Understandings and practices for a complex coevolutionary systems approach.

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Abstract: Based on an understanding that a co-evolutionary systems approach relies on the conservation of the structural coupling of human beings with the biophysical world, with each other and with other species, this paper describes four practices that researchers could employ if they wished to develop a systemic, co-evolutionary praxis (theory informed practical action): (i) rapid, multi-perspective appraisal; (ii) metaphorical inquiry (iii) social learning and (iv) systemic inquiry (an approach currently being researched as an antidote to living and operating in a projectified world). The understandings on which each of the practices is built is explored.

Rapid, multi-perspective appraisal has been developed in a series of research and consultancy settings over 20 years. It is based on the assumption that when engaging with complex situations individuals only ever develop a partial appreciation (because of their traditions of understandings and the boundary judgements that are made). This practice can be used to better formulate research questions, research design, stakeholder engagement and for systemic staff induction. Metaphorical inquiry has been developed based on the understanding that human beings live in language and that all language is metaphorical. Social learning is a new paradigm for natural resources management which moves beyond information provision, consultation and stakeholder participation to address the systemic complexity associated with multiple stakeholders attempting to transform their situations. The understandings on which these practices are built have profound implications for the practices of animal scientists as we face an uncertain future under the combined influences of human induced climate change, population growth, peak oil and ecosystem collapse.

1. Appreciating our context

At this historical moment when the evidence of widespread systemic failure is pervasive, ranging from financial to ecosystem collapse, there is good reason to reflect on our circumstances. The typical way to engage in such a reflection is to look outside ourselves at situations 'out there'. When we look we see and name peak oil, population growth, human induced climate change, poverty, social alienation and habitat destruction. We are very adept at analysing and naming problems or issues but we are not good at reflecting on what it is that we, as individuals, cultural groups, or as a species, do when we do what we do.

This paper is an invitation to the reader to reflect on what it is that they do when they do what they do. I acknowledge that many find this hard to do as the practices

associated with accepting the invitation are not commonplace in our daily living. Developing answers involves not only thinking but thinking about our thinking, or as I would have it, our doing! In this exploration of our contemporary context I want to draw attention to three matters: (i) how co-evolution is understood; (ii) how research as a form of practice is understood and (iii) how we choose to engage with situations, especially 'agriculture' and animal production situations. I introduce three heuristic devices, or conceptual models, as a basis for exploring our understanding of these matters. In the second part of the paper I introduce four forms of practice developed in research with colleagues and students. These are practices I consider relevant to purposeful practice as we attempt to innovate in managing the circumstances of our co-evolutionary future. I conclude by drawing out some implications for sustainable animal production systems in particular.

1.1 Adaptation as co-evolution

From my perspective the greatest challenge we as a species face is whether or not we can conserve, over time, our structural coupling with the biophysical world, with each other and with other species in a manner that has elements of quality. Structural coupling is a term which describes the co-evolutionary trajectory of a structure determined system with its medium or niche (Figure 1; Maturana and Varela 1987).

Understanding structural coupling involves the ability to distinguish between domains, and in so doing taking a 'double look'. This also involves relational thinking. In Figure 1 the "observer eye", commonly used by Humberto Maturana (see Maturana 2007), makes the point that the observer is always part of the system or the description, and that we can take different looks. As Bunnell (2008) points out: 'the circular arrow represents a living system in recursive autopoiesis, (its constitutive domain, or physiology). The living system as a whole also has a reciprocal adaptive relationship with its niche (its relational domain or behaviour).' Thus 'a living system cannot persist as such without conserving both. Yet we cannot claim that one causes the other, nor can we explain either in terms of the other, even though what takes place in one does alter the dynamics of the other. Pedagogically this figure serves as a touchstone for noting the difference between the generative domain and the phenomenal domain – and for recognizing that confusing these looks leads to troublesome misunderstandings'.

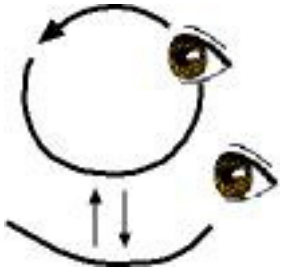

Figure 1. Two looks of an observer in noting the generative domain, or the resultant phenomenon in a different domain. This figure depicts Maturana's iconic representation of a living system that remains conserved as such as long as both autopoiesis and adaptation (structural coupling) persist (Source: adapted from Bunnell 2008).

The nature and dynamics of relational thinking and co-evolution can be understood through exploring certain phenomena and metaphors. Consider the question: How is walking conserved over time as a practice? From a relational thinking perspective the best answer is that the relationship between an organism (moving its legs in a particular way) and a medium (e.g. the floor, path etc) is conserved. Walking as a practice arises in the relationship between the two.

