Strategies for Developing Reflexive Habits in Students

Lesley Jolly, David Radcliffe

University of Queensland, Australia

Abstract
It is widely accepted that engineering graduates should not only be technically competent but they should also be skilled in communication and teamwork, have social and global awareness, be self-directed and have an expectation of life-long learning. However it is much less clear how these "soft skills" are best developed in undergraduate engineers in the context of their studies. We have worked with over 350 students from freshman to seniors to develop a reflexive approach to their work. This has been done in the context of project-based, design courses, involving both individual and group work in the disciplines of mechanical and chemical engineering. We conclude that student attitudes clearly evidenced the need for engineering staff to model reflective practice and place regular emphasis on its value as a professional learning tool. Exercises in reflective thinking are most effective if integrated into other more 'traditional' engineering tasks rather than being set as 'stand alone' tasks. We argue that the best way to make expert knowledge accessible to non-experts is through getting the experts to reflect on their successes and failures.

Introduction

Engineers and engineering students have been described as conforming to a personality type[1] that one does not immediately associate with reflexive habits. The typical engineer is reported to be concerned with order and certainty and therefore to be averse to ambiguity, to have a rather narrow range of interests, to be not given to introspection and not much interested in people. And yet for many years now reviews of engineering and engineering education around the world[2] have called for engineers to rise to the challenge of a global environment characterised by rapid social, environmental and technological change[3]. That is, the modern engineer is asked to deal with ambiguous and changing circumstances and in a social and environmental context.

Like similar reviews in North America (ABET 2000) and Europe during the 1990's, the Review of Engineering Education in Australia made sweeping recommendations for changes to how engineers are formed. The title of the final report, *Changing the Culture: Engineering Education into the Future* indicates the degree of changed required. The Review was conducted jointly by three key stakeholder groups, the Institution of Engineers, Australia (the accrediting body), the Council of Engineering Deans and the Academy of Technological Sciences and Engineering and it was funded by the Australian Government.

The Review concluded that, in addition to technical competency, graduates should have;

- the ability to communicate effectively, not only with engineers but also with the community at large;
- the ability to function effectively as an individual and in multi-disciplinary and multi-cultural teams, with the capacity to be a leader or manager as well as an effective team member;
- an understanding of the social, cultural, global and environmental responsibilities of the professional engineer, and the need for sustainable development;
- an understanding of and commitment to professional and ethical responsibilities;
- the expectation and capacity to undertake life-long learning.

The magnitude of the changes needed in engineering faculties and education programs to bring about the aspirations expressed in the Review should not be underestimated. These changes are fundamentally different in their nature and extent to the "10% "humanities" push of the early 1970s, or the "10% management" requirement of more recent times. Rather than trying to add something extra on to an engineering education, the new objectives require the incorporation of new attitudes into the core of the discipline – they require in fact nothing less than cultural change. We need to understand that meeting the recommendations of the review requires engineers to learn to be different, to step outside the stereotype described above.

Notwithstanding the scope of the task and the need for a paradigm shift in the learning culture, we argue that we can make a difference now, within existing programs and curricula through incorporation of reflective practice into every subject. That is, we hold that students need the ability to continuously reflect on their engineering experiences, to make sense of them, to be aware of and understand their own basic assumptions and to construct future actions based on these insights. Only then will they be able to broaden their view of the world and begin to situate themselves within the social and cultural environment as required. The technique that we think can best deliver this result is reflective practice or reflexivity.

Reflection and Reflexivity

According to Dewey[4], true learning occurs only through reflecting upon experiences. Describing reflection as a process that enables connections between the various elements of an experience, Dewey refers to reflection on experience as a learning loop that runs back and forth between the experience and the relationships being inferred[5]. The concept of the learning loop has gained popularity through the work of Kolb[6] and his four stage experiential learning model: 1) experience; 2) reflection; 3) generalising or theorising; and 4) planning. Therefore, the ideal experiential learner will be able to

1) involve themselves in new experiences without bias;
2) reflect upon experiences from multiple perspectives;
3) integrate their observations into logically sound theories; and
4) use these theories in decision making and problem solving.

