AN OUTLINE OF THE IDEALIZATIONAL THEORY OF SCIENCE. FOUR BASIC MODELS

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It is believed to be a commonplace truth that the majority of laws in science are of an idealizational nature. Physics constructs mass-points or inertial systems, economics -closed economies, the humanities- rational subjects, etc, etc. But the juxtaposition of this observation with the picture of science made public in the philosophy of science is astonishing. One of features common to neopositivism and Popperian falsificationism, which are the two most influential methodological orientations for a long time, is that they completely ignore the role of idealization in science. Neither was the problem of idealization touched upon by later orientations[1]. It was only in the seventies that there appeared some new methodological proposals focusing their attention just upon this question.

The first person to realize how exceptional is the role played by idealization in science was Leszek Nowak. According to his views, idealization was not one of the methods used in science but it was the method of formulating scientific statements and theories. Thus he declared idealization to be the corner stone in the process of building scientific theory[2]. Shortly after this pronouncement views emphasizing the role of idealization were expressed by Frederick Suppe[3]. Nowak developed his idea into a full-blown theory within the philosophy of science. Since the early seventies his conception expanded in different directions and was refined, transformed and applied by its author, his collaborators and students [Nowak 1992] The amendments were so numerous that it is difficult to reconnoitre what is the present form of the idealizational conception of science.

The goal of my paper is to present the updated version of the idealizational theory of science. My exposition will contain a description of the main models of scientific theory as conceived by this theory of science. A special emphasis will be put on the problems of testing and explanation.

1. Model I

a. The structure of a theory

The Idealizational Theory of Science (ITS)[4] is based on the assumption that for each factor F there exists a set of factors $\{p_1, ..., p_k, p_{k+1}\}$ which influence the factor F. The set of those factors is termed the *space of essential factors* for F (in short: P_F). Factors from the set P_F influence F to a various degree. The set P_F ordered with respect to the intensity of the influence exerted on F is the *essential hierarchization* of P_F. If, for example within that order the factor p_{k+1} precedes p_k,

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the factor p_k precedes p_{k-1} etc, then it means that p_{k+1} is a *principal factor*, whereas the others are *secondary factors* for *F*. The following configuration of factors

S_F

(k)	p_{k+1}
(k - 1)	p_{k+1}, p_k
....	
(1)	$p_{k+1}, p_k, ..., p_2$
(0)	$p_{k+1}, p_k, ..., p_2, p_1$

is termed the *essential structure* of the factor *F*. On the (0) level of that structure appear all the factors from the set P_F. On the level (1) there are only factors $\{p_{k+1}, p_k, ..., p_2\}$, on the level (2) there are only factors $\{p_{k+1}, p_k, ..., p_3\}$ etc., and finally on level (k) there is only the principal factor p_{k+1}.

A hierarchical system of relationships (dependencies) which link factors from subsequent levels of S_F with the factor *F* corresponds to the essential structure N_F

(k)	f_k
(k - 1)	f_{k-1}
....	
(1)	f_1
(2)	f_0

This sequence of relationships is termed the *nomological structure* of the factor *F*. The dependence which links *F* with its principal determinant is termed the *regularity*. Dependencies linking *F* with factors from lower levels of S_F are the subsequent *forms of manifestation* of a regularity. An *i*-th-form of manifestation of a regularity is the superposition of a dependence linking *F* with factors from the *i*+1 level of S_F and the dependence expressing the influence of the factor p_{i+1} on *F* .

The aim of researchers is to formulate theories which describe regularities and subsequent forms of their manifestation. But various circumstances deform the process of the formulation of a theory and in consequence procedures for testing a theory and offering explanations with it become deformed too. ITS is thus constructed as a sequence of models. The model I of ITS shows how the formulation of a theory, its testing and explanation could proceed were it not disturbed by deformative circumstances. Further models take those circumstances into account, showing how they influence processes of constructing, explaining and testing a theory. The model I of ITS explains how an ideal researcher formulates laws, constructs and tests theories, as well as explains facts. The ideal researcher should obey the following postulates

(p_1) he can enumerate all the factors he believes to be essential for the magnitude he is interested in;

(p_2) he knows how all the factors he recognizes as secondary influence the magnitude studied;

(p_3) he can produce conditions under which all the factors recognized as secondary are set to zero (he possesses the technical means that enables him to conduct a perfect experiment);

(p_4) in constructing a theory of a given factor he is not assuming a theory of any other factor .

