Theorizing theories: Agency, structure and meaning in sociotechnical transitions

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The Sussex Energy Group

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Accelerating innovation to reduce energy use

Improving energy efficiency is widely considered to be the fastest, cheapest and safest means to mitigate climate change. While progress has been made through incremental change to existing heating, lighting, power and transport systems, more radical changes are needed if we are to significantly reduce carbon emissions.

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Emergence

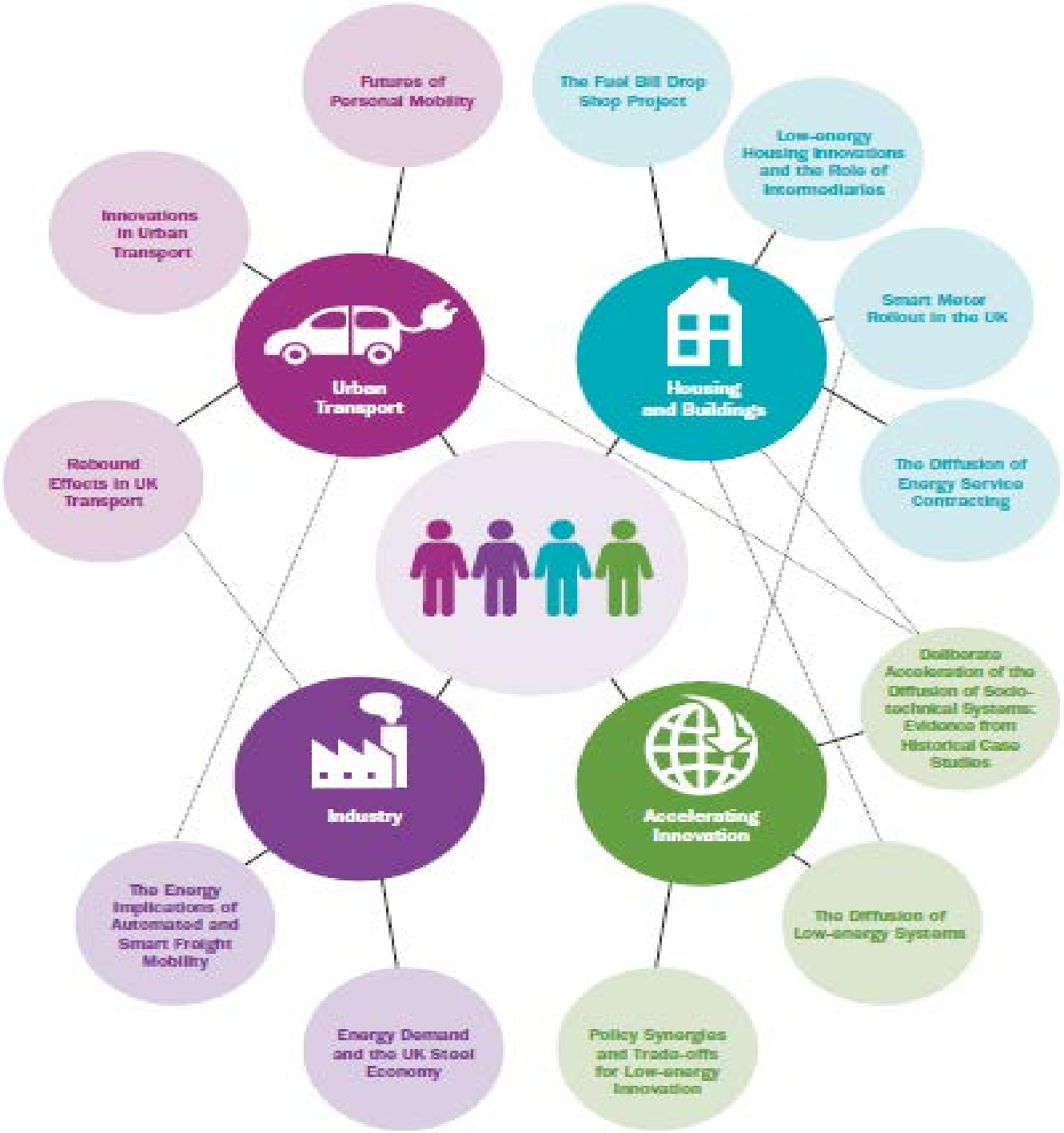
Emerging technologies, behaviours, institutional arrangements, and business models struggle to become established against more dominant systems. Space needs to be created for learning that leads to the development and improvement of new innovations. Our research looks at emerging innovations and uncovers the mechanisms and processes that provide the conditions for success.

Diffusion

Innovations spread when incentives, cultural values, infrastructures, research and policies support their diffusion and when they become aligned with people's expectations and behaviours. Diffusion is driven by market mechanisms, but also by consumers, businesses, policy makers and civil society. We explore how the diffusion of low-energy innovations occurs, with the aim of gaining insights on how infrastructures, business models, social norms, values and public policies need to change for particular innovations to spread more widely.

Impacts

It is difficult to estimate the historical or future impacts of low-energy innovations given the complexities of economic, institutional and social systems. The links between economic growth, energy efficiency improvements and energy consumption remain poorly understood. We use a variety of techniques to estimate the historical energy savings from low-energy innovations and to identify the mechanisms that shape those impacts. These methods help us to explore future energy savings and identify how they might be increased.



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- Strong empirical dimension as well
- Intended to show how energy use and demand is embedded in a sociotechnical system

Sociotechnical systems

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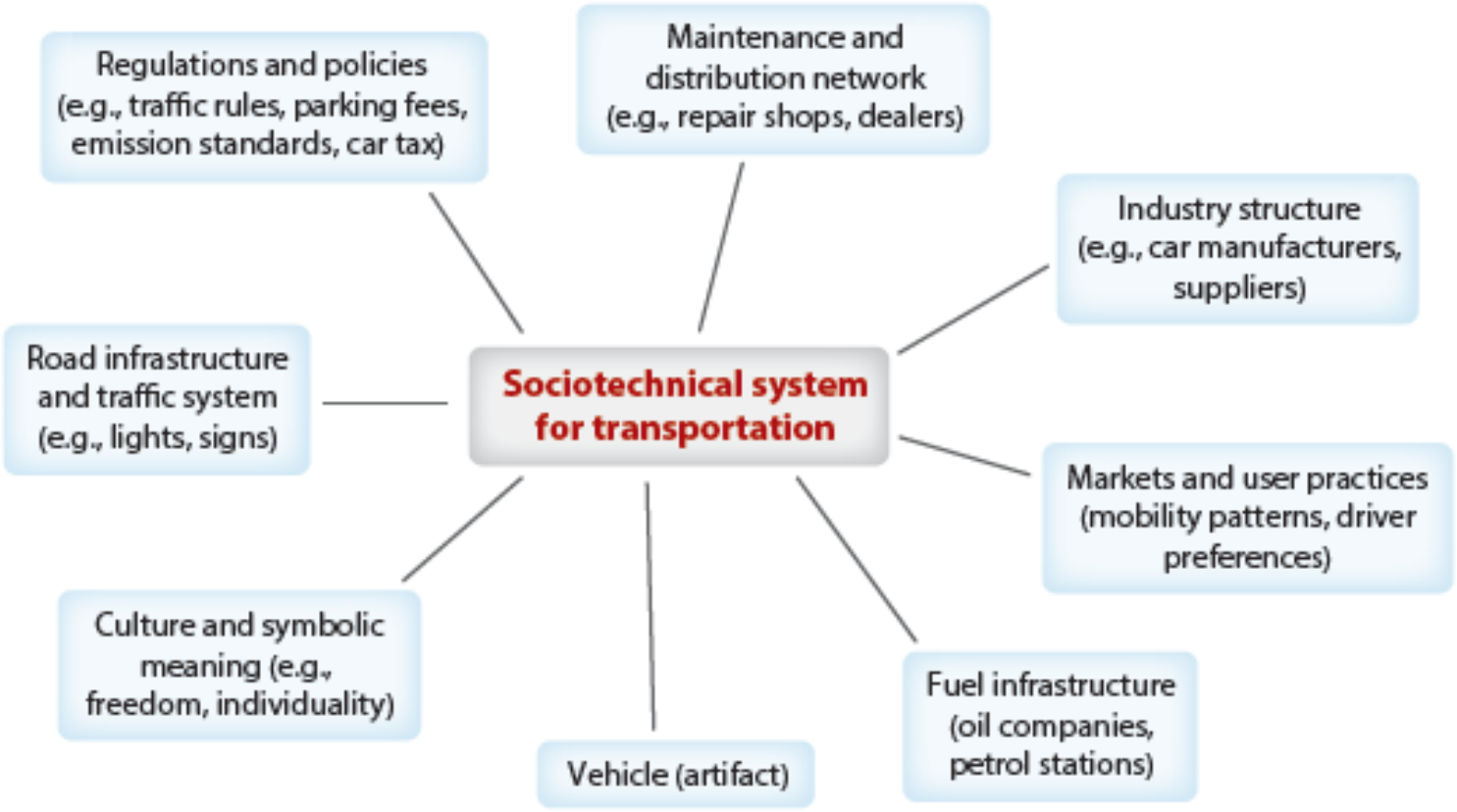

