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Education for Sustainable Development Curriculum Audit (E4SD Audit): a curriculum diagnostic tool for quantifying requirements to embed sustainable development into higher education – demonstrated through a focus on engineering education*

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ABSTRACT: There is an emerging global consensus across a range of professions that significant change is required in preparing graduates to play a role in facilitating the societal transition to sustainable development in the coming decades. However, a literature review on curriculum renewal and embedding sustainability within higher education curriculum shows that this process is actually quite fragmented, sporadic and *ad hoc*. Indeed, there is a lack of strategic guidance on how an education programme might make a transition to *education for sustainable development*, or with regard to the timeframe within which a transition might be possible. A strategic and systematic audit process has been introduced called the Education for Sustainable Development Curriculum Audit (E4SD Audit), developed by The Natural Edge Project to address these issues, and is a curriculum diagnostic tool that quantifies the requirements for embedding sustainable development into higher education. The audit context is identified within the need for rapid curriculum change in engineering education, but it is widely applicable. An overview of the E4SD Audit process is provided with a short example of how it might proceed. Comments are given on considerations for facilitating the audit and supporting the implementation of recommendations.

INTRODUCTION

Sustainable Development in the Face of Climate Change

While few would argue that the scale and nature of society's impacts on the Earth's biosphere could previously have been predicted, the last 30 years have seen a growing awareness and understanding of the complexity of the problems that are being faced. The launch of the *Fourth Assessment Report* by the Intergovernmental Panel on Climate Change (IPCC) in April 2007 provided an unequivocal link between climate change and current human activities, especially burning fossil fuels, deforestation and land clearing, the use of synthetic greenhouse gases, and the decomposition of wastes from landfill [1]. This link was also confirmed by the 2006 release of the UK *Stern Review*, which stated that global emissions of greenhouse gases must stabilise by 2015 for the world to have any chance of limiting the expected temperature rise to two degrees [2]. A two-three degrees average increase in the global temperature is predicted to result in dangerous levels of climate change, including significant ice and glacier melting, sea level rises, the increased frequency and severity of natural disasters, and greenhouse gas release from vast tracts of thawing permafrost across Siberia [3].

It has become clear that it is inevitable that society will need to adapt to a new climate regime as a result of a rapid increase in greenhouse emissions since the Industrial Revolution. There is a parallel and crucial requirement to focus on both reducing the emissions of greenhouse gases and therefore stabilising the corresponding increases in global temperature, and to also prepare for a certain level of adaptation by society and the environment to an altered climate regime, assuming the appropriate stabilisation is achieved. This interest in practical solutions is expected to continue to increase as governments, companies and institutions in Australia, as well as around the world, are beginning to set their sights on targets to reduce emissions in the order of 60% by 2050 [4]. A study by the Dutch Government published in 2000 on the scale of change required stated the following:

> *In setting a time-horizon of 50 years – two generations into the future – it was found that ten to twenty-fold eco-efficiency improvements will be needed to achieve meaningful reductions in environmental stress* [4].

The Brundtland Commission's 1987 report titled *Our Common Future* – although written 20 years ago – provides one of the best supporting documents for international guidance for achieving such mitigation and adaptation efforts [5]. The report's inclusion of the term *sustainable development* is now one of the most widely used references to describe the type of global development that can meet the needs of today while also addressing our responsibility to future generations.

The Role of the Engineering Profession

The incoming president of the World Federation of Engineering Organisations (WFEO) and former president of Engineers Australia, Barry Grear (AO), has questioned:

> *What aspirational role will engineers play in that radically transformed world? … An ever-increasing global population that continues to shift to urban areas will require widespread adoption of sustainability. Demands for energy, drinking water, clean air, safe waste disposal, and transportation will drive environmental protection* [alongside] *infrastructure development* [6].

*The authors are part of The Natural Edge Project (TNEP), which is an independent sustainability think-tank based in Australia. TNEP is administratively hosted in-kind by Griffith University and the Australian National University.

Indeed, it is very likely that future engineering and design will contain very little to do with creating fossil fuel-based products and services. While the first principles underpinning engineering and design (such as thermodynamics, fluid mechanics, structural mechanics, etc) will remain the cornerstone of engineering education, the knowledge used to explain them and the cases used to apply them will require rethinking. These first principles underpinning engineering for hundreds – if not thousands – of years need to now be rapidly reapplied to a range of significant 21st Century engineering challenges. These include providing electricity and energy, industrial processes, transportation, built environments, and water and sanitation.

