

An Integrated Social Fabric Matrix/System Dynamics Approach to Policy Analysis

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Abstract

All socioeconomic systems are characterised by a complexity of interacting influence patterns that would usually incorporate institutional, environmental, technological and behavioural relationships. The challenge for management is to develop a sufficiently detailed understanding of these influences in order to develop effective opportunities and mechanisms for control. This challenge is heightened by the tradition of 'partial' or non-holistic thinking that continues as the conventional wisdom in the management field. Though the imperative for holistic thinking is intuitively supported by most managers, the difficulties associated with implementing these ideas into management practice may be perceived as being 'too hard' or 'open ended' for practical application. System dynamics modelling is an appropriate process for developing an holistic understanding of any socio economic system. A realistic model can be applied to the development of management strategies and decision support. To a novice modeller, however, model construction can be an intimidating process lacking in the kind of systematic procedural support seemingly offered by the more conventional, non-holistic management school. To a large degree, the integration of the qualitative social fabric matrix with quantitative system dynamics presents a more systematic modelling process for practical application. The proposed amalgamation also yields some added conceptual insights into the nature of management processes and prospects for control.

Background To a New Management Conceptual Synthesis

The consideration of systems as holistic, feedback driven entities is a feature of both institutional economics and system dynamics. Key issues and effects are considered within the context of the whole system within which they operate. Only through their location in such a broad system context can the real nature of specific influences be really understood. In the context of management, the effective organisation and control of socioeconomic systems can really only proceed upon the basis of familiarity with those underlying processes of cause and effect that define system behaviour.

Witte (1954) has suggested that institutional economics is not so much a self-contained independent body of theory relating to the functioning of the economic system as it is a method of approaching economic problems. He defines the method as a 'practical problems' approach.

The central problem of institutional economics is the conceptualisation of organisation and control processes within the economy. Institutionists generally seek to construct 'pattern models' (or maps that define patterns of influence or causation within a system under consideration). Market performance and change is explained by placing participant behaviour in its institutional and cultural context.

The institutional economics framework is orientated to the elaboration of system causation or 'patterns of influence'. It is essentially a descriptive or qualitatively-focused domain with organisational change or evolution as its central focus. The central tenet of this framework is that prospects for system change cannot be considered from anything less than a holistic or systems perspective. System conduct and performance are considered to be the product of collective system influences that cannot be revealed through desegregation. A system is considered to be more than the sum of its parts. Market systems are perceived to be self-organising, emergent structures. There are no real axioms of behaviour; the 'rules' are as much the subject of change as the outward manifestation of the system itself. Institutional systems are inherently dynamic. Equilibria and their attainment are not important research issues. If they exist at all, equilibria are forever transitory and, as such, serve as unsuitable benchmarks to guide the development of directed or planned policy.

In more recent times, what will be described as a 'neo-institutional' school has emerged with some increased applied orientation. The boundaries surrounding this school would be the subject of controversy. The neo-institutional school would, in effect, be a suitable home for the entire conceptual/applied domain of system dynamics. Loosely located within the Operations Research domain, system dynamics models represent change as a function of the interplay between underlying patterns of positive and negative polarity feedback. Negative polarity feedback structures are consistent with stability or order while positive feedback is consistent with growth. The method can explicitly incorporate all those behavioural, institutional, technology and environmental aspects which are the major concerns of general institutional theory and, as will be discussed below, is strongly compatible with the applied focus of neo-institutional investigations.

Another currently non-aligned theoretical school that might fit within the neo-institutional framework is the more recent area of complexity theory. Colloquially described as an 'emerging science at the edge of order and chaos' (Waldrop 1992), complexity theory countenances system emergence as a dynamic process characterised by order or chaos. The central focus of this new area is the mathematical representation of systems as emergent, self-organising structures. A major theme is the sensitivity of systems which simultaneously incorporate positive and negative feedback relationships to stochastic events and to the detail of underlying system relationships. Change can be 'triggered' by even seemingly minor disturbances or developments. A number of investigators have considered change processes of this nature through system dynamics

simulation (eg. Radzicki, 1990, Mosekilde and Rasmussen, 1986). If a system is subject to 'complex' change, the implications for policy prescription and system control may be quite different from those that might apply to a non-complex system.

