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Investigating Current Social, Economic and Educational Issues using Framework and Tools of Complexity Science

George Rzevski

Abstract: There exists compelling evidence that as evolution follows its course the complexity of our social, economic, educational and cultural environments increases. Methods and tools that were suitable for resolving issues arising in stable environments are not effective under conditions of uncertainty created by the occurrence of frequent, unpredictable events. The new Science of Complexity offers a framework and software tools for resolving issues which change during the problem-solving process. The power of Complexity Science concepts (self-organisation, emergence, autonomy, evolution, adaptation) backed by intelligent software tools is illustrated by a variety of case studies from the author's rich experience as a researcher and practitioner, including large-scale logistics, social security provision, fraud detection, security screening, data mining, knowledge discovery, education and many others.

Keywords: Complexity, Self-Organisation, Emergence, Evolution, Adaptation, Multi-Agent Technology

Introduction

There are many important issues that we do not know how to resolve. Here are some examples:

- We do not understand the mechanism of global warming
- All our attempts to eradicate poverty, inequality and crime have, so far, failed
- We are not sure why globalisation increases the standard of living across the board but also increases the gap between the rich and the poor (except in Ireland)
- We spend large amounts of money on 'war against terrorism' without visible results
- We have built an exceedingly complex global financial system that occasionally disintegrates with catastrophic social consequences
- Most large computer-based systems are delivered late and over budget, and some never manage to work as intended
- We still create much too large commercial, administrative and health organisations and pay chief executives huge salaries and bonuses, although there is sufficient evidence to demonstrate that smaller organisations are more profitable, customer-friendly and employee-friendly
- We continuously increase the size of comprehensive schools in spite of evidence that smaller schools provide better educational conditions and enjoy superior academic success

Should we not stop for a moment and reflect on Einstein's suggestion that we cannot solve problems applying the same thinking as when we created them?

All the issues listed above are *complex*, though they were not necessarily purposely created complex, nor due to someone's incompetence; they *emerged* as unforeseen consequences of billions of small and large decisions that participants make during their routine daily work. As such, they can be resolved only by the application of new thinking that embraces Complexity Science, as recently formalised by the Nobel Prize winner Ilya Prigogine [1].

This paper outlines fundamental concepts of Complexity Science and illustrates how they could be used to solve complex problems.

What is Complexity?

A situation is complex if it consists of a large variety of autonomous components engaged in rich interaction. A good example of a complex system is the global market, in which massive numbers of different suppliers, customers, middlemen, investors and administrators produce, sell, purchase, borrow, invest and regulate, often exchanging information using high-speed communication networks such as the Internet. The global behaviour of such a system is unpredictable – it *emerges* from a myriad of interconnected local behaviours of constituent components. Contrary to conventional economic theory the free market is never in equilibrium [2]. The frequency of occurrence of events that affect economies is so high that the system has no time to settle down and perpetually operates *far from equilibrium*, as explained by Prigogine [1], or *at the edge of chaos*, as described by Santa Fee Institute researchers [3].

Complex systems are nonlinear; a small disturbance may cause large changes in their global behaviour (*butterfly effect*) whilst large disturbances may go unnoticed [4]. A butterfly effect (or snowball-like behaviour) causes unpredictable serious consequences in many complex systems, including global financial networks (current subprime credit fiasco), self-combustion and epidemics.

To accommodate unpredictable external or internal events a complex system autonomously (without being instructed to do so) *self-organises* (changes its behaviour or even structure) and is therefore said to be *adaptive* and *resilient*. For this reason businesses operating in a dynamic environment, such as a global market, are sometimes designed to be complex with a view to exhibiting adaptiveness and resilience and to *co-evolve* with their environment.

The following three paragraphs from Wikipedia are a good introduction to the concept of complexity.

"Complexity has always been a part of our environment, and therefore many scientific fields have dealt with complex systems and phenomena. Indeed, some would say that only what is somehow complex – what displays variation without being random – is worthy of interest.

The use of the term complex is often confused with the term complicated. To understand the differences, it is best to examine the roots of the two words. "Complicated" uses the Latin ending "plic" that means, "to fold" while "complex" uses the "plex" that means, "to weave." Thus, a complicated structure is one that is folded with hidden facets and stuffed into a smaller space. On the other hand, a complex structure uses interwoven components that introduce mutual dependencies and produce more than a sum of the parts… This means that complex is the opposite of independent, while complicated is the opposite of simple.