According to the WFEO, it is critical that engineering graduates are equipped with the relevant knowledge and skills to effectively address such sustainable development challenges in society [7][8]. This message has been reinforced in various ways within guiding documentation like policy statements, charters and code of ethics statements from a growing number of national professional engineering bodies, including for example the UK's Royal Academy of Engineering, the Institution of Professional Engineers New Zealand, the Institution of Civil Engineers (UK), the American Society of Civil Engineers and Engineers Australia [9-13].

PROGRESS IN EDUCATION FOR SUSTAINABLE DEVELOPMENT IN ENGINEERING

The definition of core terminology is as follows:

- *Course* and *Programme*: a *course* in this article refers to a unit of study that usually has a unique code and name/ title. A student may study between 30-40 *courses* in an undergraduate degree *programme*;
- Within the higher education sector, the term *learning and teaching* is often interchanged with *education*. In this article, the authors use *education* given the popularity of the term *education for sustainable development*;
- In this article, the authors use the collective term *staff* to refer to anyone employed in the higher education system to teach or manage (eg convene) some aspect of teaching (in addition to their other research and service requirements).

Increasing Global Dialogue

The global call for change towards *education for sustainable development* in higher education has been building, with particular resonance over the last 20 years. In 1987, the Brundtland Commission advocated all types of education to *reach out to as wide a group of individuals as possible, as environmental issues and knowledge systems now change radically in the space of a lifetime* [14]. A decade later, following declarations such as Talloires, the Thessaloniki Declaration and alliances such as the GHESP Global Alliance, the 1998 UNESCO World Conference on Higher Education produced a *World Declaration on Higher Education in the Twenty-First Century: Vision and Action* [15-17]. This Declaration stated the following:

> *Higher education it-self is confronted therefore with formidable challenges and must proceed to the most radical change and renewal it has ever been required to under-take* [18].

2005 marked the commencement of the United Nations Decade of Education for Sustainable Development (2005-2014), which has acted as a further catalyst for global dialogue [19].

There has been a number of significant engineering education conferences, workshops and fora around the world over a similar timeframe that have focused on the specific need for engineering education for sustainable development; several of these are highlighted here.

In 1994, an international workshop of educators from the Asia-Pacific region examined the *Fundamentals of Environmental Education in Engineering Education*, concluding that *all* engineers needed to be environmentally educated so that they understood the issues involved in sustainable development and cleaner production [20][21]. A decade later, the 2002, 2004 and 2006 *International Conferences on Engineering Education in Sustainable Development* all emphasised that engineering education, especially higher education for the training of decision-makers, researchers and teachers, should be oriented towards sustainable development and should foster environmentally-aware attitudes, skills and behaviour patterns, as well as a sense of ethical responsibility.

The 2004 conference declaration (the Declaration of Barcelona) reaffirmed the following:

> *Engineering has responded to the needs of society and without a doubt, today's society requires a new kind of engineers … There is evidence that sustainable development has already been incorporated in engineering education in a number of institutions around the world …* [22].

The 2007 *Australasian Association for Engineering Education Conference* (Melbourne, Australia), the 2007 *International Conference on Engineering and Education Research* (Melbourne, Australia) and the 2007 *International Conference in Engineering Sustainability* (Perth, Australia) all feature engineering education for sustainable development as topics for dialogue and deliberation.

Limited and *Ad hoc* Implementation in Engineering Education

Although dialogue on the topic of education for sustainable development in engineering is increasing, a literature review of the topics and papers presented at engineering events provides a sobering picture of sporadic, fragmented and largely *ad hoc* approaches to curriculum renewal. In reality, there has been a lack of significant action on making the transition to education for sustainable development in engineering.

Conference themes and journal topics include issues affecting the ability of engineering education to be changed (ie organisational, resourcing, funding, timeframe and content issues). By far the most prolific papers were on the topic of single champions or small teams discussing individual and unconnected initiatives in the subject area of education for sustainable development. Some papers documented the success of strategically embedding case studies and flagship courses (predominantly in the first year and at the postgraduate level), but these efforts have rarely been documented as part of a longer-term strategic plan for curriculum renewal. Few papers discussed methods to integrate sustainability theory, knowledge and application across programmes and across disciplines. There is a general lack of literature on strategically

and systematically *planning* and implementing a holistic curriculum renewal process in engineering education to embed sustainable development.

