Multilevel Dynamics & Local Policy in Global Systems Science

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European FP7 FET TOPDRIM Project

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Exploring complex socio-techno-environmental systems across the boundary

Global Systems Science

Global Systems - examples

epidemics & health
financial crashes

Global Systems Science

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epidemics & health
cities and populations
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GSS - Science for Policy

- **science** to address policy questions
- **tools** – *policy informatics*
- **policy** based on scientific evidence
- **engagement** policy makers – scientists – citizens

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GSS has emerged from the European Commission.

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GSS – Europe-Japan collaboration ?

Global Systems

Global phenomena impact on individuals top-down

Flu
Terrorist attack
Fashion
Price of bananas
…

Global Systems

Global phenomena impact on individuals top-down

But individuals impact on global phenomena bottom-up !

Flu
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CO_2 Emissions
Traffic jams
Riots & Revolution
Twitter
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Global phenomena impact on individuals top-down

But individuals impact on global phenomena Bottom-up !

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Terrorist attack
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Local micro-dynamics matter in global systems

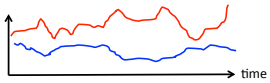
Global System Science and Policy

Fundamental Questions

How can policy makers know the policy will work?

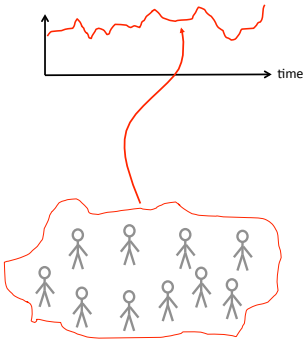
How can science inform policy makers
at local, national & global scales?

Science



Some systems can be modelled at a single level

Science



Some systems can be modelled at a single level

Some systems must be modelled bottom-up

Science

Macro-Level – "the global system" – just one

Micro-level – everything – all 7 billion individuals

Science

Macro-Level – "the global system" – just one

Cannot simulate
7 billion x 7 billion
interactions

Micro-level – everything – all 7 billion individuals

Science

Macro-Level – "the global system" – just one

Meso

What happens at the intermediate 'meso' levels ?

Micro-level – everything – all 7 billion individuals

Science

Macro-Level – "the global system" – just one

Macro-macro-meso

Macro-meso-meso

Meso

Micro-meso-meso

Micro-micro-meso

What happens at the intermediate 'meso' levels ?

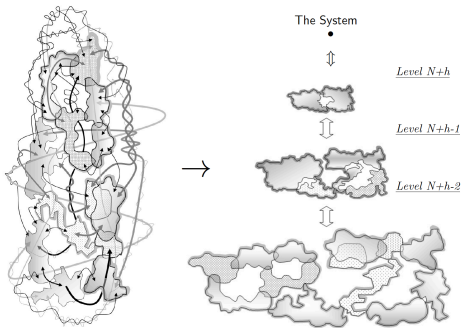
Micro-level – everything – all 7 billion individuals

Science

Level N+h	societies, ...	nations, ...	climate, ...
Level N+h-1	...	...	...
Level N+h-2	individual animals, ...	regions, ...	humans, environment, weather, ...
...	organs, bones, ...	cities, ...	cities, water, power, ...
Level N+2	cells, ...	neighbourhoods, ...	buildings, transport, mountains, clouds
Level N+1	...	...	...
Level N	proteins, fluids, ...	houses,roads, shops	people, rain, planes

System have multilevel structure and dynamics

Science



? Can complex systems be resolved into discrete levels ?

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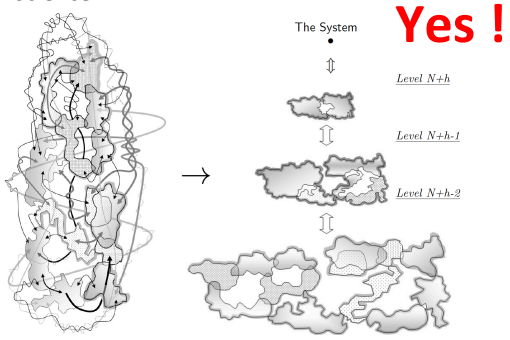

Yes !

