

Energy, Transport, Environment and the Policy Challenge

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This paper explores, using real and current examples, how a focus on the world as complex can affect the development and implementation of policy. I am writing it from my perspective as Chief Scientific Advisor (CSA) for the UK Department for Transport and the Department for Business Innovation and Skills in the sense that I draw on this experience in selecting examples. But the views expressed are my personal reflections and are not necessarily representative of Government policy. Indeed it is not the purpose of this article to critique any policy; rather it is to show how policy development, particularly on complex issues, can benefit from the experience of such examples as part of a process of continual improvement.

Some Examples of Policy Challenges Modernisation of a Major Transport Hub

My first example is of the decision to modernise a major Transport Hub. In a densely-populated country like UK, such an activity is almost certain to cause fierce public debate.

From a policy perspective, there are many factors pertinent to making such a decision. First there is the economic argument; we can show, from historical data, that new hubs do create economic value in the surrounding area, as well as directly to users of transport services. However we also have to take into account that there may be people who will lose their homes and/or their livelihood as a result. Historical data suggest that, in the long term, this is acceptable to the public, *provided* the numbers are not too great. Then there are issues of noise and air pollution. There are also wider arguments centred on whether we should be facilitating more travel given the reality of climate change.

What can happen in policy circles is that the economic, environmental and social

issues are considered separately, the debate becomes polarized and the public and others feel they have to choose between opposing priorities. However, if we can look at the situation *holistically*—while still making the many and often conflicting views and objectives explicit—a clearer, more balanced, perspective can emerge.

Willingness-to-pay studies suggest that the British public currently place a very high premium on travel. So, given the demand for travel, if we do not improve the hub for one mode, then the likelihood is that, if there is sufficient capacity, other modes will absorb some of that demand. And, given the proximity of the UK to some other countries, some of the demand may be absorbed by capacity there. Thus, from a national perspective, a UK decision *not* to modernise the hub could result in displacing the economic and social advantages (and disadvantages) whilst, say, the additional level of carbon emissions may or may not be unaffected.

So the decision whether or not to increase capacity at a hub could lead to unpredictable outcomes in terms of energy use and of carbon emissions and of other sources of pollution if we build it or if we do not; and at the same time it may or may not bring economic activity to the area, support the economy more widely and respond to public demand for travel.

One of the other outcomes of systemically-conceived policies is that they are likely to be more robust and sustainable in the sense of remaining appropriate over a longer timescale. This is especially important in areas such as the creation of transport or energy infrastructure, as these need to be long-term solutions and are not easy to change once committed. And when Government is looking—as it increasingly is—to finance such infrastructure through private finance, companies will not take up such options if the policies are not evidently robust and

sustainable. So this is another reason for tackling policy decisions systemically and with the long term in mind.

Energy Policy and Public Opinion

Another example of policy development—although one where success or otherwise will not be known for some time—is that of renewable energy in the UK. The UK has almost the lowest percentage of its energy supply generated through renewable sources in Europe. There is currently great interest in offshore wind farms; this is ‘in fashion’. However, the engineering issues of building and maintaining such structures are complex and as yet unsolved—and in some respects are on the edge of engineering feasibility. The attempt to solve these technical challenges requires huge investment, currently estimated at £50-100 billion. In parallel, the government is also still intending to develop new coal-powered generation, although the technology for carbon capture and storage does not yet exist. Meanwhile nuclear energy generation, which is sustainable and has proven robust technology, is not being progressed, in part due to adverse public opinion.

I would regard this as an example where public opinion, rather than scientific or even economic considerations, is impacting policy and could even be said to be forcing us into a situation where we will not have enough electricity for our needs. One key aspect of the formation of public opinion is the media; the media selects what information the public receives and also plays a part not only in *shaping* public opinion but in *representing* it. The importance of this media role in our democratic process cannot be over-emphasized and, whilst I am not at all advocating any loss of freedom of the press, I do feel we should include media behavior considerations in our modelling and understanding of the development of policy; and we should recognize the importance of the government providing good-quality public information, for example to counter the possibly polarized positions taken by different media.

So what I am trying to illustrate is that better and more robust decisions may be made if we look at policy development in a systemic fashion, addressing head-on the conflicts be-

tween social, economic and environmental goals and making explicit the inter-dependencies. We must also take into consideration the impact of the processes of governance which often lead to institutionalized separation of these issues; and it would be helpful to include the role of public opinion and the role of the media in understanding and modelling how decisions get made.

Smart Ticketing

One ‘success story’ of a policy developed systemically is the travel ‘smart card’, piloted through the hugely successful Oyster card in London, which allows payment for travel on buses, the underground and local trains through deducting payments for each journey from the card to which sums of money can be transferred in advance. Extension of such a smart card concept would, in principle, allow the traveller to pay for any sort of public transport journey in the UK, thus resulting in the traveller having no need either to carry cash or to make multiple purchases or transactions. As well as helping the passenger, this would vastly increase the efficiency and speed of the process, reducing the need for staff who sell and check tickets. And it would, of course, give government a very easy way anonymously to gather data on the ways people travel, taking a whole-journey perspective that could facilitate better planning of transport infrastructure; it could also lead to ‘smart’ ways to impose a carbon tax on travel. We could even, in the fullness of time, potentially include payment for some elements of the cost of personal journeys in cars.

