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► To cite this version:

Laetitia Bornes, Catherine Letondal, Rob Vingerhoeds. Using a Quali-Quantitative Modelling Tool to Explore Scenarios for More-Than-Sustainable Design. *Relating Systems Thinking and Design* 12, Oct 2023, Host: Georgetown University, Location: Amsterdam, NLD | ONLINE, United States. hal-04387992

HAL Id: hal-04387992

<https://enac.hal.science/hal-04387992>

Submitted on 11 Jan 2024

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Relating Systems Thinking and Design (RSD12) Symposium | October 6–20, 2023

Using a Quali-Quantitative Modelling Tool to Explore Scenarios for More-Than-Sustainable Design

Laetitia Bornes, Catherine Letondal, and Rob Vingerhoeds

The systemic design approach is particularly relevant to imagining and designing more-than-sustainable futures while respecting planetary boundaries. It involves navigating between spatial, organisational, and temporal scales in order to give weight to long-term effects while addressing the urgency of the situation. It is also a question of perceiving interdependencies and underlying structures, as well as anticipating possible rebound effects.

Representation in the form of models, such as causal loop diagrams, sometimes makes it easier to understand and communicate a complex situation, as well as to identify leverage areas for action. Causal loop diagrams represent the structure of a system but do not represent the orders of magnitude of its current state, its dynamics, or projections of possible futures.

Yet many of the problems we face are physical and quantifiable (e.g. carbon emissions, land artificialisation, etc.), and we need tools to address them. Systems dynamics, a legacy of hard systems thinking, can help us to imagine, compare and combine design leverages over time through simulation. However, stock and flow modelling tools are hardly used by systemic designers, as they require coding and mastery of the principles of system dynamics.

In this workshop, we explore the potential of modelling to support more-than-sustainable design. Prior to the workshop, participants are guided through an example application to familiarise themselves with the formalism of quali-quantitative modelling. Through this example, they discover how the

interactive modelling tool can be used to explore scenarios and support design and planning decisions.

During the workshop, participants practise quali-quantitative modelling on a case study drawn from their own experience or on the case study presented by the organisers. They are invited to discuss their own experiences and the projects for which modelling would have been of interest before discussing the benefits and limitations of modelling in these different cases. The aim is to share the potential of this approach while gathering feedback from the systemic design community. The workshop is, therefore, primarily aimed at systemic designers who have already worked on projects involving quantitative data and are interested in a modelling tool, but it is open to all kinds of participants, including novice ones.

KEYWORDS: modelling, tools, systems dynamics, sustainability, sociotechnical systems, rebound effect

RSD TOPICS: Mapping & Modelling, Socioecological Design, Sociotechnical Systems

A quali-quantitative modelling tool

Modelling can be a powerful tool, not only for making the internal mental models of different stakeholders explicit (Checkland et al., 1990) and for synthetically representing a complex situation but also for exploring and testing solutions in a virtual world (Schön, 1983).

In particular, in the design of interactive systems (Bornes et al., 2022), modelling can be used to represent influences between the different scales of design identified by Buchanan (1992) and consolidated in the context of systemic design by Jones (2013).