Sociotechnical systems

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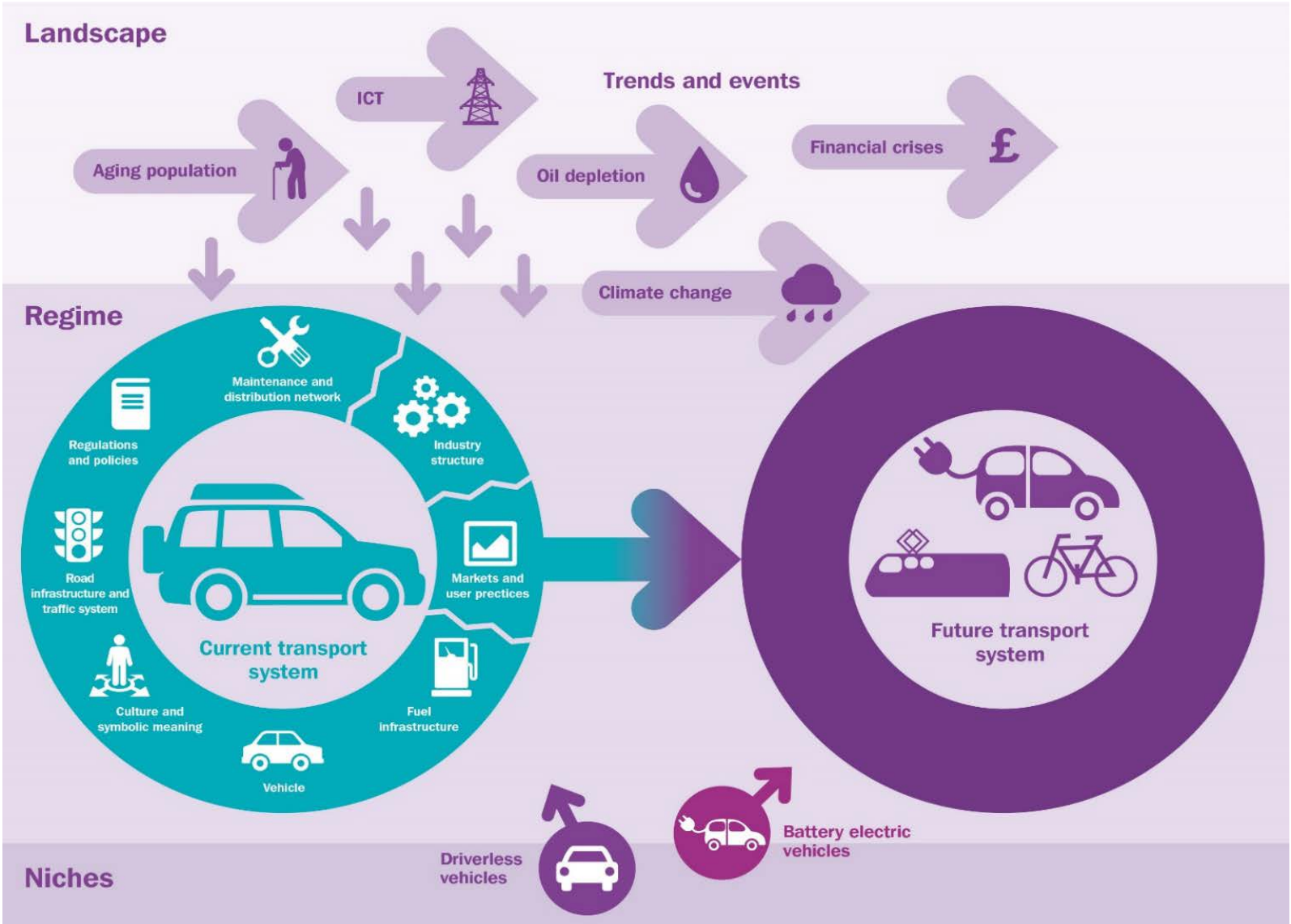

Complications and limitations

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- Socio-technical transitions has been criticized
  - Frank Geels handling of 7 criticisms in *EIST*
  - Also a nice piece on power and politics in *Theory, Culture, and Society*
- But – is this like Ptolemaic astronomers simply adding epicycles?
- What *type* of theory is it – agency, structure, meaning (the three “Is” of interests, institutions, and ideas)?
- What other theories are also useful at explaining science and technology (or “science, technology, and society”) broadly, or sociotechnical change more specifically?

Ordering theories

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Theory	Discipline(s)	Emphasis	Key concepts	Key authors
Actor Network Theory (ANT)	Sociology, science & technology studies	Agency: how actors (human and non-human) build actor-networks	Network assemblage, translation, enrollment	Bruno Latour, Michel Callon, John Law, Steve Woolgar
Social Construction of Technology (SCOT)	STS, history of technology	Meaning: how different groups of social actors interpret technical artifacts, systems or services	Interpretive flexibility, relevant social groups, technological frame, closure, heterogeneous engineering	Wiebe Bijker, Donald MacKenzie, Trevor Pinch
Large Technical Systems (LTS)	History of technology	Systems: Large-scale, capital intensive socio-material systems and sub-systems; how system builders develop systems and construct societies	System-builders, momentum, reverse salient, load factor, vertical and horizontal coupling	Thomas Hughes, Jane Summerton, Oliver Coutard, Todd La Porte, Iskender Golkalp, Erik van der Vleuten

Ordering theories

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Original Article

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Ordering theories: Typologies and conceptual frameworks for sociotechnical change

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“Ordering” theories?

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- **Internal components.** The “pieces” of what makes an individual theory work, what separates it from others, what makes it unique
- **A menu.** A list of options for students, researchers, and other stakeholders.
- **A way of classifying.** Better grappling with ontologies and epistemologies, assumptions behind theories, ways of comparing them across each other, taxonomies and typologies.

Two (and a half) research questions

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- **What theories or concepts are most useful at explaining the adoption or diffusion of technology?**
- **How can these be integrated, if at all?**
- **Can you give me relevant supporting articles, reports, books and other sources of data for further information?**

Name	Discipline	Institution
Thomas Dietz	Environmental sociology	Michigan State University
Paul C. Stern	Behavioral science	National Research Council
Ihonen Jari	Engineering	VTT (Technical Research Centre of Finland)
John Urry	Sociology	Lancaster University
Johan Schot	History	University of Sussex
Frank Geels	Innovation studies	Manchester University
Rene Kemp	Sustainable development, innovation and social transitions	Maastricht University
Harro Van Lente	Science and technology studies	Maastricht University
Marianne Ryghaug	Interdisciplinary studies of culture	Norwegian University of Science and Technology
Peter Wells	Business and sustainability	Cardiff Business School
Wiebe Bijker	Science and technology studies	Maastricht University
Richard Hirsh	History	Virginia Polytechnic Institute & State University
Gordon Walker	Sociology	Lancaster University
Giulio Mattioli	Transport Studies	University of Leeds
Sheila Jasanoff	Science and technology studies	Harvard University
Mimi Sheller	Sociology, history	Drexel University
David Nye	History	University of Southern Denmark
Trevor Pinch	Science and technology studies	Cornell University
Marilyn Brown	Public policy	Georgia Institute of Technology
Frank Southworth	Engineering	Georgia Institute of Technology
David A. Kirsch	Business history	University of Maryland
Jillian Anable	Transport studies	University of Aberdeen
Willett Kempton	Energy policy	University of Delaware
Linda Steg	Behavioral science	University of Groningen
Jonn Axsen	Transport studies	Simon Fraser University
Tim Schwanen	Transport studies	University of Oxford
Donald Mackenzie	Science and technology studies	University of Edinburgh
Edward Hackett	Human evolution and social change	Arizona State University
Marc Dijk	Transport studies	Maastricht University
Matthew Watson	Sociology, human geography, sustainability	University of Sheffield
Adrian Smith	Science and technology policy, grassroots innovation	University of Sussex
Allison Hui	Sociology	Lancaster University
Sharlissa Moore	Science and technology studies	Michigan State University
Robert O. Keohane	Political science	Princeton University
Andy Stirling	Science and technology studies	University of Sussex

Limitations

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- This table shows only those who were interviewed, not the almost 50 who were approached
- It is a convenience sample, moderated by personal networks
- Mostly social scientists, fewer arts/humanities or natural science/life science/engineering scholars
- It is an illustrative sample, but by no means a representative one
- Mostly elite/senior scholars, all experts, not users or laypersons or the disenfranchised

What is a theory?

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- Abend (2008) offers eight different definitions of ‘theory’ utilized within sociology alone, from observations to explanations to discourses and concepts
  - Models?
  - Frameworks?
  - Heuristics?
- Simple (relationship between variables) versus complex (being decomposable into constructs or ideal types, enabling those relationships to be tested or falsified)

Ordering theories

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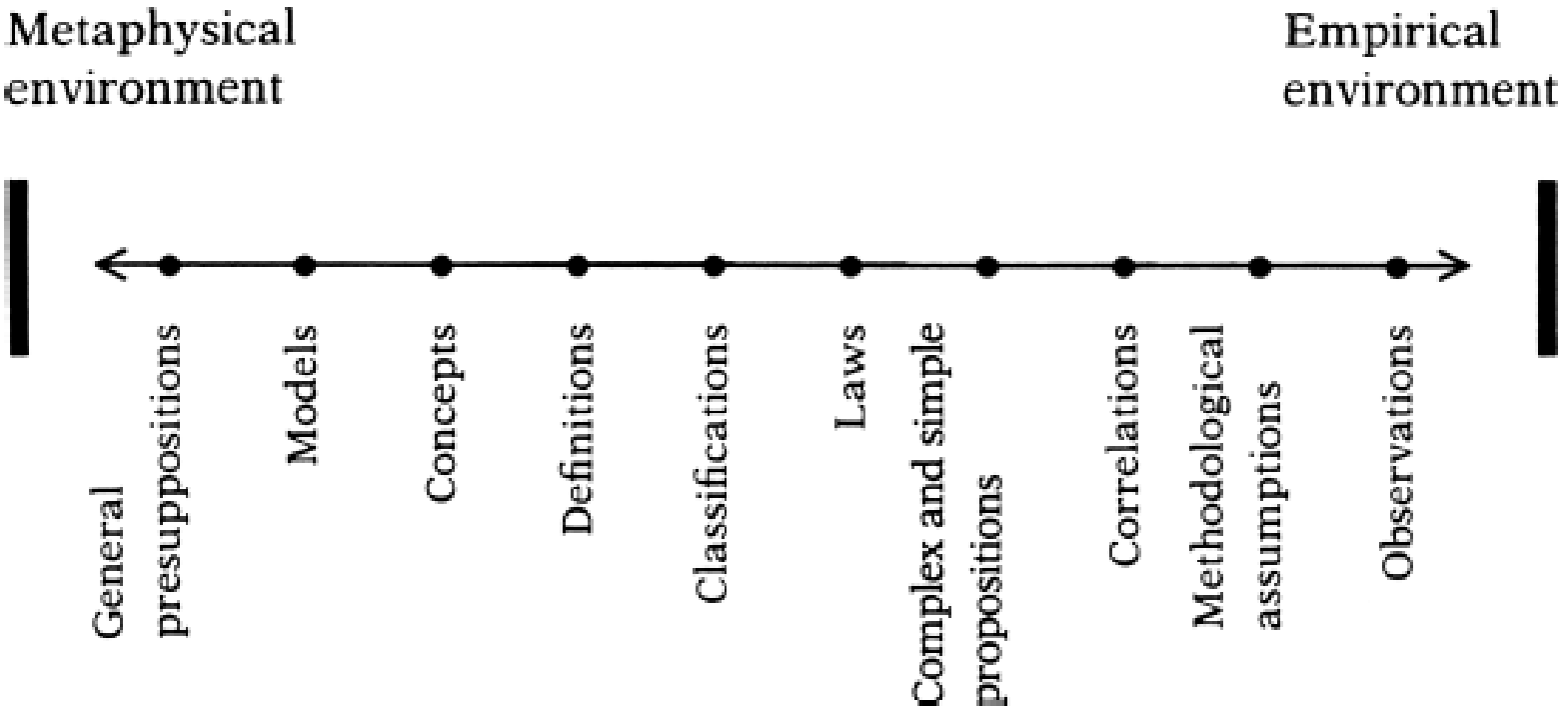
Figure 1: Metaphysics, empirics and a continuum of scientific components



What is a theory?

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- Middle range theories, “high” theory, meta-theory’ or even a ‘material-semiotic method’
- Most critically, *habitus* and mechanism of socialization, theories as a social filter
- Our definition: “any theoretical construct, conceptual framework, analytical tool, heuristic device, analytical framework, concept, model or approach relevant to technology and society”

What is “sociotechnical change”?

