# MECHANISMS AS MODAL PATTERNS

Joseph Rouse, Wesleyan University

SPSP 2016, Rowan University, Glassboro, NJ

Philosophical discussions of mechanisms are often contrasted to laws and D-N explanations. I challenge such contrasts, guided by a reconception of laws and necessity first introduced by Marc Lange and John Haugeland, and extended in my book, *Articulating the World*. The underlying moral is to avoid prior philosophical conceptions of laws or necessity, and begin with the roles played by lawful invariance in scientific practice. Philosophical explications of lawfulness can then ask *how* these roles are played in various sciences.

Attributions of lawfulness play at least three important roles in the sciences: explanation, inductive projection, and counterfactual reasoning. To avoid the persistent shadow of the D-N theory, I focus on induction and counterfactual reasoning. Nelson Goodman taught us that some putative conceptual relations are inductively projectible; some aren't. Projectibility is a kind of invariance. A pattern evident on one occasion "ought" (rationally) to hold in other cases. Projectibility does not concern which patterns *are* lawfully invariant, but which ones are "lawlike," intelligible *candidates* for invariance across contexts.

Mechanisms are a distinctive kind of projectible pattern that need not be verbally expressed. The dynamic, spatio-temporally organized patterns of mechanisms are often explicated by diagrams or models rather than statements. Haugeland's account seems especially appropriate here: instead of talking about laws, *ceteris paribus* clauses, and justification, Haugeland speaks of patterns, noise, and pattern-recognition. He aims, however, to understand the *modal* character of these phenomena: the forms of invariance ("necessity") and normative accountability ("salience", "holding", and "telling") that allow for defeasible forms of inductive projectibility and conceptual understanding.

Lange and Haugeland emphasize scientific understanding in research, paralleling the emphasis on *discovery* in the mechanisms literature. As Lange notes, "a basic presupposition of scientific research is that we do not need to examine everything in order to know everything. Rather, a few observations, restricted in space, time, and other respects, sometimes suffice to render salient a hypothesis that is accurate to all unexamined cases in a remarkably wide range of cases". A few observations do not justify *accepting* that the salient pattern continues to hold for unexamined cases; they justify *exploring* that pattern *as* defeasibly projecting its invariance. Such exploration may articulate and qualify the originally discerned pattern. These descendants are nevertheless recognizable as further developments of the *same* pattern. The originally salient pattern was thus not yet fully determinate. The mechanisms literature similarly attends to sketchy beginnings, components of a larger, unspecified mechanism, and so forth.

The salience of a pattern is not a psychological propensity to generalize, but a normative consideration of how the pattern *ought* to be manifest elsewhere if it *were* to go on in the same way (note that the subjunctive conditional plays a constitutive role here). Judgments of salience admit some disagreement, but most possible pattern extensions are ruled out by a default continuation of what is salient in context. That default pattern is sensitive to other commitments, and hence can shift with further understanding. In Lange's example, the Boyle-Charles Law and the van der Waals Law each saliently extends a pattern of pressure/volume relations under different background assumptions. Most inductive extensions of those data are not salient or projectible, however.

The next point is pivotal. The counterfactual invariance of lawful and accidental patterns might seem to differ only in degree. Accidents hold under *some* contingencies, while even acknowledged laws do not hold under *all* counterfactual suppositions. Lange and Haugeland attribute lawful invariance not to patterns singly, but only to multiple patterns that collectively compose a lawful domain. Lawful patterns have a maximal collective invariance: they hold under any and all counterfactual suppositions consistent with a lawfully domain-constitutive group. The collective counterfactual invariance of a group of projectible patterns provides an independent criterion for the autonomy of disciplinary domains. Those patterns that are collectively interdependent, with each pattern holding under conditions that do not violate the others, mark out domains of conceptual intelligibility.

This modal holism is crucially shaped by the prospective orientation of scientific research. No research field has a complete, inferentially closed set of laws. Scientific research instead undertakes inductive strategies to articulate, extend, connect and refine the salient patterns they uncover, and thereby advance scientific understanding. Pursuing an inductive strategy situates the patterns studied within a larger pattern of invariance. The commitment is not to their correctness, but to their projectibility. If an initial sketch of a mechanism is a projectible pattern, then it is confirmable *and revisable* by its instances. Further instances that go on in the same way genuinely confirm the mechanism, while unexpected or unarticulated variations in the pattern provide evidence for revising *it*, the *same* pattern originally indicated as salient.

