Integrating Narratives and Model Analysis: New Epistemic Tools for iHPS

By: Julia Sanchez-Dorado & Claudia Cristalli

In past years, it became clear to philosophers of science that models are crucial tools for understanding and predicting complex phenomena. Recently, works at the intersection of philosophy and history of science looked at philosophy of history and at the discussions on the explanatory role of narratives (Little 2017; Roth 1989; Mink 1978) for a more inclusive account of explanation (Morgan 2017a, 2017b, Currie and Sterelny 2017, Beatty 2017). In this paper, we argue that the application of the concept of narrative to the analysis of scientific models provides some new epistemic tools for the integration of history and philosophy of science.

Philosophers of science are beginning to look at the philosophy of history for a definition of what counts as narrative (Morgan 2017a). Following the suggestion of philosophers of history, narratives should be explanatory in virtue of their very structure (Roth 1989). We use narrative studies as a springboard to ask how models produce "assertions" on aspects of the world despite their non-compliance with major requirements of first-order logic (Roth 1989). Differently to scientific theories, which the received view defined as sets of truth-apt propositions in a formal language.

Models are not strictly speaking true or false. Nonetheless, models produce particular kinds of "assertions" about the target systems they represent, which do not substitute or invalidate the propositional type of assertions made by scientific theories; rather, they enrich the knowledge that theories afford with context-based, case specific circumstances. Morgan (2017b) and Beatty (2017), among others, recently focused on finding narrative structures that would prove particularly useful in scientific explanation. We presently expand on their account of narrative explanation and apply what we consider to be key features of narrative structures to the analysis of scientific models. Our case study is the San Francisco Bay Model (SFBM), a hydraulic scale model built to study the effects of a plan to dam up the San Francisco Bay proposed by John Reber in the late 40s (Weisberg 2013:2). This model testifies for a "revolution" in the history of hydraulic engineering, since it changed the approach of both scientists and lay people to a scientific question of extreme relevance for the San Francisco community. At the same time, the SFBM invites philosophers of science to give a closer look at the kind of "assertions" that the model produced. By integrating narratives in an account of models, we aim to cast new light on the non-deductive explanatory function of models.

We start from Roth's challenge to identify explanation as a product of the very structures that constitute narrative (Roth 1989) and isolate three narrative structures with explanatory value: (1) colligation/juxtaposition (Morgan 2017b), (2) belief/expectation, and (3) doubt/surprise. The two terms defining each narrative structure are often used together and may be used to capture slightly different meanings. "Colligation" (1) is a term famous to philosophers of science thanks to William Whewell (1794-1866), who in his The Philosophy of the Inductive Sciences, Founded Upon Their History ([1840] 1847: 46-48) uses colligation as a technique for discovery. (2) and (3) are both introduced by Charles Sanders Peirce (1839-1914), in his 1877 "The Fixation of Belief": we discuss them as providing the context for a meaningful application of colligation or juxtaposition. Once some narrative structures are clearly defined, we ask what they may be particularly good at. Beatty (2017: 31) suggests that narratives provide stricter constraints than first-order logic for judgements over possibilities: what is "'historically,' 'narrative' possible" is much more much narrowly defined than what is "just logically or physically possible;" we maintain that the "historically possible" does not necessarily constitute a subset of the logically possible either and may contain radically surprising features, i.e. features that could not be

deduced a priori from the initial conditions. Again, models – especially physical ones – offer strong evidence for the possibility of such a radical surprise (Rouse 1950: 138; Morgan 2012: 34). To sum up, we see narratives as (1) knitting particular facts together in a way that theories cannot do (via colligation), (2) exploring contingent possibilities and giving contingent explanations for contingent events, (3) at the same time attaining a kind of generality via the use of general structures (such as expectation and surprise).

We can improve our understanding of scientific models by examining them in terms of the key features of narrative structure pointed out above. The San Francisco Bay Model (SFBM) is a physical scale model that denotes the San Francisco Bay and aims to selectively represent some behaviours of the water flows in the bay (U.S. Army Corps 1963; Huggins and Schultz 1967). With the help of a complex system of pipes and tanks, and the combination of different scales (1:1000 for the horizontal scale, 1:100 for the vertical scale, 10:1 for the slope, 1:100 for the time scale, etc.), the SFBM managed to knit numerous features of the Bay together in a coherent whole. Through colligation (1), scientists brought together a set of relevant parameters under an overall guiding conception (Morgan 2017b: 89). The SFBM was an exploratory tool insofar as it allowed engineers to investigate the consequences of different contingencies in the Bay. For instance, the model was used to study the possible effects of constructing barriers throughout the Bay (2). Lastly, the SFBM was a successful resource to integrate understanding of particular disrupting events (effects of barriers in the Bay) and general background phenomena (the behaviour of currents and tides in nature). In doing so, the SFBM was a material resource to make underlying beliefs explicit and to generate well-defined “doubts” (3).

We see the application of narrative structures to model analysis as a contribution of historical methods to a problem in philosophy of science, and the philosophical analysis of models as a test-board for the validity of narrative claims. In this, history and philosophy of science are brought one step closer.

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