Developing the courage to be incompetent

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The Australian Government's innovation statement, *Backing Australia's Ability* (DEST 2001) committed them to creating 21,000 university places over five years in science, technology and mathematics courses that will 'meet the needs of industry.' But little research exists on how to prepare science students for industry work. One of many critical reviews of undergraduate science education in America (National Research Council, 1995, p. 4) reported:

> The needs of the workforce are changing. This dynamism of the labour market is putting a premium on students who have a broad knowledge of different subjects, skill in synthesising and communicating information and the ability to work in teams. Students educated with a narrow disciplinary focus and with solitary learning styles can have difficulties in adjusting to such an environment. Indeed, such difficulties are a dominant theme in the complaints made by business leaders about contemporary undergraduate education.

This paper reports what one successful innovation consultancy thinks makes scientists valuable to industry. It is the product of a 3-year qualitative study of commercial innovation and innovators (Steiner 1996). The consultancy studied employs 90+ physicists, chemists, computer scientists, engineers and industrial designers. After presentation of its empirical data, this paper explores philosophically why it is difficult to produce innovators like this through conventional science education. It suggests it is difficult to produce many of the characteristics of innovating scientists because they are the characteristics of scientific incompetence. It further suggests it takes courage to be incompetent and it concludes with some preliminary suggestions for how science educators can tap into the student places created to support industry by helping science students find the courage to be incompetent.

Definitions

Competence: Kuhn (1970) suggests members of a scientific discipline community are judged as competent by their fellow members on the basis of their adherence to and skilled employment of a disciplinary matrix or paradigm—that is, the beliefs, practices, values and world view of their discipline. Heidegger (1977) says their acceptance by the community is conditional on them not questioning or challenging their paradigm beyond what is necessary to maintain its validity. Scientists need for professional acceptance affects their identity, their sense of themselves as 'good' scientists (Heidegger 1996). On my interpretation of Kuhn and Heidegger, I define 'competence' as the practical and philosophical acceptance of one's paradigm and identity without challenge and without questioning.

Incompetence: If we accept my philosophical definition of competence, then it follows that to be *incompetent* does not mean merely to be unskilled or careless. Rather, to be incompetent is to be willing to question and doubt one's paradigm and to work outside it sometimes. Drawing on Heidegger (1996), I say to be incompetent (authentic) as a scientist means to see oneself as a unique and free individual rather than as a discipline-defined (inauthentic) identity who conforms to a paradigm. This paper suggests that incompetence defined like this is what makes innovation possible and is the basis for the characteristics the innovation consultancy prefers.

Innovation: Mogee (1993; p. 412) defines innovation as 'the process by which technological ideas are generated, developed and transformed into new business products, processes and services *that are used to make a profit and establish marketplace advantage'* (my emphasis). Innovation is not about ideas but about realised, operationalised ideas that actually make money rather than only having money-making potential. This distinction was clearly articulated in the recent Government review of Cooperative Research Centres (Howard 2003).

Innovation as Mogee defines it calls for certain skills and attitudes that the management team of the innovation consultancy describe in the next sections. These are the characteristics they look for (and have found) in scientists and engineers they hire for their consultancy. These characteristics resonate throughout seminal innovation studies (Schon 1963; Robertson, Achilladelis and Jervis 1972; Makino 1987; Kanter 1988; Nonaka 1990; DeNovellis 1992; Hinterhuber and Popp 1993). The managers' remarks emerged in lengthy individual depth interviews (two to six hours) with all ten directors and business group managers. They were interpreted hermeneutically from a Heideggerian phenomenological perspective which is synthetic rather than analytic, that is, it looks for relations rather than distinctions. It is not a 'scientific' methodology but an interpretive one in which impressions are as significant as 'facts.'