The author's major aim in this paper is to explain the conceptual and applied strengths ensuing from an alliance between institutional economics and system dynamics. This is not the first time that such an alliance has been proposed. Radzicki (1988) discussed the conceptual strengths of an alliance between institutional economics and system dynamics and described the product as 'Institutional dynamics'. While following the latter's general argument, the following discussion will focus on the development of an analytical process that draws on the strengths of that conceptual synthesis. In comparison with Radzicki's discussion, a more specific synthesis between the so-called neo-institutional movement and system dynamics is proposed. In effect, a powerful new tool is developed to facilitate resource management and policy investigations.

The Nature of Neo-Institutionalism

The institutional framework is particularly rich in terms of interpretive scope. Little guidance, however, is provided in the institutional literature regarding procedure. Ramstad (1986, p.139) observed that the main problem with the institutionalist framework is an unclear impression of how holistic principles might actually be integrated into an analysis. How does one actually do holistic work? Little guidance is provided on such practical issues. It is easy to be sympathetic with the frequently expounded view that institutionalist writings often approximate vagueness and unsupported speculation (a common criticism of the writings of John Commons; Seckler (1975), for example, provides a strong critique in this regard). The need to incorporate theoretical rigour into the institutionalist framework is a preoccupation of some components of the more recent institutional literature. It is (semantically) useful to classify adherents of the latter movement as neo-institutionists. Included in this group are Hayden (1982), Bush (1983) and Radzicki (1988). Nelson and Winter's (1982) work on evolutionary modelling also fits in here. These contributions are all considered in Gill (1993). The ensuing discussion in this paper will, however, focus on Hayden's social fabric matrix.

The Social Fabric Matrix

The holistic paradigm (synonymous with the institutional framework) may be represented by an influence map or matrix (Hayden 1982). Such a matrix is merely a systematic attempt to identify the relevant set of influences that shape the behaviour of a system. The matrix involves no statement about equilibrium or normative outcomes; nor may it be applied for deterministic prediction. It is merely a 'picture' of a system. If one wishes to examine the behaviour of a system, the matrix is used to qualify the nature of the constituent system elements and the linkages between them. The process of constructing such a matrix will force the investigator to assume a holistic perspective of the system being modelled. As an form of inductive investigation, the social fabric matrix provides a systematically applied treatment of the philosophical notions of institutionalism. Of course, any modelling process will involve some

abstraction from reality. However, when placed in an appropriately inductive context, the insights derived from an analysis will usually facilitate the development of effective management and policy plans. It is the nature of complex systems that at least some system detail will be beneath the resolution of any conceivable model. All models are abstract and all management systems may be fairly classed as complex (Stacey, 1993).

The appropriate currency for the valuation of modelling exercises of this nature is the strength or usefulness of the ensuing insights into system cause and effect for management planning and policy development (Hayden, personal communication). The social fabric matrix may also serve as a highly effective mechanism through which the dynamic interaction of participating system actors might be harnessed towards the development of an overall shared understanding of the causes of identified resource management problems and opportunities for control. The matrix construction process may be managed as a participatory exercise with representation from all relevant interest groups. There are no real knowledge prerequisites to limit system actor participation. All that is required is skilled group facilitation.

An Applied Example of Social Fabric Matrix Modelling

A recent policy investigation undertaken by Gill (1993), will illustrate the concept and practice of social fabric matrix modelling. The relevant problem to be addressed is the apparent slow pace of development of the Australian pollination services market. In countries such as the USA and New Zealand, beekeepers derive substantial proportions of their income from renting hives for crop pollination. A great deal of research effort has been devoted to defining the technical benefits of managed pollination for specific crops. In many countries, various forms of legislation has been passed ostensibly to facilitate the smooth working of the market. The economic incentives to both the producers of crops benefited by managed pollination and beekeepers have been well documented. For example, Gill (1989) determined that paid pollination is, under most conditions, a highly attractive economic proposition for most beekeepers in comparison with honey production. Why, then, are most Australian beekeepers reluctant to become involved? Some general propositions identified by industry participants may be tested to address this question:

- (a) an agricultural system incompatible with intensive pollination requirements (the 'wrong kind of crops', for example);
- (b) an industry perception of inappropriate policy structures (the Government is holding the market back);
- (c) apparently low relative returns to the pollination activity (honey is consistently more profitable);
- (d) high 'hidden' transaction costs (priced and unpriced; it may, for example, be costly for a beekeeper or a grower to 'learn the ropes' of pollination practice);

- (e) apparently incompatible beekeeper behavioural characteristics (beekeepers may not like being tied to a second party via a contract; their independence may be 'compromised'); and
- (f) apparently incompatible grower behavioural characteristics (growers may not like to place too much dependence on beekeepers who might 'stand them up' if a good honey flow coincides with pollination).

