INNOVATION KNOWLEDGE ACQUISITION:
The Tacit Knowledge of Novices

Peter Busch, Debbie Richards
Computing Department,
Division of Information and Communication Sciences,
Macquarie University, Australia
{busch,richards}@ics.mq.edu.au}

Abstract: Innovation has become recognized as a key factor in the success and even sustainability of an organization but solutions to acquiring knowledge related to innovation are lacking. Strategies such as multidisciplinary teams, suggestion boxes and incentive schemes, flat organizational structures allowing the mail clerk access to the CEO are some of the techniques employed in industry. In this paper, we suggest a psychology-based technique using scenarios to measure innovation expertise. To date we have used our inventory on a novice population, but will soon administer it to an expert population. We present the findings to one of the scenarios and note that the results are contrary to what was actually done or suggested by the innovator.

Key words: Innovation, tacit knowledge, innovation knowledge, knowledge management

1. INTRODUCTION

For many organisations, innovation has become accepted as a vital part of sustainability. However, recognizing and managing innovation is not so well understood. Innovation is more than being new, different or first. "Innovation is... a significant and complex dimension of learning in work, involving a mix of rational, intuitive, emotional and social processes embedded in activities of a particular community of practice"[5 p.123]. Viewing innovation as a process is a key aspect of our approach. Thomas, Watts-Sussman and Henderson [16] state that these processes include making sense of our environment, particularly ambiguous new events, in a way which allows new connections to be made to familiar situations. However, innovation is not simply a process of trial-and-error rooted in experience.

Please use the following format when citing this chapter:

Richards, D., Busch, P., 2006, in IFIP International Federation for Information Processing, Volume 228, Intelligent Information Processing III, eds. Z. Shi, Shimohara K., Feng D., (Boston: Springer), pp. 259–268.

Innovation needs to produce timely and ongoing results "involving a complex mix of tacit knowledge, implicit learning processes and intuition" [6 p. 124].

Gloet and Terziovski [8] point out that innovation is often defined as the turning of knowledge into "new products, processes and services to improve competitive advantage and meet customers' changing needs" [p. 404)]. Also, since innovation is closely tied to an organizations culture [15] strategies for knowledge management will play a vital role within the organization to nurture creativity and innovation type knowledge [8].

There is clearly a connection between tacit knowledge and innovation knowledge [11]. Both have been recognized to support competitive advantage, are highly experience based and difficult to articulate. We have thus adapted our research using work-place scenarios to capture tacit knowledge to the capture of innovation knowledge which we consider to be a form of 'workplace smarts'.

Unlike approaches using techniques focused on identifying innovators, such as the Kirton Adaption-Innovation (KAI) [10] Inventory or the Myers-Briggs Type Indicator (MBTI) Creativity index [9], we focus on the behaviour (response to a situation) of individuals who have had results rather than on character or personality traits (such as self-confidence, independence or risk-taker). This is because, in keeping with the findings from the longitudinal Minnesota studies of Van de Ven, Angle and Pool [17], we consider innovation to be a process tending to involve a group rather than a number of "discrete acts of a single entrepreneur". Individuals will vary in their ability to "think out of the box" at different phases – sometimes coming up with a new problem to fit the solution invented, sometimes taking a risk and putting all the resources into quickly developing a better material for the product or sometimes being slow and methodical to ensure that the safety regulations are clearly met.

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 [12]. 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.

2. THE APPROACH

The proposed work will carry on and extend the previous work of Busch and Richards [4, 3, 2] 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. The focus will be on the patterns of behaviour which emerge, how they fit into the various phases of the innovation process and how these responses correspond to our current understanding of innovation including the

various psychological models, instruments and approaches which exist [15, 19]. As in our previous work, the inventory will initially be based on case studies in the literature, interviews and a pilot study. In this study we will additionally allow experts to enter and maintain their own experiences via a supporting tool. Easy and self-managed maintenance is an important feature when dealing with knowledge which is by nature continually changing and evolving.

We have adopted the Novelty-Generation-Model (NGM) developed by Schweizer [14] 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 NGM is a bio-psycho-social 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. 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: (1) mastery goals which concerns the degree to which an individual personally wishes to become competent in something and (2) performance goals which concerns the degree to which the individual wishes to prove their competence to others [18]. These two motivations can be classified as intrinsic and extrinsic, respectively. The existence of extrinsic motivations highlights the importance of social factors when it comes to creativity and innovation. Schweizer's model will be used 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.