This prospective autonomy of scientific domains has two importantly conjoined aspects: their lawful invariance and their normative accountability function together. Different kinds of invariance result from different ranges of counterfactual stability. Scientific disciplines should not contravene one another's claims about actual events. They nevertheless differ in ranges of *counterfactual* invariance or “necessity”. Some biological patterns may hold under counterfactual circumstances that would violate the lawfulness of chemistry or physics. For example, R. A. Fisher’s evolutionary model shows how sex ratios within a population at birth evolve due to different mortality rates before reproductive maturity. Selection pressures for more offspring of whichever sex would be under-represented at reproductive maturity persist until the sex ratios at maturity stabilize at 1:1. That adaptive pattern would hold even if the mechanisms of sex determination were “impossibly” different, where the latter impossibility is physical or chemical rather than biological.

The more important point is that domain-specific forms of counterfactual invariance are interdependent with that domain’s normative accountability. Projectible patterns within a domain must “hold” under any circumstances consistent with the other patterns that together constitute a lawful domain. Domains nevertheless differ in their standards for whether a pattern does hold. They also differ in the skills, materials, and instrumentation needed to *tell* whether the standards were upheld. Consider first how scientific standards of confirmation differ in multiple normative dimensions: precision, accuracy, openness to *ceteris paribus* exceptions, and noise tolerance. Mechanisms, for example, only remain invariant under a partially specifiable range of background conditions. Moreover, not all counterfactual suppositions are relevant to a scientific domain. Lange notes that evolutionary biology is unconcerned with how species would have evolved had the moon not broken off from the earth. It likewise makes no difference to internal medicine how coronary response to epinephrine would vary had mammalian hearts evolved differently. And so forth.

When a pattern remains relevantly invariant is also interdependent with whether and how scientists can *tell* if the pattern still holds. *Ceteris paribus* clauses do not render laws vacuous by turning possible counterexamples into confirming instances, if scientists can distinguish cases that are legitimately excluded from those that aren't. A similar point applies to the experimental skills and instrumental capacities that let a pattern show up in different circumstances. Apparent counterexamples to a pattern sometimes instead reveal improper technique or preparation, failure to discern different manifestations of the pattern, inadequate shielding from interference, or other improper executions of relevant skills. Sometimes skills properly accord with past practice, but need improvement to allow recognition that a pattern continues to hold. The counterfactual invariance of the pattern, the normativity of when it "holds", and how to tell the difference go hand in hand.

For Haugeland, these considerations show the interdependence of two different conceptions of intelligible patterns. Traditional accounts of laws treat lawful patterns as "orderly or random arrangements—the opposite of chaos" (1998, 273). On an alternative conception, what identifies a real pattern is expert ability to discern it: patterns just are candidates for pattern-recognition. The orderly-arrangement conception cannot be autonomous, because it presupposes a more basic pattern that individuates the *elements* of that orderly arrangement. The sense of patterns and their elements as recognition-candidates also cannot stand on its own, however. By themselves, such patterns cannot provide a standard that differentiates *genuine* recognition from its mere semblance.

These two senses of pattern correspond to Salmon's (1984) distinction between ontic and epistemic accounts of explanation: does the explanation appeal to an actual mechanism operating in the world, or to the scientific representation and understanding of the mechanistic pattern? Haugeland shows how scientific understanding requires both conceptions together, in maintaining a "precarious equilibrium" between two forms of pattern-recognition. Outer recognition shows the constitutive, projectible invariance of an intelligible pattern, such as the Krebs cycle, or protein synthesis from an RNA template. Inner recognition tells whether a new case fits that pattern. The equilibrium between them is precarious in their possible conflict. Some ways of performing experiments, applying concepts, and modeling the outcomes—the basic skills of scientific practice--might have outcomes in conflict with the pattern being explored, or its relation to other patterns in the same domain. The ability to resolve these conflicts coherently is a genuine achievement. That ability confers intelligibility upon the patterns, pattern elements, and scientific skills that are involved. Maintaining stability ("necessity") in the face of possible counterexamples is criterial for the correct performance of the skills that disclose it. Otherwise they would not be skills, but only habits. The ability to learn, communicate, use, and correct those skills, with outcomes that confirm and refine the pattern, then vindicates in turn its projected lawfulness.

Explanatory patterns in the mechanisms literature have a tripartite structure: mechanisms explain phenomena, and both are attested or challenged by various data. In Haugeland's terms, both phenomena and the mechanisms that explain them are lawful patterns. The data and scientists' skills at producing, interpreting, and assessing their bearing on these patterns are forms of "inner recognition". The distinctions among data, phenomena and explanatory mechanisms are nevertheless iterative: reliable and intelligible data are themselves a phenomenon explained by a reliably invariant experimental system.

