We raise the question how Ireland can become an innovative knowledge economy. Questioning received orthodoxy we show that Irish culture should put more value on scientific skills, promote a scientifically literate culture, and reform institutional and structural support systems to develop an innovative knowledge-based economy. Developing the idea of knowledge as essentially a complex emergent phenomenon we illustrate the importance of system supports for the development of knowledge and learning through the idea of a national system of innovation. Using the Priority Pointing Procedure, derived from Nomology we explore the key priorities for Ireland.

Introduction

A decade of phenomenal growth has seen Ireland achieve close to full employment and with incomes at European levels. The cultural orthodoxy sees fortuitous planning by development organizations, enlightened taxation policy and educational excellence as the successful rain dance that brought economic progress (MacSharry & White 2000). The witchdoctor’s orthodoxy views Ireland as well placed to become Europe’s leading knowledge economy, a stated policy goal. The cultural orthodoxy envisions the possibility of foreseeing and influencing the future. The real world however is wicked. It is nonlinear, a system of “punctuated equilibriums” where order persists for periods of time and is followed by rapid change (Casti, 1991; Gell-Mann, 1995; Gould, 2003; Johnson, 1997; Kauffman, 1993; Taleb, 2003). The insidious consequence of this is that the past provides a poor guide to the future.

The shift to the knowledge economy is a problem of change. Change is essentially a wicked problem, with issues of interconnectedness, complicatedness, uncertainty, ambiguity, conflict, and societal constraints (Mason & Mitroff, 1981; Rittel & Webber, 1973; Roberts, 2001). Understanding change and addressing the problems of change requires tools that address complex problems. One method for exploring difficult problems is through the Priority Pointing Procedure (Brugha, 2000), rooted in Nomology. Nomology is based on abstracting existing “regularities in human behaviors that are present in almost all fields of decision making” (Brugha, 2000). It derives from Kant’s idea that our knowledge of nature conforms to the structure of the human mind (Kant, 1985). The origin of Nomology related to an attempt to resolve policy problems of transport in a conurbation (Brugha, 1974). It specifically addressed the issue of large-scale complex societal problems too difficult to solve using any mathematical or computer model.

The basic inference of Nomology is that qualitative structures are not unique to particular subjects, times and regions. They are central to how the mind works and are the reason for similarities between languages and cultures and academic fields. Nomology does not fit into any field; it is a meta-modeling approach that suggests that the generic categorizations of human activities should be applicable to every field including Policy (Brugha 1998a, b & c). Nomology is focused on understanding the nature of problems. It works on the basis that people attempt to resolve complex problems by breaking them down into less complex ones using simple questions Brugha, 1998a), reflecting our common mental structures. These questions have the form “is the problem more of this sort, or that?” Derived from Nomology, Priority Pointing uses three such dichotomies to identify the general location of the priority problem within any system under investigation. In developing our argument we make the link between Nomology and a number of other areas. We draw the links to Stacey (2000, 2002), who has developed a theory of knowledge, which is rooted in complexity theory. Stacey starts from George Mead’s idea of gesture and response in animals, where meaning arises from the complex coordination of gesture and response in social acts, a process that is the result of the emergent behavior of increasingly complex self-organizing systems. We develop this idea with examples from research and practice on knowledge and innovation (Cook & Brown, 1999; Lundvall, et al., 2002; Mokyr 2000, 2002), and link to the idea of a national system of innovation (Freeman, 1995; Godin, 2004; Lundvall, 1994, 2004).

We illustrate a misunderstanding at policy level of the term knowledge and suggest that Ireland may be less well positioned than imagined to capitalise on becoming an innovative knowledge-based economy. Questioning received orthodoxy, we show that Irish culture should put more value on scientific...
skills, promote a scientifically literate culture, and reform institutional and structural support systems to develop an innovative knowledge-based economy. In terms of a complex system we illustrate how structure of the social systems and the history of those systems determine the space and capability for future development and innovation.

Complexity, policy and the knowledge economy
State Policy and the Importance of the knowledge economy

State policy has played a critical, if not always positive, role in the development of the Irish Economy. Despite visionary schemes such as rural electrification, economic development in Ireland stagnated up to the end of the 1980s (Lee, 1989, Ó Gráda, 2002). De Valera’s vision of comely maidens dancing at the crossroads yielded to the cruel reality of the emigrant boat. State initiatives were more discursive than action oriented. The Telesis report (1980), withheld from publication for more than a year, was substantially ignored in the 1984 paper on industrial policy (Lee, 1989). More recently, the Culliton report (1991) focussed on the importance of economic policy as the driver of industrial policy and of prosperity. Through a combination of State policy, location, and luck, the late 1990s saw the development of “the Celtic Tiger”, and has led to a clustering of IT and Pharmaceutical companies in Ireland (Ó’Riain, 1997a, 1997b, 2000; Tallon & Kraemer, 1999; Kraemer & Plice, 2001 Krugman 1997).

More recently the Irish State, through the Information Society Commission (ISC, 2002), has recognized the importance of the knowledge-based economy, envisioning a move to a ‘knowledge-based society’ as the prerequisite for future economic development, “holding the status quo is not an option. We move forwards and embrace the conditions necessary to underpin higher value economic activity, better jobs, and new social prosperity. Or we prepare to fall into relative decline.” (ISC, 2002 pp 7)

We are constantly reminded of the rise of the “knowledge economy” (Godin, 2004), with the attendant requirement for change in state, business, and society (ISC, 2002). There is no doubt that change is important, something recognized since Heraclitus commented, “the only constant is change”. In the biological world, Darwin determined that “it is not the strongest of the species that survive, nor the most intelligent, but the one most responsive to change” and evolution provides a powerful metaphor for the development of society and business. Even the rate of change and renewal appears to be increasing. Drucker (1994, 1999) suggests that increasing interconnectedness and intensifying complexity will require change and renewal more frequently, alluded to by Toffler (1970) and reinforced by Gleick (1999). It is clear that the ability to learn to manage change is a “sine qua non” in today’s world, and that those economies that thrive will be knowledge-based “learning economies” (Johnson & Lundvall, 2001).