The reactions of beekeepers and prospective pollination users to these and any other propositions they might be able to identify, may be considered through a social fabric matrix process. A somewhat simplified matrix is presented in Figure 1. The behaviour of any system may be described as the product of interaction between five sets of influences: institutional structures, technology, the environment or ecosystem, attitudes and beliefs, and values. Values are the basic behavioural givens of any system. Values define culture, religion and other components of an individual's basic socio-cultural makeup. Values are not easily changed; they are resilient to influence from other system components. They also determine or shape attitudes and beliefs. Unlike values, attitudes and beliefs are subject to influence from other parts of the system. They may, for example, be the target of directed change through policy. Patterns of cause and effect between these five influence groups may be circular, or, in other words, are shaped by feedback. The purpose of the social fabric matrix is to propose the existence of linkages between matrix components. Links may be described in physical, financial or abstract terms. Neither the strength of individual links or their constitution are described. The matrix is a purely qualitative construct.

The 28 elements in Figure 1 are arranged into the five general influence groupings: institutions, technology, environment, beliefs and attitudes (grouped together here for convenience) and values. A key to the various elements is provided at the foot of the matrix. Key institutions include various government bodies in addition to commercial and non commercial industry groups. The technology components encompass both beekeeping and crop production. Environment elements incorporate land (public and private), climate and seasonal conditions or outcomes. Beliefs and attitudes encompass a range of goals ranging from lifestyle to financial expectations. Other beliefs pertain to a widespread expectation of open access to public flora resources (within national parks and other public land) for all beekeepers. Finally, basic value structures incorporate the notion of beekeeper independence or control over one's own destiny. This last (labelled 'autarky') is a value expressed by many in the beekeeping industry to be in some conflict with the expectation for closer cooperation and contractual commitment associated with commercial pollination activity.

The final configuration of the matrix is less important than the process underlying its construction. Through building the matrix, the analyst will derive relevant insights into the cause of the problem under investigation. As a matter of procedure, the matrix is constructed through a process of consultation and interaction with system actors. The final product should reflect the thinking of the system's constituency, not just that of the analyst. A cell may either contain a '1'

Figure 1 Social Fabric Matrix to Explore the Evolution of the Honeybee Pollination Market

Receiving Components \ Delivering Components		Social Institutions										Technology				Environment			Beliefs					Values				
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
1	HBRDC	1	1	1	1	1	1	1	1	1	1	1	1	1						1	1	1	1	1	1			
2	State Agric Depts	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				1	1	1	1	1	1	1		
3	Other Govt Inst	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				1	1	1	1	1	1	1		
4	N Comm Plln Users		1	1	1	1	1	1	1	1	1	1	1	1						1	1	1	1	1	1	1		
5	Comm Plln Users	1	1	1	1	1	1	1	1	1	1	1	1	1						1	1	1	1	1	1	1		
6	N Comm Beekeepers	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			1	1	1	1	1	1	1	1		
7	Comm Beekeepers	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			1	1	1	1	1	1	1	1		
8	Un-managed Bees				1	1	1	1	1								1	1		1								
9	Ind Assoc	1	1	1	1	1	1	1	1	1	1	1	1	1	1					1	1	1	1	1	1	1		
10	Ind Plln Assoc	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			1	1	1	1	1	1	1	1		
11	Beekeeping Tech				1	1	1	1	1			1	1															
12	Grower Tech				1	1	1	1	1			1	1															
13	Plln Research		1	1	1	1	1	1	1	1	1	1	1	1						1	1	1	1	1	1	1		
14	Extension Tech		1	1	1	1	1	1	1	1	1	1	1	1						1	1	1	1	1	1	1		
15	Public Land						1	1	1																			
16	Private Land				1	1	1	1	1																			
17	Climate				1	1	1	1	1																			
18	Qual Seas: Phys				1	1	1	1	1			1	1	1	1					1	1	1	1	1	1	1		
19	Qual Seas: fin				1	1	1	1				1	1	1	1					1	1	1	1	1	1	1		
20	Income Goal				1	1	1	1		1	1	1	1	1														
21	Intergen Rel Goal				1	1	1	1		1	1	1	1	1														
22	Leisure Goal				1	1	1	1		1	1	1	1	1														
23	Lifestyle Goal				1	1	1	1		1	1	1	1	1														
24	Other Motivations				1	1	1	1		1	1	1	1	1														
25	Property Rights				1	1	1	1		1	1	1	1	1														
26	Autarky																											
27	Other Bkpr Values																											
28	Plln User Values																											