A Time Lag Dilemma and Rapid Renewal Imperative

The authors have outlined the need for significant and immediate action to address the issues of climate change and sustainable development. As engineering educators consider how curriculum might be transitioned to education for sustainable development, it is important to realise that a *wait and see approach* is not an option. Figure 1 summarises the *time lag dilemma* currently facing engineering education.

In the *wait and see* or *laggards approach*, the education institution delays any transition until the merits of such a transition are proven in the market (ie by data from other institutions), supposedly to reduce their risk exposure. However, such an approach actually exposes the institution to potential accreditation difficulties with professional engineering bodies, the potential for reduced demand for graduates and the potential for falling student enrolments.

In the *business as usual approach*, the education institution adopts an *ad hoc* approach to curriculum renewal whereby courses are updated to include sustainability content at the individual staff member's discretion. Here, the transition is likely to be fragmented and there is significant potential for overlapping curriculum development, gaps in the curriculum, and new curricula that do not meet the immediate needs of graduating students or future employers.

In contrast to these two approaches, the *lock-step approach* involves a rapid successive embedding of sustainability principles, knowledge and application across the programme(s) offered. It relies on a systematic and strategic approach to assess, plan and implement the curriculum transition to education for sustainable development. The risk management focus of this approach minimises the potential for mismatching or mistiming the transition, with regard to industry demands, student expectations and budgetary constraints and opportunities.

Within the *lock-step approach*, a number of common *elements* of rapid curriculum renewal are emerging from literature review and informal enquiry within the authors' higher education academic network. The preliminary grouping of elements is listed below. Ongoing research and trials are intended to further inform the elements prior to full publication in the *International Journal of Sustainability in Higher Education* in September 2008.

The elements of a rapid curriculum renewal process (preliminary grouping) are as follows:

- Awareness-raising activities;
- Scoping workshops with key staff;
- Education for Sustainable Development Curriculum Audit (E4SD Audit);
- Curriculum – existing course renewal (integrated approach);
- Curriculum – new course development (flagship approach);
- Outreach and bridging (recruitment/professional).

In summary, each element plays an important role in achieving the curriculum transition to education for sustainable development. The omission of an element may slow the transition and can also negatively impact on the quality of the curriculum renewal outcomes. However, it should be noted that the elements are not intended to be implemented in a linear manner, nor are they exclusive; one element may contain similar activities to another and elements may be repeated or reviewed at various stages in the transition. The elements are used on an *as required* basis, considering the needs of the programme.

Within the identified elements of curriculum renewal, it can be seen that there is an element called the Education for