Driven by the growth of Information Technology, and the strength of the US and other economies in the 1990s, and fuelled by a number policy documents on the importance of a knowledge economy (OECD, 1996a, 1996b, 1997; Stiglitz, 1998, 1999; Romer, 2000) consensus has emerged. A number of States, including the UK (DTI, 1998), New Zealand (MTI, 1999), and Australia (Australia, 2001), have produced reports on the importance of the knowledge economy. Ireland takes this a step further in discussing the term “knowledge society” (ISC, 2002). At a regional level the avowed aim of the European Union is to make Europe “the worlds most innovative knowledge-based society” by 2010 (EU, 2000a, 2002f xxxx).

We begin by asking if this is this more than empty rhetoric, a debate generating more heat than light? The knowledge-based economy, under various guises, is seen as the cure for all society’s ills. Decades of experience in IT tells us there “there are no silver bullets” (Brooks 1987, 1995). There is a problem inherent in the idea of the “magic bullet”. As Bond (2003) points out “Technology is frequently imagined as society’s ‘magic bullet’, and as such will silence all opposition to its critics. However, it may prove to be a flawed solution to longer term problems.” (Life is more complex than any panglossian approach would suggest. Each era of change brings with it losers as well as winners at both micro (individual) and macro (country) level. Why is an innovative knowledge-based economy seen as a panacea? An antonym of panacea is ‘magic cure’, and one wonders if the focus of the knowledge economy is the modern equivalent of the alchemist’s quest for the philosopher’s stone. Alchemy holds a lesson for us. Newton was one of the last of the alchemists and one of the first scientists (White, 1997). By exploring the phenomenon of the knowledge-based economy, we may be able to begin the winnowing process, and find the true value in the idea.

Policy as a wicked complex problem.
An obsession with predicting the future is a universal human characteristic (Brown, 1991; Casti, 1991; Johnson, 1995; O’Nullain, 2002; Pinker, 2002). From the shaman’s reading entrails and the Oracle at Delphi to astrologers preparing horoscopes, people seek to determine what the future will be. Modern attempts at long-range economic and weather forecasts have fared little better than their predecessors, due

Casey & Brugha
to the non-linear nature of the phenomena (Casti, 1991). If predicting the future is difficult, influencing the future is more arduous, akin to the witchdoctor who commands rain from the heavens. If the rain comes, the witchdoctor is the cause. The past decade of phenomenal growth has seen Ireland achieve close to full employment and incomes at European levels. The cultural orthodoxy sees the fortuitous planning by development organizations, enlightened taxation policy and educational excellence as the successful rain dance that brought economic progress (MacSharry & White 2000). The witchdoctor’s orthodoxy sees the location of high technology companies such as Intel, Microsoft and Dell as exemplifying the success of the past rituals and views Ireland as well placed to become Europe’s leading knowledge economy. The cultural orthodoxy envisions the possibility accurately predicting the future. This ignores the wicked, non-linear, nature of our world (Casti, 1991; Gell-Mann, 1995; Gould, 2003; Johnson, 1997; Kauffman, 1993; Taleb, 2003). The insidious consequence of believing the witchdoctor is that it builds complacency, reinforces vested interests, and dwells on the past, itself a poor guide to the future.

Unfortunately for the orthodoxy the Irish economic miracle is due as much to exogenous factors as to endogenous ones. A complex combination of location and luck played no small part in the development of the “Celtic Tiger”, as Ireland’s economy caught up with that of other European countries after three quarters of a century of under-performance (Krugman, 1997; Ó’Riain, 1997a, 1997b, 2000; Tallon & Kraemer, 1999; Plice & Kraemer, 2001; Ó’Gráda, 2002.). One could as easily ask why the Irish economy stagnated for so many decades while other countries thrived, as it is to ask why it grew in the 1990s (Lee, 1989; Ó’Gráda, 2002; Garvin, 2004). Tactically we may have been doing things right, but strategically were we doing the right things?

Krugman (1997) has examined the growth of Ireland from a geographic perspective, and see a number of elements to its success. First, the development of “weightless” goods (e.g. Financial Service and Software) where peripheral location is not a serious restricting factor makes Ireland as good a choice as any other in Europe, becoming a backshop (a location easily accessible when required) within the European Union. Second, is the possibility of self-reinforcing success, the possibility that the early location of firms created a demonstration effect, which resulted in herding. Ireland appeared attractive as a location. Early firms set up and did well. Other firms chose Ireland as it delivered on the early success, creating a cascade effect. This is similar to the model developed by economist Brian Arthur (1990) where historical accidents can create a self-reinforcing mechanism that concentrates an industry geographically (Arora, et al., 2000). This is similar to the idea of path dependency in complexity theory where the process of future choices are constrained by past decisions. The fundamental problem is that the link between cause and effect is weak and not predictable.

This problem becomes more apparent in relation to policy questions raised by Amsden and Mourshed who asked “why, in fact, did heavy investments in education in Korea and Taiwan initially lead to brain drain and unemployment, not spillovers in the domestic economy?” (Amsden & Mourshed, 1997). This parallels the experience of mass exodus of the first fully educated generation of youth from Ireland in the 1980s. Amsden and Mourshed pointed to the importance of policy packages in Korea and Taiwan countries which were “designed to build long-run technological capabilities and subsidise companies so they could compete immediately abroad and at home” (Amsden & Mourshed, 1997). The route Ireland followed in late industrialization was the converse of this approach, “industrialization by invitation” through attracting Foreign Direct Investment (FDI) in the form of Multinational Corporations (MNCs) (Trauth, 2000; Ó’Gráda, 2002).

**Addressing the policy problem**

What is required for Ireland to prosper, to develop as an innovative knowledge-based economy?. This is neither an easy nor a simple question to investigate. We are looking at a national agenda for development, in a rapidly changing world. Given the difficulties it could be compared to attempting to steer a canoe, through a fog. The nature of change, means that the question being addressed is often only properly understood when an answer is found (Mason & Mitroff, 1981; Roberts, 2001). One of the respondents to the primary research ventured as much when commenting “these are difficult problems to solve there are no easy solutions and the new directions are not obvious”. The Priority Pointing Procedure (Brugha, 2000) helps to identify new directions in a systemic way.