? Can complex systems be resolved into discrete levels ?

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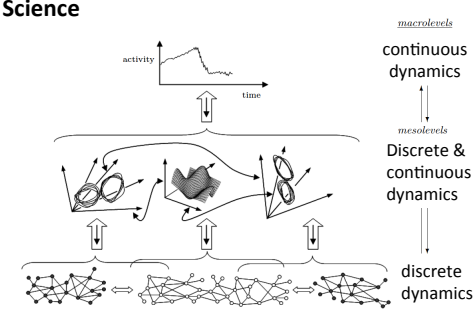

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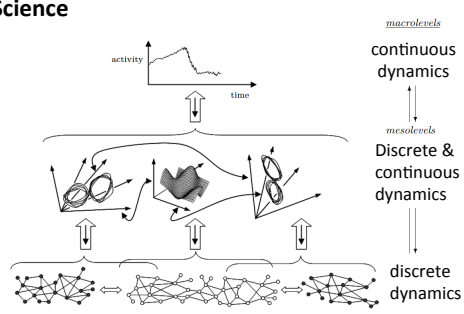

'prediction' for policy involves bottom-up and top-down dynamics in complex systems

Science → Tools for Policy

e.g. TRANSIMS

Bottom-up simulation for road traffic dynamics

e.g. EPIWORK

Simulation of epidemics

Science → Tools for Policy → Engagement

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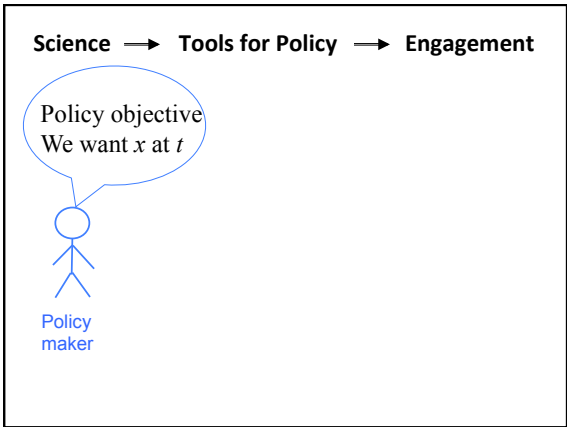
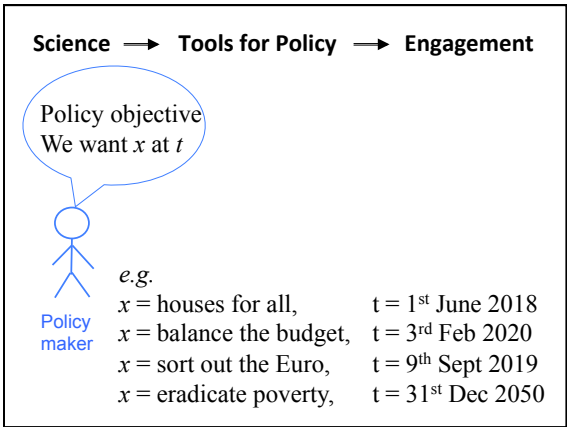
How can scientists engage policy makers?