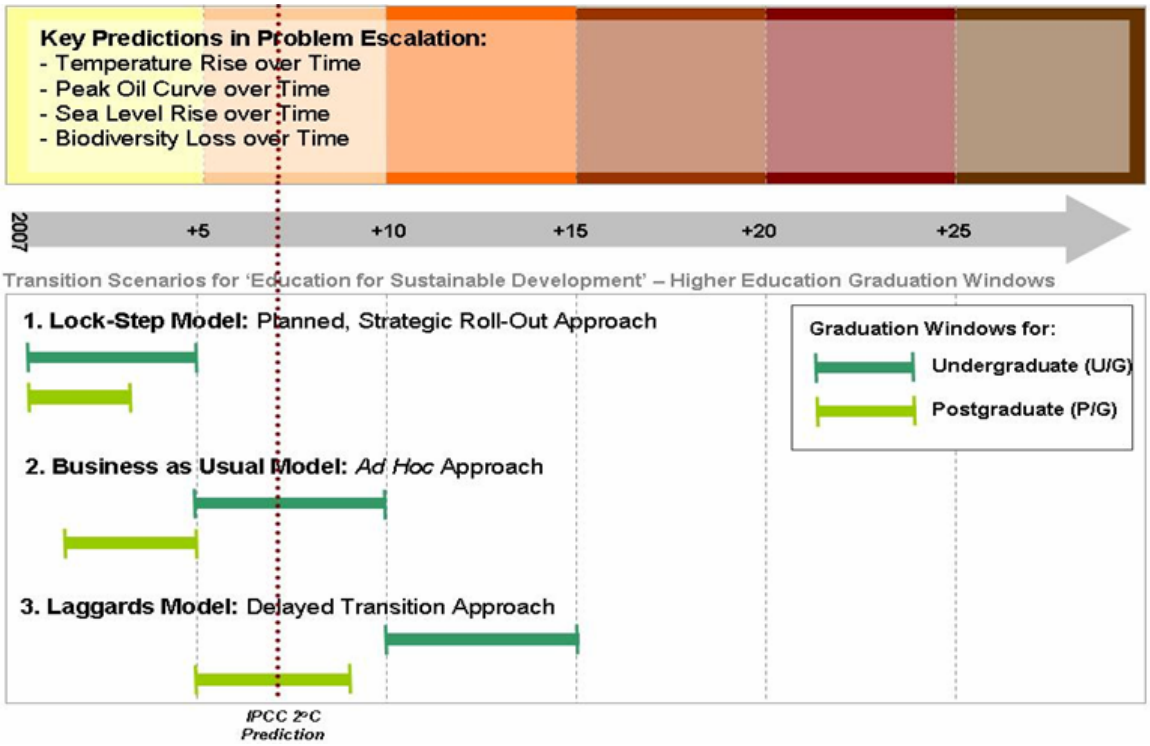

Figure 1: The time lag dilemma for higher education.

Sustainable Development Audit (E4SD). This element provides management with an opportunity to scope the needs of the programme(s) to inform decision-making and planning for the transition to education for sustainable development.

THE E4SD AUDIT

Aims and Objectives

The E4SD Audit process provides a strategic opportunity to systematically review the programme of study, facilitating a *risk management* approach to the curriculum renewal process. It aims to provide structured recommendations on how rapid curriculum renewal for E4SD can be viably achieved through the following objectives:

- Provide a detailed diagnosis to inform efforts to deliver an effective enhancement of the existing offering to engineering students, both across (breadth) and within (depth) programme curriculum;
- Identify areas within the existing curriculum that omit or conflict with recognised sustainability principles, theory and application;
- Identify inconsistencies across and within courses in each degree programme in the language and message about sustainable development theory, knowledge and application;
- Consider the relevance of E4SD to specific graduate attribute requirements specific to the institution including areas of recognised strengths and niche offerings;
- Acknowledge efforts already undertaken in curriculum renewal for sustainable development and identify ways to build on these efforts.

Method Summary

The E4SD Audit is undertaken by an Audit Team comprising (depending on curriculum needs), at a minimum, an E4SD Auditor, the programme convenor, an expert in sustainable development for the discipline area, and a staff member trained in providing learning and teaching support.

The E4SD Audit process comprises the following components:

- An initial *meeting* with management and the programme convenor to confirm the audit method and logistical details for the audit process (ie to ensure that it is as non-confrontational and collaborative as possible);
- An *introductory session* with the staff responsible for the delivery of courses to explain the scope and audit intentions. This session may also include a *graduate attributes workshop* to explore how E4SD is perceived and the preferred manner in which to embed its principles and practices into the programme curriculum to align with the programme's intended graduate attribute outcomes;
- A series of *semi-structured interviews* with the staff responsible for course delivery, to inform the *assessment and classification* of courses in the programme by the E4SD Auditor or an equivalently credentialed auditor. This might be undertaken on an individual level or in a group format, depending on the programme's size and preferences;
- A *SWOT analysis* (Strengths, Weaknesses, Opportunities and Threats) led by the Auditor of the preliminary audit findings for each course to identify the recommended content for inclusion;
- Collaborative *mapping workshop(s)* with individual staff or small groups of staff responsible for delivering each course to discuss the preliminary results of the assessment and classification process, as well as opportunities and constraints for addressing the preliminary recommendations for each course (and providing learning pathways to and from other courses);
- The production of an *audit report*, which contains the course classification summaries and recommendations regarding suggested content (where relevant) for curriculum renewal;
- A *scoping of resource and timing requirements* based on the diagnosis and recommendations to address areas of focus in particular courses across the programme, such as existing course renewal and new course development/ replacement.

