An Approach to Understand, Capture and Nurture Creativity and Innovation Knowledge

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Abstract

In many organisations (e.g. IDEO, Nissan, Chaparral Steel) the ability to be innovative and first to the market is their key to success and even survival. Finding and retaining creative minds is difficult, as innovators often become entrepreneurs of their own companies. Current recruitment techniques include the use of psychometric instruments (such as the KAI inventory and Myer-Briggs), role-playing, skill tests and scenario analysis. Our approach is complementary and based on the view that since innovation is a process, starting with novelty-seeking behaviour and ending with an innovative product, that certain individual characteristics and personality traits will be appropriate at different phases of the process. To capture innovation-related knowledge, we acquire 'war-stories' from recognised innovators in the form of scenarios and potential responses. This story-bank becomes a means of identifying potential business partners or employees who will respond in ways considered desirable by the organization as well as a means for identifying what areas the individual or organisation are deficient with respect to the innovation process.

Keywords

Creativity, Innovation, Tacit Knowledge, Knowledge Management

INTRODUCTION

In today's competitive and changing knowledge economy, to remain or become a leader, organisations must do more than keep up with the status quo, they must be innovative and creative (Leonard and Sensiper 1998). While technology can improve productivity, it cannot generate and implement new ideas, for this we need people (Jacob and Ebrahimpur 2001). Creativity is linked to high problem solving ability but is more than the ability to come up with novel ideas. What is also needed is a high level of motivation and persistence (Kaufmann 2001). In the past organisations have employed instruments such as the Kirton Adaption-Innovation (KAI) Inventory or the Myers-Briggs Type Indicator (MBTI) Creativity index (Gough 1981) to identify innovators. However, the KAI inventory is focused on such things as better understanding of oneself and others in order to improve managing and working in teams with people of different personality and decision types. For example, Kirton defines an innovator as someone "less concerned with 'doing things better' than with 'doing things differently'" (Kirton 2001). This may be true but as Claxton (2001) points out, innovation without implementation leads to fatigue and cynicism, while implementation without innovation leads to bureaucracy. The related KAI literature actually recommends a balance of types within a group and is thus not really seeking to identify individuals who will be able to both generate and realise the innovation. Unlike approaches using techniques such as the KAI Inventory or MBTI Creativity Index, we focus on the behaviour of individuals who have had results rather than on characterising the nature of this type of person. In keeping with the findings from the longitudinal Minnesota studies of Van de Ven *et al.* (2000), we consider innovation to be a process rather than a number of "discrete acts of a single entrepreneur". Thus, our approach will sometimes result in "thinking out of the box" by adding new scenarios and/or responses and sometimes previously suggested responses will be appropriate.

Decision making is one of the key behaviours we are concerned with. Research has shown that decisions are arrived at through the combined use of almost equal amounts of tacit and explicit knowledge (Giunipero, Dawley and Anthony 1999). The approach that we propose captures knowledge-in-action via scenarios, which can be viewed as cases grounded in the real world and based on experience, thus spanning both codified (explicit) and practical (tacit) knowledge (the Authors 2002). While this project focuses on innovation knowledge, the approach to be developed will be extensible to the capture of other types of knowledge and will further our understanding of expert behaviour, expertise and knowledge itself.

Our inventory will contain narratives entered and maintained by recognised innovators in the field of interest. As Information and Communication Technology (ICT) is our field of expertise, we will initially focus in this field. The use of stories in knowledge management has been explored by others, such as Schultze and Boland (1997) who have suggested a discussion database as an effective way of communicating organisational memory. Stories provide context and stimulation (Snowden 2002) that is often missing from more traditional forms of information

and knowledge repositories such as manuals and databases. They allow the past, current and future cultures surrounding the story to be both explained and created. Mitroff *et al.* (1974) suggest that data only becomes information when "tied to an appropriate story that has personal meaning to the individual who needs the information, the organisation in which he is located, and the type of problem that he faces". They call such a system a Management Myth-Information System. The stories we offer, however, will be more structured and context based than the current approaches to handling narratives, as we will also be collecting a range of potential responses to the situations described. Additionally, we will capture scores associated with each response indicating the perceived desirability of such a response. Our approach will use stories in the form of scenarios as a means of learning how to handle certain situations in the case of training and how to identify applicants for recruitment that will respond in ways considered desirable by the organization.