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- Broadest sense, shift or alteration in technology and society
- Innovation studies: patterns of adoption or diffusion
- STS: (socio)technological change
- Sociology/politics: social acceptance
- Business studies: market acceptance or commercial acceptance
- SCORAI: sustainable innovation
- Behavioural science: attitudes, support, values, pro-environmental/technological behaviour
- Our definition: “people adopting or using technology, rather than resisting or inhibiting the use of it”

Ordering theories: the long-list

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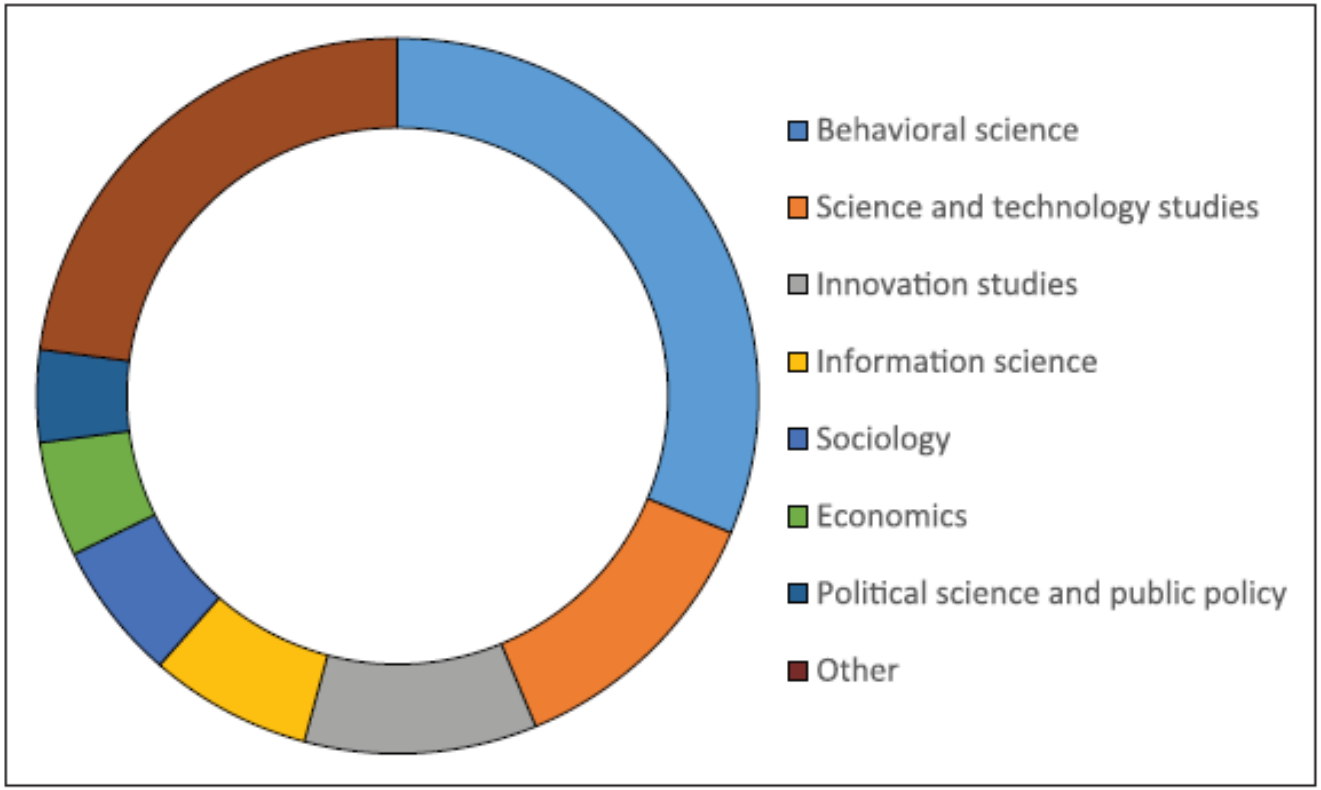

Figure 2. Academic discipline for selected theories (n = 96). 'Other' disciplines include history, organization studies, political ecology and geography, transport studies, business studies, communication studies, conflict resolution, consumption studies, development studies, energy studies, ethics and moral studies, legal studies and jurisprudence, linguistics and semiotics, marketing, and mathematics.

Ordering theories: the long-list

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No.	Discipline	Name	Key author(s)	Application to sociotechnical diffusion and acceptance
1	Behavioral science	Attitude-Behavior-Context (ABC) Theory	Paul C. Stern, Stuart Oskamp	A kind of field theory for behavior intended to be environmentally sustainable, inclusive of accepting environmentally friendly technologies. Behavior (B) is an interactive product of 'internal' attitudinal variables (A) and 'external' contextual factors (C).
2	Behavioral science	Attribution Theory	Kelvin Lancaster, F. Heider	Attempts to explain why ordinary people explain events as they do, including the adoption of new technology, and it suggests that the two most influential factors are internal attribution to characteristics of the individual or external attribution to a situation or event outside of personal control
3	Behavioral science	Comprehensive Technology Acceptance Framework	N.M.A. Huijts, Linda Steg	Proposes a complex model of technological diffusion predicated on experience and knowledge which are then mediated by trust, issues of procedural and distributive fairness, social norms, attitudes, and perceived behavioral control
4	Behavioral science	Cognitive Dissonance Theory	Leon Festinger	Argues that people in general are motivated to avoid internally inconsistent (dissonant) beliefs, attitudes and values, including when they adopt new technologies or practices

Ordering theories: the short-list

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Table 1. Most frequently mentioned theoretical approaches (respondents = 35).

No.	Name	Frequency mentioned by respondents (n)	Frequency mentioned (%)
1	Sociotechnical Transitions	15	43
2	Social Practice Theory	14	40
3	Discourse Theory	10	29
4	Domestication Theory	9	26
5	Large Technical Systems	9	26
6	Social Construction of Technology	9	26
7	Sociotechnical Imaginaries	7	20
8	Actor-Network Theory	7	20
9	Social Justice Theory	7	20
10	Sociology of Expectations	6	17
11	Sustainable Development	6	17
12	Values Beliefs Norms Theory	5	14
13	Lifestyle Theory	4	11
14	Universal Theory of Acceptance and Use of Technology	4	11

Sociotechnical transitions

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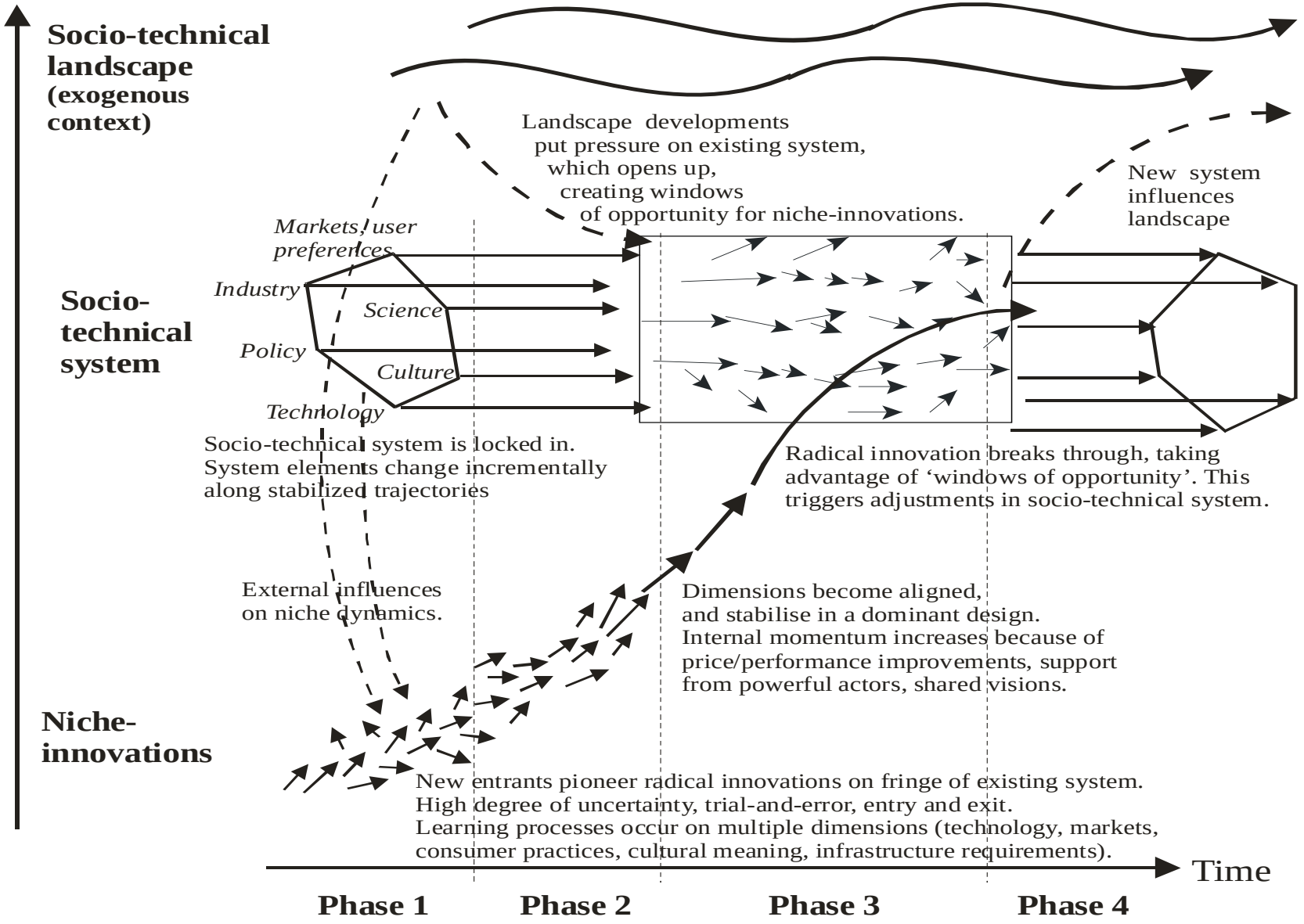

Social practice theory

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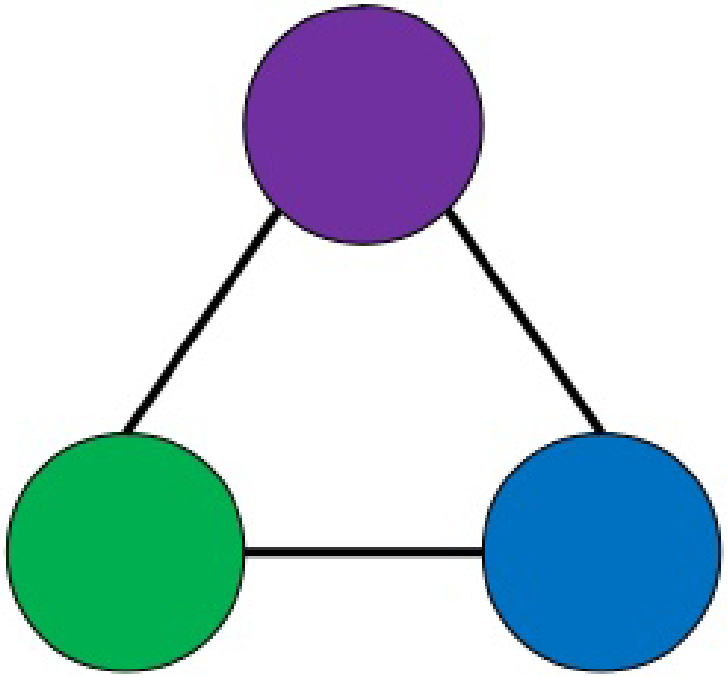
Meanings

What to eat for breakfast, when, with whom, where, why



Materials

Food/ingredients, condiments, shops, recipes, kitchens, appliances, utensils, crockery etc.