Lange and Haugeland emphasize the normative and alethic-modal autonomy of scientific domains, and consequently a strong scientific disunity. In *Articulating* *the World*, I argue instead that lawful domains are only partially autonomous, in ways nicely illustrated by the mechanisms literature. Mechanistic explanations work at hierarchical levels, but they also integrate mechanistic organization and function across levels, in "interfield theories" and the occasional emergence of new disciplines. The only-partial autonomy of lawful domains reflects the "two-dimensionality" of conceptual articulation in the sciences. I call the most basic dimension *homonomic*. Development of theoretical modeling and experimental systems and skills within a single scientific domain is homonomic. The concepts involved are typically first explicated by experimental phenomena that provide "well-behaved" settings for working out conceptual relationships and their applicability in models. The inductive projectibility of its concepts and models then has the kind of holistic interdependence characterized earlier.

Homonomic understanding is normally complemented by heteronomic development of its concepts, practices and skills. These more tentative and less systematic modes or fields of research and interpretation draw upon resources and concerns outside their scientific domain. Sometimes they address issues arising in one locus with skills, materials, or phenomena developed elsewhere. On other occasions, they take up issues at or across domain boundaries. Sometimes they coalesce into cross-disciplinary research programs. Over time, these programs may develop into disciplines with their own norms and projectible patterns, as cell biology emerged between biochemistry and classical cytology. Heteronomic explorations may remain a limited effort, become a persistent interdisciplinary trading zone, or lead to a newly autonomous domain. The conceptual open-endedness of research domains reflects a practical commitment to taking one's concepts as inductively projectible as part of a counterfactually invariant set, but one whose full contours are not yet determined.

Heteronomic inquiry is thus indispensable to the *significance* and contentfulness of scientific understanding. Significance is also at issue homonomically, of course. Heteronomic significance nevertheless distinctively contributes to scientific understanding. We care about the internal development and articulation of scientific domains *because* they are not entirely self-contained. Whether a science's conceptual relations display a counterfactually invariant pattern in the world (rather than displaying the discipline's sloppiness, inattentiveness, or trivializing self-vindication) is *at issue* in the ongoing development of the field. A discipline's empirical accountability arises not only from its internal ethos, but from heteronomic accountability to other practices and concerns. These conceptual patterns are not merely artifactual if they inform issues arising elsewhere.

I conclude with Salmon's distinction of *three* conceptions of scientific explanation: epistemic, modal, and ontic. Advocates of mechanistic explanation disagree about whether mechanisms are epistemic or ontic explanations, but they mostly repudiate modal conceptions. I instead reconceive alethic modalities as integral to scientific understanding in practice. The ontic and epistemic conceptions then come together as complementary aspects of a larger modal pattern encompassing scientific research along with its objects of study. In *Articulating the World*, this re-conception of scientific understanding in practice is part of a naturalistic account of scientific understanding as a form of biological niche construction. How mechanistic modeling belongs to that larger story must nevertheless be reserved for another occasion.

REFERENCES

Bechtel, William 1993. Integrating Sciences by Creating New Disciplines: The Case of Cell Biology. *Biology and Philosophy* 8: 277-299.

_______________ 2006. *Discovering Cell Mechanisms*. Cambridge: Cambridge University Press.

_______________ and Abrahamsen, Adele 2005. Explanation: A Mechanistic Alternative. *Studies in the History and Philosophy of Biological and Biomedical Sciences* 36: 421-41.

Craver, Carl 2007. *Explaining the Brain*. Oxford: Oxford University Press.

___________ and Darden, Lindley 2013. *In Search of Mechanisms*. Chicago: University of Chicago Press.

Darden, Lindley 2006. *Reasoning in Biological Discoveries*. Cambridge: Cambridge University Press.

Haugeland, John 1998. *Having Thought*. Cambridge: Harvard University Press.

______________ 2013. *Dasein Disclosed*. Cambridge: Harvard University Press.

Lange, Marc 2000. *Natural Laws in Scientific Practice*. Oxford: Oxford University Press.

___________ 2007. Laws and Theories. In S. Sarkar and A. Plutynska, eds., *Companion to the Philosophy of Biology*, 489-505. Oxford: Blackwell.

___________ 2009. *Laws and Lawmakers.* Oxford: Oxford University Press.

Rouse, Joseph 2015. *Articulating the World*. Chicago: University of Chicago Press.