THEORETICAL AND METHODOLOGICAL BACKGROUND

Any research involving creativity and innovation requires a working definition of what is meant by these terms. Use of these terms has become so popular, particularly in the mottos, mission statements or objectives of many organisations, that they can in many cases be interpreted as meaning little more than "we want to appear to be different and ahead of the rest". We want to avoid such a trap. In seeking to identify creative and innovative people we are not just seeking to identify those who are able to produce ideas or behaviours that are different or even new. As indicated in our introduction, we make a distinction between creativity and innovation, roughly defining creativity as coming up with a new idea and innovation as implementation of that idea. In this section we want to break these notions down further and add a further term which acts as a precondition to creativity: novelty-seeking. We have adopted the Novelty-Generation-Model (NGM) developed by Schweizer (1994) , a clinical psychologist in the Dept of Technology and Innovation, Erasmus University Rotterdam. The NGM is well-grounded in the theory and previous work on creativity and innovation and provides definitions and concepts which we apply to the development of an innovation knowledge inventory. The Authors have collective expertise in the Knowledge Management field.

Definitions and the Novelty Generation Model.

In this subsection we introduce some of the key concepts of the NGM and provide more precise definitions of the notions of novelty-seeking behaviour, creative behaviour and innovative performance. The model is presented in Figure 1. We cover most, but not all, of the terms in the diagram in our discussion below. Much of the discussion is a summarisation of the work contained in Schweizer (2004).

The NGM is a biopsychosocial approach. The approach recognises that at a genetic level some people are, for instance, more inclined to look for new problems and able to come up with novel solutions. Metabolism also plays a part as the body's breakdown or production of chemical substances such as neurotransmitters, such as Dopamine or hormones have been shown to affect novelty-seeking behaviour. Above average novelty-seeking individuals have been found to seek out more stimulating experiences, possibly via drugs. Highly creative behaviour has been linked to reduced Latent Inhibition (LI) (Carson, Peterson and Higgins, 2003) which is the extent to which the brain is able to ignore stimuli outside of the current focus of attention. While novelty-seeking individuals are likely to invent a problem that does not currently exist, they are slow to find a solution as they go through a process of "incubation" of the ideas which seems to reduce the retrieval of solutions or patterns that might already be stored in memory. It is interesting to note, in this the year of Einstein, that Einstein was considered a slow learner/thinker at school. Claxton (1997) has found that a low speed of thinking is inspiring. This fits with a physiological view that associates "low levels of cortical activation, more right than left hemisphere activation and low levels of frontal-lobe activation were found to accompany the state of creative inspiration" (Martindale, 1999 in Schweizer 2004). Given that the creative process requires at times over-stimulation and at other times under-stimulation it is also common for creative individuals to exhibit mild to strong mood-swings.

Moving to the psychological aspects of novelty-seeking and creativity we find a number of personality theories including Pearson's novelty-experiencing scales (NES) (Pearson 1970) which included a construct "tendency towards creativity". Some, such as Loewenstein (1994) see novelty-seeking more in terms of curiosity based on a greater need for information or sense-making by the individual. Looking at novelty-seeking as distinct from creativity allows us to distinguish between those who are bored easily and seek something "new" to replace the boredom. What they replace the current boredom with may not actually be a novelty, simply a change for them. It could be trying new foods or an insatiable hunger for learning more about our planet. "Novelty-seeking behaviour does not mean to produce something novel, that is creating something. Novelty-seeking behaviour is purely the absorption of novelties, which may serve as a pre-phase for creative acts" (pp 41-42). Following Cloninger *et al.'s* (1994) Temperament and Character Inventory (TCI) "individuals high in Novelty Seeking tend to be quick-tempered, excitable, exploratory, curious, enthusiastic, exuberant, easily bored, impulsive, and disorderly' (p.22). Schweizer summarises Cloningers findings as follows "Novelty-seekers represent a type of

human beings who continuously learn and study and who perceive stagnation as an unpleasant state, whereas change, diverse interests and variation are perceived as pleasant states" (42-43). More recently Cloninger has concluded that "self-directedness, cooperativeness and self-transcendence" are character traits conducive to creative behaviours. Zuckerman (1994) offers sensation seeking scales which includes: thrill and adventure seeking; experience seeking (e.g. via travel or the arts); Disinhibition (via social activities); and boredom susceptibility which is a low threshold for repetition and routine. Cloninger's novelty seeking and Zuckerman's sensation seeking scales correlate about 70%.