Science → Tools for Policy → Engagement
Policy objective
We want x at t
Policy maker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We want x at t
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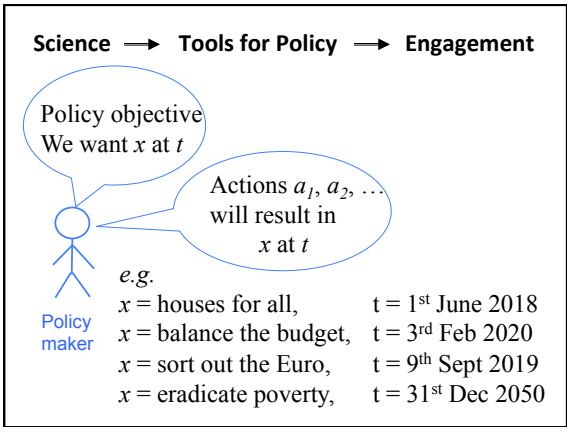
e.g.
x = houses for all, t = 1st June 2018
x = balance the budget, t = 3rd Feb 2020
x = sort out the Euro, t = 9th Sept 2019
x = eradicate poverty, t = 31st Dec 2050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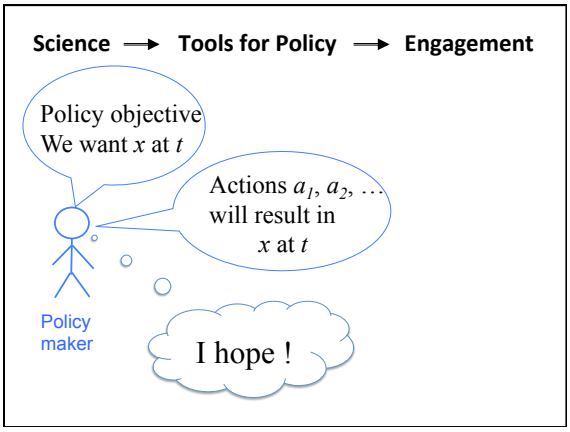
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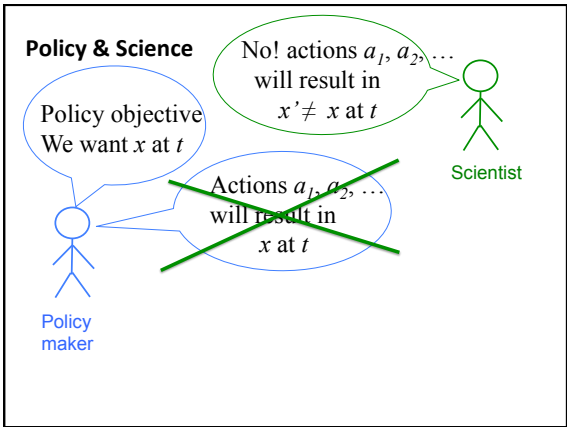
Policy & Science
No! actions a1, a2, …
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x'≠ x at t
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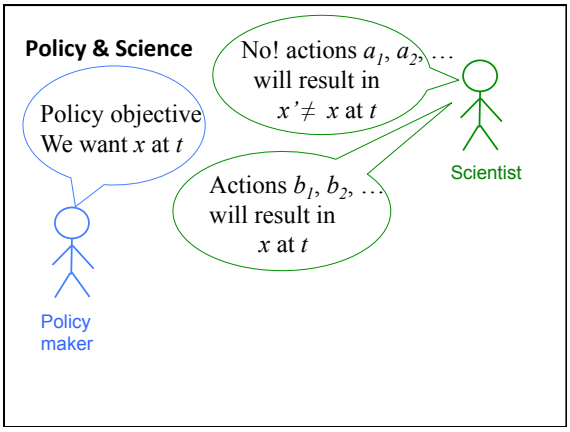
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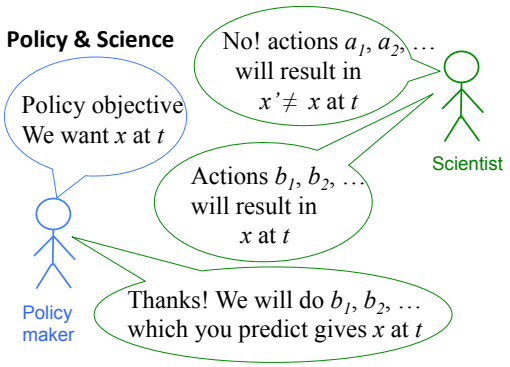

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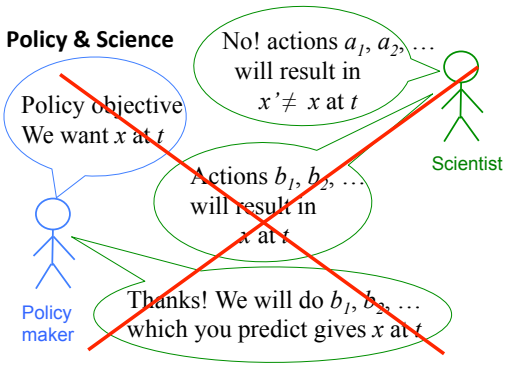

Point predictions are impossible in complex systems!