While building a theory of the factor F, an ideal researcher (in the sense of model I) first reconstructs the space of factors essential for F. The set of factors recognized by him as essential for F is termed an *image of a space of essential factors* for F and designated with the symbol $O(P_F)$.

Let us suppose that a researcher settled that $O(P_F) = \{q_1, ..., q_n, q_{n+1}\}$ but does not judge all the factors from the set $O(P_F)$ as equally important. In his next step he performs an essential hierarchization of the set $O(P_F)$, i.e. orders the factors from $O(P_F)$ with respect to the intensity of influence they exert on F. If that order takes the following form $q_{n+1}, q_n, ..., q_1$, then it means that in the researcher's view the factor q_n influences F most and the other factors influence it to a lesser and lesser degree. The first factor is considered by the researcher to be the principal factor, and the other ones to be secondary factors for F. Consequently, the researcher assumes that an essential structure of the factor F is a configuration of the following form

(n) q_{n+1}
(n - 1) q_{n+1}, q_n
....
(1) $q_{n+1}, q_n ,..., q_2$
(0) $q_{n+1}, q_n ,..., q_2, q_1$

The configuration of factors which a researcher believes to be identical with the essential structure of the factor F is termed the *image of an essential structure* of the factor F (in symbolic notation: $O(S_F)$).

Having distinguished principal and secondary factors in the set $O(P_F)$, the researcher constructs the most simplified picture of the investigated domain of reality. He eliminates from $O(P_F)$ those factors which he regards as secondary for F. The method of elimination is *idealization.* Idealization is performed by means of idealizational assumptions. ITS regards as an idealizing assumption a propositional function $p(x) = d$ if and only if d designates a minimum (usually zero) value of the factor p and that function is not satisfied by any real object from the universe of the considered domain.

Let q_i be one of factors recognized as secondary for F. Taking the idealizing assumption $q_i(x) = 0$, we abstract from the significance of that factor, excluding it from the set $O(P_F)$. Idealizing assumptions are accepted in such an order that they successively eliminate secondary factors in concordance with their greater significance. So, by virtue of the assumption $q_1(x) = 0$, the factor q_1 does not belong to the set $O(P_F)$ any more. The assumption $q_2(x) = 0$ eliminates from that set the factor - q_2 , etc. Finally, after accepting the assumption $q_n (x) = 0$, only the principal factor q_{n+1} belongs to the set. Thus following the above procedure, what is gradually reached are still shorter reducts of the initial image of the space of factors essential for F

$$\{q_{n+1}, q_n ,..., q_2, q_1\}, \{q_{n+1}, q_n ,..., q_2,\}, ...\{q_{n+1}, q_n \}, \{q_{n+1}\}.$$

A certain classification of objects from the range of the factor F is obtained simultaneously with the reduction of the initial list of essential factors. The objects characterized by the following conditions

$$U(x) \text{ and } q_1(x) = 0 \text{ and ... and } q_n(x) = 0 \text{ and } q_{n+1}(x) \neq 0$$

are *ideal types of the nth rank*, and those objects on which factors from the sequence $q_{n+1}, q_n ,..., q_i$ (for $1 \leq i \leq n+1$) assume non-zero value are *ideal types of lower ranks*. Ideal types of the lowest (zero) rank are real inquired objects on which all factors claimed to be determinants of F assume a non-zero value.

After performing the reduction of $O(P_F)$ and the classification of objects from the range F, an ideal researcher formulates an idealizational statement of the form

T^n_F: if $U(x)$ and $q_1(x) = 0$ and $q_2(x) = 0$ and... and $q_n(x) = 0$,
then $F(x) = k_n(q_{n+1}(x))$.

T^n_F is an idealizational statement because there are idealizational assumptions in its antecedent. Besides, it is just such an idealizational statement that applies to ideal types of the highest rank n. It postulates that a regularity is the relation k_n between the factor F and the factor q_{n+1}. This is recognized as the principal and only determinant of F in the domain of ideal types of the rank n. Statements of such a kind are defined in ITS as idealizational laws.