Collins and Ison (2009) note that the word 'adaptation' has always been important in scientific fields associated with evolution, ecology and environmental change. At the level of metaphor two possible conceptions of 'adaptation' are possible. Both have significant practical and policy implications but the implications differ. The first metaphor, and the most widespread understanding, is that of 'adaptation as fitting into'. In this metaphor something (predetermined) is fitted into a situation (also predetermined or knowable in advance) to which it is fit-able or suited, like when doing a jigsaw.

The other metaphor is that of 'adaptation as a good pair of shoes'. This metaphor requires a little more explication. What makes a good pair of shoes at a given moment? Well, usually because you have worn them in, they are comfortable, flexible etc. But these same shoes may not be a good pair of shoes if you were to put them in a cupboard for a year before wearing them again. Why? Because your feet will have changed! Within this metaphor a good pair of shoes arises from the recurrent interactions between shoes and feet – this is an example of co-evolution. The process could be understood by expanding Figure 1 to depict the changing nature of structural coupling over time – a process in which there is mutual influence. For those who understand the dynamics of co-evolution, and are not so interested in shoes, then the metaphor is 'adaptation as co-evolution'. Rather than seeing adaptation as one way, co-evolution is different – the idea of a separate environment is set aside in favour of processes of mutual interaction which in human social systems can be seen as processes of learning and development (Ison 2009).

1.2 Research practice

The term praxeology means to develop a theory of practical action. This field of scholarship is, I contend, underdeveloped and in part accounts for why it is difficult to orchestrate effective action amongst individuals who have different disciplinary backgrounds (Ison 2008a). As a means of reflecting on what it is we do when we engage in research practice I want to present a general model of research as a form of practice (Figure 2). This figure is designed to be used heuristically. In its simplest form research practice involves a researcher with a framework of ideas (F), a methodology (M) and an area of concern (A)…a 'real world' situation. What more can be said about this conceptualisation? Well we can posit that many researchers, but not all, actively choose a theoretical framework from which to engage with their research questions ….for example complexity theory might be chosen as the theoretical framework from which to answer questions about a particular social situation. On the other hand epistemologically naive empiricists may argue, or imagine, that they come to situations as if they were theory free. Equally, social researchers who are theoretically adept may forget that the purposeful choice of any particular theory does not negate the understanding that as human beings with a

history they too have traditions of understanding which they bring forth in the moment, and that these, as embodied understandings, may be different to the theories they espouse in moments of rational reflection.

Most commonly the idea of methodology is associated with some form of rational choice and with this choice a range of methods and techniques become deployed. In Ison and Russell (2000) we argue that methodology, rather than being simply the logos of method, is something that has to be experienced where the key experience is that of the degree of coherence, or congruence between espoused theory and practice.

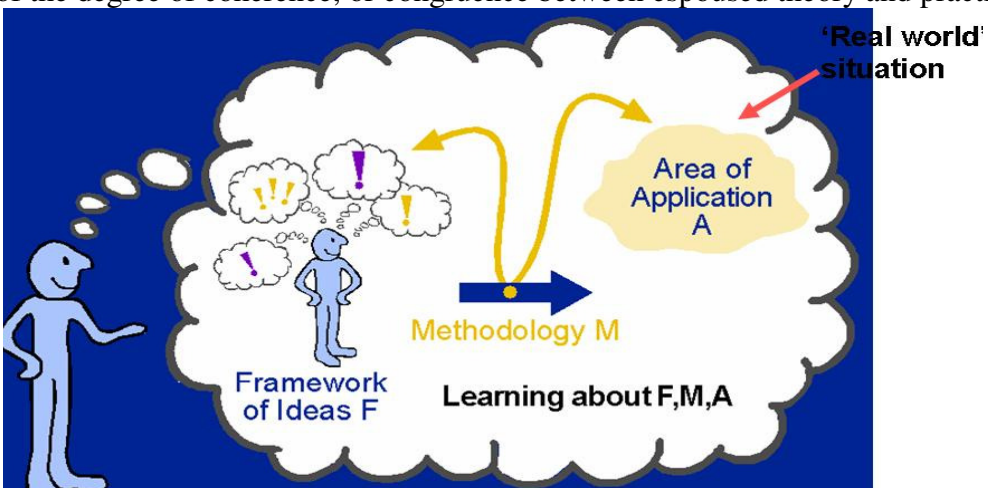

Figure 2. An heuristic model of research as a form of practice (Source: Blackmore, Ison & Jiggins 2007, following Checkland 1985).