Many other personality models have been offered, many of which contain constructs or attributes concerned with novelty-seeking or creativity and focus on providing personality traits to distinguish different types of individuals. Creativity has become associated with the personality traits of "judgemental autonomy, self-confidence, risk-taking, non-conformity, independence, and a critical attitude towards norms" (Schweizer 2004 p. 46). But as Schweizer further points out "to create something requires a combination of many traits, including the discipline and perseverance to transform new ideas into a product". (p 47). A more realistic alternative to trying to equate a personality type with being novelty-seeking or creative is to view creativity as a process. This process includes the phases of: preparation (attention directed to an area), incubation (focus on other things, area moved to the unconscious), illumination (an insight occurs) and verification (insight produces something that others can recognise) (Wallas 1926). Mumford and Gustafson (1988) describe creativity as a syndrome with five elements that take into account various characteristics of the individual as well as the characteristics of the environment which influence and evaluate what is produced. If we view novelty-seeking, creativity and innovative performance as three distinct behaviours, an organisation interested in employing "innovative" employees is really seeking to either create a team which comprises of members that exhibit one or more of these behaviours and is able to work with others to provide the behaviours they lack (as we said earlier this is in effect what the MBTI is really seeking to do) or we need to employ people who are a "combination of moderately high novelty-seeking with efficient, organized and persevering behaviour [who] can be expected to be the ideal combination for the production of novelty" (p49).
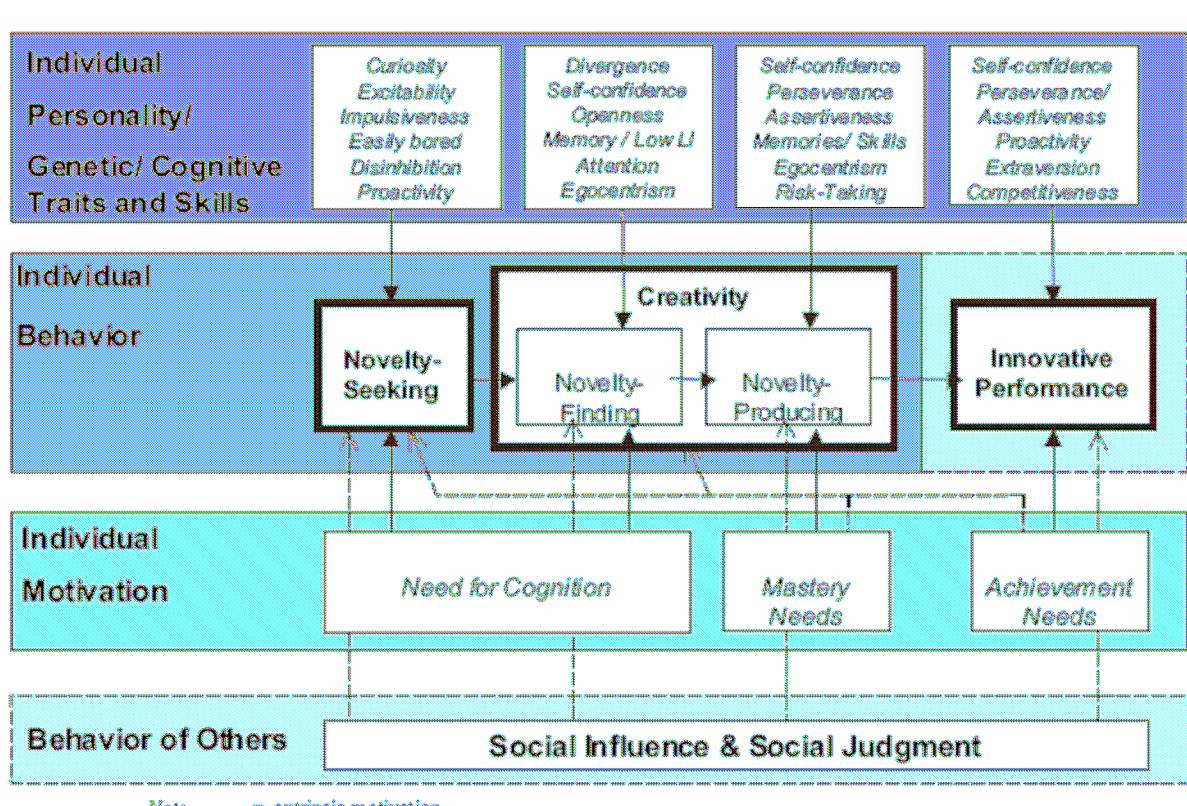
Figure 1: The Novelty Generation Model: A Biopsychosocial Approach (Scweizer 2004)

Based on the literature, including those briefly introduced above, Schweizer has developed the Novelty Generation Model. In the model, the first step is novelty seeking followed by creativity which is broken into novelty-finding and novelty-production. To move beyond the novelty phases requires development of something that can be recognised by others and is highly dependent on two specific motivations that are part of motivation and achievement goal theory: mastery goals which concerns the degree to which an individual personally wishes to become competent in something and performance goals which concerns the degree to which the individual

wishes to prove their competence to others (Van Yperen 2003). These two motivations can be classified as intrinsic and extrinsic, respectively. The model in Figure 1 shows intrinsic motivations in solid lines and extrinsic motivations in dashed lines. While only touched on in the preceding discussion, the existence of extrinsic motivations highlights the importance of social factors when it comes to creativity and innovation. Just as expertise is a title conferred by others and is very dependent on environmental factors, including cultural and social, whether an idea is deemed to be novel and worthy of development depends on those to whom the idea is presented. Similarly, Schweizer reminds us "history teaches that social recognition for a new idea is not necessarily received by the person, who had the new idea, but the person who is able to convince others about this idea. Here lies the difference between creativity and innovative performance" (p. 51).

