EuropeanFSRE2000
Volos

Draft 1

A CRTICIAL REFLECTION ON FARMING SYSTEMS AS ADAPTIVE , EVOLUTIONARY, AND LEARNING SYSTEMS: A THEORETICAL EXPLORATION

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December 1999

A paper to be presented at the Fourth European Symposium on European Farming and Rural Systems Research and Extension, in Volos, Greece, April 3 to 7, 2000.

Workshop "Learning processes in research and extension".

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Janice Jiggins and Niels Roling

Abstract

The paper deals with cognition, traditions of understanding, social cognition, and social learning. It uses these concepts, and the biological understanding on which they are based, to critically reflect on adaptive management of farming systems and rural change, and the potential of social learning as the basis for 'ecological rationality'.

Key words: cognition, traditions of understanding, social cognition, and social learning

1. **What this Paper is About**

The starting position of this paper is based on a generalised snapshot of where we are:

- the management of agriculture, or plants, animals, forests, water, or soils by farmers is no longer the major centre of the management activity required to put food on our tables: an increasing proportion of what we eat and drink and use as fuel or fibre is managed through manufacture from component fractions and/or the products of chemical and industrial processes, and along extended chains of market-mediated supply and demand;
- profit is taken through value adding, not primary production; an increasing proportion of the value added is controlled by non-farm interests; farmers are becoming dependent contractors whose farming system choices are beholden to other decision-makers;
- rural communities can no longer survive on the back of farming; a relatively few farmers can produce sufficient to meet demand in competitive markets; non-farm agro-industry and food industry employment is greater than farm labour requirements; much of this employment is located in urban areas;
- industrial farming's profits equal or exceed its costs to human health, animal health, the biological and physical environment, and of pollution;

and a more speculative picture, none the less empirically grounded in senior executives' statements, of where they expect us to be in ten years' time:

- global food retailing controlled by five transnational companies;
- patents on the genetic material of the world's marketed crops, trees, farmed fish and livestock in the hands of three to five transnational companies;
- transformation of (parts of) food production into a manufacturing process, based on the bioengineering of artifical life forms;
- cheap mobile phones with cheap internet dial up service, widely available, and virtually costless data transmission no longer dependent on intermediaries or landline infrastructures;

- a majority of consumers far removed from agricultural or rural lifestyles, who no longer handle raw food, and who regard rural landscapes as the space for touristic and leisure pursuits, and urbanised values;
- a majority of consumers who do not know much about the way food is manufactured yet have various perceptions of what constitutes 'healthy' food, food safety, and healthy farming environments.

Many would seem to welcome such a future scenario, and maybe it could be accomodated within normal processes of change, were it not for the imperative of sustaining the productivity of the ecological functions on which human life depends.Whether by farming or by other means, the ecological services of landscapes hitherto used for agriculture, will need to be managed. In all events, the incipient trends indicate that the conventional relationships among research providers, advisors, and farmers are on their way out and that our approach to farming and rural sytems development is set to take a radical turn.

This paper examines the biological basis of *cognition* as offering a response to the challenges posed by the scenarios above. We have explored some aspects of this challenge in two recent papers (Jiggins and Roling, 1999a; Jiggins and Roling 1999b). While remaining somewhat sceptical about an exact homologous application of the findings of neurobiology, neural network research, and evolutionary biology to the social domain, we have found the lines of research sketched in the following sections to be frutiful in understanding *collective cognitive process* as a basis for systemic change.

2. **Cognition**

Maturana and Varela (1987, 1992), two Chilean neurobiologists, carried out a pioneering study of the visual and neurological apparatus of 'seeing' in frogs and, more generally, on animal percpetion. A key finding is that it is impossible for biological organisms to directly apprehend the world (the mind is informationally closed). People, as all other biological organisms, are structurally coupled to their environment via triggered response mechanisms. The coupled structure co-evolves as people determine the world they experience. It is the *duality* that evolves. The separate evolution of each, independent of the other, is not possible. And it is in this evolutionary sense we can state that *all learning is adaptive*. Thus to speak of social learning as 'adaptive management' is somewhat simplistic.The insights of 'adaptive managment' research (Gunderson et al. 1995; Berkes and Folke 1998) give us a *trajectory*, but no grip as yet upon goal-directed behaviour as daily experienced.

