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Commentary

Ten challenges for computer models in transitions research: Commentary on Holtz et al.

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ABSTRACT

The emergence of a dedicated modelling community within the transitions field is to be welcomed, and the authors of a recent paper in EIST (Holtz et al., 2015) make many valuable points. We build on their position paper in two ways. First, we reflect on some of the ways in which modelling in other areas of 'sustainability science' has sometimes fallen short of the strengths articulated. Second, we extend some of Holtz et al.'s discussion of the epistemological and ontological challenges for modelling transitions. We suggest ten challenges in response to the more optimistic claims made by Holtz et al., and we provide some additional suggestions for ways forward. In particular, we suggest that seeking closer integration of qualitative, socio-technical analysis with models may not always be the best strategy. Rather, pluralist 'bridging strategies' and dialogue between analytic approaches may be more productive.

1. Introduction

The transitions community has traditionally relied on detailed case studies, of both historical transitions and current policy and innovation developments. Now, it is refreshing to see the emergence of a dedicated modelling community within the transitions field. The authors of a recent paper in EIST (Holtz et al., 2015) make many valuable points, and the emergence of this community within the wider transitions field is to be welcomed. In particular, it is exciting to see the efforts of modellers to grapple with the co-evolutionary, multi-agent character of transitions, which contrasts favourably with dominant modelling traditions such as CGE (Computable General Equilibrium), IAMs (Integrated Assessment Models) or linear optimisation.

However, along with the enthusiasm of opening up new research space, it is important not to overstate the benefits of models for transition research. The strengths of modelling are well articulated by Holtz et al., as are some of the limitations. We seek to build on their position paper in two ways. First, we reflect on some of the ways in which the use and development of models in other areas of 'sustainability science' has sometimes fallen short of the strengths articulated, and has sometimes obscured key issues. Second, we extend some of Holtz et al.'s discussion of the epistemological and ontological challenges for modelling transitions. Hence, it is in the spirit of constructive engagement that we suggest ten challenges in response to the more optimistic claims made by Holtz et al. for using system models in transition research, and we provide some additional suggestions for ways forward. Our ten challenges were inspired by the Holtz et al. position paper, but they should not be

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read simply as a direct critique of Holtz et al., whose work we appreciate. Rather, these challenges are a critical response to a range of issues that the position paper raised and that we have observed in related fields of modelling.

It is also important to note that Holtz et al., and other recent surveys of modelling in the transitions arena (e.g. Li et al., 2015), make clear that there is a rich diversity of modelling approaches being applied in the field, and that these are used for a variety of purposes. Not all of the challenges we raise apply directly to all types of models and all uses. In a similar manner to the Holtz et al. paper, we aim to set out issues that are of general relevance to the transitions modelling community.

2. Operational challenges for modelling transitions: lessons from related fields

2.1. Challenge 1: Hidden assumptions remain

We agree with Holtz et al. that modelling requires explicit recording of key assumptions, and that the process of developing models can be a valuable way to create greater precision and clarity about such assumptions. But it is an overstatement to say that it requires making "all" assumptions explicit. In practice, many assumptions can remain 'backgrounded' and hidden, either because they are not properly documented, or because they are implicit assumptions that have not been recognised even by the modellers themselves (Kloprogge et al., 2011; Miller, 2015). Many such assumptions are inevitably subjective judgements made under uncertainty (Funtowicz and Saltelli, 2014; Kloprogge et al., 2011), often unconsciously (Craig et al., 2002), and they carry the perspectives, assumptions and values of the modellers who make them. Publishing source code and data is helpful (see, e.g. DeCarolis et al., 2012), but it remains important not to overstate the extent to which model-building and application clarifies the epistemic ground on which we stand.

2.2. Challenge 2: Ambiguity in interpretation is important

There is a basic ambiguity in the relationship of a model to the real world (Beven, 2009; Hennig, 2010), and model interpretation thus requires reasoned (and subjective) judgement (Huntington et al., 1982; Sugden, 2009). This ambiguity should not simply be consigned to a footnote (as in Holtz et al.), since doing so misrepresents the importance of subjective judgement in the process of learning from models. Cartwright (2009) discusses very different possible interpretations of models when used as 'experiments', with different epistemic claims and underlying assumptions. The point here is that ambiguity about the nature of the claims, and the process of interpretation, has important implications for how models should be used. Yet sustained attention to such issues is lacking in many areas of modelling in social science (see, e.g. Rodrik, 2015; Lorenz, 2009), despite the readiness of analysts to apply models to policy questions. We therefore encourage greater reflection on the process of model interpretation, the nature of the knowledge generated through modelling, and the implications for application of models to policy questions.

2.3. Challenge 3: Uncertainty analysis frequently downplays the remaining uncertainties (Funtowicz and Saltelli, 2014)

In particular, modelling in related fields has frequently not acknowledged the importance of ignorance (Stirling, 1999), including 'meta-ignorance' (an inability to know the limits of our knowledge; Spiegelhalter and Riesch, 2011). State-of-the-art methods for dealing with uncertainty help, yet at the same time such methods are often deployed as part of a narrative repertoire that serves to downplay the uncertainty and ignorance that remains. We thus agree that while one can use global sensitivity testing to understand how robust our options are in the face of *many of the* uncertainties, we should not assert, as Holtz et al. do, that we can do so in the face of *the many* uncertainties, i.e. it must be recognised that such efforts are partial, and not definitive.

2.4. Challenge 4: Validation may be impossible for predictive applications of models (Hodges and Dewar, 1992)

Holtz et al. recognise this, by discussing the way in which the validity of models for future projections may be unknown. Issues of validation have been a vexed question for a range of types of models applied in the broad field of sustainability science, with differing definitions revealing a variety of underlying beliefs about what constitutes validity, how it should be established (David, 2009; Ormerod and Rosewell, 2009), and how different model uses impose different validation requirements (Windrum et al., 2007). Much like the concerns about the epistemic claims that can be legitimately derived from models (discussed under point 2), challenges in validating models have strong implications for the way in which models should be used in policy processes. Unfortunately, experience from other domains (such as mainstream economics, IAMs and energy system modelling) suggests that concerns about the extent to which quantitative models are or are not validated are often put in the background of policy advice that derives from such models. We therefore welcome the attention to validation issues highlighted by Holtz et al., but we urge future work to acknowledge the implication: that models that cannot be validated should be used and presented with caution and humility.