In Figure 2 I retain the language of Checkland's (1985) original articulation of what he called the FMA model. Rather than 'area of concern' my preference is for the term 'situation'; this has a particular rationale which I describe below. For the moment let's accept that a generic description of research as a practice comprises a researcher (R) with a history, a tradition of understanding, possibly a chosen framework of ideas (F), a chosen M and a situation (A) in which the research is practised as a means of understanding, discovering, describing or changing something. If we consider Figure 2 systemically, as a whole then there are emergent properties of this practice; these include the possibility of:

- learning about each or all of F, M or A;
- considering the conduct of the research – the act of connecting F, M and A as a form of performance – e.g. how effective was the research (first-order effectiveness)?
- taking a meta or second order perspective on the researching system-environment relationship (as depicted in Figure 1 and in Figure 2 by the person operating at two levels);
- becoming aware that a limitation of the model is that it suggests researchers 'stand' outside the situation – which is not the case, even though we may act '*as if*' it were the case.

This heuristic (Figure 2) can be used to explore other aspects of research practice – by introducing more and different actors e.g. co-researchers etc; by reflecting on the implications of epistemological awareness , but perhaps most importantly, for

becoming aware of the nature of situations in which research practice is being conducted.

1.3 How we choose to engage with situations

There is a rich literature on the nature of situations. Historically the main predisposition of researchers has been to refer to the 'problem' without awareness of the literature on the social construction of 'problems' and the realization that the 'problem metaphor' also conceals the idea of opportunities. The nature of situations cannot be divorced from our own epistemological, theoretical and methodological commitments. Thus for some researchers the situation of interest is a reality independent of the observer in which some phenomena or a phenomenon is of concern. Others, as exemplified within the field of systems scholarship, have coined neologisms to describe situations with particular features. Ackoff (1974) distinguished between messes and difficulties; Rittel and Webber (1973) between wicked and tame problems and Shön (1995) between the 'swamp' of real life issues and the high ground of continued 'technical rationality'. What is interesting is that all of these authors were 'planners' and they coined different terms to describe what was basically the same set of phenomena that they had experienced.

A more recent neologism, beginning to be conserved amongst researchers who claim commitments to 'complexity theories', is the 'complex adaptive system' (e.g. Plsek & Greenhalgh 2001; Ison & Schlindwein 2006). From my perspective this is best seen as part of a lineage of responding to situations which are experienced as uncertain, complex, contested, interconnected (see Steyaert & Jiggins 2007) by the practice of coining a neologism and reifying the situation as 'some thing'. From my perspective what makes this particular set of neologisms interesting is that they all characterize a particular type of situation in which most forms of contemporary practice – across all domains – seem inadequate. Climate change adaptation is a case in point as well as hunger, food security etc. Ison (2008a) also suggests that taking up and institutionalizing trans-disciplinary research within the current national and international R&D systems can also be considered in this light.

Ironically, forty years after Rittel and Webber (1973) first coined the term 'wicked problems' there are well argued exhortations to develop capacities to manage 'wicked problems' beginning to appear in policy circles (e.g. APSC 2007). These exhortations may, or may not, be linked to the need to introduce complexity and systems thinking perspectives. At one level this is well and good. However, there is a trap awaiting the unwary. The trap arises from the practices of neologising and reifying (which also includes categorizing and typologising); without awareness these practices can produce unintended consequences. In many areas of human endeavour the act of categorization is common – in research practice the development of typologies is common. Although sometimes useful the act of reification and the circulation of the products of reification in academic discourse in particular leads us to lose sight of how these 'things' came into existence and, further, the validity or viability in contemporary circumstances, of their on-going use. This in turn can blind us to the choices we can make, and thus the responsibility we have, for how we engage with situations. At its simplest we can choose to engage with a situation as if it were a

mess, difficulty, complex adaptive system, wicked or tame problem etc but each choice brings with it different consequences.

Let me exemplify these claims by exploring how we can choose to engage with agricultural situations and thus with practices designed to generate sustainable animal production technologies and practices. In this section I draw on the innovative and radical ideas that informed the development of student-centred learning approaches at the former agriculture faculty at the University of Western Sydney (Hawkesbury) (Bawden et al 1985).

How agriculture is conceptualised determines how agricultural research is framed and thus what constitutes an innovation – a change for the better. Building on agroecosystems analysis (Conway 1985) and Checkland's (1999) concept of human activity systems a model developed at Hawkesbury (Bawden et al 1985) and used for teaching and research for many years conceptualises dynamic autotrophic (plants), heterotrophic (animals) and decomposing sub-systems being managed but managed for a social purpose (Figure 3). This conceptualisation enables an exploration of the question of purpose (of research, farming, cropping animal production etc) and how purpose for farming systems is attributed differently by different stakeholders. Because we each have different histories and thus mental models, the question of purpose underpins conceptually many of the issues associated with participation. In the past, researchers have often mistakenly attributed purpose (e.g. profit maximisation in the case of farm management economists) in isolation from those affected by their attributions. Similarly dairy scientists have, from my perspective, too often focused on optimising rumen efficiency at the expense of herd or whole farm viability and sustainability (see Pearson & Ison 1987).