Policy & Science

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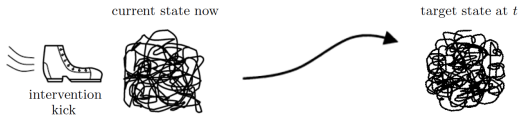

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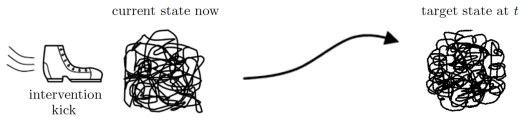

What kind of social 'predictions' can science make?

Policy & Sciences of the Artificial

Complex socio-techno-environmental systems

are artificial systems !

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Artificial systems are created by accident or **design**

Policy & Sciences of the Artificial

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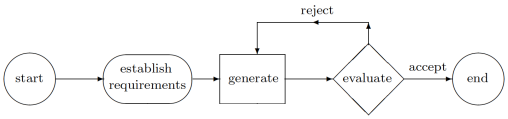
Policy is *designing the future*

Design

The requirements & generate – evaluate cycle of design



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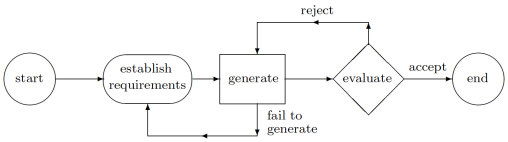
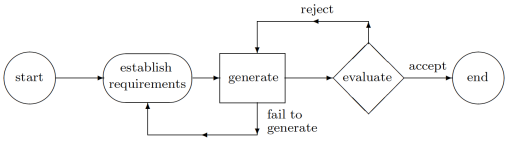


Requirements and solutions coevolve in design:

Design is a *process* that results in
what you think you want from
what you think is possible.

Design

The requirements & generate – evaluate cycle of design



Requirements and solutions coevolve in design:

Design is a *process* that results in
what you think you want from
what you think is possible.

There may be better solutions, but you didn't find them

Design

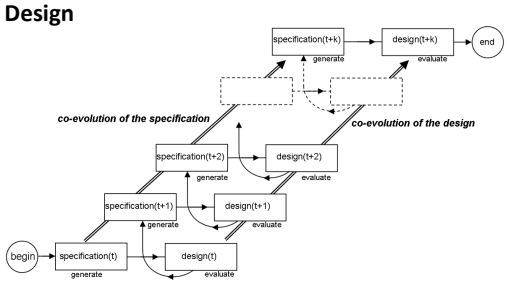


Fig. 9.5 The co-evolution between specification and design through a generate-evaluate spiral

The design process involves experimenting and learning each time round the coevolutionary cycle

