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BOOK REVIEW

Systems Science and Scientific Metaphysics

Martin Zwick: *Elements and Relations: Aspects of a Scientific Metaphysics*; Volume 35, IFSR International Series in Systems Science and Systems Engineering, Springer Cham, Switzerland, 2023, XVIII + 702 Pp, EUR 67.59 Hbk, ISBN 978-3-030-99402-0

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In this encyclopedic volume of 702 pages, Martin Zwick provides an exposition of systems science's nature, origins, development, contemporary status, and potential. The volume is capacious in its breadth, substantive in its depth, and both technically sophisticated and heuristically promising in its methodological suggestions. In addition, inspired by philosopher of science Mario Bunge (2010), Zwick develops his own stance on systems science's nature, interpreting it as an attempt to formulate an exact and scientific metaphysics (ESM). Its exactitude derives from its mathematical formulations; its scientific character from its grounding in established scientific theories and empirical findings; and its metaphysical standing both from a realist stance concerning what is the case and an objectivist understanding of knowledge.

Zwick discusses three sorts of systems, concrete, abstracted, and conceptual, abstracted. Concrete system are physical systems, like those studied by physicists. Abstracted systems concern nonphysical systems in the sense that those systems' physical properties are abstracted from, for example, the systems studied by the social sciences. Conceptual systems are completely nonphysical and so completely abstract, such as mathematical systems.

In the body of his work, especially "Notes," Zwick characterizes systems science metaphysics in terms of elements and relations. Elements are entities of various complexities; and relations are, on the one hand, the internal relations that constitute an entity and, on the other, the external relations that specify its temporal, causal, and other connections with its external environment. That environment is itself composed of complex entities. Such systems can be studied synchronically, in terms of their current states, and diachronically in terms of the origins, development, flourishing, and demise.

Zwick is assiduous in his efforts to aid his readers (whether they be systems scientists, scientists, humanists, or lay persons) in grasping his tome. His main strategy is to divide his book into three major parts: (1) a 38-page "Essay" that presents his entire view, what he calls "a dense sketch of a scientific metaphysics"; (2) a 246-page "Commentary" that lays out the scientific bases of systems science metaphysics, including his own brand, which he calls "a candidate ESM"; and (3) a 306-page "Notes" section that provides a wide-ranging account of the three major types of systems, conceptual, abstract, and concrete.[1] Zwick then provides a set of reading approaches for these various sorts of readers. And he illustrates many of his central claims with illuminating figures and tables.

But not to be outdone, there is a remarkable 128-page Appendix with a complete list of the very instructive tables and figures that Zwick employs throughout his exposition. Most importantly it includes a 27-page "Auto-Critique," where Zwick lays out what he posits are the shortcomings of his own work, while at the same time contextualizing them. Zwick examines the internal and external deficiencies, incompleteness, and less than ideal features of his own exact, scientific metaphysics. This critique ranges from the inexactitude and distortion of his verbal presentations to the fact that he has presented only a metaphysics of problems.

I thank the author, Martin Zwick, for very illuminating conversations about his book; and the editor of this journal, Stuart Newman, for facilitating the publication of this review. The author played no role in the writing of this review.

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[1] The author indicated in conversation that Notes provide a set of mini essays on systems theories, models, and ideas that can be accessed in the characterization of a systems science metaphysics.

The systems that he has examined and detailed are the deficient ones that characterize only the realities of current becoming. What is further needed, Zwick points out, are diagnoses of the problems of these systems, as well as "therapeutics," ways of fixing them, and "euphorics," strategies for improving them. But there's more: ten pages of acknowledgements set within the context of Zwick's own professional development. Here the reader finds the author situating himself and his work within the becoming that is the current object of systems science research.

Zwick's work will challenge any would-be reader; but taking up the challenge will, in this reviewer's view, be well worth the time and effort that it will require.

As a scientific naturalist philosopher of science, I find myself in broad agreement with Zwick's project and his proposed ESM.[2] His ESM has similarities with the scientific realist project of the American philosopher Wilfrid Sellars. Sellars (1963) proposed that philosophy is the discipline that deals with all things in the widest scope possible. Thus, he presents scientific realist versions of the major philosophical disciplines, metaphysics, epistemology, and ethics. Such versions are guided by two central guiding methodological principles: (1) science is the measure of all things, what is and what is not, and (2) manifest (common sense) and scientific images of what is and what is not are to be unified in a synoptic vision of reality. It is from this substantive and methodological perspective that I offer some comments on Zwick's project and ESM. Due to limitations of both competence and space, I will confine myself to comments and suggestions that I hope will prove helpful in the development of an ESM.