To clarify, adopting the definitions of Schweizer (2004)

> Novelty seeking is dopamine-regulated, exploratory behaviour supported by specific personality and by cognitive parameters and is intrinsically motivated by the need for cognition, and extrinsically motivated by the mastery or achievement needs (p. 54).

> Creativity is behaviour supported by three processes that are fed by specific sets of personality and cognitive traits: firstly, the process of novelty-finding intrinsically motivated by the need for cognition and secondly, the process of transforming the novel findings into a visible product, which is intrinsically motivated by mastery needs, while both processes can also be motivated by mastery needs, while both processes can also be motivated extrinsically by achievement needs; and thirdly, a non-causal process that emerges in the metacognitive and contemplative levels of self-aware consciousness (p. 54).

> Innovation is the outcome of an interaction between individual and social factors including on the one hand an individual's behaviour fed by specific personality traits and achievement needs and on the other hand the either intrinsically or extrinsically motivated social judgement behaviour of others who publicly acknowledge aspects of novelty in the product(s) presented by this individual within a defined range of comparison, either because they do experience novel stimuli in this product and/or because they experience it as socially desirable to pass such a novelty judgement (p. 62).

We intend to use Schweizer's approach as a framework for structuring the capture and application of the innovation knowledge inventory. We will seek to capture scenarios that address each of the personality/cognitive traits and skills; individual behaviours, individual motivations and the behaviour of others.

Knowledge Based Systems and Tacit Knowledge Measurement and Diffusion

As part of the tacit knowledge measurement and diffusion research previously conducted by the authors, a tacit knowledge inventory of ICT workplace scenarios (the Authors 2003) was developed. Extensive case studies using this inventory were conducted in three organisations to determine who were significant holders of tacit knowledge, what social networks existed within the organisations, whether cliques or bottlenecks existed to impede knowledge transfer and whether biographical factors such as age, gender, ethnicity and education had an impact on the amount of tacit knowledge held or transferred. This approach was developed after extensive review of the literature on the nature of tacit knowledge and research into its measurement. While a few isolated and domain specific approaches have been explored by others, the work led by Sternberg at Yale in the field of psychology was the most well-reported, established and accepted. Thus, the approach we have to tacit knowledge testing follows along the lines developed by Wagner and Sternberg (1991a, 1991b). Our use of scenarios to capture knowledge is also in keeping with current thinking within the field of knowledge management (Snowden 2002).

The measurement approach adopted is one of workplace scenarios with options for dealing with a situation which are 'tested' by respondents. Sternberg's group at Yale tends to use in the order of 12 scenarios with 4 – 12 answer options on average for each scenario. After various investigations we found that the basic 'themes' of tacit knowledge in the IT workplace could be handled with 16 scenarios with as few as 6 answers (for Scenario 5) and up to 12 answers (for Scenario 3). For each one of the answer options presented there were seven-point Likert scales (Extremely Bad, Very Bad, Bad, Neither Good nor Bad, Good, Very Good, Extremely Good). Participants did not see a numerical value, only the wording from Very Bad through to Extremely Good was visible so that respondents would not be biased by numerical weightings to questions. Two Likert Scales per scenario were presented, requesting both an Ethical and a Realistic value as a means of working out how much variation there would likely be between what a person 'should' be doing, as opposed to what they would actually do. A similar approach had been adopted by Wagner and Sternberg (1991a; 1991b). Identification of experts was achieved by asking respondents to choose colleagues they felt were particularly proficient at what they did in the social network analysis component of the questionnaire. This list of people within each organisation were identified as comprising the expert group. Identification of experts and non-experts is a key factor in determining

the existence of tacit knowledge as it is assumed that experts hold more tacit knowledge than their non-expert counterparts. The details of the research goals, methodology and case studies of our previous work are given in (the authors 2004; the authors 2003). The essence of the work was development, deployment and detailed analysis of a survey conducted within three organisations. The questionnaire included an inventory of 16 ICT workplace scenarios that sought to test how experts (as nominated by their colleagues as part of the survey) responded to these typical scenarios. See Figure 2 for a sample scenario and answer option that relates to specific knowledge in the ICT industry. The responses of the peer-identified experts are treated as the tacit knowledge oracle and compared against the responses of novices. To determine if there are differences between population groups (age, gender, ethnicity, educational background, employment tenure) and the levels of tacit knowledge present within the groups, and whether this knowledge is likely to be passed from and among these different groups, biographical data was also collected via the survey. The responses of the experts and novices, together with their biographical characteristics were analysed using statistical methods and modelled qualitatively using Formal Concept Analysis (Ganter and Wille 1999), which permitted finer grained analysis in a graphical form.

