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On Models, Objects, Fantasy

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This article presumes that a media theoretical discourse on modeling can be effectively stated in structural and functional terms that are shared to a certain extent by mathematics and science. This leads to constructions in non-classical logic, set theory, and topology that are necessary to understand questions that are usually excluded from scientific discourses because they challenge the dominant paradigms of causality, representation, or identity.

We are primarily interested in writing practices or media operations that demonstrate different aspects of model-object relations, and not in models as immaterial, purely formal, non-temporal, or non-spatial entities or ideas. The insight that practices such as writing, diagramming, counting, imaging, etc. predate any specific philosophical or scientific concept or theory of text, image, and number is not new: it belongs to the premises of so-called ‘German media theory’ that emerged among European philosophers, historians, and literary scholars in the late 1980s around questions of textuality, structuralism, technology, knowledge, and science.¹ Even though a few scholars in this field have successfully engaged with the history and philosophy of science, mathematics, logic, or engineering to a degree that one could say the subject of media theory is science, mathematics, and technology, the discourse over all has so far failed to formulate any consistent methods that would enable an actual dialogue with mathematics, logic, or science beyond the individual scholarship. This can be interpreted as the media problem of media theory, i.e. that media theory still lacks a *writing* which would allow it to not only talk about mathematics, science, or engineering, but actually enable a dialogue with these disciplines.

¹ In lack of a better term we refer to the label of “German Media Theory” even though it is misleading, because the German discourse was heavily influenced by French structuralism and post-structuralism such as Jacques Lacanian psychoanalysis or Jacques Derrida’s literary theory, as well as Canadian and US American media studies. See for a general discussion on ‘German Media Theory’, ‘Cultural Techniques’ and in particular the work of Friedrich Kittler: Bernhard Siegert and Geoffrey Winthrop-Young, *Cultural Techniques: Grids, Filters, Doors, and Other Articulations of the Real*, First edition, Meaning Systems, Volume 22 (New York: Fordham University Press, 2015); Bernard Dionysius Geoghegan, “After Kittler: On the Cultural Techniques of Recent German Media Theory,” *Theory, Culture & Society* 30, no. 6 (August 12, 2013): 66–82. A good searchable resource for publications and discussions is also Jussi Parrikka’s blog *Machinology* (<https://jussiparrikka.net/category/german-media-theory/>).

1. Some Definitions and Demarcations

In this article, we draw a distinction between object and thing. An object can be named and defined. For example, René Descartes defines an object as a physical entity with mass and extension in the sense of *res extensa*; or again, Gottlob Frege and Rudolph Carnap define an object as what falls under a concept.² Whereas a Thing functions as an unnamed object that presents itself as being impossible to define and symbolize (i.e. in classical logic) and for this very reason insists on being symbolized as an object of desire, i.e., fantasy object.

For example, in Galileo's science the totality of the natural numbers was an impossible to symbolize Thing until Georg Cantor formulated set theory and created an actual infinity where 1,2,3... does not go on forever, but is generated by the formula 'n+1' and included in an object, i.e., the set of natural numbers. This movement from the *real* - the impossible to symbolize in science - to *reality* - the possible to symbolize in mathematics - is used here simply to landmark how a simple writing procedure may be used to achieve something that was impossible at a phenomenological or empirical level.

Psychoanalysis coined the terms, Thing and fantasy-object to explain, respectively, the structure of drive and desire around the problem of symbolization. Though it is uncommon (but not unheard of, see Max Black's utilization of Jung's archetypes) to use the framework of psychoanalysis in the context of mathematics and science, we have the conviction that it is crucial to explain the function of modeling both within and without the realm of science. For instance within the history of science, a prominent position by Hans-Jörg Rheinberger implicitly utilizes the structure of the drive to describe the epistemology of experimental research. It states that models of science are used precisely because that what drives scientific research, the *epistemic thing*, is somehow absent, deprived, not ready-at-hand, or yet unknown. While the French predecessors of this line of historic epistemology such as Gaston Bachelard still operated openly with psychoanalytic vocabulary using terms like 'desire', 'libido', or the Freudian 'thing' (as cipher for the unconscious) that are carefully