While this has led some fields to come up with specific definitions of complexity, there is a more recent movement to regroup observations from different fields to study complexity in itself, whether it appears in anthills, human brains, or stock markets.”

Following the train of thoughts suggested above, the intuitive interpretation of the term Complex as ‘difficult to understand’ is correct as long as we accept that the main reason for the difficulty is the interdependence of constituent components. It follows that it is not possible to simplify complexity without losing effects of this interdependence.

The often-quoted statement made by Stephen Hawking at the end of the 20th century best illustrates the importance of the increasing complexity of our environment:

"*I think the next century will be the century of complexity*."

In a classification of systems according to their predictability, complex systems are situated between random and stable systems, as shown in Fig. 1.

CLASSES/*Features*	**RANDOM SYSTEMS**	**COMPLEX SYSTEMS**	**STABLE SYSTEMS**	**ALGORITHMIC SYSTEMS**
Uncertainty	Total uncertainty	Considerable uncertainty	No uncertainty	No uncertainty
Behaviour	Random	Emergent	Planned	Deterministic
Norms of behaviour	Total freedom of behaviour	Indigenouse or externally imposed norms of behaviour	Behaviour governed by laws and regulations	The system follows instructions
Degree of organisation	None	Self-organisation	Organised	Rigidly structured
Degree of control	None	Self-control by means of self-organisation	Centralised control	Centralised control
Irreversible changes	Random changes	Co-evolves with environment	Small temporary deviations	None
Operating point	None	Operates far from equilibrium	Operates at an equilibrium	Operates according to the specification

Fig. 1. Classification of systems

Physics, often referred to as the queen of sciences, was for centuries preoccupied with studies of systems in equilibrium, such as the movement of solid bodies and fluids. The laws governing the behaviour of such systems are valid at any place and any time and are reversible. The elegance and power of these ‘natural laws’ led many scientists to believe that, with the advancement of science, it will be possible to reduce the understanding of all systems to a similar set of simple and logical laws. This notion is known as Reductionism. Recent research, following the work of Prigogine, has shown that, to the contrary, in physics like in all other branches of science, the majority of interesting phenomena are complex, consisting of richly interlinked elements, and are not reducible to simple laws.

Complex systems are primarily of interest because of their capabilities to *Self-organise* in response to events that affect their behaviour and to *Co-Evolve* with their environments and consequently, their properties are *Emergent* and their behaviour is *Adaptable* to changes and *Resilient* to attacks.

Examples of Complex Systems

Examples of Complex Systems include: ecology, a swarm of bees, a human being, human society, culture, free markets, a city, epidemics, a terrorist network, climate, road traffic, the Internet, a swarm of software agents and the life span of an aircraft or a car.

A common feature of all the systems listed above is that they do not have centralised control; their behaviour emerges as a result of the interaction among their components and between components and the environment. The decision-making power of different components (often called Agents) may vary, but as a rule, Agents have certain autonomy limited only by intrinsic norms of behaviour; they do not work under external instructions. The trajectory of such systems in time is not predictable precisely, though they do exhibit discernable *patterns* of behaviour.

Examples of complex systems where a high autonomy of constituent Agents provides substantial robustness in the face of strong external attacks on the system include: epidemics, terrorist networks and the Internet.

Complexity versus Determinism

There are two contrasting philosophical theses.

The first thesis is that the world is, in principle predictable (deterministic). It is based on the 'grand design' and any uncertainty is due to our inability to understand it. Great philosophers and scientists subscribed to this worldview, including Aristotle, Kant, Newton and Einstein.

The second thesis is that the world is inherently unpredictable (complex). It evolves with time due to the autocatalytic properties of some of its elements. Its evolution is irreversible and leads to an increase in complexity. The future is not given; it is under perpetual construction. Supporters of this thesis include Buddha, Darwin, Popper and Prigogine.

Evolution Generates Complexity

Two interesting questions are where complexity comes from and why there are currently so many complex issues?

There exists compelling evidence that as the evolution of our Universe takes its course, the ecological, social, political, cultural and economic environments within which we live and work increase in complexity. This process is *irreversible* and manifests itself in a higher *diversity* of emergent structures and activities and in an increased *uncertainty* of outcomes.

Evolutionary changes occur in steps, often called *paradigm shifts.* Some examples are given in the next sections.

