Systems Thinking and Economics Teaching

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ABSTRACT

This paper discusses the position of System Dynamics and Systems Thinking in the present university education system particularly in the UK. It shows the difficulties that a interdisciplinary subject can have in finding a true home. It also discusses the difficulties experienced currently with the teaching of Economics. Much of the difficulty is caused by the paradigm used by the practitioners and teachers. The paper defines the Systems Paradigm and suggests that Systems Thinking with all its ramifications such as holism, dynamic equilibria and feedback is a useful tool which should be incorporated into all Economic Curricula. The paper is illustrated by examples from the authors own experiences.

1 Introduction

There is no doubt that the modern discipline of economics is in a state of some disarray or at least this is true of its dominant modern mainstream component. (Lawson, 2000) Such a statement is common amongst academics today. This paper discusses the development of economics as a subject, in particular two opposing viewpoints – the realist and the instrumentalist view. The opinion of the authors is that a new pedagogy is needed and suggests that the Systems paradigm is very suitable as a pedagogic tool for teaching economics.

At the same time, Systems Thinking is having difficulty is establishing itself especially in UK universities because of its interdisciplinary nature. Most UK universities are organised as a faculty structure which makes it difficult to incorporate interdisciplinary subjects

The plan of the paper is to discuss what is meant by the Systems paradigm and the reasons why this, as a subject of study, is difficult to site in a modern UK university. We then look at the general epistemology of modelling and show how this relates to Economics. The need for a new paradigm – the Systems paradigm – is posited and some general examples are given. This paper should be read in conjunction with its sister paper – The Introduction of Systems Thinking into the Economic Curricula of Ukraine – which is also presented at this conference and provides a practical example of the points covered here.

2 The Systems Paradigm

Systems thinking consists of many parts. An essential component is that of holism which can be traced to the early Greek philosophers and it is later present in the work of Hegel and Kant. The world is seen as an interdependent, interlocking network of relationships. The relationships are often more important than the things themselves. Changing one of the variables changes the whole picture. This is the essence of holistic thinking. One cannot understand a situation by examining its constituents. The behaviour of a system is much more than the summative behaviour of its parts.

Before the 1940's, the terms System and Systems thinking had been used by several scientists but it was Bertalanffy's concepts of an open system and a general systems theory that established systems thinking as a major scientific movement. With subsequent strong support from cybernetics, the concepts of systems thinking and systems theory became integral parts of the established scientific language and led to numerous new methodologies and applications – systems engineering, systems analysis and System Dynamics. (Capra, 1997)

System Dynamics was developed by Jay Forrester in the 1950's (Forrester 1961). This exists in both qualitative and quantitative form. Qualitative System Dynamics has pioneered the production of causal loop diagrams which are an excellent way of capturing mental models. It relies heavily on feedback loops and the analysis of these loops can reveal valuable insights into possible long term behaviour. They are particularly useful in revealing possible counter-intuitive behaviour. On the quantitative side, the methodology of stacks and flows backed up by excellent software allows dynamic simulations to be conducted (Powersim, 1996 - Peterson D W and Elberlein R.L, 1994)
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About the same time, a group of scientists were meeting at the Macy conferences (Heim, 1991) consisting of such famous names as Norbert Weiner, John von Neumann, Claude Shannon, Warren McCulloch, Ross Ashby, Gregory Bateson and Margaret Mead. They founded a second systems strand which came to be known as Cybernetics. The list of names gives an indication of the interdisciplinary of the new subject – mathematics, operations research, anthropology, neuroscience, philosophy, information theory, game theory and computing. From this, developed the work of Ashby (Requisite Variety) and Stafford Beer (Organisational Structure) The basic premise to Beer's work (which is now known as Managerial Cybernetics) is that the structure of an organisation is an important contributor to the behaviour of the system (Beer, 1972) Beer developed a model called the Viable System Model (VSM) which acts as a template for an organism that is viable in a hostile environment (Beer, 1988).

