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Exploring the future with complexity science: The emerging models

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ABSTRACT

The 'futures field' can be divided into five major segments or futurist schools, together with their complementary but differing research methodologies and time horizons. These are generally subsumed under the terms 'futures research', 'futures studies' and 'foresight'. Complexity science applications are outlined for each of the schools, and these provide evolving theories for futures thinking. (1) Environmental and geosciences treat the Earth and its various components as typical out-of-equilibrium systems with dissipative processes. (2) Infrastructure and socio-technological systems emerge through the diffusion of investment capital, with the endogenous transformation of the urban system. (3) Social, political and economic sciences are being reshaped away from the notion of economic equilibrium, and describe social emergence by means of agent-based models. (4) Human life, mind and information sciences are evolving with the development of complexity models in neuroscience, immune systems, epidemic modelling, social media technologies and artificial intelligence. (5) Business and management science involves examining the viability of successfully undertaking transactions in a complex adaptive system, in which the systemic structure evolves over time. Geographical information systems are integrated with agent-based modelling for corporate foresight.

1. Introduction

This article is a sequel to the author's paper 'Futurists and their schools: A response to Ziauddin Sardar's 'the namesake'' [1] and focuses on the application of complexity science to the five main futurist schools. The schools may be differentiated in terms of their time horizon for futures research, in so far as the *Environmental and Geosciences* school has the longest at say 100–200 years, *Infrastructure and Socio-technological Systems* range from 50 to 100 years, *Social, Political and Economic Science* look forward up to perhaps 25–50 years, *Human Life, Mind and Information Sciences* have a similar time horizon, and the *Business and Management Science* school has a relatively shorter term at perhaps 10–20 years. The schools include ten or more sub-categories each, with a total of perhaps 50–60 sub-categories, but it would be too fragmented to analyse the minor differences in the futures research techniques between sub-categories. There is an appreciable difference or distance between the schools and they employ distinctly different sciences and complexity science applications to undertake their futures research. The complexity science models that are developed for each of the futures research segments contribute to a theory of futures research that is relevant within each of the schools. The 'futures field' is not described by a single school as it encompasses the complementary theories and models used across all the futurist schools.

Futurists are engaged in the serious consideration of future conditions, and prescience is the foreknowledge that arises from futures research in relation to the behaviour of complex adaptive systems. This differs from both forecasts and the use

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of prediction, which are more relevant for applied sciences such as thermodynamics, hydrodynamics or aerodynamics in which fluid flows or structural stresses can be calculated with a degree of confidence. 'Futures research' has a systems science orientation involving modelling, whereas the term 'futures studies' tends to have a social science connotation and it is more qualitative or descriptive than the rigorous quantification of futures research. 'Foresight' is the most popular term within management science, industry, commerce and business sectors.

The evolutionary sciences, such as astronomy, geology, ecology, anthropology and archaeology have an historical evolutionary path, in which a series of events have been interpreted retrospectively into a pattern to provide an explanation of the phenomena. The same evolutionary processes will also create the future, and it follows that futures research is in fact an evolutionary science. Complexity science, or the science of evolution and complexity, is dependent upon spatial structure and it is quite consistent to simplify reality in economics by the aggregation of individual humans into households, such that households and establishments become the basic transacting entities and firms or corporations are merely an aggregation of establishments. These aggregations do not result in any significant loss of detailed information, compared with the selection of the disparate levels of the individual and the firm in the neoclassical model. However the benefit in selecting households and establishments as transacting entities is that they can be aggregated vertically to form business sectors and economic divisions, or horizontally to form residential and business districts with further aggregations into towns or cities and states.

2. Relevant transacting entities for futures research, futures studies and foresight

In the case of the civil system a central premise of this paper is that the economy is a complex adaptive system of transacting households and establishments. The urban structure of cities can therefore be defined as a collection of transacting entities, and a fundamental property of these entities are that they are located in space and time. Ecostructures (towns and cities) of households and establishments are complex adaptive systems for the diffusion of investment capital, and they evolve with increasing complexity to economise on the unit cost of transactions. In both futures research and corporate foresight, smart human agents provide the households and establishments with their mental capabilities for goal setting, prediction and adaption to other transacting entities and hazards. Investment capital is the system growth parameter that creates spatial structure with the evolution of the world system of cities, and plays a central role in the evolution of civilisation. Investment capital has the equivalent properties to 'exergy' [2] in an ecosystem and investment flows drive the economic system away from equilibrium towards 'far-from-equilibrium stability'. This sets up gradients between locations in the rate of return on property investments. The qualitative evolutionary driver of the system is the increase in planning standards and the physical quality of life that correspond to the stages of development.

A dominant paradigm within the social sciences (both sociology and economics) has been methodological individualism, with the explanation of social phenomena from individual rationality rather than instinctive behaviour. Societal futures studies consider the unique world of each person or the 'interior individual', and the interaction between humans and their evolving natural and artificial environments. The human being plays a part in the evolution of emergent complexities, not only as a biological but as a psycho-social being too. Futures studies deal with cultural–social–technological evolution, and society's information systems play a part in this evolution. There is an integration of both organisational artefacts such as states, civil institutions and establishments, and cultural artefacts such as language, communications, customs, religion, ethics and value systems.

Organisational or corporate foresight is a systematic attempt to look into the longer term future of scientific or technological developments, in conjunction with the economic, environmental, social and political issues that will impact on the strategic direction of the organisation. It is a way of looking at a range of possible future scenarios in order to take investment decisions that shape the future, rather than an attempt to make detailed predictions about markets and technical advances. Foresight means taking action to avoid harmful situations and to protect ourselves from suffering the consequences of inadequate preparation or errors of judgement. Foresight also implies the ability to plan, in order to seize opportunities when they present themselves. Organisational foresight tends to use a geodemographic classification of households, since the individual dimension provides a level of detail that would take futurists beyond what is required by the commercial world.

3. Environmental and geosciences

Environmental and geosciences embrace ecosystems, geophysical systems, climate, marine life and wildlife, natural resources, land-use, natural hazards and pollution.

The interacting dynamic metasystems of the planet include the astrophysical, geophysical, physical, biological and civil systems. Complexity science treats the Earth and its various components (hydrosphere, atmosphere, biosphere, and lithosphere) as typical out-of-equilibrium systems with dissipative processes. In view of the enormous timescale of anthropogenic evolution over many generations in relation to the shorter time span for societal evolution, it is useful for futures research to partially uncouple the biological metasystem containing individual humans from the civil metasystem in which the household becomes the unit of society. Long-range futures research requires that a distinction is made between the ecosystem of which humans are a part and the economy, which should relate specifically to the households, establishments or organisations, artefacts, buildings, cities and states created by humankind.