Unit 14 – Tutor resource
Classroom Culture – Working with Complexity and Chaos

Who dares to teach must never cease to learn.
- John Cotton Dana

Learning is what most adults will do for a living in the 21st century.
- Perelman

The only person who is educated is the one who has learned how to learn and change.
- Carl Rogers

Teachers open the door, but you must enter by yourself.
- Chinese Proverb

Introduction

These units are designed for educators planning to use EAC materials anywhere in an academic teaching program. They are primarily intended for use by individual tutors, although they can provide the basis for discussion about the changing nature of classroom activity in university settings.

In order of presentation the units are -

1	Being successful as a Portfolio Project Manager of student learning teams	Thinking of yourself as a Portfolio Project Manager (PPM) can help establish a useful and stable space and role for yourself when introducing interactive /experiential learning strategies. This unit introduces the PPM as a classroom role and explores how to adopt and sustain it.
2	Working with chaos and complexity	Cause and effect are familiar elements in engineering. They also exist in classrooms and workplaces. In the 21st century cause and effect relationships are becoming more complex. This unit explores ways in which an understanding of a model of cause and effect relationships can help educators work with concepts of chaos and complexity both in the classroom and more generally.
3	Managing the changing face of learning	This unit focuses on identifying how conflicting expectations and assumptions affect all aspects of classroom experiences. It identifies how differing classroom conditions affect specific learning strategies, and suggests ways to support and value differences rather than relying on a single teaching strategy.

Each Section begins with some practical stories of the relevance of the ideas, suggests activities for testing and application and provides a short summary of the theoretical concepts informing the theme. It suggests some ways for incorporating one or more EAC Units into existing or planned academic units of study.

Working with chaos and complexity

Engineering Feats – mastering Chaos and Complexity

"In The River" – Chaos

When pilot Sully Sullenberger's cool response to crisis enabled him to land a crippled plane in the Hudson River without losing any passengers or crew, he showed a mastery of 'Chaos thinking'. After a flock of birds disabled both engines, he assessed all the apparently available options as 'impossible' and calmly advised airport control, *"We'll be in the river".* Then he used his knowledge and expertise to achieve the unthinkable – landing a fully loaded passenger plane on water without sinking! Application of planned responses did not assist, and probes for alternate outcomes simply indicated there were no achievable options. His choice to ***act*** in the face of so many unknowns undoubtedly saved everyone, but could not have been anticipated as a viable option at any time before he took it.

"Wheel gone!" - Complexity

When an RAAF F1-11 fighter lost a wheel on take off from Amberley Air Force base in Queensland on July 18, 2006, it was successfully returned to earth with minimum possible damage and no loss of life. Those involved used thinking strategies related to those applied by Sullenberger. However, on this occasion, the time factor, capabilities and resources were quite different. The plane had a full fuel tank and was otherwise fully functioning, so the pilot could continue to fly a mission while a team on the ground used the F1-11 flight simulator to design and assess all the possible options for a safe landing. These experts ***probed*** for every possible variation, made sense of the data as it emerged from their explorations, and devised a response strategy that brought both pilot and plane back safely.

Chaos and Complexity Thinking

This is the kind of thinking that students are invited to employ in using these Engineering Across Borders study units. This project set itself a goal of generating new ways of creating and sharing knowledge. As the ALTC proposal document noted -

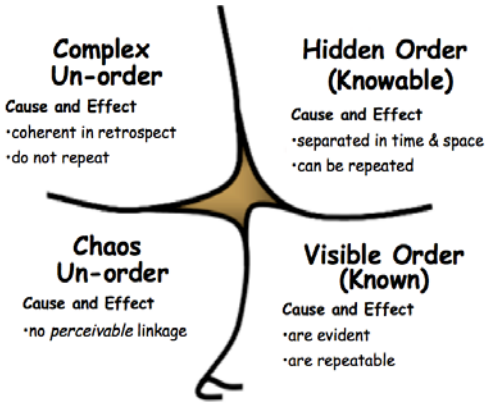
> *Acceptance of the need for developing cultural intelligence in engineering students is present, and a wealth of cultural knowledge to facilitate this is available. However knowledge of how to effectively educate engineering students on cultural issues is lacking.*

These materials are made available to be adapted - and added to - from your own expertise. Nevertheless a core premise underlying their use is that students are able – and will experience an increasing need - to experience discontinuities and uncertainties in their future workplaces. Therefore they will benefit from learning to exercise and trust their own expertise, while developing a healthy respect for the unknown, with a corresponding understanding that they can move to new levels of awareness and competence through their own efforts.