A third strand is called self-organising systems This is a general name that includes the work of Prigogine and the mathematics of non-linear behaviour. It allows the possibility of self-evolving structures at far from equilibrium conditions. Non-linear Dynamics allows the possibility of chaotic (i.e. deterministic but not random) behaviour. (Prigogine,1985)

A distinction must be made between first and second order cybernetics. The original work, from the 40's, was heavily influenced by engineering and machines. The control loops were predominately negative, leading to homeostasis. It leant heavily on classical Newtonian concepts and linear causality. Second order cybernetics originated with van Foester around 1970. He coined the term " cybernetics of cybernetics" Basically, second order cybernetics recognises the importance of the observer. Every observer changes the system that is observed (this is actually a result from Quantum Theory). Second order cybernetics is more interested in morphogenesis and positive feedback loops than in homeostasis and negative feedback loops. System Dynamics is generally regarded as first order although it uses both positive and negative feedback loops

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In the last decades, a paradigm shift has occurred. We believe that the new paradigm is the systems paradigm. This sees the world as an open system which is non-linear, chaotic, self regulatory, self adapting, holistic and dynamic. It usually operates in far from equilibrium conditions and in fact it is "the difference which makes the difference". 'Systems thinking' will be used in this paper as a general name for the various branches of knowledge that help describe the processes in this paradigm.

3. The position of Systems Thinking in Universities

There is no shortage of discussion about the changes which have occurred and continue to occur in higher education. While the detail of cause and effect may be complex, at the heart of the change lies the reality that higher education in many countries has shifted from an elite to a mass system and, as this has happened, many of the underlying processes and practises in our universities have been placed under strain.

Which university does not extol its flexible delivery, links with industry, diversity of students, international role, links with other education sectors, graduate employability, range of courses, teaching quality, research quality or community service (called Reach Out in the UK). Is diversity in higher education, to the extent that it exists, the product of different levels of resourcing rather than any genuine difference in aspiration or mission?

At the heart of these new approaches lies the repositioning of universities as players in what are called 'distributed knowledge production systems', where complex, real world problems are tackled with resources and knowledge drawn from a range of agencies and perspectives. Universities still occupy a privileged place as producers of knowledge but they are far less adept at drawing creatively on knowledge that is being produced and configuring knowledge relevant to a range of contexts. It can be argued that as universities apply themselves to complex, social; and economic issues, new levels of interconnectivity will be required with greater capacities for application and integration of knowledge and better collaboration among producers of knowledge. Such trends are not confined to research but span the range of university work. There is a growing focus on the outcomes of university education, and interest in defining, developing and assessing the general capabilities of university graduates. Problem based approaches to university education are being explored and new courses being designed to prepare graduates for careers in fields which cross traditional boundaries. All these developments challenge the dominance of discipline perspectives in university courses (Coaldrake, 2001)

There is a mismatch between discipline based structures and cultures and the need for activity which crosses disciplinary boundaries. The issue is not just one of discipline cased cultures and rewards but also the location of budget and management responsibility with a disciplinary structure. Work requiring activity outside the departmental boundary can be discouraged in order to retain resources within the unit.

Thus, there are problems for any interdisciplinary subjects. It is recognised that these subjects are needed but structural and resource issues prohibit them from taking place. In the UK, the Research Assessment Exercise has, counter- intuitively, also worked against such connectivities. Each school or department enters its research staff into certain well-defined areas and thereafter expects that the staff research is focused on that area. Systems Thinking does not sit naturally in any of these areas and so younger staff are discouraged (by the system) from doing interdisciplinary research.

The author of this paper is a vice president of the UK Chapter for Systems Dynamics which every year offers a prize for the best student work in Systems Dynamics. This includes all levels – the only criteria being that it is the student's work. Each university that has any connection to System Dynamics work is circulated but the number of courses that are teaching Systems Dynamics in the UK is in single figures. This is despite a healthy membership of the UK chapter (it is one of the biggest after the US). Such a state is depressing. (actually, the only Masters course in System Dynamics in Europe is taught in Bergen Norway.!) Young academics cannot easily find positions in the UK where System Thinking is actively taught. Although we have five PhD students in Sunderland who are currently using System Dynamics, there is no System Dynamics now taught in our university.

3 The Epistomology of Models

3.1 Modelling

First we must address the question as to what is the nature and purpose of a model. As a mathematical modeller, I teach that a model is a simplified version of reality designed for a particular purpose. (Moscardini, 2000) Purpose and nature cannot be separated. Newton's model is a simplified version of motion on the earth's surface and was designed to explain reality, as it was known in the seventeenth century. It was not designed to explain or represent atomic particles and the attempt to force this explanation delayed the discovery of quantum theory for fifty years. The simplification part of the modelling process is performed by making assumptions.

