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Computational models in systemic design

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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.

Source: Stefan van der Heijden, 2018.

Source: New Plastics Economy, Ellen MacArthur Foundation, 2018.

Source: Fab Lab Foundation, 2018.

How does design approach complexity in sustainability?

Complexity and sustainability in design

Systemic design

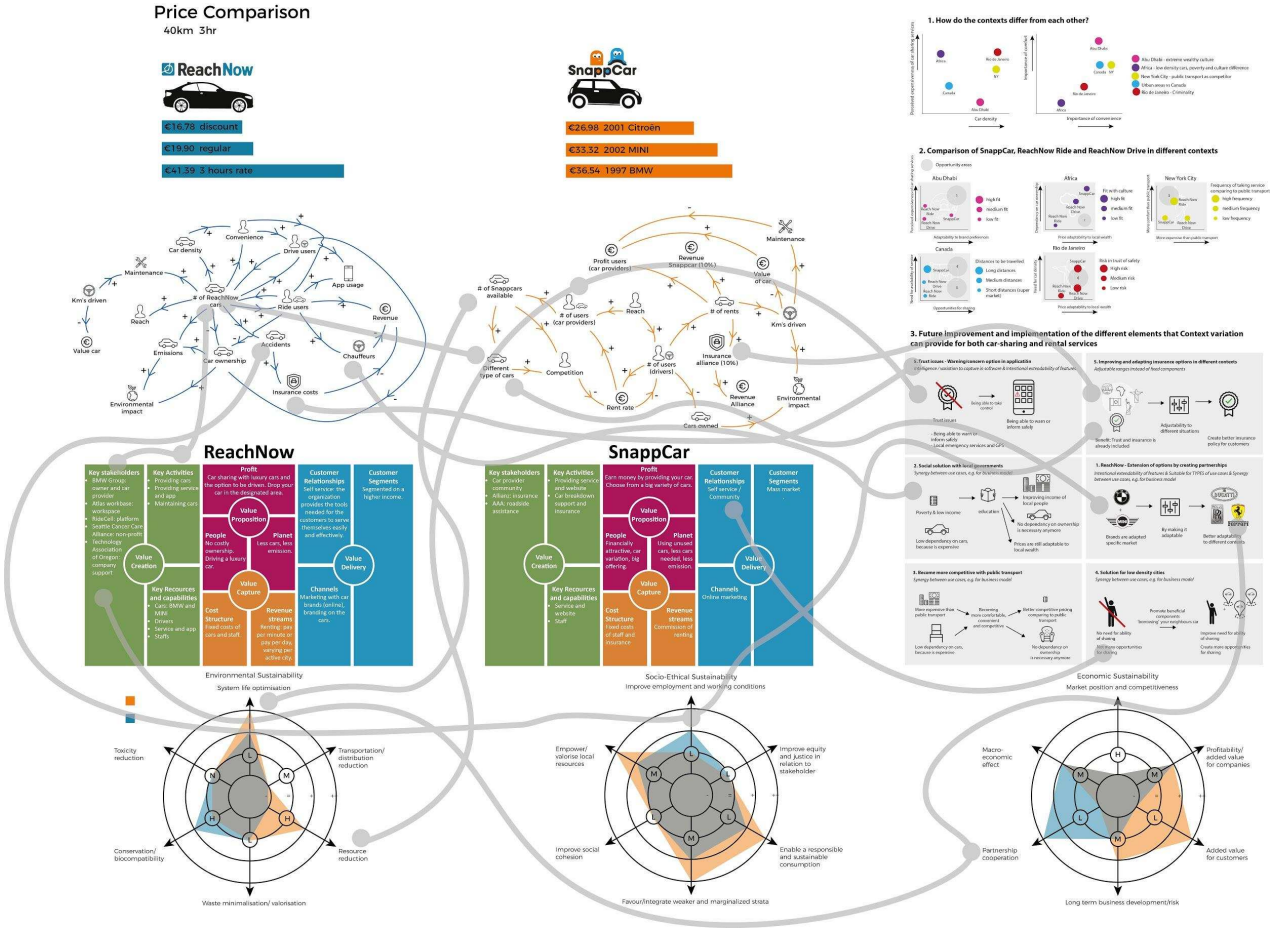
“Systemic design is distinguished from service or experience design in terms of scale, **social complexity** and integration. (…) By integrating systems thinking and its methods, systemic design brings human-centered design to **complex, multi-stakeholder service systems** as those found in industrial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

