Evidence for Accreditation:
input from Faculty and Student Assessments

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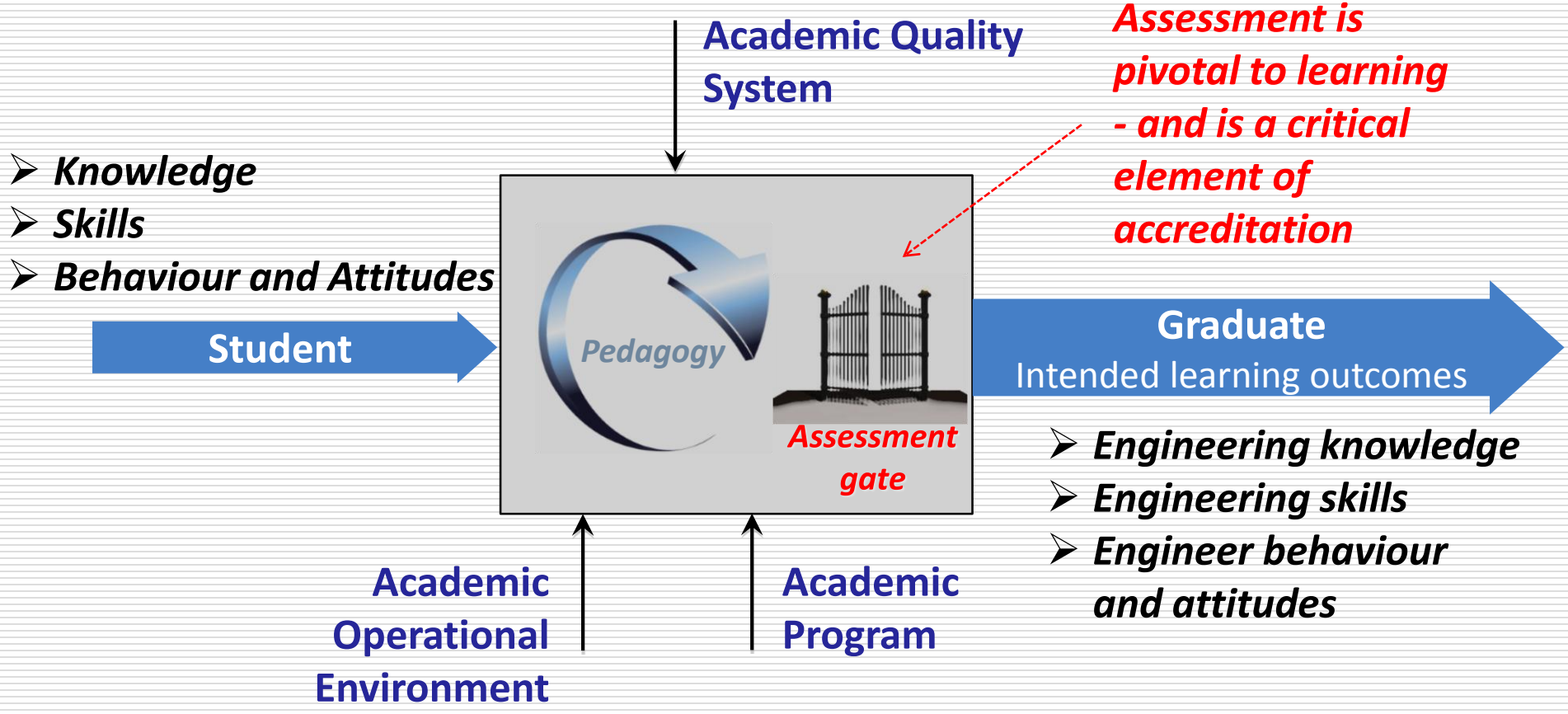
Overview: evidence-based accreditation

- **accreditation criteria and practice**
  - IEA-ENAEE best-practice exemplar
  - Engineers Australia: focus , process, and standards, expectations
  - evaluation of self-study document
- **EA visit expectations and activities**
  - faculty and program leadership teams
  - academic participation
  - student and graduate input
  - industry stakeholders
  - assessed work for demonstrating learning outcomes
- **issues and questions**
  - improved assessment of project work
  - sharing best practice

model of engineering education (+ accreditation)