² Cf. Gottlob Frege, "Über Begriff Und Gegenstand," in *Funktion, Begriff, Bedeutung - Fünf Logische Studien*, ed. Günther Patzig (Göttingen: Vandenhoeck & Ruprecht, 2008), 47–60. P. 49. and Rudolf Carnap, *Der Logische Aufbau Der Welt*, 3rd ed., 1966. p. 5. On the difference between thing and 'vorgestellter Gegenstand', see Martin Heidegger, *Bremer Und Freiburger Vorträge (GA79)* (Frankfurt a. M., 2005). p. 16.

avoided by Rheinberger who rather refers to Heidegger's notion of *Zeug* (ready-to-hand) to explain the dynamics of experimental systems.³

In this paper, we agree to keep psychoanalytic, or any expert vocabulary for that matter, to a minimum because if used metaphorically it becomes just as confusing as the technoscientific jargon that has plagued both German and U.S. media theory. Instead, we propose *constructions* that can be given a semantics based on psychoanalytic, philosophical, mathematical, logical, or linguistic theories. Because of the heterogeneity of the diverse fields, it is important that our constructions can be followed by the expert and non-expert alike.

This paper explores the possibility for developing a media theoretical analysis of model-object relations that can account for both fantasy and formalization in the realm of models, independent of the discursive context in which they appear. We will show through examples where a media theory has to divert from the philosophy and history of science and technology, a demarcation which also implies a certain proximity to these disciplines. For instance, within the philosophy of science and technology, most model theories set up the problem diachronically, suggesting that the history of models began with iconic or haptic, concrete types of models that resemble the form or Gestalt of the modeled object simply on a different scale or in a different medium. From there, models seem to have progressed to more abstract or even purely structural models that lack any analogy with the object in form/Gestalt as they are used today ubiquitously in mathematics, engineering, and science.⁴

³ Hans-Jörg Rheinberger's dual notion of *technical objects* and *epistemic things* has been productive both in media theory and history of science, but he uses 'thing' and 'object' synonymously, which dissolves the distinction between the two elements in experimental systems - epistemic things and technical objects - into somewhat of a gradual differentiation. What he coins 'epistemic thing', he also refers to as 'research or scientific object'. These things or objects are "physical structures, chemical reactions, biological functions, that constitute the objects of inquiry. As epistemic objects, they present themselves in a characteristic, irreducible vagueness. This vagueness is inevitable because, paradoxically, epistemic things embody what one does not yet know. Scientific objects have the precarious status of being absent in their experimental presence; they are not simply hidden things to be brought to light through sophisticated manipulations." (Cf. Hans-Jörg Rheinberger, *Toward a History of Epistemic Things: Synthesizing Proteins in the Test Tube* (Stanford, Calif.: Stanford, Calif.: Stanford University Press, 1997), p. 28.)

⁴Cf. Max. Black, *Model and Metaphors: Studies in Language and Philosophy* (Ithaca, New York: Cornell University Press, 1962).. Roland Müller, "The Notion of a Model: A Historical Overview," in *Philosophy of Technology and Engineering Sciences*, ed. Anthonie Meijers (Amsterdam: Elsevier, 2009), 637-64. Bernd Mahr, "Das Wissen im Modell," *KIT-Report Berlin: Institut für Telekommunikationssysteme, Projektgruppe KIT 150* (2004): 21. Gelfert takes a more functional approach and starts his primer on scientific models with the Ising Model of ferromagnetism (cf. Axel Gelfert, *How to Do Science with Models*, SpringerBriefs in Philosophy (Cham: Springer International Publishing, 2016), <https://doi.org/10.1007/978-3-319-27954-1>. p.1.)