In order to facilitate this project, I make two slight, and hopefully non-distorting, reformulations of (1) Zwick's characterization of types of systems and (2) his understanding of key conceptual features of those systems.

Zwick identifies concrete systems with those studied in physics. Abstracted systems are those same systems, but the features of those systems that are the object of investigation are ones abstracted from those systems. They are studies in the social sciences. Conceptual systems are entirely abstract formal systems. An ESM is the projected result of the study of these three types of systems.

The Sellarsian counterpart ESM that I aim to compare with Zwick's Bungean-inspired ESM shares with the latter a metaphysically realist stance, including scientific realism. In addition, it shares an objectivist epistemology that maintains that cognitive successes reveal mind-independent realities, that is, knowledge as fallible justified true belief is constituted by successful access to such realities, rather than by any sort of subjective cognitive state. Put another way: S knows that p is true because p exists rather than p exists because S knows that p.

On the basis of this basic metaphysical and epistemological agreement, I recast Zwick's description of conceptual, abstracted, and concrete systems in the following manner:

I take concrete systems to be about the best current scientific account of what is the case. They include the contents of both the social and natural sciences. And, given a realist account of the content of the arts and humanities, the sciences also address the contents of the arts and humanities. Thus, on my formulation, concrete systems include more than purely physical entities. The entities and relations with which the social sciences, arts, humanities deal are also concrete systems. Further, on my categorization, conceptually developed systems provide a wealth of different sorts of systems that have been and are used to understand concrete systems or can be developed into abstract models of concrete systems. Abstract models can be or already are instantiated in concrete actual systems, those systems that we have currently justified belief that they make up the furniture of the world. The potential for mathematical formulation enables some of these abstract models to capture real systems with exactitude. They are the basis for the mathematical exactitude of systems science, and, so, an exact and scientific metaphysics. On Zwick's categorization, conceptual systems are those that concern the social sciences since they investigate aspects of reality that are abstracted from the physical. According to Zwick's categorization conceptual systems are purely formal systems. They require regimentation of elements and rules of connection between elements to be useful. On my account, abstract systems already have such structure as well as semantic content. As such, they provide the potential models for scientific investigation in the natural and social sciences as well as investigations in the humanities and arts. As features of an ESM, I maintain that conceptual systems must be more than formal systems.[3]

In developing ESM, Zwick finds the concepts of several types of systems to be of central importance in the discussion of the features of systems. Beginning with matter and energy, they are information, utility, agency, and cognition (specifically human cognitive agency). Zwick orders these according to their generality of application to systems.

[2] This reviewer is not expert in systems science. So, he is not in a position to assess the representative character of the author's presentation of systems science nor the contribution to that discipline that the author's systems science exact metaphysics makes to the discipline. But I cannot help but think that experts in the field will find Zwick's work to be highly relevant to their own.

[3] I here assume the generally accepted semantic theory of scientific theories and models and the failure of the syntactic accounts of scientific theories and models to account for the theoretical content of scientific claims. Of course, this restriction can be understood to apply merely to those conceptual systems that are intended ESM candidates and not exclude a more inclusive systems science view of conceptual systems that also allows for purely formal systems.

These concepts, on Zwick's account, manifest the wholeness, continuity, and distinction of systems discussed in the synchronics of systems. In contrast, the diachronics of systems is illustrated in the discussion of the origin, development, maturity, and demise of systems. These systems are studied in the natural and social sciences, the humanities, and the arts. Zwick treats both the being and becoming of these systems, the former under the category of synchronics, and the latter under that of diachronics. My remarks will concern some features of each of these systems. In doing so, I interpret these categories as ways to characterize various sorts of systems.[4]

