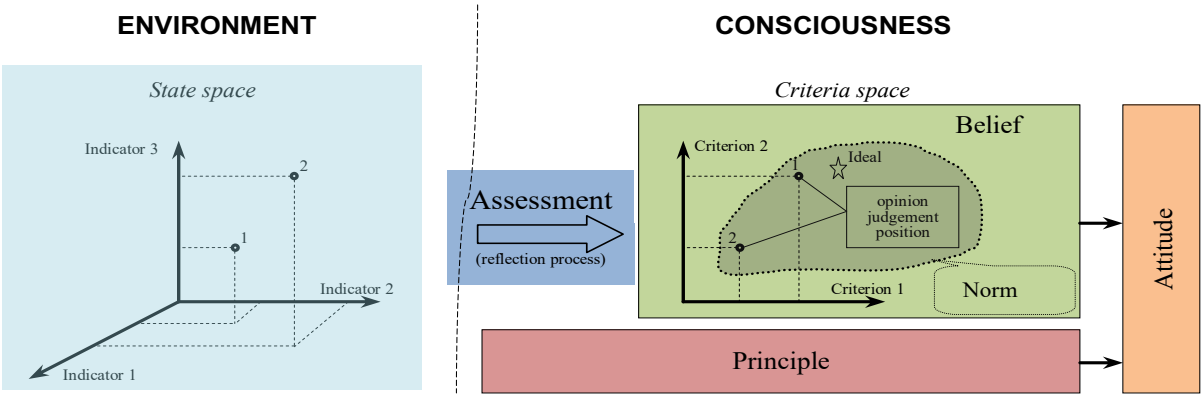

Fig. 11. View forms of personality directivity

The subjective state space, existing in consciousness, reflects the subject's *awareness*—the information (the set of images) the latter has at the time of decision-making, at the time of the assessment process, etc. This information can be either narrower than the real world (due to insufficient observations, limited sensitive and cognitive capabilities of the subject, etc.) or wider (e.g., due to the results of the subject's *auto-reflection*, or *second-kind reflection* [14], as well as due to fantasy and creativity). An important role in the content of the subject's awareness and in the formation of this content can be played by other subjects interacting with the former, which is the subject matter of social psychology.

Concluding this section, let us analyze the components of the personality structure from the viewpoint of their "dynamism" (as the reciprocal of the characteristic time required for changes), i.e., the possibility of purposeful change by the subject itself (in the process of self-development) or by other subjects (in the process of control).

Components 1–6 in

Fig. **10** are ordered almost in the descending order of dynamism. Indeed, the biopsychic attributes, capabilities, and temperament are the least susceptible to changes, although they can and must be formed and developed during training [19], but the time and effort expended for this are great.

The emotion-volition forms and cognitive abilities (intelligence) also change rather slowly (in the process of exercises [17, 19]). Concrete cognitive processes (sensation – perception – image) are much more dynamic and timely.

Experience is formed and then developed rather slowly in the process of education.

Personality directivity is formed in the process of upbringing and then developed in the process of activity.

The components of the view forms of personality directivity have significantly different characteristic times. For example, the upper-level components (worldview, valuations, value orientations, and life position) change extremely slowly; principles, beliefs, and attitudes, slightly faster. The ideals, norms, and aspiration level are even more dynamic. And the processes of forming concrete subjective appraisals (opinions, judgements, and positions; see

Fig. 11) are timely. The components of the incentive forms of personality directivity have almost the same dynamism.

6. SYSTEMIC ACTIVITY STRUCTURE

A direct combination of Fig. 6, Fig. 8, and
Fig. **10** gives the systemic activity structure presented in Fig. 12. It includes the subject of activity, the activity itself (the procedural components are indicated by a dashed rectangle), and the subject matter of activity.

The systemic activity structure in Fig. 12 allows identifying three groups of internal components of activity: psychic (mental), procedural, and behavioral ones; see Fig. 13.

The *psychic components of activity* are the components of the personality structure, need, motive, reflection (more precisely, auto-reflection), assessment, and self-regulation.

The *procedural components of activity* (cf. (3.1)–(3.3)) are:

$$\text{need} \to \text{motive} \to \text{goal} \to \text{tasks} \to \text{technology} \to \text{action} \to \text{result} \to \text{reflection/assessment}. \tag{6.1}$$

The *behavioral components of activity* are action, the state of the subject of activity, and result.