Design

Policy is planning and designing the future

Design is making the system as it *ought to be*

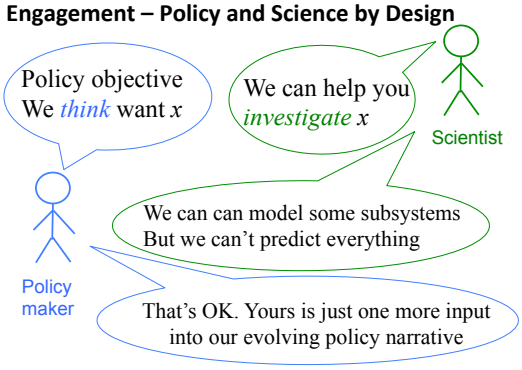
Design is a process – it takes time

Design is a process – it involves experiment & learning

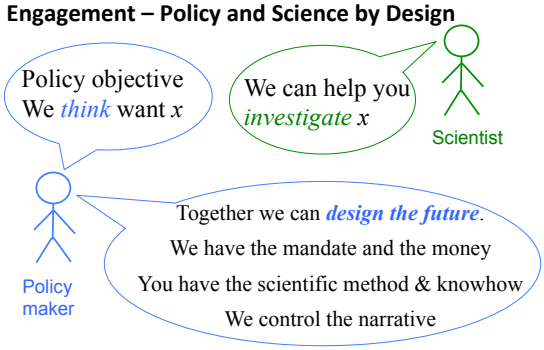
Design requirements & solutions coevolve

Policy making is a design process (even if not recognised)

Engagement – Policy and Science by Design



Engagement – Policy and Science by Design



Engagement – Investigating Multilevel Dynamics

e.g. Tidworth Mums

Army wives – moved with their soldier husbands

Engagement – Investigating Multilevel Dynamics

e.g. Tidworth Mums

Army wives – moved - loneliness, lack of child care facilities

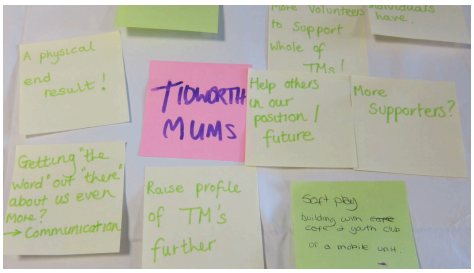
Engagement – Investigating Multilevel Dynamics

e.g. Tidworth Mums

Top-down policy – how can we solve this problem ?

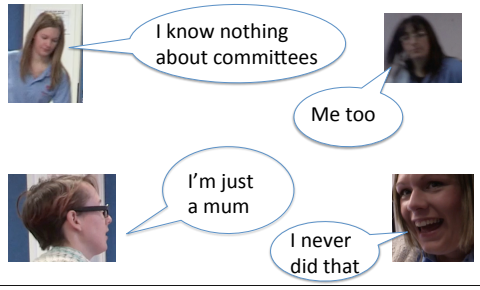
Engagement – Investigating Multilevel Dynamics
e.g. Tidworth Mums

Top-down empowerment – what do you need ?



Engagement – Investigating Multilevel Dynamics
e.g. Tidworth Mums

Top-down empowerment – help to form a committee



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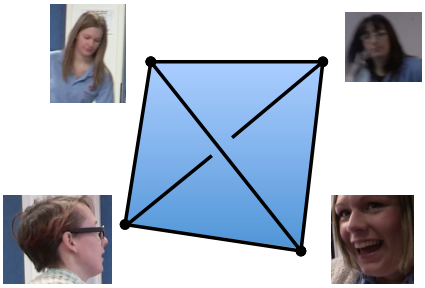
e.g. Tidworth Mums

Emergence of higher micro-level structure (hypersimplex)

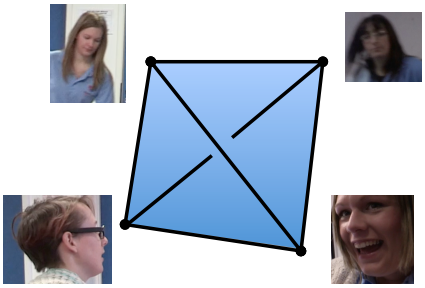


Engagement – Investigating Multilevel Dynamics
e.g. Tidworth Mums

Committee organises and runs a nursery

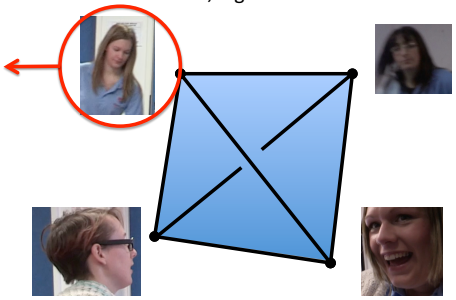
Engagement – Investigating Multilevel Dynamics
e.g. Tidworth Mums