Skills

how to source/shop for/ store/prepare/cook/eat/ share breakfast food

Discourse theory

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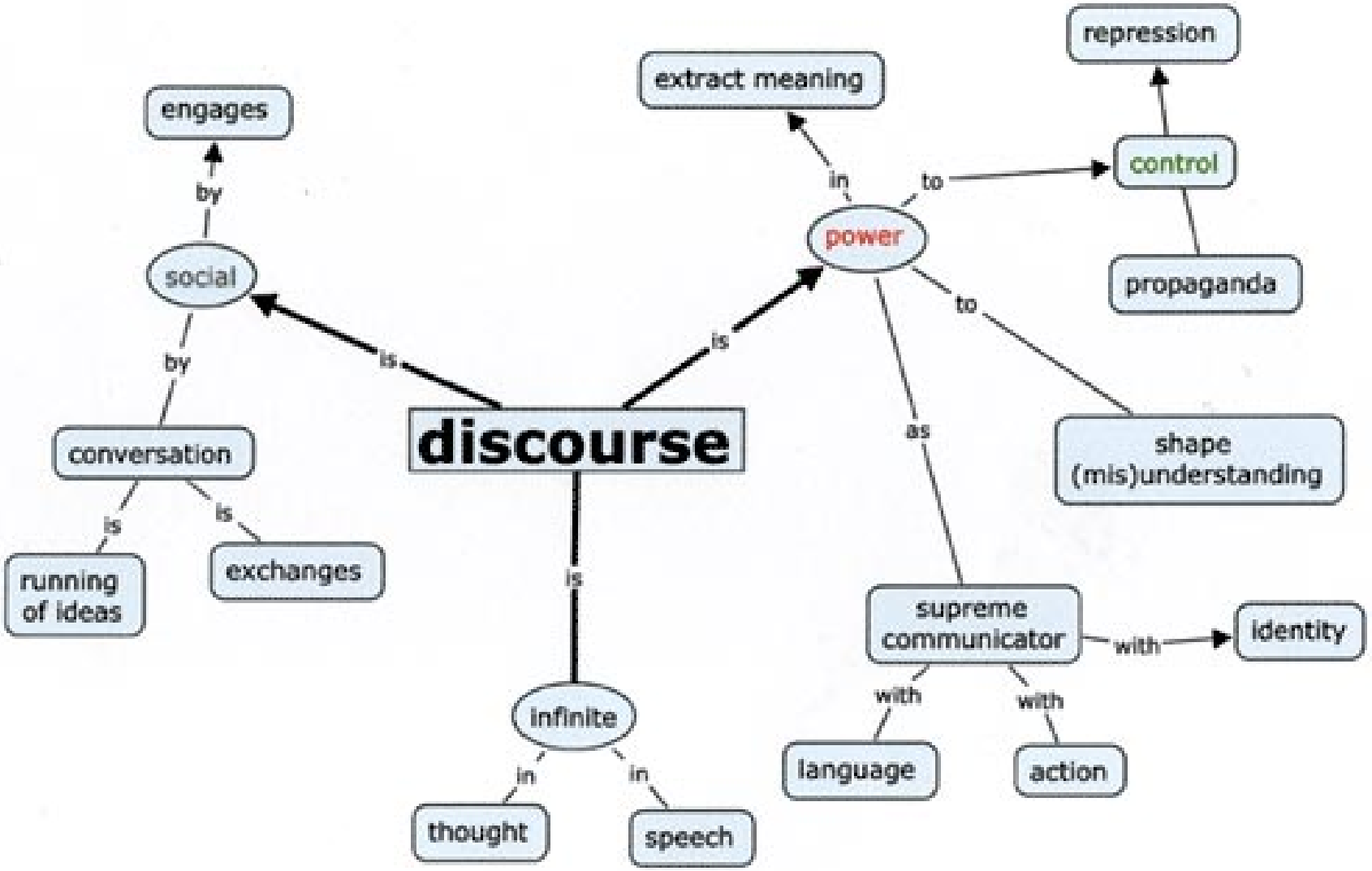

Domestication theory

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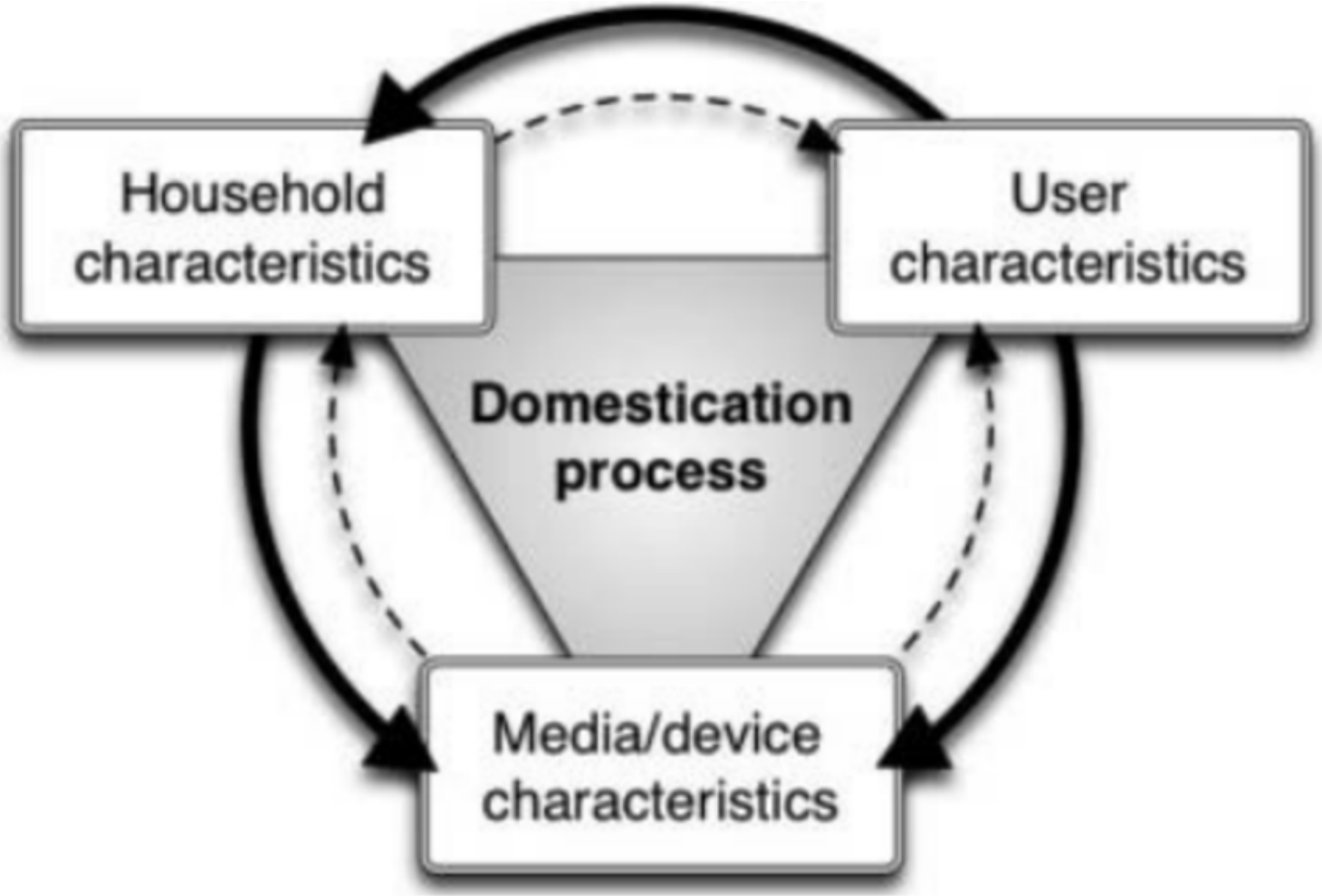

Large Technical Systems

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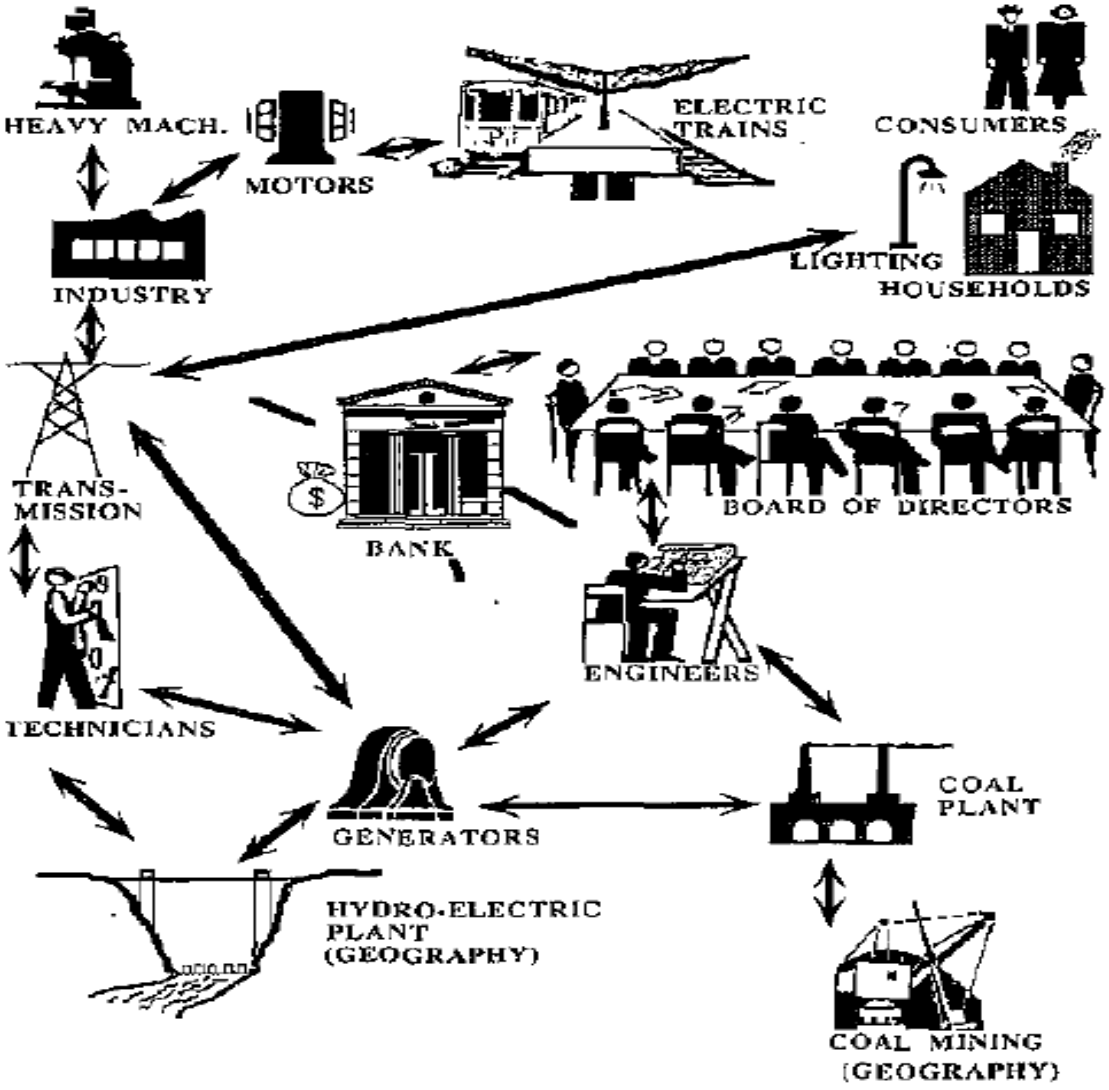