The *external components of activity* are criteria, norms, principles, requirements, and conditions.

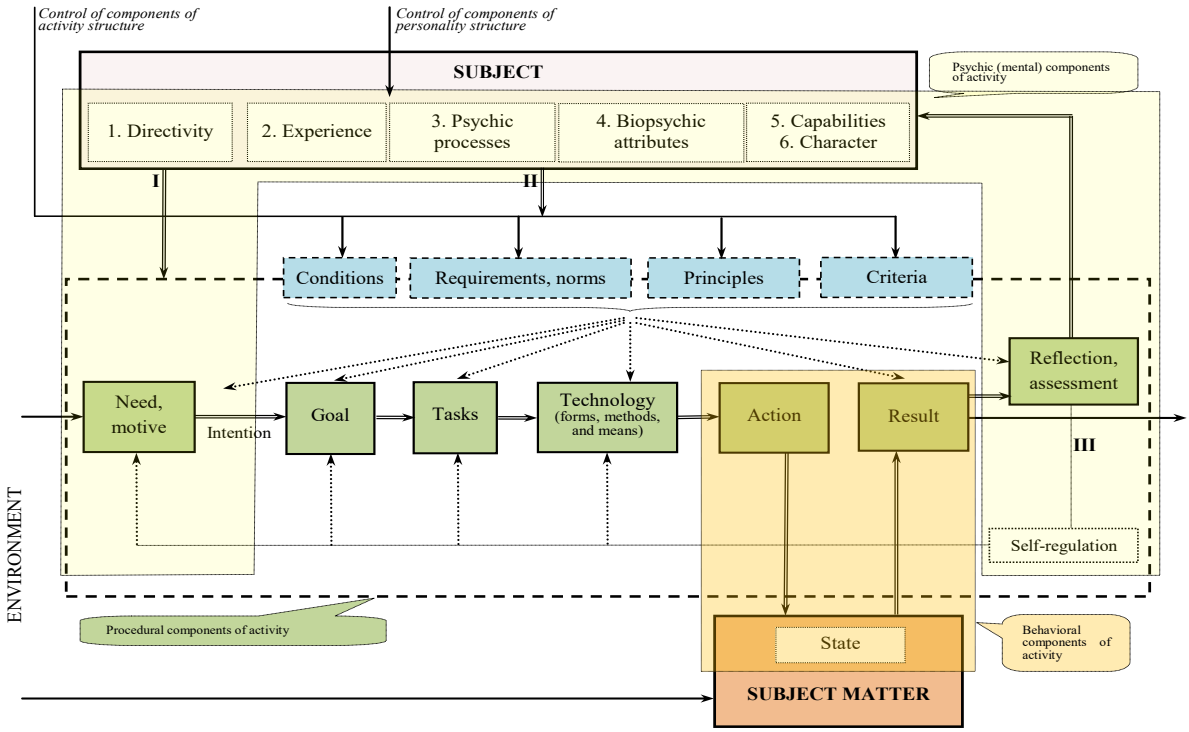

Fig. 12. Systemic activity structure

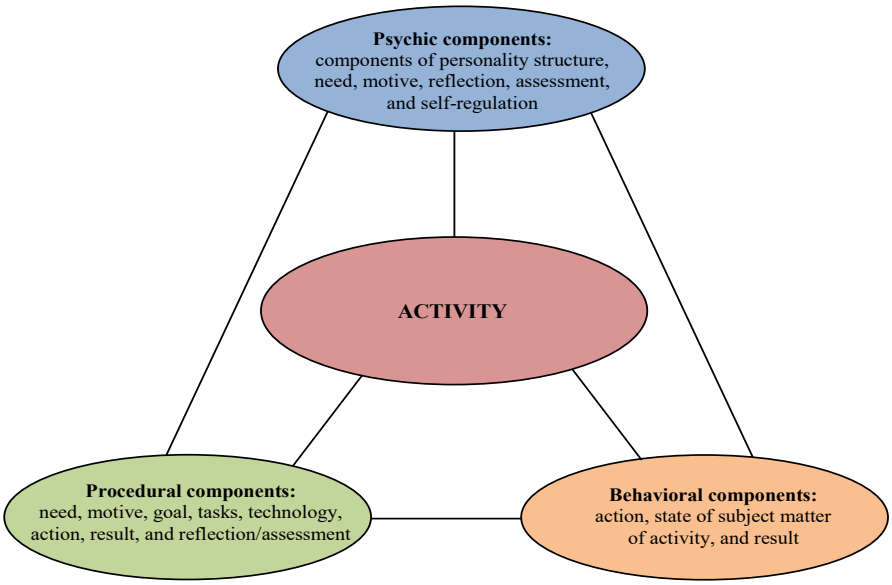

Fig. 13. Internal components of activity

Note that the systemic activity structure under consideration is "maximal", and in particular cases, real activity can be described by a fragment of this general structure. For example, as the result of an *impulse*, the subject can perform some action not quite consciously (without formulating a clear goal, without decomposing it into tasks, without choosing an appropriate technology, etc.). Another example is the so-called regular activity (see the classification of activity types in [1]) in which goals are fixed (and often set externally), the technology is mastered and does not change over time, and uncertainties do not occur (there is no need to develop the technology for new conditions of activity). Regular activity is adequately described only by the behavioral components ("action → result," etc.).

The systemic activity structure presented in Fig.12:

- includes/further develops the well-known approaches to the description of activity structure; see Sections 3 and 4, as well as the publications [7, 12, 15, 19] on the psychology of activity and the monographs [1, 15] on methodology;
- integrates the well-known approaches of psychology to the description of personality structure; see Sections 2 and 5, as well as [11, 19, 23];
- identifies one external and three internal substructures of activity: the psychic (unobservable from the outside), procedural ("partially observable"), and behavioral (observable) components of activity;