First to matter and energy, the study of which is the concern of the natural sciences, in particular, physics and its various branches. It is widely claimed that physicists aim for a theory of everything, TOE. Zwick proposes his ESM as an alternative to TOE. He does so because he has in mind a reductionistic understanding of that aim. Call it RTOE. He has doubts that RTOE is possible as an epistemic project (human cognitive capacities may be intrinsically incapable of accomplishing such an endeavor) and thinks it metaphysically ill-advised because reality does not have the systematic features required by RTOE. Moreover, he argues that even if such a project were accomplished, it is obviously not a genuine RTOE. This is so, first (though Zwick is not explicit about it) because chemistry, biology, and the other natural sciences have not been reduced to physics, not to mention psychology, the social sciences, the humanities, and the arts. Put another way, the entities studied in all these disciplines have not been identified with those of basic physics. Or, if the proponent of RTOE is not claiming reduction by identification but rather explanatory reduction according to which physics explains the results of the other natural sciences, that project too is questionable. In other words, the claim that the forces embodied in the laws of physics do or can explain all phenomena is highly problematic. But most obviously, RTOE is obviously incomplete. It leaves out all the social sciences, not to mention the arts and the humanities, the metaphysics of the currently projected physics, RTOE. It should be replaced by a general system's ESM.

However, I suggest that RTOE is not the most accurate view of the metaphysical implications of the explanatory practices of current physics. Rather than reduction by either identification or explanation, one often finds physicists successfully appealing to higher level, rather than fundamental level, physical features as explanatory of physical phenomena (Batterman 2021; Green and Batterman 2021). The lowest level components of complex purely physical phenomena or the smallest spatial and temporal levels of purely physical phenomena turn out to be insufficient to explain such physical phenomena as the phase transitions of gases and liquids and the stability of structural features such as bridges and railroad tracks. The causes of such phenomena are higher-level components or higher-scale physical features of complex purely physical entities. Lowest-level components or smallest-scale features are necessary but not sufficient to explain these results. Thus, on this account of the explanatory practices of current physicists, one finds emergent purely physical properties. Confining the explanatory range of TOE to physical objects we have an emergent view of TOE, ETOE. As I see it, ESM and ETOE appear entirely compatible, indeed, supportive of each other as far as physics goes.

Further, there is no evident reason to think that ETOE will revert to the overreach of RTOE with respect to the other physical sciences, not to mention the life sciences, the sciences of mind, the social sciences, the humanities, and the arts, given that ETOE finds emergence already present at purely physical levels and especially given the explanatory successes of all the latter, the details of some of which Zwick presents in his book.

ESM, like ETOE, finds matter and energy necessary but not sufficient for understanding all the systems and relations, both internal and external, that constitute the metaphysics of the world of being and becoming in which we humans find ourselves. Moving up the emergent ladder, we find information. Zwick provides the reader with an account of the contributions of various developers of and contributors to information theory. As it has been developed, information is a feature of abstracted systems. As such it has no physical measure or dimensions. But it has been applied successfully to explain the maintenance and operation of concrete systems. So, though abstract, it is a feature of concrete systems. Zwick highlights genetic information, the sources of agency, information in utility measures, and cognition. Thus, on Zwick's view, information is a broadly instantiated and a distinct feature of concrete systems. It has not only epistemological status, representing a way that researchers can divide up and classify processes and features, but also ontological status.

Here I suggest that the cases examined by Zwick can be understood in a different way, thus offering a somewhat different metaphysical picture. Instead of what we might call Zwick's broad notion of information because it can be constituted by syntax alone, I offer for consideration a narrower notion of information, one that requires information to have not only syntax but also a semantic feature, an aboutness that is a feature of cognition broadly construed, that includes both conscious and nonconscious processes (Clark 2016).

[4] In doing so, I believe it provides a helpful way both to understand Zwick's ESM and compare it with rival accounts, without distorting his categorizing strategy.

How, then, does a systems scientist handle the other informational types included in Zwick's broad notion? Shannon, a major figure in the development and application of information theory, famously described informational processes as those that reduce the uncertainty of a message. This description can be misread as a semantic view of information. While it is clearly the case that physical processes can carry information, that is, be vehicles of information in the semantic sense, it is also clearly the case that "Shannon information" can and is interpreted in a non-semantic fashion. Here we can understand "reduction in uncertainty" as an increase in the probability of a certain result, where that result is the effect of a purely physical process, not an increase in the subjective or objective probabilities of cognitive agents concerning the content of a message. As such, "message" is a placeholder term for any result of the process. The result of the process need not be a message in the sense of an item that is about something, some sort of representation. For example, genetic information involves physical processes, at the level of living things, that specify how the basic chemical components of living things (DNA, RNA, etc.) produce the proteins that go on to make the tissues, organs, and so on that comprise a living thing. This is a goal-directed causal process, goal-directed in the sense that it is an explanation in terms of what the process is for. So, it captures another feature that Zwick makes central to concrete physical systems, utility. And it is also a causal process, in the sense that it explains in efficient terms how the process proceeds. As an efficient causal process, it is of the same type as the transmission and transformation of matter and energy. On this understanding of information, however, there is no need to invoke either syntactic or semantic information to explain these processes. However, as I read him, Zwick's broad account of information makes such processes semantic, or at least syntactic. A narrower account of information, I contend, is closer to the ESM for which Zwick is aiming.[5]