Because the biology of the mind is informationally closed, each person's *perception* of the world they experience is unique: we can have an experience in common but literally cannot share a common experience. The articulation and sharing of learning comes about through *languaging*; thus we bring forth *a* world (rather than reveal, as the tradition of normal science would have it, the nature of *the* world). Perception at a distance (through technology or theory), mediates and extends our networks of shared learning. But, it is important to stress, the brought-forth world is not *an arbitrary or idiosyncratic world*; it is grounded in constant empirical interaction with, and probing of, an environment.

3. **Traditions of Understanding**

An important complementary concept is that of *multiple traditions of understanding*, created between dualities that are alike with eachother but significantly different to others. Consider

the way that science works within intellectual traditions which serve both to offer new perspectives through the disciplinary doors that are opened, but also to constrain perception and understanding by the doors that remain closed to science or to particular disciplines. What Ison and Russell (eds.1999) call *first order change*, that is, change *within* existing traditions of understanding and practice, can be seen as both useful and necessary. But they argue for complementary commitment to *second order change*, that is, systemic change which brings about change in the structure of traditions. An analytic report of semi-structured interviews carried out by Ison with extensionists, middle managers and senior executives in R&D organisations suggests *that explanations of experience are explained in terms of experience*, and that "the generated experience always remains secondary to the world of daily living" (p.157). In plain words, the ways we understand the world are coloured by the world we experience; or, as Maturana and Varela would say, 'Knowledge is effective action in the domain of existence'' (1987, 1992).

What is the domain of existence ? We might say that it is composed of a *material* world (physical matter, energy etc.), whose behaviour and nature can be expressed in terms of invariant natural law; an *artificial* world (of manufactured things which do not spontaneously occur in nature); a *biological* world (of spontaneously self-reproducing phenomena); and a *societal* world (of conscious, reflexive thought and action). These are not entirely distinct structural domains; they are separable only by the acts of perception and languaging; as such, every 'community of knowledge', or Ison and Russell's traditions of understanding, may set different boundaries around what is the perceiving organism, and what is its environment.

Mary Douglas provides further insight into how traditions of understanding arise. In 1986 she published a path-breaking book about how social groups, and social institutions, develop and use a reasoning of their own. The basic idea is that individuals live and communicate within a social institution, where an individual finds vocabulary and references for thinking. Through daily communication, individuals converge toward the norms of the group they interact with, sharing the same vocabulary, modes of reasoning, and comparable values. Hutchins (1995) similarly researched the interaction among seamen on an US warship. He found each one knowing only part of the information needed to 'steer the ship', each with discrete formal tasks laid down in an Operations Manual, and yet together they formed a 'moral community' whose collective understanding ensured that the actions needed to *actually* steer the ship in fact occurred. It is this insight, into communities of knowledge, traditions of understanding, and learning groups, that at present is enriching the concept of *social* cognition. (Earlier psychological studies defined individual learning as a process of a person learning by him or her self, and social learning as a process of learning from someone else).

4. **Social Cognition**

In some respects social cognition theory seems to contradict adult learning theory (cf. Kolb 1984), in which individual experiences are seen to determine the individual's knowledge, and vice versa, via feeback among concrete experience, active experiment, abstract conceptualisation and critical reflection . However, Douglas argues that within social groups, through social interaction, individuals share concepts and reflections that can over-rule an individual's own experiences and observations. Indeed, this sociological observation has been tested and measured frequently in the laboratory, also by those, such as Ostrom (1992), who are interested in understanding how collective agreement can overcome individual selfish choices in the management of natural resources. This trait can of course have positive but also negative consequences. People can develop a 'group think' that is detrimental to the

achievement of their own purpose, or at odds with their own survival, because not empirically coupled to their 'domain of existence'. (It might be thought that our current economic thinking is an example).