We would like to propose a synchronic approach by asserting that the primary relationship between model and object is not mimetic, but *functional*. As an example, we think of a child that plays with a toy, let us say a hobby horse. For the playing child, the hobby horse is a model of a horse not because it ‘describes the object horse in a certain way’, but because it can be used like a horse. Contrary to appearances, a model does not work within the field of mimesis (description, resemblance, illustration, transfer of properties) but has a functionality within the field of language (sentential functions, nomination, performance, and utility). Thus, a hobby horse can be spoken about and function as a model and not resemble it at all. This is Gombrich’s famous example: The hobby horse is made out of a broomstick, buttons, and rags, and it functions like a horse in the theory-fantasy of the child.⁵ Further still, anything that can be said about a horse by the child, any sentence that is true about a horse in the theory qua fantasy of the child, can be said and done with the hobby horse. For example, the hobby horse makes the statements of the fantasy of the child seemingly true (‘a is a horse’ is true in a hobbyhorse model). But this ‘seemingly’ is still a forced way of speaking, since if the hobby horse is actually a fictional object, it must not simply contain true statements relative to a model, but contain false statements. Usually, when people speak of ‘theories’ they mean only the collection of true statements that are verified either by deductive or experimental procedures. If the Thing is being used as a model of a theory, then it is made functional and used to confirm true statements of that theory. But a childlike theory becomes a fantasy because it includes false statements about a Thing that has lost its commonsensical attributes and where, at the limit, nobody knows what is being talked about or referred to. A child can say, for instance, ‘The car flies through the air’ which, in the theory of the child, may be taken for the true in reference to a car that he throws across the yard. The child may insist on the reality of the statement while the adult speaks of its irreality. The adult may insist that it is a ‘model-car’ and as such confirms true statements about cars on streets, while the car for the infant may not at all be a ‘model’ and is, on the contrary, being used to confirm false statements that refer to some unknown or imaginary Thing. Thus, the fantasy object can confirm both false and true statements, while the model object confirms only true statements. Here we recognize the difference between *structure* and *model*: a *structure* satisfies both true and false statements while a *model* only true. We will come back to this important distinction in section 2 below.

⁵ E. H. Gombrich, *Meditations on a Hobby Horse, and Other Essays on the Theory of Art ... 3rd Ed.* (London: Phaidon, 1978). p.4.

Clarification

In the above, what is meant by a theory qua fantasy of the child?

Here, we need to make the distinction between the subjective and objective 'of'. That is to say, between the child's theory (subjective) and the theory about the child (objective). Traditionally, the analytic Object Relations School, from Klein to Winnocott, reduces the 'theory of the child' to the objective interpretation and attempts to verify its hypotheses in the observation of the child. In which case, the use of false and meaningless statements are viewed as a regression on the part of the observed, the child, and not the observer, the therapist (contrary to what many critics of psychoanalysis may think). On the other hand, subjectively, we can ask what would be a child's theory, or more precisely, a childlike or infantile theory, which is not simply a theory happening inside the head of the child (still psychology), but a kind of theory that would admit false, if not meaningless statements from the place of the adult. No doubt, if we define a theory as a collection of true statements and/or theorems, then we must change our definition of *theory* to something like that of a *doctrine* if we want to write false statements within the theory itself (See section §2.). With regard to the analytic tradition, it should be noted that after 1923 and the publication of *The Genital Organization of the Infant*, Freud no longer speaks of children's sex or a theory of sexuality as he had in the *Three Essays on Sexuality (1906)*, but the childlike aspects of sex, i.e., an infantile theory which inevitably must contain false statements. Unfortunately, the mainstay of the post-Freudian tradition, both pro and con, have bypassed this nuance.

Coming back to our description on differentiating the construction of a model from a structure:

A. Take a domain of things, and specify any object, a spool, a chair, bicycle, etc., then use it to confirm a true statement like 'b is made of wood'. Create a collection of such statements in correspondence to such an object. Now call this object a 'model' and the collection of true statements a 'theory'. We can have a theory of spools, for example, where one specified spool, can be taken as a model for any true statement on a spool. Here, 'a spool' is not a referent, but a referential function, a

'specified spool', that corresponds an object of a domain to a predicate and name in the language of the theory.⁶

B. Now, take the same domain of things, but this time use it to confirm a false statement, then ask what the referent of a false statement is, or indeed, what would a theory be that would include such objects or statements. A theory of a child? An infantile theory? Leaving a detailed response to these questions for later. Create a collection of such false statements in correspondence to such a referent. Now, call this Thing at the limit, a 'fantasy-object' and the collection of false statements attempting to designate it a 'fantasy proper'. We can have a fantasy spool, for example, where 'that spool there' is taken as a kind of screen, or indeed, fantasy, referred to by *a false statement on some Thing* we may be simply ignorant of or not.