- structurally coincides with the SEA model and can be integrated [1];
- is an input-output model with feedback,[8] a classical model for control theory [13];
- is complementary to decision theory, game theory, theory of collective behavior (the models of opinion dynamics and action dynamics under the influence of the environment [2, 3]), the models of learning (the development of experience) [17], and the theory of control in organizations [18]; see Section 8.

7. PERSONALITY AND ACTIVITY

Now let us establish the correspondence between the systemic structures of personality (Fig. **10**) and activity (Fig. 12). For this, consider a scheme in which the components of the personality structure influence the activity; see Fig. 14 and Fig. 15, where the

[8] *More precisely, with two feedback loops. One loop (through self-regulation, see arrow III) corresponds to the timely (insignificant, "automatic") correction of the activity components by the subject. The second loop (through the subject itself, see arrows I and II) corresponds to relatively slower and more significant corrections; see also arrow 2 in Fig. 5.*

significant/determining influence is reflected by a continuous arrow, and the less obvious one by a dashed arrow.

For the procedural components of activity, the following assumptions seem natural: for need and motive, the incentive forms of personality directivity are primary; for goal, the view forms; for tasks, cognitive processes and attributes; for technology, the experience of a personality; for action, its biopsychic attributes; for reflection/assessment, the view forms of personality directivity.