Evolution of English Language

Researchers investigating the development of the English language through centuries noticed two big steps in its evolution, the first during the life of Chaucer and the second during the life of Shakespeare. The two creative geniuses, each in his time, enriched the vocabulary and grammar of the language and thus increased both its power and its complexity. In general, the destruction of a structure that limits further developments and its radical reconstruction to enable creativity and innovation is called *Constructive Destruction*.

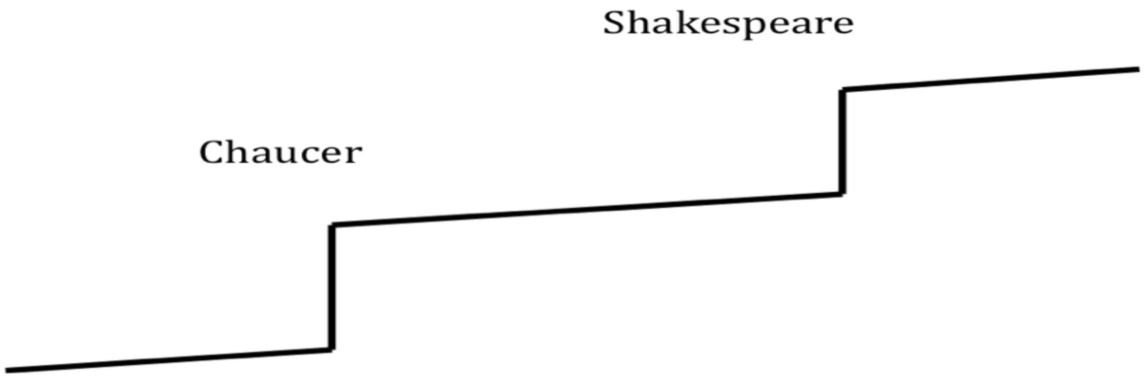


Fig. 2. Evolution of English Language

Evolution of Science

The evolution of science as a succession of paradigms has been well documented by Thomas Kuhn [5]. The purpose of the simplified model shown in Fig. 2 is to underline changes in science relevant to our current discussion, that is, progress from perceiving the world as stable and controllable to accepting that it is complex: ever-changing and rich in diversity and uncertainty.

Newtonian science was concerned with systems in equilibrium, static or dynamic. These are stable systems (when disturbed, they return to equilibrium) and their reversible behaviour is independent of location or time. Although primarily applicable to planetary motion and subatomic particles, Newton’s laws gave us an elegant method for building simplified models of everyday phenomena. Einstein increased the complexity of our perception of the world by postulating curvilinear space and principles of relativity and, finally, Prigogine developed the foundations of Science of Complexity, which perceives the world as irreversibly evolving towards an unknown future – a future that is not given [6] and which emerges from interactions of the billions of autonomous components comprising the Universe.