In addition to modelling the knowledge and the features of the knowledge holders, we sought to map the likelihood of intra-organisational diffusion of tacit knowledge among information technology personnel. The term likelihood is used here, because absolute knowledge transfer is difficult to prove other than through the ability of reading another's mind. In order to gain an insight into knowledge flows, we used Social Network Analysis (SNA) (Wasserman and Faust 1994) to illustrate relationship patterns between participants in the form of questions answering who is seen, how frequently, the meeting importance and the formality of the meeting (for example, a chance meeting at the coffee machine vs. a formally organised and conducted meeting).

Scenario 2

The network manager wishes to install a token ring network. This person has been with the organisation for 6 years, you however are a junior technical analyst, but realise that a Ethernet backbone would better suit the layout of the building.

You have been with the organisation for three years, but before that you were a network administrator for a couple of years in another small organisation.

To complicate matters further you are a Certified Novell Engineer (CNE), the manager does not actually have this qualification but has 'work experience' instead. Admittedly you realise the network manager has been able to acquire the necessary hardware and software at 'reasonable' rates (because the administrator is good friends with the suppliers of equipment), however you know that an Ethernet network would be simple to install and also relatively 'affordable'.

Rate each of the following responses in relation to the given scenario. It is advisable to read all of the responses before replying.

1. Approach the network manager with contacts of your own (made during your time in the previous organization) whom you feel could offer an even better deal.

ETHICAL
Choose one:

| Extremely Bad | Neither Good nor Bad | Extremely Good |

REALISTIC
Choose one:

| Extremely Bad | Neither Good nor Bad | Extremely Good |
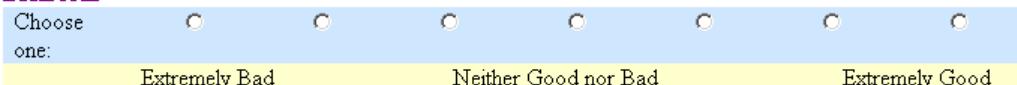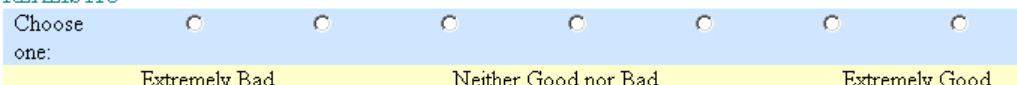
Figure 2: Scenario 2 from the tacit knowledge inventory and Answer Option 1

FOCUSING ON CREATIVE AND INNOVATIVE KNOWLEDGE

The proposed work will carry on and extend the previous work of the authors with a narrowing of focus on innovative and creative type knowledge and a change of direction into application of the approach to personnel recruitment and training. In the proposed project we are not concerned with determining the social networks within an organisation or measuring the flow of tacit knowledge. This could be done in a subsequent project. The purpose of the inventory is different and the proposed method for development of the inventory is new. In our previous work we developed the inventory based on interviews and a pilot study. In this study we will offer an approach which allows experts to enter and maintain their own experiences. The approach is not domain-specific

but can be used in which innovation knowledge is to be captured. Direct capture of expertise from the source avoids the costly need for intermediaries such as knowledge engineers and the inevitable loss of knowledge through interpretation and translation. Easy and self-managed maintenance is an important feature when dealing with knowledge which is by nature continually changing and evolving.

Instead of focusing on the characteristics of innovators, such as personality and decision styles, which may not really be indicators of successful implementation of innovative ideas, this project will focus on capturing their behaviour via their retelling of their stories in the form of scenarios. In a nutshell our approach will involve the recognised innovators entering their key "war-stories", identifying a number of possible responses to the situation and providing a score for each response indicating the merit of such a response. Expert innovators from the same field will also rank and add their responses to the scenarios of other experts. Thus a bank of scenarios will be both developed and tested and available for use to determine whether the behaviour of a (potential) employee is similar and whether training may be needed in some areas. The approach and inventory also becomes a valuable means of exploring questions such as whether there are patterns of behaviour by innovators within and/or across (sub)fields and will provide a rich source of data for discovering the knowledge that expert innovators utilise.

To explain the various types of knowledge and where our research efforts fit into existing research, we have developed a knowledge hierarchy as shown in Figure 3. What begins as TK (Stage 1) (components of which may never be articulated), ultimately becomes separated from that which is able to be articulated (Stage 2), and eventually is so (Stage 3). In due course knowledge becomes categorised (Stage 4) and thereafter codified into rule sets (stage 5). The definitive examples of codification include mathematical, chemical or other scientific formulae. Finally, but not absolutely, the formulae are based on the axioms of the mathematics, which cannot be both complete and consistent, and on the decision that the interpretation of the axioms is valid in the domain in which they are being applied. Codification rests ultimately on continuing agreement to decisions previously made – no absolute or complete articulation is therefore ever possible. This research is largely concerned with the transference process from stage 2 to stage 3. Stage 1 merely serves as a foundation to knowledge extraction, and stages 4 and 5 are already well researched in most disciplines.