Information, in the semantic sense, is central in Zwick's characterization of synchronic categories, as are the other major systems science categories, utility, cognition, and agency, especially human agency. Zwick presents multiple proposals of prominent systems scientists concerning systems with these features. They have offered multiple abstract models of how these features might be, have been, and are instantiated. Zwick shows how they might be related, but in the Notes section does not take a definitive stand concerning whether, or to what extent, they are part of his ESM.

In the final chapter of Part II, Chap. 6, the part devoted to systems science's connections (via abstracted and conceptual systems) with current work in the sciences, humanities, and arts, Zwick focuses on a particularly important agential system, humanity. Previous chapters of Part II, as we have seen above, have included purely physical (matter and energy), informational, directed (utility-seeking) agents.[6] In this chapter, Zwick introduces a systems historical model to understand key features of the systems that constitute human agents, both the internal relations that make up that kind and the external relations that constitute humankind's current situation. From a systems science point of view, he is setting the human situation within the theoretical context of the internal and external relations of an open system, a system still in the stage of becoming, one that faces the possibility of decline and demise, as well as the possibility of further maintenance and advance, though not one of continual advance to some perfected state. The latter possibility, in Zwick's view, is not available to any sort of system. This is so because of what he contends are the built-in metaphysical constraints of all systems in any environment. Very roughly, the ordering that betters a system's identity and maintenance leads eventually because of inevitable environmental variety to a deficit in flexibility and, thus, to the inability to change sufficiently. On the other hand, too much flexibility leads to disorder and the loss of systems identity. Zwick, provocatively, calls this sort of limitation metaphysical evil. Yet this metaphysical limitation also can be the source of new systems.

Nevertheless, even though metaphysical evil is unavoidable, two general sorts of systematic evils can to some extent be remedied. The lacks present in both societies and the environments in which humans act can be partially repaired and improved, as can the failings of individual humans who themselves are composite systems operating within natural and social environments. The overall aim of such actions is to improve the well-being of both social and individual systems as well as the environments in which they operate, where well-being is measured in terms of differential maintenance and reproduction of these systems.

The historical model developed by Zwick focuses on the social, religious, and scientific aspects of human well-being. Zwick argues that the religious aspects of human development have been created to improve the social well-being of humans and the scientific to correct religious and cultural lacks and errors, while furthering individual and social

[5] In conversation, Zwick has pointed out to me that his notion of information can be considered a narrow one in so far as it makes syntax a sufficient condition for the presence of information, while my account of information is broad since it requires both syntax and semantics. We both agree that cognitive agents, qua cognitive, must make use of semantic information. In contrast with Zwick, I find references to syntactic information in the characterization of the role of genes in the production of proteins, metaphorical.

[6] Zwick reserves the term "agency" for living entities, especially humans. I use the term broadly to cover all entities that do something. Indeed, I take agency to be a necessary condition for existence. In my view there are no epiphenomena.

well-being and, thereby, improving human social life. The principle aim continues to be individual and social well-being, a project of all individuals and societies, though necessarily never a completely adequate endeavor.

On Zwick's view, the first two sorts of attempts at improvement, on the social and religious level, have species-wide beginnings. However, the scientific one originated in the West and is only more recently spreading worldwide. But even the latter has not proved completely successful, not merely because of the limitations of any systems and its aspects, the limitation of metaphysical evil, but also because of the challenges of environmental crises and the dangers of nuclear warfare, both of which arguably have been created by science itself.

Thus, the historical model makes clear why Zwick's systems science account is a problems-centered approach, one that, as I noted above, could be and should be supplemented, as Zwick notes in his Appendix, by both therapeutic and euphoric measures.

His systems science historical model also helps us understand another important claim made by Zwick. Even though Zwick is advancing what he calls an exact scientific metaphysics based on systems science, he is not identifying systems science with science. There are differences. For one, we have seen that systems science is concerned with three sorts of systems, conceptual, abstract, and concrete. Science aims to account for only abstracted and concrete systems, those that are currently the content of science's (both social and natural) best justified theories and empirical observations. Second, on Zwick's account, the objects of the humanities disciplines and the various arts are themselves complex systems. These systems are distinct from the ones studied by the sciences. But there is a further difference: systems science assesses the sciences, the arts, and the humanities in terms of their adequacy with respect to individual and social well-being. In this sense, it is itself a normative science.