Key to matrix elements:

HBRDC: Honeybee Research and Development Council; **State Agric Depts:** State agriculture departments; **Other Govt Inst:** Other government institutions; **N Comm Plln Users:** non-commercial pollination users; **Comm Plln Users:** commercial pollination users; **N Comm Beekeepers:** non-commercial beekeepers; **Comm Beekeepers:** commercial beekeepers; **Ind Assoc:** industry associations; **Ind Plln Assoc:** Industry pollination associations; **Beekeeping Tech:** Beekeeping technology; **Grower Tech:** Grower technology; **Plln Research:** Pollination research; **Extension Tech:** Extension technology; **Qual Seas: Phys:** Quality of physical season; **Qual Seas: Fin:** Quality of financial season; **Intergen Rel Goal:** intergenerational relevance; **Other Bkpr Values:** Other beekeeper values; **Plln User Values:** Pollination user values.

or be empty. The presence of an entry in a particular cell indicates the existence of a direct relationship between the relevant row and column elements. Row items are arranged to 'deliver' to column items. In row 1, for example, the HBRDC (the beekeeping industry's research organisation) 'delivers' to state agriculture departments, other government institutions,

commercial and non commercial beekeepers and pollination service users and so on. These flows may be bi-directional. The constitution of these deliveries is not specified (in general, they may be either financial, physical or some kind of information flow). Various circular influence patterns may be observed. One of the major insights derived through such an analysis is the distinction between direct and indirect influence paths. Indirect influence paths are readily traced through the matrix. The distinction between direct and indirect causality may be important to the development of strategic policy initiatives. Direct paths may be the more cost effective and controllable target for policy manipulation.

It is possible to generate meaningful management or policy initiatives from a social fabric matrix analysis. By focusing on paths or patterns of influence within the system, the analyst will be able to better understand the likely chain of events flowing from specific initiatives. In addition, the approach emphasises the need for a multidisciplinary or collective process for policy development. Physical, financial and socio-cultural relationships may be all equally relevant to the overall specification of system behaviour. Individuals with skills encompassing this spectrum will be required for the development of strategies for system control.

One major observation in relation to the pollination market development problem is the very significant influence of participant attitudes, beliefs and values. The relevant rows corresponding with these items are very 'busy' in terms of entries or links to other system components. The nature and pace of change will be a function of feedback between the behavioural, physical and financial components of the system. An apparent imperative for management or policy is to in some way harness this feedback to facilitate behavioural change. Given the predominance of values in this feedback chain, the task will be very difficult.

As a qualitative construct, the social fabric matrix cannot be manipulated to investigate the evolution of influence patterns over time. If scenario testing is important to the development of management strategies, some kind of measurement is required. The structure provides a snapshot view of a system in its currently observable form. Though it may be possible to deduce the potential for forthcoming system developments through observation, little help is provided with regard to the interpretation of the outcomes of such events.

Integration of the Social Fabric Matrix and System Dynamics

The system dynamics modelling procedure has a long-standing tradition in the area of quantitative systems representation. The procedure can incorporate the same holistic dimensions as the institutional framework.

The social fabric matrix is a powerful process through which an investigator might develop insights into the nature of system functionality. As a qualitative modelling procedure, the emphasis is on the development of insights shared with actual system actors. The social fabric matrix may be regarded as a systematic system learning process. If some subsequent quantitative investigation is required, revealed system insights may be directly translated into a formal system

dynamics model for further exploration. The two procedures are highly compatible, in both conceptual and applied terms. Likely synergies include an extra degree of structure to what is normally a very open-ended system dynamics modelling process. The social fabric matrix has substantial utility as a 'brain-storming' device to set the general dimensions of the system under consideration. Through its translation into a system dynamics formulation, the chances of omitting important holistic components from the quantitative model are reduced. The system dynamics model is orientated to the articulation of relationships suggested in the static matrix formulation. Simulation is the operative procedure.

