

A CO-EVOLUTIONARY FRAMEWORK FOR UNDERSTANDING TRANSFORMATION & RESILIENCE OF SOCIO-ECONOMIC SYSTEMS: THE EXAMPLE OF SOUTH YORKSHIRE MINING COMMUNITIES

Working Paper: J. McGlade, R. Murray, J. Baldwin, B. Winder, K. Ridgway

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1. Introduction

1.1 Problems in understanding evolutionary social systems

Ever since the advent of the social sciences in the 18th century, a key preoccupation has been the understanding of change and the evolution of social structures. However, such researches are complicated by the fact that the processes ultimately responsible for structuring long run societal dynamics, are both elusive and inherently unpredictable. At root this problem is concerned with the nature of causality and its solution lies in the difficult task of unravelling the complex array of micro-macro interactions linking individual purposive action to the larger scale collective processes that produce societal change (McGlade and van der Leeuw 1997).

From this it follows that the central issue in understanding socio-economic dynamics concerns the problem of emergence; i.e. the role of phenomena such as collective action or the spontaneous generation of new innovations. In our present context, this would include the propensity for social institutions and industries to generate options that are the result of unplanned outcomes. Thus any attempt to deal with the transformative aspects of social and industrial systems must acknowledge the important role played by initially, seemingly trivial or marginal events or decisions and their propensity to produce unintended outcomes over the long-term. It is in this sense that we can speak of the need for an understanding of history if we are to have any appreciation of socio-economic evolution.

The natural and social worlds we inhabit are replete with examples of the way that essentially arbitrary, or unintended features emerge to determine subsequent historical pathways. As Arthur (1988) has pointed out, the evolution of technologies, provides us with a number of examples where the role of chance elements create entirely new irreversible evolutionary trajectories. For example the first typewriter keyboard systems emerged in a competitive market, with the eventual dominance of the current QWERTY system being due more to the action of chance rather than strict technological advantage; in fact this system was inferior to at least one other of its rivals. In another example, Arthur discusses the role of *historical path dependence* and points to the importance of the role of both chance and necessity in directing the evolution of urban agglomerations. In explaining the historical evolution of urbanism at the regional level, he uses an analogy from genetics i.e. that chance events act to 'select' the pattern that becomes fixed, but regions that are economically attractive have an intrinsic 'selective advantage,' and thus have a higher probability of achieving dominance. These examples cited by Arthur might collectively be described as conforming to the 'QWERTY principle of history': historical, events that come together in an *unplanned* way, create inevitable and irreversible historical outcomes.

What is clear from these examples is that the nature of socio-economic change is far from trivial and is poorly understood by recourse to developmental evolutionist models that are predicated on notions of progressive unfolding (*cf.* Giddens 1979). Indeed, it should be noted that all societal systems are characterised by highly nonlinear interactions and recent discoveries of chaotic trajectories at the heart of many biological, ecological and environmental systems has caused a revision of our long held assumptions on the nature of order/disorder and by implication, causality itself. Perhaps the most important aspect of this theoretical realignment is that in underlining the essentially nonlinear nature of socio-economic relations, it foregrounds the importance of *instability* and *discontinuity* not as aberrant processes, but rather as key concepts for understanding the nature of social systems.

In what follows we shall attempt to demonstrate the importance of such a perspective for socio-economic systems generally and more specifically, so as to gain new insight into the evolutionary dynamics traced by the South Yorkshire coal industry, viewed as a complex co-evolutionary system.

2. Complexity and Socio-economic Systems

2.1 The nature of complexity

Recent years have seen the arrival of a new interdisciplinary approach to the analysis of complex, nonlinear systems and a gradual incorporation of these ideas into fields as far apart as chemistry, physics, ecology, urban and regional geography and the social sciences generally (see Edmonds 1996; McGlade and van der Leeuw 1997, and Byrne 1998 for useful reviews). As a new interdisciplinary field, Complexity Theory (Waldrop 1992, Kauffman 1995) is essentially concerned with studying the general attributes of nonlinear systems and chaotic dynamics. Complex systems are those systems "whose aggregate behaviour is both due to, and gives rise to, multi-scale structural and dynamical patterns which are not inferable from a system description that spans only a narrow window of resolution" (Parrott and Kok 2000).

While Complexity Theory may be fashionable at the moment, it must be remembered that the underlying principles are far from new. For example, the central ideas underlying phenomena such as chaotic dynamics, bifurcation, phase transitions and emergent behaviour, have a long history and form the core of studies in nonlinear dynamics and Complex Systems Theory (e.g. Thom 1975; Nicolis and Prigogine 1977; Haken 1977; Allen 1982; Thompson and Stewart 1986; Ruelle 1990). Among the most influential research has been that of Ilya Prigogine and colleagues (e.g. Nicolis and Prigogine 1977; Prigogine 1978, 1980; Prigogine and Stengers 1984) with their investigations of 'far from equilibrium' phenomena and the study of system transformation in terms of 'order through fluctuations'.

2.2 Complexity and social systems

While these ideas had been discussed in areas such as economics and anthropology (e.g. Arthur 1988; Adams 1988), it was not until the 1990's that the impact of complexity theory can be said to have made significant inroads into the social sciences generally. Specifically, this perspective and its central ideas have been viewed as having important consequences for conventional epistemological approaches (Hayles 1992; Reed and Harvey 1992; Gilbert and Doran 1994; Harvey and Reed 1994; Shermer 1995; Byrne 1998).

2.3 Complexity and sustainability

It is something of a paradox that despite the wide coverage and prominence of the theme, 'sustainability' yet remains an exceedingly ambiguous term, occupying a territory in which it appears to be 'all things to all people'. Any survey of the literature necessarily must conclude that sustainability is best described as having an 'elastic' meaning, eminently malleable and infinitely variable in usage. Thus it can be invoked to support a variety of positions depending, for example, on our valuation of natural and man-made capital (e.g. Faucheux and O'Connor 1998).

While the search for a comprehensive definition of sustainability is destined to remain elusive, what is clear, however, is that an important distinction must be made as to what kind of sustainability we are dealing with – be it environmental, economic or social – since each has a distinctive meaning as well as being relative to a specific spatio-temporal domain. But beyond the terminological confusion and slack usage, there are more fundamental problems which need to be addressed; for example, regardless of whether we are discussing resources, economies or societal systems, sustainability must not only be temporally and spatially defined, but most important, it must be contextualized with respect to specific political, ethical and social parameters (McGlade 2002). But perhaps most imperative, if we are to come to terms with sustainable outcomes from a complexity perspective, is to situate such issues within an

evolutionary framework. This will allow us to focus on one of the key aspects of sustainable systems generally, i.e. their resilience.

3. Resilience and Stability

3.1 Resilience

Despite its frequent usage by ecologists, economists and some social scientists, resilience is not a unitary concept with a precise and unambiguous definition. In the ecological literature, for example, it has two distinct meanings. The first emphasises stability, control and constancy (*engineering resilience*) – attributes of a desire for optimal performance, while the second, by contrast, focuses on persistence, adaptedness and unpredictability (*ecological resilience*) – attributes of an evolutionary perspective. These latter, for example are consistent with sustainability (Holling 1996). Research using a model of engineering resilience, deals with stability near an equilibrium state and is concerned with resistance to disturbance and speed of return to equilibrium (e.g. De Angelis *et al.* 1980; Pimm 1984; Tilman and Downing 1994). By contrast, ecological resilience focuses on conditions far from equilibrium and is concerned with the role of instabilities in pushing the system beyond a threshold or bifurcation point, to a new stability domain. Here, resilience is measured by the magnitude of disturbance that can be absorbed before the system changes structure (Holling 1973). A wide variety of applications exploring ecological resilience now exists, spanning resource ecology, wildlife management, fisheries, animal ecology and plant-vegetation dynamics (e.g. Holling *et al.* 1977; Walker *et al.* 1981; Walters 1986; Sinclair *et al.* 1990; Dublin *et al.* 1990).

Studies such as these have been instrumental in shifting the ecological debate from an evolutionary model based on the maintenance of stability, to one dominated by a sequence of interacting adaptive cycles based on a developmental sequence defined by four functions: exploitation, conservation, release and re-organisation (Holling 1986). More recently, these ideas have been extended to encompass the idea of *panarchy*, which emphasises the evolutionary nature of nested adaptive cycles, with each level going through the cycle of growth, maturation, destruction and renewal (Gunderson *et al.* 1995). A key emphasis in this model is that periods of gradual growth and rapid transformation not only coexist, but act to compliment one another (see also Günther and Folke 1993).

3.2 Resilience and societal systems

All socio-economic systems that can be seen to persist – particularly over long time periods – can be described as being characteristically resilient, in the sense that they are able to *incorporate* change and perturbation without collapsing. This ability to absorb changing circumstances as defined by environmental, social, political or cultural fluctuations is itself a function both of the flexibility of structural organisation and system history. The role of history is of crucial importance, in the sense that a particular regime that has been exposed to regular, periodic disturbance, will be more adapted to periodic change than a system which is visited by perturbation and/or extreme events on an irregular basis.

Any loss of resilience, will move a particular socio-economic system closer to unstable thresholds, causing it to flip from one attractor state to another (metstability); thus, for example, exploitation to extinction of a particular resource will have an effect on the local ecosystem, inducing system transformation and an irreversible change to an alternative state. Resilience can be said to be one of the primary properties of nonlinear, nonequilibrium systems and needs to be understood more fully if we are to come to terms with sustainable social-natural systems.

A major problem that we are faced with in pursuit of a model of resilience within the context of industrial development is that this cannot be deduced from conventional equilibrium approaches. However, neither can it be derived by the simple superimposition of Holling's (1986) resilience cycle for ecological dynamics. This general theory of ecosystem function - incorporating insights from hierarchy theory (Allen and Starr 1982; O'Neill *et al.* 1986) - has been argued as an appropriate basis for understanding the generic evolutionary behaviour underpinning ecological, economic and societal dynamics (e.g. Gunderson *et al.* 1995; Berkes and Folke 1998; Peterson 2000).