Social Construction of Technology

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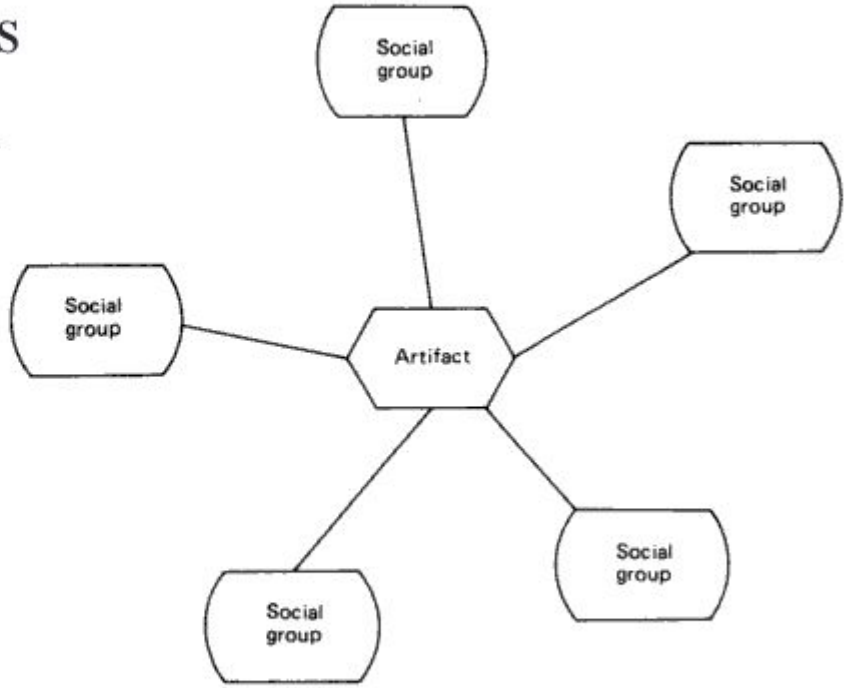
Terms:

- Relevant Social Groups
- Interpretive Flexibility
- Closure



Sociotechnical imaginaries

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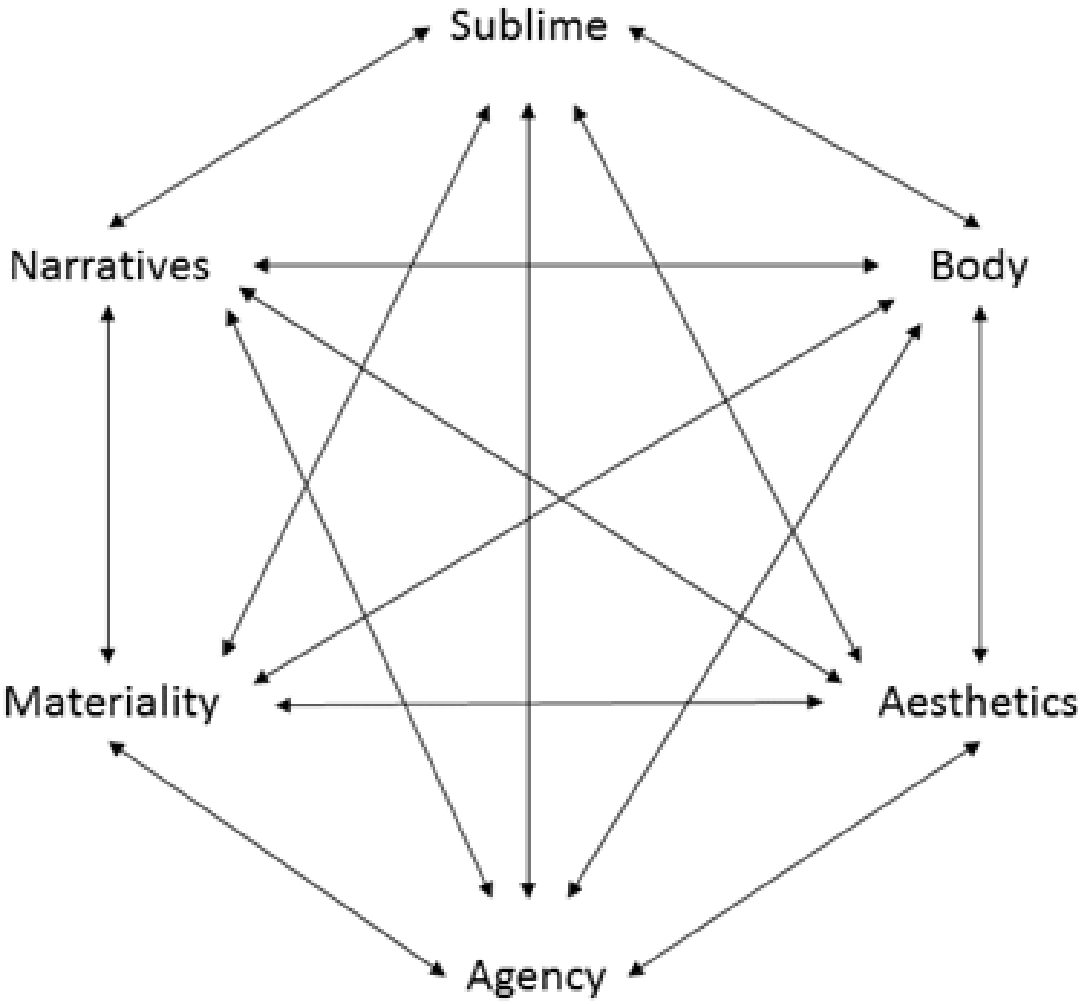

Actor Network Theory

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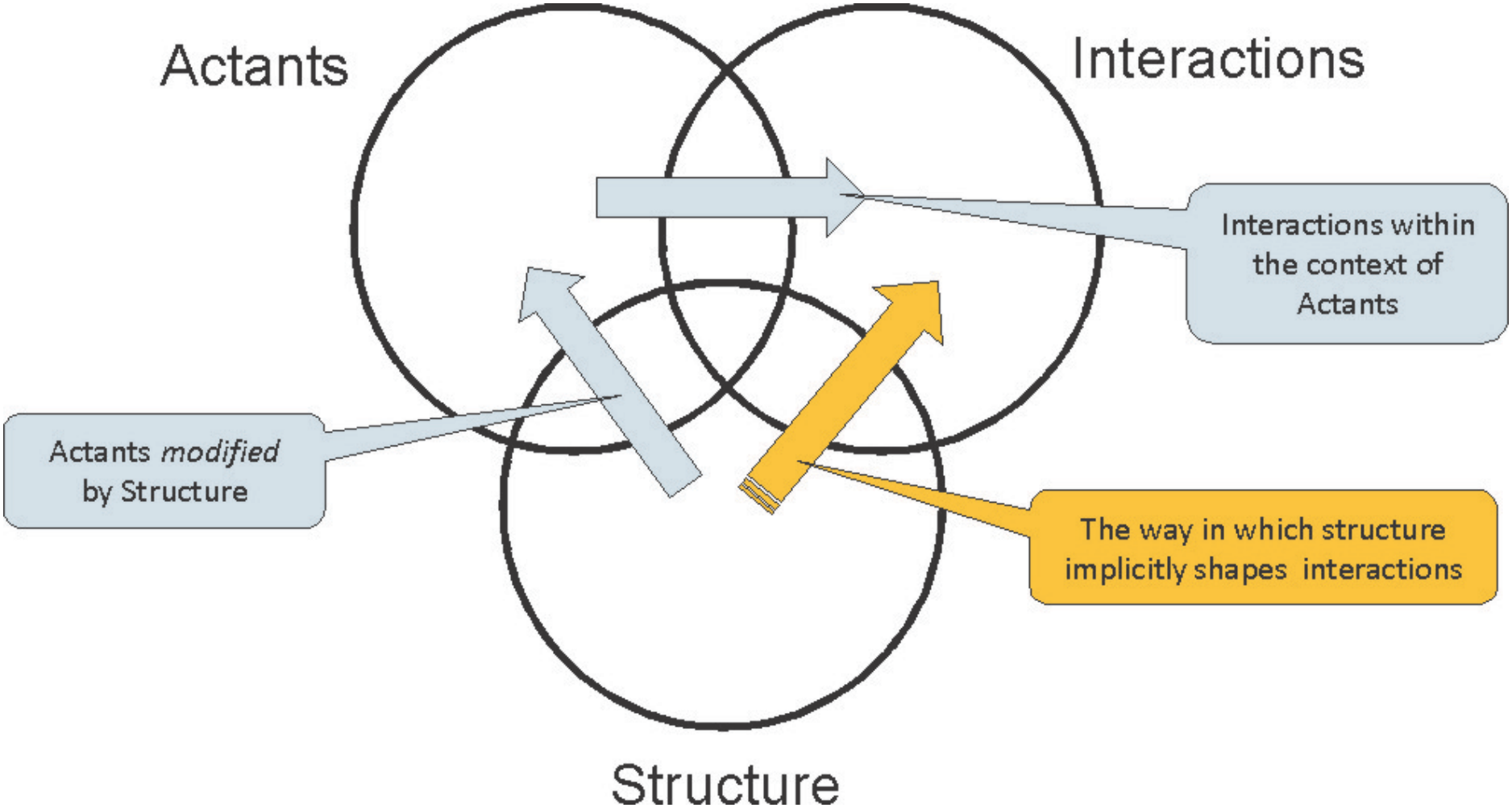