This kind of practice is precisely what is being promoted by new accreditation processes for graduate engineers in Australia[7], and clearly has the potential to deliver on many of the recommendations about graduate attributes put forward by the Review. However, the

profession's traditional emphasis on solving well-defined problems tends to limit the extent to which the cultural change that is required can be achieved even where reflection occurs. We wish to make a distinction here between reflection on engineering problems as phenomena divorced from the practitioner, and reflexivity as reflection on personal experience of engineering practice, which fundamentally changes the relationship between engineer and engineering. Some of the recent writing on reflection seems to us to tend in this direction.

In an oft-quoted development of the loop metaphor, Argyris[8] distinguishes between single-loop learning and double-loop learning. Single loop learning occurs when "an error is detected and corrected without questioning or altering the underlying values of the system", whereas double loop learning occurs when errors "are corrected by first examining and altering the governing variables and then the actions". While this is certainly necessary as a first step to a true improvement of practice, rather than just local adjustment, all too often the engineer will translate this dictum in purely technical terms. Thus, students in our project very often identified the governing variables as solely technical ones, ignoring social and contextual aspects of practice such as the difficulties they had experienced in group work or their inability to seek help with their problems.

Schön[9] also sees the learner as engaging in experience, reflection, restructuring and planning. However, he advances the notion of reflection by distinguishing between *reflection-in-action* and *reflection-on-action*. Best known for his use of the term 'the reflective practitioner', Schön postulates that our knowing is in our action, and that such knowledge is tacit. When reflecting-in-action, "There is some puzzling phenomenon with which the individual is trying to deal. As he [*sic*] tries to make sense of it, he also reflects on the understandings which have been implicit in his action, understandings which he surfaces, criticises, restructures, and embodies in further action". Note once again that the discussion is of action, and can easily be translated to a problem-focus rather than a self-focus.

John Cowan[10] extended Schön's work to encompass a third reflective loop: *reflection-for-action*. Reflection-for-action is anticipative: here the learner "defin[es] their aspirations…[and]…establishes priorities for subsequent learning". This formulation is described in Cowan's three loop diagram[11]:

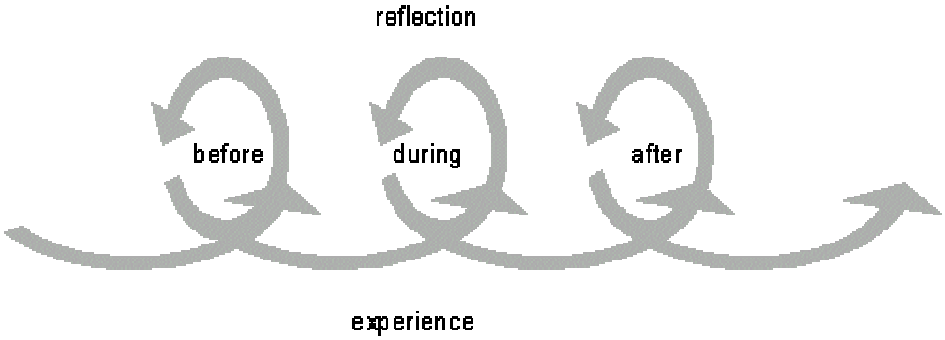

Figure 1 - Cowan's Model of Reflexivity: Progressive Reflection on Experience

While Schön tends to use the terms ‘reflection’ and ‘reflexive thinking’ interchangeably, Darling[12] uses the time at which introspection occurs to distinguish between reflection and reflexivity: reflection occurs after an interaction whereas, as in Cowan’s model, reflexive processes incorporate introspection within the period of interaction. Darling further elaborates that reflection is related to self and improving future practice whereas reflexivity is a pro-active tool to simultaneously improve communication and provide insight into priorities prior to reaction. Reflexivity can therefore be seen as the application of the fruits of reflection during action, and a higher order skill. It has long been a part of anthropological analyses[13], since the anthropologist needs to be constantly taking account of how their own cultural presuppositions inform their perception and understanding of other people’s cultures. The best way to illustrate this is by interleaving Cowan’s three loops around the person, in this case an engineer, thus:

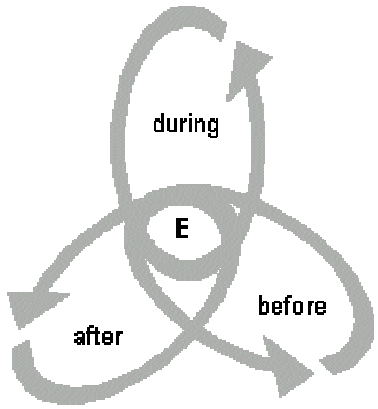

Figure 2 - Proposed Model of Reflexivity Focused on the Person

Reflexivity can now be seen as an ongoing process of reflection before, after and during action, revolving around the reflecting self. The region "E" represents not experience but the practicing engineer (or the engineering profession), the core from which reflection emanates and to which it returns in a never-ending loop. Reflection is now a tool in the continuous construction of reflexivity. Reflexivity is a way of relating to the world and a basis for understanding and responding to experience. It is a self-consciousness about practice as it occurs which allows the practitioner to maintain better communication with all other parties, because nothing is assumed.

This allows them to work more effectively in teams because they are constantly assessing how they are relating to the project and others in it. Reflexivity allows them to operate in a more responsible way because they are always anticipating future actions and their consequences, and allows them to keep learning and responding to change. While this ideal is familiar to the anthropologist on our team, in our experience engineers still have some anxiety about it. There appears to be a fear that the secure foundations of the discipline (and therefore trustworthy results) are somehow threatened.

We have spent the last two years developing strategies for training engineering undergraduates in reflexivity with the support of a CUTSD grant and colleagues in the Chemical and Mechanical Engineering departments at the University of Queensland.

Details of the study

Over the past two years we have introduced and evaluated a variety of reflexive tools for engineering students across the four years of the degree program. This study is summarized in Table 1. In this paper we report key findings from parts of this study.

Table 1 Scope of Study

Student Cohort	n	Learning Context	Reflexive Tools
Freshman	200	Team project	Process observation; Concept mapping
Juniors (Mech Eng)	240	Individual design project	Log / journal; Critical Incident report
Seniors (Mech Eng)	50	Capstone team design	Essay / paper
Seniors (Mfg & Mat)	25	Capstone team design	Log / journal; Critical incident report
Seniors (Chem Eng)	65	Capstone team design	Log / journal; Critical incident report

While training in reflection may be achieved through a variety of techniques, the act of transferring thought processes into words may lead to higher levels of abstraction and analysis, thus rendering the reflective journal a particularly appropriate tool for the development of such skills. While other Schools of Engineering in Australia use the reflective journal, it is most commonly introduced in first year with little later reinforcement. We had previously used journals in a fourth year design class and found that students were generally resistant to the extended writing task and required a lot of training, follow-up and encouragement to undertake what they understood as a “soft”, hence non-engineering skill.

For this study, we decided to introduce the journal exercise as an advanced skill during semester 1, 1998, in senior design subjects in chemical and mechanical engineering with a total of 90 students. Since these subjects were largely self-directed and students worked in small groups, it was planned that the journals would allow students to work on their group and personal management skills as well as the more technical issues. As well as keeping a journal on the progress and problems in their project, at the end of semester students were asked to write a reflective account of a critical incident which occurred during their design project.

Students' reflective thinking was assessed according to how well they met the four stages of Tripp’s[14] procedure for critical incident analyses, namely:

1) describe an incident
2) provide a contextual explanation of the incident
3) find a more general meaning
4) articulate a position

In both the chemical and mechanical engineering departments the journals and critical incident analyses were incorporated into the assessment for the subject, but was given a much higher percentage of the marks in one department than the other. This had a significant effect on the degree to which the students took the task seriously, with more percentage points eliciting a much more serious approach. The necessary skills of group process and reflection were introduced in seminars run by Jolly, a social scientist, and weekly follow ups were carried out.

While student performance of the critical incident analysis varied, few students managed to progress solidly beyond stage 1, with attempts to do so being tokenistic in nature. At the end of semester, students willing to submit their journals for perusal did so. Journal entries were of similar nature to the critical incidents; description of group process was adequate, yet little attempt was made to relate incidents to broader issues and forward planning was made without reflection.