Accreditation must evaluate these three elements

IEA-ENAEE best-practice exemplar covers

- nature of the accreditation agency for peer evaluation
- criteria (and standards) for all three elements (environment, program, and quality systems)
- accreditation process should be
  - consistent, fair and robust
  - a transparent process with confidential program evaluation
  - comprehensive - across pathways
  - based on pre-visit documentation and
  - evaluation visit – student/graduate attainment, all stakeholder input, facilities
  - criterion-referenced for decision making and quality improvement
  - reporting of outcomes and publication of status
- agency capacity, including recruitment and training of evaluation panel members

graduate outcome areas in the IEA Accords

Knowledge-oriented

1: Using engineering knowledge

Defined Knowledge Profile for all areas

Problem-solving Skill Group

2: Problem analysis

3: Design/development of solutions

4: Investigations

Range Statements for Problem Solving

Skill-oriented Group

5: Modern Tool Usage

9: Individual and teamwork

10: Communication

11: Project/Engineering Management

Attitude-oriented Group

6: The Engineer in Society

7: Environment and Sustainability

8: Ethics

12: Life long learning

- **achievement is defined for each outcome in each Accord**
- **Accord signatories operate accreditation systems that test substantial outcomes equivalence to the Accord "exemplar"**
- **similar frameworks are defined by ENAEE (EUR-ACE) and CDIO**

IEA definition of Complex Engineering Problems

Complex engineering problems cannot be resolved without in-depth engineering knowledge, much of which is at, or informed by, the forefront of the professional discipline, and have one or more of the following characteristics:

- involve wide ranging of conflicting technical, engineering and other issues
- have no obvious solution and require abstract thinking, [and] originality in analysis to formulate suitable models
- require research-based knowledge … informed by practice at the forefront of the discipline … allows fundamentals-based, first principles analysis
- involve infrequently encountered issues
- are outside coverage of standards and codes of practice for professional engineering
- involve diverse groups of stakeholders with widely varying needs
- have significant consequences in a range of contexts
- are at high level, including many component parts or sub-problems

Engineers Australia accreditation

- focuses on two questions:
  - Do the educational environment, program and quality systems assure delivery of the Stage 1 competencies (graduate learning outcomes) for the next 5 years?
  - Is the range and depth of technical competence appropriate to the named discipline specialisation?
- a holistic peer judgement (rather than audit) of compliance with accreditation criteria in three areas:
  - operating environment (6 criteria) - leadership, staffing, ...
  - the academic program (5) – program target outcomes, ...
  - quality systems (10) - industry input, assessment, ...
- accreditation process and outcomes
  - pre-visit scrutiny of Faculty documentation and follow up
  - 3-day evaluation visit
  - recommendations on accreditation (and conditions)
  - commendations, and recommendations for improvement

EA Stage 1 Competency Standards

- contextual role statement (of mature professional)
- 16 elements of competency for entry to practice
  - knowledge and skills base (6)
  - engineering application ability (4)
  - personal and professional attributes (6)
- consistent with IEA graduate attribute exemplars
- each element is elaborated with "indicators of attainment"
- the Standard is used for
  - individual assessment (of graduates of non-Accord recognised programs)
  - program design (by educators)
  - program accreditation (by evaluators)

EA Stage 1 Competency Standard for Professional Engineer

Units of Competency	Elements of Competency (Professional Engineer)
1 Knowledge & Skill Base	1.1 Comprehensive, **theory based understanding** of the underpinning natural and physical sciences and the engineering fundamentals applicable to the engineering discipline. **1.2 Conceptual understanding** of the mathematics, numerical analysis, statistics, and computer and information sciences which underpin the engineering discipline. **1.3 In-depth understanding** of specialist bodies of knowledge within the engineering discipline. **1.4 Discernment** of knowledge development and research directions within the engineering discipline. **1.5 Knowledge** of engineering design practice and contextual factors impacting the engineering discipline. **1.6 Understanding** of the scope, principles, norms, accountabilities and bounds of sustainable engineering practice in the specific discipline.