Notwithstanding the important insights that Holling's evolutionary model provides, its essentially 'organic' nature is an inappropriate model for capturing the complexity of socio-economic systems, in part because social systems are more than simply functional entities – they are defined by symbolic and cognitive attributes. In fact organic analogies for social systems are consistent with a long philosophical tradition. For example classical authors¹ as well as early Christian writers² emphasised the similarity between natural and societal dynamics, believing that societies could be understood by direct analogy with organisms, following a cycle of growth, maturity, senescence and death (Tainter 2000). Such ideas, implicit in the later work of historians such as Oswald Spengler (1918) and Arnold Toynbee (1962) held sway in the social sciences until the 1980s when their structural shortcomings, particularly the under-developed relation between agency and structure, as well as their inherent evolutionism, were critiqued by a number of sociologists and anthropologists, most notably Anthony Giddens. Importantly, Giddens (1979, 1984) provides a robust argument against the idea that societies 'adapt' to anything, since they are not equivalent to biological organisms (1979: 21). Instead, social change is seen as non-teleological – a set of contingent, discontinuous transitions which have no inherent developmental logic or pattern.

An additional problem in utilising ecological resilience as an analogy for societal systems, is that human systems are not *neutral*; they are an historical product of specific social, political and cultural relations: a factor running all the way from local relations of production to larger scale regional, national and global levels of interaction. Thus, if we are to attempt to isolate the important driving forces of irreversible change which represent a non-sustainable option for society - then we must situate such goals within a milieu that recognises, 1) all socio-natural systems (*sic* environment) are embedded in webs of power relations. and 2) these networks of power act to both enable and constrain human aspirations and desires. It is in the exercise of such power that the moral and ethical universe within which humans are situated, is subject to substantial modification and even destruction.

In summary, what we can say from the perspective of our focus on industrial dynamics, is that while resilience is a useful concept for understanding the long-term evolution of human-modified environments, it needs to be reconfigured to take account of the specific human and socio-political contexts that drive system transformation and change. In essence, we might summarise the main attributes of resilience from a socio-economic perspective as having the following characteristics:

- The amount of re-organisation and change a social system can undergo, while still retaining the basic institutional and socio-economic structures
- The degree to which the system structure is capable of self-repair and self-organisation

¹ Polybius (1979), writing in the 2nd century BC, when accounting for the defeat of Carthage by Rome noted: "Every organism, every state and every activity passes through a natural cycle, first of growth, then of maturity and finally decay". Thus, at the time of their original conflict, Rome was in the ascending phase of the cycle, while Carthage was in decline.

² The third century Christian writer Cyprian in a passage quoted in Toynbee (1962) deplores the cycle of senescence and decay that can be seen in the world around him as part of the natural order of things.

This implies:

- Institutional flexibility
- The conscious use of historical knowledge
- The desire to increase the capacity for knowledge production and learning
- Conscious management of change to incorporate uncertainty and unintended consequences

3.3 The resilience of industrial systems: The UK coal industry

In discussing the concepts of any system collapse and/or transformation, a clear defining issue in deciding the extent and nature of the altered system state is to what degree the observer is involved with that system. Consequently, knowledge is of great significance in understanding the true nature of growth/decline dynamics. In considering the case of the UK coal mining industry it is important to document the history, and in doing so, unearth some of the catalysts, political and otherwise, of the immense changes the industry has endured and the subsequent effects experienced by the communities and individuals who relied on this sole source of purpose and prosperity. Further to this, the concept of resilience is presented as a particularly useful tool in categorising different patterns of behaviour and change observed in industrial systems. An interesting and insightful comparison can be made in looking at the different circumstances surrounding the decline of both the British and German coal mining industries. A crucial distinction has already been made between engineering and ecological resilience. This is key to understanding how two very similar industrial systems dealt with change and the extent to which this change was eventually managed.

3.4 The history of UK mining and mining communities

Although open cast mining has been carried out in Britain from Roman times, it was the development of deep cast mining which became an integral and essential part of the Industrial Revolution. Coal powered this revolution and, with the development of the railways and the iron and steel industries, it was the only power source that could meet the enormous demands placed upon it by these new industries' needs. Its position therefore was pre-eminent and unchallenged. This situation remained unchanged throughout most of the twentieth century. During the Second World War, for example, mining was a 'reserved occupation', as the fuel the miners supplied was vital to the war effort. It became accepted by the wider community that miners were regarded as unique, in the sense of a special case, or somehow untouchable – beyond the reach of too much government interference. The existence of this belief on the behalf of the miners would eventually contribute to the industry's accelerated downfall.

Until 1947, coal mines were privately owned and, while the conditions for the miners varied considerably, they were generally harsh. This was in part due to the owners of the mines, but it was also affected by geological conditions, such as narrow seams. Coal was the principal fuel, and in great demand, so mine owners found it even remained profitable to work difficult seams. At this point, it is worth remembering that at this time the pre-nationalised and highly fragmented industry provided 90 per cent of Britain's energy. However, the impetus to nationalise in the Labour party's first term of post-war government came not so much from the desire to improve the miners' lot – although this undeniably played a part – but that, through nationalisation, the industry as a whole would benefit from the economies of large scale production. It was a direct development, or application, of what became the famous Clause IV of the Labour Party Constitution, which called for the 'common ownership of the means of production, distribution and exchange':

The premise of nationalisation in the 1940s was quite different – [it was] that as private businesses, these industries had under-invested, been inefficient, and lacked scale. As nationalised firms they would mobilise resources and adapt new technologies, they would be far more efficient, and they would ensure the achievement of the national objectives of economic development and growth, full employment, and justice and equality. (Yergin and Stanislaw, 1997 ed: 25-27.)

The process of ‘public corporation’ saw The National Coal Board appointed by the government to assume control over the industry until its remnants were re-privatised in 1994/5, at which point RJB Mining bought the major British Coal assets and became the UK’s largest producer. Two other businesses, Mining Scotland and Celtic Energy, were given localised shares of what remained of the industry at this time (EIA, 2001).

3.5 Decline of the industry

The decline of British coal mining continued without respite throughout the post-war period, although, of course, with a massively accelerating trend of decline since the 1980s as the effects of the availability of alternative sources of energy from the North Sea oil and gas fields became manifest. The near terminal contraction of the industry came with a series of pit closures in the 1980s and early 1990s. The scale of this more recent decline may be judged by the fact that in 1981 there were 211 collieries still working in Britain; this has shrunk to 14, (Fig.1) and several of these survivors are currently under threat. Over the same period, the number employed in the industry fell from 279,000 to fewer than 7,000 (Gore et al, 2000: 18) (Fig.2). Given the geological dictates of the coal-mining industry, epicentres of intense unemployment have therefore fallen on relatively few areas, but they are, of course, all the more devastating for that.

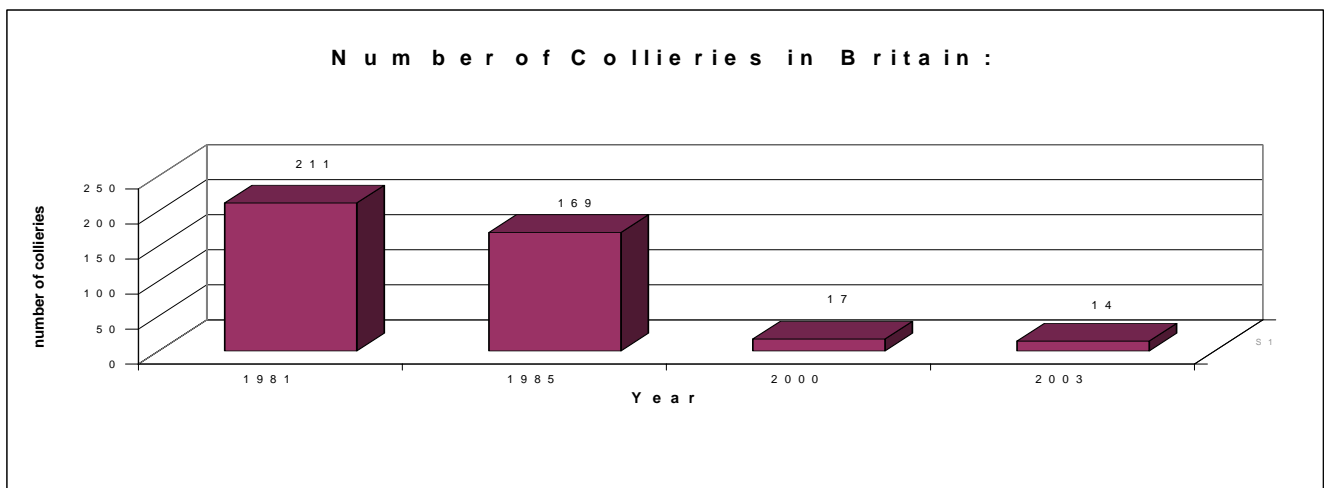


Figure. 1. Source:
 Gore, T., Dabinett, G. and Breeze, J. (2000) *Improving Lottery Funding Access and Delivery in the British Coalfield: Coalfields and Lottery Study Phase II. An Independent Report to the Department for Culture, Media and Sport and Lottery Funding Bodies*. London: Dept for Culture, Media and Sport. (Additional 2003 figure).

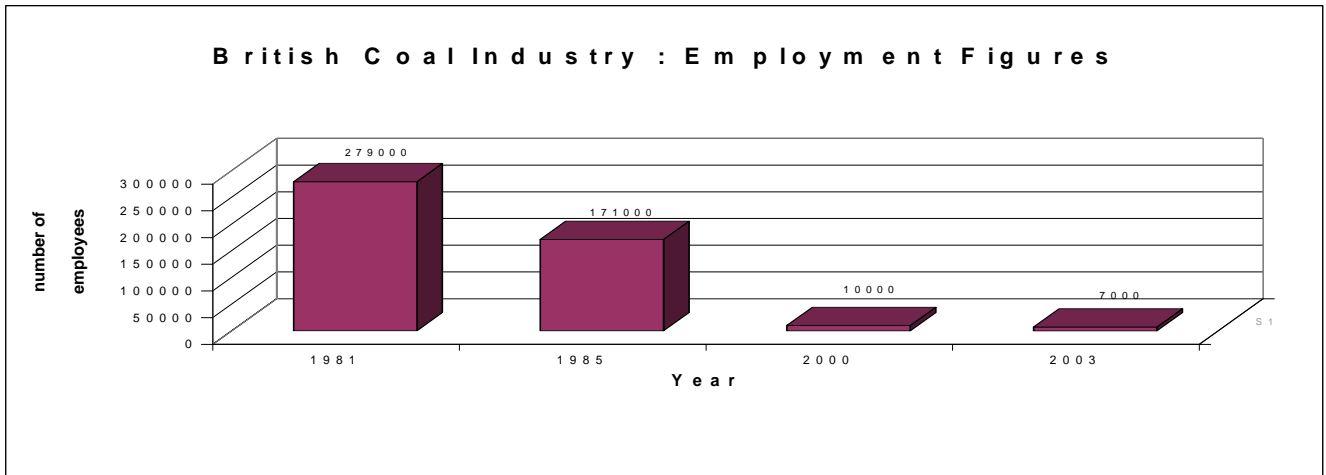


Figure. 2. Source: As above.