This structure is robust



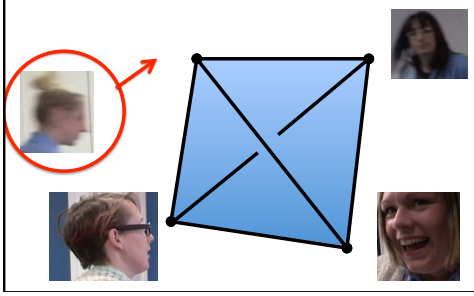
Engagement – Investigating Multilevel Dynamics
e.g. Tidworth Mums

This structure is robust, e.g. husband transerred



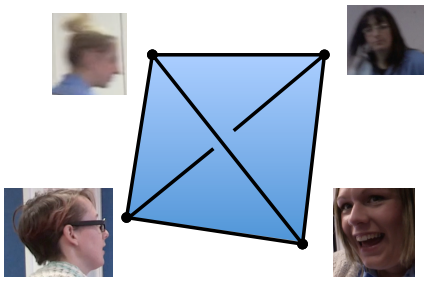
Engagement – Investigating Multilevel Dynamics
e.g. Tidworth Mums

This structure is robust – it can reconfigure



Engagement – Investigating Multilevel Dynamics
e.g. Tidworth Mums

This structure is robust, and 'self -repair'



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e.g. Tidworth Mums

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Engagement – Investigating Multilevel Dynamics
e.g. Tidworth Mums

How can policy makers know the policy will work?

How can science inform policy makers
at local, national & global scales?

We can simulate such systems at the microlevel

can investigate different approaches
can investigate robustness and **sustainability**

Engagement – Investigating Multilevel Dynamics

e.g. Art in Urban Transformations

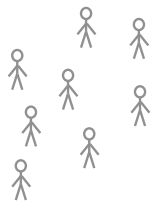
Art can be catalytic in social systems *e.g.* Warsaw

Experiment – art in Rochdale

high unemployment
many people on welfare
many children in deprived families
poor self-image

Engagement – Investigating Multilevel Dynamics

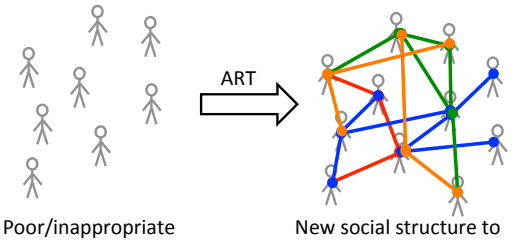
e.g. Art in Urban Transformations



Poor/inappropriate
social structure

Engagement – Investigating Multilevel Dynamics

e.g. Art in Urban Transformations

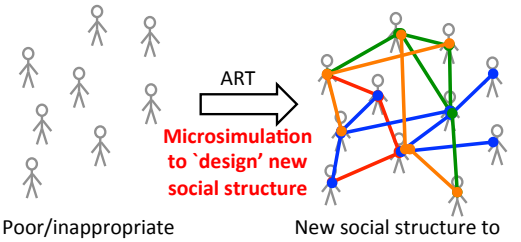


Poor/inappropriate social structure

New social structure to Support new interactions

Engagement – Investigating Multilevel Dynamics

e.g. Art in Urban Transformations



Poor/inappropriate social structure

New social structure to Support new interactions

Video ?

Global Systems Science for Sustainable Policy

long term persistence of some features
e.g. human beings, literature, science,…

Do no harm … Avoid N-S ML system trajectories

Simulating changing non-sustainable behaviour?

Evidence-based science better than guesswork

Conclusions – Global System Science for Policy

- We live in a global system
- Global systems have local bottom-up dynamics
- Simulation the only way to explore some systems
- Systems can (will!) be simulated at the micro-level
- GSS will develop new multilevel theory
- GSS can inform dynamics and sustainability
- Global System Science – tools – policy – engagement
- Europe – Japan collaboration for GSS ?
- GSS Roadmap now being written – join us !

email - jeff.johnson@open.ac.uk