We were aware of a common perception amongst the students that so-called “soft skills” were not "real engineering" and that this inhibited their learning. In second semester 1998 we therefore developed a protocol for a junior design subject in mechanical engineering using the Institution of Engineers Australia’s model for a professional practice report leading to corporate membership. This allowed us to model the practice of reflection on one’s own performance and the writing of a critical incident report on the semester’s work as “proper engineering”. The subject entailed individual rather than group work but the outcome of the critical incident reviews in this case showed that these students were aware of many of the same problems as the ones experienced by those students working in groups.

We used the NUD*IST software suite to analyse 94 critical incident reports from juniors and seniors. NUD*IST stands for Non-numerical Unstructured Data by Indexing, Searching and Theorizing by Qualitative Solutions & Research Software. This software allows the researcher to analyse textual and other data that is unstructured in order to clarify what is contained within it. The software enables patterns to be identified, issues to surface and theories to be developed. This sort of qualitative analysis of rich data sources has traditionally been done by social scientists using pen and paper methods. NUD*IST helps to manage the process by being able to manipulate large amounts of text and analysis electronically. Analysis by NUD*IST leads to the creation of concept maps that highlight the recurring issues that emerged from the reports and their relationship to various factors. Two such concept maps are depicted in figures 3 and 4

While technical issues were mentioned quite often in association with the incidents that students judged to be critical, they were rarely critical in themselves. The exception was the case of a problem with a computer program which was mentioned four times as often as any other technical matter. While only the seniors worked in groups, some of the issues that arose for them in group work, such as poor communication and time management, were also identified as major concerns by the juniors working individually. Only 7 of the ninety-four papers picked a positively critical incident but those students identified a very similar pattern of contributing factors to the other.

Where the critical incident related to matters of design process (figure 3), poor problem solving skills were approximately three times as likely to be the cause as lack of technical skills. In particular, students identified failure to use a variety of sources for ideas and advice, and a tendency to settle too early on a single solution, as recurrent problems. Elsewhere (figure 4) they were aware of poor performance in the areas of communication, time management, organisation and taking on working roles within the group as impeding their ability to achieve their design.