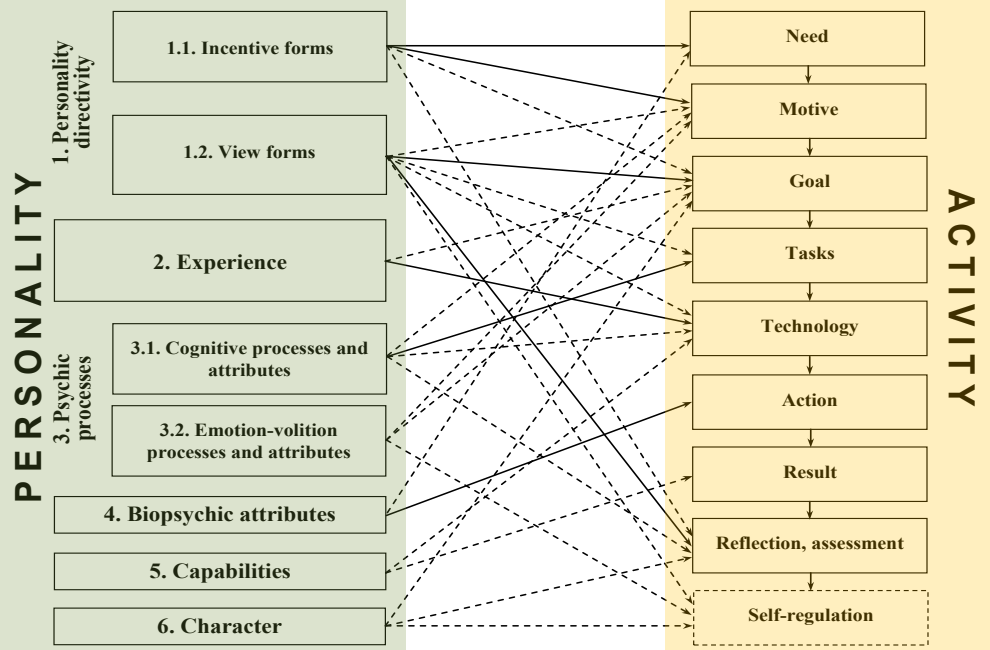

Fig. 14. Influence of components of personality structure on procedural components of activity (see arrow I in Fig. 12)

The external components (in the first place, the constraints and conditions of activity) significantly depend on the environment. But personality characteristics are also important for the external components of activity. For example, the norms of the subject's activity are influenced by social, corporate, and group norms (on the one hand) and its personal norms (on the other).

For the external components of activity, it can be assumed that the view forms of personality directivity play the key role. Various personality characteristics have the greatest influence on the norms of activity and the criteria for assessing its results; see Fig. 15.

Of course, the arrows in Fig. 14 and Fig. 15 do not exhaust the influence of "personality" on "activity." An in-depth study, systematization and justification of this influence are global and topical problems for future research.

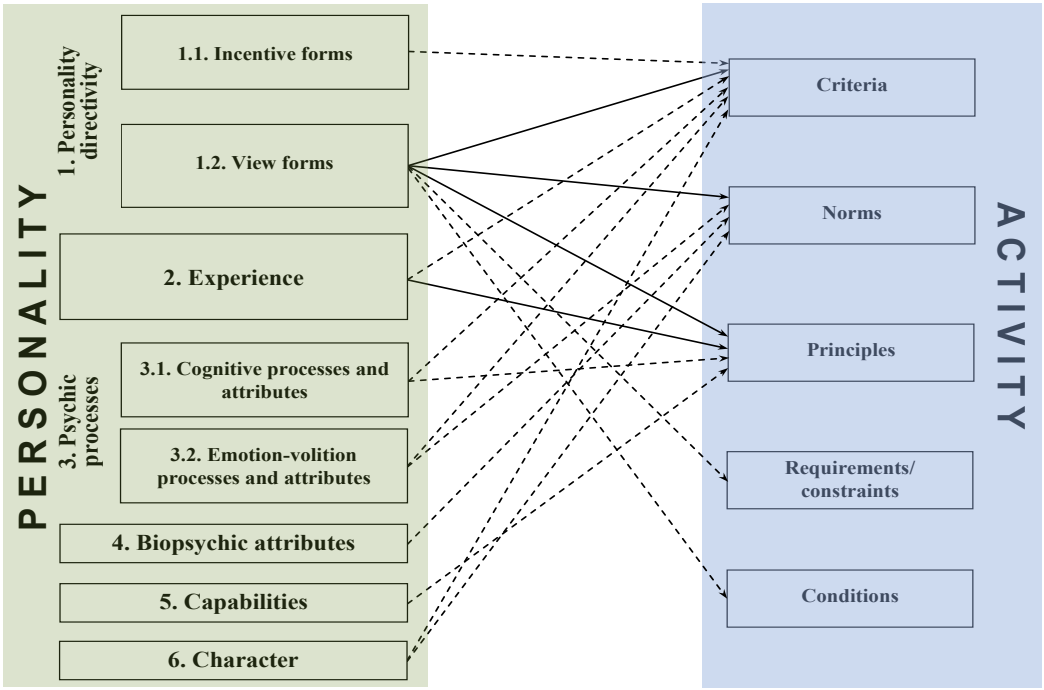

Fig. 15. Influence of components of personality structure on external components of activity (see arrow II in Fig. 12)

8. CONTROL

As it has been underlined in Section 1, the goal of control of a subject is to ensure the desired result of its activity. This statement equally applies to the case when a subject controls his activity himself (see Fig. 12) and to the case when the goals are set by another subject (see Fig. 7).