Findings

Skills and Qualities of Innovators

According to the managers, innovators must be energetic, enthusiastic, competitive, innovative, thrive on change, diversity and challenge, and be able to live with uncertainty. They must be intelligent and able to respond to surprises in client situations. They must also be self-starters and high achievers. They must be 'sparkly' people. They must not be reticent; they should be confident. One said they should have the highest ambitions to achieve and another said they needed drive and the ability to make things happen. 'There are plenty of technical people or creative people out there, but they don't have the confidence or drive to make things happen.' Another said, 'They need a lot of drive that comes from their personality rather than from management.' A director prescribed, 'People who are team players but self-directed.' A business unit manager said, 'They should have wide vision of the work that they do and of themselves and a wide range of interests rather than tunnel vision.' He continued:

> Because no one person can know much about a range of disciplines—electronics and market research for example—they need to be able to talk to each other about the consequences of some thought or idea or new suggestion. They need to be able to accept new ideas and think about what the implications are for their specific component of whatever it is they're doing and they need to be able to say whether it's good, bad or indifferent or leads to new possibilities or it closes off some possibilities. People need to have an open mind about what they're doing and be prepared to accept other people's ideas and use them in their own area of skills or qualifications.

A director identified a complementary skill:

> The place needs people who communicate well so they can assert a lateral idea because someone'll always say, 'No, it won't work'. You need to have communication skills and the confidence in a team environment to assert a different approach that might be the most innovative, but you have to drag the troops with you. How creative the organisation is is about balancing the need to get consensus from the team to move forward quickly with individuals expressing alternative views.

Social skills include being personally agreeable and having people skills. Managers say innovators must get along with other people on the team, with clients and with clients' staff who may feel threatened by the consultancy's involvement. They should be able to communicate well both in written and oral form. They also should be good listeners and empathetic with clients whom the

director who listed this quality seems to equate with being able to predict what clients expect or how they will react. But managers are not only looking for a range of skills and qualities. They are also interested in how potential innovators understand themselves, their work and their obligations in the workplace. This information emerged in response to the question: What attitudes should an innovator have?

Attitudes of Innovators

Some of the recurring themes in response to this question were teamwork, problem-solving and desire to learn. A business unit manager pointed out that there was no room for individualists, prima donnas and stars. He said, 'They will be team players, not an ego kind of person who wants to go out and do it all themselves. It takes a certain maturity to realise that when you're working for a client, it's not your design that's going to save the day. It's a real team effort.'

Commenting on the problem-solving nature of an innovator's work, a director said he looks for 'a challenge-seeking attitude.' He explained, 'They have to respond positively to things going on outside rather than curling up in their shells and waiting for it to go away.' Two directors also mentioned the importance of wanting to learn new things. One said, 'They must want to learn and not imagine that they know everything, but at the same time they have to have considerable confidence in their abilities.' Another said innovators must be 'interested in their discipline, interested in commercial factors and not just content to play transistors in the back room.' A business unit manager said innovators should be open to anything, ready to participate in anything. Another said innovators should be 'open-minded and interested in other things that are going on so they are ready to contribute, mix.' Managers also had a range of views about what education was optimal for innovation.

Education for Innovators

All managers said innovators need a university qualification in a technical discipline like science or engineering, but one director said, 'There's some debate about whether that is right because we have people who are very good innovators, managers, even directors who don't meet those qualifications. Three business unit managers of the largest groups only have a [technical school] diploma.' One business unit manager felt a university degree was better than a technical school qualification because 'it implies more knowledge and more personal commitment and it looks better on a *cv*.' (*Curriculum vitae* are sent out with proposals when seeking new clients.)

There is some disagreement about the value of graduate qualifications. One director said a second degree was necessary while another said graduate qualifications were preferable and a third reported PhD. graduates 'have been the best from the point of view of having been trained to think analytically and creatively to solve problems. Usually people so equipped are capable of thinking along other lines and being diverse as well.' Another director concurred with the value of such skills but didn't say they came only from PhD. graduates. He said innovators' education had to make them good at 'finding out information and employing it in fields that are outside their experience rather than doing rote learned tasks of reproducing something.'