Nomology utilizes some of the concepts described by Simon (1996): “Complexity frequently takes the form of hierarchy and that hierarchic systems have some common properties independent of their specific content”, and that “nature is organized in levels, and the pattern at each level is most clearly discerned by abstracting from the details of the levels far below”. There is a larger sense in which nature appears to be fractal, an idea that patterns of behavior repeat at different levels of complexity. This has parallels across many streams of thought from Kostler (1964) to Pirsis
The basic inference of Nomology is that qualitative structures are not unique to particular subjects, times and regions. They are central to how the mind works and are the reason for similarities between languages and cultures and academic fields. Nomology does not fit into any field; it is a meta-modeling approach that suggests that the generic categorizations of human activities should be applicable to every field including Policy (Brugha 1998a, b & c). Nomology is focused on understanding the nature of problems. It works on the basis that people attempt to resolve complex problems by breaking them down into less complex ones using simple questions Brugha, 1998a), reflecting our common mental structures, our underlying shared phylogeny (Maturana & Varela, 1992). Derived from Nomology, Priority Pointing focuses on three dichotomies to identify problems within a system. The first dichotomy examines what needs to be done to resolve the problem within a system. If we are uncertain about the action to take, then we will focus on planning. If, on balance, we feel relatively clear about the direction that should be taken we will focus on putting a solution into effect. The second dichotomy examines where the action needs to take place. The resolution to the problem is either through actions on place, for instance in some structural element of the State, or through focusing on the people involved in the system. The final dichotomy asks which way a problem should be resolved. Should we rely more on using position, an impersonal approach, or should we be focusing more on people using a personal solution to the problem? This dichotomy is the perennial dilemma of a top down versus a bottom up approach to problem solving. In section 3 below we explore the issue of problem understanding, and link it to the core concepts of knowledge and innovation and explain how Priority Pointing can improve our understanding of complex policy problems.

Analyzing at the level of the national system of innovation

In examining the problem it is important to focus our analysis at the right level of detail. In our discussion here focus on the level of the State and the States role in innovation and development. How do countries innovate, and how do they create the systems of innovation that drive national growth? We can see this generally in historical analysis by Wright (2000) and Mokyr (2002). Wright (2000) points to the agglomeration of States in the late middle ages in Europe as the advent of technology (the printing press) created defined language boundaries across Europe as a driving force behind innovation and development, people shaping technology, then being shaped by it. The increasingly complex nation states were able materially to support the societal conditions that preceded growth. There was a new openness as the “Scientific Method” developed in the age of “industrial enlightenment” (Mokyr, 2002). These developments set conditions for growth and development (Mokyr, 2002). To structure this historic analysis and to understand current development we need to use the idea of a national system of innovation. The concept of a national system of innovation derives from the work of Freeman (Freeman, 1995; Lundvall, 2004)

In developing the idea of a national system of innovation Lundvall, et al. (2002), highlight the problematic nature of the difference between tacit and codified knowledge (Johnson & Lundvall, 2001), an issue we return to in section 3 below. General macro-economic theory has focussed on rational expectation and general equilibrium frameworks. This purely instrumental rationalism of traditional economics leaves no room for learning by individual human agents. New growth theory (Romer, 1986, 1990) stresses the importance of investment in research and education. Lundvall, et al., (2002) link the role of innovation to relationships involving non-price relationships, questions of trust and the difficulties in transmitting tacit knowledge, illustrating the importance of diffusing cultural constraints for the transfer of tacit knowledge. Acemoglu & Robinson’s work on the role of politics in economic performance reinforces this view (Acemoglu & Robinson, 2002). Lundvall, et al., (2002) demonstrate how rationality is tied to performance and the idea of communicative rationality (Habermas, 1984) “characterized by a shared and genuine interest in understanding new phenomena, mastering new techniques and sharing their knowledge” (Lundvall, 1996) is preferable to strict instrumental rationality under which no learning would take place. This approach resolves the problem of the contradictory predictions of economic theory. This is supported by Sala-i-Martin (2002) examination new growth theory. Reiterating Mokyr (2002) and Acemoglu & Robinson, (2002) Sala-i-Martin finds clear evidence that institutions are important for growth in that they affect the efficiency of the economy. The key argument is that it is hard to come up with better technologies within an economy if do not have right institutions.

The structure of the system of national innovation is critical to economic progress in that its structure guides what is produced and what competencies are developed. The question Lundvall et al., address is how does the capacity for learning one of the key elements of the communicative rationality in a knowledge economy develop (Lundvall, et al., 2002). The rate of change within economies places a premium on rapid
learners in the current learning economy (Lundvall & Johnson, 1994; Archibugi & Lundvall, 2001). The effectiveness of investment in Information Technology, (a human defined artefact) is linked to tacit knowledge and understanding of social relations (Markus, 1983; Markus & Benjamin, 1997; Remenyi, et al., 1999, 1999b; Brown & Duguid, 2002).

Systems that are better able to innovate are better able to change. The emphasis is on dynamic structures and Lundvall, et al., (2002) argue for building new institutions for policy learning and co-ordination to improve national systems of innovation. The idea of a national system of innovation (Johnson & Lundvall, 2001) encompasses both the cultural context of innovation and institutional structures that affect innovation from an autopoietic perspective. Governments, policies, and institutions shape economic incentives and the rules of the market and have a first order effect on economic development (Mokyr, 2000, 2002; Acemoglu & Robinson, 2002). The importance of the system of national innovation is that its culturally embedded structure guides the development of competencies and the dynamics of production within a State.

Examined in the light of the national system of innovation the invidious consequences of concentrating policy on Foreign Direct Investment (FDI) in Ireland over the past decade becomes apparent. FDI has had a distorting effect on indigenous industry. Arora et al. (2000) has found that Irish software companies have tended to be smaller than the international average and have a lower life expectancy to relate to the presence of Multinationals. There have been few spillovers effects to the local economy (Arora, et al., 2000). The over reliance on FDI was commented on as far back as the Telesis report (1980) which “queried the Irish emphasis on foreign investment, and advocated greater commitment towards developing an indigenous industrial base.” (Lee, 1989 pp 531). More recently Ó’Gráda describes the policy of encouraging FDI as a replacement of a strategy or “export-subsidizing industrialization” replacing a Strategy of “import-substituting industrialization” (Ó’Gráda, 2002).

The idea of national systems of innovation recognizes that innovation is engendered in language and dialogue as dynamic forms of interaction generate new knowledge. Knowledge is autopoietic, a term that means self-producing, generated at the boundary as data from outside perturbs the system. Dynamism is central to understanding knowledge and innovation. To generate knowledge requires a dynamic element. Our access to knowledge is socially mediated; culture constrains patterns of thought and of value. The more open a culture is to ideas, the more dynamic and questioning it is, and the better ecosystem it creates for generating innovation and knowledge. The more static a culture is, trying to preserve everything and resisting the dynamic element the poorer the ecosystem. The culture, structure, beliefs, and values of a society create a national system of innovation that ideally links theory and practice, using learning based on human communication generating new innovative forms.