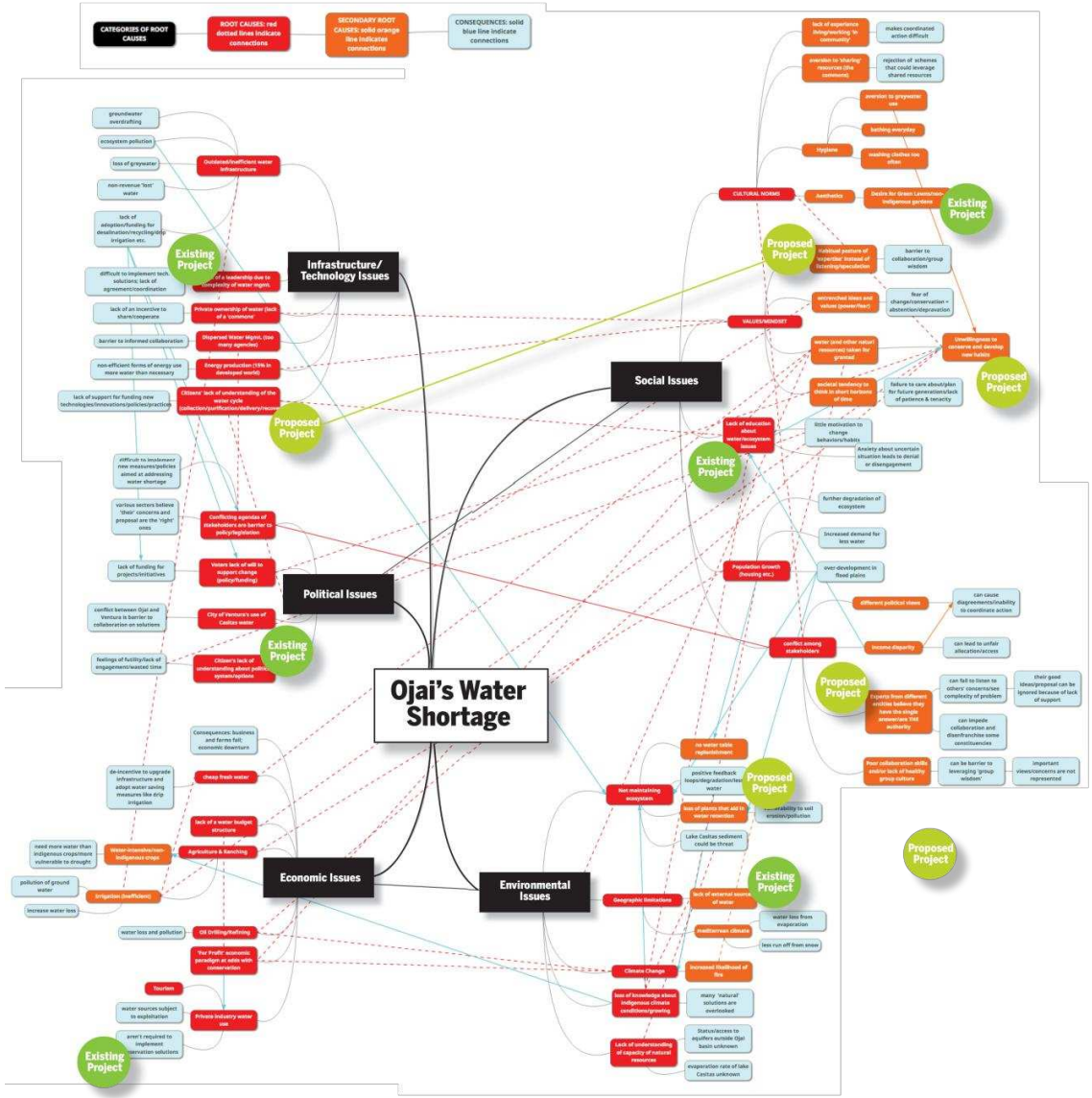
Sources: Jones, P., 2014, Systemic Design Principles for Complex Social Systems, Irwin, T., 2018, The Emerging Transition Design Approach;