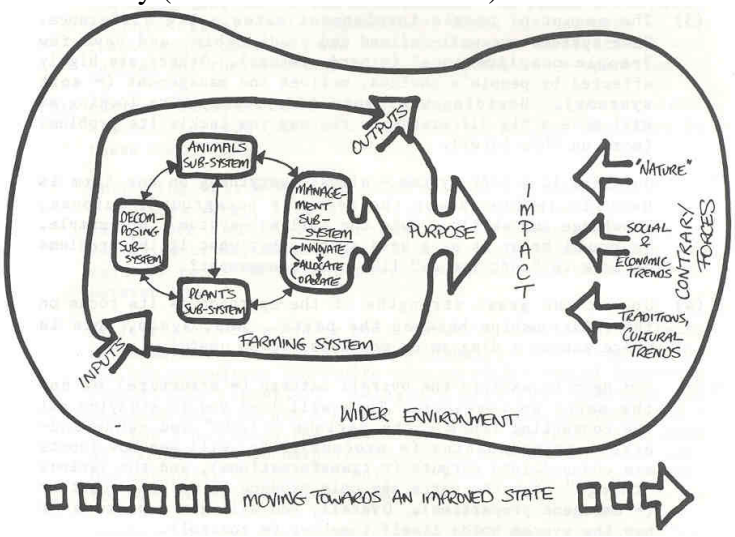

Figure 3. A version of the Hawkesbury conceptual model of farming as a human activity system depicted as a system co-evolving with a changing environment (Source: see Bawden & Packham 1987).

The other feature of note from the Hawkesbury conceptual model was the coupling of a farming system with a wider environment which together changed over time - an example of co-evolution not adaptation to an environment (Ison, 2003). In Figure 3 a number of forces are depicted as 'impacting' on this co-evolutionary process (in later versions of the figure these were changed to double-headed arrows in recognition that

'forces' had the potential to act in different ways). This conceptualisation contrasts with understandings of agriculture or farming in which implicitly or explicitly the only measure of performance is productivity (or efficiency) and agricultural practice or agricultural enhancement is seen as purely a scientific or technological endeavour. Exploring this model, i.e., using it heuristically, enables different stakeholders to reveal how they are conceptualising agriculture or farming as a system of concern. Engaging with questions of purpose also enables boundary shifts in thinking such as, for example, moving to a 'livelihood system' of which farming is part, rather than 'farming' being ***the*** system of interest.

My own early experiences of farming, international development and the innovations at Hawkesbury were important influences in shaping my research trajectory over the succeeding 25 years (see Ison & Russell 2000). In the next section I describe four practices arising from this 25 year programme that researchers could employ if they wished to develop a systemic, co-evolutionary praxis (theory informed practical action).

2. Practices relevant to a co-evolutionary future

2.1 Rapid, multi-perspective appraisal

Rapid, multi-perspective appraisal is a way of engaging with situations that acknowledges complexity and uncertainty and recognises that all human beings have traditions of understanding out of which they think and act (see Ison & Russell 2007). In part this research was inspired by the work of Robert Chambers and others who developed Rapid Rural Appraisal (RRA), later Participatory Rural Appraisal (PRA) and then later still, Participatory Learning and Action (PLA). My motivation however grew out of my own experiences of development failure (Ison & Russell 2000) and my conviction that similar phenomena operated in my own country i.e., Australia. I also became more aware of the social construction of problems and how, all too often, these were formulated from a narrow, non-systemic perspective that led to research that was either irrelevant or not utilised. A particular limitation that soon appeared to me in my academic career was the limitations of narrow disciplinary perspectives (Figure 4).