Knowledge, complexity and culture: Understanding problems through priority pointing
Autopoiesis, culture and complexity

Auto-poiesis is a complexity-based theory that can be used to examine the issues of culture and the national system of innovation. Autopoiesis provides a biological analogy for understanding the development of human language and understanding (Maturana & Varela, 1980, 1992). Autopoiesis claim is that basic principles of biology can be traced from simple cells up through animal societies to man. For instance people use chemicals such as pheromones to communicate in a way similar to other species (Watson, 2000). At a higher level of development, mammals and especially humans use language as an autopoietic function. The key difference is that “human language confers the capacities for self-identity, self-consciousness, and reflection” (Denning, 2003), to a degree not seen in other species, including higher primates (Deacon, 1997). Pirsig (1992, 1995) traces similar patterns of increasing complexity from inorganic life to the levels of society in a comparable albeit not identical mechanism to Maturana & Varela.

Autopoiesis has been used to examine a number of aspects of information systems, knowledge and social systems (Kay and Cecez-Kecmanovic 2002; Luhrmann, 1986; Mingers, 1995). Sveiby (2001) recognized the link between autopoiesis and Polanyi’s (1958) concept of “personal” knowledge and uses the idea of autopoiesis as a basis for epistemology in his ‘knowledge based theory of the firm’. Winograd & Flores used autopoiesis to consider the question of design “how a society engenders inventions whose existence in turn alters that society” (1986: 4). Using autopoiesis we can describe social activities in human terms as a “highly sophisticated process of cooperative interaction between people in the medium of symbols in order to undertake joint action” (Stacey, 2000). This impinges directly on our understanding of innovation. Innovation is defined as “the action of innovating; the introduction of a new thing; the alteration of something established; a new practice or method” (OED, 1992). Innovation is essentially a creative endeavor, generating something, be it simple or profound that did not exist previously. Koestler defines creative acts as “the combination of previously unrelated structures
in such a way that you get more out of the emergent whole than you have put in” (Adams, 1996). This is the idea of synergy as the basis for human progression described by Corning (2003).

This symbiotic combination of ideas as the basis for human innovation parallels the genomic combination that underpins the evolutionary process of speciation, the innovation of new forms in nature (Marguiles & Fester, 1991; Dennett, 1995; Marguiles & Sagan, 2003). Autopoietic interaction underpins the evolution of species (Marguiles & Fester, 1991; Marguiles & Sagan, 2003). In autopoietic terms the structure of the systems and the history of those systems determine the space and capability for future development and innovation. In biological terms the development of cells necessarily preceded the evolution of flora and fauna. In social terms interaction and language, the swapping of ideas in a synergistic manner form the basis for innovation. At the same time, cultural frames constrict what actions and innovations are possible. Foucault illustrated this problem when describing ‘regimes of truth’ which constrain us “it acts upon their actions: an action upon an action, on existing actions” (Foucault, 1982 p 220). This anticipates Kuhn’s analysis of how paradigms constrain normal science (Kuhn 1970), and Mokyr’s description of how the openness of the industrial enlightenment, the culture of the time created systems of national innovation that led to the industrial revolution (Mokyr, 2002)

**Knowledge, contingent, complex and emergent**

The question of what knowledge is, is vexatious. It is beyond the scope of this piece to provide more than a précis of this question[1]. Our view is that understanding the idea of knowledge and the nature of knowledge is best understood by understanding the paradox of knowledge. The essential paradox of knowledge is that it exists in two form’s a tacit form which cannot be processed, the idea of knowledge as flow and an explicit form knowledge as a thing (Snowden, 2002). Snowden (2002) and Allee (1997) both use the idea of the wave and particle theories of light to explain this paradox. Light exists both as a wave and as particles, each dimension is important as each explains different elements of light and our understanding of light is incomplete if we take a single perspective. Snowden (2002) links to Stacey’s view of knowledge when he describes the flow element of knowledge as “an ephemeral, active process of relating”.

This dual nature of knowledge is reflected in the etymology of the word. Wittgenstein said, “The limits of my languages are the limits of my knowledge”. The word knowledge illustrates the limits of our language and the difficulty in recognizing the dual nature of knowledge. The words data and information are nouns, words that represent things. The word knowledge in English has both a noun and a verb form, and “covers the ground formerly occupied by several verbs, and still answers to two verbs in other Teutonic and Romanic languages” creating a “… difficulty in arranging its senses and uses satisfactorily… It covers the ground of the Ger. wissen, kennen, erkennen, and (in part) können, of Fr. connaître to ‘know by the senses’ and savoir to ‘know by the mind’ … To know may mean either to perceive or apprehend, or it may mean to understand or comprehend… Thus a blind man, who cannot know about light in the first sense, , may know about light in the second, if he studies a treatise on optics” (OED, 1989). When we talk of knowledge we are talking of a process and a thing.

Knowledge in this sense is essentially complex and autopoietic, emergent as is language itself. Drawing on Damasio (1996), Stacey finds that “Mind is the action of the brain, rather like walking is the action of the body”. Stacey concludes that “knowledge is that act of conversing and new knowledge is created when ways of talking and therefore patterns of relationship change”. This view of knowledge is reflected in the embodied, emergent nature of language. Ramachandran (2003) has detailed how the mind, the body and language may have co-evolved, indicating at the same time how the body, language and creativity are intimately linked together. Recent work (Ramachandran & Hubbard, 2001; Ramachandran, 2003) based an examination of people with Synesthesia leads to the theory that language was boot-strapped by a number of factors in the brain. These include the hierarchical nature of tool-making being co-opted for the hierarchical nature of. The “pre-existing translation if you like between the visual appearance and the auditory representation.” (Ramachandran, 2003). And the cross activation between the hand and the mouth. Ramachandran illustrated this through an example of Darwins “when people cut with a pair of scissors you clench and unclench your jaws unconsciously as if to echo or mimic the movements of the finger” (Ramachandran, 2003). Language, is therefore and emergent complex phenomenon. We see in this a reflection of the base cognitive structure of Nomology. Recent theories the embodied mind support this view (Damasio, 1996; Deacon, 1997; Lakoff & Johnson, 1999; Maturana & Varela, 1992). Regularities in the mind, and the presence of human universals are a consequence of our evolutionary descent (Deacon, 1997; Dennett, 1995). This underpinning for Nomology, has been confirmed by Neurobiology (Damasio, 1996), by the presence of human universals across all cultures (Pinker, 2002; Harris, 2000) and behaviours (Ekman, 1992). It reflects the commonality of universal grammar and the role of metaphor as a core constituent of language (Lakoff & Johnson, 2003).
This raises the fundamental question of how can an economy be based on something that cannot be possessed, or can only in part be possessed. Knowledge is embodied and embedded in people, their relationships, their interactions, and their reflective actions. Knowledge is generated in language and dialog as dynamic forms of interaction generates new knowledge. A national system of innovation is essentially an ecosystem that ideally gives rise to and supports a rich and diverse set of innovative possibilities. The more open a culture is to ideas, the more dynamic and questioning it is the better ecosystem it creates for generating innovation and knowledge. The more static a culture is, resisting and imitating to change the less innovation is generated. The danger is that a policy approach becomes a monoculture, favouring ideas that have worked in the past. For Ireland the over reliance on FDI could be perceived as similar to the over reliance of the potato as the staple food crop, a development that led to the Irish famine.