In conjunction with content analysis of the related literature to clarify the concepts and phases, development of our inventory has begun with possible scenarios based on innovation stories recorded in the literature. Professor Gordon Bell's [1] book on "*High Tech Ventures: The Guide To Entrepreneurial Success*", see Figure 1 for an example, and Edward De Bono's 30+ books related to thinking, and 'lateral thinking' in particular, provide excellent starting points. Schoen's [13] landmark book "*The Reflective Practitioner*" provides valuable vocation specific guidance in the interpretation of the literature and interviews. Initial validation of our scenarios with innovation experts, such as Bell, is also underway. For example, the initial scenario in Figure 1 has been reviewed by Bell resulting in 8 answer options instead of the original six evaluated by novices in our study described in the next two sections.

Scenario 1

You've come up with an innovative new software product. You get a lot of money to start making this product. You start working on developing the software. However it seems that development isn't going as quickly and smoothly as you would wish. Your technology and product development departments are understaffed compared to your marketing and sales departments and you find that while you are making great progress marketing and sales-wise, your product development leaves a lot to be desired. You begin to fear that the product may never actually be completed.

Do you:

a) Cease operations and return any remaining funds to the investors because the technology is inadequate to support the product. **(what Bell suggested)**

b) Reduce the company to a minimal marketing effort until a product can be built.

c) Do nothing and hope the problem resolves itself. **(what Bell suggested)**

d) Hire more technology and product development people.

e) Give the product up for dead and instead concentrate on marketing and sales and spend more money with the hope of generating indeterminate future revenues. **(what Bell actually did (bad))**

f) Grab the money and escape to the Bahamas.

Figure 1: Scenario 1 developed from Bell and McNamara [1] pp. 273 – 276
Ovation: The case of the missing product

3. THE APPROACH

Similar to our previous work in developing an IT Tacit Knowledge inventory, we have established an inventory with twelve 'innovation' scenarios. A screenshot including a scenario based on Figure 1. We want our two sample populations to

1. rate via a Likert scale the good(ness) or bad(ness) of given answers to relevant innovation scenarios
2. consider extending the inventory/questionnaire by adding innovative scenarios and answer options of their own, if the participants can think of any

In other words we would like not only to capture data with regard to how people answer our scenarios, we would also like to extend our questionnaire for future use.

Each individual (innovator or novice) will work with no more than about 4-5 scenarios. We feel from prior research that respondents are likely to concentrate more if given less to do. We value the quality of their feedback. The time taken would be roughly 30 minutes.

We will be using our two sample populations to:

1. obtain 'expert' innovative feedback from our innovators.
2. obtain 'novice' feedback who will be acting as a 'control' group

We hope to find differences in the responses to our questionnaire/inventory based on the sample populations. Through incorporating biographical information we may find differences in the answering of the scenarios on the basis of gender, or employment seniority, language other than English and so on. As Information and Communication Technology (ICT) is our field of expertise, we will initially focus on this discipline.

As our novice population we have chosen the MPCE360 (Maths, Physics, Computing, Electronics) class. MPCE360 is a 'management' unit rather than a Maths, Physics, Computing or Electronics unit per se. The unit is concerned with innovation and how to come up with an idea, turn it into a product, how to build a business plan and market it. The unit is offered to all students at Macquarie University, although usually only (Division of) ICS (Information and Communication Sciences, i.e. Departments of Maths, Physics, Computing, Electronics) students tend to enroll in it. They require (at least) 41 credit points of subject completion and a GPA of at least 2.0 to be allowed to enroll in the subject. The MPCE360 class tends to vary from 20 (they are 3rd year students) to about 30 years of age.

For the innovators, we could expect recent (university) graduates and upwards to be involved in this study. Realistically though an innovator is likely to be somewhat older than an average fresh 'out of university' graduate. We would expect the age ranges to vary from roughly 30 to 80 years of age. These are however 'ballpark' figures. Of the 'innovator' cohort, we expect anywhere from 6 (pessimistically) to 12 (optimistically) 'innovators' to participate. To be 'recognised' as an innovator, as opposed to merely 'claiming' to be one, infers a process of public scrutiny. Therefore, we intend to contact recipients of innovation awards and other known innovators. The individuals we will be approaching will by definition generally fit within the category of people experienced at what they do.