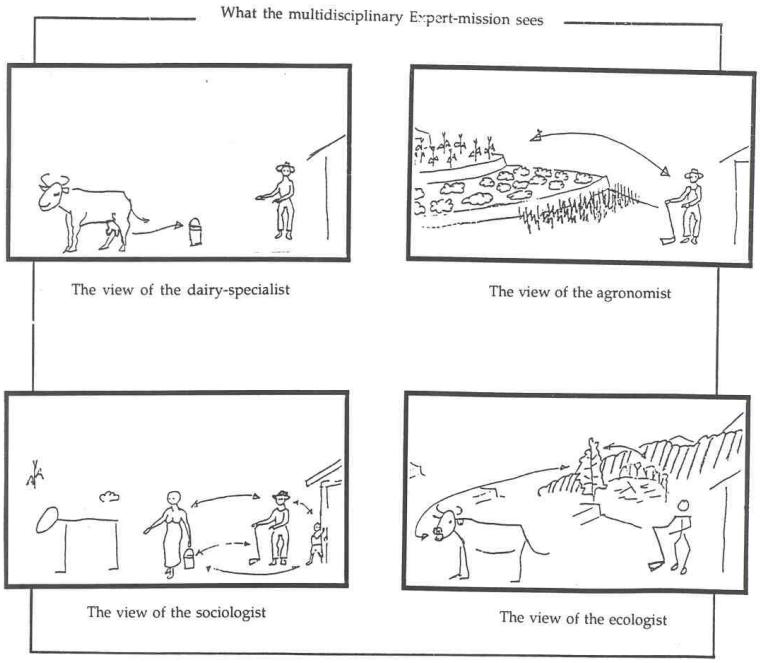

Figure 4. A series of abstractions from a particular situation from the perspectives of disciplinary experts. One can add these perspectives together (multidisciplinarity) or actively synthesise or articulate the implications of the differences (interdisciplinarity). (Source: Adapted from Pearson & Ison 1987).

In our adaptive research on RRA and PRA we were able to successfully design and conduct multi- and interdisciplinary engagements between different disciplinary experts and local people and thus to: (i) value different perspectives and knowledges; (ii) better understand the systemic dynamics of local situations; (iii) build stakeholding in research activity; (iv) remove commonly held misconceptions held by city- based experts about rural realities and (v) develop more appropriate research hypotheses systemically situated in the lives and circumstances of the intended beneficiaries (e.g. Figure 5; Ison & Ampt 1992; Ampt 1993; Webber & Ison 1995).

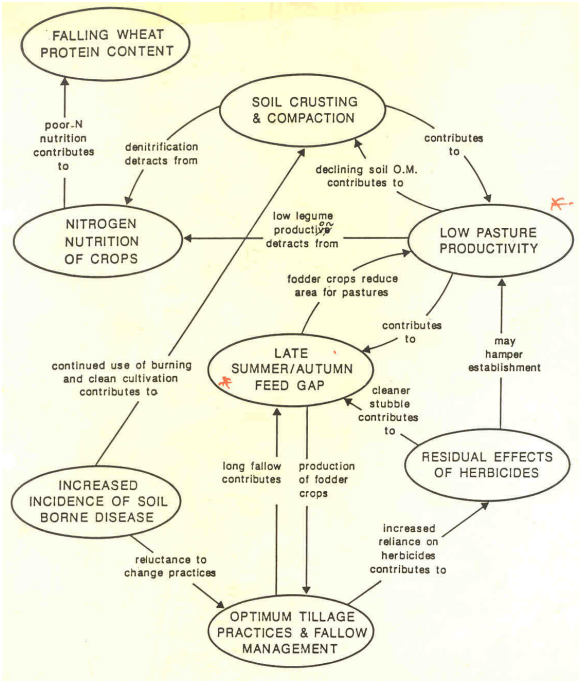

Figure 5. The basis for a research programme: a conceptual model of the systemic factors giving rise to a late summer-autumn feed gap for livestock derived from a PRA conducted in the Forbes Shire, NSW (Source: Ison & Ampt 1992).

Designed and managed appropriately rapid, multi-perspective appraisal can be a means to generate co-researching relationships and to generate genuine interdisciplinary collaboration. It can also become a means to break out of the limitations of the linear transfer of technology trap (see Ison & Russell 2007). This work has been further developed for use in organisational settings such as for staff induction (Armson et al 2001). Because our approach is inquiry based and recognises the complexity of the situation, systemic understandings of an organisation can be built, as well as personal networks, which increase staff effectiveness. The traditional induction model falls into the trap that considers there is a single, knowable organisation which can be introduced to new staff by senior management.

2.2 Metaphorical inquiry

Ison (2005) and McClintock et al (2004) outline the nature and rationale for our research on, and with, metaphor; this research is also built on an appreciation of the last 30 years of cognitive science research and the propositions that all human beings live in language and that all language is metaphorical. Our concern has been to develop ways of appreciating and working with metaphors in which the broader research agenda has been to develop a praxiology for systemic environmental decision making in the context of sustainable development through systems practice (McClintock 1996; McClintock et al 2003; 2004; Helme 2002; Ison 2002).