The culture, structure, beliefs, and values of a society create a national system of innovation ideally generating links between theory and practice, learning based on human communication generating new innovative forms. These elements are reflected in the economic development of States and in the technical progress that states make. The economics of knowledge generate a nonzero sum game with the possibility of increasing returns to an economy, returns based on human capital and the interaction of people. Learning in a knowledge-based economy creates both the capability to generate new innovation and the capacity to absorb knowledge generate elsewhere. The active participative nature of knowledge and its fundamental importance for growth force us to recognise that learning is a lifelong process. It also points to the need for educational reform to ensure educational structures recognise and respond to the needs of students.

Our understanding of knowledge and its role in wealth emphasizes the importance of having the correct national structures to maximise innovation within the economy. Our understanding of knowledge illustrates that Irish dependence on mobile external intellectual property for wealth generation is a pernicious legacy of an over reliance on Foreign Direct Investment. Fundamentally, Ireland needs the correct State policies in place to foster local innovation, a system of secondary education that produces a scientifically literate knowledgeable society, a system of tertiary education that generates new knowledge, an industrial system that works with the educational system to produce innovative goods and services, a system of state structures that provides the overarching framework to support innovation. The system must be dynamic enough to anticipate, pre-empt, and adapt to exogenous change yet static enough preserve the ability to change. These are key priorities for the Ireland if it is to really become an innovative knowledge based economy.

Understanding the nature of problems

Understanding the nature of the problem is the key to addressing the problem. Problem framing and understanding is key to problem solving (Casey & Brugha, 2005a, 2005b). Alverson (2002) notes “much problem-solving effort is directed at structuring problems, and only a fraction of it in solving problems once they are structured” (Simon, 1996 p. 187). He describes “The problem-setting stage, where the issue is defined as a member of a certain class, as critical to understanding is the exercise of Aristotle’s concept of phronesis. Phronesis often translated as ‘prudence,’ ‘practical wisdom,’ or sometimes simply ‘ethics.’ It is an action-oriented concept, associated with doing the correct thing in a given situation, and is often characterized as wise deliberation.”.

The idea of framing the problem draws on a number of domains. Fundamentally we see the world as portioned into a number of problem domains. These have been variously described by a number of authors. Weinberg (2001) describes the nature of problem as existing in three domains, simple problems amenable to linear cause affect analysis, machine simplicity; problems with large numbers of elements that can be resolved through statistical analysis; and the set of problem he refers to as organized complexity resolvable through whole systems thinking. Snowden (2002) takes this a stage further and use four types of classification (see Figure 1) problems to which the solutions are known, those which are knowable though analysis, those which are chaotic and unconnected and complex problems.

Snowden’s definition mirrors that of Roberts (2001) who proposes that wicked problems are those where “1). There is no definitive statement of the problem; in fact, there is broad disagreement on what ‘the problem’ is. ). Without a definitive statement of the problem, there can be no definitive solution. In actuality, there are competing solutions that activate a great deal of discord among stakeholders – those who have a stake in the problem and its solution. 3). The problem solving process is complex because constraints, such as resources and political ramifications, are constantly changing. 4). Constraints also change because they are generated by numerous interested parties who “come and go, change their minds, fail to communicate, or otherwise change the rules by which the problem must be solved” (Conklin & Weil, N.D., p. 1). “ This is the definition of a policy problem such as the development of an innovative knowledge-based economy. Snowden
calls his approach to addressing complex problems, multi-ontology sense making. In a similar vein Roberts approach requires a plurality of perspectives in framing and resolving the problem. This parallels Richardson’s view of pluralism in Management Science (2005) that “to fully understand complex systems we must approach them from many directions - we must take a pluralistic stance.”

Figure 1 Problems Classification (after Snowden, 2002)

In adopting Nomology and Priority Pointing to address the problem we are explicitly adopting a pluralistic approach. Priority Pointing is in Snowden’s terms developing an environmental probe, to enable us to sense the priorities and to respond to them. We have developed this notion of pluralism in a number of previous papers (Brugha, 2001; Casey & Brugha, 2005a). The essence of pluralism is reflected in how we deal with our natural dichotomies. We see dichotomies reflected in the everyday world, the conflict between tacit and explicit knowledge, left and right brained thinking, thought versus action. In developing a pluralistic approach we seek to accommodate all dichotomies in a dynamic cycle of understanding. Nomology recognizes that every system involving qualitative understanding will have an inbuilt tendency to try to find balance between all the relevant dichotomies. Nomology’s idea of balance parallels that of Fitzgerald & Howcroft (1998) who proposed the metaphor of polarity to analyze the notion of meaning, an idea also used by Carroll (2001). The idea being that magnets have both a north and south pole. Neither can exist without the other—remove the North Pole section of a magnet and a new magnet is created from this section with both north and south poles. “These poles exist not in isolation of each other, but by virtue of each other” (Fitzgerald & Howcroft 1998; Carroll, 2001). We must learn to live with these contraries (our dialectic paradoxes or dichotomies), which generates creative tension (Carroll, 2001).