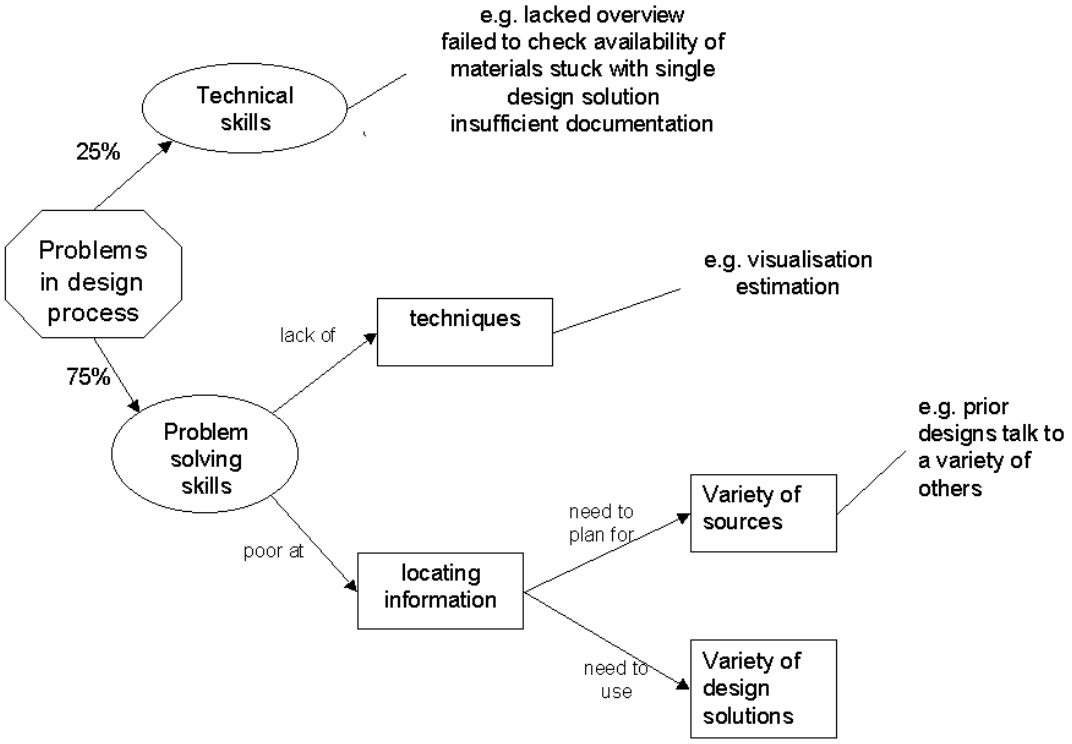

Figure 3 - Concept Map of Relative Difficulties Experienced by Students during Design Tasks

Students were advised that their adoption of group roles such as chairperson, timekeeper, agenda setter and gofer would be crucial to the success of their work together, but found it quite difficult to spontaneously take on any roles or co-ordinate their activities without duplication. They tended to blame this on a lack of leadership within the groups, each waiting for someone else to give orders, or complaining about their own not being heeded. As with all student groups, there were some individuals who did not pull their weight and a tendency for people to work away as individuals, not sharing results and thus giving themselves more work.

This failure to organise the groups was generally linked to other faults in organisation, which many students saw as failures to set rules and deadlines in the light of collective aims and objectives, a quite sophisticated insight. Those students in the third year class who were working individually also identified the failure to set deadlines as a problem. While time management could be seen as an organisational problem, it was not always identified that way by the students, but rather as a matter of unrealistic expectations. The problem of poor organisation was also linked for both sets of students to poor communication. Those working in groups felt that better organisation would have improved communication while those working alone were aware that they shrank from asking advice and discussing their work with others, to their detriment.