In the next stage an idealizational law is subject to subsequent *concretizations*. Idealizing assumptions are removed and corrections are introduced to the consequent of the law T^n_F. The removal of idealizing assumptions takes place in reverse order to that in which they were accepted. Therefore the first correction introduced takes into account the influence of the factor q_n which is the most significant of the secondary ones. The idealizational statement which contains this correction is a sentence of the following form

T^{n-1}_F: if $U(x)$ and $q_1(x) = 0$ and $q_2(x) = 0$ and ... and $q_n(x) \neq 0$,
then $F(x) = k_{n-1}(q_{n+1}(x), q_n(x))$

and it is called the *first concretization* of the thesis T^n_F. The statement T^{n-1}_F applies to ideal types of the rank n-1 and determines the common influence on F of the factors q_{n+1} and q_n, factors which are essential for F within the domain of ideal types of the rank n-1. The dependence k_{n-1}, which is intended to express that common influence and recognized as the first form of the manifestation of the regularity k_n, is a superposition of the dependence k_n and the dependence (called a correcting function) which holds between F and the factor q_n. Further concretizations of T^n_F are formulated following the same principles thereby representing subsequent forms of the manifestation of regularities. The procedure of concretization is completed when the *factual statement* of the following form has been formulated

T^{0}_{F}: if $U(x)$ and $q_1(x) \neq 0$ and $q_2(x) \neq 0$ and... and $q_n(x) \neq 0$,
then $F(x) = k_0(q_{n+1}(x), q_n(x), \ldots, q_1(x))$

In the antecedent of this statement there are no idealizing assumptions any more. It is the final concretization of the law T^{n}_{F}. The dependence k_0 described in this statement is a surface form of manifestation of the regularity k_n. The sequence of statements

$$T^{n}_{F} \longrightarrow\!\!| \; T^{n-1}_{F} \longrightarrow\!\!| \; , \ldots , \longrightarrow\!\!| \; T^{0}_{F}$$

where ——| denotes the relation of concretization, is the *simple idealizational theory* of the factor F.

b. Testing

The testing of a simple idealizational theory consists in testing an idealizational law and all of its concretizations. ITS defines that procedure in a way which does not differ considerably from the commonplace conception of testing in contemporary methodology of science. Although the commonplace conception deals exclusively with testing of factual statements (such as T^{0}_{F}), nevertheless, by virtue of the assumption (p_3) from model I statements belonging to an "idealizational part" of a theory are also being tested in a similar manner. For example, the testing of the law T^{n}_{F} under conditions of model I consists in producing such a situation in which $q_1(a) = 0$ and ... and $q_n(a) = 0$ and stating that, let us say, $q_{n+1}(a) = r$ and deciding whether the value of $F(a)$ equals $k(r)$ or is different from it. In the former case the law T^{n}_{F} is acknowledged as being confirmed whereas in the latter as being refuted.

c. Explanation

The correct explanation of the fact that the factor F assumes upon a given object such and such an intensity consists within model I, in showing how the value of F upon a depends on the value of the principal factor for F on the same object a and how is it modified by factors which are recognized as secondary. What is required here in model I is that the chain of explanatory premises should start with an idealizational law and then proceed according to the following scheme

$$T^{n}_{F} \longrightarrow\!\!| \; T^{n-1}_{F} \longrightarrow\!\!| \; , \ldots , \longrightarrow\!\!| \; T^{0}_{F} \text{ and } P \longrightarrow_{L} E$$

where the sequence $T^{n}_{F}, \ldots, T^{0}_{F}$ is a (tested) simple idealizational theory, ——| is a relation of concretization, $\longrightarrow_L$ the relation of entailment, P are initial conditions and E is the sentence to be explained.

2. MODEL II. THE STRUCTURE OF A THEORY

In model II the idealizing assumption (p_4) is replaced by the more realistic condition which claims that a researcher has at his disposal theoretical knowledge in the form of simple idealizational theories of the factors $F_1, \ldots, F_w$.

The removal of the assumption (p_4) leads to the modification of the concept of a scientific theory. Now a researcher who builds a theory of the factor F is characterized by the conditions (p_1), (p_2), (p_3) and non-(p_4). He can still proceed according to the strategy described in model I. But he makes use of that possibility only in the last resort, i.e. when he realizes that the theory of the factor F does not follow from a set of simple idealizational theories which are at his disposal. From the point of view of model II a typical way of building a simple idealizational theory of the factor F consists in deducing it from a set of previously accepted simple idealizational theories. A *compound idealizational theory* is thus a typical theoretical construct within that model. It is defined as a sequence of pairs (each pair being conceived of as a theoretical model)

$$(Z^n, T_F^n), (Z^{n-1}, T_F^{n-1}), \dots, (Z^0, T_F^0),$$

where:

(1) Z^n and T_F^n are sets of idealizational laws with the same n idealizing assumptions;
(2) statements from the set Z^i (assumptions of the i-th-model) are logically independent and the statement T_F^i (the solution of the i-th-model) is a consequence of statements from the set Z^i;
(3) the magnitude being determined in the statement T_F^i is the factor F;
(4) each statement from the set Z^i is a concretization of some statement from the set Z^{i+1}.