Systemic design - Giga-mapping



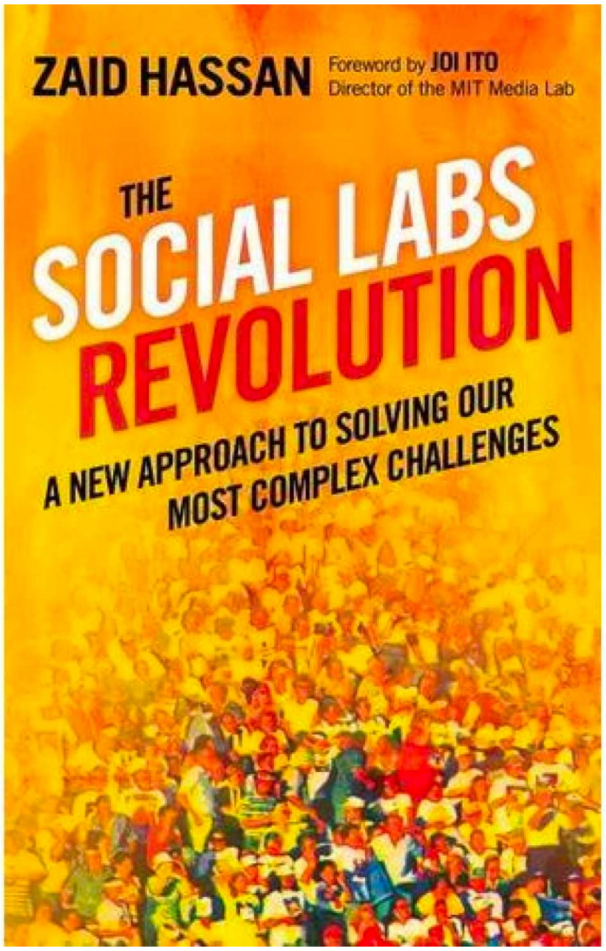
Source: B. van Zwet, C. Mui, J. Janbroers, M. Terranea, S. Botterweck, 2018 (student project)