The set of different factors (the components of the personality structure, the external components of activity, and the influence of the environment), as well as the relations between them ("the source of influence" → "the subject matter of influence") and the components of activity (see causal relations in Fig. 12 and Fig. 14), can be used to construct *models of activity control*. (For details, see [16, 18] and Chapter 7 of the monograph [1], devoted to the management of complex activity.) Such models are based on the chains of relations between the components of the structures of activity and/or personality. The beginning of the chain is a component of the personality structure (or a component of the activity structure) to which control is applied, the subject matter of control; the end of the chain is always[9] the result of activity.

The most complete, but at the same time the least specific, is the set of all the relations between the entities in Fig. 12 and Fig. 14. Any model implies abstraction; therefore, in each case, some of the elements of the chain can be omitted (eliminated from consideration). Indeed, the model allows getting abstracted from the intermediate elements of the chain. But the researcher needs to keep all the elements in his field of vision, in order to "see the big picture", understand clearly the assumptions introduced (what is abstracted, which factors are consciously neglected) and be sure of the observability/measurability of the factors used. The issues of measuring the personality traits of people were discussed, e.g., in the reference book [24, 25]. Here are some examples.

The theory of control in organizations rests on the assumption that the choice of action by the subject is a *decision-making* process described by a corresponding mathematical model (a decision rule, often a game-theoretic or collective behavior model; see below).

[9] *If the researcher does not solve any particular control problem, the "chain" of his interest may not be terminated by the result of activity. Anyway, he needs to see the fragment of his interest within the general personality and/or activity structure.*

Within this theory, there are several types of control, classified by the subject matter of control; numerous models were given in the book [18].

1. Institutional control (control of the constraints (conditions, requirements, and principles) and norms of activity) is the most stringent types of control. Here the controlling subject deliberately restricts the set of all admissible technologies, norms, principles, actions, and results of activity of the controlled subject. Such a restriction can be implemented through explicit or implicit impacts, i.e., legal acts, orders, etc., or moral and ethical standards, corporate culture, etc. The resulting "model chain" has the following form:

$$\text{"constraints and norms of activity} \rightarrow \text{decision rule} \rightarrow \text{result of activity."} \tag{8.1}$$

2. Motivational control (control of preferences, i.e., the criteria of assessing the results of activity, both by the controlled and controlling subjects) is "softer" than institutional control. Here the preferences of the controlled subject are changed in a purposeful way. Such a change can be implemented by introducing a system of incentives for choosing proper actions and/or for achieving proper results of activity. The resulting "model chain" has the following form:

$$\text{"criteria for evaluating performance} \rightarrow \text{decision rule/model} \rightarrow \text{action} \rightarrow \text{result of activity".} \tag{8.2}$$

The "real chain" on the example of motivational control has the following form:

$$\text{"criteria for assessing the results of activity} \rightarrow \text{motive} \rightarrow \text{goal} \rightarrow \text{tasks} \rightarrow \text{technology} \rightarrow \text{action} \rightarrow \text{result of activity."}$$

In other words, the fragment "→ motive → goal → tasks → technology →" is immersed in the *decision model*.

3. Informational control is the "softest" (indirect) type of control, as compared with institutional and motivational ones. Here the subject's awareness (beliefs and opinions) about essential parameters are properly changed [14]. First of all, the matter concerns the parameters of the environment.

Such essential parameters are often the opinions, actions, or results of activity of other subjects (e.g., the so-called social pressure, studied in social psychology). A subject has some degree of *trust* to other subjects and considers their *reputation* to change its opinion in accordance with a particular model of opinion dynamics.

The two most widespread classes of mathematical models of opinion dynamics are the models of consensus (in which the subject "averages" its opinion with the opinions of those subjects with which it interacts; see [3]) and the so-called threshold models (in which the subject demonstrates conformity behavior: being subjected to social pressure, the subject makes its own decision or agrees with some opinion only when the proportion of other subjects behaving in this way exceeds its own conformity threshold; see [2]). The interested reader is also referred to [11].