McClintock (1996) elaborates on how we understand and use metaphor. His starting assumption was that different 'countrysides' could emerge from different ways of working with people because an explicit focus on metaphors and researching with people provokes different understandings and practices. His research began with the

proposition that considering different metaphors is a way of appreciating diverse understandings and creating opportunities to learn for participants - to become both responsible and response-able. It is also a way of exploring the context of a situation before formulating problems or opportunities for purposeful action, a basic starting point for systems practice for environmental decision making (Blackmore and Morris 2001). Metaphors provide a way to understand our understandings and how we use language because our ordinary conceptual system, in terms of which we think and act, is metaphorical in nature. Paying attention to metaphors-in-use is a way we can reflect on our own traditions of understanding (McClintock *et al* 2003; 2004).

Metaphors both reveal and conceal, but because we live in language it is sometimes difficult to reflect on our-metaphors-in-use. The strategy of *mirroring* particular metaphors or metaphor clusters thus holds open the possibility for reflection and learning (Figure 6). For example, as outlined by McClintock (1996), the metaphor countryside-as-a-tapestry reveals the experience of countryside as a visually pleasing pattern, of local character and diversity, and of what is lost when landscapes are dominated by monocultures. However, the metaphor conceals the smell, danger, noise and activity of people making a living. By exploring metaphors, we can make part of our language use 'picturable' and thus rationally visible, publicly discussible and debatable, as well as a psychological instrument which can be a practical resource 'with which and through which we can think and act' (Shotter 1993). It may also be used to explore and trigger enthusiasms – where enthusiasm is a predisposition to action (Russell & Ison 2000b).

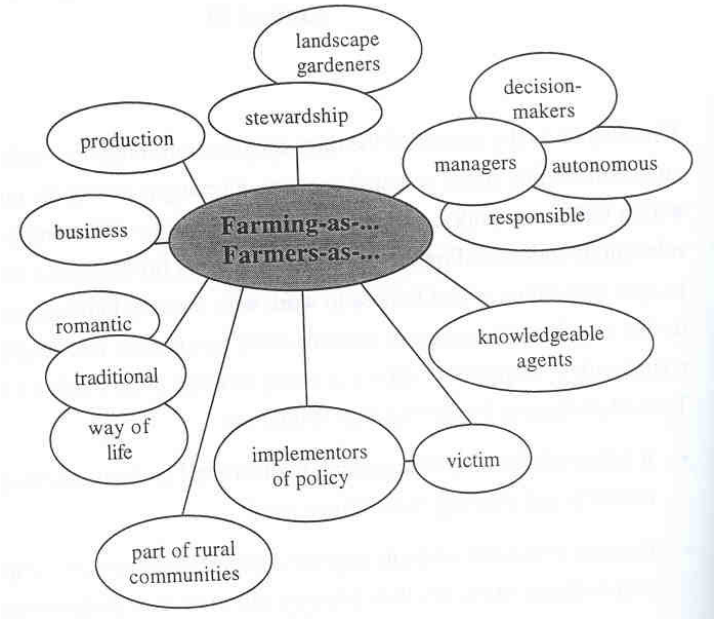

Figure 5. A metaphor cluster generated in England in 1994-6 where the metaphor is read as: *farming or farmer as*…… (Source: McClintock 1996).

McClintock's (1996) conclusions contribute to an agenda for meeting demands for increased transparency and participation in environmental decision- making. This in turn requires the building of social and relational capital through processes of social learning (see below). McClintock (1996) identified two parallel ways for working with metaphor: acting as practitioner–narrator and practitioner–facilitator (practitioner

here can be translated as researcher, advisor, manager, community worker or government agent). The role of practitioner–narrator includes the following steps:

1. Make initial distinctions around the metaphors in present use (e.g. for landscapes, lifestyles, products, events).
2. Bring forth metaphors of the practice context.
3. Explore the metaphors by considering revealed and concealed aspects.
4. Judge enabling and disabling metaphors and identify alternatives.
5. Iterate, involving different people, different sources of metaphors, or different issues.

A practitioner–facilitator can use metaphors to create a space for understandings to emerge. A six-step process has been proposed:

1. Propose initial distinctions around metaphors and anticipate ways in which the distinctions can be meaningful.
2. Consider activities for jointly bringing forth and exploring metaphors (in workshops or on farm walks).
3. Consider activities to jointly juxtapose metaphors and consider what each metaphor implies and does not imply (a proxy for revealed and concealed aspects).
4. Revisit the distinctions around metaphors and propose further distinctions around judging metaphors, choosing between metaphors, and dominant and reified metaphors.
5. Consider activities to facilitate processes of 'moving between metaphors'.
6. Iterate steps 1 to 5.