What is important to note is that in the fantasy (B) of a child, an object like a spool no longer functions as a model for all spools, but is put into a very singular relation of the child to replace some Thing that is missing from the domain or universe of discourse of the child. It is the inclusion of this void into the domain, or more extensively, the consideration of a Thing without an underlying domain or universe of discourse, that distinguishes a model-theory from a theory of fantasy. More simply, one could say that the false or fictional statements that the spool confirms in the discourse of the child, 'The spool flies like a bird', 'The spool is a little man', etc. refer to nothing, i.e., they are fictions of language without a domain.

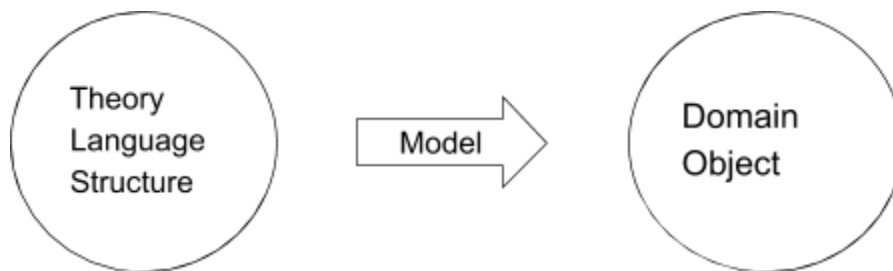
What is more, because the object is no longer simply a model, but the object of a fantasy, it cannot be substituted for any other spool, it is not *relative*, it is not a *type of spool or a functional spool*, but an *absolute*: it is that spool itself that the child desires. Many parents have noticed that not just any blanket or toy will do when appeasing the cry of a child: it is that toy or that blanket that does so. And should one take it away, it is as if the parent has just taken away any possible toy and destroyed its universe.

⁶ A technical footnote: to introduce an object, or individual, into a theory requires not introducing a singular object, or Thing, into the theory in the sense of 'that object', but a type of object. Though there are various ways of introducing this typification, from B. Russell's theory of Definite Descriptions and Hilbert's Epsilon Calculus to the modern theory of Categories, we only call attention to the problem here.

2. Models in Mathematical Logic

Mathematical logic, surprisingly as it may sound to non-mathematicians, is able to symbolize/write not only *models* - which can only confirm true statements of a relative nature or quality - but *structures* which can confirm both true and false statements. This is a decisive point of contact between mathematical logic and media theory, since it allows us to give a coherent reading and effective writing of falsehoods that would have been, in other accounts, left to an aesthetic and literary presentation of fiction. This is why we say that the fantasy object has not simply an imaginary, but real component that belongs both to an individual subject and object.

In mathematical logic, the model connects the language of a theory to a domain of objects by determining an interpretation of the language:

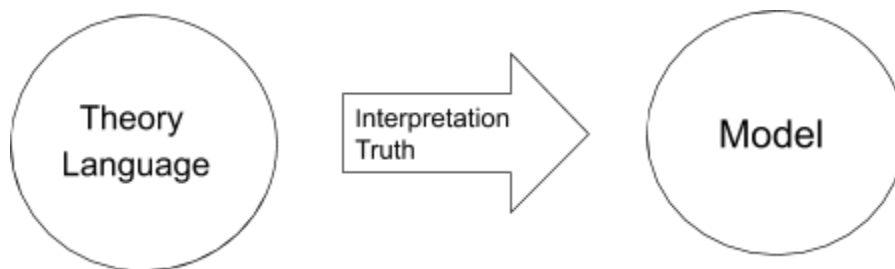


If we are concerned specifically with a mathematical theory-language, then J. Keisler and C.Chang give the following definition: “Model theory is the branch of mathematical logic which deals with the relation between a formal language and its interpretations, or models.”⁷

Or, in the pretense to create a more formal theory, one can drop the consideration on the domain/object and simply state the domain is not empty, then call model theory the interpretation of the formal language in a model. In which case any consideration of the Object-domain has been subsumed by the Model.

Thus:

⁷ Chen Chung Chang and H. Jerome Keisler, *Model Theory*, 3rd ed, Studies in Logic and the Foundations of Mathematics, v. 73 (Amsterdam ; New York : New York, NY, USA: North-Holland ; Sole distributors for the U.S.A. and Canada, Elsevier Science Pub. Co, 1990). p1.