The priority point probe
Priority Pointing treats the issue under investigation as a system focusing on three dichotomies to identify problems within a system. The first dichotomy examines what needs to be done to resolve the problem within a system. If we are uncertain about the action to take, then we will focus on planning. If, on balance, we feel relatively clear about the direction that should be taken we will focus on putting a solution into effect. The second dichotomy examines where the action needs to take place. The resolution to the problem is either through actions on place, for instance in some structural element of the State, or through focusing on the people involved in the system. The final dichotomy asks which way a problem should be resolved. Should we rely more on using position, an impersonal approach, or should we be focusing more on the person, using a personal solution to the problem? This dichotomy is the perennial dilemma of a top down versus a bottom up approach to problem solving.

Figure 2 Dichotomies and Activities

The development of two dichotomies for each of three questions produces eight principal activities described by Brugha (1998a, 2000). This is illustrated in Figure 1 above. A healthy balanced system will find equilibrium between doing too much and too little of each activity (Brugha, 1998b). The development of any system naturally flows through each of the eight activities beginning with uncertainty, moving to more certainty over time. Within these dichotomies, a vigorous system will alternate between people versus “place” (structure-orientated) approaches, and personal versus positional (non personally-interacting) approaches to resolving a problem, establishing equilibrium along the way.
The first two dichotomies lead to the four general activities termed Push, Pull, Perception and Proposition. The third dichotomy leads to the eight principal activities - Pounce, Procedure, Price, Policy, Promotion, Productivity, Pliability & Practice. These activities are represented in the Priority Pointing Wheel (Figure 3) below. The imagery of the wheel is important as Nomology takes a systems approach to decision making considering the whole, not just the parts. Within Priority Pointing the focus can move between the four quadrants and eight sectors, which operate in a cycle when solving a problem in management. Each activity is important and there is a natural flow through the quadrants to resolve a problem, figuring out conceptual proposition of the problem, agreeing on the common perception of the solution, pulling people into alignment to ensure that the plans can be put into effect, finally pushing the system into alignment to ensure the changes to the system are practiced. The application of the procedure is based on asking six open questions (Brugha, 2000). The questions are designed to elicit responses along existing dimensions that are believed to reside in the minds of the respondents. The six questions are broken down into two general questions and four specific questions that address the four general activities (quadrants) of the Wheel. These questions need to be “expressed in colloquial language familiar to the respondent, relate specifically to that sector, and be completely open and unbiased” (Brugha, 2000).

The two general questions are divided into a general punch and a general prevention question. The questions in the four quadrants can be either punch or prevention questions creating the possibility of a pool of eight questions to draw from. In analyzing the four quadrants we are examining two specific dichotomies, ‘planning’ v. ‘putting’ and ‘people’ v. ‘place’. These dichotomies represent the vertical and horizontal halves of the wheel respectively. The questions need to be carefully chosen to ensure that there are both punch and prevention questions in both people and place halves of the wheel. Similarly, there should be a punch and a prevention question in both of the planning and putting halves of the wheel. Using this approach the a questionnaire comprising the six questions listed in Table 1 below was developed.

<table>
<thead>
<tr>
<th>Sector</th>
<th>Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Punch</td>
<td>What is needed for Ireland to become an innovative knowledge-based economy?</td>
</tr>
<tr>
<td>General Prevention</td>
<td>What is preventing Ireland from becoming an innovative knowledge-based economy?</td>
</tr>
<tr>
<td>Prevention Question in Proposition Sector</td>
<td>What is stopping us from resolving these problems?</td>
</tr>
<tr>
<td>Punch Question in Perception Sector</td>
<td>What should be done to increase our understanding how to become an innovative knowledge-based economy?</td>
</tr>
<tr>
<td>Prevention Question in Pull Sector</td>
<td>What is holding us back from working better as a society to become an innovative knowledge-based economy?</td>
</tr>
<tr>
<td>Punch question in Push Sector</td>
<td>Are there any structural or policy changes we can make which will help us become an innovative knowledge economy</td>
</tr>
</tbody>
</table>

Figure 3 The Wheel

The questions are divided into two categories punch and prevention. Punch is defined as “the need to have sufficient support for some activity”, and Prevention as “the need to ensure that no activity is used excessively” (Brugha, 1998b). Punch and prevention are used to indicate the flow of power within a system. A balanced system will find equilibrium between doing too much and too little of any activity. In a complex environment, this balance is a dynamic not a static equilibrium and is responsive to change, calling for the constant adjustment of the system. This reflects our understanding of complex non-linear systems and is indicative of change in the modern business environment.
Determining Ireland priorities

Primary research

Primary data was gathered using a survey mechanism using six questions. The primary questions were of “what does Ireland need to do to become an innovative knowledge-based economy?” 135 questionnaires were posted to individuals within Irish based Information and Communications Technology (ICT) companies and related organizations who have an interest in this area. Individuals were selected from Chief Executive Officer/Chief Technology Officer level from companies who are involved in industry trade and lobby organization such as The Irish Software Association, and ICT Ireland. Further questionnaires were sent to University researchers and senior members of semi-state organizations including Forfás[2], Science Foundation Ireland, Ireland Information Society Commission and Enterprise Ireland. A total of 39 responses were received giving a response rate of 28.78%. To maintain the anonymity of the respondents the single page survey included identical stamped addressed envelope for returning the surveys. The option was provided for respondents to identify themselves to receive a summary of the completed research.

The replies to the primary survey point to a number of fundamental issues. There was recognition that “these are difficult problems to solve. There are no easy solutions, and the new directions are not obvious”. In the current climate, there is a competition for resources “lack of commitment at Government level and other more critical priorities with respect to resources”. Having achieved success in the 1990s respondents saw Ireland “Resting on the laurels of the Celtic tiger”; we have become too complacent to the dangers. “We are in the ‘fat dumb and happy’ phase of our economic/industrial development. When we wake up to the threat of east European and Chinese knowledge economies it may be too late”. There is a clear “recognition that a knowledge-based economy will not come out of the current business/education/union structure we have today”. The national system of innovation is flawed and inimical to innovation.