Basically, knowledge at Stage 3 or above is a form of codified or explicit or book knowledge. Below Stage 3 we have tacit or implicit knowledge, which is that component that is not necessarily written anywhere, but we tacitly understand that using such knowledge is likely to lead to greater personal success. The overwhelming majority of knowledge research to-date has focussed on explicit knowledge. Expert systems themselves can be viewed as mechanisms for categorising knowledge and thus reside at the fourth level. Current knowledge-based systems (KBS) research is predominantly concerned with the development of ontologies as a way of acquiring domain and task structures. Ontologies provide a formal model and thus fit into the fifth stage in our knowledge hierarchy in Figure 1. Similarly, the previous focus on the development of general problem solving methods (PSM) also fits in the final stage. We suspect this focus on stage three or above types of knowledge is due to the apparently increasing difficulty in capturing knowledge as we move down the levels. In support of this claim, we note that the shift to developing ontologies and general PSMs was a response to the problems associated with getting experts to articulate their knowledge into expert systems. These knowledge-level modelling approaches were aimed at providing a structured means of acquiring and organising knowledge. Further they aimed to support the reuse and sharing of knowledge as another means of alleviating the knowledge acquisition bottleneck. While modelling and formalisation of knowledge has been a key focus of traditional KBS research and has offered numerous computational solutions, Knowledge Management (KM) research has stressed the importance of implicit or tacit knowledge but offers few technological solutions for its identification and transfer. In both communities tacit knowledge is often treated as that knowledge which can't be captured. Our work is focused at Stages 1 and 2 where research efforts and solutions are few.

Given that non-codified tacit knowledge is difficult to diffuse technologically (Haldin-Herrgard 2000); socially embedded (Keane and Allison 1999; Lado and Zhang 1998); and contextually based (the Authors 2003); capture and transfer of tacit knowledge is best transmitted through face-to-face interaction and repeated contact (von Hipple 1994 in Audretsch 1998). Based on these findings we could conclude that the most appropriate means of identification or transfer of creative knowledge would be to place the innovator and trainee or job applicant in the same location, be it in an office or in the field, and encourage discussion. Given the short supply and the value of such an expert's time this is impractical and overly expensive. Thus for cost and logistical reasons we propose the next best alternative as the capture of the experts experience into an innovation knowledge inventory.

Our approach will not interfere with intellectual property (IP) concerns as it does not seek to capture the actual ideas of the innovators but to capture the way that they think and behave. For example we are interested in how innovators handle risk, how they incubate, test and persevere with an idea, how they recognise when to change track, etc. To a large extent these are management type issues and tie in with Sternberg's (Sternberg 1998; Sternberg Wagner and Okagaki 1993; Wagner and Sternberg 1985) three types of tacit knowledge, management of 'oneself, others, and one's career'.
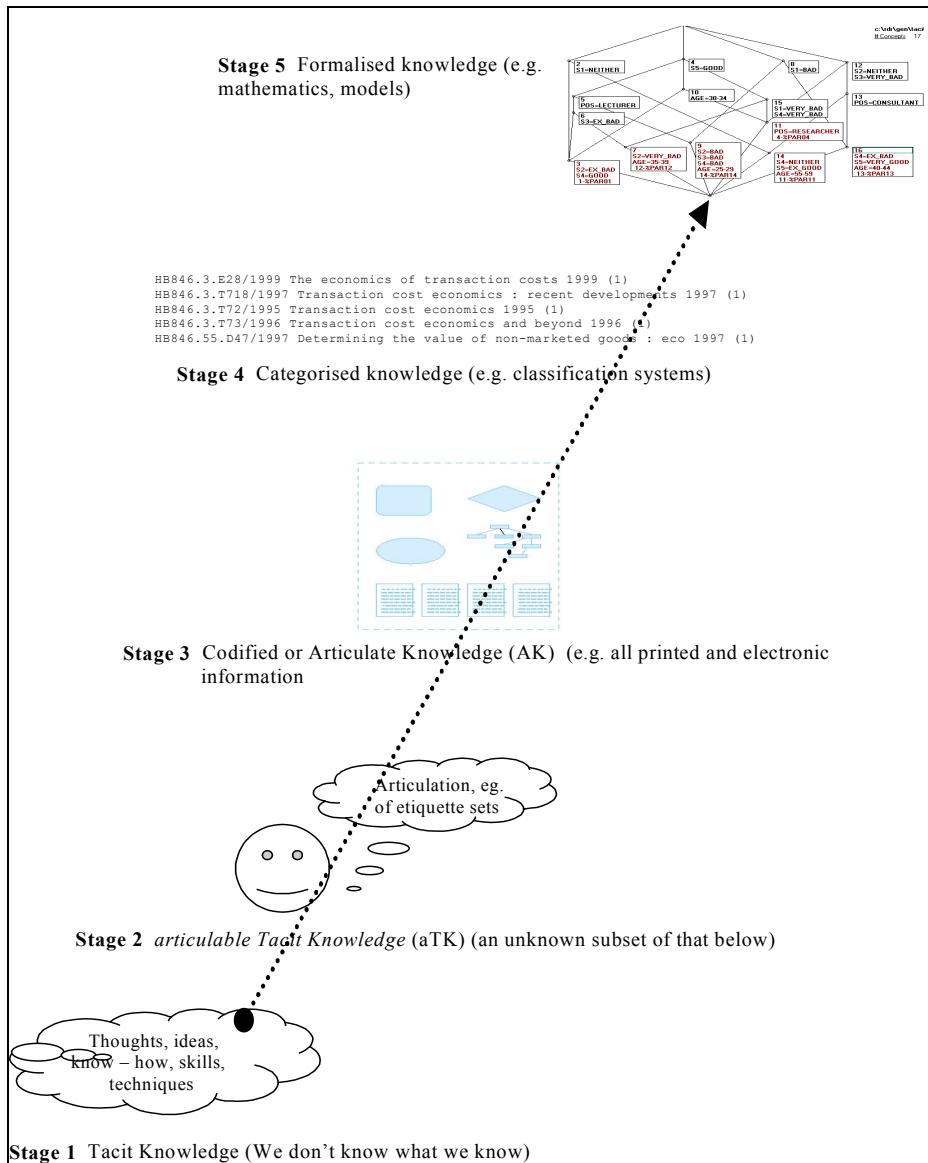
Figure 3: The knowledge hierarchy