The Cynefin Domains

This unit introduces a way of thinking about the forces found regularly in classrooms. It uses the concept of cause and effect relationships to explore five different conditions that may be found at different times in education and elsewhere, and draws on the work done by David Snowden and his colleagues, under the general title of the Cynefin Domains of Knowledge.

In the context of mechanical engineering, 'stress' causes 'displacement', that is, stress is the *'causal action'* and the *'effect'* is the displacement experienced by specific elements. [1] Similarly in the Cynefin model each set of 'causes' has a relational 'effect' on those experiencing their context as a moment-to-moment living environment. Specific relationships between cause and effect, as illustrated in the Cynefin Domains model, indicates the extent – or otherwise -



Cynefin Domains of knowledge showing cause and effect relationships

[1] http://www.physicsforums.com/showthread.php?t=127768

of the "Orderliness" in each context (Snowden and Boone, 2007).

Dis-order - The central 'greyed out' space is a useful starting point for exploring the model. 'Dis-order' refers to the condition in which relationships between cause and effect are (or are believed to be) unknown, or undetectable, and therefore unmanageable. It is the absence of any apparent 'cause/effect' linkage that can make this domain 'frightening', leading individuals who believe they are 'in' it, to experience varying degrees of distress. If an individual or organisation blunders into this Domain (really a mental construct rather than a real 'space'), an essential first step concerns recognizing the need to seek relevant cause and effect relationships with which to achieve resolution of the problem or situation at hand. Failure to do so can lead to severe distress, retreat to 'safe' havens that are unlikely to be helpful in resolving the problems being experienced, and may even lead to increasing distress, failure to act effectively and – if continued – to disaster.

The surrounding four Domains provide cause and effect relationships enabling diagnosis of a situation – by a designated leader and/or participants - before taking action. As shown in Figure 1, beginning with the Domain likely to be most familiar, these are:

Visible Order – familiar situations where cues and indicators are well **known** and Cause and Effect relationships are *evident* and easily *repeatable*. The familiar 'classroom' setting is an example of such a 'Visible Order' domain. Here are seats in orderly rows, display media at the 'front' of the room near a lectern (or a single desk facing all the others), and everyone has an unspoken – but quite powerful - expectation that the 'leader' has the answers and can impart them. Anyone entering this space already knows their 'role' here and behaves accordingly, without need of any reference to additional cues.

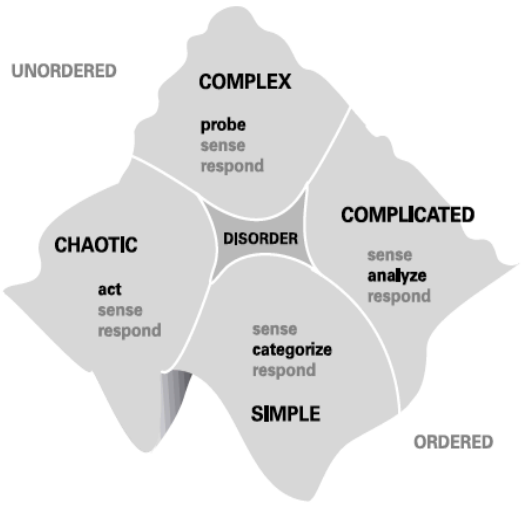
Hidden Order – refers to situations where cause and effect are separated in terms of both time and space but can be *discovered* and can be *repeated*. Examples in an educational context include a laboratory, workshop or other space where roles are familiar, but tasks involve direct engagement with tools and materials under the guidance of a 'leader'. Thus the 'hidden' nature of the task is '*knowable'*, can be discovered through action and under guidance of an expert, and, once acquired, can be repeated with the goal of increasing proficiency.

Complex Un-Order – [the 'un' is a humorous, while respectful, reference to Bram Stoker's use of the term 'un-dead' meaning neither 'dead' or 'alive', but in some indeterminate state in between] this domain refers to those situations where 'order' is only found after events have ended; where new knowledge has emerged from grappling with unknown and incomplete data; where the outcomes are not exactly repeatable, although the learning gained from the effort can be acquired and codified to some extent, and may be useful in future conditions, which may be similar but never exactly the same. In education, doctoral and honours work could be thought of as occurring within this domain.