Transition design – system map

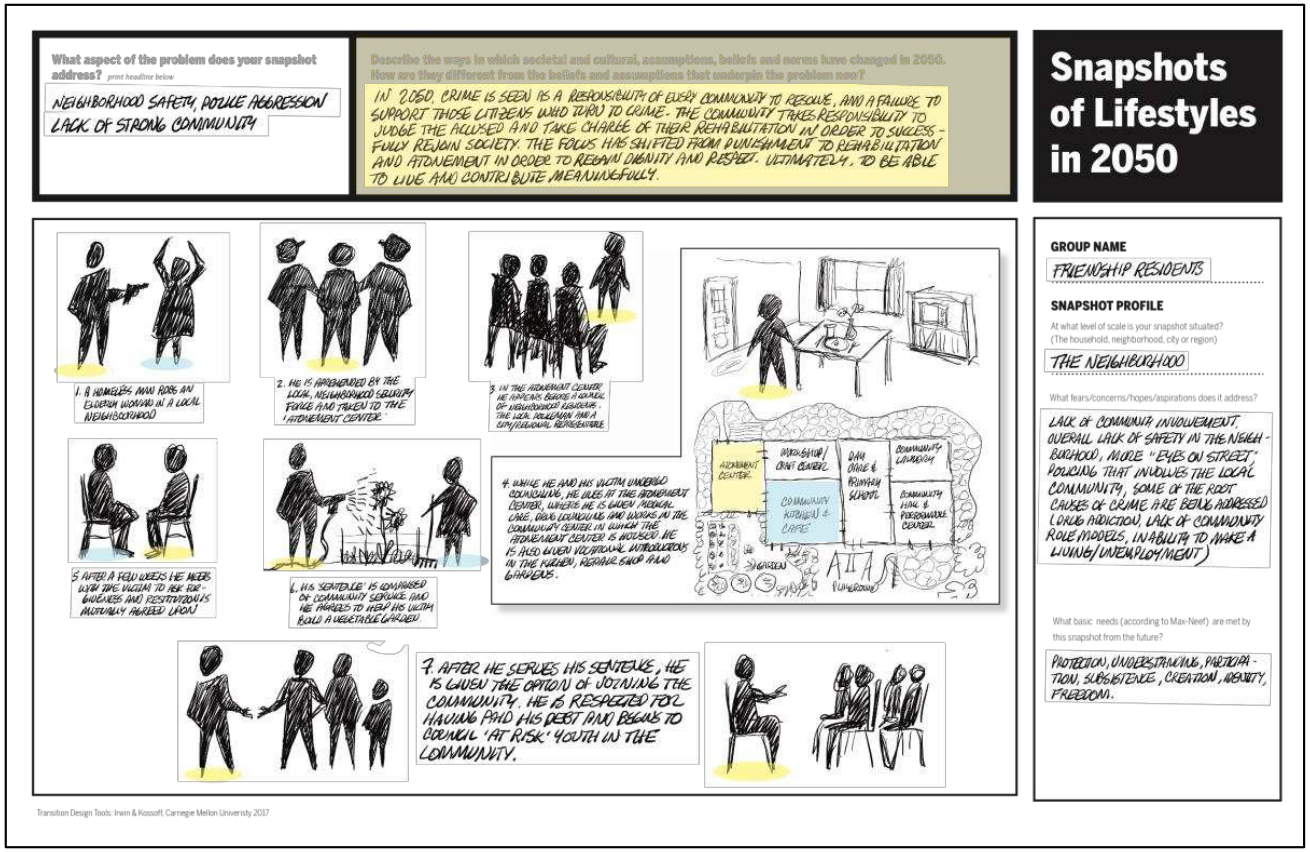


Source: T. Irwin, 2018, The Emerging Transition Design Approach

Systemic design – participatory design and co-creation



Transition design – future visioning



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 Brock[3]

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 Hjorth[a,1], Ali Bagheri[a,b,*]

Networks

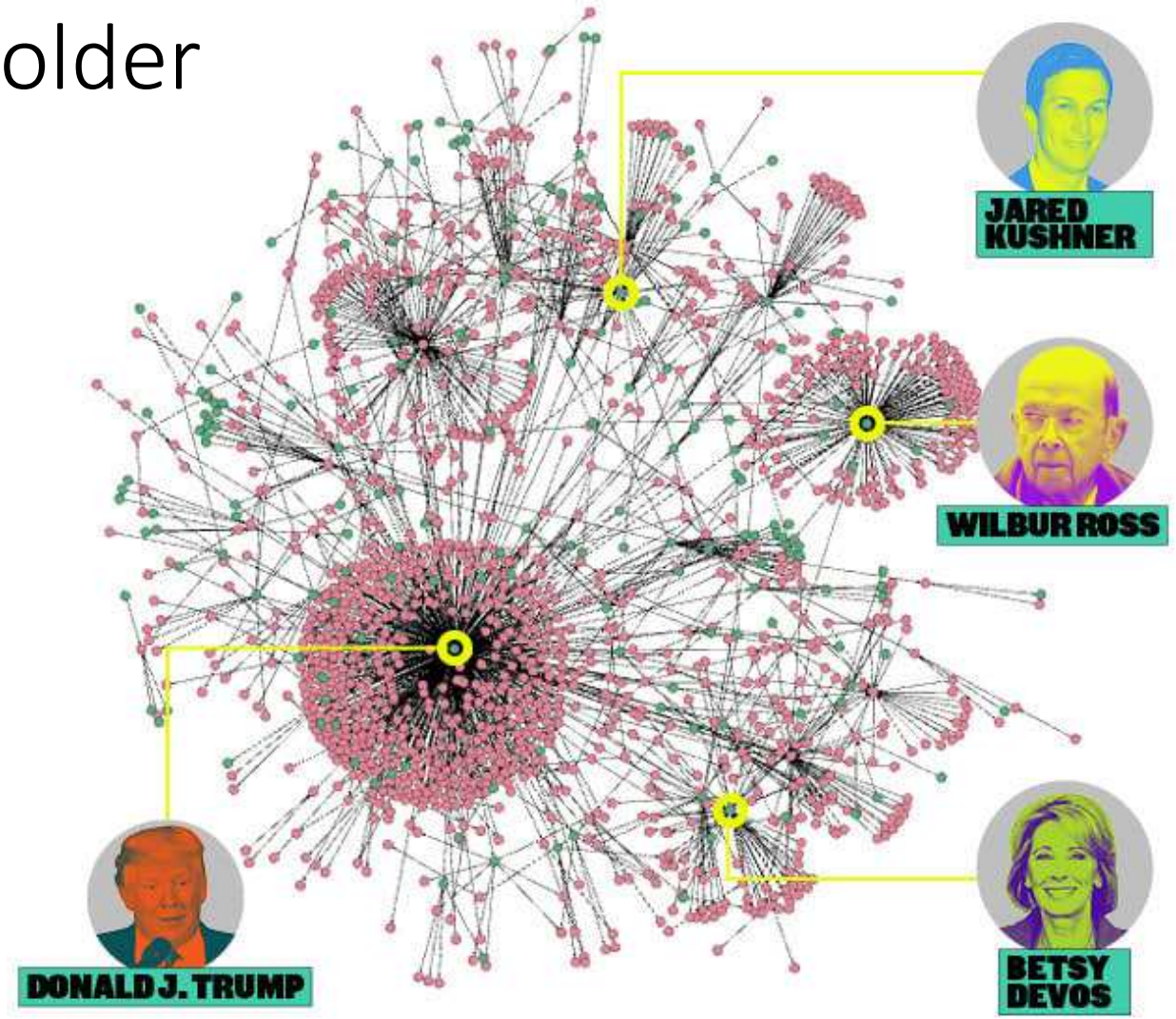
Disentangling intangible social–ecological systems