Systemic Thinking in Carbon-Footprinting

As another example where complex systems analysis would help is in the field of carbon ‘foot-printing’. Carbon-foot-printing clearly has an important role but it must be thought through systemically for it to be effective. For example, it is easy to calculate—and hence set limits for—the carbon ‘footprint’ for contracts for acquisition of, for example, a car door and forget to do the same for the door handles or locks; all sub-systems need to be included in the analysis in the contract and we need to get

better at doing this systematically. On a larger scale one of the items on the agenda for the Copenhagen meetings was seeking the introduction of industry 'footprints' which would avoid some of the difficulties of focusing primarily on national targets: for example the attribution of the carbon in goods to the country of manufacture rather than to the country where the goods are used. There remains work to be done in this field.

Link to Complexity Theory

Change is Not Linear—Sooner is better

So far, I have emphasized the need to embrace the overlap between economic, social and environmental perspectives in creating, as examples, transport and energy and manufacturing policy and to be inclusive and thorough in setting regulations and contractual arrangements. This is part of the way to deal with the complexity of the real world, but it is not the whole story; complexity thinking also emphasizes the importance of *timing* and the potential for so-called 'runaway effects' and 'tipping points'. People sometimes ask me whether it makes any difference *when* we start to reduce carbon emissions, for example. Can we not do more, later? What we understand in dealing with such non-linear relationships between factors is that we will reach points of no return when, for instance, the increase in temperature due to carbon in the atmosphere will 'run away' and change irrevocably and exponentially. So earlier reduction of emissions is better, and although our solutions may be less optimal and sophisticated than if we had waited for better research or a more supportive political climate, we may face more intractable problems by waiting for the 'best' solution.

So, for example, I am keen that we start to regulate petrol and diesel cars in relation to energy efficiency and emissions *now* and not wait for the advent of electric cars or better-developed hybrid vehicles; we have enough experience to show that the focus on climate change and the current economic situation has already led to changes in car usage and in choice of cars purchased, so we have every reason to expect that regulation would be effective; but time is of the essence.

Unexpected Outcomes

We also have to think how to educate people to assume that there are likely to be unexpected outcomes of policies and decisions, however well-researched and well-planned they are. Our self-evident inability to anticipate and act in advance to prevent the current financial crisis was in part due to policy decisions being taken and then largely left alone—without sufficient attention to check over time whether these policy decisions were leading to any behaviors or outcomes that had not been expected or intended. We do not always—as yet—institutionalize such follow-up and review processes in our policy-making frameworks.

Changing Worldviews

One of the difficult aspects of encouraging policy makers to think in this complex way is that it requires them to change their worldview. Civil servants and politicians have, perhaps, not been challenged to think differently about 'the way things are' since their days in education, when, perhaps, they embraced free market economics or regarded good scientific practice to be about identifying clear, separable cause-and-effect chains in service of clear, unambiguous outcomes. Dealing with the complexities and interdependencies of policies, goals and implementation processes requires a huge shift in thinking.

The arguments for policy-making with complexity in mind are easy to identify and hard to counter. So what are the barriers to working in this way? As I have already discussed, part of the problem resides in the ways people largely think about the world,—that is, as a 'system of parts' where cause-and-effect relationships are both definable and linear and separable. Equally, our governance processes mirror this thinking, with different departments largely working separately to develop policies on seemingly separate issues; in many cases, with insufficient attention to tracking, reviewing and refining the impact of those policies once they are adopted—until there is a crisis that cannot be ignored.

Where Next? How Can the “Complexity Community” Help?

Reflecting on the Ways to Collect Data and Use Models

One of the issues is to challenge the way we collect data and use models. Data collection is often driven by the desire to test pre-defined hypotheses; and these hypotheses are often attempts to establish causal links between actions and outcomes. Complexity thinking emphasizes that outcomes are the result of multiple, interacting causes and can sometimes be constellated by symbolic or extreme, unexpected events. So, we may be better to collect data more widely and look, *post hoc*, for patterns in them. We can then see what emerges rather than impose what we expect to see and, inevitably and unhelpfully, narrow what data we collect and what they tell us.

Equally, it is important to make hypotheses as we explore such emergent patterns and collect subsequent data to test our inferences. For example, we noticed in the UK last year that domestic energy usage had reduced. Was this driven by the recession or was it evidence that the public are beginning to take climate change seriously? As confidence in the economy increases and electricity usage increases again, we will be able to differentiate between attitudes to economic issues and attitudes to environmental concerns. And there may be other indicators which differentiate between attitudes to these two factors that complexity considerations can help ensure we explore. So the relationship between data collection and hypothesizing is a complex but important one.

Looking at the reasons for domestic energy use is an example of the complexities of understanding motivation. Hypothesizing and modelling motivation is, without doubt, one of the most difficult areas in which to work and one to which academics increasingly need to pay attention.

Modelling does, however, play an important part in exploring inter-relationships in certain kinds of complex problems and takes us further than we would get by just ‘thinking’ about such problems. And it helps us to focus

our attention increasingly on processes and networks and flows rather than on objects and events.

Key challenges

So, the challenges to those of us in the “complexity community” are themselves multi-faceted and complex:

- How can we give advice on data collection and the use of hypotheses and how can we feed real-time data into large-scale complexity models in such a way to inform decision-makers?
- How can we model complex inter-relationships and coevolutionary processes to usefully shape policy even if this cannot give a unique solution?
- How can we help policy-makers and politicians understand that policies often, have provably unpredictable outcomes?
- How can we best communicate these complex and challenging ideas?

This article attempts to set out descriptions of problems rather than solutions; but without an elaboration of the problem in reasonably well-grounded terms, complexity science research and analysis will continue to address complex but synthetic problems. It is with this reality check in mind this paper offers some small insight on what is really happening in one space of the set of complex problems we all face.

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