Underlying all of these issues are cultural attitudes. There is a problem of “vested interests and cultural apathy” and there is an acknowledgment that “culture takes time to change”, particularly the issue of our cultural attitudes to science and entrepreneurship. The Irish education system is not geared to science reflecting, “peoples attitudes to science in general”. Institutions and structures do not just shape attitudes, values, and beliefs in a vacuum; they embed and reflect existing values, beliefs, and attitudes making change difficult. Ireland’s approach to universities as places of learning, not places of commerce results in a “mindset in universities, which does not recognize that its role is essential in creating knowledge, protecting IP and commercializing it”. This combination of problems results in “inertia at all levels”. Ireland does not value science and is not willing to pay for it, illustrated by the historic low levels of investment in R&D. The “governments percentage of the contribution for R&D (about 26%), is much less than in other countries. It follows that we are dependant on non-governmental investment, which while admirable, yields outcomes which are less readily altered for Ireland’s strategic interests”. “Our attitude as a nation that science is highbrow and not for the masses” and a “cultural bias against science particularly since the down turn” is at the core of the problem. A number of other problems are competing for attention and people are “preoccupied with the current bread and butter issues distracted from the problems in these areas”.

The issues that are holding us back are deep structural, and cultural issues, not superficial ones. There is a clear incongruity between where Ireland needs to go and the current value system. There is an unwillingness to pay the price required to become an innovative knowledge-based economy. Ultimately it requires a “question of belief in what the building blocks of the future are; people must be convinced of the value of the knowledge-based economy”, without an appreciation of this there can be no real progress towards a culture of lifelong learning (“education at all levels”) and entrepreneurship (“risk culture”).

Identifying Ireland priorities

Brugha (2000) suggests a three-level analysis of the results of the priority pointing procedure. “The primary diagnostic method is to seek the greatest imbalances, e.g. push versus pull, then pliability versus productivity, and then, within pliability, punch versus prevention. The secondary diagnostic method is to accept the view of the greater number, e.g. push rather than pull, and then practice rather than pliability. Notice the conflict that can arise between the primary and secondary methods. The tertiary method is by content analysis.” Applying all three methods in this case leads to the same conclusion, a culture apathetic to science does not value the skills and activities needed to develop an innovative knowledge-based economy. This problem is preventing us from taking action to resolve our difficulties. There is an urgent need for a debate at a societal level to highlight this problem. Concomitant with this is the need for the State to promote the scientific and engineering skills required to develop an innovative knowledge-based economy as well as reforming the institutional and structural support systems to enable this to happen. The content analysis also throws up the issue of lack of resources to solve the problem. This ties in the areas of Price and practice and shows some of the deeper issues with pliability in the State.
The primary data provides us with a cogent summary of the current situation of the Irish State on the route to becoming an innovative knowledge-based economy. The problem is one of awareness and of the negative perception of the value of science in society. The problem is a pernicious one, with self-reinforcing negative feedback circuits. There are problems with the education system because we do not value science. The route to resolving the problem is through promotion and pliability, essentially reforming the structures to improve the education system to create a scientifically literate culture. But because we do not value science promoting these changes is difficult and making the necessary changes to the existing structures is complex. The proper framework for an innovative knowledge-based economy is missing. There is poor understanding of science, little research and development, and poor linkages between university and industry, essentially a lack of communicative rationality. The structures and the policies that should enable a dynamic vibrant informed citizenry is missing. In its place are bureaucratic, static structures, inflexible and resistant to change. Intractable problems including changing attitudes, reforming obdurate cultures, and transforming obdurate values have yet to be tackled. There is a lot to be done and it must be done in a coherent systematic way, treating the whole rather than each part of the system individually.

**Supporting Research**

There is significant supporting research for our conclusions. There is general problem of education for the innovative knowledge-based economy, difficulties in research and development, problems with structures, University, Industry, and Technology Transfer, issues of Culture, Values and Innovation and difficulties caused by the role of the State and its institutions. We provide a summary of these findings here. For the full details of this research we direct you to Casey (2003) & Casey & Brugha (2004)

The Global Information Technology Survey 2003 (WEF/Insead, 2003), which examines readiness for the knowledge-based economy of the future, ranked Ireland 24th in quality of mathematics and science education, 28th for literacy and 37th for secondary school enrolment. One notable point that it found there is only a 77% completion rate for secondary education, figures confirmed by the Central Statistics Office. The IMD Global Competitiveness survey examination of Ireland in relation to 29 small economies ranked Ireland 17th for scientific education (IMD, 2003). In recent EU surveys Ireland ranked last of the EU 15 in belief in the importance of the development of new skills are important for career (EU 2002b, 2002d; EuroStat 2001)

The problems with the education system are ongoing issues that were in one sense compounded by the introduction of free secondary education in 1966. As Wickham (1997) points out “Because it simply made access to the academically oriented system easier, rather than changing the system itself, it ensured for the next thirty years Irish education would be marked by continual ‘academic drift’ (NESC, 1985).” The education system values rote learning over vocational development and distorts the content of second level education, setting the focus of education as jumping a specific hurdle rather than as a preparation for life. The problems of the points systems is linked with Lee’s criticisms of the educational aspirations of the Irish professional classes and their “obsession with entry into secure professions (law and medicine) rather than science and technology” and “their lack of entrepreneurial drive” (Lee, 1989; Wickham, 1997). The high points required for law and medicine and the ongoing decline in points for science and engineering illustrate the persistent nature of this problem.

David Guile points to similar deficiencies in the structure of education systems within the EU, systems which foster an impoverished notion of knowledge as a process of acquisition of facts (Guile, 2003). The flaw he points to is that this approach conflicts with the needs of a knowledge-based society to generate new knowledge, to innovate. Guile calls for the development of tools for tools for intellectual exploration, criticism and understanding among students, further emphasizing the urgency of the Taskforce recommendations

In relative terms, the EU currently lags US spending by 0.75% of GDP. In absolute terms this mean the US spends 40% more on government funded R&D as a percentage of GDP than the EU. When converted into monetary terms the difference is $92.67 Billion. The figures for Ireland indicate a miserly approach to investment in R&D. Ireland spends 1.21% of GDP on R&D using the GERD approach. Accounting for the distortion to GDP caused by transfer pricing of Multinationals in Ireland (Barry, 2002) and using the lower figure of GNP Ireland still emerges with a figure of 1.42% investment in R&D. These differences are magnified when compared to the EU target figure of 3% (Gannon, 2003)

The Irish Sate is required to investment an extra $595 million per year to make up its current shortfall. In 2000 the Irish Government established Science Foundation Ireland (SFI) with the goal of establishing a world-class scientific infrastructure in Ireland. The figures above include investment by Science Foundation Ireland in R&D since and indicate that even if SFI realizes its ambition to establish 50 world class research groups within Ireland will
not even manage to keep pace with other countries. The Higher Education Authority (HEA) recognises the “The need for significant allocations for research technology and innovation will be difficult trajectory for Ireland” (HEA, 2002). This again points toward the issues of price and promotion and the problems with pliability in the Irish innovation system.