Units of Competency	Elements of Competency (Professional Engineer)
2 Engineering Application Ability	**2.1** **Application** of established engineering methods to complex engineering problem solving. **2.2** **Fluent application** of engineering techniques, tools and resources. **2.3** **Application** of systematic engineering **synthesis and design** processes. **2.4** **Application** of systematic approaches to the conduct and management of engineering projects.
3 Professional and Personal Attributes	3.1 **Ethical** conduct and professional accountability 3.2 Effective oral and written **communication** in professional and lay domains. 3.3 Creative, innovative and pro-active **demeanour**. 3.4 Professional use and management of **information**. 3.5 Orderly management of self and professional **conduct.** 3.6 Effective **team** membership and team leadership.

indicators of attainment (action oriented evidence)

2.1 Application of established engineering methods to *complex* engineering problem solving.	a) **Identifies, discerns and characterises** salient issues**, determines and analyses** causes and effects**, justifies and applies** appropriate simplifying assumptions, predicts performance and behaviour**, synthesises** solution strategies **and develops substantiated conclusions.** b) **Ensures** that all aspects of an engineering activity are soundly based on fundamental principles - by diagnosing, and taking appropriate action with data, calculations, results, proposals, processes, practices, and documented information that may be ill-founded, illogical, erroneous, unreliable or unrealistic. c) **Competently** addresses engineering problems involving uncertainty, ambiguity, imprecise information and wide-ranging and sometimes conflicting technical and non-technical factors**.** d) **Investigates** complex problems using research-based knowledge and research methods. e) **Partitions** problems, processes or systems into manageable elements for the purposes of analysis, modelling or design and then **re-combines** to form a whole, with the integrity and performance of the overall system as the paramount consideration. f) **Conceptualises** alternative engineering approaches and **evaluates** potential outcomes against appropriate criteria to justify an optimal solution choice. g) **Critically reviews and applies** relevant standards and codes of practice underpinning the engineering discipline and nominated specialisations. h) **Identifies, quantifies, mitigates and manages** technical, health, environmental, safety and other contextual risks associated with engineering application in the designated engineering discipline. i) **Interprets and applies** legislative and statutory requirements applicable to the engineering discipline.

EA expects to see mapping of target outcomes

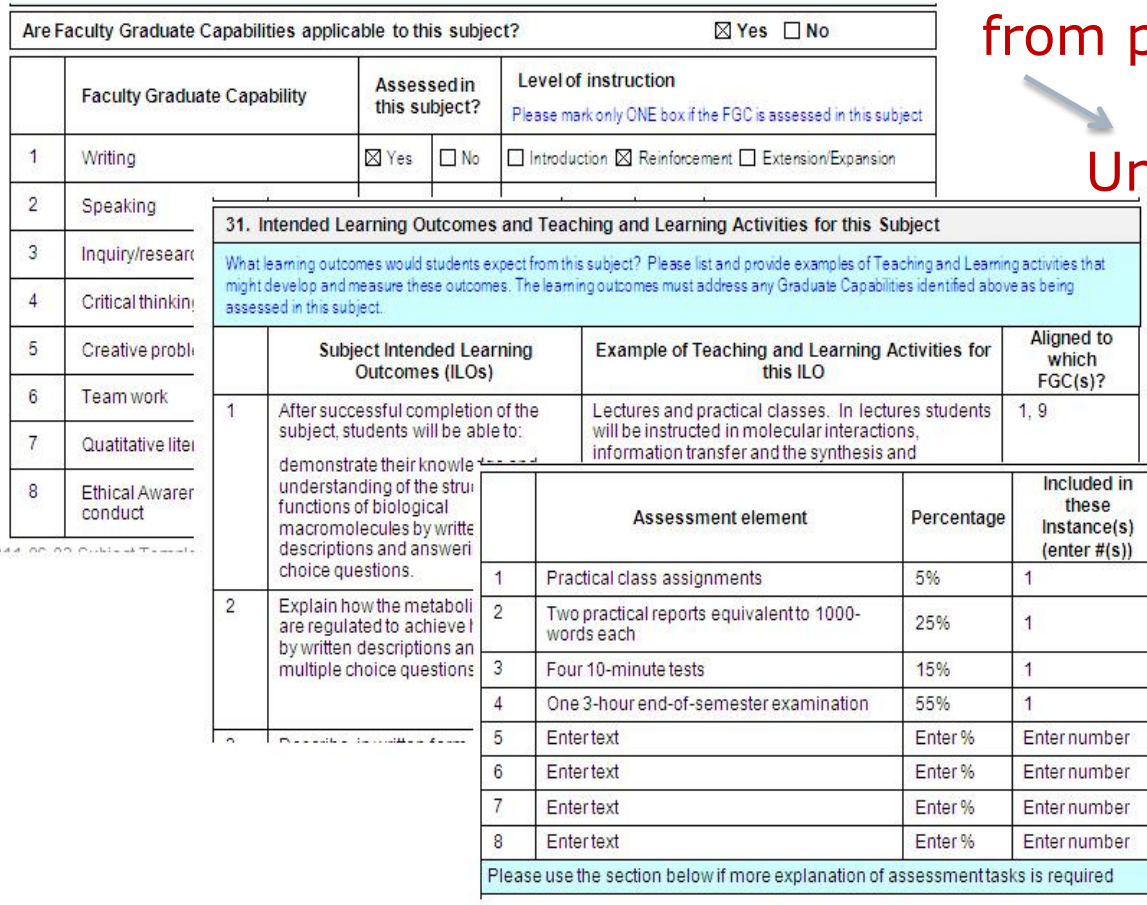
assigning a target level of attainment (e.g. 0 – 5) to each graduate attribute for each program unit provides a good way of developing the outcomes, choosing pedagogy and aligning assessment tasks