Chaos un-order – there seems to be no perceivable cause and effect relationship in this domain, although this may simply be that the pattern of events is simply too large with so few repeatable factors that humans can only see the chaos. In some respects, key features of the current situation of education and learning could be said to have arrived in this domain. The familiar order of 'professor' and 'student' / 'knower' and 'learner' are under challenge from a range of sources. Technology, easy access to information, exploding rates of data creation and social and life style changes are all challenging the 'known' order of 'teaching' and 'learning'. Medieval conditions relating to knowledge creation and learning gave rise to current university structures and are long gone. Yet the comfort of their familiarity makes it difficult to let them go, while the combination of challenges noted above are making current academic contexts almost unrecognisable descendants of those 'orderly' settings.

So what?

In Figure 2, the Domains are provided with descriptors (Simple, Complicated, Complex, Chaotic and Disorder) indicating their essential nature. The four Domains can also be seen as subsets of two quite different contexts – known as 'Ordered' and 'Unordered'. As leaders, educators and individuals begin to understand the working of differing sets of causes and effects, they are more able to make conscious choices for appropriate responses leading to effective action within in each Domain. That is, we become aware of the need – and potentially more able - to act in ways that Snowden and Boone define as 'contextually appropriate'.



Cynefin Domains showing response sequences relevant to each one.

While academic teaching contexts cater effectively for the 'Ordered Domains' – named in Figure 2 as 'Simple' and 'Complicated' - less attention is paid to preparing students for effective responses in the 'Unordered' Domains of the 'Complex' and 'Chaotic'. An emergent problem, arising from this, is that workplaces, and other social contexts, are becoming places where much is unknown and it is accepted that not everything relevant can be known all at once. This, in turn, requires a greater capacity to operate effectively on limited knowledge. And this, in its turn, involves accepting that real understanding may only arrive *after* the event. However, academic contexts are lagging behind in their capacity to provide students with requisite skills for operating in such conditions. Since it is not possible to 'know everything', effective operation in the Unordered Domain requires a capacity to perform effectively and efficiently in conditions of 'incomplete information'. This may involve the use of *probes* to collect enough data to make sufficient sense of conditions in order to respond appropriately in short time frames. Expert capacity to operate in this mode seems to require a mindset conditioned to working with incomplete knowledge and without the comfort of known outcomes.

The engineers and simulation experts who used the RAAF simulator to *probe* for every possible variation made sense of the data as it emerged from their explorations, and devised a response strategy that brought pilot and plane back safely. This is the kind of thinking that these Engineering Across Cultures study units aim to help educators convey to students. Since culture is one of the most powerful influences on thinking and behaviour, and also one that is simultaneously well known (our own culture) and an almost complete mystery (other people's cultures – and aspects of our own culture that are so ingrained we cannot easily recognise them) the Units of study provide a range of perspectives which educators can use to introduce and guide exploration of 'culture' in all its diversity.

The Engineering Across Cultures Approach

How is an understanding of the Cynefin Domains relevant to production and use of the Engineering Across Cultures teaching materials?

As noted above, materials for the Engineering Across Cultures project create conditions in which students must learn to work in the 'Complicated' and 'Complex' Domains. The activities encourage them to work just sufficiently beyond current levels of knowledge as to stretch their capabilities for absorbing, managing and responding to new information - and develop their self-confidence while doing so.

It is anticipated that this 'stretch' will enable them to become consciously aware of their current attitudes and beliefs in regard to the value and benefits of acquiring cultural intelligence. Developing the ability to probe for information, recognise the value of taking action and *then* analysing the outcomes extends students' own intelligent awareness of the impact of culture on all aspects of engineering. It is anticipated that these activities will assist students to develop agility in recognising the actual needs of specific contexts instead of relying on habitual responses.

The materials and activities invite students to create experiments, discuss issues and allow patterns to emerge as they develop new thinking habits that enable them to more safely trust their own observations and experiences. Relevant references to a variety of expert sources are included throughout the materials – but the belief underpinning everything is that taking action to engage with information generates new knowledge unique to each individual and therefore more likely to become embedded operating principles as students pursue their engineering careers.

Conversely, the notes for tutors accompanying each Unit of study, and supported by these three Units, provide educators with background information and ideas for stretching their own intellect and awareness. It is hoped that all parties will have encountered a range of new experiences, gained confidence in less familiar learning contexts, and feel more self-assured when facing the unexpected and unanticipated, especially in regard to learning processes and expectations.

Making the Changes – altering current behaviours and expectations

Studying in the 'Simple" Domain

First year university students entering their first lecture theatre do not head for the stage and the lectern. They are able to 'make *sense* of' the setting and without conscious decision-making, categorise themselves as 'students' and respond by heading for the rows of tiered seats. Here they await the experience of 'being told' about their subject's core principles, notions and beliefs.