Given Zwick's extensive discussion of both the history of systems science and its important founders, developers, and current purveyors, as well as Zwick's own convincing systems science interpretation of important non-systems science thinkers, including philosophers, mathematicians, and scientists, I think he has made a convincing case for his claim that systems science has conceptual, abstract, and concrete components as he describes and defines them. However, though I think he is right that university systems will continue to have distinct units of science, humanities, and arts, it is not clear to me that he has established their epistemological and metaphysical distinctness. Indeed, despite his advocacy of ESM, these areas remain in his account distinct from the sciences.

Yet there is some reason to think that the connections between disciplines outside the sciences and Zwick's ESM can be tightened. Zwick's historical model of humankind's quest for improved individual and social well-being treats religion as a separate endeavor from the sciences. Moreover, Zwick's efforts to integrate theology, broadly construed as the thought structures of religious understanding, with the sciences are cautious. Given his support for ESM, one might expect an explicit rejection of supernaturalism or nonnaturalism. But Zwick does not go that far. On the negative side, Zwick does critique the limitations of religious traditions in their function of supporting social and individual well-being, and their lack of recognition that the sciences must play a role in overcoming these limitations. In addition, Zwick rejects the separatism of religion and science advocated by such thinkers as Steven Jay Gould, opting rather for a supportive interactionism between science and religion. Indeed, Zwick suggests that, like the sciences, religious beliefs can be pursued in an experiential fashion. Surprisingly, given his commitment to ESM, Zwick does not consider a systems view of religion and religious claims that is more thoroughly naturalistic and scientific. I have in mind biologically and psychologically based accounts of religious beliefs that do not involve the supernatural or nonnatural (Rottschaefer 1998, 2016; Rue 2005). Nor does Zwick address the epistemic inadequacy of either natural or revealed theologies, inadequacies that motivate such scientifically naturalistic understandings of religious traditions and theologies.

I offer one further suggestion of a way that a scientific naturalistic philosophical approach—one compatible with ESM—might address the current problematic human condition that is the focus of Zwick's historical model. I suggest an account of human moral agency, one that provides a scientifically well-founded account of the nature, acquisition, operation, and improvement of moral agency (Rottschaefer 2020). This account, like Zwick's ESM, maintains that there are objective moral facts. And it lays out in some detail their biological, psychological, social, and cultural bases. Zwick's systems science analyses of utility and human agency also address some of these bases.

Finally, I think that Zwick's commitment to a normative element in systems science fits with his correct assessment of how, beginning at least with the biological sciences, normativity and goal-directedness are part of any ESM. And it gives expression to Sellars's methodological principle to pursue a synoptic vision of the manifest and scientific images. On that view human agents incorporate currently the best relevant scientific findings into their individual, social, and cultural activities. They, thereby, advance the human project which, on Zwick's view, is a central project of ESM and its sources in systems science.

In conclusion, I emphasize that readers who take advantage of the challenge of Zwick's prodigious volume will be well rewarded for their efforts.

References

Batterman R (2021) A middle way: a non-fundamental approach to many-body physics. Oxford University Press, New York

Bunge M (2010) Matter and mind: a philosophical inquiry. Springer, New York

Clark A (2016) Surfing uncertainty: prediction, action, and the embodied mind. Oxford University Press, New York

Green S, Batterman B (2021) Making sense of top-down causation: universality and functional equivalence in physics and biology. In: Voosholz J, Gabriel M (eds) Top-down causation and emergence. Springer, Cham, pp 39–64

Rottschaefer W (1998) The biology and psychology of moral agency. Cambridge University Press, Cambridge

Rottschaefer W (2016) Schellenberg's evolutionary religion: how evolutionary and how religious? Religious Stud 52(4):475–496

Rottschaefer W (2020) Affording affordance moral realism. Biol Theory 16:30–48

Rue L (2005) Religion is not about God: how spiritual traditions nurture our biological nature and what to expect when they fail. Rutgers University Press, Piscataway

Sellars W (1963) Philosophy and the scientific image of man. In: Colodny R (ed) Science, perception, and reality. Routledge & Kegan Paul, New York, pp 1–40

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