Prgram Unit (examples)	maths & science	engin'g spec'n	engin' method	engin'g tools	synth & design	comm'i cation	team-work	…
Maths 1	1	1	1	1	0	0	0	
Mechanics 1	2	2	1	1	0	1	1	
Systems 1	2	2	2	2	1	0	0	
Design 2	0	0	2	3	3	2	3	…
Project Man'g	0	1	1	2	3	3	3	…
…								
Capstone project…	2	4	4	4	4	4	0	
program target	**3**	**4**	**4**	**4**	**4**	**4**	**4**	**…**

example levels: 0 – none, 1 – basic, 2 – developed, 3 - competent / fluent
4 – professional / complex, 5 – advanced (postgraduate)

elaboration into course unit targets, teaching activities and assessment

used for peer review, refinement, approval



Are Faculty Graduate Capabilities applicable to this subject? ☒ Yes ☐ No

	Faculty Graduate Capability	Assessed in this subject?		Level of instruction (Please mark only ONE box if the FGC is assessed in this subject)
1	Writing	☒ Yes	☐ No	☐ Introduction ☒ Reinforcement ☐ Extension/Expansion
2	Speaking			
3	Inquiry/researc			
4	Critical thinkin			
5	Creative probl			
6	Team work			
7	Quatitative liter			
8	Ethical Awarer conduct			

31. Intended Learning Outcomes and Teaching and Learning Activities for this Subject

What learning outcomes would students expect from this subject? Please list and provide examples of Teaching and Learning activities that might develop and measure these outcomes. The learning outcomes must address any Graduate Capabilities identified above as being assessed in this subject.

	Subject Intended Learning Outcomes (ILOs)	Example of Teaching and Learning Activities for this ILO	Aligned to which FGC(s)?
1	After successful completion of the subject, students will be able to: demonstrate their knowle understanding of the stru functions of biological macromolecules by writte descriptions and answeri choice questions.	Lectures and practical classes. In lectures students will be instructed in molecular interactions, information transfer and the synthesis and	1, 9
2	Explain how the metaboli are regulated to achieve h by written descriptions an multiple choice questions		

	Assessment element	Percentage	Included in these Instance(s) (enter #(s))	Central exam required?	Subject ILO(s) to be assessed in this element
1	Practical class assignments	5%	1	☐ Yes ☒ No	1, 2, 4, 6
2	Two practical reports equivalent to 1000-words each	25%	1	☐ Yes ☒ No	1, 2, 3, 4, 5, 6
3	Four 10-minute tests	15%	1	☐ Yes ☒ No	1, 2
4	One 3-hour end-of-semester examination	55%	1	☒ Yes ☐ No	1, 2, 3, 4, 6
5	Enter text	Enter %	Enter number	☐ Yes ☐ No	Enter number
6	Enter text	Enter %	Enter number	☐ Yes ☐ No	Enter number
7	Enter text	Enter %	Enter number	☐ Yes ☐ No	Enter number
8	Enter text	Enter %	Enter number	☐ Yes ☐ No	Enter number