These assumptions can be of three types: -

i. Type 1 Relevancy Assumptions
   One can decide to ignore quantities or variables that are adjudged to be not important in a certain behaviour. For example, when rolling smooth balls down a smooth surface, friction is assumed to be negligible. Similarly for air resistance in many gravity examples. (we say adjudged to be negligible as we do not know in advance whether they are or not. Sometimes it is the things that are adjudged to be negligible that actually are important). Often variables are ignored because there is no mathematics or current theory that can handle them. An example would be Chaotic behaviour which is only now has the mathematics and computing power available to deal with it. When I was at university, chaotic behaviour was known as pathological behaviour and was ignored as non-standard.
ii. Type 2 - Intermediate Assumptions
   These are a special case of Relevance Assumptions. Often, when one is trying to study a complicated situation, it is expedient to first study simple cases. If one was modelling traffic flow, then in the first model, one might assume that all traffic is a particular type and size i.e. no distinction is made between lorries, cars and motorbikes. This is obviously an intermediate stage and the various different cases must eventually be added to achieve any sense to the model.
iii. Type 3 - Restrictive Assumptions
   The final type are assumptions of constraint i.e. they specify the conditions under which this model should be used. Outside these conditions, the model is not valid. These are to my mind the most important assumptions as violation here completely invalidates the model.

These three classes are not mutually exclusive. Models exist which are only valid when friction is not present (type 3) but the reason for this is that the mathematics of friction was too difficult to include (type 1) and that when the mathematics is available and understood, it will be included (type 2).

3.2 Instumentalism vs. Realism

There is a healthy debate being conducted as to the nature of models. One view called Instrumentalism holds that while scientific theories are predictively useful ways of talking, they should not be thought to provide true descriptions of reality. Perhaps the most famous avowal of instrumentalism was Copernicus' advertisement of his heliocentric hypothesis as nothing more than an aid to astronomical calculation -- a predictive instrument, not purporting to be a true description of astronomical realities. The realist holds the view that reality is as science describes it or attempts to describe it. This goes back the Pythagoreans who believed that numbers were reality itself.

If the purpose of a model is to explain behaviour (e.g. the theory of super strings in Fundamental Particle Theory) then, we think scientists accept that type 1 and 2 assumptions exist and work continues on this basis. Whenever possible, these assumptions are relaxed and a better theory emerges. No quantum scientist ever claims that the latest theory is the complete explanation. They are always working towards a better understanding (type 3). These scientists do experiments. They use their theory to predict some event and then test if this event has occurred. If it hasn't they revise the model – if it does they then do more tests. It is a continuous striving for better understanding. If an electron does not do what the theory predicts, then this outcome is not harmful to mankind. We therefore think that the use that is made of a model is very important especially so – as we shall see – in the case of Economics

4 The Status of Economics

4.1 General Structure

Economics or Economic Sciences is currently in a troubled state.(Keen 2001, Omerod 1995) From the outside, it appears to consist of a well reasoned, coherent body of knowledge but once one begins to read the literature, it is evident that there are many versions of economics:- e.g. Marxian Economics, Neoclassical Economics, Austrian Economics, Sraffian Economics, Keynsian Economics and Institutionalist Economics. Each of these has a completely different mental model of economics which then results in different conclusions. . They are all based on assumptions which are either unverifiable or unrealistic but thenceforth each version is internally consistent. The Neo-classical school assumes the existence of a general equilibrium in the market and gives all consumers identical tastes and preferences i.e. there is just one consumer. The Sraffian School is based on the concept of the production of commodities by means of commodities, the Keynsians believe in the fundamental importance of uncertainty and market intervention and the Instumentalists in the importance of social and political influences. All these schools have a common property – inflexibility. Each is convinced that they have the correct answer and are very resistant to change. They control the main economic journals and thus bringing about change within Economics is difficult.

4.2 Is Economics a Natural Science.

I believe that part of the current crisis engulfing Economics is that it considers itself a ‘ hard ‘ science. The following quotation is typical.