It should be remembered that the peak of mining employment was as long ago as 1928 although some job losses between that date and the Second World War – and also in the period immediately after – were due to the increased mechanisation of the industry rather than a reduction in demand and/or output of coal.

In terms of outputs, the dramatic decrease in coal production and consumption has echoed the downward plunge of numbers of collieries open and miners employed. In 1971, the UK produced 94 million tonnes of coal and other solid fuels and consumed 88 million tonnes. In 1981, the figures were 78 and 73 million tonnes, respectively. By 1991, the UK was a coal importer, producing 58 and consuming 67 million tonnes. By 1999, production and consumption had fallen drastically to 20 vs. 37 million tonnes (Fig.3). Ironically, although demand rose in 2000 to 38 million tonnes, the shortfall was met by increasing imports; the implication being that the rump of what remained of the industry was too stretched to be able to respond to the new demand at a price competitive with imported coal (National Statistics, 2002). What was left was just a shadow of an immense and powerful industry.

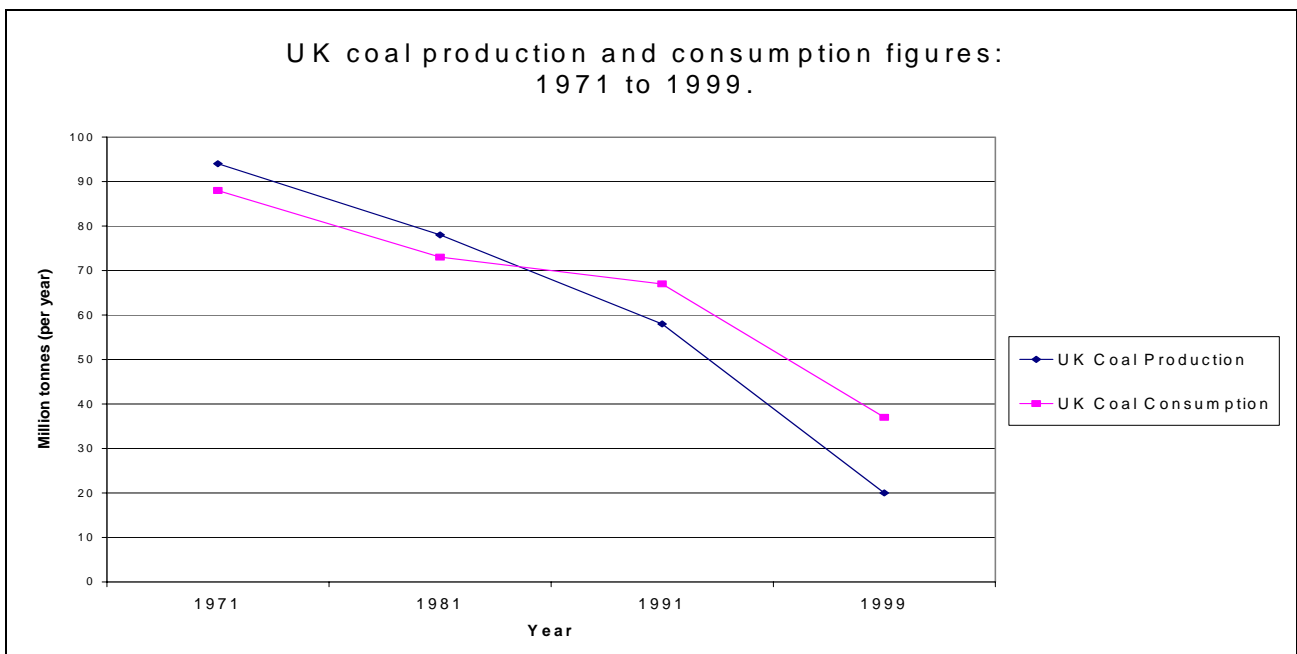


Figure. 3. Source: National Statistical (2002) *UK in figures – Commerce, energy and industry: Energy*, <http://www.statistics.gov.uk/ukinfigs/commerce.asp>.

‘Places synonymous with coal mining – Barnsley, Mansfield, South Wales – saw its complete end or, in a few cases, saw its virtual end, with one or two pits continuing, using a quarter of the labour that they once had, eking out a survival in an uncertain economic world where closure could come at any time.’ (Turner, 2000: 4.)

The economic effects have been devastating. The then Department of the Environment, Transport and the Regions reported in 1999 that:

‘South Yorkshire, at the heart of England’s Coalfields has a Gross Domestic Product of less than 75 per cent of the European average – the lowest of any UK region on EU statistics,’ and that this figure continues to fall. It also accurately summarises the main challenges facing pit communities: ‘... a unique combination of concentrated joblessness, physical isolation, poor infrastructure and severe health problems.’ (DETR, 1999: 1)

It is generally held that it was not until the 1970s and the NUM’s confrontation with the 1973 conservative government – the confrontation culminating in the three day week, and early general elections on the platform of ‘Who governs Britain?’ – that considerations other than coal being a relatively cheap and above all, a nationally produced power source came into play. Miners had always been regarded as a special case, to be co-operated with rather than confronted. Now coal became a political issue. The source of power *for* the nation became seen as a struggle for power *over* the nation. The strike action was organised by Joe Gormley, the then President of the NUM, with military precision. For the first time, tactics such as secondary picketing and flying pickets¹ were introduced on a massive scale. He chose his moment well, coal stocks at the power stations were low and winter was approaching. Crucially, he also had the sympathy of the general public who were still inclined to afford miners special consideration. His was a totally convincing victory.

It was Margaret Thatcher in her second government (1983-1987), buoyed by her sweeping electoral victory after her emphatic victory over Argentina in her retaking of the Falkland Islands, who felt confident enough to take on the perceived might of the NUM. In order to destroy the power of the union, she set about systematically destroying the industry, having a horror both of the monopoly nationalised industries and the monopoly trade unions (Yergin and Stanislaw, 1998: 105-113). Crucially, just as Heath had been fatally weakened in his struggle against the miners by international events outside his control (the arbitrary raising of oil prices by the OPEC cartel), so Thatcher’s strategy was helped by external events in the emergence of alternative power sources, primarily the increasing flows from the North Sea oil and gas fields, and the sourcing of cheaper coal supplies from Eastern Europe.

In considering the miners’ strike of 1984, it is now clear that the confrontation with the miners was carefully planned. At this point the industry was losing money at a horrendous rate, the government subsidy having risen to \$1.3 billion a year; but the NUM, now led by Arthur Scargill, who had succeeded Gormley, was resisting any rationalisation of the industry that involved any mine closure or loss of jobs. Secondary picketing and the use of flying pickets, astoundingly effective tools in the miners’ previous confrontation with Heath a decade previously, had been made illegal through an act of parliament. The government had also ordered the Central Electricity Generating Board (CEGB) in charge of the national power generation plants to stockpile a huge amount of coal so that, this time round, power supplies would not be disrupted. The government also managed to manipulate the NUM

¹ Flying pickets were organised squads of strikers who were bussed in to various places, principally mines or power plants to add reinforcement to existing pickets and/or blockades. Secondary picketing is picketing at a place other than one’s own place of work.

into calling the strike from the spring of 1984, a time of year when coal would be in reducing demand for the following six months (Yergin and Stanislaw, 1998: 105-113). When the miners were eventually defeated, after a year of often violent resistance, it was clear that the industry would now be rationalised, and changes were to be made on an incredible scale.

As a further catalyst to decline, one effect of the miner's strike was to radically alter energy production and consumption patterns within the UK. In 1989, the government began liberalising its electricity markets. Prior to this, the cost of domestic coal had greatly exceeded that traded on the international markets. In effect the CEEB had been subsidising the British coal industry. The new versions of the CEEB, National Power and Powergen, were freed from this constraint and were able to source coal from wherever it was cheapest. This caused demand for British coal at British prices, to plummet (EIA, 2001). In 1992, the British coal industry reached a turning point. Growing competition from increasingly available nationalised gas, the imminent removal of the regional electricity companies' captive supply markets, and newly-enacted pollution goals all worked to accelerate the steady decline of the industry (EIA, 2001). In fact, between 1986 and 1996, coal consumption, including imports, declined from 114.2 million tonnes to 71.4 million tonnes (xrefer, 2002).

Historically, pits have always been subject to closure. Seams become exhausted or peter out to an extent where it is no longer viable to work them. Similarly, other geological reasons can cause a pit closure; shifting and unstable rock strata, flooding or the coal face area filling up with gases can all make a particular mine unworkable. The difference from pre 1980s pit closure to that post 1980s is that, before that pivotal decade, miners could always find other work in mining. They might have to travel to secure this new employment – although often only within the same coalfield area – but jobs were available if they sought them. Post this dramatic watershed of the 1980s and 1990s, the miners, now mostly ex-miners, were faced with an entirely new prospect: no likelihood of ever working with coal again.

3.6 Comparing the decline of Germany's mining industry

The question arises as to whether different government interventions could have prevented the spectacular decline of former mining communities. In addressing this, it is of great interest to learn how similar demise within this sector has been handled in other countries. As a comparable power, Germany also faced an enforced run down of its coal industry, as costs of domestic coal production increased and other alternative sources of energy became an option. In contrast with the UK, Germany's handling of the transition was marked by co-operation and dialogue between the government, employers and union, which, because of the strife in the UK, has not been evident here. The result has been a far greater degree of planning in advance of the closure decisions and government money to facilitate transition was provided in advance rather than after the event. Co-operation, incidentally, has led to a larger proportion of the German coal industry surviving compared to its UK counterpart (Schubert and Bräutigam, 1995 in Critcher et al, 1995b, *Regeneration of the Coalfield Areas: Anglo-German Perspectives*). Critcher notes in the Afterword of the same work that although there are doubts about detail in terms of the success of the German approach, it had significant advantages over that adopted in the UK, which could be summed up in one word, 'planning'.

In Germany there was an attempt to plan everything: the annual production of coal, the closure of pits, the training of miners, the reclamation of land, the regeneration of the local economy... In Britain, by contrast, the only extant plan seems to have been the long-term intention to privatise the remnants of the coal industry. Symptomatic of the improvised and incremental nature of the British trajectory was the reaction of Secretary of State, Michael Heseltine to widespread political opposition to the wave of proposed pit closures originally

announced in October 1992. Seventy-five million pounds of special aid was subsequently made available; it was to be channelled through the Training and Enterprise Councils (by no stretch of the imagination representative bodies); they were to be given two weeks to submit proposals to the Government. In such a context, any kind of serious planning is not viable. (Cricher, et al, 1995b: 183-4).