Social justice

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Concept	Definition	Major influences	Overarching Goal
Distributive justice	Equitable distribution of social and economic benefits and burdens within and across different generations	John Rawls, Ronald Dworkin, Brian Barry	Justice: The act of being morally right or fair, and providing equal rewards for equal merit (influenced by Plato, Socrates, the Bible, Thomas Hobbes, and John Locke, among others)
Procedural justice	Adherence to due process and fair treatment of individuals under the law	The Magna Carta, Edward Coke, Thomas Jefferson	
Cosmopolitan justice	Universal respect for individual human rights regardless of one's identity	Immanuel Kant, Charles Beitz, Amartya Sen, Martha Nussbaum, David Held, Thomas Pogge, Peter Singer, Rabindranath Tagore	
Justice as recognition	Appreciation for the vulnerable, marginalized, poor, or otherwise under-represented or misrepresented populations and demographic groups	Nancy Fraser, Gordon Walker, Kirsten Jenkins	

Sociology of expectations

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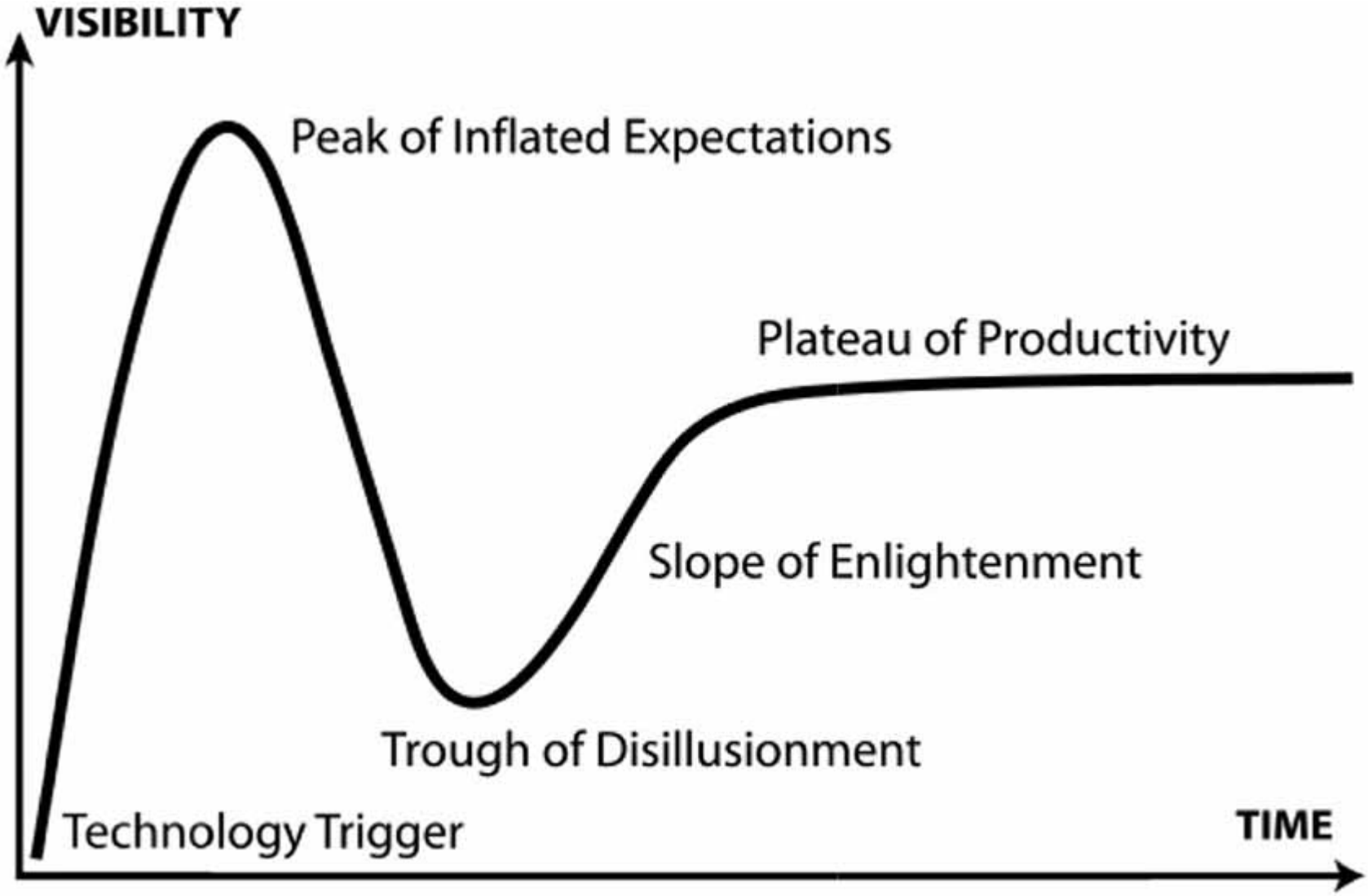

Sustainable development

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Values-Beliefs-Norms

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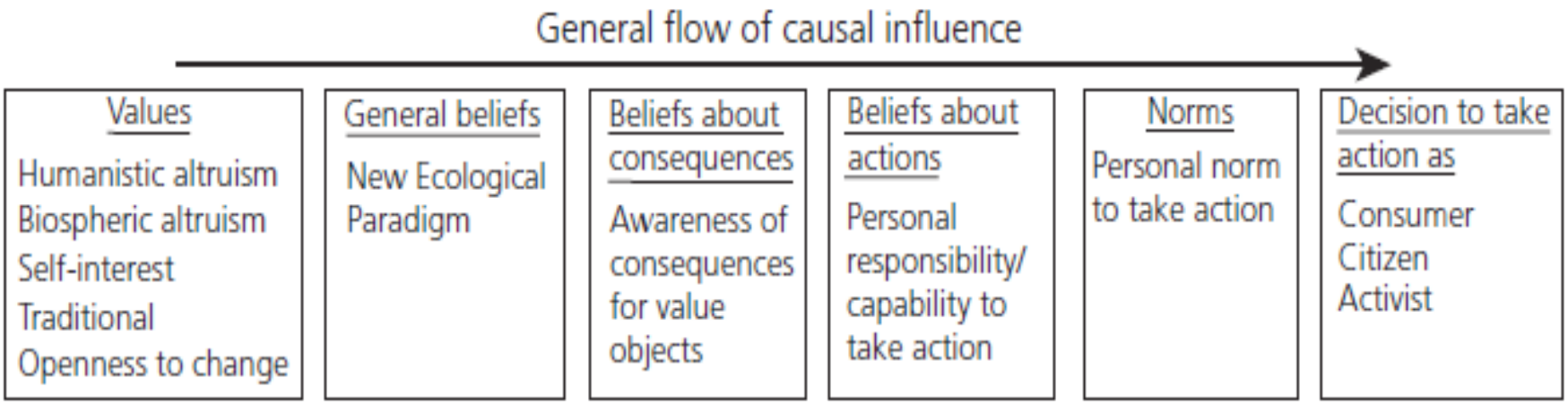

Lifestyle Theory

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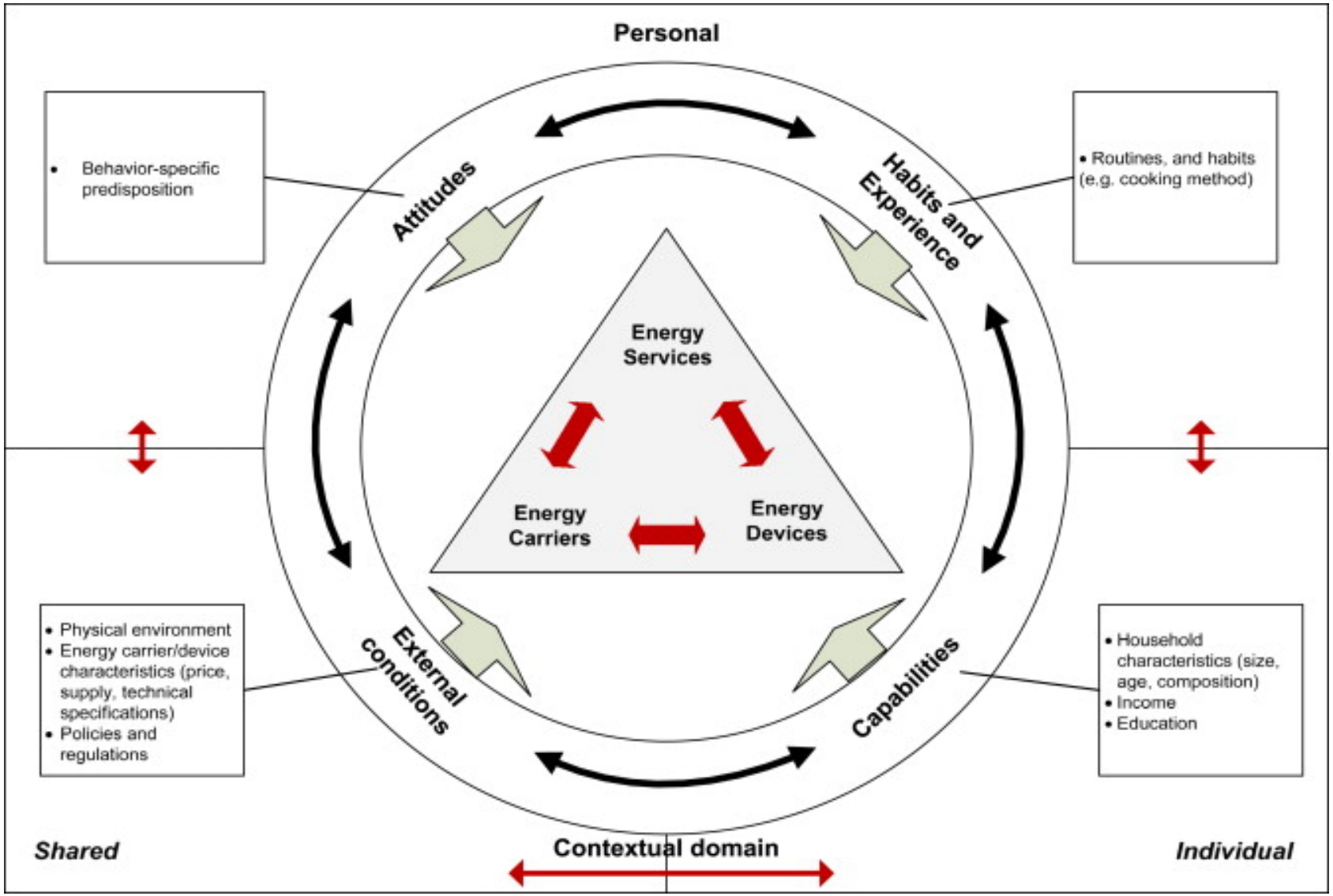

Unified Theory of Acceptance and Use of Technology (UTAUT)