As can be seen, the structure of a compound idealizational theory is determined not only by the relation of concretization but by the relation of logical consequence as well. So a compound idealizational theory is a more realistic construct than a simple idealizational theory.

3. MODEL III.

a. The structure of a theory.

What is being analyzed within model III are the activities of a researcher who meets the condition (p_1), but fails to meet conditions (p_2), (p_3) and (p_4). The condition (p_2) is replaced within that model with an assumption saying that a researcher knows how *certain* secondary factors influence a magnitude being studied, and the condition (p_3) is replaced with an assumption saying that he can only minimize (but not reduce to zero) the intensity of factors recognized as secondary.

The consequence of removing the assumption (p_2) is a further still more realistic description of scientific theory. The counterpart of the concept of a simple idealizational theory introduced in model I (and valid also in model II) in model III is the concept of a simple approximational idealizational theory.

Let us suppose that an ideal researcher (in the sense of model III) knows how factors $q_n, \dots, q_{i+1}$ influence magnitude F, but he is unable to detect how the remaining factors from the set $O(P_F)$ influence magnitude F. In this situation he decides to perform a concretization of the thesis T^n_F with respect to factors q_n, ..., q_{i+1}. This results in the following statement

T^i_F: if $U(x)$ and $q_1(x) = 0$ and $q_2(x) = 0$ and... and $q_i(x) = 0$ and $q_{i+1}(x) \neq 0$ and... and $q_n(x) \neq 0$, then $F(x) = k_i(q_{n+1}(x), q_n(x), ..., q_{i+1}(x))$

Having obtained it he performs an approximation of the statement T^i_F. This approximation is a factual statement of the following form

AT^i_F: if $U(x)$ and $q_1(x) \leq a_1$ and $q_2(x) \leq a_2$ and... and $q_i(x) \leq a_i$ and $q_{i+1}(x) \neq 0$ and... and $q_n(x) \neq 0$, then $F(x) \approx_\varepsilon k_i(q_{n+1}(x), q_n(x), \ldots, q_{i+1}(x))$

where: $a_1, a_2, ..., a_i$ are (non-zero) numbers from the set of values of factors $q_1, q_2, ..., q_i$ and ε is a variable which depends on factors $q_1, q_2, ..., q_i$ in such a way that the smaller values of those factors are the smaller ε. The value of ε is always lower than the constant N (a threshold of approximation) chosen by a researcher.

The sequence of statements

$$T^n_F \text{ —| } T^{n-1}_F \text{ —| }, \ldots, \text{ —| } T^i_F \approx\approx| AT^i_F$$

where —| denotes a relation of concretization and ≈≈| denotes a relation of approximate concretization (approximation), is the *simple approximational theory* of the factor F.

The concept of a compound idealizational theory introduced in model II corresponds now in model to III the concept of the *compound approximational idealizational theory*. A compound approximational theory of the factor F is defined as a sequence of theoretical models (Z^n, T^n_F), ..., (Z^i, T^i_F), (AZ^i, AT^i_F). Its sub-sequence (Z^n, T^n_F), ..., (Z^i, T^i_F) shares all properties enumerated in the definition of a compound idealizational theory, and every assumption of the model (AZ^i, AT^i_F) is an approximation of some statement from the set Z^i, whereas the statement AT^i_F is a consequence of statements from the set AZ^i.

b. Measurement

What is also discussed in connection with the removal of assumption (p_2) in model III is the question of the empirical control of statements with the help of measurement procedures. The solution of this problem proposed in ITS draws its inspiration from Nagel's remarks in his *The Structure of Science*. Nagel observes that the central problem of the theory of spatial measurement is the question of the rigidity of measuring bars. For if the differentiating forces responsible for deformations of those bars are not eliminated then a measurement will be charged with some error[5].

Therefore, in Nagel's view, each method of spatial measurement "tacitly involves the notion of a rigid body which in theory is isolated from influences that may alter the relative lengths of physical objects and which *by definition* therefore has an unchanging length" [Nagel 1970, p.227].