4. RESULTS AND FINDINGS

Seventy-three (73) MPCE360 students were introduced to the study in a practical session and invited to participate. Those who chose to participate (71) filled out the paper based version of the (anonymous) questionnaires with their biographical information and their responses to 4 randomly assigned scenarios.

We present only a small selection of our results here to illustrate our technique. These results concentrate on the findings of our novices, of whom 23 answered Scenario 1 (figure 1) with its associated options for dealing with the given scenario.

Innovation Knowledge Inventory for Information Systems

We realise that any of the following questionnaire scenarios may be tackled from an IDEAL (ethical) and a REALISTIC (perhaps methical) point of view. We would like you to select BOTH an IDEAL AND REALISTIC value for each answer option.

Read each scenario and select what you consider to be the most appropriate scale for each answer option. Remember we would like you to select BOTH an IDEAL AND REALISTIC value for each answer option.

Scenario 1

You've come up with innovative new software product and you get a lot of money to start making it.
You start working on developing the software, however it seems that development isn't going as quickly and smoothly as you would wish. Your technology and product development departments are understaffed compared to your marketing and sales departments and you find that while you are making great progress marketing and sales-wise, your product development leaves a lot to be desired. You begin to fear that the product may never actually be completed.

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

1. Hire more technology and product development people. If your problem is understaffing in the technology and product development departments then it's obvious that you need more staff.

ETHICAL

Choose one: Extremely Bad — Neither Good nor Bad — Extremely Good

REALISTIC

Choose one: Extremely Bad — Neither Good nor Bad — Extremely Good

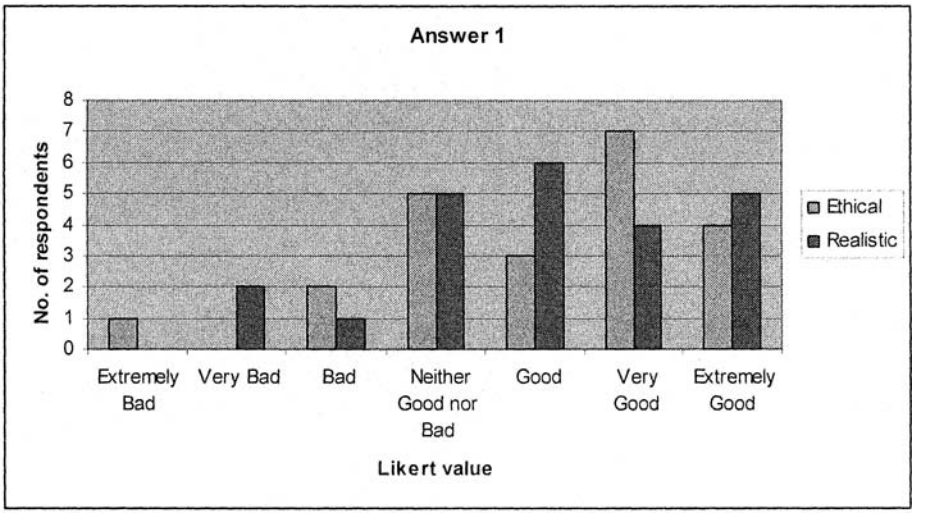

Figure 1. Scenario 1, answer 1 (n=23)

An examination of table 1 reveals our sample population is young (20 to 27 years of age, but heavily concentrated in their early 20s), mainly male (18 out of our 23 participants), overwhelmingly ethnic (where ethnic in the Australian context refers to non Anglo-Celtic) and more specifically concentrated in the Chinese and to a lesser extent, the sub-continental ethnic groups. Finally the novices were generally school leavers (highest qualification was typically the HSC) as one would expect.

Turning our attention to Answer 1 (figure 1) for Scenario 1 ("Hire more technology and development people. If your problem is understaffing in the technology and product development departments then it's obvious that you need more staff"), there is clearly a skew towards answering this question in the affirmative.

Table 1. Our sample population (MPCE360) who answered Scenario 1; n=23 Fields: gender; age; 1st language other than English; occupation now; highest qualification gained.