Örjan Bodin [a,b,*], Maria Tengö [a,b]

Are there opportunities to apply these techniques to design?

Prioritise stakeholder engagement

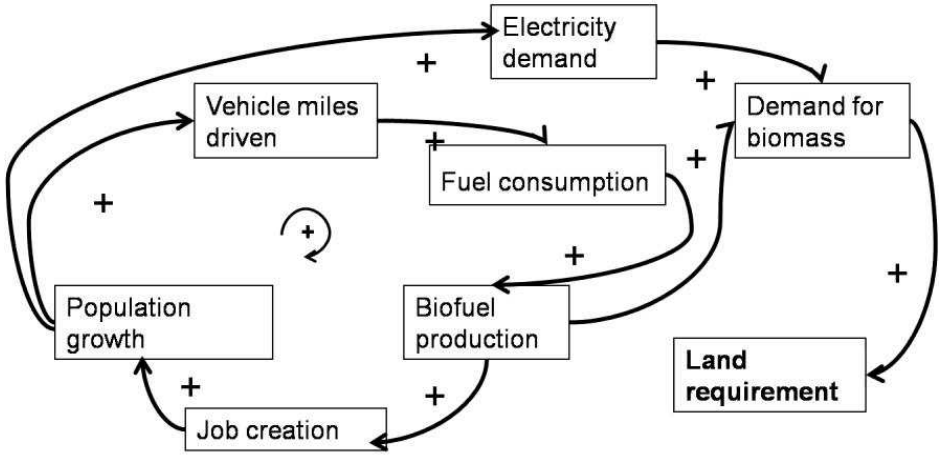
- Network science
- Data scraping and crowd-sourced data