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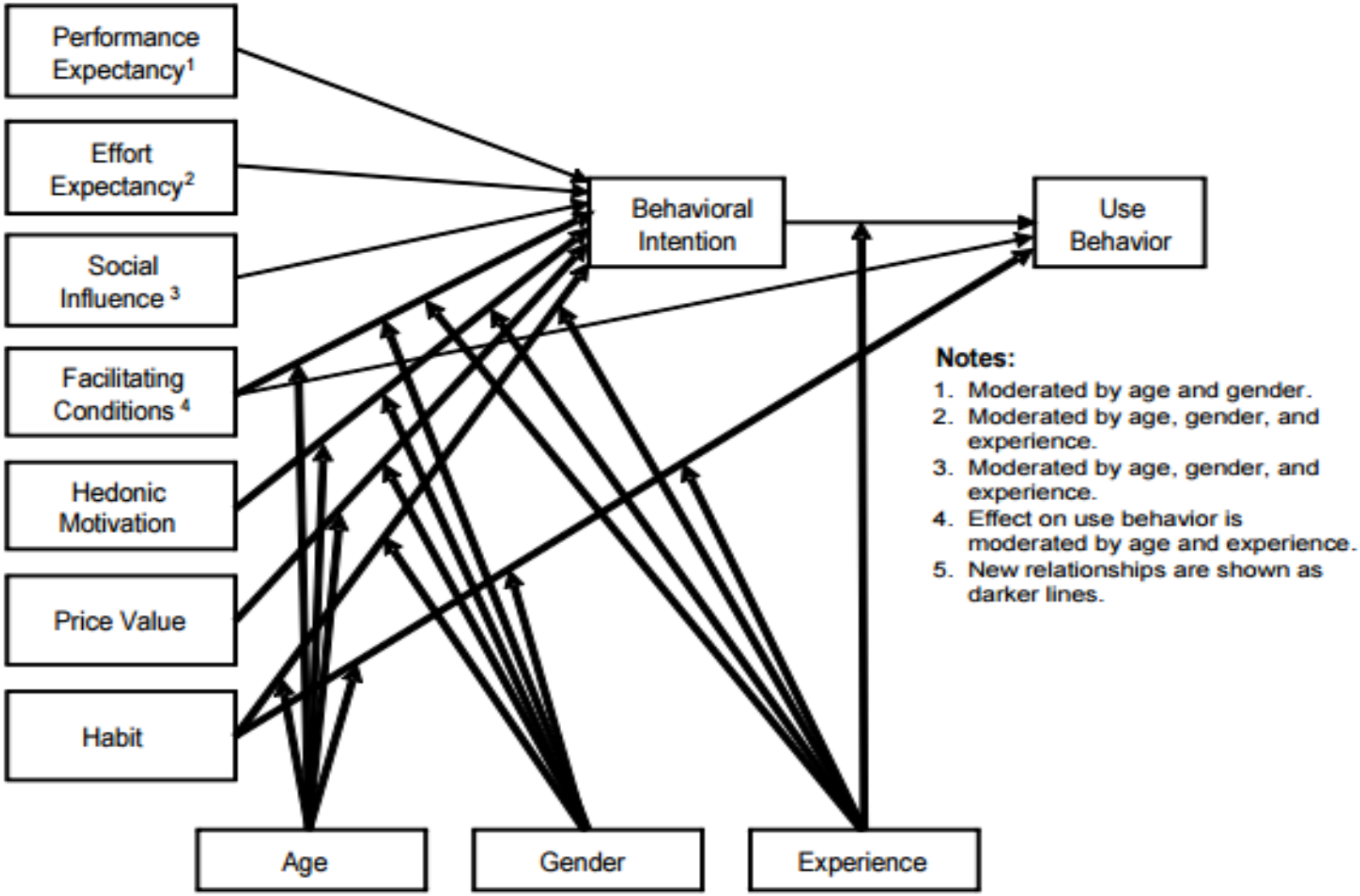

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How in the world does one classify or organize such a diverse group of theories?

Ordering theories

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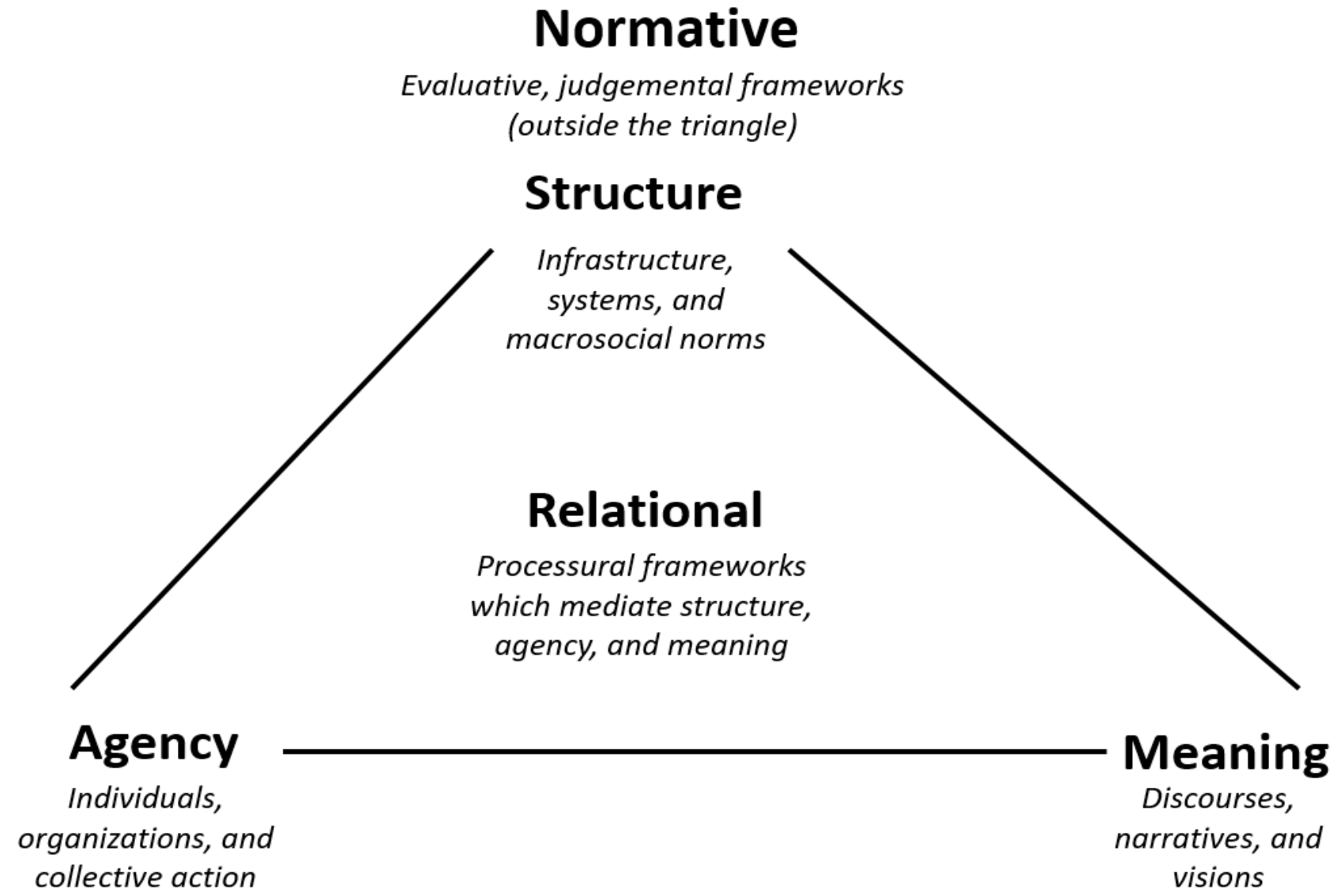

Ordering theories

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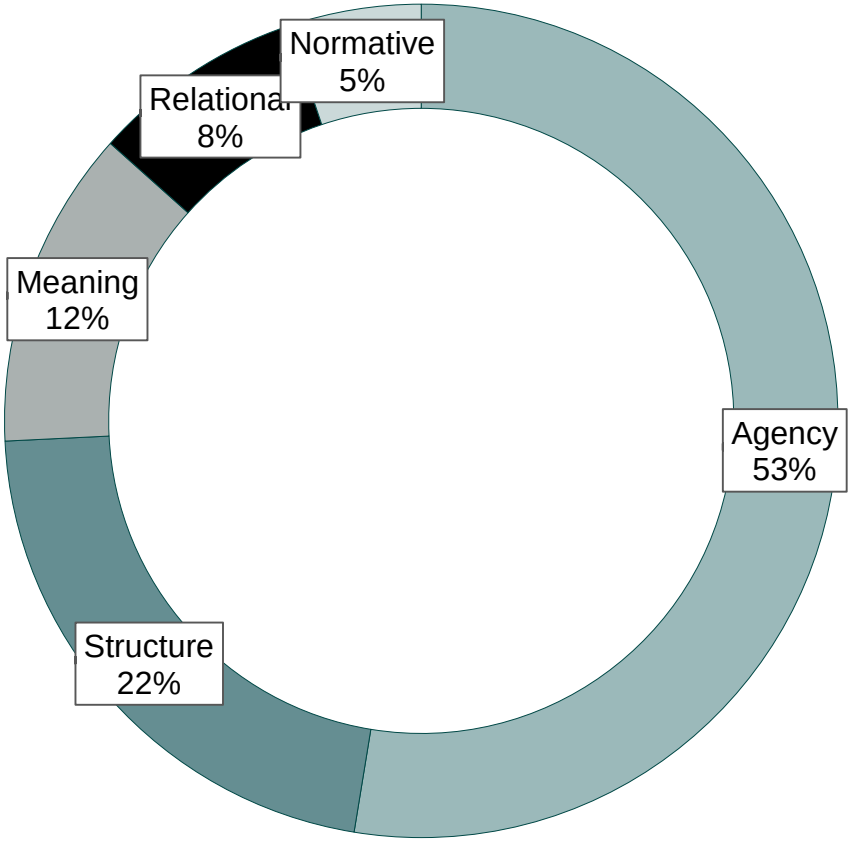
Analytical strategy and emphasis of selected theories (n=96)