> *“ The essential condition of any science is the existence of regularities which can be analysed and forecast. This is the case in celestial mechanics. But it is also true of many economic phenomena. Indeed, their thorough analysis displays the existence of regularities which are just as striking as those found in the physical sciences. This is why economics is a science and why this science rests on the same general principles and methods of physics” (Allais, 1992)*

The origins of Economics as a subject go back to Adam Smith in the eighteenth century. At that time the Newtonian paradigm was dominant and Economics followed the dominant intellectual pattern of the day. The Newtonian paradigm treats the world as a closed, static, linear, deterministic, reductionist process that is going to equilibrium.(Moscardini, 2001). It used the sublime mathematical achievements of Newton and Liebnitz to advance this model and had spectacular successes. Economics unfortunately used the same pattern and has failed to adapt.

> *“Most macroeconomics texts are obsessed with the idea that every 'sensible' macro model must define a full employment or natural unemployment solution. This perspective seems to be part and parcel of the landscape of the Newtonian conception of science. [Clower, 1988]*

The other argument against this position is due to second order cybernetics. The realists are trying to accurately model reality. This of course is an admirable endeavour and is to be supported but type 1 assumptions are important here and it is doubtful whether reality can ever be absolutely modelled. Certainly, where humans have a major influence, it is impossible. This type of modelling depends on the repeatability of experiments and where humans are concerned this is simply not possible. Humans act differently for a variety of reasons- hormonal, the weather, emotional or simply cussedness. The mathematics to deal with human behaviour i.e. stochastic theory is available nowadays to deal with this , but it can only produce probabilities – not facts.
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4.3 Is Economics a Social Science.

In the realist view, theories do not affect the phenomena they describe. Whether a photon is a particle or a wave packet does not affect the behaviour of light – it only affects our understanding of it. In second order cybernetics, interaction between economic theories and economic systems is accepted. Economic theories do affect economic systems and often entire countries - consider any of the post soviet transitional economies. Often new economic theories are developed because theorists wish to change social systems – Marx is an example.

This would seem to place Economics in the Instrumental camp.

> *" Page after page of professional economic journals are filled with mathematical formulas leading the reader from sets of more or less plausible but entirely arbitrary assumptions to precisely stated but irrelevant theoretical conclusions. Year after year, economic theorists continue to produce scores of mathematical models and to explore in great detail their formal properties; and the econometricians fit algebraic functions of all possible shapes to essentially the same sets of data without being able to advance, in any perceptible way, a systematic understanding of the structure and the operations of a real economic system" (Leontief, 1982)*

Another strong advocate is Milton Friedman. Friedman defines the function of a theory to generate testable hypotheses. In his view, theories are successful in so far as they are confirmed and scientists must not worry to much about whence theories are produced. He quotes that scientists often assume that a body is moving in a vacuum when that is not the case. Perfect competition in Economics is an assumption of similar standing. He states that hypotheses are valid if they predict correctly.

The Instrumentalists claim that the purpose of economics is to predict but unfortunately the predictions from economic theory are very important to mankind. The outcomes, predictions and theories frame the thoughts of political leaders who then pass laws that enshrine that dogma. For example, the current theory is that Market Behaviour should not be controlled and that all markets will settle where they settle. This then has tremendous influences on industry and business. Businesses that are not doing so well are left to collapse even though the government could tide them over. The transitional economies of the former Soviet Union have abandoned central market control and are following free market economic theory. The results are generally disastrous. The outcomes are not what the theory predicts but the theorists will contend that this is because either the time period is too short or because the governors didn't follow the tenets well enough. There is no seeming thought as to whether the theory might be wrong or that the assumptions in the theory do not apply.

We believe that Economics should not be classed as either Realist or Instrumentalist. We do not believe in yes/no, either/or logic. Mathematics went through the True/False debate 100 years ago when Russell wrote Principia (Russell, 1930). The conclusion after twenty years of work was that no one knew whether mathematics was right or wrong. Hilbert rescued the debate by declaring that mathematics was consistent. i.e. it was a body of knowledge that did not contradict itself and new theories did not contradict what had gone before. Economics is in a similar position now. It should recognise that it is built on assumptions and therefore cannot be totally realist whereas it is not fully Instrumentalist because (due to unrealistic assumptions) its predictions are always treated with caution. It is in need of a rethink.