G.	Age	1st LOE	Occ. Now	Highest Qual.
M	24	Marathi	Student	Bachelor
M	23	Arabic	IT support	
F	27		Project Coordinator	
M	23	Chinese	Student	
M	24	Chinese	Student	HSC
M	23	Mandarin	Student	HSC
M	21	Hindi	Student	HSC
F	21	Farsi	Student	Certificate
F	20	Indonesian		Dipl. of Comp. Sci.
F	22	Indonesian	Student	HSC
M				Associate Diploma
M	22	Chinese	Assistant Accountant	B.Sc.
M	22	Chinese	Student	SIBT Diploma
M	26	Farsi	Student	B.Soft.Eng.
M	21	Italian	IT	Certificate
M	27	Mandarin	Student	HSC
M	21	Cantonese	Sales	
M	26	Tamil	Director/Manager (Telec Contr)	Diploma
M	23	German	Student	
F	21		Computer Developer	HSC
M	22	French	Retail Assistant	HSC
M	21	Italian	IT	HSC
M	23	Chinese	Student	HSC

Our novices on the whole (with the exception of a few ambivalent "Neither Good nor Bad") considered the hiring of more staff both ideally (ethically) and realistically a good idea.

In responding to Answer 2 ("Recommend to the board to cease operations and return any remaining funds to the investors"), our novices tended towards the negative. Again a grouping were ambivalent, expressing a neutral opinion, but the majority clearly felt this answer was not a good idea, surprisingly feeling more strongly about this answer from a realistic point of view.

Answer 3 ("Give the product up for dead and instead concentrate on marketing and sales and spend more money with the hope of generating indeterminate future revenues") was also greeted in the negative by the novice sample population. Very few thought this option a good idea. Again there were some 5 students who were undecided on this point.

With regard to Answer 4 ("Reduce the company to a minimal marketing effort until a product can be built. It'd be a shame to give up on something so promising")

our novices were almost evenly divided in their opinions, although marginally more considered the reduction in marketing a generally good idea. Interestingly some 5 and 7 novices (ethical and realistic) respectively took a neutral stance on this answer. One can speculate this is so either because they genuinely felt the option to be neither a good nor bad idea, or alternatively because they could not be bothered concentrating on the problem at hand (a couple of novices appeared to select "Neither Good nor Bad" for all answers).

Turning our attention to Answer 5 ("Do nothing safe in the knowledge that the problem will most likely resolve itself") the novices were overwhelmingly opposed to this option. Again some 6 and 8 (ethical/realistic) out of 23 novices took an impartial stance. Only 2 novices felt this to be a good idea (ethically and realistically).

Not that surprisingly, Answer 6 ("Grab the money and escape to Switzerland") was also viewed overwhelmingly negatively by the novices (18 ethically, 13 realistically). A few novices (4 ethically, 8 realistically) felt running off with the money was actually not such a bad idea. Notably very few (1 ethically, 2 realistically) remained impartial on this issue (probably the novices who had chosen to remain neutral for all questions.

With regard to Answer 7 ("Call up someone you respect and ask them for help") our novices mostly thought of this as being a good idea (14 ethical; 16 realistic). Again a small proportion (5 ethical; 4 realistic) took an ambivalent stance, with some 4 novices (ethical) and 5 novices (realistic) considering asking for help from one more experienced to be a bad idea.

The results for Answer 8 ("Attempt to buy more time, confident that the vast funds you have will allow you this") are more evenly distributed, with a slightly higher proportion (11 ethical, 13 realistic) feeling this was a good idea. At the same time a proportion of novices (9 ethical, 9 realistic) felt stalling was a bad idea. Three novices (ethical and realistic) didn't care one way or the other.

Finally the last Answer option ("Find a scapegoat (someone who will take the blame)") was answered in the negative for the most part (14 ethical, 11 realistic). Five novices took a noncommittal stance, whilst 3 novices and 7 novices (ethical and realistic respectively) felt another to blame was actually a good idea, in fact of this last cohort, 4 novices thought this to be an extremely good idea.

The results are as one would expect, insofar as our novice population appears to have answered our questions sensibly. Certainly a small proportion choose to avoid thinking carefully about the responses preferring to simply choose the middle of the road approach, but we estimate this to be no more than 2-3 students (after examining questionnaires). Even from this small subset of the data we can see that our novices believed that the options a), c) and e) in Figure 1 (which is what Bell had suggested and/or done in his book) were bad options and preferred other options which Bell, the expert, had not thought were a good idea. It will certainly be interesting to compare the results of the expert sample population with those of the novices.

5. CONCLUSION AND FUTURE WORK

Through comparison of similarities and differences between the novice and expert populations we will be able to find if any patterns of novice versus expert behaviour exist when it comes to innovation. As part of that analysis we intend to employ more elaborate data analysis techniques such as our use of Formal Concept Analysis [7] should provide more detailed results.