This prospective integration between the neo-institutional framework and system dynamics is, however, subject to some apparent compromise in that the former, and specifically the social fabric matrix, is potentially capable of a far more holistic representation of socioeconomic systems than any workable system dynamics representation. Though this limitation seems worthy of some concern, the practical import is likely to be small. System dynamics models can potentially be extended to capture sufficient detail for most investigations. Even the social fabric matrix may be perceived to be a compromise to the comprehensive holistic ideal of the traditional institutional economist.

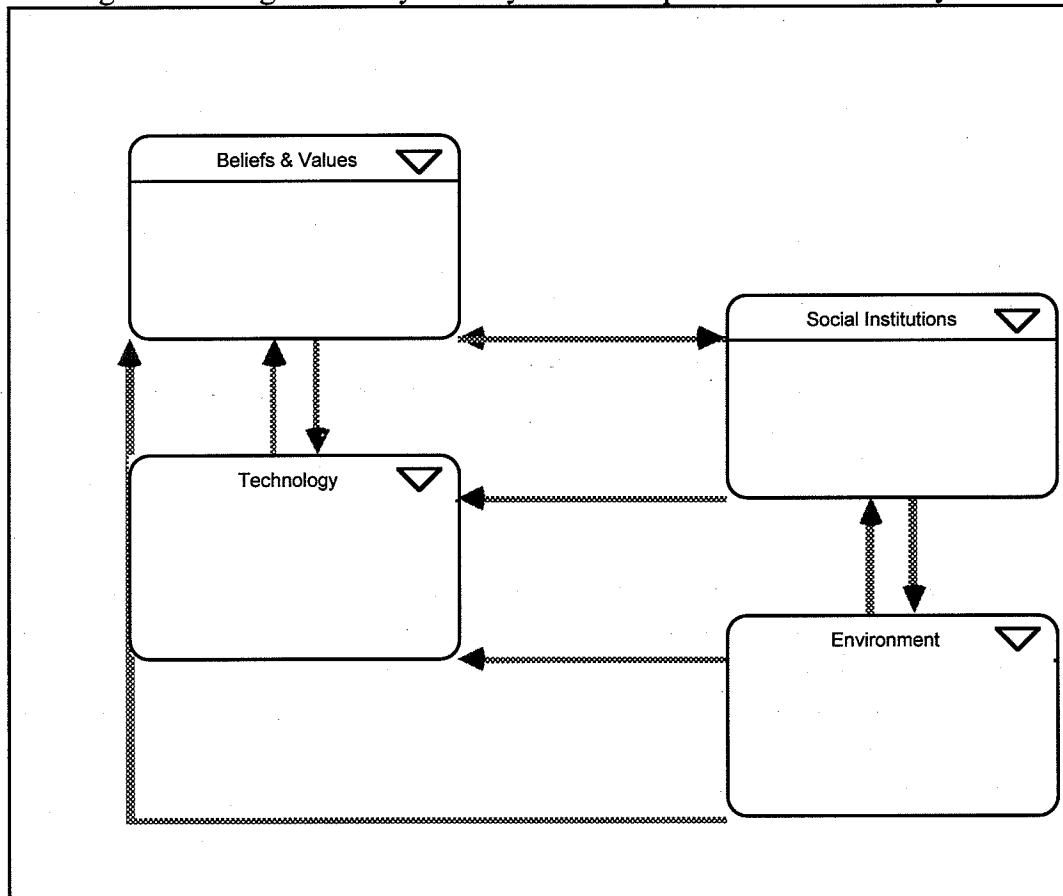
In practical terms, a social fabric matrix is translated into a system dynamics formulation through the quantitative representation of all the direct and indirect linkages identified through the matrix development process. An appropriate starting point is the development of a five sector system dynamics model; one sector for each of the five influence groups: institutions, technology, environment, attitudes and beliefs and values (or at least some combination of these groups). A high level system dynamics map of the preceding matrix is presented in Figure 2. For convenience, beliefs, attitudes and values have been aggregated into the one sector.

