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Computational models in systemic design
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Suggested citation:
Computational Models of Complexity to Design for Sustainability

Questions and opportunities

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Sustainability and social systems

• Take a commonly know sustainability challenge, such as plastic waste
• The first inclination is to deal with the waste directly, e.g. by organising beach clean ups
• The first design thought leads to rethinking the products made of plastic, such as packaging.
• Quickly designers dealing with this issue see the need to take into account human systems connected to plastic, such as a local community, the global plastic supply chains, or the worldwide network of additive manufacturing.
• These are all examples of complex social systems.
100% reusable, recyclable or compostable plastic packaging by 2025

FOLLOW THEIR LEAD

MATERIOM – connecting a global network

Source: Fab Lab Foundation, 2018.
How does design approach complexity in sustainability?
Complexity and sustainability in design

**Systemic design**

“Systemic design is distinguished from service or experience design in terms of scale, social complexity and integration. (...) By integrating systems thinking and its methods, systemic design brings human-centered design to complex, multi-stakeholder service systems as those found in industrial networks, transportation, medicine and healthcare.”

**Transition design:**

“A new, design-led approach should enable stakeholders to arrive at a shared definition of the problem and an understanding of its complexities and interdependencies”

Systemic design - Giga-mapping

Source: B. van Zwet, C. Mui, J. Janbroers, M. Terranea, S. Botterweck, 2018 (student project)
Transition design –

system map

Source: T. Irwin, 2018, The Emerging Transition Design Approach
Systemic design – participatory design and co-creation
Transition design – future visioning

Groups were provided with narrative templates and examples of how to develop future, lifestyle-based narratives that incorporate solutions holistically into lifestyles. This template provided participants with a way to think about the world they wanted to see in 2050 and how they could contribute to making it happen. The springboard for the future design emerged from these discussions.

Source: T. Irwin, 2018, The Emerging Transition Design Approach
How do complexity scientists approach social systems?
Computational models of social systems in sustainability - examples

Systems of differential equations

Slow Response of Societies to New Problems: Causes and Costs
Marten Scheffer,1* Frances Westley,2 and William Brock3

Agent-based models

Agent-Based Modeling and Industrial Ecology
Robert L. Axtell, Clinton J. Andrews, and Mitchell J. Small

System dynamics

Navigating towards sustainable development: A system dynamics approach
Peder Hjortha,1, Ali Bagheria,b,*

Networks

Disentangling intangible social-ecological systems
Örjan Bodina,b,*, Maria Tengöa,b
Are there opportunities to apply these techniques to design?
Prioritise stakeholder engagement

- Network science
- Data scraping and crowd-sourced data

Prioritise interventions

• System dynamics

• Participatory modelling

Source: Schmitt Olabisi, L., et al., 2010, Using Scenario Visioning and Participatory System Dynamics Modeling to Investigate the Future
Simulate stakeholder / user behaviour

- Agent-based model
- Purely theoretical

Opportunities for design - examples

**Stakeholder analysis**
- Prioritise stakeholder engagement
- Simulate stakeholder/user behavior

**Future visions**
- Simulate sustainable business models
- Simulate future supply chains and industries

**Design choices**
- Prioritise potential interventions
What may have prevented computational modelling in design for sustainability to date?
1) Can humans be modelled?

Recommendations:
• Acknowledge assumptions and values
• Leverage data from online tools
• Address ethics issues
2) Are design and modelling compatible?

Recommendations:
• Leverage designers’ intuition as a starting point
• Develop designer and stakeholder-friendly interfaces
• Involve stakeholders in the development of the model
3) Can you model with limited data?

Recommendations:
• Don’t underestimate data available
• Work with plausible models and multiple scenarios
• Develop models in an iterative way
Take aways

• Make your assumptions explicit and consider ethics questions
• Leverage data from online tools and big data analysis methods
• Develop simulation interfaces for designers and stakeholders
• Leverage stakeholders’ intuition
• Adopt an iterative approach to model building
Next steps: demonstrator case studies

Case requirements
• Social complexity, sustainability objectives, designers involved
• Curiosity, willingness to experiment
• Access to data

Case 1: Designing a marketplace for material reuse in the built environment
  ➢ Modelling the current and future built environment ecosystems
  ➢ Prioritizing stakeholder engagement

Case 2: Redesigning the psychiatry system
  ➢ Identifying sources of stagnation in current system
  ➢ Prioritizing stakeholder engagement
Thank you!