Metaphorical inquiry can also be used to explore theoretical entailments of propositions, projects, policies etc. For example, in my work reported in Ison (2002) I engaged with policy makers responsible for a new 'knowledge transfer strategy' through a process of exploring their metaphors in use. From my perspective the policy proposed was designed to treat wicked problems as tame and was thus unlikely to work. It was my action of being highly critical of the policy in a public forum that led to my invitation to come and speak to the Ministry officials. This dynamic is important – it is what I call the 'politics of invitation' (see High et al 2008) – as it creates the underlying emotional dynamic that unfolds. My method led, as I had hoped, to a very authentic conversation (see Guba & Lincoln 1985), one that was highly reflexive, and thus unusual among the five or so people involved. From my follow-up evaluation it was evident that my approach had been effective in triggering reflexivity but it did not trigger any on-going relationship or set of activities. Boxelaar et al (2007) make the point that interventions that merely offer a critique that challenges the prevailing narrative settings can increase uncertainty (and one might surmise, cognitive dissonance). They argue for practices that "create an alternative narrative space in which people can place themselves, particularly practices that enable people to perform and enhance their identities within a context of change". It is not clear however, what practices can achieve this, nor do they give consideration to the effects of powerful institutional arrangements such as the 'project' i.e., our manner of living in a projectified world (see Ison et al 2007).

2.3 Social learning

For many years now there has been concern about stakeholder participation in R&D. This is a genuine concern but unfortunately many participatory approaches have been poorly managed or have not been judged effective by those involved. Based on my own experiences I have come to the view that participation is a necessary but not sufficient ingredient of systemic, co-evolutionary practices. For this reason we have turned our attention to social learning. As outlined by Collins & Ison (2006) 'while the 'social' in social learning refers to the collective process that can take place through interactions among multiple interdependent stakeholders who are given proper facilitation, institutional support and a conducive policy environment, the findings of the SLIM project suggest that social learning can be understood as one or all of the following (SLIM 2004):

1. The convergence of goals, criteria and knowledge leading to more accurate mutual expectations and the building of relational capital. If social learning is at work, then convergence and relational capital generate agreement on concerted action for managing complex natural resource issues. Social learning may thus result in sustainable resource use.
2. The process of co-creation of knowledge, which provides insight into the causes of, and the means required to transform, a situation. Social learning is thus an integral part of the make-up of concerted action.
3. The change of behaviours and actions resulting from understanding something through action ('knowing') and leading to concerted action. Social learning is thus an emergent property of the process to transform a situation.'

4 The title for a governance mechanism which policy makers can employ.

Social learning, like a good concert orchestra, is about creating an effective performance amongst multiple stakeholders. The key need social learning addresses is: how can an effective performances amongst multiple stakeholders in 'wicked problem' situations be orchestrated? This involves the transformation of complex situations to improved situations through changes in understanding and practices of those involved (Figure 6).

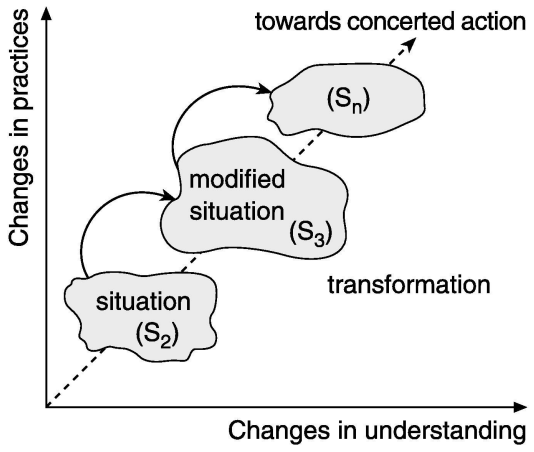

Figure 6. Situations characterised by complexity, uncertainty interdependencies, multiple stakeholders and thus perspectives can be transformed through concerted action by stakeholders who build their stakeholding in the process. This leads to changed understandings (knowledge in action) and practices (S = situation; Source: SLIM 2004a).

Systems-based social learning research provides one of the few theoretical and praxis (theory informed practical action) frameworks capable of dealing with 'wicked problem' challenges such as climate change adaptation and the global water crisis. This is an area for further research; we need to better understand how social learning and systemic approaches can be introduced and sustained so that they effect ongoing social and institutional transformations that are viable.