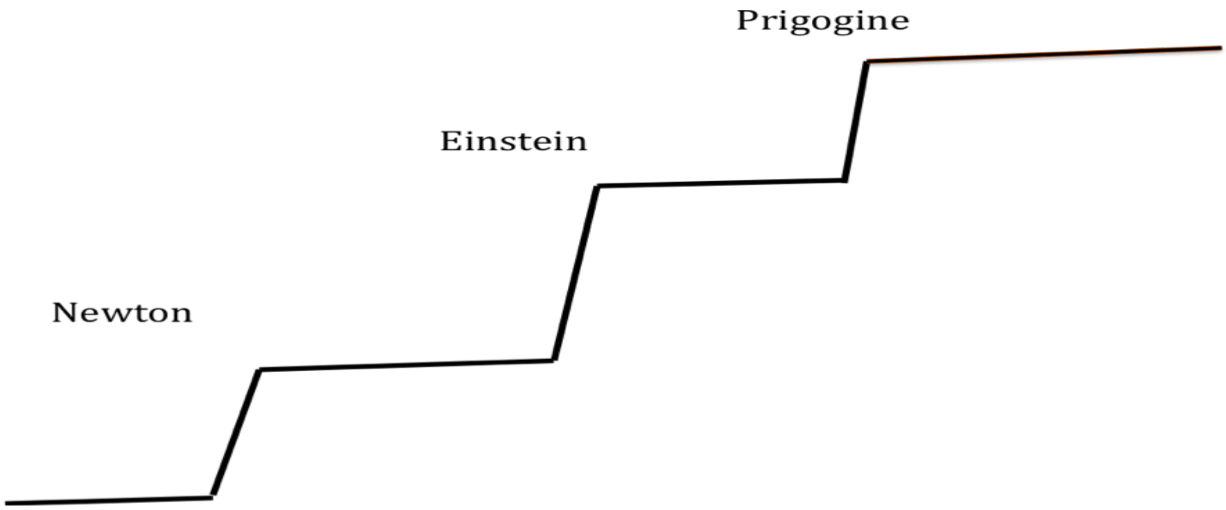


Fig. 3. A simplified model of Evolution of Science

Evolution of Society

Society co-evolves with technology for wealth creation. Industrial Society, where the key resource was Capital and the majority of people were employed in industrial production of goods, superseded the Agricultural Society, in which the key resource was Land and the majority of people were employed in agriculture. We have now entered a new transition from industrial to *Information Society*, in which the key resource is *Knowledge* and where the majority of people are employed in knowledge-based services (information processing) rather than the production of goods.

At each transition we experienced a stepwise increase in complexity of our economic environment and, consequently, in business, administration, political, educational and cultural environments. The current transition towards an Information Society is particularly notorious by its very steep increase in complexity caused by globalisation, as enabled by (a) the rapid spread of the Internet across the globe, (b) a considerable increase in opportunities (and reduced cost) for global travel, and (c) concerted efforts at reducing tariffs and adopting instruments that facilitate the global exchange of goods and services.

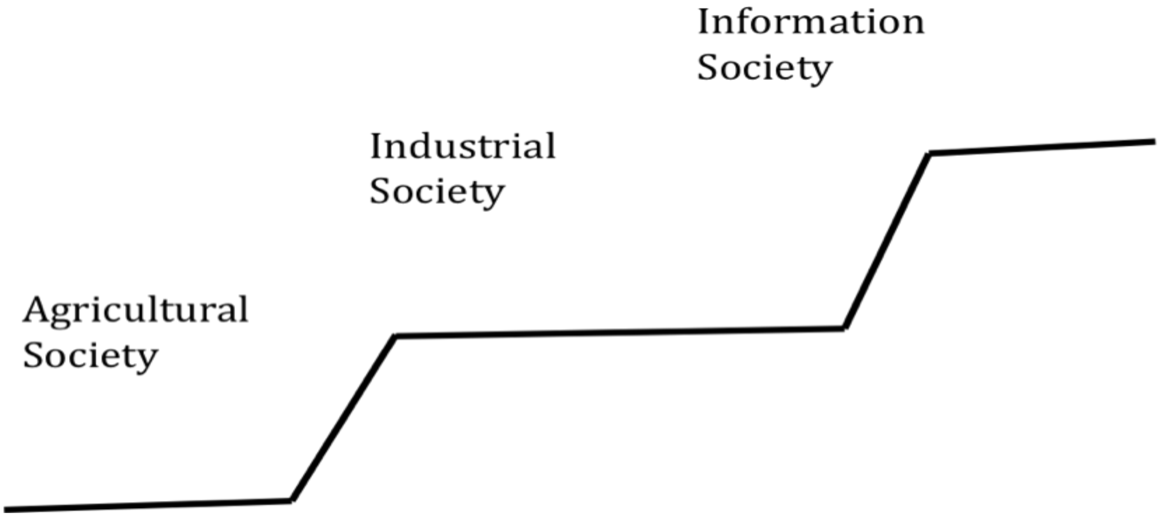
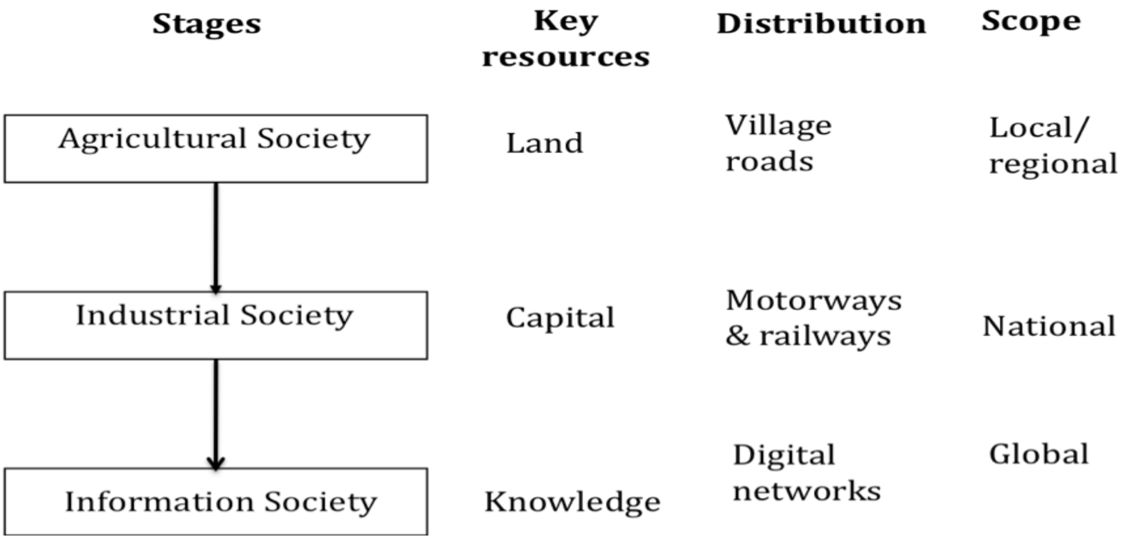