Once we have developed and validated our innovation inventory, we intend 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.

We intend to compare our approach to the key psychometric approaches offered for innovation testing. We propose to administer techniques such as MBTI, KAI or other psychology-based techniques in order to correlate our findings with these other approaches and to validate the NGM. For instance, we will test whether certain personality traits and characteristics or motivations correspond to the phases in the NGM.

ACKNOWLEDGEMENTS

Our first thanks must go to Professor Gordon Bell [1] for providing feedback on our 'innovation inventory'. We would also like to take the opportunity to thank our MPCE360 class at Macquarie University for providing the 'novice' dataset necessary for our innovation research.

REFERENCES

1. Bell, G., McNamara, J.F. (1991) *McHigh-Tech ventures : the guide for entrepreneurial success* Perseus Books Publishing L.L.C. New York U.S.A.

2. Busch, P., Richards, D., (2003) "Building and Utilising an IT Tacit Knowledge Inventory" *Proceedings 14th Australasian Conference on Information Systems* (ACIS2003) November 26-28 Perth Australia.
3. Busch, P. Richards, D. (2004) "Acquisition of articulable tacit knowledge" *Proceedings of the Pacific Knowledge Acquisition Workshop (PKAW'04)*, in conjunction with *The 8th Pac.Rim Int.l Conf. on AI*, Aug 9-13, 2004, Auckland, NZ, :87-101.
4. Busch, P., Richards, D., (2005) "An Approach to Understand, Capture and Nurture Creativity and Innovation Knowledge" *Proc. 15th Australasian Conference on Information Systems (ACIS2005)* Nov 30-Dec 2nd, Sydney, Australia.
5. Cottrill, K., (1998) "Reinventing innovation" *Journal of Business* Strategy Vol. 19(2) pp. 47-51.
6. Fenwick, (2003) Innovation: examining workplace learning in new enterprises *Journal of Workplace Learning 15(3):123-132.*
7. Ganter, R., Wille, R., (1999) *Formal concept analysis: Mathematical foundations* Springer-Verlag Berlin Germany.
8. Gloet, M. and Terziovski, M. (2004) Exploring the relationship between knowledge management practices and innovation Performance *Journal of Manufacturing Technology Management, 15 (5): 402-409.*
9. Gough, H. (1981) "Studies of the Myers-Briggs Type Indicator in a Personality Assessment Research Institute" *Fourth National Conference on the Myers-Briggs Type Indicator,* Stanford University, July 1981, CA.
10. Kirton, M. (2001) "Adaptors and Innovators: why new initiatives get blocked" J. Henry (ed.) *Creative Management* 2nd Edition, Cromwell Press Ltd, London, 169-180.
11. Leonard, D., Sensiper, S., (1998) "The role of tacit knowledge in group innovation" *California Management Review* Berkeley; Spring 40(3) (electronic).
12. Richards, D., Busch, P., (2002) "Knowledge in Action: Blurring the Distinction Between Explicit and Tacit Knowledge, G. Forgionne, J.N.D, Gupta and M. Mora (eds) Journal of Decision Systems Editions Hermes 11(2) pp. 149-164
13. Schoen, D.A. (1987) *Educating the Reflective Practitioner* Jossey-Bass, San Francisco, CA.
14. Schweizer, T.S. (2004) *An Individual Psychology of Novelty-Seeking, Creativity and Innovation* ERIM Ph.D. Series, 48.
15. Sternberg, R., Wagner, R., Williams, W., Horvath, J., (1995) "Testing common sense" *American psychologist* 50(11) :912-927.
16. Thomas, J., Watts-Sussman, S., Henderson, J., (2001) "Understanding strategic learning: Linking organizational learning, knowledge management and sensemaking" *Organization Science* 12(3) :331-345.
17. Van de Ven, A. H., Angle, H., Poole, M.S. (2000) *Research on the Management of Innovation: The Minnesota studies*, New York: Oxford University Press August (paperback) Originally printed 1989.
18. Van Yperen, N. W. (2003). "Task interest and actual performance: The moderating effects of assigned and adopted purpose goals" *Journal of Personality and Social Psychology, 85*(6), 1006-1015.
19. Wagner, R., Sternberg, R., (1991) *TKIM: The common sense manager: Tacit knowledge inventory for managers: Test Booklet* The Psychological Corporation Harcourt Brace Jovanovich San Antonio U.S.A.