> *The object of our analysis is, not to provide a machine, or method of blind manipulation, which will furnish an infallible answer, but to provide ourselves with an organised and orderly method of thinking out particular problems: and, after we have reached a provisional conclusion by isolating the complicating factors one by one, we have then to go back on ourselves and allow, as well as we can, for the probable interactions of the factors among themselves. This is the nature of economic thinking. [Keynes, 1936]*

5 The Case for Systems Thinking in Economics

Many of the concepts and procedures of first-order cybernetics admittedly seem useful for sociology: system boundaries; the distinction between systems, subsystems and suprasystems; the stress on circular causality; feedback and feed forward processes; auto- and cross-catalysis, etc. However, several reasons can be put forward to support the case that second-order cybernetics is more likely to influence sociological thinking in the future.

- The interactions between the subject matter and the observer should be included in the system to be studied. This will lead to increased study of phenomena like self-reference.
- Its origins in biology means that it tends to change rather than stability, for morphogenesis rather than homeostasis, and this may lead to an increasing stress on self-organization, and to a realistic awareness that sociological phenomena often cannot be forecast, but at best understood.
- Maturana and Verela's work on autopoiesis (self-production). This attempts to define the key concepts of a living system.
- The continuous emergence of new levels of organized complexity within society, at which new behaviour can be demonstrated and new

> interactions with the environment become possible. This would fit in with Prigogine's work defined earlier,

The fact that most economic predictions do not correspond to reality seems to have little effect on the thoughts and teachings of the economic schools.

As an example, consider the linear Supply and Demand curves (who actually believes that they represent reality but whose predictions are virtually meaningless) and the idea of an equilibrium market price. This also assumes that there is only one consumer!! Most consumers or actors act in a particular way – say naïve, adaptive or rational expectations. Yet, this is still taught worldwide. (Sloman, 2000) At the end of a typical series of lecturers on supply and demand , it might be added by the lecturers that, of course, these curves are not linear but this just means that the mathematics is more complicated. That is not true.. The mathematics is completely different and the consequences of non-linear behaviour as opposed to linear behaviour is enormous – in fact totally different. There is no detrimental judgement for the earlier economists because one can only use the mathematics and the paradigm that exists at the time. The judgement is on Economics today when better mathematics exists and there has been a paradigm shift. Economics has failed to recognise this and refuses to move on. One is reminded of De Bono's definition of experts (De-Bono, 1970)

> An expert is an expert because he understands the present situation better than anyone else except the fellow expert with whom it is necessary to disagree in order that there can be as many experts as there disagreements. An expert may have contributed towards the shape of the hole. For such reasons experts are not the first to leap out of the hole that accords them their expert status and start digging elsewhere……… So experts are usually found happily at the bottom of the deepest hole- often so deep that it hardly seems worth getting out of them to look around (De-Bono, 1970)

It is obvious from the preceding discussion that systemic tools are ideal to use in the study of economic behaviour. Systems thinkers do not claim deterministic outcomes for their theories. As their systems are open then the future is not known in advance. The outcome from each simulation will be different. There is then an implementation stage where the possible outcomes are discussed and rated probabilistically. This would avoid slavish adherence to rigid theory.

As educators, we are particularly interested in how to teach economics. We are not advocating that all current economics should be discarded. Some great intellects have contributed to this knowledge and many of the models are good (remembering type 3 assumptions). What is needed is a paradigm shift in the thinking of economic teachers. They should recognise that many new methodologies exist and in my opinion should incorporate systems thinking into their courses. Instead of teaching the Law of Supply and demand, the students could construct causal diagrams and System Dynamic models of a simple market. This would give them insight into one they are doing and certainly help understanding. When they are discussing the concept of the Firm or an industry, they could use the Viable System Model of Stafford Beer which would give greater insights. When the are examining Walrus

General Equilibrium Model, then they could look at some non-linear dynamics and the concept of stability

There is a continuing debate amongst educationalists as to the balance between how much students are taught and how much they are encouraged to think for themselves. [Illich, 1971 - Richmond, 1993 - Moscardini, 2000] We support pedagogies where students have the opportunity to build their own models, experiment with them, make mistakes and discuss their results under the supervision of their tutors. Such an approach encourages the use of divergent, holistic thinking rather than convergent reductionism. It also provides the opportunity to answer questions such as " What if? Time spent analysing past data may be of no relevance to the present time because of the accelerating nature of change. Dynamic models can reveal much more but have been hampered by the scarcity of good interactive software. The current development of such modelling tools, especially in the general area of Systems Dynamics, has provided the means to overcome these problems.