It would appear from this that instead of planning and allocating funds appropriately to the overall strategy as in Germany, the British approach was to close first and then divert money to the issue only when it became politically expedient.

It is argued here that the high levels of adaptive behaviour displayed by the German mining industry and its active management of change coupled with its preparedness and communication with government, is strongly characteristic of the ecological concept of resilience described above - particularly in its ability to absorb perturbations and potential problems through co-operative dialogue. Further to this, an element of conscious pro-activity might also be characteristic of human systems which can be modelled using this form of resilience, in contrast to the more reactive/retroactive activity observed in the British mining industries approach to coping with change. This outlook has increased both economic and social sustainability beyond the former German mining communities. The literature has shown a far greater resistance to transformation in the British mining industry, though the particular nature of this change should be the subject of some scrutiny. Throughout its evolution, the industry has been subject to technological development as increased levels of mechanisation were introduced. This inevitably required a degree of new knowledge acquisition on the part of the workforce, though importantly, the system's structure was largely unaffected and resistance in this respect was minimised. Critically, such significant developments, including the introduction of performance related pay schemes, were designed to improve the efficiency and effectiveness of the extraction process and were, on the whole, readily accepted. This unilateral drive for optimisation of industrial process is mirrored by the desire to achieve optimal performance – a characteristic of systems displaying a form of engineering resilience. This leads to a 'brittle' system that has no 'slack' or inbuilt flexibility.

In looking at the history of coal mining in Britain, it becomes apparent that the industry has not been subject to the regular, periodic perturbation, a feature which complexity science has emphasised, and which equips such systems with a greater adaptive capacity to deal with future unanticipated change. Historically, the region's mining sector typically experienced few changes in social organisation, environment and culture (bodies of influences which remain incredibly constant to this day), and had developed a confidence in its ability to 'weather the storm' of political influence. This preoccupation with control and constancy, again indicative of a more engineering form of resilience, meant the industry was ill-equipped and poorly prepared to deal with unpredictable changes. The institutional flexibility, will to learn and conscious appraisal and management of change - all features that ecologically resilient socio-economic systems commonly incorporate - were simply not present in the industry when new demands were placed upon it. Ironically, the knowledge held from previous encounters between the National Union of Mineworkers' (NUM's) and the Heath conservative government in 1973 led the majority of miners to believe that once more their interests would be protected. This self-belief and ignorance of the true nature of change, developing global markets and the threat of alternative power sources severely weakened their hand initially and later their power to negotiate – sustainable outcomes became less likely as the year-long 1984 strike wore on.

It should be made clear, however, that in dealing with issues of socio-economic transition, time is a crucial element which should be acknowledged when considering the relative 'success' of adaptation. The length of time made available to the industry to accommodate and prepare for change was doubtless confounded by breakdowns in negotiations and consequent strike action, but even initially

was un-realistic in facilitating any meaningful sustainable outcomes following from the transition. In the words of one miner:

The only grievance that I've got is that they shut all the pits at once. Surely there should have been two or three pit that stayed open until they could retrain the miners. They knew they were closing the pits, they should have hung back a bit, and shut one at a time, give them time to retrain the miners. (GL: Case 3)

The shortcomings of inflexibility and embedded traditional knowledge and practices, thus conspired to produce a classic case of systemic collapse (*cf.* Tainter 1988). By way of contrast, in the following sections, we shall attempt to outline the elements of a framework based on the co-evolution of social, cultural and economic processes that is based on the promotion of resilience and the possibility of sustainable socio-economic transformation.

4. Towards a Co-evolutionary Framework

4.1 Introduction

So far we have argued the need to understand industrial systems from a complexity perspective, so as to emphasise their nonequilibrium, evolutionary nature. Such an approach emphasises the capacity of small, unanticipated (contingent) events to generate structural transformation and, importantly, the role played by co-evolutionary dynamics in affecting discontinuous change. Elsewhere (McGlade 1995, 1999a,b) we have suggested that human-environment interaction, seen in terms of a model of *human ecodynamics*, of necessity must be conceived of as a reciprocal set of interactions driven by positive feedback processes. This co-evolutionary perspective, argues for a non-functionalist human ecology in which human agency plays a vital role in creating environmental outcomes that are subsequently seen to act back on human societal processes. Thus the reproduction of society is a consequence of this continuous reciprocal dynamic¹. Consistent with these ideas is the need to view any co-evolutionary dynamic from long-term perspective, thus, recognising the importance of history in creating the enabling and constraining conditions within which socio-economic systems co-evolve. Such a research agenda is designed to present a more complete and integrated view of human societal structuring; it thus eschews current developmental evolutionary models, emphasising in their place, a discontinuous, non linear perspective, that acknowledges the crucial importance of different temporalities and scale-dependent dynamics in the emergence of societal structure (McGlade 1999b).

Generally speaking, a co-evolutionary perspective focuses on the way that self-organising processes at work in socio-economic systems act to generate the system's evolutionary character. In an important contribution to these concepts, Norgaard (1984, 1994) has presented a co-evolutionary model within the context of sustainable development, based on the mutual feedbacks and nonlinearities between values, knowledge, social organisation, technology and environment. The most significant aspect of Norgaard's model is that it contains no external relations, everything is 'symmetrically' related. All component processes are involved in a co-evolutionary dynamic that is constantly changing in ways that are not necessarily predictable. Each of the 'subsystems' defined (values, knowledge, organisation, technology and environment) is composed of different types of ways of valuing, knowing, organizing and doing things (*ibid*: 35). The metaphor of biological fitness is employed to explain the co-evolutionary process; i.e. selective pressures determine subsystem survival. In this sense, values and

¹ This is consistent with Alain Touraine's (1977) argument when he states that understanding human societies from an evolutionary perspective is not just about production *per se*, but more importantly, the process of self-production.

beliefs that enhance the co-evolutionary process survive and multiply, while less 'fit' ones disappear. From a developmental perspective, there is no implied teleology in co-evolutionary development; thus:

“...knowledge, technologies and social organisation merely change, rather than advance, and the 'betterness' of each is only relative to how well it fits with the others and values. Change in the co-evolutionary explanation, rather than a process of rational design and improvement, is a process of experimentation, partly conscious, and selection by whether things work or not” (*ibid*: 37)

What is being argued is that the environment acts as a determinant in the way people behave as guided by knowledge, social organisation and technologies, while at the same time, “how people know, organize and use tools determine the fitness of characteristics of an evolving environment” (*ibid*: 46).

As a general theory of development and as a contribution to the sustainability discourse, Norgaard's contribution is highly significant. Yet there are a number of aspects of his model that require scrutiny. First the notion that socio-economic dynamics can be reduced to discrete subsystems is problematic. As a residue of systems theory it suggests, for example, that societies can be neatly partitioned into functional categories and thereby analysed from a cybernetic perspective. There is also a 'fearful' symmetry in the relationships between the subsystems, such that the causal linkages are defined as being equal. In reality the relationship between such linkages – comprising a variety of weak and strong links - is constantly changing since socio-economic systems are perforce, *evolutionary* systems. Moreover, in reality, the so-called 'subsystems' evolve at different rates.

Consistent with other models of sustainability, a key component missing from this framework is an expression of the central role exercised by power and authority and their various manifestations, in articulating societal systems. Curiously, while making the astute comment that environmental problems are essentially problems of 'social organisation' (as opposed to seeing them in terms of the need for purely technological solutions), no mention is made of the crucial role of the circuits of power and authority that articulate all social and political structures.

4.2 A co-evolutionary model for industrial & societal transformation

In an effort to promote an alternative model of co-evolution – one that encompasses some of the structural issues described above, particularly the interdependence between agency and structure - Figure 4 presents a revised schema based on the mutual interaction of values, knowledge, agency, social organisation and resources. By contrast to Norgaard's model, each of the five domains, are not considered as subsystems, but rather as the locus of *processes* that are connected to each other through self-organising dynamics driven by nonlinearities. Importantly, the connectivities involved are periodically weak and strong as expansion and contraction takes place continuously. Some domains are more tightly coupled, and this is dependent on the capacity of a single domain or cluster to dominate or exercise control on the evolutionary trajectory of the socio-economic system. Discontinuous change, collapse, transformation and re-constitution comprise the 'normal' co-evolutionary behaviour of the socio-economic system. It should be noted that such a model stands in opposition to frequently hypothesised ideas of 'stability' and 'equilibrium' as intrinsic system goals.

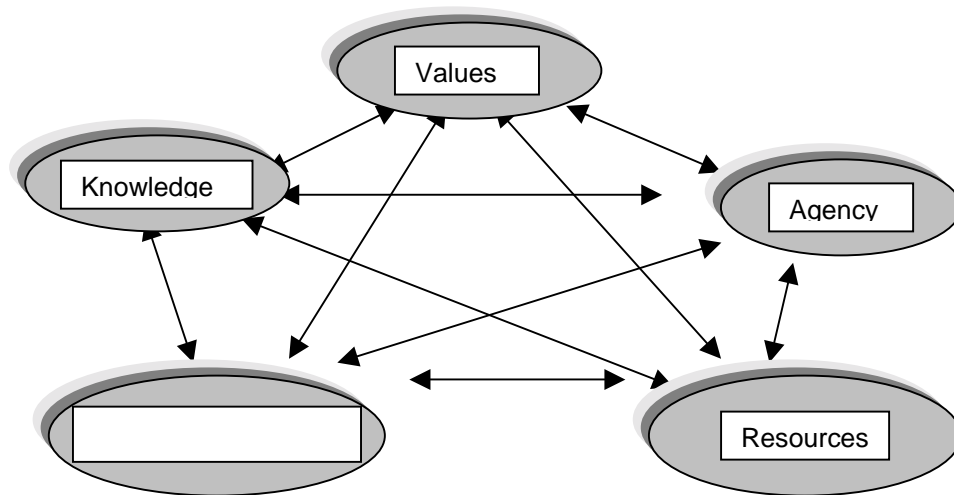


Figure 4: A co-evolutionary model for socio-economic systems

While the manifest complexities underpinning co-evolutionary dynamics are daunting, we can usefully summarise the main attributes of the processes involved, thus:

Values: These assume a key role, since values, philosophies and beliefs comprise the cultural knowledge of a society that ultimately finds expression in ideology. This is a critical domain, for it comprises the engine of socio-economic systems, responsible for both its practical goals and its highest aspirations. Moreover, it stands in opposition to instrumentalist perspectives that view entities such as agriculture and irrigation as simply material technologies. By contrast, we are arguing that technologies are expressions of value systems.