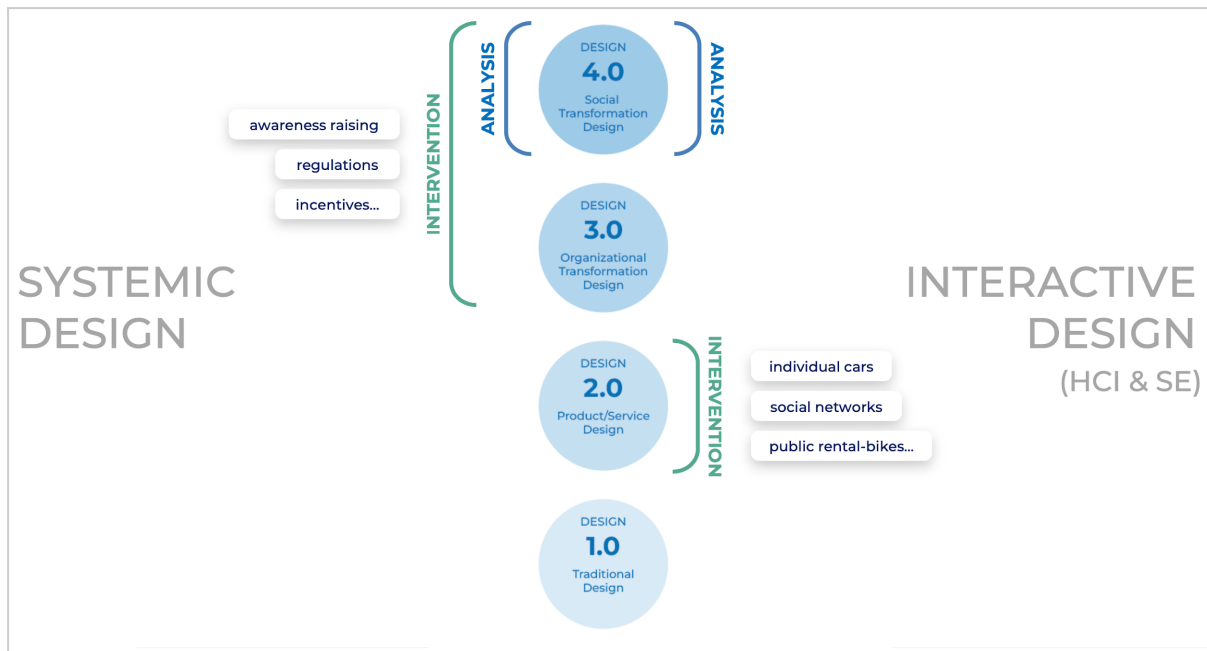


Figure 1: Levels of design, inspired by Jones, P. (2013).

Many systemic designers use causal loop diagrams (Kim, 1992) as a valuable tool for representing the complex system they are studying. These diagrams allow them to represent and understand the system (Systemic Design Toolkit, n.d.), as well as to identify levers for action. However, causal loop diagrams do not allow us to explore and test scenarios: they represent the structure of the system but not its current state or potential future states (Sterman, 2000). In addition, these diagrams are purely qualitative (no orders of magnitude or delays), which can be a hindrance when dealing with quantitative physical phenomena (e.g. carbon emissions, land artificialisation, etc.) that must remain below planetary boundaries (Raworth, 2017).

Stock and flow diagrams can be used to model the physical dynamics of a system (Meadows et al., 2009), but they are rarely used by systemic designers, probably because systems dynamics modelling tools require coding and mastery of systems dynamics.

This is why we propose an interactive quali-quantitative modelling tool (Bornes, 2023), which draws on the simplicity of causal loop diagrams and embeds the basics of system dynamics in an interface suitable for modelling socio-technical systems. The

computational part of the tool is comparable to the World3 model used in *The Limits to Growth* (Meadows et al., 1972).