The complete chain is as follows:

$$\begin{aligned}&\text{"environment} \rightarrow \text{sensation} \rightarrow \text{perception (+ emotions)} \rightarrow \text{image (+ experience)} \rightarrow\\ &\rightarrow \text{opinion} \rightarrow \text{belief (+ experience + will)} \rightarrow \text{attitude} \rightarrow \text{motive} \rightarrow \text{goal} \rightarrow \text{tasks} \rightarrow\\ &\rightarrow \text{technology} \rightarrow \text{action} \rightarrow \text{result of activity."}\end{aligned} \tag{8.3}$$

The corresponding "model chain" for (8.3), which incorporates some fragments of (8.3) within the opinion dynamics model and the decision rule, has the following form:

$$\begin{aligned}&\text{"environment} \rightarrow \text{belief (+ experience)} \rightarrow \text{opinion dynamics model} \rightarrow\\ &\rightarrow \text{opinion} \rightarrow \text{decision rule} \rightarrow \text{action or result of activity."}\end{aligned} \tag{8.4}$$

In a particular case, beliefs may coincide with opinions, and the resulting opinion of the subject can be considered the final result. Note that the decision rule in (8.4) can be treated as an attitude model, i.e., a mapping of opinions into actions; also, see standard solutions in [1].

Interestingly, in (8.1), (8.2), and (8.3), the action or result of activity is the only "variable," which is observable (at least, partially detected by objective means). The

overwhelming majority of modern models suggested by the theory of control in organizational systems consider this particular case, regardless of the exact action of the controlled subject (e.g., the information about the uncertain parameters reported by the latter to the controlling subject; the volumetric or temporal characteristics of its activity).

The model chain (8.4) contains two "variables": one "internal" (perhaps directly unobservable), which is the belief or opinion of the subject, and the other "external," which is the action or result of its activity. On the one hand, chain (8.4) has been underinvestigated: the only exceptions are several strategic behavior (manipulation) models for the opinions of subjects [3], probabilistic models (Bayesian models or controlled Markov processes), and "logical" models, widely used in artificial intelligence and robotics within the BDI-architecture of software agents (B–"belief," D–"desire," and I–"intention"). On the other hand, it is "richest" and most promising for future research.

In order to illustrate the transition from the general activity scheme (see Fig. 12) to the basic model of control in organizational systems, consider a somewhat simplified model of the subject's decision-making about its actions. The details can be found in [18].

Assume that a subject (an actor of some SEA) chooses actions (strategies, states, etc.) from a set A of all admissible actions. Hereinafter, an *action* will be denoted by y ($y \in A$). Let a parameter $r \in R$, further called the *type*, reflect all significant individual characteristics of the subject. In many applications, the subject's type is interpreted as the efficiency of his activity, or the rate of learning, or the most desired result of activity [18].

The choice of an action $y \in A$, together with the impact of an environment, lead to a *result of activity*, further denoted by $z \in A_0$; here A_0 is the set of all admissible results of activity. A possible noncoincidence of the subject's action and result of its activity is due to the impact of the environment, in particular, the actions of other subjects, etc.

The functional relation between the subject's action $y \in A$ and the result $z \in A_0$ of the activity may have a complex character, described by probability distributions, fuzzy information functions, etc. [18]. For the sake of simplicity, let the result of activity be a known function $w(\cdot, \cdot)$ of the action and the *state of the environment* $\theta \in \Omega$: $z = w(y, \theta)$. This parameter reflects the impact of the environment. The function $w(\cdot, \cdot)$ is often called *the technological function*. It describes all variations in the state of the subject matter of activity due to the actions of the subject and the impact of the environment. (Recall that the result of activity is the state of its subject matter achieved in the course of activity.)

Assume that the subject has preferences on the set of all results $z \in A_0$, being able to compare different results of activity with each other. The subject's preferences will be described by its utility function (goal function, payoff function) $f: A_0 \times R \to \Re^1$: of two results of activity, the subject prefers the one corresponding to a greater value of its utility function. The subject's goal is to maximize the utility.

When choosing an appropriate action $y \in A$, the subject considers its own preferences and the effect of the action on the result of activity $z \in A_0$. Given the type and the state of the environment, the subject will choose an action maximizing its utility:

$$y^*(A, w(\cdot), f(\cdot), \theta, r) = \arg\max_{y \in A} f(w(y, \theta), r). \tag{8.5}$$

Expression (8.5) describes the *decision rule model*. Subject's choice $y^*(A, w(\cdot), f(\cdot), \theta, r)$ depends on:

- the set of admissible actions A;
- the technological function $w(\cdot, \cdot)$;
- the utility function $f(\cdot, \cdot)$;
- the state of the environment $\theta \in \Omega$;
- the subject's type $r \in R$.