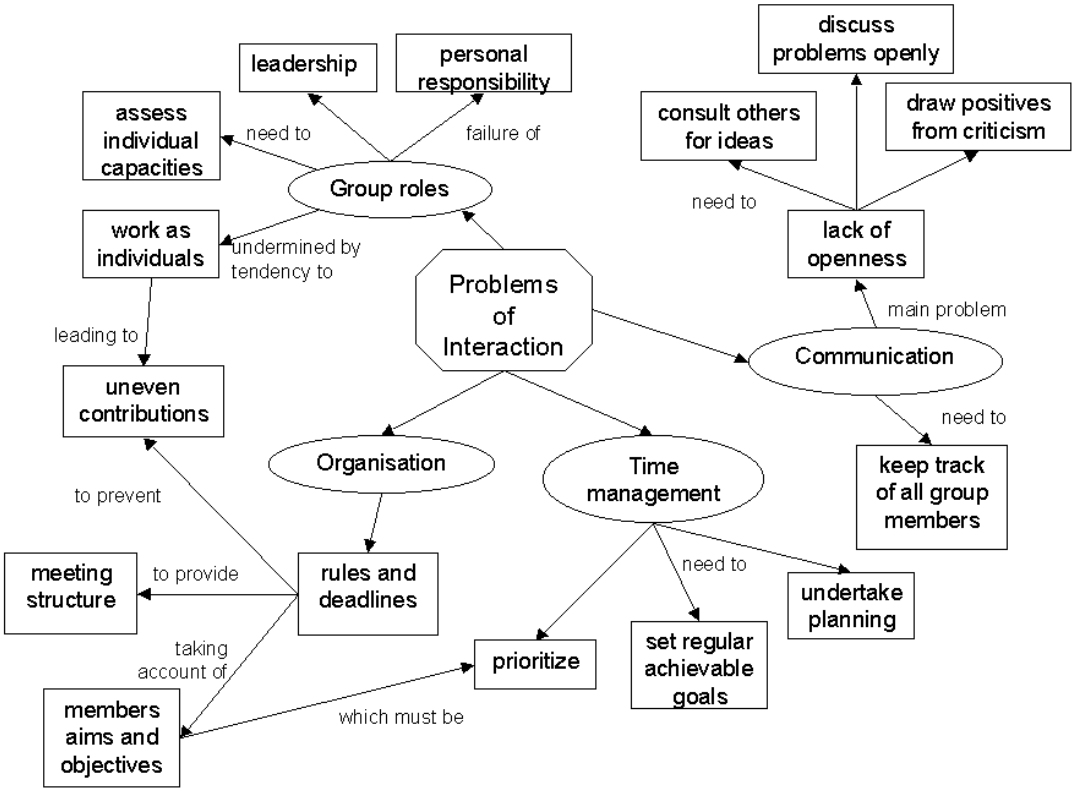

Figure 4 - Concept Map of Difficulties Students Experienced with Interactions

When we had first read the critical incident reports, our impression was that little reflection was happening. More systematic analysis revealed a sometimes sophisticated degree of reflection and set us wondering about our own deafness to what students were actually saying. However, the analysis does not reveal the achievement of any reflexivity of the type we were aiming at, in that students were not using the insight gained by reflection to modify their plans for the future or their attitudes to practice. For instance, it came as a severe disappointment when one of the brightest students (as measured by grades) recorded that he had learned to avoid innovation as it had resulted in wasting a lot of time. It was also apparent that the character and bias of the students was such that, if they were to take the process seriously at all it had to be modelled as "real engineering" by engineers and thoroughly incorporated into subjects beginning at the first year level. We therefore made some changes to our approach for the second year of the project.

One of the first changes that we thought would be beneficial was the reduction of the writing task. Engineering students commonly labour under an over-full curriculum and complain that they are not at home with extended writing tasks. Therefore, in the interests of staying close to the engineering model and in recognition of the time constraints, we adapted the journal to a log based a professional practice report. This reporting format is used by the Institution of Engineers, Australia to guide graduate members who are seeking corporate membership and

have to record the professional skills they have developed. We retained the critical incident report for senior students but reduced that for earlier years to a concept map which required less writing and would perhaps look more like engineering in its similarity to flow charts. Models were provided.

The observation that students had achieved reflection but not reflexivity led us to think about ways in which we might stage their acquisition of this skill. We decided to start introducing the relevant skills with the freshman class in 1999 (~500 students). As part of a subject called *Introduction to Professional Engineering*, students elect to work in small groups on their choice of one of five design projects. We included attention to group processes, communication skills and reflective practice as part of the design plan and assessment criteria for the Mechanical and Chemical projects, involving about 200 students. Students taking the projects in Electrical, Civil and Mining were not exposed to our material, and thus provide a control group. In keeping with our understanding that reflection and reflexivity need to be modelled by engineers, we trained faculty and tutors in group process, journal keeping and assessment of reflexivity so that the students were not given the impression that this was an external imposition on engineering practice.

In previous years we had used roles such as chairperson, timekeeper and gofer as aids for the students to think about the collaborative process. This year we introduced the notion of having a "group process observer". Each fortnight a different group member was designated as the person who would be responsible for attending to what went on in the group and reporting back to the others at the end of their term of office on what they had observed. We elected to ask the students for concept maps incorporating reflection on both content and process instead of a critical incident report and tutors were trained in preparing and marking concept maps. Analysis of the students efforts reveal less awareness of contextual rather than technical aspects of the process, as we expected, but perhaps the most revealing outcome of this part of the project has been the light it has thrown on teaching staff and their attitudes.

While the faculty involved in the project have been positive in their attitudes, some find many of the processes we are concerned with here as strange as the students do. More time in training would be one way to tackle this, but greater problems exist in the case of tutors who were either postgraduate students or final year undergraduates. Having been trained to think of engineering in the traditional, narrow way, many of them were inclined to be sceptical about our interest in reflexivity and group processes. While some did a very good job of struggling through the concept maps with the students and reminding them to reflect on process, others tended to let their groups ignore the very issues we were interested in. When it came to assessing the final reports there was a distressing tendency for very neat and tidy flow charts with no reflection to get better marks than those (admittedly sometimes incomplete, messy) concept maps which attempted to incorporate this ambiguous, ill-defined process, which was the object of the exercise.