Knowledge: Knowledge is here conceived as four mutually interdependent, but semi-autonomous communities, comprising: *scientific*, *institutional*, *technical*, and *local* knowledge categories. The importance of this distinction we have earlier discussed as a pre-requisite for representing complexity. Our definition of societal resilience was based on the capacity of a society to continuously renew its stocks of knowledge and consign those that are perceived to be redundant; in fact, failure to allow knowledge exchange in this way can lead to fossilisation and possible collapse. Co-evolution, then, can be thought of as a ‘knowledge intensive’ process.

Agency: Actions are here viewed as human interventions in the system. These may be purposive or contingent and given the nonlinearities structuring socio-economic processes, they can result in wholly unintended consequences. As we have earlier noted, agency is intrinsically related to the application of ‘means’ to achieve ‘outcomes’; thus, it is intimately related to power. The distinction, separating “power over” from “power to” is an important structuring principal for it recognises the capacity of human agency to engage in either exploitative relations or alternatively, to empower people.

Resources: In the sense used here, resources follow Giddens’ (1979, 1984) distinction between *allocative resources* (those involving control over nature) and *authoritative resources* (those involving control over social interactions). Allocative resources thus comprise the material features of the environment (raw materials) as well as the instruments of production, technology and their products. By contrast, authoritative resources comprise the organisational elements of human spatial interaction as well as the communication and information content defining human social interaction. Crucially, it is the specific interrelationship between these two types of resources that accounts for the variety of asymmetric power relations (enabling or constraining) that characterise all human social institutions.

Social organisation: The connectivity that characterizes all societal systems is the product of a diverse array of social, political, economic and ideological linkages. These comprise networks of interactions that act to generate various types of order and organisation. In the most generic sense, networks arise as a solution to coping with complex societal problems. Social networks are usefully conceptualised as distributed systems i.e. a *heterarchy* comprising clusters of relatively decentralised social groups, rather than a single all-inclusive hierarchy. Control in such systems is not so much absent but is fluid, circular, and essentially discontinuous - rather like processes involved in solving a jigsaw puzzle. What is most significant, is that within such a heterarchy, comprising a diverse array of semi-autonomous nodes – e.g. local, regional and national administrative bodies - novel structure can emerge spontaneously from the increasing and decreasing rates of connectivity across the system enacted by political decision making processes.

The difficulties in conceptualising such 4-dimensional dynamics is clear and can only be imperfectly captured by a 2-dimensional figure. Perhaps the best way to grasp the co-evolutionary framework is to conceive of it as a topological ‘rubber sheet’ model, with a variety of possible stretching and folding capabilities as it is ‘pushed’ and ‘pulled’ in a number of directions over time. This sequence of asymmetric topologies best defines the self-organising features of evolutionary development

(Figures representing changing patterns of influence in S. Yorkshire’s coal fields are to be presented – Fig 5 in development).

The real advantage of a co-evolutionary approach is that it challenges our conventional scientific methodologies, forcing us to think in terms of ‘wholes’ instead of parts. However logical this may seem, its implementation is not easily achieved, for it requires us to jettison reductionist models upon which scientific enquiry has been based for the past 200 years. Co-evolution is attractive precisely because it presents us with a model of reciprocal human-environment dynamics that is intuitively satisfying and moreover, suggests new pathways along which we can confront complexity. On the other hand, from a practical perspective, any approach that cuts across disciplinary boundaries carries with it a particular set of difficulties (and even mistrust) that comes with any attempt to restructure conventional scientific discourse.

Such an epistemological shift has the added advantage that it encourages a pluralistic approach to knowledge acquisition and hence actively reconfigures the territory of decision-making. Practically, this involves a move from a search for deterministic causal linkages between risk and planning strategies to an arena of negotiated solutions, for a *dialogic* methodology (*cf.* McGlade 1995). This proposal is consistent with Norgaard’s (1994: 102) call for ‘conceptual pluralism’ and the promotion of a more democratic situation – one based on increasing decentralization and local community participation.

In what follows, we shall attempt to operationalise the co-evolutionary framework by applying its principles to an empirical example – the mining industry in South Yorkshire and more specifically, the region’s coalfield communities.

5. South Yorkshire mining communities: A case study

5.1 Mining communities post culture: Co-evolutionary systems in decline

In developing our case for the application of the model in understanding societal resilience in South Yorkshire's mining communities, the insights and appraisals we present are largely based on the findings and evidence from a series of qualitative interviews conducted between the months of July and November 2002. A total of 41 men who worked in the mining industry for varying periods of time were interviewed according to a semi-structured interview format designed to cover the many assumptions that persist concerning the closure of the mines across South Yorkshire and the subsequent effects upon local mining communities (quotes are followed by interviewee's initials and case number). Coupled with a review of the literature surrounding mining and the development of coalfield communities, the results of the interviews form the main subject base from which the findings, understanding and subsequent inferences regarding the nature of resilience and the changing co-evolutionary process within these traditional social networks are made. In line with the ideas presented by Warwick and Littlejohn (1992), communities are understood to be 'locally-based forms of interaction' exhibiting a wealth of social networks. In their words;

'Networks provide resources, but also may create constraints, for households in particular localities. Such resources may be characterised ... as 'local cultural capital' (local ideologies, the knowledge, skills and influence contained in local social networks). Together these points seem to establish the continuing attachment of individuals and groups to forms of 'community'.

As well as providing a useful taxonomy for conceptualising different patterns of change related behaviour displayed by industrial systems, the distinction between engineering and ecological resilience is also significant in applying the concept to the case of former mining communities, which, given their historical, geographical, economic and cultural independence can be viewed as both highly specialised and identifiable social systems. We argue that these regionally specific human systems can be typically characterised by, and modelled upon a rigid, hierarchical and stable form of *engineering* resilience, similar to that which has been observed in the local industrial dynamic with which the workers were strongly synonymous. The almost closed systems of formerly self-sustaining pit villages now exist only as a financial drain on the regional economy to which their role was once vital. Despite the widespread disappearance of the industrial networks upon which communities were formed, the social structure and cultural processes remain largely unchanged and a sub-optimal, though belligerently stable organisation persists. This idea is captured succinctly by Warwick and Littlejohn (1992);

Our approach will parallel that of recent sociological work which has stressed, despite predictions of their demise under the impact of social change, the continuity of traditional social networks – based on kinship, friendship and neighbourliness in household and community settings. Repeatedly our data point to the significance of such networks as bases of continuity and as resources to be drawn upon in a period of change. (Pg xii).

This resource, similar to social capital, has been termed 'local cultural capital' by the authors in acknowledgement of its importance to these post-industrial localities in supporting the longevity of local values, identity, structure and ideology. Though historically, undeniably crucial to the integrity, moreover the survival of such isolated systems, we credit this influence with some degree of responsibility for the prevailing reluctance to consign old knowledge in favour of a new learning, more accommodated by the changing environment. Without criticism of its purpose, this influence, and the social networks in which it resides should be understood as a significant driving force behind non-adaptation in the region's coal field areas. Virtually no evidence of an adaptive and more fluid form of

resilience can be cited following research into these systems given, amongst other indications (requiring some degree of scrutiny), persistently high levels of unemployment coupled with chronically low levels of new knowledge and retraining acquisition. There remain large numbers of former miners in South Yorkshire who, for a variety of reasons (including culturally acknowledged capital), do not adapt to changes in their environment, nor are they seen to facilitate any degree of social or economic diversity.

Further evidence of this conscious reluctance to accommodate and adapt to changes in the system's environment (and in doing so, evolve), can be outlined systematically through an application of the proposed co-evolutionary framework. Each of the model's domains are discussed here in turn with reference to the case study, while keeping in mind the interconnectedness (through self-organised dynamics) and feedback effects which continually shape the essence of each process and the degree of influence on the overall evolution of the system. **(Relate to Fig 5: Patterns of mutual interaction, local influence and contribution to overall evolution)**

5.1.a Social organisation:

The bulk of our discussion here is to focus on the monoculture that emerged in mining communities across the region, given its application to a framework for understanding social interaction and the associated conflicts that were experienced as a result of this position. The process of social organisation must be understood in relation to the reciprocal influence of many processes, though it is held the most significant is that of values: a common solidarity between workers and a bond that stems from a social capital, common culture, shared risks, kinship and camaraderie. Little evidence exists for the claim that, despite a more or less, unified local understanding or *schema*, an even distribution of capital (economic or social) has ever really existed. In fact, a clear hierarchy was observed in mining communities across the country:

‘The whole ethos of mining communities was a respect for social order, even a respect for those in the local social hierarchy’. (Turner, 2000).

Turner (2000) also points to housing as a strong indicative factor of the social class system in mining localities, holding that ‘you knew what someone's job was simply by the house that he and his family would occupy’. It was not only deputies and mine management who, at one point were perceived to have greater ‘cultural capital’ or be distinct in the context of class, so too were many of those working outside the industry; teachers, even shopkeepers. The question of power is addressed in relation to agency and resources, though more in reference to organisational influence.

The issues which emerged as a consequence of this top-down hierarchy have been outlined in relation to the decline of the industry, while more individual experiences following from the changes rigorously imposed on communities are the subject of further discussion

Monoculture

Mines were created where accessible seams of coal had been located. Shafts were sunk, workers recruited, and a village to house these miners built. New communities were created that had but a single reason for existence. Everything depended on the pit. Despite an uneven distribution of capital, there was a pattern of *monoculture* in all the lives of those connected to mining. The pit was the sole job generator for the entire community. Other jobs, such as those in retail, depended directly and entirely on the wealth generated by the miners.

There is nowhere else like the coalfields. Their long history as the engine of the nation's industrialisation meant that they developed a cohesion, a reliance on a single industry and an

independent existence with few parallels. This was their greatest strength when the mines were producing and now it is their greatest weakness. (DETR, 1999: 1)

A remarkable study has been produced of the devastation wreaked on these closed communities by the pit closures. In *Coal Was our Life* (2000), Royce Turner revisited the pit villages that were the focus of *Coal Is Our Life*, written in the 1950s by Norman Dennis, Fernando Henriques and Clifford Slaughter, which explored the nature and ethos of pit life at a time when the mining industry appeared invulnerable and secure. It is an emotionally powerful piece that does an excellent job in contrasting pit life before the watershed years of the 1980s and 1990s. In it, he describes the ethos unique to pit life that developed:

The social code governed the minor intricacies of life, through to the important life decisions. It was a code which was shot-through with altruism: you looked after those who couldn't look after themselves; you helped, if you could, your friends and family. (Turner, 2000: 9)

This became even more true after when the pits were brought into public ownership under the auspices of the NCB. The local ethos and way of life became unified at a national level. Now, all those living in mining villages owed their livelihood to the one employer, the 'Board'. One body, the Union, represented their interests. Their off-duty leisure interests were more likely than not to be centred on the social club, financed by the union. The social aspect of mining communities as a close-knit group of individuals appears to have endured, as all but 2 of the men interviewed in the course of our research (n=39, 95.1%) stay in contact with other ex-miners. The level of communication between ex-miners also remains high, despite no longer working together in the same industry, as 23 of the men (56.1%) said they see other ex-miners 'all of the time'.