Encountering the 'Complicated' Domain

Passive 'waiting' may be OK for a lecture; it is less useful in tutorials, and a total disaster if it is the individual's only continuing response. At some point, students must become able to sense the complicated nature of what they are encountering, *analyse* their context and incoming information, and devise conscious responses of their own. As they do so, they develop 'Complicated' thinking capabilities at a level suitable to their context. However, students graduating with a high level of expert-driven 'complicated' thinking, may remain largely unaware of the 'Complex' Domain where there are few certainties and no absolutes.

Continuing reliance on other experts to guide and shape learning eventually creates a sense of dependence that traps thinking and response patterns within the 'Ordered Domain' of Visible and Hidden Order,rendering learners unready for the uncertainties and discontinuities of the 'Unordered Domains' of workplace Complexity and Chaos. As long as they are in roles requiring adherence to pre-set structures and routines, they can depend on previously acquired knowledge and expertise and are safe and able to perform well. However, if/when life and work begin to demand that they operate in situations with increasing numbers of relatively unknown factors, this dependence on expertise - their own and others' – may fail them.

Challenging dependence on 'experts'

Moving beyond 'Complicated' is never a simple process. It involves acceptance that knowledge is not fixed, that uncertainty must become a familiar companion, and even the most trusted experts have not been here before us. In the spirit of operationalizing the Cynefin Domains, we acknowledge that taking students – and ourselves as acknowledged experts in our own fields – into this unknown terrain is a complex task, with dead ends, false starts and abandoned ideas.

In so doing, we celebrate all those creative and innovative thinkers in engineering who have found new ways to use their knowledge and improve the context of our lives. My personal favourite as a young girl was Barnes Wallis, an engineer who worked across naval and aircraft design, pioneered the remote control of aircraft and featured in the movie "The Dam Busters" with his design for a bouncing bomb. *The story described in The Dam Busters reflected the difficulties Wallis often faced in persuading those in authority or who controlled funding sources to support his ideas.*

http://en.wikipedia.org/wiki/Barnes_Wallis

The story also records his vast capacity to persist against all odds when the purpose was important, and to persuade others to accept his radical and often unconventional thinking. He understood the importance of 'Complex' thinking and was not averse to taking action to press home a point.

Practical Applications

Classroom contexts usually come with an unspoken expectation of recreating a "Simple" domain. Familiarity with the context creates a sense of safety and security; and the orderliness of the relationships usually experienced reduces personal insecurities. If the environment moves away from this by introducing activities expecting students to work independently, the shift in expectations can unsettle 'taken for granted' assumptions and create an atmosphere of distrust and uncertainty. Since this also has potential to generate uncertainty in you as an educator, we offer the following tips and hints to sustain your own ability to work on and in the "unordered Domain." The following table lists events or reactions that may arise as a result of students becoming disoriented or uneasy in 'new' learning contexts.

Alongside each one are suggested responses on which to build your own unique rerpertoire of responses. This is supported by references to research and information for further exploration - either in anticipation of these kinds of events, or afterwards.

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Events and Behaviours	**Possible responses**	**Research and information -** References and links to sources for guidance
There is a lot of resistance to moving into groups and an expressed degree of discomfort with group work and activities	• It may be helpful to have groups pre-selected and put sheets listing group member names on the tables before students arrive. Then it is somewhat like a 'party' setting where they have to find their names, and the task itself moves them forward more quickly. • Be Patient. While some gentle urging is useful, demonstrating that you can 'out wait' them is more effective. This may feel like you are 'losing time', but, in fact, you are gaining control of the learning space in a different way, and it seldom takes long for everyone to settle into the next mode of operating • Once everyone is settled, it may be useful to refer briefly to the group-based nature of most workplaces and note that cooperative behaviour - not unnecessary reluctance - is better respected there. • Make it clear that contributing to the activities enhances their capacity for becoming better engineers because of the opportunities to *work with* their knowledge rather than simply *memorising* things.	Stephen Brookfield – see http://stephenbrookfield.com/Dr._Stephen_D._Brookfield/Critical_Incident_Questionnaire.html for a tool he uses as a combined reflective and feedback tool His books are listed at http://www.amazon.com/Stephen-Brookfield/e/B001HOEZ68 Wilfred Bion see "The central concept in Bion's theory is that in every group, two groups exist: the "work group" and the "basic assumption group". Bion was not referring to factions or subgroups within the group, but rather to two dimensions of behavior within the group." From http://209.34.253.86/upload/2004_ODN_Conf_Proceedings.pdf http://www.yale.edu/peace/management.htm http://www.eslfocus.com/articles/managing_the_university_classroom_giving_freedom_taking_control-449.html
Student/s become unsettled and demand a return to a passive state where they only have to listen	• Be Patient. Trust that the new operating mode will become a habit after a while – as long as you sustain the requirement for them to work, not simply listen. • Believe in – and emphasise - the value of having them work things out for themselves. The two case studies that open these notes demonstrate that this ability may well be one of the most important things they learn with/from you. • Draw a parallel with learning sports. While information and theory is important 'working with' the ball is the only effective way of acquiring skills and capabilities.	
Student/s pretend to do the activity, but, under cover of surrounding noise, talk or joke around	• Be vigilant. This approach to learning does require the educator to move around a lot. Offer your help; observe quietly and unobtrusively. Trust that almost all students are genuinely concerned to do their best. • Have relevant consequences available when you need to remind an individual or group about the value of effective participation. These may include: o [short term] loss of marks; delays in returning work; requirement to do additional work; o [long term] delays in final results; missing out on relevant work-related experiences that could be included in a resume; lost opportunities for picking up experience in applying theoretical knowledge.	