As we are concerned with lower level knowledge at Stages 1 and 2, the approach we propose focuses on the behaviour of experts rather than the difficult and dubious task of getting experts to describe what they know. In keeping with Sternberg's (Sternberg *et al*. 1995) observation that tacit knowledge is transferred without the assistance of others the approach elicits the behaviour directly from the expert (and the response directly from the trainee or job applicant) rather than through an intermediary such as a knowledge engineer. However, in contrast to Sternberg's further observation that there tends to be low environmental support for acquisition of tacit knowledge, our goal is to offer a technology-enhanced approach.

The approach we offer does not invalidate tests such as the (KAI) Inventory to determine character traits but recognises as part of the NGM that different traits and motivators will be relevant at certain stages of the innovation process. In keeping with our previous knowledge acquisition research, we prefer to let experts do what they are good at doing, which is solving problems, rather than attempting to define generalised problem solving methods or knowledge models that lead to a bottleneck in the knowledge acquisition process and generally require a knowledge engineer or other specialist such as a psychologist to intervene.

Following content analysis of the related literature to clarify the concepts and phases, development of our inventory will begin with possible scenarios based on innovation stories recorded in the literature. Gordon Bell's book on "High Tech Ventures: The Guide To Entrepreneurial Success" and Edward De Bono's 30+ books related to thinking, and 'lateral thinking' in particular, will provide excellent starting points. Following the same process we used in development of our IT tacit knowledge inventory, our initial scenarios will be reviewed by actual innovators and used as a basis to recall their own experiences through an interview process. Donald

Schoen's landmark work on "The Reflective Practitioner" will provide valuable vocation specific guidance in the interpretation of the literature and the interviews. In the longer term the tool we develop will assist the innovator themselves to reflect and structure their scenarios and responses.

Once we have an initial inventory, we will refine using the following approach:

1. Identify and enlist a group of three to five recognised innovators within a given subfield, initially within the field of ICT. Innovation experts will be identified by their peers, in accordance with Sternberg's approach and our past work. Entrepreneurs tend to be easy to identify as their successes are usually publicly acknowledged. These experts will identify those who assisted them in the process, so that we include the range of roles and phases within the innovation cycle. From our experience in the knowledge acquisition field, we note that the most common practice is to use one expert as an oracle or in extreme cases to discard expert opinion and resort to textbook knowledge. The former approach is naïve and the latter approach will only provide explicit knowledge and not address the tacit component that is a vital part of innovation. To address this we will apply a technique we have developed to identify and resolve the differences between experts opinions.

2. Record a number of key problem situations or scenarios that each innovator has experienced. These scenarios could include positive and negative situations that they feel were significant in their success. Negative situations could have been situations they in hindsight should have avoided or handled differently which resulted in reducing the level of success or prolonging the time before success was achieved. Or the negative situation could be one that they successfully turned around to their advantage. In addition to describing the situation they faced, they provide one or more possible responses to the problem and provide their own score for each response following the seven point Likert scale, as shown in Figure 2. We provide some structure to motivate the acquisition process by seeking to acquire at least one scenario for each phase of the NGM: novelty seeking; novelty finding; novelty producing and innovative performance. Each scenario will be classified as belonging to one or more of these phases. This will be done in consultation with the expert at the time of collection. The NGM will then be applied to the set of potential responses to determine whether each of the appropriate personality traits and motivators that affect that phase have been considered. If not, we will ask our expert if he/she can identify a response for those types of people not covered.