The pit, the reason for the community's existence, was a physically dominating presence. It seared itself into the consciousness of all in the village:

Ackton Hall worked its last shift in 1985. Virtually in the centre of town, its three shaft, extensive pit top winding gear had dominated the sky-line for more than a hundred years. Its very structure symbolised grit, hard work, a macho, somewhat monolithic, culture, a blackened world into which men descended, day after day, night after night. (Turner, 2000: 11)

It could be argued that other heavy industries had similar set ups in terms of single industry or company villages or towns. Shipbuilding might be cited as a case in point; but where you could build ships you could also fish, for example. The iron and steel industries were similar in being dominant employers, but these often generated a range of craft based manufacturing industries around them; some of which could survive in their own right even though the 'host' industry was suffering severe contraction. Although job and community identity were strong in these cases, the mining communities built a far stronger sense of uniqueness. Miners communicated only with other miners or those connected with mining, and lived in distinct communities where it was automatic to reinforce the self-esteem of the community; an esteem fuelled by social capital, the nature of their work and the skills needed to do as well as the comparatively high levels of remuneration. All this led to an insular mentality, the closest anthropological comparisons being to a separate tribal life. The end, when it came, was therefore all the more shattering. It was not just jobs that went, but an entire way of life for an entire community.

People did have a regular source of a reasonable income. There were structures in place which bolstered that stability: family and friendship ties; the union; the fact that you could nearly always get a job, if you wanted one. When the coal industry was closed down, that stability was destroyed. Once redundancy monies were spent, incomes dried up. Mining villages were not the

kind of places to attract inward investment and, at least in West and South Yorkshire, not places where there had been a high emphasis on education. (Turner, 2000: 1)

With the destruction, not only of jobs, but more importantly, the destruction of their communities, the miners were being asked – and were expected to – embrace a whole ethos that was diametrically opposed to that which had served them well for generations:

But what was gone was the spirit...There may be training places and ‘employment opportunities’ and self employment starter packs and new priority areas. But it was an unquantifiable spirit that held these places together. A spirit which had developed over generations, based on collectivism, kinship, advancement by co-operation rather than individuality. The social institutions that characterised the places were all symbolic of that: the Co-op; the miners’ welfare; the club trip; the union. The spirit that those trying to foster an ‘enterprise culture’, where the engine was individual effort and the motivation was individual gain, [was] never quite understood. (Turner, 2000: 4)

And, commenting on this same point, Rees and Thomas (1991) point out:

It [Enterprise Culture] wasn’t a culture that was going to be easily embedded in a place where every man had been a union man, and every family, more or less, had rented their house from the council or from the ‘board’.

The component parts of this unique situation can be summarised as follows:

- A sense of invulnerability leading from a combination of the ‘specialness’ of their situation and the work they undertook which was shattered by the events after the 1984 miner’s strike
- Because of the ‘single purpose’ nature of mining communities, it was not just jobs and the lifestyle of individuals that were devastated by pit closures but that of entire communities. This was the equivalent of the disintegration of the total fabric of the miner’s entire way of life. This also added to the difficulties experienced subsequently by those attempting to attract inward investment to these communities
- A work and cultural ethos which valued the collective rather than the individual initiative predisposed many miners against individual solutions such as individual retraining or options such as self employment
- The pit closures, and how they were handled, created a community-wide trauma that can be best understood by employing psychological terms; particularly those of loss, bereavement, mourning and a sense of betrayal.

5.1.b Values:

Values are held to be of critical importance in understanding the very fabric of social identity, group appraisals and consequent behaviour. In fact, in discussing this integral concept, a knowledge of this identity, common to the subject group, is necessary in that it is seen to underpin both the creation and development of a community’s value set. The themes of a miner’s identity and self-concept were discussed in a number of interviews.

Miners don’t like discipline. They don’t like that assembly line grind, where you’re not part of a team, and you’re not part of a collective effort. Also, identifying with something. People say, “I’m a miner, but I work in the chicken factory” or “I’m a miner, but I’m unemployed at the moment”. Twenty-odd years later, people are still miners. [DD: Case: 2]

Coming from mining families, generations of whom were likely to have worked in the mine, gave miners sense of identity, and continued to reinforce that sense of identity. In such communities, sons of miners grew up in the expectation that they would become miners and daughters of miners with the expectation that they would marry miners.

Your life was a particular way because you were a miner, or because you were married to a miner. It influenced every thing you did. You were in a trade union because you were a miner; you drank in particular places because you were a miner, you married particular people because you were a miner. You behaved in particular ways because you were a miner's daughter, a miner's wife, a miner's son. (Turner, 2000: 65)

The ex-miners interviewed in the course of our research displayed a very strong family tradition of employment in the mining industry with 40 (97.6%) of the subject group reporting an average of three generations of their family having worked in mining, leaving only 1 subject reporting no ancestors having worked in mining before. This shared social identity in turn contributed to a sense of self-worth, which was further reinforced by two main factors. Firstly, as indicated, the public in general was sympathetic towards miners, regarding their dangerous work as making them a case for special consideration, and secondly; they were highly paid relative to the educational qualifications they had obtained. This pay differential between miners and other manual workers, skilled and semi-skilled people, put them top of the pecking order and gave them a status they relished. The closure of the mines meant not only a loss of jobs, but also a loss of identity and a loss of structure and meaning to their lives. What follows could be called 'psychological disintegration'. In general, in a society where identity is largely defined by what we do, the unemployed are defined by what they are not – or at least, not any more (Kelvin and Jarrett, 1985: 45). The ex-miner is not a miner, a face-worker or mechanic. Moreover, take away the prospect of re-employment in the field that the person has been operating in and this sense of identity is further eroded. A lorry driver who loses his/her job has every expectation of securing another similar position. An unemployed miner, when there are no longer any pits open, has not. Their *self-concept* is shattered. To put it more colloquially, 'they just don't know who they are anymore' (Marsden, 1982: 155 et seq).

You're secure, or you thought you were secure at the time. But it's all gone wrong. I thought I'd stay at Lofthouse Colliery until I was 65. [MW: Case: 32]

They (*the Government & Coal Board*) never thought what it would be like for someone who had worked in a totally different environment for 25 years and that they (*miners*) would be like a fish out of water. [JT: Case: 41]

In the case of the mining communities, this process does not happen in isolation but as a part of the wider disintegration of the community. The single structures (Coal Board, NUM) that provided a framework for individual and community identity and values have gone, though these concepts and beliefs remain. Faced with this, it is not surprising that the 'fortress mentality' referred to in relation to the work of Rees and Thomas (1991) should become a more likely behavioural mode than one of risk-taking entrepreneurship, or one of embracing new (and strange) challenges in new work environments in new locations.

Returning to the development of values, it becomes clear that the physical conditions in which miners worked are of great relevance in understanding both the creation and resilience of certain sets of values. Perhaps the most obvious being a common sense of solidarity and likeminded conscientiousness, which follows from a common goal and from carrying out demanding operations in such a hazardous and difficult environment.

The danger...was all part and parcel of the job, and we accepted the danger and in some ways it made you special. Nobody can be a proper miner unless they're born into the community. It's something in the blood. (SB: Case 4)

When you first start you need to soon get a really close group of friends. It's the camaraderie and the thing that you're all in it together; it's like the wartime spirit, like the armed forces. Everyone feels like they've got a job to achieve, but it's a horrible job, nobody likes the actual job but there's still a feeling of satisfaction when you achieve what you want to achieve, so it's like you're all in it together, very big teamwork, teamwork's a big big thing in mining, everyone's a team. The majority of miners wanted to see coal coming out of the pit, some people think that miners are all lazy, most miners wanted to go to work and do their job, and get it done well. (NM: Case 5)

In addition to this, the necessity of a mutual dependency and behavioural predictability in order to minimise risk of injury has meant that any notion of enterprise or 'maverick' behaviour was intensely discouraged and has led to an under-developed sense of individual enterprise. The sense of solidarity, vital in pit work, has made it more difficult for miners to adjust to post-pit employment opportunities. The qualities 'trained' out of them – individualism and enterprising behaviour – are those that respond more effectively to the new entrepreneurial culture.

The nature of mining work and the pressures experienced in such an environment led to what has been described in the interviews as an overwhelming sense of 'camaraderie'. This goes beyond the notion of a coping mechanism and formed the most common response given by interviewees when asked what they enjoyed most about the industry. Others spoke of this camaraderie and intense bond extending to communities, though with hindsight, they sensed it was not an outlook suited to change.

See a miner's world was, if you like...his family, his job and the village and everything circled round that. That's why they were so tight-knit. (JT: Case 41)

As they were close knit, they were united, and all the very positive things, that close knitness and unitedness has ended up pulling them down. I think they'd be better ripping out communities completely, rather than letting them fester and die. Split 'em up. If you've got close knit, but it's all destructive at moment, or seems to be.... (MG: Case 25)

They almost have to change their culture. That's the difficult bit, the mentality of it all. I don't know how you do that. Some people have been there so long. (PB: Case 11)

The psychology of individuals is of great significance to realising the rewards which follow from the acceptance and kinship found in social networks which incorporate identity. This capital, commonly characterised as solidarity, followed from an adherence to, and upholding of, shared values, politics and beliefs. The consequences for those who were perceived to have contravened this common, collectivist obligation and social cohesion were dire, and social exclusion inevitably followed. For those men who were unwilling, even unable to continue with strike action, no degree of compassion would be shown.

... we all stuck together, all looked out for each other, except when strike come, after strike, that did split a lot of people and communities. It weren't so bad at Dinnington, but at Maltby, if you went back to work, you had to move house, else your windows would be through every night. Still now, it's very deep in Maltby and that. (PD: Case 18)

The development of both implicit social support networks, as well as a very explicitly recognised union upholding the common value set is, in many ways, a predictable event in the evolution of this socio-economic system when we take into consideration the historic struggle for power over resources and the huge number of labour who felt disadvantaged. As with any process, however, its state is not continual. The huge increases in crime, completely alien to pit villages 50 years ago is testament to the change in values such places have experienced. The social codes of conduct akin to the miners' sense of proud identity and social discipline exerted by the union are no longer present.