The question of how a text or image relates to the material of a mathematical writing - symbols, markers, etc. - and how this leads to true or false statements of both theory and material objects, is related to the media theoretical question of how to describe an object that is both inside and outside the subject and that - by resisting symbolization - insists on being symbolized.

For this purpose, one specific area of mathematical model theory seems to be worthwhile spending at least a little time on: the so-called semantic model theory in the tradition of Alfred Tarski which, at its core, is an investigation into the correspondence between a formal language of a theory and its domain by determining a truth-definition and a model.⁸

A model in this restricted sense is a material piece of text or an object, that can produce true statements about a set of individual objects, but only if there is already some meaning attached to them. This is why the phrase ‘the semantic theory of models’ is used by Tarski since the problem of truth is regulated, in a *relative* sense, to an interpretation in a model. One says, for example, ‘ $2+2 = 4$ ’ is true in the model of natural numbers \mathbf{N} . Or the structure $(\mathbf{Z}, +)$ satisfies the axioms of a group since any statement formulated using integers and addition in \mathbf{Z} such as $2 - 3 = -1$ is true in a group, whereas the structure $(\mathbf{N}, +)$ is false in a group since it does not allow for an inverse operation. What is important to note here is that this writing of a false structure is never detailed or taken seriously in the construction of theory.

⁸ Cf. Alfred Tarski, “The Concept of Truth in Formalized Languages,” in *Logics, Semantics, Metamathematics. Papers from 1923 to 1938*, 2nd ed. (Indianapolis, IN: Hackett Pub. Co., 1983), 152–269.

The reference of the parenthetical writing of a structure such as $(Z,+)$ is not yet confirmed as true or false on a domain but is only relative to the language of a theory. More simply put, *models* are relative to a domain - or other models or theories - while *structures* are relative to the language of a theory. If a mathematician or scientist is not interested, in *theory*, in writing false statements, their *practice* cannot avoid them. The question remains as to whether there is not something like a *theory*, a *doctrine*, for example, that would be able to include a reference to the mathematical and scientific act and false statements, without reducing this to mere questions of errors of practice.⁹

To begin to respond to this question, let us introduce here a more *absolute* definition of truth, Tarski's celebrated *Truth-Structure*, where the truth of statements like 'The snow is white' is true if and only if the snow is white', may be confirmed as true without any reference to a model or underlying domain.¹⁰

Tarski formulated this surprising result by first noting that in order to state the truth of a statement it must conform to two conditions: it must be formally correct and materially adequate. In the former case, a formal system or scientific language can not be left in the state of ordinary language and be allowed to refer to itself. Thus, if we write:

The snow is white is true

We cannot tell whether the predicate 'is true' refers to the letters in the sentence or to what the sentence refers to. So in order to insure that we are indeed not referring to the letters on the page, a scientific language must make a distinction of levels and correct the sentence with quotations to read:

'The snow is white' is true

Here, now the sentence 'The snow is white' is a citation or mention and is formally correct in that we have avoided the problems that come with self-reference (the Liar's paradox, Grelling's Paradox, etc.).

⁹ The modern theory of categories can be considered in some respects as an attempt to generalize the theory of models to the practice of the mathematician.

¹⁰Tarski, *The Concept of Truth in Formalized Languages*, 193. p. 156.

By providing one further condition, a material adequation, we can finally state the truth. If 'the snow is white' is just a citation, we must determine what it is a citation of. This 'what' can be written on the right hand side as:

'The snow is white' is true if and only if the snow is white

Now, the sentence on the right hand side is what the quoted sentence on the left hand side is true of. Though there have been several different interpretations of just what this material adequation refers to, they mainly fall between two polar opposites, a realist or idealist interpretation of material adequation. The realist says that 'the snow is white' is true because it corresponds to an object in reality and the statement on the right is just a description of this reality, while the idealist says that the sentence is true because it corresponds to the coherence of a world view or *Weltanschauung*. Without examining all the possibilities here, it suffices for our argument to note that Tarski himself said neither. Rather he took a survey and noted that the everyday person in the street said that statements were true, not because they correspond to the facts or a world view, but because they are stated and said, i.e., that it is on this purely enunciative act of speech that something is true.