One part of this problem is the matter of building up a critical mass of students and staff who are familiar with the concepts and processes. However we feel that to wait for a generational change would be admitting defeat and accepting that the engineering profession cannot change from within. After all, there are many engineers who are capable of producing the kind of engineering

called for by the frequent Reviews, even if they are not in the habit of thinking about how they do what they do (rather than the scientific bases of what they do). They cannot be left out of the change process in the hope that younger generations will suddenly be different. The development of more socially and environmentally responsible engineers, capable of adapting throughout their careers to changing technologies and workplaces needs to be a staged process, but it needs to involve engineers at all levels of expertise, as we argue below.

Staging expertise development

Table 2 summarises Benner's[15] model of professional development as modified by Butler[16]. Benner argues that the progression to expert status starts from a position of depending wholly on rules until finally, through long experience, the rules become unconscious, though remaining the basis of practice. Butler suggests that higher orders of practice, the competence and proficiency that the world of practice demands, are arrived at only after substantial reflection on practice. This allows the practitioner to gain as much from experience as they do from received wisdom, and that the application of rules is not necessarily important to expert practice. This accords well with our experience and our understanding of what this means for the prosecution of more responsible engineering education appears in bold in the following table.

Table 2. Moving from novice to expert.

STAGE	CHARACTERISTICS	STRATEGY
Novice	No experience Sticks strictly to rules Unable to decide which tasks most relevant	Limit expectations until experienced gained; Clarify rules **Provide clear rule statements** **Reward rule use**
Advanced beginner	Low level unsupervised performance Belief in single solution Ask for answers Unwilling to explore problems	Help prioritising; Support understanding of context **Teach prioritising** **Present problems in context** **Reward risk-taking**
Competent	Can analyse complex problems Uses conscious, thoughtful, analytic reflection Conscious planning Lacks speed and flexibility of higher levels	Involve in decision making and planning Move away from emphasis on detail **Demand more self-government of students** **Reward innovation**
Proficient	Intuitive response to "big picture" Uses experience of 'typical' events Considers fewer options than competent person	Draw publicly on experience in context of actual problem Avoid insistence on rules; Avoid extreme novelty **Train tutors to call on experience** **Don't ask them to tutor where no experience exists**
Expert	Acts "by instinct" Is unaware of rules	Document both successful and unsuccessful interventions to bring expertise into conscious knowledge **Involve instructors in reflection on their own practice**

It would be relatively easy to set out a teaching program for the lower levels, abstracting rules for journal writing, reflection and so on, but practical and theoretical problems remain. The practical one is the problem that those who are expert in one set of practices may well be novices in another, and students need to have desired outcomes modelled to them by those inside the profession. This requires teachers to share their engineering expert status with students in a setting where they are equally novice in reflecting on it and coming to reflexive conclusions. The more serious problem is that just applying a set of rules for reflection will not result in

reflexivity, the changing of attitudes and orientation to the social practice of engineering. Students must be brought to believe, as those in the profession who call for change believe, that better engineering outcomes should and can be obtained. What this means is that the path to reflexivity must start at the bottom of the table with today's experts using reflection on their practice, in partnership with students, to move towards a reflexive stance with respect to the world of engineering practice.

Future Work

We plan to develop a strategy to guide the staged development of reflexivity in staff, tutors and students in the School of Engineering, based on the model of professional development and incorporating continuous reflection at all stages. Our plan has three stages congruent with the reflexivity model:

1. Faculty reflection and planning
   At this stage academic staff will work together to reflect on past experience of developing reflexivity in students, and decide how to organise this training in the coming year. This will include deciding which level of development each class is expected to be at for each task and planning instruction and assessment accordingly. They will then share the fruits of this reflection with tutors and prepare them for their share of the training.

2. Teaching as reflection in action
   Teaching staff will not only introduce students to tools such as the journal, but will participate in the journalling and in-class reflection themselves. This will allow for very strong modelling of reflexivity as well as fruitful reflection on actual tasks to hand. Even when dealing with situations where students are novices and therefore reliant on rules, reflection will be used to emphasise the correct application of rules and to move students towards a sense of prioritising. At another level, staff will have group meetings to reflect on the process and make any necessary adjustments during semester.