Control consists in a purposeful influence on each of these factors or their combinations. (Here the term "purposeful" means that the influence shall lead to the desired action of the

subject or the desired result of its activity.) Depending on the subject matter of control, different types of control are distinguished.

For example, the influence on the set of all admissible actions of the subject (the conditions, requirements, and norms of activity; see the general activity scheme in Fig.12) and the technological function (the technology of activity) is institutional control; see (8.1) and [18].

The influence on the subject's utility function (the criteria for assessing its activity in terms of the general activity scheme in Fig.12) is motivational control; see (8.2) and [18].

The influence on the subject's awareness of the state of the environment (and, possibly, its awareness of the values of other factors) is informational control; see [14, 18].

The influence leading to a change in the subject's type can be interpreted as *control of components of personality structure*.

Within this model of the subject's decision-making, the general activity scheme (Fig. 12) takes the simplified form presented in Fig. 16 (here, abstraction consists in omitting a number of entities, and some relations become trivial or degenerate).

The scheme in Fig. 16 is an "elementary brick," i.e., a particular model of the structural element of activity (see Section 4) of the subject making a decision on its action. Such bricks can be used to describe uniformly even more sophisticated types of complex activity and their control, in particular, in multi-element, multilevel, dynamic systems operating under uncertainty [1, 2, 3, 13, 14, 18].