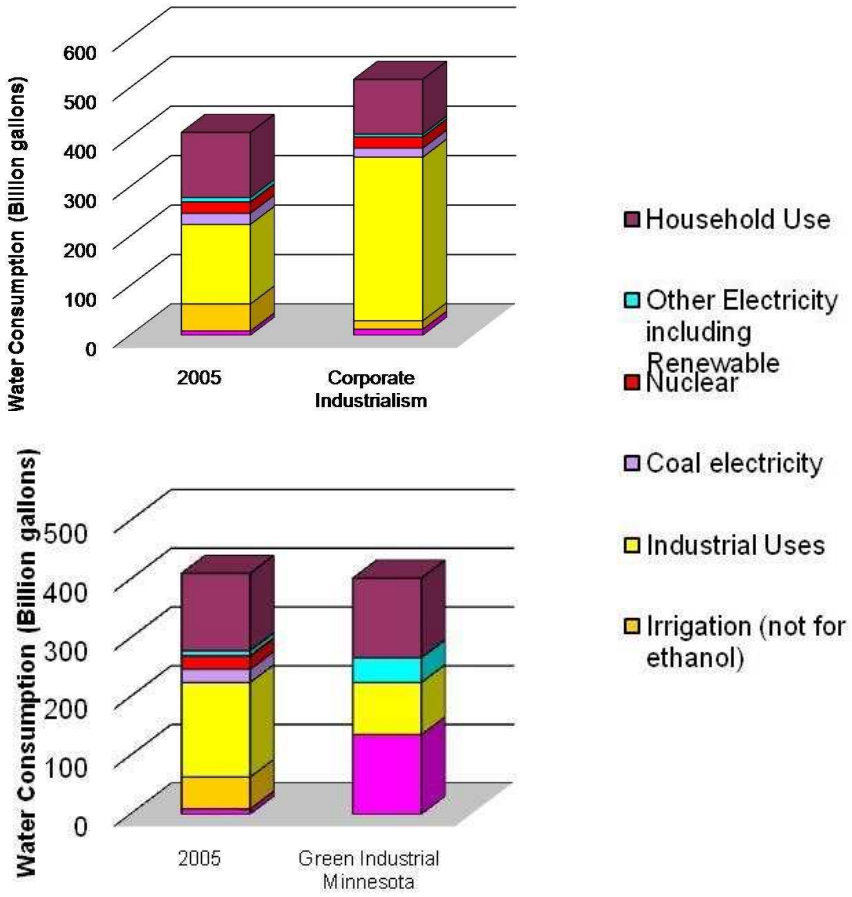


Source: Templon, J., Cormier, A., Campbell, A., Singer-Vine, J., Buzzfeed.

Prioritise interventions

- System dynamics
- Participatory modelling

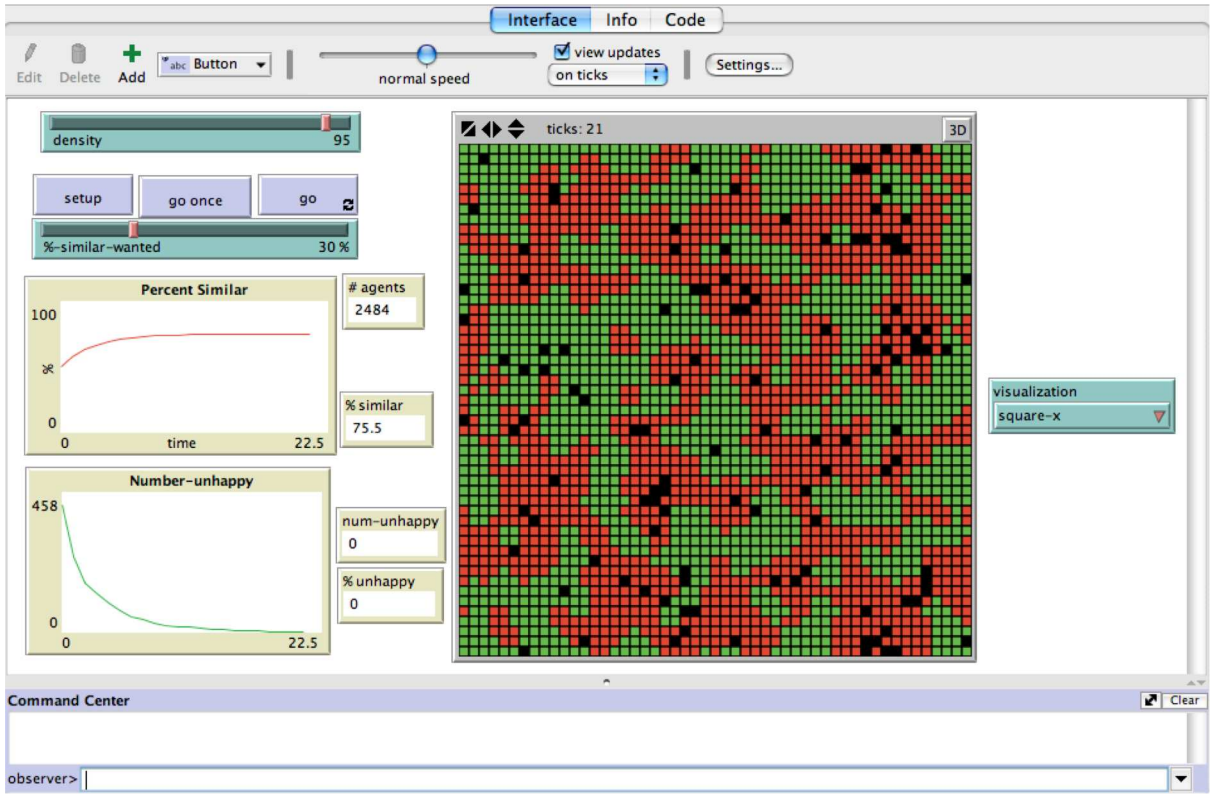




Source: Schmitt Olabisi, L., et al., 2010, Using Scenario Visioning and Participatory System Dynamics Modeling to Investigate the Future

Simulate stakeholder / user behaviour

- Agent-based model
- Purely theoretical



Source: Schelling, T., 1978, Micromotives and Macrobehavior; Wilensky, U., 1997, NetLogo Segregation model.

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!