Contrary to Tarski's absolute theory, 'truth' in the context of any model theory has its limits: whatever a model speaks about can only be 'true in a model', i.e., in a theory or model previously formulated in some kind of language. Thus, we can write:

'The snow is white' in English and in a geographical model if and only if the snow is white

Here, stating the truth of a sentence is restricted to a reference to the English language and accompanied with a specific domain of investigation (geography) where snow could be found. Yet, what is often bypassed or confused is that Tarski's more *absolute structural* definition has no such limitations. For example, we can make the following true statement:

'The sky is polka dot' is true if and only if the sky is polka

Or even write more formally:

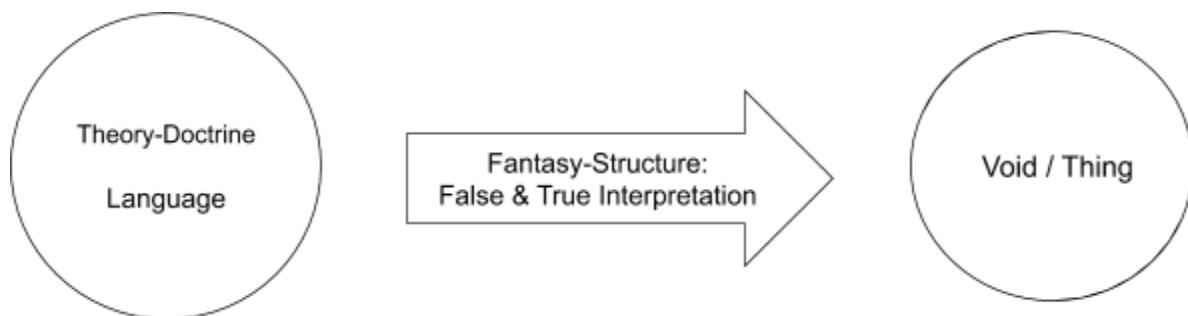
$\delta(a) \Leftrightarrow p$

Where we have not yet given any specific interpretation to the language being used to state a truth definition. (If we should so desire, we can make 'δ' stand for 'the truth', while 'a' is the name of the sentence 'p' made equivalent by '↔').

What is important to note here is that truth and structure, once disengaged from a model, no longer depend on a previously established domain, interpreted language, or theory.

If all models are structures, in the sense that they are specified by the written formulas of a theory, not all structures are models: there are not only structures that are satisfied by false, if not meaningless statements, but structures that have no underlying domain or ontology.

To conclude this section we abbreviate a theory of structure with a diagram:



No doubt, these are only informal and introductory remarks of problems that merit a more detailed presentation¹¹. But in this introductory section, a parable may help to set our vocabulary.

In using her radar a flight controller at an airport can look at the blip on her screen (model) to determine whether an airplane (object) is coming in at the right time, runway, altitude, etc. These are all confirmed as true statements in English (language) by the flight controller and tested by the measurements (theory) done by computers on the plane and in the control

¹¹ For a more detailed exposition, see Robert Groome: "The Phantom of Freud in Classical Logic", *Umbra(a): Science and Truth*, Buffalo, n.y. 2000, 117-142.

tower. Now, imagine there is nothing there (Thing), but the flight controller still thinks there is a blip, or inversely, there is something there and there is a blip, but the flight controller doesn't see it. In these two cases, the blip need not be simply an accident or error of the controller or the devices, but could very well be a fantasy if it allows her to formulate not simply an accident of practice, but produce false statements that may be believed in and affirmed in a theory-doctrine. This difference between the construction of fantasy - as the formulation of false statements in a doctrine - and the experience of fantasy *in practice*, as indistinguishable from error, obstacle, and accident, will become crucial in our next section. This has epistemological consequences: A mathematical model may explain mechanical systems, at the limit of what an animal does, but the moment it includes the subject (in any physical, social, or cognitive aspect) it fails.

3. Models and Fantasies in Science

Unlike mathematical structures, a scientific or 'theoretical' model (in the terminology of Max Black) can not work with a singular or thing that would not be restricted to a type just as it cannot work with a universal that would not be restricted to a domain. Here, then, for the purposes of this paper we make the distinction between a *restricted universal*, or the general, and an unrestricted universal. In a similar manner, we make the distinction between a typified object, or particular object, and a singular object that is not restricted to a type. In mathematical logic these distinctions between the restricted universal/unrestricted universal and the restricted singular (or particular)/unrestricted singular are familiar.