Fig. 4. Evolution of Society

As shown below, we are relentlessly moving from local, regional and national communities to a genuine 'global village', where those with skills and means to acquire digital technology can communicate and trade across the world.



Stages	**Key resources**	**Distribution**	**Scope**
Agricultural Society	Land	Village roads	Local/ regional
Industrial Society	Capital	Motorways & railways	National
Information Society	Knowledge	Digital networks	Global

Fig. 5. Complexity of social systems increases with every stepwise change

Paradigm Shifts Created by the Transition to an Information Society

Globalisation

In the socio-economic sphere there is a very important shift from nation-centred industrial markets to the global economy, enabled by the abolition of tariffs and rapid Internet growth. As a recent OECD report shows, globalisation increases wealth across the board (there is a saying among economists "the globalisation tide lifts all boats"). During the last 30 years the world as a whole has enjoyed unprecedented economic growth, with one downside feature: the gap between rich and poor has increased in all countries except Ireland.

Transition from Manufacturing to Knowledge-Based Services

The shift of manufacturing from the developed to developing countries is a part and parcel of globalisation. The replacement of manufacturing by knowledge-based services as the main wealth-creating activity may be achieved only in countries where there exists advanced IT and a large number of highly competent knowledge workers: researchers, designers and decision makers in financial services, IT, engineering, consulting, media, construction, architecture, entertainment, etc. The early adoption of knowledge-based services provides an excellent opportunity for economic prosperity at the time when manufacturing-focused countries face stiff competition.

Emergence of the Digital Leisure Industry and Social Websites

The current shift from paper-based and analogue media to digitally-enabled entertainment as a dominant leisure activity was made possible by the astonishing progress in designing miniature and powerful processors and memory chips, and appropriate communication and application software, as evidenced by the rapid spread of multi-channel digital TV, digital cameras, cellular phones and digital audio and video devices. This is complemented by a rapid growth of websites for downloading and uploading art, music and multimedia products. Apple iPod and iTunes together with YouTube and My Gallery are the icons of this revolution. The spread of the so called 'social websites' where individuals display their creative products to be perused by global audiences is particularly significant and almost certain to continue well into the second half of this century. The shift from corporate media to internet-based media has many unexpected implications, not least the "long tail" [7], "the wisdom of crowds" [8] and "economy of attention" [9] phenomena.

Personal Globalisation

Through specialised websites, such as www.elance.com it is now possible to outsource many personal tasks such as: search for dating partners, personal secretarial tasks, personal website design, bookkeeping for freelancers, private maths coaching for pupils, and graphic design for weddings. Outsourcing provides opportunities to take advantage of better value for money, eg, services of a college graduate in India for $15 per hour (versus $60 per hour in the USA), maths coaching from Bangalore for $99 per month or graphic design from Argentina for a wedding at $65 per job; but also, to reduce inequality of knowledge workers around the globe by providing freelance work for those in developing countries.

Supercrunching

As available computer storage space increases relentlessly and the Internet enables sharing of data, there is a trend to improve intuitive judgements of experts with extensive data mining, aimed at discovering useful patterns in data, which amounts to using computers to discover *Knowledge*, the key resource of the Information Society. Supercrunching is used extensively in marketing to individual consumers but also in unexpected areas, which include football coaching, medical diagnosis and in teaching – discovering which teaching methods work with which individual student.