2.4 Systemic inquiry – an antidote to living in a 'projectified world'

Systemic inquiry is a particular means of facilitating movement towards social learning (see above). It can be seen as a meta-platform or process for 'project or programme managing' in that it has a focus on (i) understanding situations in context and especially the history of the situation; (ii) addressing questions of purpose; (iii) clarifying and distinguishing 'what' from 'how' as well as addressing 'why'; (iv) facilitating action that is purposeful and which is systemically desirable and culturally feasible and (v) developing a means to orchestrate practices across space and time which continue to address a phenomenon or phenomena of social concern when it is unclear at the start as to what would constitute an improvement. We have used systemic inquiry as a basis for a research contract with the Environment Agency (England & Wales) and as a conceptual model of how to structure and evaluate our research activities in a context that is dynamic, uncertain and with many interdependencies. In this research (see Collins, Ison & Blackmore 2005) we have found the use of particular project management methods (e.g. PRINCE2) to seriously constrain social learning and the systemic appreciation of what has to be done. Contemporary projects are designed for certainty, regularity, and the mistaken belief that all 'wicked problems' can be tamed within a project.

Systemic inquiry builds on, and extends Churchman's (1971) epistemological assumptions; it is concerned with the design of inquiring (or learning) systems and is grounded in various traditions of systems scholarship including second-order cybernetics and applied systems studies (Ison et al 2007). Churchman (1971) addressed the design of inquiring systems. He reflected that the tendency, then prevalent, was to bolster science and its research as the paradigmatic exemplar of an inquiring system. He rejected this and observed that '….reflective learning in the literal sense…. is the thinking about thinking, doubting about doubting, learning about learning, and (hopefully), knowing about knowing' (p. 17). He defined 'inquiry' as an activity which produces knowledge (p. 8); put another way inquiry facilitates a particular way of knowing which, when enacted, makes a difference. As Churchman (1971) observed, when exploring the metaphor of a 'library of science', the common definition of science as a systematic collection of knowledge is 'almost entirely useless for the purposes of designing inquiring systems……in other words knowledge resides in the user not in the collection… it is how the user reacts to the collection ..that matters' (p.10).

Systemic inquiry is an approach to managing complexity which is adaptive to changing circumstances and which draws explicitly on understandings of systems thinking, action research, cooperative inquiry and adaptive management. It is a key element of doing systemic development through which particular transformations – personal, social, situational – are realised (Ison et al 2007). There is still much more to

be done however in understanding how best to set up and institutionalise 'systemic inquiries' and to develop the praxis skills that are necessary to make them effective.

3. Implications for sustainable animal production systems

Part of my purpose with this paper was to create the circumstances for you to reflect upon what it is that you do when you do what you do. This inward look is far too rare in science and technology institutions. As I remarked earlier it is much easier to look outside ourselves. When we look we see across the globe many current or recent examples of systemic failure associated with animal production. These include: (i) BSE in the UK; (ii) distortions in global nutrient flows as exemplified by the transfers of nutrients in animal feeds from places like Thailand to the Netherlands (and the associated problems with nitrate pollution); (iii) ecological, economic and biological distortions in animal production systems that occur through practices such as feedlotting (see Pearson & Ison 1987); (iv) emerging problems with synthetic hormones in animal products; (v) the potential for emergent problems to arise from use of transgenic technologies; (vi) diversion of human or animal edible material to biofuels in the face of growing food insecurity; (vii) the positive relationship that arises between lifestyle diseases and intake of animal protein in the diet. There are undoubtedly more. Not all would agree that these are examples of systemic failure, suggesting that most are best thought of as 'wicked problems'.

In my experience a major contributor to this list of systemic failures is the lack of appreciation amongst researchers and technologists of what technology actually does in social systems. Too often technology is thought of as some-thing in isolation from a user and a context. Technology mediates our social relations and through its use changes who we are as well (Ison et al 2006). Adopting a systemic co-evolutionary perspective can help reframe research where, for example, technologies, such as a breed of cow, can be seen as a mediating object, which facilitates the emergence of new social asymmetries and social learning and at the same time delivers enhanced biodiversity outcomes (Steyaert et al 2007). Other examples include innovative use of institutional arrangements around animals as part of delivering ecosystem services (e.g. substituting native deer, and hunting, for beef production as part of a system to deliver high quality runoff for urban water in Texas).

The contemporary issues we face and the incidence of systemic failure suggest that in doing what we do there is no longer room to do the wrong thing righter! Conceptualising innovation in animal production as a systemic co-evolutionary domain is a means to acknowledge the inherent uncertainty, complexity, interrelatedness, multiple stakeholdings and thus perspectives present in animal production situations. This is a choice we can make. Research also exists showing that science and technology can exacerbate complexity and uncertainty. This strengthens a case for considering the understandings and practices I have outlined in this paper. However, undertaking this shift involves abandoning certainty and being open to inquiry and surprise. This is difficult for many. A temptation is to reach for a new theory or set of explanations, such as some of those proffered under the guise of complexity science, in the belief that they offer a new form of certainty (Ison & Schlindwein (2006). This should be avoided.

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