Nagel adds that in the case of errors caused by deformations of measuring bars -"numerical values ascribed to spatial magnitudes as a rule will not be bare numerical data". Those bare numerical data are usually subject to a correcting analysis [Nagel 1970, pp.228-229]. He does not explain, though, whatthat analysis would really consist in.

From the point of view of ITS, Nagel's remarks are accurate but inconsistent with his own methodological conception. For they lead to the conclusion that it is not true that measurement reports are sentences of the following type

(1) $W(x_0) = kd\ (s_0)$,

where W is the dimension (e.g. length) of a measured object x_0, d is the length of a measuring bar s_0, and k is the number of applications of s_0. Sentences of that form are formulated in science, but with the tacit assumption that s_0 is a (perfectly) rigid measuring bar. In such a case sentence (1), in its full formulation, is an *idealizational measurement report*

(2) if $F_r(s_0) = 0$ and $A(s_0, x_0)$, then $W(x_0) = kd\ (s_0)$,

where F_r is the sum of differentiating forces whereas $A(s_0, x_0)$refers to the activity of applying the bar s_0 to the object x_0. A researcher interested in the accurate result of a measurement makes concretization of the thesis (2). The concretization of (2) is the following sentence

(3) if $F_r(s_0) = m$ and $A(s_0, x_0)$ then $W(x_0) = kd\ (s_0) + (m)$,

where $m > 0$, and Θ is a correcting function showing how differentiating forces deform the bar s_0. If $F_r(s_0) = m$, then what can be inferred from (3) is a *factual measurement report*

(4) $W(x_0) = kd\ (s_0) + \Theta(m)$.

A researcher who does not need exact data or cannot perform concretization contents himself with an approximation. The approximation of the thesis (2) is the statement of the following form

(5) if $F_r(s_0) \leq$ a and $A(s_0, x_0)$, then $W(x_0) \approx_\varepsilon kd\ (s_0)$

from which, if $F_r(s_0)$ = b and b $\leq$ a, a factual report of the following form is inferred

(6) $W(x_0) \approx_\varepsilon kd\ (s_0)$

Factual reports of the type (4) or (6) are used in hypotheses testing, although to be able to formulate such factual reports one has to start with the formulation of idealizational measurement report.

c. Testing

Since perfect experiment is not possible any more within model III, a researcher considered in it is not able to perform tests of statements belonging to an "idealizational part" of a theory. It refers to tests conceived of in an ordinary way, i.e. in accordance with the commonplace conception of a theory and its testing. But he may use the strategy of approximations of idealizational statements. A positive result of testing the approximation of a statement indirectly confirms its idealized form. But a negative result of testing does not lead to its immediate disconfirmation. Rejection of an idealizational statement can be accepted only when approximations of all its concretizations have been disconfirmed.

d. Explanation

What also alters in model III, together with the concept of a theory, is a scheme of explanation. It assumes the following shape

$$T^{n}_{F} \text{---}| \; T^{n-1}_{F} \text{---}| \; , \dots , \text{---}| \; T^{i}_{F} \approx\approx| \; AT^{i}_{F} \text{ and } P \longrightarrow_{L} E$$

where the sequence of statements T^{n}_{F}, $T^{n-1}_{F}, \dots,$ T^{i}_{F}, AT^{i}_{F}, is a simple approximational idealizational theory of the factor *F*.

4. Model IV

a. The structure of a theory

A researcher in model IV does not meet any of the assumptions (p_1)-(p_4) listed above. He knows, in particular, that the magnitude *F* he is interested in is influenced by some factors which he is unable to identify. Such factors are termed in ITS *disturbing factors.* An image of the essential structure of the factor *F* which a researcher knows to be incomplete, because it does not take into account all factors essential for *F*, is a scheme of the following form

(n) q_{n+1}
(n - 1) q_{n+1}, q_n
....
(1) $q_{n+1}, q_n, \dots, q_2$
(0) $q_{n+1}, q_n, \dots, q_2, q_1, z^F$

where z^F is a set of disturbing factors. The structure of this form is called the *image of an essential structure (of the factor F) open to disturbances.*

