5 questions about complexity

Bruce Edmonds' answers

1. Why did you begin working with complex systems?

My answer to this is rather personal. It starts with a very basic fact, namely that my father was a physicist and my mother a social worker. I remember them discussing some of the social theories my mother studied. My father thought little of these theories, saying that knowledge is no good unless you can state it precisely (i.e. not only in vague analogies) and it gives you some "leverage" upon the world (i.e. it is useful in some way). My mother's reply was that social matters were much more complicated than physicists imagine and not explainable merely in terms of atoms and forces. The argument was never settled – neither had a good reply to the other's points. The reason turns out to be that they were both right, but it took me many years to realise this.

Other results of this parentage was an interest in social issues, which my mother talked about, and being brought up with computers which my father brought home from his laboratory. At some stage I read a book about mathematics, and was fascinated. In particular it listed an axiomatisation of set theory, explaining that all known mathematics could be expressed in the set theory that they specified. This interest (along with a complete failure to succeed in writing good English or learn any facts) led to me studying my mathematics as my first degree. Then however, I went into youth work, partly because: I found social systems more interesting and I had become aware of some of the limitations of analytic mathematics (in particular its applicability).

By 1992, I had been thinking about several related things for a while, namely: the limits to formal analytic modelling techniques; the difficulty of understanding social systems; and what exactly it is that makes something complex. For my sins I started a doctorate in philosophy on "the meaning and definition of complexity". At that time there were relatively few things written about the concept so it gave me a good excuse to read material from almost any part of the library. In 1994, by sheer dumb luck, I got a job with Scott Moss who was using computers to model economic systems. I started doing this as well, as part of what later came to be known as "agent-based social simulation": using complex computer programs to try and understand complex social phenomena. Despite my hubris in choosing the topic and a ballooning list of references I managed to complete my thesis in 1999.

Thus, although I first came across complex systems in an entirely abstract way, I ended up rejecting general abstract approaches and instead have concentrated on practical ways by which we can seek to understand them using simulation modelling.

2. How would you define complexity?

The nearest I have come to this is the definition which is the conclusion of my thesis, namely:

> *Complexity is that property of a model which makes it difficult to formulate its overall behaviour in a given language/framework, even*

when given reasonably complete information about its atomic components and their inter-relations.

The essential aspects of this are that:

- you will only get a more specific definition of complexity given specific contexts, fields or frameworks, there is no general approach that is practically applicable;
- complexity usefully appertains to models of phenomena rather than to the phenomena themselves, it is a property of the models and only the phenomena if you conflate your model with the reality it represents;
- as projected upon the world complexity is a negative concept: covering everything that is not simple, thus almost anything can be thought of as complex.

For details see my thesis[1].

3. What is your favourite aspect/concept of complexity?

The complexity bandwagon has helped encouraged some *existing* trends in the development of science, including the following.

- The use of complex simulation models instead of (or along with) analytic models, thus adding to the menu of tools available to the scientist. No longer is it always felt necessary to "shoe-horn" phenomena into analytically tractable mathematical or statistical models when this necessitates the use of assumptions that obscure important aspects of what is being understood. In particular one does not have to use numerically based models but can model much phenomena in a more straight-forward manner. This has resulted in a swath of simulation models that are more specifically descriptive in nature and do not resemble a traditional theory from physics in that the model itself can be difficult to understand completely.
- A re-thinking of the purpose and processes of science. In particular the range of uses that models can be put to (for example to inform and be informed by good observation), as well as different ways of using models together (e.g. in chains of models or as complementary to each other). Simplistic accounts of "how one does science" have become less narrow and prescriptive.
- The use of a wider range of evidence. For example, in computational models of social phenomena it is possible to utilise reports from people of what they do and why by including this process in a formal computational process. Thus the introduction of simulation models allows for more of the evidence to be formalised and thus seriously considered as part of the scientific discourse. Science now tries to deal with a broader range of evidence (and by implication phenomena) than it did previously.
- A long-overdue breakdown of the myth that the truth about our universe must be, in some sense, simple. Thus the excuse of "for the sake of simplicity" is gradually being replaced by more honest phrases referring to limitations of time; computational resources; or imagination. No longer does everybody expect the truth to be simple, nor are they only convinced by accounts that are simple. In this

[1] Joke!

respect science is growing up, with some acceptance that many fields (e.g. economics) will end up looking more like biology and less like physics.

4. In your opinion, what is the most problematic aspect/concept of complexity?

Since complex systems covers all systems that are not simple, it includes pretty much everything we encounter. Under this usage, "complexity" rapidly looses any useful positive meaning and becomes a "dustbin" concept, rather like "context" or "system". For this reason there is not, and will never be in any meaningful sense, any "science of complexity" – a science of complexity makes no more sense than a science of non-red things. Similarly (at least so far) there is no coherent body of knowledge that could be honestly called "complexity theory" but rather a collection of techniques and tools from different fields, loosely (and sometimes rather uncomfortably) bunched together under the same label. The hype associated with these terms confuses the public and raises false expectations within funding bodies.

Thus, in my view:

- There is no hidden principle of complexity to be found behind observed phenomena;
- There never will be a "Science of Complexity";
- There is no "Complexity Theory".

5. How do you see the future of complexity? (including obstacles, dangers, promises, and relations with other areas)

It has no future as an identifiable field or cluster of fields.

Like Systems Theory or Cybernetics before it, it will slowly fade away and across into the humanities and public discourse. Simulation approaches will take its place alongside statistical and analytical approaches as "just another tool" to be used as and when it is helpful. However, some of the lessons the label stands for (e.g. those listed in answer 3 above) will permeate all areas of science and become part of the accepted or standard view.

Thus the dangers are short-term and common to many other new trends and labels. Approaches associated with complexity will be subject to too much hype for a while and their usefulness will be both under- and over-estimated, depending on the age of those who judge them. While this stage lasts, there will continue to be much confusion caused by the word "complexity", so much so that serious researchers will start to seek to avoid using it. On the other hand politicians will start to use it in speeches, demanding such as "a complexity-led solution" to particular problems.

It is a flash-in-the-pan, but it signals slower and more fundamental changes in the way science works, as science continues to adapt to the subject matters it can cope with.