Please use the section below if more explanation of assessment tasks is required

from program LOs

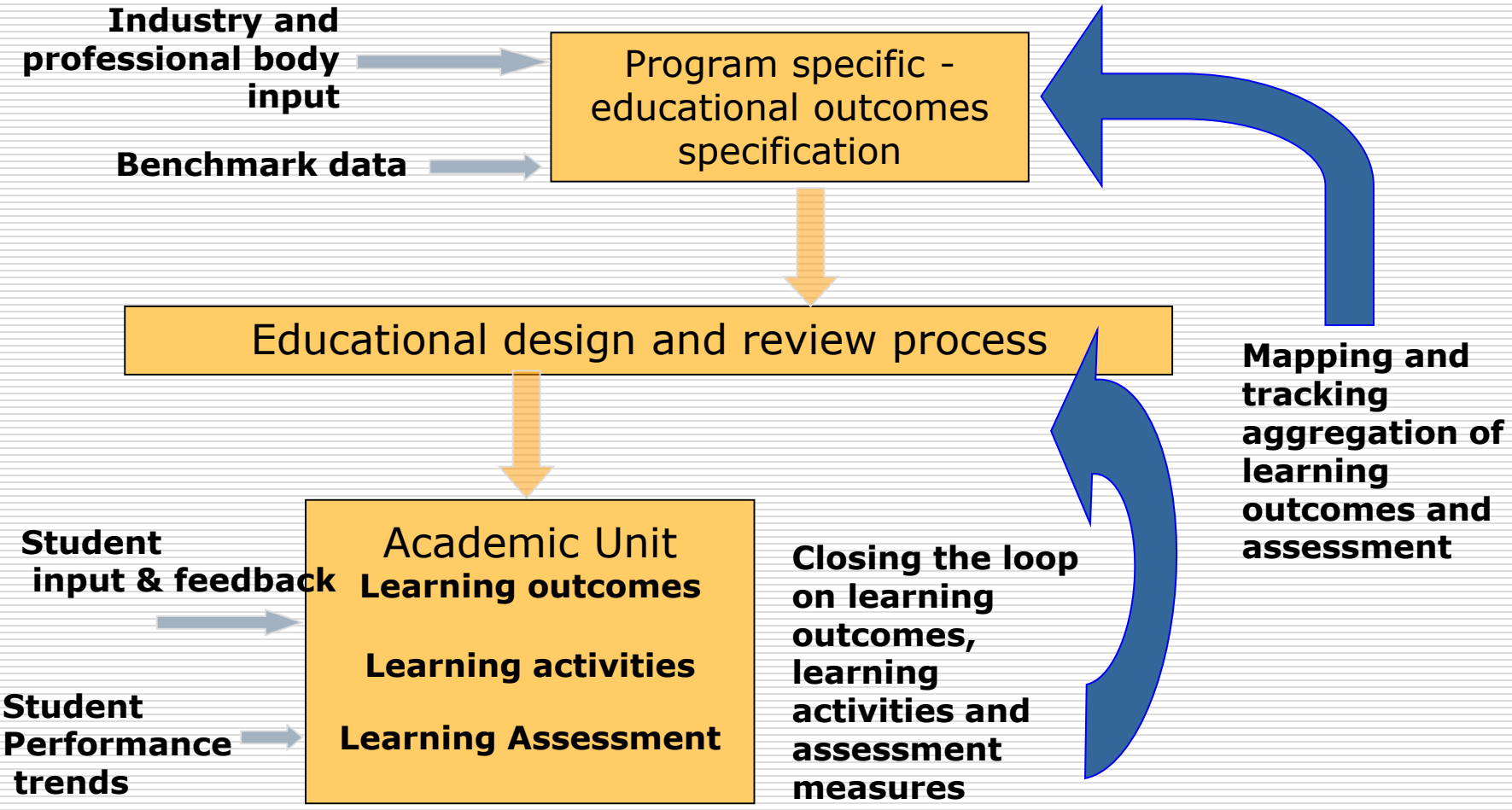
Unit Learning Outcomes

Teaching and Learning Activities

Assessment

courtesy: Australian Council of Deans of Science

EA expects industry and student input to outcomes-based education design and delivery



Accreditation Timeline (weeks)

-16 Board confirms Panel and Visit Date

Faculty submits self-study (~ 300 pp) – sent to Panel

-8

Panel Teleconference (chaired by VM)
– issues and requests for further information to Faculty

- 4

3 day visit
introductory training by the VM
panel meetings chaired by Panel Chair
VM and Panel Chair serve on discipline sub-panels
all members provide feedback to VM on templates

V1 Report prepared by VM and sent to panel members and Accreditation Manager (AM) + 4

V2 Revised, checked by AM;
sent to Faculty for fact check + 6

V3 finalised by VM (may consult with Chair) + 8

Board Meeting (VM attends for Item) - decision + 12

Faculty notified of decision and recommendations and sent Final Report + 13

The Visit Manager (VM) is an experienced accreditor in casual employment by EA and is a full panel member. Other panel members are volunteers