The next section tries to answer the question, what is the source of such characteristics? Can science educator create or encourage them in their students? It offers a philosophical rather than psychological or sociological answer that forms the basis for the suggestion that science educators can produce industry-valued innovators by encouraging scientific incompetence.

Technical Persons Versus Authentic Persons

Murdick (1969) describes a *technical person* as 'an individual with perceived competence or technical skill in a certain product or knowledge area, generally obtained from formal courses of specialised study (as distinguished from general academic education or from an apprenticeship').

Technical skills are said to encompass a general understanding of technical activities as well as the ability to apply methods and techniques to specialised areas. A 'technical person' seems a fair description of most scientists. The predominance of the word 'specialised' in this description is important to the following philosophical analysis.

Martin Heidegger (1977, 1996), whose philosophy is the foundation for this paper, has criticised scientists for their preference for representing the world in what he sees as a simplified and controllable form that lacks the practical complexity of what he calls *the public world*, the non-specialised, non-scientific world in which most people live. Heidegger says the knowledge of these simplified specialist worlds created by specialist scientific disciplines is 'deficient' in the sense that it lacks practical complexity and connection with the ordinary public world. (Heidegger 1996). Kuhn (1970) has likewise suggested that scientists operate in *different worlds* determined by their specialist paradigms, the implication being that these different worlds are not those accessible to the uninitiated. In addition, both Heidegger (1977) and Kuhn (1970) and many contemporary philosophers of science (Bijker, Hughes and Pinch 1987; Callon, Law and Rip 1986; Lynch 1993; Pickering 1992) have argued that science prescribes perspectives and practices that generate faith in the knowledge and methods produced through them. This makes it unlikely that scientists will leave their different worlds or seek affirmation in the public world. Resistance to industry input into education and research priorities is a reflection of this rejection of the public world's relevance to science. And finally, Kuhn (1970) in particular has emphasised the dire consequences of moving outside one's paradigm. Exclusion from the specialist community and loss of all credibility, he says, are the prices paid for violating what Heidegger (1977) calls 'binding adherence to the rule and law' of one's specialty. This is why I say it takes courage to be incompetent, to question or transgress one's scientific paradigm. You lose your place in the discipline community and with it you lose your identity which is tied up with being a 'good' scientist. Wolf (1994, p. 53) illustrates this in relation to physics:

> The real problem facing physics today is the arrogance of many physicists who have long been isolated from industry and the real world and who simply do not see addressing society's needs as their province. Such physicists do not want to recognise anything different as 'proper' physics. If someone moves outside their narrow definition of physics, he or she has simply 'left physics,' and anyone thus diverted is rarely invited back.

I argue that science educators necessarily must indoctrinate their students into the specialised different world of science, preparing them to see and do science as prescribed, and enforcing the need for binding adherence if one wants to be seen as a 'good' scientist. In so doing, I suggest science educators create technical persons who may be 'competent' but who must also be inauthentic or professionally conformist to be so. Heidegger and Kuhn are not critical of science educators for indoctrinating science students into a scientific paradigm. Both Heidegger and Kuhn acknowledge the effectiveness of the scientific approach to knowledge-making. Delineating specialist realms of interest and prescribing approaches to them make research efficient and make cumulative progress possible. Technical persons are important to specialist knowledge-making and routine productivity.

But Kuhn (1970) especially points out that this approach does not encourage creativity, adventurousness or discovery. According to the consultancy managers cited above and many studies of innovation, these qualities are important to innovation. Further, innovators are not in the knowledge-making business. They are in the money-making business and the money to be made must be made in the public world, in what Heidegger (1996) refers to as the world of the 'wearers and users' of what is made and what business refers to as 'the marketplace'.

While Heidegger is not motivated by such mundane concerns as money-making and market responsiveness, he is concerned about human potential and he sees the mandated conformity at the root of science as a danger to human potential because it prevents people being authentic, that is, it

prevents people existing in the world as unique and creative individuals, as their genuine nature allows.