Moreover, people are good imitators (evolutionary neurobiologists, such as Pinker 1997, would argue that this is reproductively fitting, since it has saved the costs to the individual of continually inventing an independent heuristic framework), and good at stabilising rule bases that are effective in the domain of action. Some definitions of 'an organisation' draw on this explcitly, seeing organisations as a functional expression of known behavioural regulartities or patterns, an extension of the human mind which frees up individual time to deal with other things. It allows behaviour to be guided *without an individual having any direct empirical evidence* that this is in fact the most effective way to behave. This might lead us to suppose that instituional change must involve methods and mechanisms for re-connecting key institutional actors to empirical enquiry.

There are further elements that can be fruitfully expored along these lines. The findings from research into the mathematics of networks, especially as these are being explored in neural networks, is revealing in more detail how the two tendencies, of 'group think' and 'imitation', can lead to counter-productive outcomes. It seems that *premature* sharing of new information, or *premature* development of dense inter-connectivity, leads the networked group to settle early into behaviours - patterns of interaction - which might not be the most effective available, or even, be detrimental to the achievement of the given purpose. By 'premature' here is meant early development of self-referential closure, before feedback mechanisms from the (social and/or natural) environment are adequately established. Self-referential conceptual knowledge that, even if not or no longer valid, lacks feedback mechanisms toward other groups and/or the natural world, is thus very difficult to change. These findings help us (among other things) to understand the methodological emphasis in second order research (i.e. change of systems, rather than first order change or change within systems), on (1) metaphor ('languaging' - acts of co-creating new descriptions of the world), (2) development of new (social and natural) feedback loops, and (3) the trans-formation of the structures within which learning takes place.

5. Social Learning

If adaptive management might be an inadequate label for capturing social learning, another line of research might help us to understand why social learning is not a sufficient mechanism for societal adaptation.[1] Evolutionary biologists suggest that, if a population can *only* learn, the signal from the environment which triggers learning gets attentuated as it is propagated through a population. Contrariwise, if everything is fixed in innate structure, populations cannot respond to new triggers (unless the innate structure just happens to be the configuration that is optimal). In neural network research optimal solutions seem to be reached quicker if networks display a *mix* of three states of connectivity: unchangeable (i.e pre-programmed or innate structures), changeable (through mutation and recombination of innate structure i.e by evolution), and learnable (i.e develop in the light of experience). Learning gives rise to a selection pressure which, through differential reproductive success, increases innate structure over successive generations, but never to the point of a fully

[1] Note from the dicussion so far that what is meant by 'learning' is not equivalent to a search for the 'truth', but rather for understanding that is fitting. The problems of existence are not those of science, and do not necessarily need the costly apparatus of science to resolve. It is this subject- and context-specific problem-solving that, Tooby and Cosmides argue (1997, cited in Pinker 1997), constitutes 'ecological rationality'.

programmed structure; with fewer connections to make, every element in the population learns the lessons of experience more quickly and there is less pressure to fix these through reproductive selection. Learning thus guides the evolution of structure (and not vice versa).

Giddens (1984) has made a sociological rather than biological analysis of structuration, pointing to *legitimation* (norms, rights), *domination* (allocation of resources and decision-making power), and *signification* (interpretative schemes, sense-making) as the three essential qualities of *historic*al evolution. In the sociological (as distinct from evolutionary) sense, *antecedence and context* are causative through *agency*, that is, *intentionality* and the ability to make a difference. It is the reflexive quality of intentionality, which so far as studies have thus documented appears to be unique to human beings, that, we argue, offers grounds for that systemic change in agricultural and systems is posible. The Santiago School of Biology captures the same thought in image of the 'Cognitive Triangle', the inter-play among Intentionality, Perception, and Action, in a given domain of existence (Maturana and Varela 1992; Capra 1996). The elements of the cognitive system translate quite neatly into Giddens' three elements of structuration, viz., legitimation, signification, and domination.