3. Edit the situations and responses to remove redundancy, such as irrelevant side issues or repetition. This involves subjective interpretation by the researchers and thus must be performed carefully and validated with the originator of the scenario.

4. Give each innovator the scenarios of other innovators and asked to provide a score for each response. Addition of new responses and scores will be possible.

5. Evaluate the scenarios, responses and scores quantitatively and qualitatively to remove duplicates, errors and inconsistencies to produce a validated inventory. This may involve follow-up discussion with the innovators.

The revised set of scenarios and responses forms the testbank or innovation inventory. We acknowledge that there are many types of knowledge related to innovation. For instance, innovation in technology and design and development or in management, sales and customer relationship management. While we will direct the innovator to provide scenarios that cover the whole innovation process, it will depend on the experiences of the individual to identify which part/s of the process were key in their personal success or avoidance of failure. The collective experience of our experts will form the inventory.

This approach will be repeated in multiple subfields within ICT and potentially beyond. The areas to be targeted include: biotechnology and Wireless networking due to our access to experts in these areas.

It is our mid-term goal to develop a tool that will support experts in entering their experiences. However, we are unsure whether experts would be agreeable to interact with a software interface. We believe that experts are more likely to want to share their stories in a face-to-face interview context. We think, however, that at step 3 we could convert the interviews into a more structured web-based presentation, as in Figure 1, which can then be used in step 4 by the experts. The tool should be able to facilitate step 5 and contain the final produce from step 6.

A longer term goal is to adapt and extend the tool to allow the scenarios to be randomly assigned to potential and existing employees so that it can be used to identify individuals, and to what extent, they behave similarly to the identified innovators. We will need to devise various algorithms to determine acceptable ranges of behaviour and incorporate the use of weightings to allow some scenarios to be more or less important in generating a score. For personnel selection, the goal would be to provide an innovation index/score ranking applicants to assist with the selection process. The tool may be extended to allow other details regarding other selection criteria to be included to make the process more streamlined. For training purposes, algorithms will be developed which will provide scores indicating what knowledge is currently lacking in the individual and to propose a training programme for the individual. To achieve this goal we will need to refer to and incorporate other research in the psychology, training and recruitment literature.

Research has shown that the use of workplace scenarios in job selection is an effective way of determining workplace success (McDaniel *et al.* 2001). Such tests are useful for measuring actual skills and knowledge, including tacit knowledge. To check that our inventory does in fact identify innovators, we propose to seek out one or more recognised innovative companies. Our expectation is that the overall scores indicating innovation will be high in such companies. We will use the results to prepare reports suggesting training programs needed by the organisation and depending on the results seek collaboration with the organisation to use the inventory for hiring purposes.

CONCLUSIONS

The expected outcomes of this research include: a tacit knowledge inventory for identifying innovation savvy individuals; an approach for development and maintenance of such an inventory; and a toolkit that can assist recruiters and trainers in managing innovation personnel. More specifically we hope to increase understanding of what is involved in innovation, what knowledge relating to innovation looks like, how it can be measured or characterised and our understanding of experts, expertise and knowledge in general will be enhanced. As discussed, our research fills a gap in providing an approach for capturing low level knowledge (stages 1 and 2 in Figure 1). From a knowledge management perspective we will provide a method and supporting technology to identify, capture and manage innovation knowledge.

Our approach will go beyond the retelling of stories/experiences as we will also capture potential responses to the described situation and score the perceived merits of those responses. In this way we improve the opportunity for engaging with the problem and learning from the experiences of others.

Our technique is aimed at assisting Human Resource personnel and others involved in the selection and training of employees to identify appropriate applicants and training programs. A training and recruitment technique and prototype, that can be used to identify if respondents behave similarly to the expert whose knowledge has been captured. This can be used to determine whether a job applicant is suitable and even if suitable the results can be used to create a training development program for that employee. For existing employees the tool can be used to assess whether the employee's creative abilities are growing and where further training is needed.

These outcomes will address the lack of current solutions to knowledge capital management which offer little beyond allowing people to network better, such as via communities of practice, intranets, video-conferencing, company encyclopaedias, LotusNotes™ databases and email sifting tools such as Tacitmail™ (Bennett and Gabriel 1999).

The economic and social benefits of developing the creative potential stored in Australia's human resources are clear. Innovation is a key aspect of being first to the market, by identifying individuals with the potential and nurturing them Australia can expect to become a leader. The approach we offer is not domain specific and is relevant to any field or market sector. Further, while outside the scope of this project, we believe the approach has the potential to be applied to all types of knowledge. The key is in capturing and applying the knowledge in the same or similar contexts.

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