Faculty self-study documentation and Panel T/C

- local context and future directions
- facts and figures on enrolments and graduations
- responses to previous recommendations
- addresses the 21 accreditation criteria at the program level (including target outcome mappings)
- includes appendices and links to
  - course guides (as provided to students)
  - staff profiles, student survey data, …
  - industry committee minutes, university/faculty policies, …
  - marketing material, …
- Panel Teleconference
  - identifies issues of concern
  - makes request for further information
  - confirms list of materials to be available for inspection

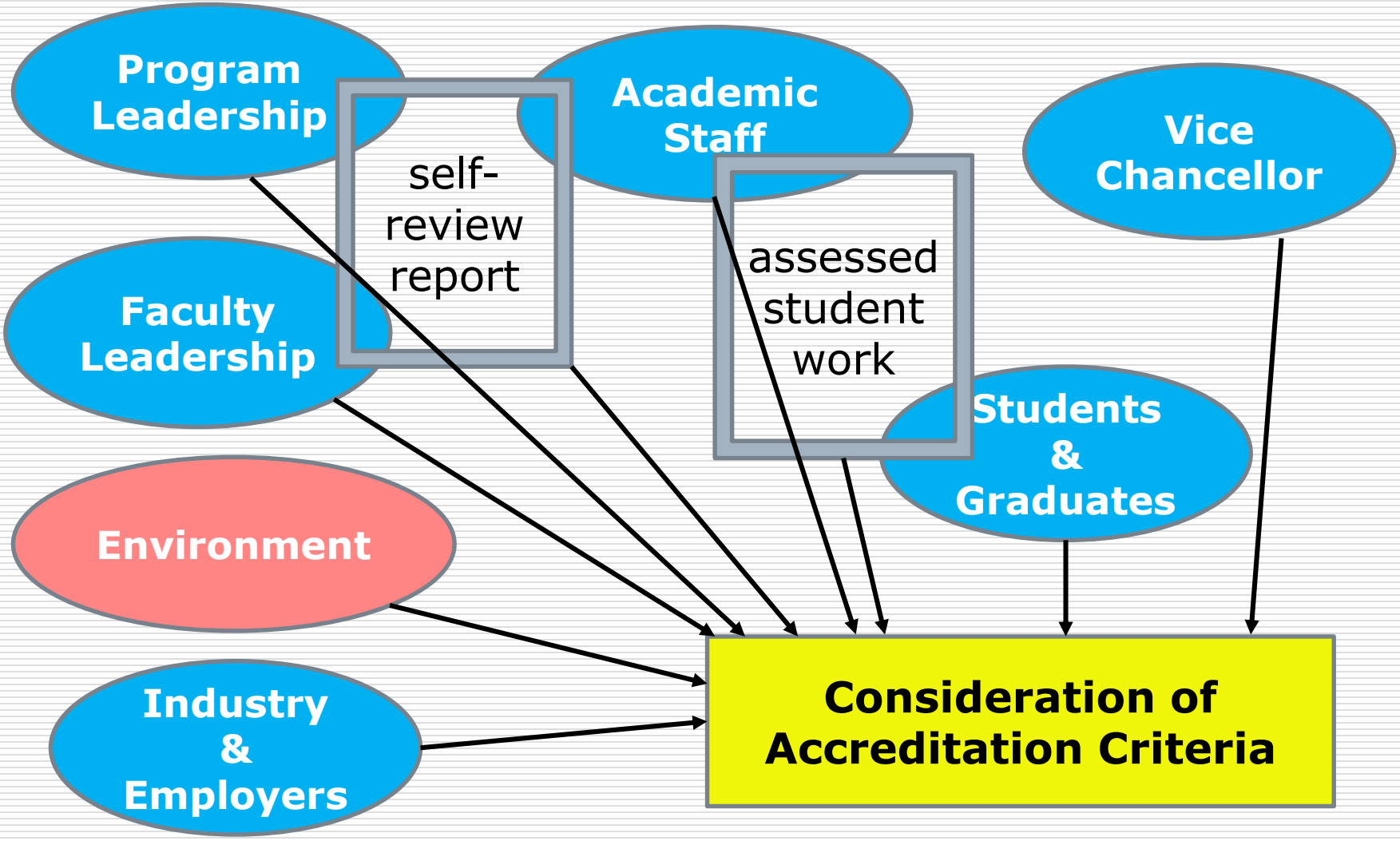
materials to be available at the panel visit

