HOW DO MODELS GIVE US KNOWLEDGE? MODELS AS EPISTEMIC TOOLS

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How do models give us knowledge? Although there have been differing perspectives on models, the philosophers of science have still generally agreed that models give us knowledge because they represent their supposed external target objects more or less accurately, in relevant respects and sufficient degrees (Bailer-Jones 2003; da Costa and French 2000; French and Ladyman 1999; Frigg 2002; Morrison and Morgan 1999; Suárez 1999; Giere 2004). The fundamental dividing line goes between those accounts that take representation to be a two-place relation between two things, the model and its target system, and those that argue that also the representation-users and their purposes should be taken into account.

The conviction that representation can be accounted for by reverting solely to the properties of the model and its target system is part and parcel of the semantic approach to scientific modelling. According to this conception, models specify structures that are posited as possible representations of either the observable phenomena or, even more ambitiously, the underlying structures of the real target systems. The representational relationship between models and their target systems is analysed usually in terms of isomorphism (van Fraassen 1980, 45, 64; Suppe 1974, 97,92; French 2003; French and Ladyman 1999).

Pragmatic approaches point out in turn, that no thing is a representation of something else in and of itself; it has to be always used by the scientists to represent some other thing (Teller 2001, Giere 2004). However, if we accept the pragmatist minimalist approach to representation, not much is established in claiming that models give us knowledge *because* they represent their target objects. In fact, we will argue that the pragmatist account just points to the impossibility of giving a general *substantial* analysis of representation that would explain in virtue of what knowledge, or information, concerning real target systems could be retrieved from the model.

As our concern is in explaining how and why models give us useful knowledge, we will approach models from a functional point of view, *as epistemic tools*. This amounts to considering *modelling* as a specific scientific practice which makes use of concrete representational means for specific purposes such as scientific reasoning, theory construction and design of other artefacts and instruments. The conception of models as epistemic tools is contrasted with the traditional view of models which assumes that models are representations of some target systems. From this perspective a scientific model is a constructed entity, which gives a theoretical interpretation of a target system in view of particular epistemic purposes. The turn to modelling thus actually implies an extended notion of a model: models can be regarded as unfolding entities constructed by scientists with various representational means, to which the epistemic purposes and various other ingredients are built in. With an example of the Carnot model of a heat

engine we aim to show that a model reduces neither to a diagram nor to a theory or an imaginary entity, but consists of diverse aspects that scientists have built into it in the process of modelling. We claim that this intricate content of scientific models, which usually is fully understood only by the scientists working in the field in question, makes models to function as epistemic tools**.**