The example from Tarski above already gives a simple example of how when working within a scientific language both the level of the object must be typed - specified - within quotes, while the absolute definition of truth is not restricted to any one domain or model. The following table can help to make these distinctions clear:

	Universal	Singular	Fields
Restricted	General	Particular	Model Scientific
Unrestricted	Universal Proper	Singular Proper	Structure Mathematical Logic

A prominent example from the history of physics is the luminiferous aether as the substantial medium of electromagnetic waves (light, radiation, etc.) that was refuted by Einstein and others at the beginning of the 20th Century.

Using the historic example of James Clerk Maxwell theory of electromagnetic fields, Black describes how the physical modeling process turned a foremost imaginary medium, the luminiferous aether, within a short amount of time from a mathematical model into an existing object: “The purely geometrical medium has become very substantial.”¹² No doubt, it would not be long before modern physics, in the advent of relativity theory and quantum mechanics, would deem all of this to be convenient fiction.

Without pausing here to ask what Black intends by “purely geometrical medium” and the status of this fiction here, we want to show how fantasy is an essential part within any modeling process and in particular in physics when it seeks to establish new physical objects, such as electromagnetic fields, atoms and other elementary particles. Nonetheless the role of fantasy is hardly ever reflected as such within the discourse of physics. Instead it is, as Rheinberger’s and Black’s works have shown, being studied in the history and philosophy of science, but only as part of the scientific practice and discourse (and not theory). As a consequence, the fantasy object, in the hands of the historians and epistemologists, has only ever been presented as something searched for in science, but preceded by an *obstacle* (Bachelard), a *paradigm shift* (Kuhn), the *irrational* (Feyerabend), a *thematic ambiguity* (Holton), *error* (Descartes), *ignorance* (Rheinberger, Fleck), all of which have been taken to result from accidents of experience or method: problems of experimentation, technique, and applications, e.g. practice. We want to show, on the contrary, with a second look and a tighter grip on the mathematical-logic problem, how to frame a *doctrine of fantasy* whose object is not only rational and systematic, but ‘odder’ than what the historians and epistemologist would like to call irrational and errors of practice and history. If we were to state this in a Lacanian vocabulary, we would say that such epistemological research leaves the object at the level of the drive - a thing of practice that proceeds by ignorance - while the desire and knowledge of mathematics and science is systematically bypassed¹³.

¹²Black, *Models*, p. 227.

¹³ Though the modern day epistemologists and historians of science, from Popper and Bachelard to Kuhn and Foucault, seem quite at home in accounting for the field of science, they often write disclaimers when

Black points out that modern physics around 1900 begins to speak about models such as Niels Bohr's model of the atom *as if* it were the atom. According to Black, all 'great physicists' around 1900 tend to disregard the difference between model and object, taking the model *as* the object. Maxwell, Bohr, and Rutherford all start to speak about their models as if they were the object itself. This leads Black to the conclusion, that whatever is going on in physics can be understood at least partially linguistically, in terms of the rhetoric of metaphor: "The difference is between thinking of the electrical field as if it were filled with a material medium, and thinking of it as being such a medium. One approach uses a detached comparison reminiscent of simile and argument from analogy; the other requires an identification typical of metaphor."¹⁴

According to Black, the metaphoric use of models occurs whenever a causal explanation is lacking, the "heuristic fictions" are not an accidental but a necessary part of modern science, that nevertheless bears the risk of "self-deception by myths."¹⁵ As a consequence, physics has to work through "half-understood metaphors".¹⁶ Just like a metaphor is composed of two parts, two concepts and the transference from one to the other, a theoretical model is composed of two "fields" and the transference between a secondary and "better-organized" object onto the primary field of inquiry).¹⁷ Black's definition of metaphor in itself is insufficient, since he defines it as the transfer of property from one object to another, something we would define as metonymy, not metaphor. But from a media theoretical point of view, his difficulty to distinguish between a mathematical and what he calls 'theoretical model' is also interesting.

Black does not state this explicitly, but his readers must deduce from his argumentation on Maxwell's and others use of "heuristic fictions" that the secondary part of a the theoretical model, the "better-organized field" in physics usually means the 'mathematically formalized field', therefore the secondary part of a theoretical model in physics could be simply called the mathematical framework of algebraic formulas in which natural laws are written. This at least seems to be what Maxwell himself states:

it comes to account for the field of mathematics. One exception to this observation would be the work of Michel Serres.