Threats from New Forms of Violence

As globalisation takes its course with the rapid increase in the number of people connected to the Internet and/or travelling across the globe, new global complex systems have emerged, such as terrorist networks, global epidemics, massive hacking attacks, phishing and spamming. It is only a matter of time before hackers attack with swarms of viruses.

Ineffectiveness of Very Large Systems

Under currently prevailing conditions of perpetual change, very large systems appear to be too rigid and unable to adapt to rapid changes in their environments. Examples from the UK are many and include the following:

Supersize comprehensive schools with 1,500 to 2,000 pupils have the worst record of bad behaviour in the classroom and limited academic achievements (source: the charity Human Scale Education). In contrast, smaller schools provide a student-friendly pedagogical environment and consequently good academic results.

Very large private companies as a rule generate less profit than small-to-medium size enterprises.

Exceedingly large computer systems, including the UK National Health Service System, Ambulance Management System, Air Traffic Control System, Inland Revenue System and Drivers Licence System are too often delivered late, over budget and in some cases, never achieve expected performance.

In contrast to the difficulties experienced by large airline companies, a new generation of small and highly efficient jet aircraft, with 3 to 4 seats only, are starting a revolution in aviation by prompting a large number of start-ups promising to offer regional air taxi services.

The Prospect of Cloud Computing

There is a trend to store data on servers located in big server farms and to access it from any point in the world where the users may happen to find themselves. A related trend is to subscribe to web services rather than to purchase software. The concentration of data and applications in cyberspace is known as the CLOUD.

Our information-processing world is growing rapidly, its capacity doubling approximately every two years. In 2008 it is characterised by:

- 100 billions clicks per day
- 4 billion digital devices (such as computers, telephones, RFIDs, etc) connected to the internet (in excess of the number of neurons in a human brain)
- 55 trillions links between web pages (similar to the number of synapses in a human brain)
- 2 million emails per second
- 8 terabytes of traffic per second
- 65 million [?? billion] 'phone calls per year
- 600 billion RFID tags in use

By 2030 or 2040, all computers, personal organisers, telephones, iPods, TVs, DVD players, modems, radios, film projectors, video players, hi-fi decks, including all their content, ie, data, films, videos, broadcasts, podcasts, newspapers, books, music, emails, blogs, websites, magazines, will be linked forming one Global Intelligent Network - the Cloud.

Moreover, a great many natural and designed objects on the planet (livestock, aircraft, trains, vehicles, manufacturing plant components, etc.) will be linked by means of RFID tags to the, so called, The Internet of Things, which will be, naturally, a part of the Cloud.

And so will most people.

The next technological revolution will be the shift from the current data-driven Internet to the new Semantic Web and it is likely to be dramatic, as the new generation of systems will be enabled to 'understand' the meaning of data. The Semantic Web is an old dream of computer science researchers, now firmly on the way to be realised with its first programs based on ontology and multi-agent software now being released and tested in commercial applications. Further progress is ensured by the concentrated effort of a large number of researchers in the EU and USA.

Functionality required to implement Semantic Web is fundamentally different from that offered by current software technology. Interpreting the semantics of sentences expressed in a natural language requires intelligent computational effort rather than the brute force of current software. All successful current Semantic Web prototypes are based on ontology and multi-agent technology.

Complexity and Universities

Universities have for centuries retained their basic structure. Their relevance to societal needs has been maintained by perpetual adaptation of curriculum and syllabuses to ever-changing social, economic, cultural and technological environments.

However, rapid changes generated by the transition from an industrial to an information society, as outlined at the beginning of this paper, are likely to exert considerable pressures on the university sector and, consequently, it may not be possible for long to avoid comprehensive changes in the way that universities enrol students, organise teaching and research and maintain relations with governments, citizens, media, industry and commerce.