The significant influence of attitudes, beliefs and values to the overall behaviour of the pollination system was noted from the social fabric matrix. The subsequent simulation exercise confirmed this observation and helped in the development of strategic initiatives to affect change. In this case, the quantitative model served as mechanism for scenario testing. In institutional economics terms, the degree of 'ceremonial domination' (the prevalence of values over technological and/or financial incentives) was determined to be high, and would, more than likely render any conventional financial incentives based policy ineffective.

The quantitative system dynamics modelling phase, in effect, involves measurement of feedback links proposed in the matrix. This quantification is, ideally, based on hard data and the collective wisdom of the interactive group established to develop the matrix. Through the system dynamics exercise, it is possible to test or simulate identified development scenarios proposed through the preliminary matrix group discussion process. The result is a powerful qualitative/quantitative process to guide the development of management policy. If, as is recommended here, a group consultative processes is instituted for the matrix development phase, participant empathy with the investigation will continue through the quantitative system dynamics modelling phase to the

interpretation and implementation of results. The combined system investigation process will be an effective implementation of holistic policy development.

Figure 2 High Level System Dynamics Map of the Pollination System



Conclusions

Both the social fabric matrix and system dynamics procedures share a similar conceptual foundation. Institutional economics is orientated to the development of understandings about system cause and effect or influence patterns. The basic notion is that system management can only proceed upon a sound understanding of this underlying causation. There are no unrealistic axioms to describe human behaviour; management functionality, for example, needs to be placed within an appropriately holistic context. The social fabric matrix is a systematic procedure for identifying and developing system insights. It is, in effect, an institutional pattern modelling procedure. It may also serve as a structured process to facilitate the active participation of system players in policy development. System dynamics is another kind of pattern modelling, usually orientated to the quantitative representation of systems for simulation analysis. Qualitative relationships identified through the social fabric matrix process can be translated into a system dynamics model formulation. As a two part procedure, a preliminary social fabric matrix is applied to systematically explore the insights of system players and represent them in

an entirely qualitative construct. These insights, when translated into a formal system dynamics model, can be manipulated to address the concerns, expectations and ideas of system players towards the development of management strategies and policies with which they have some empathy. The strengths of each procedure are enhanced through such a synthesis.

References

- Bush, P. D. 1983. An Exploration of the Structural Characteristics of a Veblen Ayres Foster Defined Institutional Domain. *Journal of Economic Issues* 17(1): 35–66.
- Gill, R. A. 1989. *An Economic Evaluation of Alternative Management Practices and Enterprise Structures in the Australian Beekeeping Industry*, Department of Agricultural Economics and Business Management, University of New England, Armidale.
- Gill, R.A. 1993. *The Honeybee Pollination Market as a Self-Organising , Emergent System* unpublished PhD thesis, UNE, Armidale.
- Hayden, F. G. 1982. Social Fabric Matrix: from Perspective to Analytical Tool. *Journal of Economic Issues* 16(3): 637–662.
- Nelson, R. R. and Winter, S. 1982. *An Evolutionary Theory of Economic Change*. Cambridge: CUP.
- Radzicki, M. J. 1988. Institutional Dynamics: an Extension of the Institutionalist Approach to Socioeconomic Analysis. *Journal of Economic Issues* 22(3): 633–665.
- Radzicki, M. 1990. Institutional Dynamics, Deterministic Chaos and Self-Organising Systems *Journal of Economic Issues* 23(3): 633–665.
- Ramstad, Y. 1986. A Pragmatist's Quest for Holistic Knowledge: the Scientific Methodology of John R. Commons. *Journal of Economic Issues* 20(4): 1067–1105.
- Seckler, D. 1975. *Thorstein Veblen and the Institutionists: A Study in the Social Philosophy of Economics*. Boulder: Colorado Associated University Press.
- Stacey, R. D. 1993. *Strategic Management and Organisational Dynamics*. London: Pitman Publishing.
- Waldrop, M. M. 1992. *Complexity: The Emerging Science at the Edge of Order and Chaos*. London: Viking.

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Witte, E. E. 1954. Institutional Economics as Seen by an Institutional Economist. *Southern Economic Journal* 21, October: 131-40.