- course materials
  - lecture notes, tutorial worksheets, laboratory instructions
  - assessment items with model solutions
- samples of assessed student work for each course
  - at pass, credit and distinction levels
- samples of assessed capstone project work (report)
  - at pass, credit and distinction levels
- samples of students' industry training reports
- samples of students' formative portfolios
  - e.g. reflective journal
- minutes of industry liaison committees
- minutes of staff-student committees
- program marketing brochures

Typical Visit Schedule (over 3 days)

Panel Session: orientation and training			
Meeting with Faculty Leadership Team			
Meetings with Program Leadership (each major discipline in turn)			
Panel Session: inspection of student work ,etc.			
Electrical Eng. Staff Meeting Student Meeting	Civil Eng. Staff Meeting Student Meeting	Mechanical Eng. Staff Meeting Student Meeting	Chemical Eng. Staff Meeting Student Meeting
Panel Session: inspection of student work, etc.			
Meetings with Stakeholders (graduates and employers)			
Meetings with University Leadership (VC, DVC)			
Electrical Eng. Facilities	Civil Eng. Facilities	Mechanical Eng. Facilities	Chemical Eng. Facilities
Panel Session: inspection of student work, etc. discussions on key findings			
follow up on additional information with key individuals/groups			
Panel Session: finalisation of key recommendations			
Debriefing to Faculty Leadership Team			

focus of the panel visit is to triangulate input on each of the accreditation criteria



obtaining the evidence

- on the educational culture of the faculty or school
  - leadership of education
  - engagement of academics and stakeholders
  - how students are treated
  - how policies are implemented

oOn the quality and range of facilities

- input from **graduates and students** is most critical
  - only graduates experience the whole program
  - range and quality of assessed work
  - range and quality of their responses to questions

- **employers** give evidence of quality and involvement on engineering practice and employability

obtaining the evidence

- **teaching academics*** demonstrate engagement with education processes, and students, and the operation of policies
- input from **Vice Chancellor** demonstrates university commitment to engineering and education
- **leadership teams** can answer questions from the documentation and arising from the teleconference
- we aim to see academic* staff without their Head of Department or School present

sample lead questions to students and graduates

1. Do you know the range of attributes and skills that EA expects ?
2. Has the program delivered on these attributes and your expectations?
3. How do you rate the overall quality across the units you have done?
4. What were your concerns within the learning units – **assessment** – feedback?
5. **Do you solve problems and do projects that are complex and open-ended** ?
6. How do you rate the exposure to professional practice?
7. Do you write personal reflections on your learning?
8. Do your teachers have a cohesive and consistent approach to delivering learning activities across the program units?
9. How do you regard the technical breadth and depth across the program?
10. In team-based units do you take a range of team roles such as team leader? **Do you get fair individual assessment in teamwork?**
11. Are the facilities adequate to achieve the unit goals?
12. How were issues of ethics, environmental awareness and sustainable practices in engineering addressed?
13. How did you and your class provide feedback to the Faculty and School?
14. *Overall:* Are you generally satisfied with the education you have received ?

sample lead questions to teaching academics

1. What induction and educational development courses are you required/able to undertake?
2. How well does the workload model work - for you?
3. How are you involved with overall program design and redesign?
4. How do your units fit into delivery of the overall target graduate outcomes? **How do you cover complex problem solving?**
5. Do your units include input from industry practice?
6. What changes – and for what reasons – have you made to your teaching in recent years? How do students know about improvements?
7. How are assessment tasks checked and/or moderated?
8. **How do you manage student (inc. team) assessment ?**
9. **How are final year capstone projects assessed across targets?**
10. Are students attending your classes? Are there systems to support students who are not progressing well in your unit?
11. Do you benchmark your teaching practice in any way?
12. How adequate are facilities for your teaching needs?
13. What changes would you like to see?
14. Is the School/Faculty a good place to work?

sample lead questions to leadership teams

1. How is the curriculum designed and reviewed? How are program target outcomes determined? Who does the unit outcomes to overall outcome mappings? How are these used for making quality improvements?
2. How is the EA requirement for 'exposure to industry practice' ensured?
3. What are the policies and practices on academic workload/performance management, professional development, recruitment, guest lecturers …
4. How are teaching functions and academic leadership nurtured and supported?
5. Is funding adequate: how are facilities renewed; contemporary software acquired, etc.?
6. How are student entry standards maintained, and students-at-risk supported?
7. **How are student assessment items validated and moderated?**
8. What has been learned from student/graduate surveys and other student input?
9. How is input from employers and industry obtained and used?
10. What Faculty/School/Program benchmarking is undertaken?
11. Is the School/Faculty/Program achieving its goals; and what improvements are in hand?