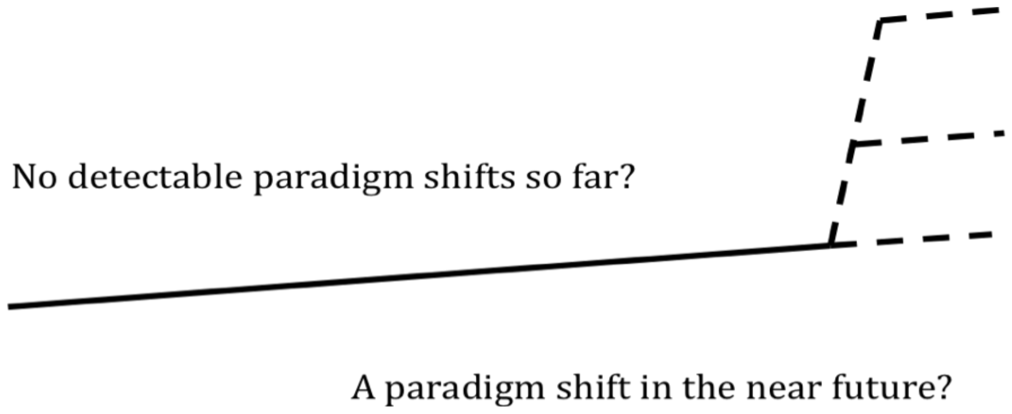


Fig. 6. Evolution of universities

The key driver for change is the new culture of diversity, dynamics, freedom of choice, self-expression and globalisation supported by Internet-based tools, which enable individuals and groups to learn, express themselves and be entertained without the straightjacket of a formal institution. I have noted the following trends pulling in this direction:

Many eminent scientists, particularly those near the end of their career, prefer to publish new ideas and research results on their websites rather than endure the long and tedious refereeing process imposed by learned journals. Free availability of advanced knowledge is bound to encourage do-it-yourself education.

Websites such as Wikipedia rely on volunteer-contributors bypassing traditional boards of paid editors. The driving force is a need for self-expression but also the practical advantage of being seen as an esteemed contributor to knowledge. I foresee an increase in the number of websites aimed at giving academics opportunities to display their credentials, organised not unlike social websites My Space, My Face or My Gallery. This seems inevitable because of the ever-increasing competition among purveyors of knowledge and a related need to attract the attention of knowledge consumers.

There is a marked increase in web-based scientific societies, clubs and forums that organise their own annual conferences, publish their own virtual journals and book reviews and significantly, some of these organisations are planning now to engage their members in developing and offering their own advanced educational courses. A good example of such a new organisation is the European Complexity Society.

There is no need to be a practitioner of futurology to predict that students will soon start demanding a greater say in designing their educational experiences in terms of content and execution. This is likely to be the first step towards a significant pedagogical paradigm shift: departure from current rigid enrolment, course design and delivery structures.

Using Complexity Science Concepts and Tools to Resolve Complex Issues

The Thesis

Complex situations can be effectively investigated only by using models that are of similar complexity to situations that are being modelled.

Leaving aside for the moment the definition of 'similar', the following argument supports this thesis. Complex situations change during the modelling process and their models must therefore be capable of adapting to the changes; the adaptation must be autonomous (without waiting for instructions from the modeller) which is only possible if models have capabilities for self-organisation and intelligence [10], [11]. In other words, *models must be able to co-evolve with the situations they model*.

The key implication of the thesis is that we must learn how to design complexity into software to construct complex software models of complex real-life systems.

In other words, models of real-life complex situations must be *artificial complex systems*. At present only multi-agent software is capable of exhibiting complexity features such as: autonomy of components (Agents), self-organisation, adaptation, co-evolution with its environment, autonomous building and dismantling of hierarchical structures, self-acceleration and constructive destruction.

Conventional top-down planning and scheduling methods are not suitable for complex situations. Current-generation computer programs cannot be used as models for complex situations because they are not adaptable. They cannot change by themselves; they must be instructed to do so by programmers.

Two Types of Complex Situations: (1) Exceedingly Complex and (2) Complex

The complexity of certain unresolved critical issues (such as global warming, poverty and population growth) is so high that we can expect, at best, to build much-simplified models of these issues with a view to gaining some insight into their resilience to our attempts to resolve them. Let us refer to such issues as *Exceedingly Complex.* An example of brilliant work on modelling of population growth carried out by Kapitza is described in [12].

In contrast, there are many complex issues where constituent components and their interactions can be identified and modelled by constructing a Virtual World (a model) almost as complex as the Real World that is being modelled. Nearly all complex business situations and many complex social, economic, security and technological problems, as well as the evolution of urban systems, fall into this category. I shall refer to such issues simply as *Complex.*

The Art of Modelling and Managing Complex Situations

1 Collecting and organising domain knowledge

The first step is to collect and organise knowledge on the domain of the real world that is being investigated. The most effective method of representing knowledge on a complex domain is to construct a network in which nodes are domain Concepts and links are Relations between

Concepts. For example, for an airline, relevant Concepts include: Flight, Passenger, Aircraft, Pilot, Maintenance, Seat Price, Route and Network. Each Concept is characterised by attributes and rules defining its behaviour. Such domain knowledge representation is called Ontology [13].