In contrast to Murdick's technical persons, *authentic persons* are non-conformists who recognise their capacity to operate *sometimes* (not always) outside professional, cultural and social paradigms. Authentic persons are characterised by 'resoluteness,' a kind of decisiveness based on seeing some situations as offering unique and special possibilities for action. Authentic persons also take responsibility for the decisions they make. Further, authentic persons value their individual freedom but, in contrast to self-centred *individualists*, authentic persons also respect the individuality of others which makes them cooperative, team-oriented and open to the alternative perspectives of others. Authentic persons are also more likely to be in tune with the public world because of their practical (ordinary) rather than theoretical (specialist) orientation to the world (Heidegger 1996). Common examples of authentic individuals that appear in Heidegger's texts are craftspeople, traditional farmers, artists and poets (Heidegger 1971). More strikingly, these characteristics of authenticity are the qualities and attitudes that emerged from the innovation consultancy study and innovation literature. But they are not the characteristics one associates with scientific competence. Hence, I suggest they are the characteristics of incompetence.

The qualities of authenticity and inauthenticity are not permanent and defining characteristics of individuals. There are no authentic or inauthentic people. Each situation or experience, especially any problematic one that prevents people operating on 'automatic pilot,' requires people to *decide* whether they will be authentic or not (Heidegger 1996). Authenticity or inauthenticity is a momentary existential choice we make many times a day. The possibility of deciding is the basis for the suggestion that science educators can develop the capacity for incompetence/authenticity in their students. They can show their students that they have choices to make, that they are not bound by the precepts of the paradigm of science practice.

Teaching Incompetence/Inauthenticity

Numerous studies document organisational success in nurturing and encouraging authenticity in technical persons in the workplace (Cooper and Hartley 1991; Ehin 1995; Mathieu and Zajac 1990; Spencer 1995; Story 1995). Among the most common management approaches that encourage innovation is to require cooperation and communication across specialties and functions and to value daring, risk-taking and error as learning tools. Such approaches are directed to encouraging and rewarding authenticity/incompetence.

Few studies deal with how to encourage authenticity in science students, although the Australian Review of Engineering Education (Simmons and The Task Forces of the Review of Engineering Education 1996) pointed the way. On the basis of understanding competence as committed paradigm practice, science educators might encourage authenticity by encouraging incompetence. They could do this by undermining their students' *blind* commitment to the science paradigm. There is no better time to do this than just before students venture out into their professional communities. According to Kuhn (1970), the young and inexperienced are the least committed to their paradigm which makes them most likely to transgress the bounds of their paradigm. But how, without destroying the science profession, can science educators undermine the very commitment to a paradigm they must first create to transform science students into skilled technical persons?

The key to teaching incompetence is to remember that authenticity/incompetence is always about situation-specific choice, not about prescriptions. Science educators can prepare students to *decide* when to be 'good' scientists and work by the book or when to be incompetent and throw the book away for a time. They can show students their range of choices and how to evaluate those choices. To do this, students need an opportunity to critically reflect on and debate the beliefs, practices and values of the science paradigm so they understand the historical and situational nature of its knowledge and doctrines and the limits of its vision and prescriptions.

They also need to be exposed positively to other industry relevant paradigms—business paradigms, human communication paradigms, consumer paradigms, political paradigms, economic paradigms, social and environmental paradigms. And they must be exposed to the practical problems of abandoning one's paradigm or failing to do so when appropriate. They need to understand the dangers and rewards of being incompetent.

Rounding out a science student's education with a final semester capstone seminar that reads and discusses government policy papers on innovation and hears from industry R&D managers, marketers, venture capitalists and professional communicators who challenge what they've been learning or cast it in a new light could be an existentially liberating experience for students who are thereby encouraged to find their courage to be incompetent. Such a seminar might also be a good way to establish that even a quite conventional science education course could 'meet the needs of industry,' the magic words to unlock all those extra student places.

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