¹⁴ Black, *Models*, p. 228

¹⁵ *ibid.*

¹⁶ *Ibid*, 231.

¹⁷ *Ibid*, 230.

“[...] all the mathematical sciences are founded on relations between physical laws and laws of numbers, so that the aim of exact science is to reduce the problems of nature to the determination of quantities by operations with numbers. Passing from the most universal of all analogies to a very partial one, we find the same resemblance in mathematical form between two different phenomena giving rise to a physical theory of light.”¹⁸

Black’s point is that the physicist’s substantiation of heuristic fictions is a rational practice in form of a *language operation*:

“There is a rational basis for using a model. In stretching the language by which the model is described in such a way as to fit the new domain, we pin our hopes upon the existence of a common structure in both fields. If the hope is fulfilled, there will have been an objective ground for the analogical transfer. For we call a mode of investigation rational when it has a rationale, that is to say, when we can find reasons which justify what we do and that allow for articulate appraisal and criticism.”¹⁹

Our hypothesis, on the contrary, is that the substantiation happens through *writing operations* that leads to a new theory, i.e. the transfer of a well known mathematics such as the matrices calculation that Heisenberg uses to formulate his indeterminacy principle but that was rather unknown in physics because it came from economics.²⁰ In the end and no matter how wild imaginations and rhetoric fly, a new theory in physics (or any mathematical science for that matter) is only as good as the mathematical equations it produces. If it is the model that guarantees true statements based on mathematical formalization, this does not mean that any one model suffices to interpret a written formula. That is why one can speak of a *structure*, mathematical or not, as a class of models that interpret the language and formulas of a theory albeit in the same, but different ways.

When a scientist transfers a well established writing technique (writing technique here stands for all media operations such as mathematical formula, diagramming, measuring, imaging, etc). onto a lesser understood field, he hypothesizes an underlying *structure* that can turn out to be either true or false in the respective model that is being set up. The practice of the

¹⁸ James Clerk Maxwell, *The Scientific Papers*, vol. I (Cambridge University Press, 1890). p. 156.

¹⁹ *Ibid*, 238.

²⁰ Cf. Christina Vagt, *Geschichte Sprünge : Physik und Medium bei Martin Heidegger* (Zürich-Berlin: Diaphanes, 2012). p. 181.

scientist necessarily involves the structure of fantasy on the way to a sound model/theory of a new scientific object, but the fantasy cannot be written as such (as structure) into the theory, because science only allows for models based on true statements. Ergo, the fantasy disappears on the threshold from scientific *practice* to *theory*.

The luminiferous aether was not a metaphor or a fiction in the imagination of the physicists, the aether primarily was used as an interpretation of Lorentz' transformation equations, the same equations that Einstein used when he abolished the luminiferous aether and replaced it by the theory of special relativity. The special theory of relativity uses the same equations as Lorentz aether theory, but it interprets them differently: same equations, different substantiation.²¹ The metaphorical transfer of properties between two concepts or fields can never be 'true' because a metaphor includes false statements: A man is not a lion (to use Black's example). And contrary to metaphor, the transference from a mathematical writing onto an empirical discourse can produce false statements, but it can also produce true statements.

If there is an object of science it is going to be designated by a constant (some variable written in a small Latin letter) that satisfies the functions of the equation (i.e. the approximation of the speed of light is written as the letter c in the Lorentz Transformations). Such an object would have more to do with mathematical writing than with the rhetoric of metaphor because the mathematics is writing what metaphor is attempting to speak about (but fails). If we ask what is being referred to by a rhetorical figure, we get something vague and equivocal, not something precise and univocal. If there is an object of science, it may be referred to with a rhetorical figure stated in words, but that is still a 'way of speaking', and not a 'way of writing' letters that fulfil an equation. In the end, we must ask both at the level of science and mathematics, not simply what is the reference of a word, but a letter.

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²¹ Cf. Christina Vagt, "Im Äther Einstein, Bergson und die Uhren der Mikrobe," ed. Eva Johach and Diethard Sawicki, *Übertragungsräume*, 2013, 133–44. p. 136.

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