5.1.c Knowledge:

Highly specialised knowledge of the industry and extraction process is developed over a great number of years. The average number of years our subject group had worked in mining was 23.7 years while the average number of years since having worked in the mining industry was reported to be 11.4. Unfortunately, this specific knowledge base of how to mine coal was just that. Such skills are not, by and large, transferable to any other industry or line of work.

I think that there are a lot of miners who will never have a chance because they can't retrain to do anything else, you put a shovel in their hands, they were bloody good, but they can't be bricklayers, they can't be plasterers, they can't do jobs that require fine skills. The people who are capable of being retrained have started into an industry, ten or fifteen years behind the people who are already in that industry. (NM: Case 5)

Comes in handy at home, but not much good for getting a job. You'd be very lucky to get one on a building site. It's a vicious circle, they won't take you on because you've got no experience, but then you never get any experience. (AG: Case 9)

Skills what you did down pit wouldn't be any good anywhere else...apart from digging holes in road or something like laying cables where you're doing manual work. Did a lot of manual work down pit. I don't know what kind of training. (Pause). Mining's unique isn't it? (AG: Case 9)

The problem is confounded by the fact that large numbers of ex-miners who have failed to secure alternative work commonly fail to express a desire to acquire new knowledge. As such, the definition of societal resilience as presented within this review is not observed, as little emphasis is placed on learning and the renewal of a knowledge base, nor is the abundance of increasingly more redundant knowledge reserves (surrounding the industry) subject to consignment (there is plenty of hard learned ability and knowledge of mine work yet seemingly little desire to learn new trades). The fossilisation that follows from such lock-in is apparent in a great number of the more isolated, almost closed systems of former pit villages across the region of South Yorkshire. In the course of our interviews, a reluctance to retrain was reported, many interviewees seeming resigned to unemployment.

... when it's a 6 month course, you're not going to learn a great deal. I mean, you can't go on a course and then 6 months later, say, 'I'm a plumber, I'm an electrician', it just don't work out does it? (RD: Case 19)

I think re-training is only worth it if they put more emphasis on it. Now it's just like a conveyor belt, get you through, get you through, instead of trying to look at the problem properly. (MD: Case 39)

When asked how helpful the various agencies involved in retraining have proven to be, the most common response (n=16, 39%) was that no experience of such agencies had been gained. Of those subjects who did report some experience of such agencies, the majority described them as being either unhelpful or very unhelpful. Similarly, the number of subjects reporting that they had received no retraining (from agencies or elsewhere) since leaving the mining industry is higher than those who reported experience of retraining (n=23, 56.1%). Of the 18 men who did undergo retraining of some kind, two thirds said the training did help them in some way, though notably this was not always in helping to secure work in alternative industries.

It is of great importance that we make clear, as a number of those interviewed reported, that this reluctance to retrain is by no means due to a lack of ability on the part of former miners. Such shortsighted conclusions only serve to confound issues. Moreover, it appeared to be the unsuitable nature of the re-training that was offered, rather than the principle of re-training, which may be held more accountable for low levels of uptake.

Because a lot have this impression of miners, that they work underground, they're as thick as posts like, general consensus is that they won't adapt in any way. But a lot of people are surprised when they do employ miners, that they are adaptable and they are intelligent like, they use their initiative. (MW: Case 32)

Yes, they need better direction in what would be the best job for them. Miners were consistently underestimated, I was underestimated, and I therefore underestimated myself. There was a lot of clever lads down the pit, a lot cleverer than me, and I see these lads now and I don't feel that society has harnessed their ability, they've got to be encouraged to go for it. Some of them just haven't got the self-confidence. (SB: Case 4)

Consideration, however, must be given to the lack of emphasis on education prevalent in a great number of mining communities. Academic attainment had never been a high priority for those whose working destiny was the coal face. Low levels of education were indeed observed in the subject group with 24 (58.5%) of those interviewed reporting that they had no educational qualifications. As a consequence of increasing mechanisation, skills other than physical strength took precedence; but these were the skills of trade and craft apprenticeships, not those supplied through school education. The National Coal Board introduced exemplary apprenticeship schemes that were generally regarded as providing a benchmark level for other heavy industry sectors to emulate. These schemes commonly included subject areas, basic literacy and numeracy for example, that one might imagine lay more in the province of schools rather than that of employers. In a sense therefore, and no doubt introduced through necessity, the 'Board' reinforced the idea prevalent in mining communities that school education was less important. School children from these communities would leave at the earliest opportunity. The boys especially would then go to the mine and learn a trade. This accentuated the tendency to rely on a single employer to provide basic needs, while leaving individual miners without a broad-based educational level from which to build new careers when it became essential, through pit closure, to do precisely that.

On an industrial level, a failure to monitor stocks of knowledge, other than those directly related to production and optimisation meant that change, in any relation to its eventual true scale and nature, was largely unpredicted and entirely unprepared for. Moreover, the union's apparent misunderstanding of global markets (the appeal of cheaper coal imports), and its staunch reluctance to any degree of change coupled with an overconfidence born out of 'what had always been' proved to be catastrophic.

I don't think that the Government or Coal Board knew what to do. They were determined to shut pits, but nothing was done to soften the blow or set up and prepare areas for mass unemployment (apart from redundancy pay). They never thought what it would be like for someone who had worked in a totally different environment for 25 years and that they would be like a fish out of water. (JT: Case 41)

5.1d Agency:

The role of agency is clear when considering former mining communities, as given the strong boundaries kept in place by strong loyalty to the union and solidarity between miners, comparatively few significant agents, or groups of agents are identified. The most notable groups exerting a conscious influence over the industry and its workforce included the NUM, regional mine management bodies (National Coal Board, NCB) and government. Following nationalisation of the industry, the government and the appointed NCB are considered to be synonymous with each other, just as the NUM is with the huge majority of miners. These two regularly opposing agents are by far the most significant to our case. In focusing on the most wide-reaching and, purposive human intervention, Thatcher's government proved to be the most significant agency in bringing about the industry's rapid decline. The careful planning that went into undermining the union has already been discussed. Conversely in looking further at the application of 'means' to achieve 'outcomes', the 1984 national miners' strike called by the NUM is noted as an enormous undertaking, given its breadth, commitment and duration. The might and strength of influence residing in the industry and its workforce was clear.

There can be little doubt that coal mining and coal miners played a central role in helping to shape the economic, social and political landscape of Britain in the industrial age. This was still the case just 25 years ago, when the miners' strike and the three-day week demonstrated not only the industrial power that they held, but the pivotal contribution that the coal industry made to the national economy and to prosperity in general. (Gore et al, 2000: 18)

The following section on resources gives some notion as to the power the NUM were able to exercise over miners (membership used to be compulsory on beginning work for the NCB, though importantly, was welcomed by all), coalfield communities and the NCB alike. In the minds of many miners, they ruled, and a sense is given that respect for management was commonly undermined as a consequence.

The union was part of the social structure. It was part of your life, day-in, day-out. (Turner, 2000).

Turner also documents the coercive power of the union. Their influence was uniformly recognised and their ability to 'persuade' workers to take up night shifts, for example was often utilised. This strength of influence coupled with actions taken in the miners' common interest was not always of benefit to individuals (though crucially, this was not the intention). Instances prior to, and following nationalisation whereby mine owners or managers displayed a respect for their employees and were, in turn, held to be fair and just by their workforce were not uncommon. These vulnerable relationships, often built on trust were irreparably damaged by union calls on such workforces to take strike action for the common good of miners across the industry (Taylor, 2001). When analysing the process of agency in relation to our case study, it becomes clear that the union exerted considerable power over the structure and boundaries of social networks. The strength the union held was regarded by some to have been detrimental to individuals, and to have kept many from being offered work, though the overwhelming sense remains that the union was a positive influence and an intrinsically worthwhile organisation.

We have already described the monoculture that emerged in mining communities, and although it is clear that some form of heterarchy existed, and persists between the bulk of 'labour' (as opposed to 'management' men) who worked in the region's mines (and their families), it is similarly the case that such communities have never existed as truly even social systems in considering the distribution of wealth and more social forms of capital. One effect, perhaps following from the regard the miners held for the NUM rather than in acknowledgement of its power, was that a certain hierarchy emerged based on status within the union. Coal field communities looked very favourably on individuals involved in local Labour politics and this elevated sense of status was also afforded to union officials/secretaries. Post strike, however, the might of the union fell, in line with huge numbers of its members being made redundant. The contraction of a formerly dominant power reflecting their common interest has proven very difficult to accept and of those left in the industry, union membership is no longer the norm.

We've got about two hundred men on site, nearly half of them are in the Union. The others are either keeping their head down because they're frightened of site, or because they think that the Union is ineffective, partly because we haven't got recognition, but we haven't recognition because them daft buggers won't join the Union. There's a big difference, the power that we had before is gone. (DD: Case 2)

The notion of empowerment of the workers came into doubt following the NUM's defeat. Their common voice had been lost and a sense of learned helplessness emerged.

(I didn't like)...the uncertainty. Towards the end I felt like I was part of history, I felt like I was in the last act of a great tragedy, and I had no say in who wrote the script. (SB: Case 4)

Listen to the miners, help them, talk. There's got to be a lot more emphasis on letting the miners talk, before they start just shoving them into jobs they don't want. (SB: Case 4)

5.1.e Resources:

Since the very beginning of the industry, an inadequate relationship has existed between allocative and authoritative resources. Upon the discovery of great abundance of coal seams within the region, it was the landowners who were to capitalise on this allocative natural resource very early on in the industry's development, with (in the absence of workers' unions, safety or employment legislation) seemingly endless amounts of money to be made. Mines were then bought and the resources to extract the coal more efficiently developed by the new mine owners/companies and much later the coal board and government post-nationalisation in 1947. As acknowledged, control over authoritative resources, that is social interactions and, to a large degree, behaviour, has been largely exercised by the NUM since its beginnings (as the Miners' Federation of Great Britain, MFGB) in the late 19th century. By 1908 the membership of the MFGB was over 600,000 giving the MFGB tremendous strength as the organisation represented over a quarter of all trade unionists in Britain. The MFGB became the National Union of Mineworkers (NUM) on 1st January 1945 retaining a membership of 533,000.