Ordering theories

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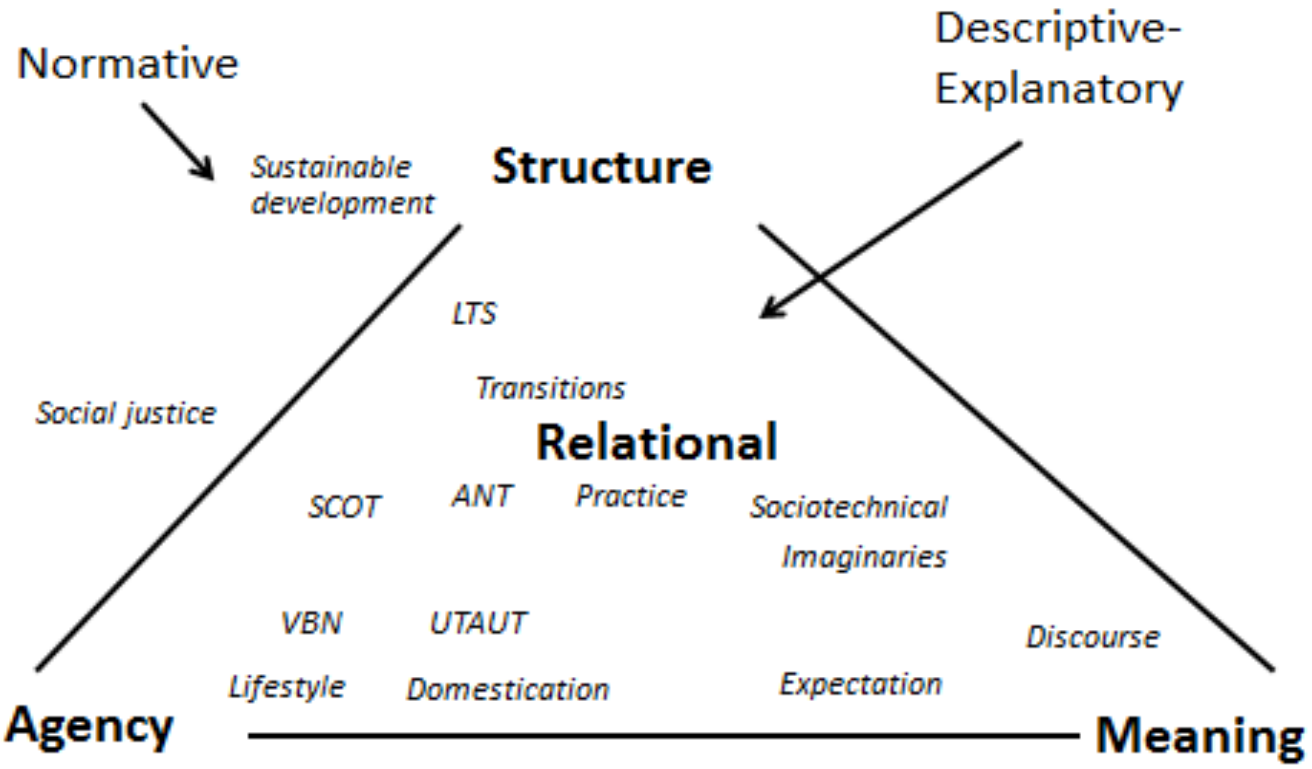
A typology of theories by analytical strategy (agency, structure, meaning, relations and normativity)



Ordering theories

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	Functionalist-Institutionalist	Interpretivist	Critical Humanist	Conflict
Goals	To search for regularities and sources of disequilibrium	To describe and understand social complexity and multiple perspectives	To describe and problematize assumptions in order to identify potential for change	To identify and modify patterns of domination
Assumptions	Society as a self-regulating system	Society as socially constructed action	Society as historical change and development	Society as a system of struggle and oppression
Topical focus	Norms, values, and institutions	Discourse, practice, and culture	Historical change and cultural difference	Societal conflict
Approaches	Refinement through causal analysis	Discovery through code analysis	Insight through critical analysis	Liberation through structural analysis
Methods	Probing representative samples of subjects	Identifying specific cases, questioning informants	Comparing specific cases or existing research, questioning assumptions	Evaluating historical evidence and structural conditions
Exemplary articulations of theories that fit	UTAUT, VBN	Domestication Theory, Sociology of Expectation	Discourse Theory, Sociotechnical Imaginaries	Social Justice Theory, Sustainable Development

Ordering theories

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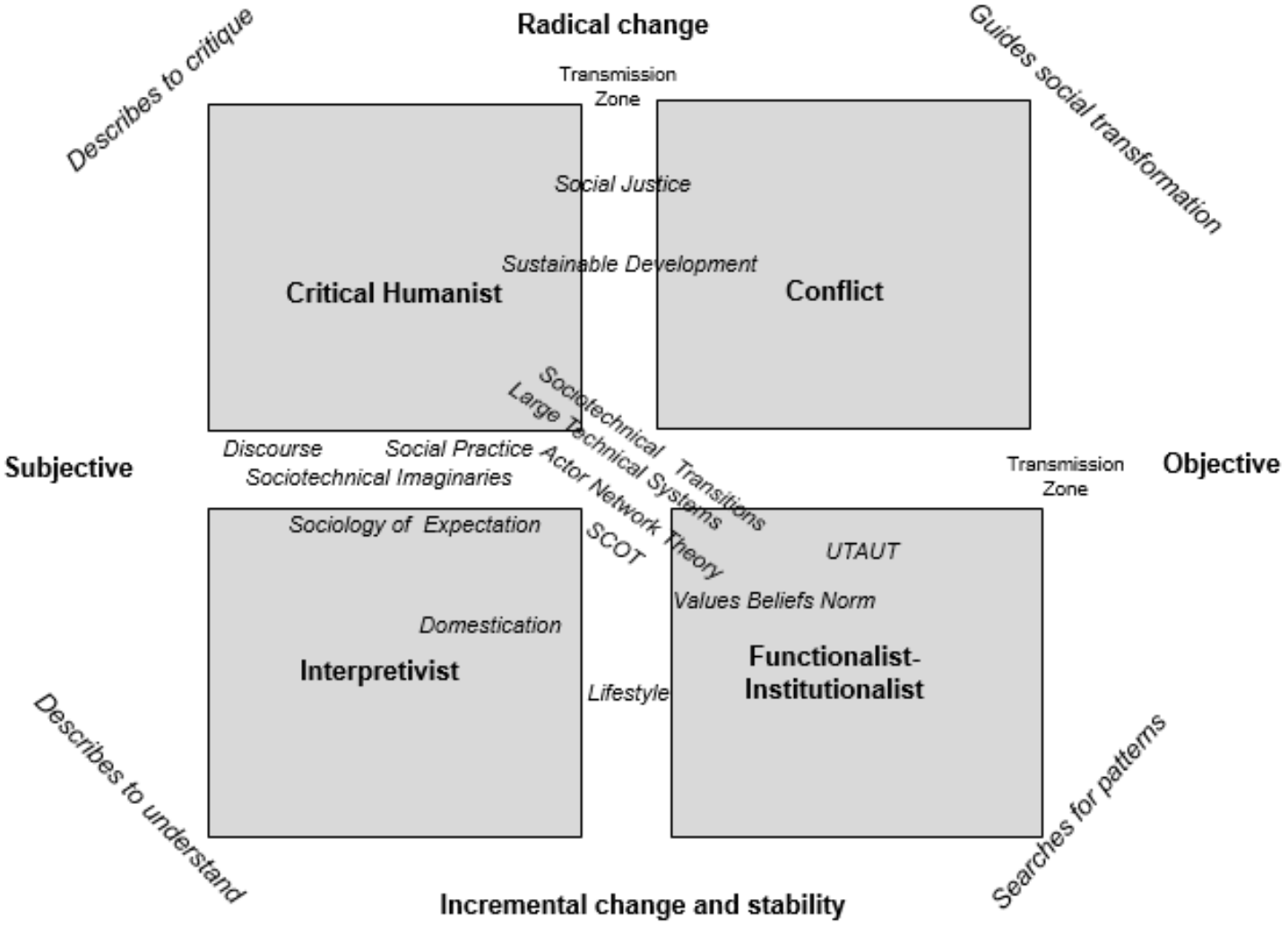
A typology of underlying theoretical goals and assumptions



Caveats and further research

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- Conflict type theories and structural theories were mentioned with less frequency, implies considered less important by the sample
- Almost no Marxist/neo-Marxist, feminist, antiracist, and multicultural approaches
- Thought about a third typology of temporal or spatial scale (individuals, communities, institutions/organizations, states, intergovernmental actors), but left this open, “let the level of analysis determine which theory you use”

Eclecticism and implications for theory and methods

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- Different theories seem attuned to different methods (e.g. UTAUT and statistical analysis, SCOT or MLP and interviews, VBN to experimental designs)
- Assumptions matter, and not all theories can be combined or are compatible “like clothing accessories”
- A meta-theoretical perspective does not necessarily require that all or many theories be integrated – merely that different representations are accounted for

Eclecticism and implications for theory and methods

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- We may need to broaden our notion of triangulation

Dimension	Explanation
Internal	Within a single method, e.g. the responses within an interview or survey support each other
External	Between methods, e.g. data from interviews is consistent with documents, observation, and physical artifacts
Evaluator	Between researchers, e.g. if using a team of researchers, cross check notes of an event, or if coding, use an inter-reliability test
Theoretical	Between concepts and theories, e.g., testing which theories best "fit" the data or vice versa

- We may need to avoid dogmatism, privilege-seeking, and power-yielding

"Theoretical monogamists or dogmatists remind me of obsolete aristocrats arguing over the maintaining of their 'pure' lineal bloodlines … discipline focused pretensions amount at root to little more than vain bids for privilege and power."

Conclusions

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1. Theoretical abundance: a mere 35 theorists got us almost 100 theories, too many conceptual tools?
   - Yes: implies none or few have strong resonance with scholars or puzzles?
   - No: reflects the true breadth of intellectual scholarship
   - Made worse by journals *always* demanding one develop a new conceptual framework?

2. Despite some of its problems, the MLP remains popular among professional researchers, even those critical of it

Conclusions

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3. Tying this back to energy and climate, users/adopters have complex motivations that are:
    - Embedded in sociotechnical systems
    - Difficult to model
    - Irreducible to a single factor, difficult to isolate
    - Dynamic, not static
    - Behave in ways not predicted by rational actor theories
4. Users matter, but they must not be treated as homogenous, and relational theories may perhaps best explain agency, structure and meaning (most popular in the shortlist sample)
5. No single theory can explain all – more theoretical triangulation, less dogmatism, needed

Contact Information

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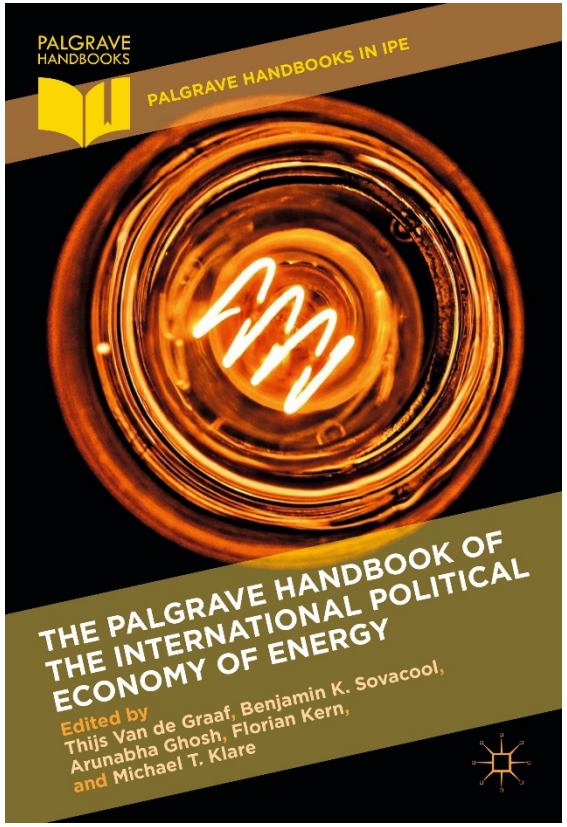

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