But here arises another part of the puzzle. In systems thinking, social and ecological systems in any given domain of existence, are organised hierarchically. Theories of hierarchy postulate that all sub-systems are encompassed in higher level systems; but that higher level (emergent) properties do not have *causal* power within the system that is obeserved. The causal forces operate at lower levels of hierarchy. Emergent properties are *descriptions* of features observable at the level at which they can be observed, and as such useful from the viewpoint of the observer seeking explanation at that level. The problem may be posed thus: importantly, people now dominate at *each* level of ecological hierarchy *except* at the basic physical levels. Explanation thus becomes recursive.

The fundamental causative details may turn out to be irrelevant, as the world itself has no need to know the details – it just goes on as it does because the details are the way they are. The counter-argument from reflexive narrative is that is precisely our *perception* of both detail and emergent property that may turn out to be decisive. We can change direction if we do not like where we are going. **If** the systemic effects of relationships at one level are believed to impact adversely on ecological functioning and structure at another level; and **if** we see that it matters to our survival that we make more appropriate choices about the scale at which adaptive management must occur; and **if** the desired features of a'domain of existence' (e.g a farming system, a rural community) can be created by a purposive learning group, **then** we have available instruments for renewal in social elarning which are complementary to those of policy and economics.[2]

A final consideration in this section is whether or not there is a mismatch between the size of effective learning groups and the size of the resource to be managed (or the hierarchical scale at which it needs to be managed). Evolutionary biologists such as Pinker suggest that the selective pressures which gave rise to our capacity for learning and languaging must have

[2] The Chicago School of economists' formula for dissolving the dilemmas of emergent property is to rely on market systems, which in their view can be relied upon to evolve rights, norms, and property regimes as needed to fix 'imperfect' action (domination) and to align intentionalities (signification) across hierarchical and temporal scales. Other economists, to be fair, see a greater role for the construction of incentive frameworks i.e. structures of rights and sanctions aligned to intentionality, or for the construction of intentionalities through e.g. service and product promotion and the instruments of policy persuasion. However, the circularity and fallibility of all three positions has been discussed already by us in Jiggins and Roling 1999 b.

operated primarily on small populations interacting only occasionally with others; any capacity for extending social cognition to larger scales of interaction must be exaptive (Stephen Jay Gould's term for capacities which accompany traits selected for other functionality). Researchers such as Andy Clark (1997) prefer to emphasise the cultural developments which extend the biological theory of mind, that is, of an embodied mind which has evolved under natural selection but which is embedded in an environment structured through cultural as much as natural forces.

It could be said that the cultural dimensions of collective cognitive process and social learning were exemplified in Seattle recently at the World Trade Organisation meeting. The protestors' experience of the concertation of languaging and learning, mediated by email and internet communication, surely marks a new era in the development of social cognition. Evident were both the mutiple traditions of understanding - of people speaking from experiences structured by divergent domains, - and the effort to co-create an experience in common through networking in a virtual domain, on hitherto unprecedented hierarchical and spatial scales.

6. Conclusion

In this article we have emphasised nested collective cognitive systems as the intentional, adaptive actor, rather than *farming systems* or *rural systems* or *knowledge systems*. Cognitive systems by definition are able to take effective action in a domain of existence. In as far as people in farming and rural sectors are taking actions divorced from the ecological characteristics of their domain, they are failing to be or act as effective cognitive systems – and neither they, nor others who depend on them, will survive. But the effective actor can develop an ecological rationality which subsumes instrumental and strategic rationality, within a moral community that takes responsibility for the trajectory in which the *duality*, of the cognitive agent and its environment, evolve as a single complex system. The pathways by which this might occur are *social learning* and *adaptation* of institutions and cultures through new definitions of intentionality and re-newed connectivity among people and people, and among people and their environment through purposively designed feedback.

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