The interplay of external and internal semiotics of domain-specific scientific theories

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We suppose that those who are reading this contribution are familiar with the traditional reconstruction of domain-specific scientific theories (DSSTs) as logically ordered and static systems of statements about their domains. The latter split into separate realities with their attributes. However, any DSST (e.g., celestial mechanics, theories of superconductivity, theories of elementary particles) is an ever-improving tool for acquiring new knowledge. It means that a more realistic reconstruction is a varied polysystem. Its interacting and changing subsystems (SS) perform specific functions in the complex process of obtaining and testing the new knowledge. According to the modified structure-nominative reconstruction, there are many SSs in DSSTs [2019; 2021].

At any moment in the history of a DSST, its *ontic* subsystem contains the notions of realities and their attributes (properties, interactions, states, and processes) in question (for instance, "planet"/Mars, "mass"; "conductor"/ "temperature", "resistance"; "particle"/ "proton", "spin"). The content of the SS concerned varies and becomes more complex due to both the experimental progress and theoretical development.

Main components of the *model* SS are models of a different kind. They represent those attributes of the realities that are important for their study under certain experimental and theoretical settings. For instance, experimentally tested models of elementary particles appear while using accelerators testing higher and higher particle energies. In a first approximation, there are *verbal/visual/intuitive*, *empirically informative,* and *mathematical* models that are integrated in the appropriate *subsubsystems* of the model SS.

A language SS contains and orders languages that are used by the DSST. Each SS has a specific net of languages that describe its components.

A nomic SS contains formulations of laws, axioms, and postulates, which represent such theoretical attributes as regularities of realities from its domain, as well as the principles of organizing and changing the theory itself.

Other SS are *definitional* (formal and informal, full and partial definitions both of the realities/attributes from the theory domain and components of the theory); *ordering* (deductive, inductive, abductive, taxonomic and the like means of assembling other subsystems of the theory); *problem* (problems, questions and tasks that are formulated and solved by the theory); *operational* (operations both with the components of the theory and with the theory itself); *procedural* (procedures as rules for performing actions); *evaluative* (evaluations of components and the theory); *hypothetical* (plausible hypotheses generated by the theory); *heuristic* (useful but not well justified heuristic considerations); *approximate* (approximations of the theory and its components) and *connecting* (connections of both subsystems and their internal components) subsystems.

All components of subsystems mentioned above have general and specific names. It gives reasons for separating a *denominative SS*. Indeed, thinking about the notions of domain realities and their attributes is impossible without using distinct kinds of reality/attribute names. The *ontic subsubsystem* of the *denominative SS* of the theory includes various kinds of names (labels, designations, acronyms, terms, symbols, diagrams, schemes, tables, and the like), which represent the domain of the theory. The ontic names of realities and their attributes are borrowed from the national natural language and the universal *physical lingua franca* [2020].

The theoretical subsubsystem of the denominative SS includes similar means of naming the theory's internal components. Sometimes the same name denotes both the reality/attribute and the corresponding component of the theory. An example is a symbol ***E***, which represents the actual electric component of the electromagnetic field and the corresponding vector function in the Maxwellian classical electrodynamics.

There are many ways to introduce and use new domain names. As an illustration, let's take the simplest case associated with the discovery of a new property *P* (its existence is taken for granted) of known realities. Let's denote its name as *N*(*P*). The obvious task of theorists is to theoretically calculate the values of *P* and then compare them with experimentally measured values. To do this, one needs to modify and use some internal components of DSST.

At the first stage, theorists should name the new problem *N*(*PR*) of calculating the values of the considered property *P*, and then formulate the corresponding *PR*(*P*) problem. In the absence of suitable models in the DSST, theorists should name the model *N*(*M*) and construct a new model *M*(*PR*) in terms of which it is promising to solve *PR*(*P*). All these components are specific in the sense that they refer to *N*(*P*).

The next step is attempts to resolve the *PR* by the existing structures from the operational SS or the name of *N*(*OP*) and the construction of new operational means of the *OP*. This event occurred in the history of quantum mechanics and is associated with the usage of matrices as new *OP*s. In the case of an approximate coincidence of the obtained numerical solution of the *RE*(*PR*), i.e., the calculated values of *P*, with the measured values, the *PR*(*P*) is conditionally/temporarily solved. As a rule, a more accurate measurement of property values creates the problem of reformulating the *PR*, as was the case with the so-called Lamb shift of the energy levels of atoms under the action of virtual particles emerging from the vacuum.

Otherwise, the cycle $P \rightarrow N(P) \rightarrow N(PR) \rightarrow PR \rightarrow N(M) \rightarrow M(PR) \rightarrow N(RE(M(PR))) \rightarrow RE(M(PR))$ stimulates the construction of a new theory with a new nomic SS. Here *RE*(*M*(*PR*)) denotes *PR* solution processes in terms of *M*(*PR*).

Thus, in modern physics, existential statements about realities should be supplemented by a theoretical calculation of their values and a comparison with measured values. These calculations are performed by working with changes to the theory's internal components, as well as the internal domain and theory names. It is important to note that while some theoretical names (for example, model names and calculated values of reality properties) indicate certain pieces of knowledge about realities, their domain names are quite arbitrary and might be independent of the nature of the named realities.