Nowadays, one can certainly say that simulation, originally a technique of first-order cybernetics, is widely used. It is also employed in second-order cybernetics to study the phenomena of emergence, and has become a much-used tool in the social sciences as well as in most other disciplines. With the increasing mass scale availability of high-speed computing equipment, even on PC's, it becomes possible to realistically simulate ever more complex problems, with the possibility to incorporate an increasing number of interacting variables in one's models. The obvious advantage of such simulations is that one can investigate the effects of changing some of the variables without actually changing them in reality, i.e., without engaging in policy action. Also, simulations with complex models allow one to discover latent consequences of certain intended actions, and to forecast the emergence and the effects of counter-intuitive behaviour

6. The New Systems Based Economics

The Biological Metaphor is now becoming out of date. Economics will be treated as complex adaptive systems rather than equilibrium systems.. This has implications for the training of economists who should be given introductory courses in Systems thinking. These views are supported by the work of Arrow and Arthur at the Santa Fe Institute. A typical course suggested by them is as follows (Arthurs, 2000)

The course should contain:

Wisdom

It will use a more realistic model of cognitive behaviour.

Traditional Economics assumes that people are alike in their thought processes maybe different preferences) and that they make choices as if they were solving complicated mathematical equations to make the best possible decisions.

These are gross oversimplifications.

Simulation now allows us to make more realistic assumptions.

Induction allows us to make decisions quickly in the face of incomplete information but even if we are rational we do not always make the optimal decision. Moreover different people may arrive at different decisions with the same information.

Webs

Agents will interact with each other in a dynamic web of relationships. It is not enough to have a model of a firm's behaviour, we must know how people interact within it, how it interacts with other firms and how these interactions change with time.

Waves

Markets will be viewed as inherently dynamic rather than static systems. Evolutionary changes in one agent will affect the evolution of another (co-evolution).

Occurs in economics when an innovation produces ripple effects throughout an economy.

Traditional Economics has never been able to explain innovation and growth except as the result of random exogenous shocks from technology.

Simulation Worlds

Traditional Economics uses mathematical proofs to model its theories. The benefit is that you can be certain of the rigour but one is restricted to simple assumptions such as perfect rationality. The new economics will turn to sophisticated computer simulations based on more realistic assumptions.

Organisational Structure

Old hierarchical structures are no longer sustainable in a complex adaptive world. There is a need to look at new structures of organisation that allow control and autonomy to coexist. Stafford Beer work is essential here.

We agree with all of this. In my courses, I have implemented the following modelling methodology which I think can apply to economics as well as other disciplines

Stage One. Dealing with complexity
- 1. 1 understanding of the system,
- 1.2 Defining the levels of recursion
- 1.3 Determining the key attributes of this structure.

Stage Two Building Qualitative Models
- 2.1 Determine major feedback loops
- 2.2 Analyse long 'and short term behaviour

Stage Three Building Quantitative Models
- 3.1 Build System Dynamic Models
- 3.2 Collect Data
- 3.3 Validate

Stage Four Measuring Performance
- 4.1 Identify the measures
- 4.2 Apply measures to the models
- 4.3 Explore different scenarios

Stage Five Applications at Different levels of Recursion
- 5.1 Combine individual models
- 5.2 Global evaluation
- 5.3 Draw conclusions

7. What's to be done

The thread of my argument is that Systems Thinking is looking for a place to reside in the university Structure and that Economics needs a firm dollop of Systems thinking. Is it not possible therefore to combine these two and solve both problems. In Sunderland, I have joined forces with an economist and over the last couple of years have had a productive time. My ideas are slowly percolating into that department. I think that more system thinkers should do this globally and publish their results.
Maybe a conference in the use of systems thinking in economics teaching could be organised. The ball is certainly in the system thinkers court as the economists have little motivation to change. The final objective would be to establish interdisciplinary departments at universities that would service many specialist subjects but this maybe many years into the future.

8 Conclusion

This paper examined the hypothesis that Economic Theory and especially economic teaching has not adapted to modern times. It remains rooted in a Newtonian paradigm and has become fossilised and inflexible. A new paradigm – the systems paradigm – is more suited to economic behaviour in the 21st century and should be incorporated into the major economic schools of thought. Two models for new economic courses, both heavily dependent on Systems Thinking are proposed.

A second paper at this conference gives details of an experimental course which attempts to do this

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