The Irish Council for Science, Technology and Innovation report on “Utilizing Intellectual Property for Competitive Advantage” (ICSTI, 2003), points out that there are significant problems with the commercialisation of research in Ireland. Key among these is there is no system of management of public funded IP, and there is lack of professionalism in technology transfer. Underpinning this is that there is no backlog of IP waiting to commercialized in Irish Universities. The poor level of R&D at a national level in Ireland is reflected in the lack of intellectual property developed by the University system. The ICSTI report also points to cultural gaps between universities and Industry.

ICSTI (2001) in similar findings states that “ten-fold increase in resources would not bring us to the level of our principle competitor countries”. Technology transfer does not just happen it has to be actively pursued. There are a number of models available. Harding (2002) provides examples from the German innovation system while Abramson et al., provide examples of the US model. People cause spillovers and knowledge transfer. The presence of MNC’s and large-scale investment in FDI in the Irish economy has resulted in some contradictory outcomes and very poor spillovers (Arora et al., 2000; Ó’Gráda, 2002). Ó’Domhnaill (2003b) describes how the boundaries between disciplines and organizations cause knowledge fragmentation. Referring to research on Japan, Ó’Domhnaill points out that technology transfer between universities and firms involves transfer of tacit knowledge linked with co-location (Wen &. Kobayashi, 2001; Ó’Domhnaill, 2003b). This is the idea of knowledge developed in Chapter 2, the creation of meaning and shared understanding through the interaction of people, leading to learning and the development of innovation and new knowledge. One specific approach to accomplishing this is through the development of business incubators designed to foster economic growth. There is a lack of development of such centers in Ireland when compared to other EU countries (EU, 2002f). Notably those countries better at transferring and diffusing knowledge have more incubators.

**Summarizing the Priorities**

The ominous state of R&D in Ireland further illustrates issues of how we value science and how our institutions structures are inadequate for future growth and development. The issue of technology transfer further reinforced this issues and also illustrated the link between knowledge, innovation structure and promotion. The detailed examination of culture points to the historical origins of the problem in the rigid cultural system and described some steps towards changing this culture, again bound up in issues of structural change, and promotion and management of change within the structures and the value system. The final step involved reviewing the role of the State the center where these changes must begin if Ireland is to become an innovative knowledge-based society. The combination of the primary data analysis, supported by the secondary data has uncovered the priorities for Ireland in developing as an innovative knowledge-based economy as the need to appreciate the value of science, innovation and knowledge. The necessary steps to resolving this situation begin through active promotion of a scientific culture, and the active creation of the dynamic flexible structures, literally a national system of innovation, to support, nourish, and encourage this new culture.

**Conclusions**

This project set out to explore “What are the key priorities for Ireland to become an innovative knowledge-based economy?” In an earlier paper (Casey & Brugha, 2004) we presented some of these findings. Fundamentally the national system of innovation is flawed and inimical to innovation. There is a problem of “vested interests and cultural apathy”[3] and an acknowledgment that “culture takes time to change”, particularly the issue of cultural attitudes to science and entrepreneurship. The Irish education system is not geared to science reflecting “peoples attitudes to science in general”. The problem is one of awareness and of the negative perception of the value of science in society, (price in the wheel in Figure 3). This is a pernicious problem, with self-reinforcing negative feedback circuits. It affects the education system because it does not adequately value science. The route to resolving the problem is through promotion of science, and pliability, essentially reforming the structures to improve the education system to create a scientifically literate culture. A further Exploration of this is given in Casey & Brugha (2004).

In this paper we have examined the policy implications for Ireland as an innovative knowledge-based economy. By highlighting the complex nature of knowledge, innovation and social policy we have questioned the cultural orthodoxy that sees Ireland well placed to become an innovative knowledge based economy. Tolstoy wrote “It is beyond the power of the human intellect to encompass all the causes of any phenomenon. But the impulse to search into causes is inherent in man’s very nature. And so the human intellect, without investigating the multiplicity and
complexity of circumstances conditioning any event, any one of which taken separately may seem to be the reason for it, snatches at the most comprehensible approximation to a cause and says: 'There is the cause'. We have attempted to address this question without falling into the trap that Tolstoy has discussed. By using a number of ideas derived from various strands of complexity theory, the nature of knowledge, language and embodied cognition; by relating them to the national system of innovation and by subscribing to the importance of a plurality of perspectives, accessed through the Priority Pointing Procedure we have begun to probe this question and to deepen our understanding of what is required to develop an innovative knowledge based economy.

Priority Pointing does not offer a detailed prescription. There is no suggestion of a magic bullet, there are no magic bullets to resolve complex problem. Priority Pointing points to where the solution is not, e.g. not more planning, than to where the solution is. It does not suggest the form of activity within the promotion and pliability sectors. It does provide a rich language with which to discuss the issues further, a language provided by the respondents. This overcomes the Wittgenstein problem: “the limits of my language are the limits of my thoughts”, by creating a language based on a shared context which points towards the actions to be taken. It is a very practical and useful procedure. The same study could be done in other countries or regions, and the results compared, both the emerging priorities and their language. The same procedure can be applied to any strategic question. The main difficulty is with the interpretation of the answers.

Ireland has and continues to rely on external support for the development of the economy. There is a perception that the way to resolve the knowledge deficits is through the spending programs such as Science Foundation Ireland. The problem is that these programs will fail without the creation of a communicative rationality that perceives the value of knowledge sharing, without the structural support to encourage such sharing and without the cultural belief in the importance of science and technology. As with any healthy system the Irish national system of innovation needs to be capable of dynamic changes, of autopoietic second order learning. Not being able to predict the future means we need to hedge our bets, by sustaining the requisite fit with our current environment while planning for (and creating) changes in this environment. The key to future economic success is diversity, trying many things, accepting that not all of them will succeed, maintaining a healthy doubt over our own plans and predictions. Like the witchdoctor we are not able to control the rain. However, a healthy dynamic system of national innovation could provide us with an umbrella.

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Notes
[3] Quotes in this section are taken from responses to the six questions.