The relationship between the coal and the communities coincides strongly with the processes involved in agency, most notably the distinction between power 'over' and power 'to'. Further to this, an important consideration has to be the politics and ideology of the agents involved. An almost inevitable breakdown in relations came about when the right wing government, preoccupied with 'market forces' came up against the will of a left wing union stubbornly resistant to change. The union's power 'over' the social networks, interaction and behaviour of miners and their communities became obsolete when the power 'to' deindustrialise was exercised.

6. Discussion: The dynamics of change

6.1 South Yorkshire mining communities: Collapse or transformation?

There is a striking dichotomy between the situation portrayed by official statistics, an uncynical one-line summary of which might be, ‘much has been done, much more needs to be done’ and the picture painted by recent social research. Unavoidably, all agencies involved in job creation feel compelled to present the best possible perspective on their performance in order to justify their contribution and existence. They have no real alternative to playing the numbers game.

In contrast with other nations – Germany being a case in point, as it is roughly at the same economic level as the UK and shared an equal dependency on coal – the UK’s strategy on dealing with the decline of the industry had more to do with a political desire to destroy the might of the industry’s union, identified in Mrs Thatcher’s memorable phrase, as the ‘enemy within’ (quoted in Critcher et al, 1995b: 187), through a rapid rundown of the industry itself, rather than planning a coherent switch over. This switch over in Germany included not only the sourcing of alternative energy supplies, but also the development and application of methodologies to help the people displaced by this transition. By contrast to the British situation, such strategies are characterised by foresight and strategic forward planning.

The ‘on the ground’ research within former mining communities reveals hopelessness, desolation and despair. An implicit assumption running through the various research reports is that there are no worthwhile jobs available and thus, inevitably, everything suffers. The unemployed ex-miners suffer increased levels of stress and related health problems; pressure and anxiety is placed upon their partners and families. Children of such families face the prospect of a lifetime of unemployment or relocation away from the area. The more able and better qualified are more likely to take the latter option; the less able remain. Crime levels increase and the area becomes more run down and dilapidated. Apart from the effect on morale of those who remain in what can be described as a slowly disintegrating environment, this acts as a powerful disincentive for outside businesses and organisations to move into the area. The result is an inexorable downward spiral.

‘The trouble with Featherstone, as with so many other former mining areas, is that whilst the old has certainly been displaced, the ‘new’ has definitely not emerged’. The ‘positive adjustment’ forecast by economists of the time hasn’t come about. (Turner, 2000).

6.2 Resilience and complexity: recipes for adaptive management

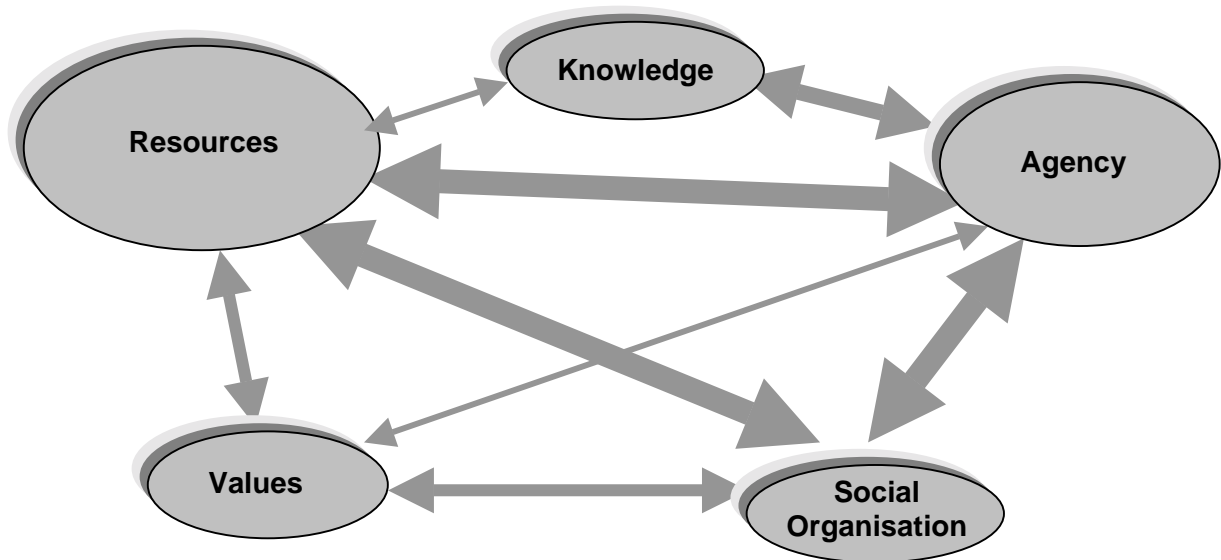
What the foregoing discussion demonstrates is that the degree of system collapse and the inability to effect sustainable strategies for transformation, effectively condemned the South Yorkshire coalfield to a type of slow death. A scenario in which local communities were caught in an ever downward spiral, as they appeared powerless to cope with the changing circumstances brought by alternative sources of energy and the threats posed by an increasingly competitive global market place. This failure to absorb change as we have seen was essentially a failure of system resilience; that is, the degree to which system structure is capable of self-repair and internal self-organization of its constituent parts. Crucially, we can see that the mining industry in this region lacked sufficient institutional flexibility to anticipate and combat changes wrought by a rapidly shifting political and economic landscape. In many ways, the south Yorkshire coalfield was a prisoner of its own history – a history of success that had locked it on to a rigid set of knowledge structures and values. In fact, the tight grip exerted by social and cultural traditions that had formerly provided the core values of community spirit and collective solidarity was to become an obstacle and ultimately a source of inaction. Thus, during the long slow

decline from the 1970s to the 1990s, it was this inertia inherent in the system and its attempts to deny the reality of changing economic and social conditions that worked against the establishment of new ideas and/or learning opportunities.

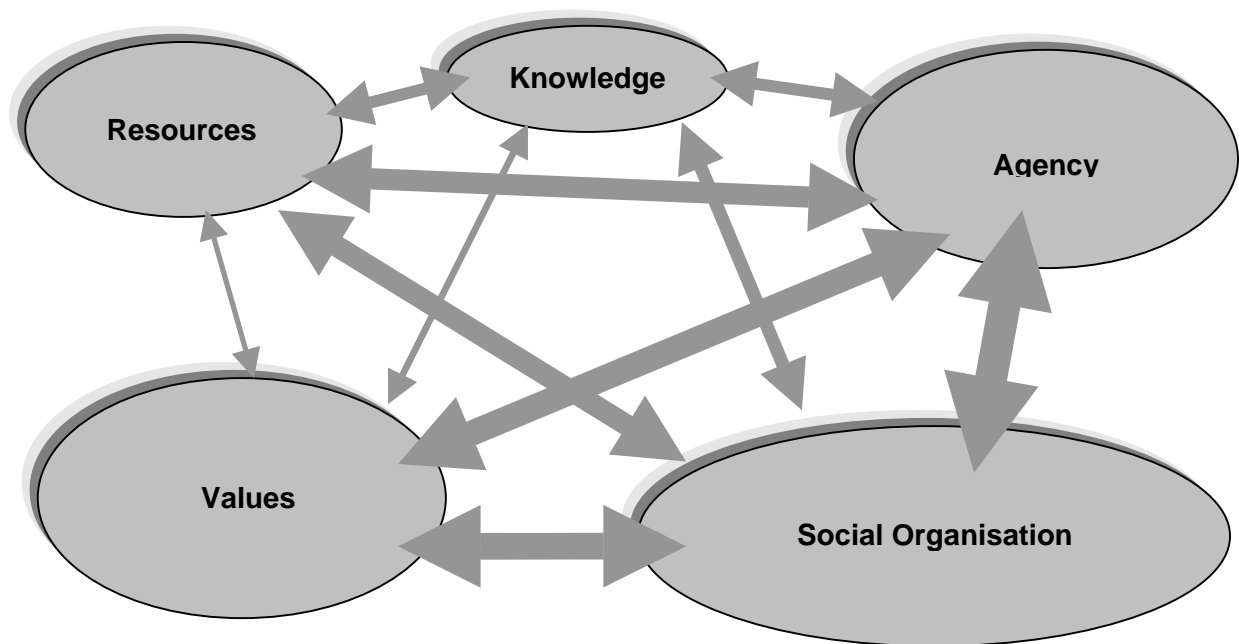
But perhaps the worst failure was the system's inability to manage change, to anticipate likely futures (however unpalatable) that was to signal the death knell of the industry. It is this ability to manage under conditions of uncertainty and to create flexible planning strategies – those designed to withstand the impact of unintended consequences – that is the hallmark of system resilience. The demise of the South Yorkshire coalfield provides us with a spectacular example of the consequences of the loss of system resilience coupled with a linear and blinkered view of the future. From a management point of view, it is above all, a failure to understand that the mining industry, as with any socio-economic system, must out of necessity be viewed as a complex nonlinear system, one that is characteristically far from equilibrium and hence, prone to the irruption of unanticipated, emergent outcomes. The message of complexity theory is that under such circumstances, the ability to make future predictions is severely compromised. By contrast, the prevailing wisdom in the mining industry seemed to be based on a 'knowable' future – one in which there would always be a market for coal, and consequently there would always be a need for a coal industry.

By way of conclusion, it is worth noting that while industrial decline is an exceedingly complex problem with multiple causes, it is clear that from a management perspective there has been a failure to acknowledge the importance of long-term strategic thinking. Planning has been characteristically short-termist, and decisions have frequently been retroactive; that is, they have been concerned with 'sticking plaster' or coping solutions, rather than the implementation of long-term adaptive management strategies. By contrast, what we have attempted to argue here is that successful adaptive management requires a more holistic reading of socio-economic systems and this can best be found in the adoption of a co-evolutionary perspective, one that recognises the centrality of institutional flexibility and change. Herein lies the basis of system resilience and long-term survival.

Fig 5. (Changes in influence of processes on socio-economic evolution: The size of each process is representative of its influence in determining the evolution of the S. Y. mining and community system as a whole. Arrow weights symbolize strength of connection – size of arrowhead at each end can be adjusted to represent which process exerts a stronger influence over the other)



1873: Resources had the greatest effect on the evolution of the socio-economic system. Landowners oversaw the creation of the industry and of workforce location to coalfields. The developing social organisation was largely dependent on this primary agency.



1973: As the NUM was able to exert greater influence on social networks (from which it grew) their power spread to govern social conduct and influenced identity throughout the region’s pit villages.

Resources as a process now included a new authoritative power 'over' the workforce and as such, perhaps the most significant means of production. A strength demonstrated by mass strike action.

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