Diagnosing a Course: Assessment and Classification

In the E4SD Audit, each course is assessed by the Audit Team on the following three items of focus:

- *Fundamental Principles/Base Theory*: the Audit Team assesses the course content's fundamental principles and base theory, considering how well the scope of the theory underpins application to contemporary, and emerging applications and challenges;
- *Knowledge*: the Audit Team assesses the information provided during the course, considering how well this knowledge explains the relevance and context of the base theory and prepares students with an understanding of issues and processes related to sustainable development;
- *Application*: the Audit Team assesses the course examples (ie case studies, worked calculations, assessment items, etc) considering how well the examples demonstrate the relevance and implementation of the base theory and knowledge to contemporary and emerging applications and challenges.

When assessing the course base theory, knowledge and application, the Audit Team is informed by the *Audit Checklist*, which has been developed from relevant professional body accreditation requirements on sustainable development content, key declarations and global commitments by the relevant institutions and professional networks for the discipline area.

The criteria for course classification are scaled from 1 to 5, as shown in Table 1, where a higher classification reflects a higher level of risk with regard to the course's sustainable development profile in the programme. A classification of 1 reflects the full integration of sustainable development theory, knowledge and application with no further work required. A classification of 5 reflects minimal to negligible integration of sustainable development, knowledge and application, where course replacement or overhaul is the most likely outcome.

The result of this assessment and classification process is the production of an *E4SD Course Diagnosis* for each course, summarising the findings of the assessment. An example of a diagnosis summary is presented in Figure 2 (see end of paper).

A key component for the success of the E4SD Audit element is the direct interaction of the Audit Team with staff who are responsible for the courses in the programme. This creates a potential for proactive and collaborative discussion regarding opportunities and constraints with the courses being assessed in

the audit. Indeed, it is important that this element is understood and implemented as a non-confrontational, proactive and collaborative approach to curriculum renewal, where staff have the opportunity to reflect on the course diagnosis and their ideas for the future.

Table 1: The course classification guide.

1	The course contains content and worked examples that address sustainable development issues and innovations of relevance to the discipline area. Sustainable development content is well integrated into the course (theory, knowledge and application), including representation in the course assessment. The course outline specifically addresses the sustainable development content.
2	The course contains content and worked examples that address sustainable development issues and innovations of relevance to the discipline area. Sustainable development content (theory and knowledge) is well integrated into the course, including assessment, but there is improvement needed in the application sustainable development in the course content/assessment. The course outline specifically addresses the sustainable development content.
3	The course contains some content that address sustainable development issues and innovations of relevance to the discipline area, although the theory and/or knowledge require updating. Sustainable development content is not accompanied by up-to-date worked examples or case studies. Sustainable development issues and/or innovations are addressed somewhat in course assessment. The course outline may include mention of the sustainable development content.
4	The course contains a scattering of content (theory and knowledge) or worked examples (application) that address sustainable development issues and innovations of relevance to the discipline area. The content is presented in an *ad hoc* manner and is isolated rather than integrated. The content and/or application addressing sustainable develop-ment may not be reflected in assessment. The course outline does not address the sustainable development content.
5	There is little to no content (theory and knowledge) or worked examples/case studies (application) addressing sustainable development issues and innovations of relevance to the discipline area. The course outline does not address the sustainable development content.

Although the course's renewal imperative requires rapid action and although the scope of curriculum change in some programme areas will be quite large, the shift to education for sustainable development can provide an exciting opportunity to staff. There is a significant opportunity to be creative and innovative in renewing a curriculum, meeting graduate competence requirements and ultimately contributing positively to society's sustainable development challenges.

Once the assessment and interaction with staff is complete, the report is finalised and becomes a strategic planning document for management. The individual course diagnosis reports also become a checklist for staff as they set about addressing engineering education for sustainable development within their courses.

Example E4SD Audit Scenario

An Education for Sustainable Development Curriculum Audit (E4SD Audit) scenario commences with an initial meeting with the Audit Team and the head of school to clarify logistical requirements (ie documentation, including course outlines, summary of assessment requirements, and meeting room needs). The Audit Team then meets with the head of school and those educators who teach in the programme in order to clarify the purpose and method of the audit. The programme's courses are sequentially summarised over a two-hour workshop in short presentations by the relevant programme/course convenor(s). During this time, notes are made by the auditors informed by relevant audit checklists and clarification questions are asked where necessary. The presence of a number of course convenors and programme convenors also provides an awareness-raising opportunity for staff members in relation to the programme content and how sustainable development is to be built into the scaffolding of the programme and courses.