sample lead questions to industry / employers

1. How are you involved with the Faculty/School?
2. Is your advice (eg to the Industry Advisory Committee) valued and used by the Faculty/School? Do you feel part of their quality and improvement system?
3. How are you/your firm involved with teaching and students? Do you provide guest lectures, placements, **project topics**, etc. **Are you involved in student assessment?**
4. How do you rate the capabilities of the students and graduates you encounter? What are their strengths and weaknesses?
5. What improvements would you like to see?

panels find that students and graduates express competences in meetings and individual conversations more clearly than in their assessed work

educators need to improve assessment practices and change pedagogy to match

(reference my WOSA presentation)

inspection of assessed work – examples and comments

- taught units - *marked*
  - quizzes and laboratory reports, examination papers
  - ***may demonstrate mastery of basics***
  - ***may not cover all material and all target outcomes***

- team-based design/project work
  - reports – specification, project management, design drawings, software simulations, etc.
  - presentation (powerpoint)
  - model artefact /demonstration software
  - assessment spreadsheet (ideally with moderated peer-assessments)
  - ***may demonstrate coverage of many target outcomes***
  - ***may not demonstrate mastery of science areas***

inspection of assessed work - examples and comments

- individual capstone project work (research/design)
  - reports (multiple) covering – problem specification, research, analysis, synthesis, evaluation, some project management
  - assessment spreadsheet
  - ***may demonstrate coverage of <u>several</u> target outcomes, including <u>complexity</u>***
  - ***may <u>not</u> adequately demonstrate <u>some</u> attained outcomes***

- *assessed* learning portfolios
  - especially for problem-based learning and project work, can capture outcomes as they are attained
  - need very good rubrics to describe levels of attainment
  - ***may provide evidence for attainment of <u>all</u> target outcomes***

increased use of projects was endorsed at the IEA Workshop 6, Wellington 2014

- **most delegations agreed that team- and individual- design oriented project work with multi-disciplinary features will cover most of the graduate attributes**
- **in designing and assessing project work, educators must ensure:**
  - overall specifications and learning outcomes are clear
  - supervisors (of specific projects) know and adopt these
  - areas of complexity are adequately covered
  - project topics/content/tools should be authentic to practice
  - reporting requirements are staged (for formative learning)
  - summative assessment has clear rubrics (for guidance)
  - good project management practice is introduced
  - teamwork should be well managed and assessed
- **ideally, accreditation panels should see all of these elements**

Australian directions ...

- **Work Integrated Learning (WIL) to put engineering practice at the centre of engineering degrees**
  - Best Practice Guidelines (Aust. Council of Engineering Deans)
  - "Virtual WIL" to overcome the problems of industry placements
- **a national project in Australia has developed Guidelines for Best Practice in BEng(Hons) capstone projects:**
  - curriculum – clear outcome and process specifications
  - supervision – focus on mentoring to the student outcomes , with formative feedback
  - assessment – clear rubrics and examples
  - collaborative benchmarking between other supervisors
- **increased use student "reflective portfolios"**
  - going beyond a 'journal/diary'

Conclusions

- robust outcomes-based accreditation requires trust and respect between the faculty and the accrediting panel, as a partnership for quality improvement
- the faculty must supply good (self-study) documentation addressing the criteria, and (random) samples of student work
- the accreditation panel must be able to gain honest input form students and graduates, teachers, program leaders and employers, to triangulate evidence and draw conclusions
- the moves towards increasing project work demands more staff training - so that students reliably attain the target range of learning outcomes, with appropriate assessment
- the use of student-reflective portfolios will also increase the reliability of future accreditation processes

References

ENAEE – IEA (2015) *Best Practice in Accreditation of Engineering Programmes: an exemplar*. http://www.ieagreements.org/Best_Prct_Full_Doc.pdf?6299

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E Crawley et al. (2011), *CDIO Syllabus v.2*. www.cdio.org

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See also references in WOSA 2016 paper:

Robin King: *Specification and Assessment of Outcomes-based Engineering Curricula for Program Accreditation*