2 Constructing a Virtual World

The next step is to build a Virtual World consisting of instances of Concepts and their Relations from domain Ontology. For an airline, a Virtual World will be a network in which nodes are Passenger P1, Passenger P2, … Flight F1, Flight F2, … Seat S1, Seat S2, … Aircraft A1, Aircraft A2, … etc, and links are ‘S1 is allocated to P3’, ‘A1 is allocated to F2’, etc. Complex systems, such as supply chains of large international organisations, and Virtual Worlds that represent them, may contain millions of objects, attributes, rules and relations. To construct Virtual Worlds for such complex problems one requires powerful multi-agent software tools [14].

3 Connecting a Virtual World to the Real World

The Real World (ie, a complex situation that is being modelled) is perpetually changing. The changes are represented by the occurrence of events exemplified, in an airline, by: Seat Booking, Flight Departure, Flight Delay, Flight Cancellation, Airspace Closure, Aircraft Failure, etc. The occurrence of every Real Event must be communicated instantly to the Virtual World where an equivalent Virtual Event is created, causing the affected part of the Virtual World to adapt to changes originated in the Real World. Every change (adaptation) of the Virtual World must be communicated to the Real World before the occurrence of the next Event [15].

4 Empowering the Virtual World to manage the Real World in real time

Managing complexity means achieving specified goals by means of adapting to complexity. In principle, complexity cannot be simplified; we must adapt to frequent changes in our environment but the decision how to adapt is critical: the adaptation must lead to achieving desired goals.

An Agent (a small computer program) is assigned to every node of the Virtual World with responsibility to maintain its integrity. For example, if a Virtual Aircraft breaks down, the Aircraft Agent sends messages to Agents of all affected nodes letting them know that this Virtual Aircraft does not exist for the time being. The message provokes a flurry of activities among affected Agents who try to accommodate the failure by searching for a replacement. As soon as a solution is found, it is conveyed to the Real World for implementation, ensuring that the two worlds co-evolve (change in unison) [16].

5 Investigating behaviours of the Real World by experimenting in the Virtual World

Once a suitable Virtual World is constructed in software, it could be used to simulate behaviours of the Real World under different states of its environment, eg, studying behaviour of a supply chain under varying market conditions [17].

6 Protecting computer systems from attacks by constructing Artificial Imune Systems

Attacks on computer systems will soon be upgraded and we can expect swarms of viruses to be sent by hackers to infect target software. Organised attacks of the new kind, in which viruses co-ordinate their penetration by exchanging information on weak points of the target, can be repelled only by swarms of software Agents tuned to effectively protect the target software by adapting the defence to the style and dynamics of the attack. The multi-agent defence, which I propose to name the Artificial Imune System, must exhibit all important features of complexity to be effective.

Examples of Applications

The author and his team have designed a large number of agent-based software systems for investigating or managing large-scale complex situations, many of which have been implemented and are in regular use. Examples include: managing a fleet of very large tankers transporting crude oil around the globe, managing car rentals across Europe, scheduling car assembly, managing an air taxi service, supporting a social service, dynamic data mining [18], semantic search [19] and simulation of virtual businesses [20].

Conclusions

The complexity of our ecological, economic, social and political environments perpetually increases, as illustrated using the various examples presented in this paper. To live and work in complex environments require new thinking and consequently a new mindset. Instead of hoping for the return of stability and steady state there is a need for continuous *adaptation* to ever-changing conditions, for developing *resilience* to unexpected attacks, for *irreversible co-evolution* with our surroundings, which amounts to accepting being able to handle, and even enjoying, perpetual change.

Complex global problems such as climatic changes, poverty, epidemics, terrorism and crime and also, the unpredictable and very painful recent disintegration of our global financial system, are exceedingly complex and therefore can be understood and possibly solved only through the framework of Complexity Science. This paper outlines new methods and tools currently available to make a start on the long journey towards gradual comprehension and solution, remembering that as time advances, problems keep changing and therefore our perception of their solutions will have to be continuously modified accordingly.

There are many problems in our working environment that are complex but manageable. The number and variety of components and the frequency of unpredictable changes in these problems are smaller, enabling us to build software models for them of equal or similar complexity. The new methodology and tools for modelling and solving such problems are outlined in this paper and references are provided for finding out more on this topic.

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