3. Learning from the process
   For students this will be the moment when they decide on their critical incident and analyse it. Staff will help them to reflect on the process in terms of their own development as well as in terms of class objectives. Staff themselves will undertake a critical incident analysis from the point of view of the teaching experience, which will feed into the next cycle of planning.

It is important to remember that a task such as a design project will include aspects where students have some expertise. Even freshmen have experience of the world which informs their basic presuppositions about engineering and which needs to made conscious. It is therefore never too early to begin incorporating reflexivity into the curriculum, and the developmental model should not be made an excuse for clinging to a teaching program that seeks to impart rules only. Nor is it ever too late to change. Old-fashioned technical expertise is still vital, and adopting reflexive habits with respect to it promises to make it even more effective in a changing but still material world.

Acknowledgment
The authors gratefully acknowledge the support of a grant from the CUTSD (Committee for University Teaching and Staff Development).

Bibliography

1. Beder, S. *The New Engineer*. South Yarra: Macmillan (1998).
2. Institution of Engineers, Australia, *Changing the Culture: Engineering Education into the Future*, Institution of Engineers, Australia, (1996).
3. Morgan, R.P., Reid, P.P., and Wulf, W.A., The changing nature of engineering, ASEE Prism, 5, pp12-17, (1998).
4. Dewey, J., *How we think: a restatement of the relation of reflective thinking to the educative process.* Heath, Boston, (1933).
5. Boud, P., Keogh, R & Walker, D., What is reflection in learning? In Boud, P., Keogh, R. & Walker, D. eds. *Reflection: Turning experience into learning*, pp. 7-17. Kogan Page, London, (1985).
6. Kolb, D., *Experiential learning: experience as the source of learning and development*, Prentice-Hall, Englewood Cliffs, (1984).
7. Institution of Engineers, Australia. (IEAust), *Manual for the accreditation of professional engineering courses.* Institution of Engineers Australia, Australia, (1997).
8. Argyris, C., *On organizational learning.* Blackwell Business, Cambridge, (1993).
9. Schön, D. *The reflective practitioner*. Basic Books, New York, (1983).
10. Cowan, J, Stockholm Pre-conference Workshop, *Teaching science for tertiary students II: Learning how to think like an engineer*. Stockholm, June (1997).
11. Matthew, B and Sayers, P., Self-reflection in the education of engineers – observations of students and staff wielding a formative and summative tool – based on parallel examples of student learning and organisational development. Unpublished paper, University of Bradford, UK.
12. Darling, I., Action evaluation and action theory: An assessment of the process and its connection to conflict resolution. pp 1-6. *The on-line conference on "The reflective practitioner." Dedicated to Donald Schön on ACTLIST.* 1st of March to 3rd of April 1998.
13. Anderson, G.L. and Saavedra, e., "Insider" narratives of transformational learning: implications for educational reform. Anthropology and education Quarterly 26(2), pp. 228-235, (1995).
14. Tripp, D., Critical incidents in teaching: developing professional judgement. Routledge, London, (1993).
15. Benner, P., *From Novice to Expert*. Menlo Park CA, Addison-Wesley, (1984).
16. Butler, J., Professional Development: Practice as text, reflection as process and self as locus. *Australian Journal of Education* 40(3):265-283, (1996).

LESLEY JOLLY
Lesley Jolly is an anthropologist who began her association with engineers in 1996 in a research project that examined gender issues amongst undergraduate engineers. Since then she has been involved in studies of the social processes involved in engineering design, a cultural change project for the School of Engineering at the University of Queensland, and most recently, a project to produced more widely skilled graduates, reported here.

DAVID RADCLIFFE
David Radcliffe is an Associate Professor in Mechanical Engineering at the University of Queensland. Dr Radcliffe's scholarly interests include engineering systems design, manufacturing systems, engineering education and rehabilitation engineering. He co-founded the Engineering Process Research Group (EPRG) which carries out empirical research focused on the process of engineering in the context of natural work settings. This research draws on and involves collaboration with the social sciences especially anthropology. David was a National Teaching Fellow, in 1994 and a Boeing-A.D. Welliver Fellow, in 1999.