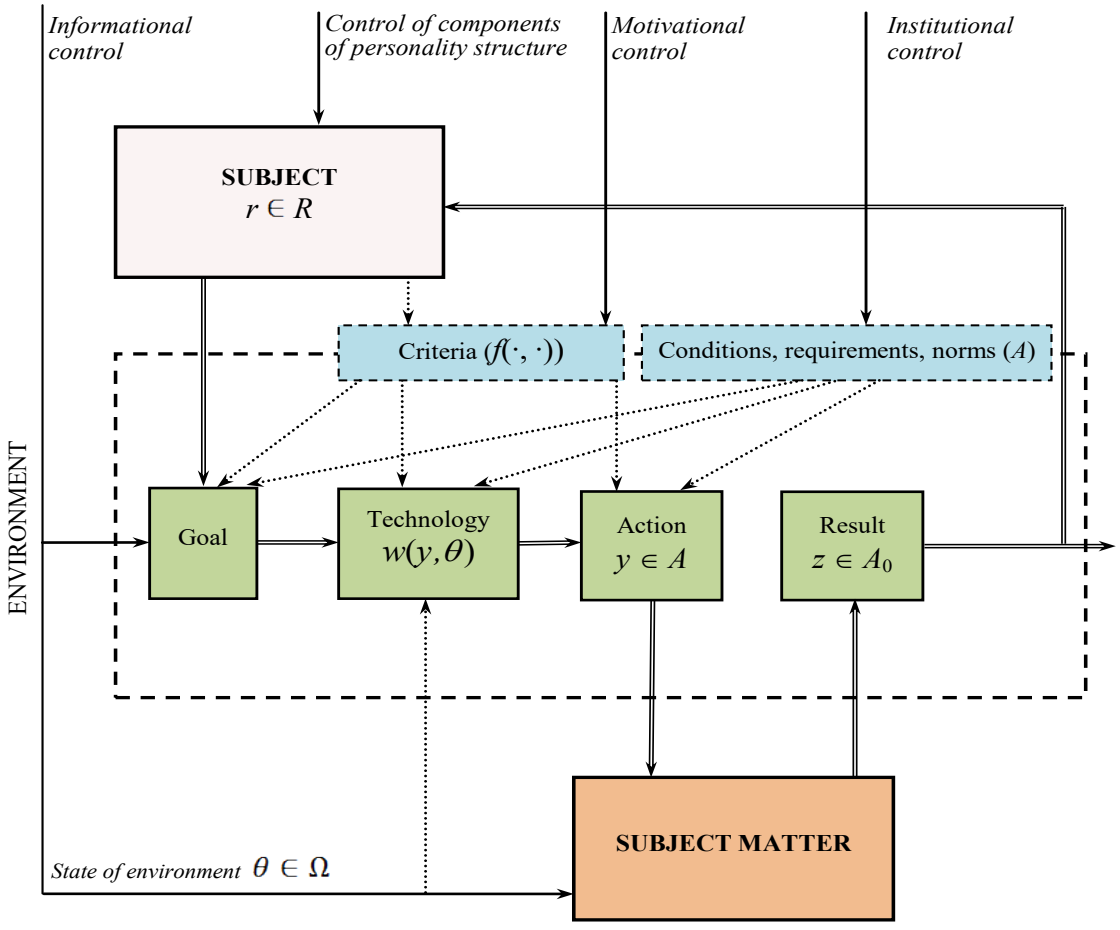

Fig. 16. Decision model, activity, and basic types of organizational control

For example, consider the set $N = \{1, 2, \ldots, n\}$ of interacting subjects. Hereinafter, the subjects will be indicated by subscripts and the time instants by superscripts. For the sake of simplicity, let the state of the environment θ_i for subject i be the vector $y_{-i} = (y_1, \ldots, y_{i-}$

$_1, y_{i+1}, \ldots, y_n$) of the actions of all other subjects. The decision rule of the subject can be written as

$$y_i^*(A_i, w_i(\cdot), f_i(\cdot), y_{-i}^*, r_i) = \arg\max_{y_i \in A_i} f_i(w_i(y_i, y_{-i}^*), r_i),\ i \in N. \tag{8.6}$$

Expression (8.6) is the definition of a *Nash equilibrium* in the *normal form game*. The (institutional, motivational, or informational) control problems for the action vector (8.6) are formulated and solved by analogy with (8.5), taking into account the corresponding specifics (see [1, 18]).

If the subjects make their decisions $\{ y_i^t \}$ at the time instants $t = 0, 1, 2, \ldots$, then their decision rules can be described by the mapping

$$y_i^t(y^{t-1}, r_i) = G_i^t(y^{t-1}, r_i, u_i^t),\ i \in N, \tag{8.7}$$

where $y^t = (y_i^t, y_{-i}^t)$ is the action vector of the subjects at the time instant t; $u_i^t \in U_i$ is the control variable; $G_i^t : A_1 \times \ldots \times A_n \times R_i \times U_i \to A_i$, $i \in N$. Under definite condition, the dynamic system (8.7) may have a fixed point (8.6). The approaches to solve the analysis and synthesis problems for the *controlled dynamic system* (8.6) were considered in [1, 13, 18].

9. CONCLUSION

Let us return to the problem formulated in Section 1 of this paper: find an appropriate description of a controlled system in terms of the personality psychology that can be used to state and solve control problems for the systems containing man. Conventionally, the general scheme of interaction between psychologists and control theoreticians can be described as follows:

1) Create and negotiate by both sides a single system of basic concepts characterizing the subject matter.

2) Create and negotiate by both sides the representations of the basic structures (a combination of factors and their relations) of a personality and its activity as the subject matters of control.

3) Formulate jointly the specific tasks of research in the form of models ("fragments" of the basic structures, like the "chains" described above, primarily (8.4)), with detailed specification of the following elements:

- the processes and phenomena to be studied, their qualitative and quantitative (if possible) description;
- the possibilities for "measuring" the key characteristics and identifying both the source data and the modeling results.

4) Develop and study specific mathematical models (chiefly, by control theoreticians).

5) Discuss jointly and give practical interpretations of the modeling results, perhaps with return to Stages 3 and 4.

This paper is a control theory-based view on Stages 1 and 2. Probably, the next steps are to coordinate the positions of representatives of various branches of science on Stages 1 and 2, with further transition to more concrete research.

Indeed, in this paper, the structures of personality and activity have been systematized, and the interconnections of their components have been established. As a result, the control problems for systems containing man have been uniformly described.

A promising area of joint researches by control theoreticians, personality psychologists and social psychologists is the accumulation of empirical material that describes the relationship (preferably quantitative) between the key components of the structures of personality and activity. The quantitatively measurable "fragments of chains" (8.1)–(8.4) can be used to construct and explore new applications-relevant control models for organizational, technical and social systems.

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