Student/s do the task in a simplistic 'let's guess' manner and show no apparent concern that they are not benefitting from the experience	If this is a single group, address the discussion and actions to them only. If it is larger proportion or the whole class, then stop the action and address the issue directly. • Some points to make include: o Practice and theory are two inseparable elements of the role of an engineer. Theory needs to be practised if it is to be of use once they are at work. o Pride in work is the mark of a professional - see the Engineers Australia resources at http://www.engineersaustralia.org.au/sites/default/files/shado/Education/echartered/competency_standards_marchversion.pdf o Collect and have ready examples of engineers who demonstrate high standards and have used their experiences to address complex problems	
Student/s do not turn up to class	• If this concerns a few individuals, use your university's communication system and policies to connect with them. If it is a larger proportion of the class, use your online learning system to connect. Stories and case studies about successful application of engineering theory in multi-cultural contexts can help students see the value of the work.	
Student/s talk loudly and appear to be ignoring instructions	• It is possible that this behaviour is actually indicative of a degree of nervousness about having to demonstrate a grasp of theory and putting it into practice. • Slow Down. If you are in the process of giving instructions focus attention on yourself – wait for silence and then proceed. • Have plenty of copies of the EAC handouts and ensure everyone is checking them through with you. • Distribute handouts and set the time frame without further ado. This way you can focus on groups where attention is lagging, and allow the rest to get on with the job.	
Student/s are silent and sullen, moving slowly to begin tasks, taking a long time to complete them	• Be patient. If you suspect this behaviour is an attempt to avoid work, be clear about consequences for incomplete work. Where the class activity is not included in assessment tasks, focus on such things as the Engineers Australia standards for engineers. • Decide if you want each activity completed within a set time, or whether moving the process through to completion - with the risk of some incomplete tasks – is a better option for this class. • Focus on the positive strengths of engineers who are culturally aware. Point out the difference between "building something" and "creating homes to meet client needs", such as in the case study of Aceh. • Challenge the class to a competition – have rewards of some kind [including an early mark!].	

Student/s ask lots of questions about the process and use actual or feigned ignorance to delay or inhibit moves to give them responsibility	• Acknowledge their right to ask questions – and then assure them that the process itself will answer the questions and they will have gained experience rather than spent time listening to you. • Announce that ignorance is best overcome through action – and the activity will draw out their knowledge. • Where you have Internet facilities available, or nearby, allow the groups to use these where relevant, and focus attention on the process of acquiring knowledge for themselves.	
Students disappointed / dislike the 'teaching' style being used – and say so. They make veiled or overt threats to complain	• Acknowledge their right to express their opinions. • Emphasise that there will be very little 'teaching' once they are working, so every opportunity to learn about their own capabilities to conduct good research and contribute to group work can provide practice for their own future success. • Invite them to think about whether they are self-motivated learners or dependent on someone else for all their direction setting.	
Student/s actually lodge complaints about 'not being taught well' in the unit	• Have your work and processes documented fully enough to provide supporting evidence for your use of the EAC approach to teaching and learning. • Invite the students to consider how much 'teaching' they will get once they graduate. • EAC is focused on assisting engineering students to understand how culture – national, business, personal – all influence the nature of engineering work. As such it is working to achieve a balance between imparting facts and assisting individuals gain insight into how 'who they are' shapes 'what they see' and 'how they work'. Such insight has the capacity to impart long-term influence on future behaviour. Lectures and knowledge-driven teaching are less able to do this.	