Over the following two days, the Audit Team then studies the course material provided in detail and undertakes the assessment, classifying each course in the programme according to the level of embedded sustainability content, using the course classification guide and an audit checklist of relevance to that particular discipline area. For each course, a detailed SWOT analysis is undertaken, which includes recommendations for where content may be improved. This information is documented in an *E4SD Course Diagnosis* (see Figure 2). The results and recommendations for each course are checked with the relevant staff member(s) for congruency of information and interpretations. It also provides an opportunity to discuss what the findings mean and what opportunities and constraints there are to moving forward with that particular course. The report is then finalised and the Course Diagnosis reports are submitted to management for planning the curriculum renewal process.

Facilitating the Audit and Implementing the Recommendations

In addressing the need for curriculum renewal in engineering education identified in this article, it is suggested that management will need to consider a range of incentive mechanisms to facilitate the E4SD Audit and to implement the recommendations. This could include the following:

- Making a strong commitment from management to the E4SD Audit and its findings from the outset;
- Including a formal request for staff to participate and acknowledgement of the additional workload. This could include recognition through the staff workload calculation of the time spent by staff contributing to the audit process;
- Recognising staff who have already embraced sustainable development in their course(s);
- Clearly communicating the intent and non-confron-tational, proactive and collaborative nature of the audit to staff in order to reduce any staff anxiety about the process;
- Providing research assistance and/or teaching buy-out for staff to address the E4SD Course Diagnosis recommendations. This assistance could include a requirement for staff to include an update of the course assessment and course outline;

- Providing research assistance and/or teaching buy-out for staff to undertake professional development in the new area. This could be packaged with specific requirements, including becoming familiar with the topic area, identifying aspects that can be immediately incorporated into existing curriculum and identifying aspects needing significant new course development. It could also include a requirement for staff to identify material in demand for postgraduate and professional development courses or, for example, in attracting regional/international students faced with sustainable development challenges;
- Providing funding opportunities (eg internal grants) for staff to investigate research opportunities in this area. Indeed, engaging staff interest in sustainable development research topics in their area of teaching has the added incentive of research recognition. It could also increase the likelihood that the course(s) would be kept up-to-date with sustainable development theory, knowledge and application.

CONCLUSIONS

At a time of significant global environmental challenges and an escalating need for sustainable development solutions, higher education institutions face a timely challenge: to equip the profession with graduates who have been exposed to theory, knowledge and applications associated with education for sustainable development. Unfortunately, while the last 20 years have seen a growth in dialogue about education for sustainable development, the reality is that education for sustainable development has been a fragmented, sporadic and largely *ad hoc* experience. Most universities and colleges have yet to seriously address sustainable development issues within curriculum.

From technical design through to policy and strategic planning roles, there is an urgent need for graduates with the knowledge and skills to provide innovative solutions to the issues being faced. In particular, it is widely acknowledged by professional institutions around the globe that the engineering profession has a significant role to play together with other professionals, in addressing climate change and in facilitating society's transition to sustainable development.

Within this context, higher education, particularly engineering education, no longer has the luxury of taking a *wait and see* or *business as usual* approach to curriculum renewal. Such approaches will expose institutions to possible accreditation difficulties with professional bodies, reduced demand for graduates and the potential for falling student enrolments. Instead, a *lock-step approach* to undertaking rapid curriculum renewal is the only real option to address the urgent need for education for sustainable development. This approach minimises the potential for mismatching or mistiming the transition with regard to industry demands, student expectations, and budgetary constraints and opportunities.

The Education for Sustainable Development (E4SD) Curriculum Audit process is an important element in the *lock-step approach* for successful and rapid curriculum renewal. It is a systematic, strategic process that takes a risk management approach to embedding sustainability into education programmes. The key to the audit's success is the commitment by management to the process and implementation of the resultant E4SD Course Diagnosis recommendations.

Readers wanting more information about this article are invited to contact the authors through The Natural Edge Project Web site (www.naturaledgeproject.net). It is noted that this Web site also contains a significant amount of sustainable development content that is freely available and open-source (under a Creative Commons Attribution Licence V3.0) [23-26].