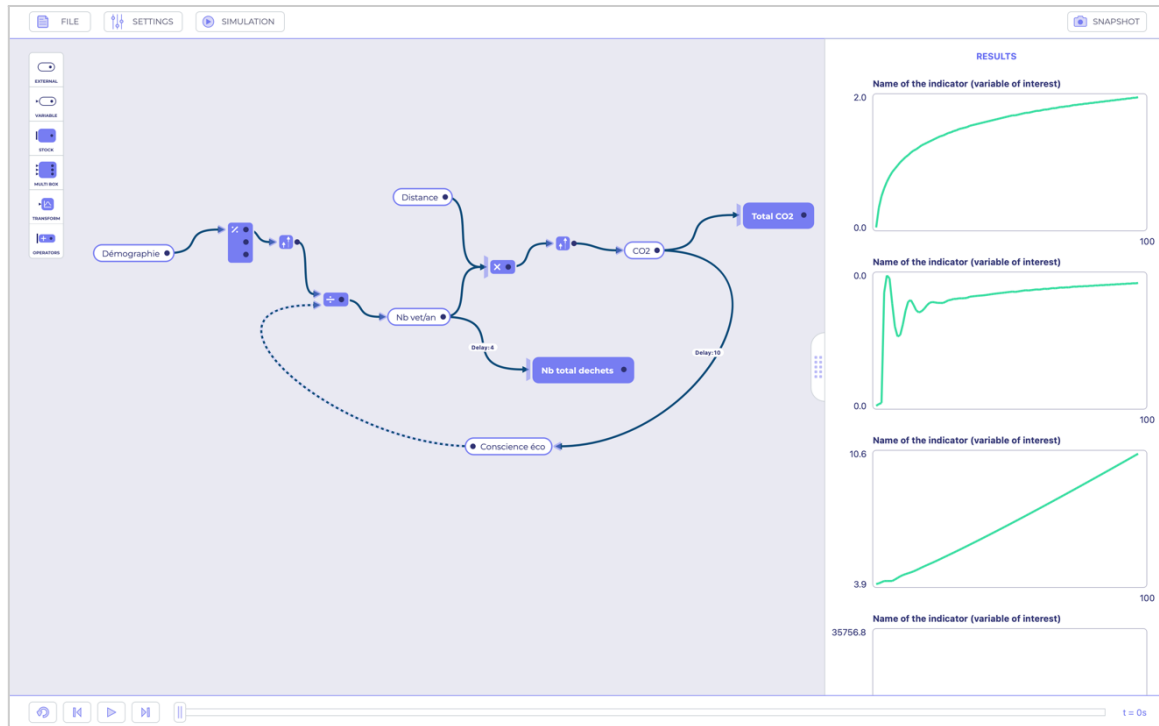


Figure 2: Screenshot of the quali-quantitative modelling tool prototype.

Workshop description

Prior to the workshop, participants are asked to watch an online pre-session (asynchronous webinar). In this pre-session, they are introduced to an example application, which they will use during the workshop. This example application could be the case of a platform for the resale of second-hand clothes and the rebound effects that this causes on several scales. Participants then learn about the formalism of quali-quantitative modelling: the meaning and function of each element available for the visual construction of the graph. They discover how the interactive modelling tool can be used to explore scenarios and support design and planning decisions through a simplified example.

During the workshop, participants practise quali-quantitative modelling on the case study introduced during the online pre-session or on a case study drawn from their own experience. They are then invited to present their models to the other groups. The last activity of the workshop is dedicated to discussions about the possible applications, the methodology, and the feasibility of such modelling, as well as the benefits and limitations depending on the case. Participants are encouraged to share their own experiences and their past projects for which modelling would have been of interest.

The aim is to share the potential of this approach while gathering feedback from the systemic design community. The workshop is, therefore, primarily aimed at systemic designers who have already worked on projects involving quantitative data and are interested in a modelling tool, but it is open to all kinds of participants, including novice ones.

Objectives

From the participants' point of view, the workshop provides an opportunity to discover an original approach that combines a qualitative methodology with a quantitative tool and to put this framework into practice through concrete examples. It is also an opportunity to meet and talk with other participants who share an interest in the modelling/mapping tools. We hope that these connections can continue beyond the workshop.

From the organisers' point of view, the aim is to receive feedback on both the tool and method (formative evaluation) from systemic designers and other potential users. We highly value the input of the participants and their perceptions of the potential of this methodological framework and its applications.

Agenda

90 minutes | online & in-person | maximum number of participants 30

Prior to the workshop, participants consult asynchronous online content, which will contain the following:

- introduction on a simple case study and the modelling approach
- introduction to the formalism of quali-quantitative modelling
- demonstration of a simple quali-quantitative model based on the case study

A flexible schedule of the workshop is as follows:

- **10 min** introduction (plenary)
- **40 min** modelling based on pre-identified variables (groups)
- **15 min** presentation of each group model to others (plenary)
- **15 min** ideation on the applicability, the contributions, and the limitations (groups)
- **10 min** sharing feedback and ideas, closing discussion (plenary)

NB: Participants can reflect on a case study drawn from their own experience, identify the associated variables, and model this case study during the workshop. Alternatively, they can work on the case study presented in the online content.

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Facilitator/organiser profiles

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After a master's degree in engineering, architecture and digital design, Laetitia Bornes worked for five years as a UX designer. Now in the 2nd year of her PhD, she is exploring the potential of modelling to support the more-than-sustainable design of interactive systems. Her research aims to enable designers and decision-makers to represent the systemic effects of their design and explore scenarios in order to make informed decisions and avoid counterproductive solutions.

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Catherine Letondal has been conducting research into human-computer interaction and human-centred design for 25 years. She initially specialised in end-user development, participatory design and tangible interaction for complex critical domains such as aeronautics. For the past five years, she has been exploring HMI-based research directions for systemic approaches.

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Rob Vingerhoeds is a Full Professor of Systems Engineering at ISAE-SUPAERO, Université de Toulouse, France. Rob's research interests include systems engineering and architecture, model-based systems engineering, concept design, and artificial intelligence techniques for engineering applications. Rob is Deputy Editor of the International Scientific Journal "Systems Engineering."