The influence of disturbing factors is eliminated by the acceptance of a *semi-idealizing assumption* of the following form

$$\forall z^{F}_{x} = 0.$$

It says that all factors from the set z^F assume a zero intensity on an object *x* . A statement with a semi-idealizing assumption in its antecedent is the *semi-idealizational statement.* A semi-idealizational statement in the antecedent of which there are also idealizing assumptions is termed the *semi-idealizational statement of the first kind*, and a semi-idealizational statement in the antecedent of which there are no idealizing assumptions is termed the *semi-idealizational statement of the second kind.*

Let us suppose that a researcher from model IV has accepted the following statement (a semi-idealizational law of the first kind)

ST_F^n: if $U(x)$ and $\forall z_x^F = 0$ and $q_1(x) = 0$ and $q_2(x) = 0$ and... and $q_n(x) = 0$, then $F(x) = k_n(q_{n+1}(x))$

and has concretized it with respect to the factors $q_n(x)$, ..., $q_1(x)$ obtaining finally the following statement

ST_F^0: if $U(x)$ and $\forall z_x^F = 0$ and $q_1(x) \neq 0$ and $q_2(x) \neq 0$ and... and $q_n(x) \neq 0$, then $F(x) = k_0(q_{n+1}(x), q_n(x), \ldots, q_1(x))$

Then, by removing the semi-idealizing assumption, that is accepting that $\exists z_x^F \neq 0$ (at least some factors from the set z assume a non-zero intensity on the object x), he performs statistical concretization of ST_F^0.

A statistical concretization of ST_F^0 is the following statement

PST_F^0 : prob{[$F(x) = k_0(q_{n+1}(x), q_n(x), \ldots, q_1(x))$] / ($U(x)$ and $\exists z_x^F \neq 0$ and $q_1(x) \neq 0$ and $q_2(x) \neq 0$ and... and $q_n(x) \neq 0$} = p.

The following sequence of statements

$$ST_F^n \longrightarrow\!\mid ST_F^{n-1} \longrightarrow\!\mid, \ldots, \longrightarrow\!\mid ST_F^0 \longrightarrow\!\mid_s PST_F^0$$

where $\longrightarrow\!\mid_s$ denotes a relation of statistical concretization is a *simple semi-idealizational theory* of the factor F.

We would have a slightly different type of semi-idealizational theory if the semi-idealizational law were concretized only with respect to the factors $q_n(x)$, ..., $q_{i+1}(x)$

ST_F^i: if $U(x)$ and $\forall z_x^F = 0$ and $q_1(x) = 0$ and $q_2(x) = 0$ and... and $q_i(x) = 0$ and $q_{i+1}(x) \neq 0$ and... and $q_n(x) \neq 0$, then $F(x) = k_i(q_{n+1}(x), q_n(x), \ldots, q_{i+1}(x))$

Then the statement ST_F^i undergoes approximation

AST_F^i: if $U(x)$ and $\forall z_x^F = 0$ and $q_1(x) \leq a_1$ and $q_2(x) \leq a_2$ and... and $q_i(x) \leq a_i$ and $q_{i+1}(x) \neq 0$ and... and $q_n(x) \neq 0$, then $F(x) \approx_\varepsilon k_i(q_{n+1}(x), q_n(x), \ldots, q_{i+1}(x))$

whereas AT_F^i undergoes statistical concretization

$PAST_F^i$: prob{[$F(x) \approx_\varepsilon k_i(q_{n+1}(x), q_n(x), \ldots, q_{i+1}(x))$] / ($U(x)$ and $\exists z_x^F \neq 0$ and $q_1(x) \leq a_1$ and $q_2(x) \leq a_2$ and... and $q_i(x) \leq a_i$ and $q_{i+1}(x) \neq 0$ and ... and $q_n(x) \neq 0$]} = p

The sequence of statements

$$ST^n_F \text{ ——I }, \ldots, \text{ ——I } ST^i_F \approx\approx\text{I } AST^i_F \text{ ——I}_s\, PAST^i_F$$

obtained in that way, where ——I denotes a relation of statistical concretization, is the *simple approximational semi-idealizational theory* of the factor F.

A *compound semi-idealizational theory* is a sequence of theoretical models of the form

$$(SZ^n, ST^n_F), \ldots, (SZ^0, ST^0_F), (PSZ^0, PST^0_F),$$

where:

(1) SZ^n and ST^n_F are sets of semi-idealizational laws with the same n idealizing assumptions and with the same semi-idealizing assumption;
(2) the statements from the sets $SZ^n, \ldots, SZ^0, PSZ^0$ are logically independent, and the statements $ST^n_F, \ldots, ST^0_F, PST^0_F$ in which the magnitude being determined is the factor F are logical consequences of statements from the sets $SZ^n, \ldots, SZ^0, PSZ^0$ respectively;
(3) every statement from the set SZ^i is a concretization of some statement from the set SZ^{i+1};
(4) every statement from the set PSZ^0 is a statistical concretization of some statement from the set SZ^0.