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The Natural Edge Project (TNEP) is an independent sustainability think-tank based in Australia and operates as a partnership for education, research and policy development on innovation for sustainable development. TNEP is administratively hosted in-kind by Griffith University and the Australian National University

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Course Name: (First Year) Introduction to Thermodynamics [ENG10XX]
Category Classification for Engineering Curriculum: CATEGORY 2

Course Code	Principles/Base Theory	Knowledge	Application/Practice
ENG101	√ *Clearly explained*	√ *Appears suitable*	~ *Room for improvement*

SWOT Analysis Summary:

- Strengths: the course appears to adopt a systematic approach to teaching momentum, mass and heat transfer. It currently incorporates an overview of some contemporary and recent applications of base theory to a range of emerging engineering innovations, providing a foundation for other courses in the programme. Case studies highlight alternative energy sources (including biofuels, wind power, etc). Note that there is further opportunity to expand on these case studies by introducing industry best practice case studies;
- Weaknesses: the course lacks a *meta-discourse* to contextualise learning within the programme. This could be addressed in the outline for the course through the use of explanatory notes such as the following: *A key component of addressing the goal of sustainable engineering solutions involves a solid understanding of momentum, mass and heat transfer. In order to contribute sustainable engineering solutions to society, students will need a strong grounding in the fundamental principles and base theory provided in this course*;
- The base theory in the course is, in some cases, still explained using unsustainable practices and processes. To address this, the course could use introductory examples of cogeneration and heat exchange, providing the opportunity to both demonstrate application of the base theory and also to expose students to growing areas within sustainable engineering practice;
- Opportunities: this course has a clear opportunity to demonstrate to expose students to a range of sustainable technologies and alternatives to current unsustainable practices. For example, using the example of a traditional wastewater treatment plant to demonstrate systems thinking may leave students with the impression that services such as wastewater treatment can only be engineered in a chemical process, rather than the possibilities of biological solutions (eg living machines), or a combination of biological and chemical treatment. Replacing or augmenting this example with an example of an ecological wastewater treatment system still provides the mechanism to discuss systems thinking while also exposing students to innovations in wastewater engineering;
- Threats: although students are exposed to base theory and knowledge, the course examples appear to include limited applications of contemporary/popular issues in engineering and environment. For example, to demonstrate atmospheric gas heat transfer, the course might examine the range of greenhouse gases, and how they absorb and reflect heat in the atmosphere. See *Additional Comments* for example content that could be considered for integrating into this course.

Additional Comments:

Additional notes and Web site references are provided below to assist the Course Convenor with addressing comments above:

- Sample Lecture: Green Chemistry and Engineering (available at: www.naturaledgeproject.net/essp);
- Sample Lecture: Introduction to the Six Types of Greenhouse Gases (available at: www.naturaledgeproject.net/essp).

Figure 2: An example of a E4SD Course Diagnosis containing a summary of the SWOT analysis for a first year course in an engineering undergraduate programme. This summary is adapted from an audit undertaken for an Australian university's civil engineering degree programme in December 2006.

Proceedings of the 4th Asia-Pacific Forum on Engineering and Technology Education

edited by Zenon J. Pudlowski

Bangkok, Thailand, provided the exciting venue for *4th Asia-Pacific Forum on Engineering and Technology Education*, held between 26 and 29 September 2005. Bangkok itself is a vibrant and varied city that acts a hub, connecting Asia with the rest of the world.

This Volume of Proceedings comprises of 45 papers presented at the Forum, representing contributions coming from 16 countries, including three opening addresses and nine keynote addresses. The Asia-Pacific region is an area that represents great diversity, both culturally and in educational matters, which in turn reflects, to some degree, the national identity and the effects of globalisation on education, and on engineering and technology education in particular. This parallels the diversity of submissions to the Forum, printed in the Proceedings, that all relate to engineering and technology education.

As with previous meetings run by the UNESCO International Centre for Engineering Education (UICEE), the Forum is divided into a number of distinct sessions, each headed by a lead paper that is considered to be most representative of the area under discussion. Topics covered include the following:

- Opening addresses
- Keynote addresses
- Case studies
- Innovation and alternatives in engineering and technology education
- Important issues and challenges in engineering and technology education
- Learning strategies and methods in engineering and technology education
- New trends and recent developments in engineering and technology education
- Quality issues and improvements in engineering and technology education
- Recent developments in engineering and technology education
- Social and philosophical aspects of technology and its impact on modern societies
- Specific engineering and technology education programmes

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