A *compound semi-approximational theory* of the factor F is defined as a sequence of theoretical models

$$(SZ^n, ST^n_F), \ldots, (SZ^i, ST^i_F), (ASZ^i, AST^i_F)\ (PASZ^i, PAST^i_F)$$

where:

(1) SZ^n and ST^n_F are sets of semi-idealizational laws with the same n idealizing assumptions and with the same semi-idealizing assumption;
(2) the statements from the sets $SZ^n, \ldots, SZ^i, ASZ^i, PASZ^i$, are logically independent and the statements $ST^n_F, \ldots, ST^i_F, AST^i_F, PAST^i_F$ in which the magnitude being determined is the factor F are logical consequences of the statements from the sets $SZ^n, \ldots, SZ^i, ASZ^i, PASZ^i$ respectively;
(3) every statement from the set SZ^j (for $i \leq j < n$) is a concretization of some statement from the set SZ^{j+1};
(4) every statement from the set ASZ^i is an approximation of one of the statements from the set SZ^i;
(5) every statement from the set $PASZ^i$ is a statistical concretization of some statement from the set ASZ^i.

b. Testing

Let us suppose that from the semi-idealizational law ST^n_F it follows that $F(a) = n$ and from an approximation of that law that $F(a)\ \alpha\ n$, and from a statistic concretization of that approximation it follows that

$*PAST^{n}_{F}$: prob{[$F(x) \approx_{\alpha} n$] / ($U(x)$ and $\exists z^{F}_{a} \neq 0$ and $q_1(a) \leq b_1$ and $q_2(a) \leq b_2$ and... and $q_n(a) \leq b_n$} = β

The thesis $*PAST^{n}_{F}$ is an *admissible prognosis* if α and β are not greater than a threshold of approximation and a threshold of statistic concretization, respectively.

The principle of testing that is valid in model IV has the following form. A semi-idealizational statement is considered confirmed if a statistic concretization of its approximation provides admissible prognoses; and it is considered disconfirmed if these prognoses, as well as prognoses inferred from statistic concretizations of approximations of subsequent strict concretizations of the thesis being tested turn out to be inadmissible.

c. Explanation

According to model IV the procedure of explanation takes place according to the following scheme

$$ST^{n}_{F} \text{——|}, \dots, \text{——|}\; ST^{i}_{F} \approx\approx| AST^{i}_{F} \text{——|}_{s} PAST^{i}_{F} \text{ and } P \text{——>}_{L} E$$

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Notes

[1] In the methodological literature of the period there are many various partial analyses of idealization [cf. e.g. Rudner 1966, pp.54-62, Barr 1971, pp.258-271, Barr 1974, pp.48-64]. These analyses did not become a starting point for any general theory of science.

[2] "A scientific theory is not a simple description of phenomena occurring around us, but it is formulated with some idealizational assumptions which leave out some features of phenomena studied and underline - as more important - others of them" [Nowak 1970, p.139].

[3] "Science is not concerned with phenomena in all their complicacy, being rather interested in some kinds of phenomena insofar as their behaviour is determined by a small number of parameters abstracted from those phenomena. Thus, the classical mechanics, while characterizing a falling body, is not interested only in those aspects of behaviour of a falling body which depend on velocity, distance covered in time etc.A colour of an object etc is one of those aspects of phenomena which are omitted. The process of abstraction from phenomena goes one step further, though - we are not interested in real velocity etc, but in velocity under idealized conditions. So, for instance, the classical mechanics is interested in the behaviour of idealized systems of dimension-less mass-points which influence one another in vacuum where the behaviour of those mass-points depends only upon positions and momenta in a given time" [Suppe 1972c, p.11-12].

[4] I present main ideas of the Idealizational Theory of Science on the basis of L. Nowak's works [1974a, 1980, 1992].

[5] "numerical values ascribed to spatial magnitudes in the measuring procedure will will in general depend on the particular period of time in which measurement is made, as well as on the particular materials used in the construction of measuring instrument" [Nagel 1970, p.227].