

# SUSTAINABILITY EDUCATION IN THE ENGINEERING AND BUILT ENVIRONMENT CURRICULUM: THE CASE FOR ASIA-PACIFIC

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## Abstract

Buildings and cities are measures of economic health in most Developed and Developing economies across the globe. The built environment is constantly changing, reflecting government policies, legislative changes and community expectations. Strategies to deliver low carbon resilient built environments require a range of different stakeholders to work effectively. Government targets, both voluntary and mandatory are putting pressure on new graduates to be fully abreast of relevant global and local issues. Increasing globalisation is finding graduates and senior professionals working on projects away from their home bases. This is putting additional pressures on graduates to understand not just the requirements for meeting the local regulatory minimum but also best practice requirements for sustainability in these regional centres.

Education has long been recognised internationally as fundamental to addressing the global challenges society faces. The unique features and issues of sustainability have a profound effect on the way academic curricula are structured. The general direction of education for sustainability is moving increasingly towards integration and innovation. However, the slow progress of the integration of sustainability in the built environment curricula may have been due in part to the practice-led approach, which is hallmark of the discipline and by the assumption that sustainability already permeates the curricula by its nature.

This paper presents the general findings of the United Nations University – Institute of Advanced Studies, Promotion of Sustainability in Postgraduate Education and Research (UNU-IAS ProSPER.Net) Project on “*Integrating sustainability education into existing engineering and built environment curriculum*” which is aimed at developing a Guide for university academics and curriculum developers to integrate sustainability thinking and practice into built environment disciplines such as engineering and architecture at undergraduate and postgraduate levels. The project used action research in a workshop structure to identify and validate issues identified in the literature and educator’s and industry experiences of teaching in engineering and built environment disciplines. The wider aim of the project is to ultimately ensure that sustainability is firmly embedded in the expanding/developing further courses/offerings to students within this rapidly changing environment.

Keywords: Sustainability Education, Built Environment Curricula, Southeast Asia-Pacific.

## 1 EDUCATION FOR SUSTAINABILITY

The United Nations has declared the decade from 2005 to 2014, the Decade of Education for Sustainable Development (UNDESD). The *UNESCO International Implementation Scheme* [1] outlined the strategic focus on the implementation of the Decade and leading the international agenda are the themes of Climate Change Education for Sustainable Development and Education for Sustainable Development. In the Asia-Pacific region, the strategy to address the needs and priorities of stakeholders in the region is identified in the *UNESCO Working Paper for the Asia-Pacific Regional Strategy for Education for Sustainable Development* [2]. These strategies strongly advocate for partnerships in the Decade’s implementation and argue the need for collaboration and networking as key elements in enhancing participation, ownership and commitment for the success and maximum impact of activities for the UNDESD.

The further and higher education sector has acknowledged the importance of learning for sustainability through various declarations [1, 3]. To equip all sectors of the society to actively engage in change for sustainability, curriculum change is recognised as urgently needed across all programs of study offered by higher education and not just those programs focusing on sustainability issues [4, p19]. Sustainability education initiatives from Australia and New Zealand have been widely published [4-6]. However, developments from other regions have received less consideration [7].

In the Asia-Pacific region, the demand for higher education has risen in tandem with overall population growth and increasing affluence, which adds urgency to the pursuit of sustainability [8]. In a review of the contributions of the region to leading practice in sustainability in higher education, Nomura and Abe [9] and Ryan et al [7] show that the Asia-Pacific region offers many creative initiatives and have made considerable progress in ‘education for sustainable development’ (ESD) and in understanding the learning dimensions of sustainability. Nomura and Abe [9] highlighted that initiatives of higher education institutions in Asia and the Pacific have been propelled by government policies and agencies as well as several regional and subregional efforts. Region-wide efforts saw the emergence of several networks such as the Promotion of Sustainability in Postgraduate Education and Research Network (ProSPER.Net) and the Regional Centres of Expertise in ESD, both developed by the United Nations University’s Institute of Advanced Studies, and the United Nations Environment Programme (UNEP) Asia Pacific Regional University Consortium (RUC) initiated by UNEP’s Regional Office for Asia and the Pacific (UNEP-ROAP) [9].

## 1.1 Educational Responses

To foster environmental literacy and build awareness of sustainability issues, the predominant trend in higher education curriculum has largely been towards learning *about* sustainability [10, 11]. **Education about sustainability** focuses on developing key knowledge and understanding about natural systems and environmental issues as opposed to learning that engages and equips for change towards sustainability [12]. **Learning for sustainability** moves beyond education *in* and *about* the environment to focus on equipping students with the conceptual frameworks necessary to develop skills to effectively enact change towards sustainability [4].

Addressing sustainability in the curriculum requires more than the addition of content [4, 13]. From the 1990s, the implications of the *‘for’ approach* to sustainability education were more widely understood and consequently, a consensus has been formed that education for sustainability should not be viewed as ‘one more subject’ to be added to curriculum. Instead, the focus should be, as a wholly integrative approach where sustainability is seen as a context for delivering the aims of education and not as a competing priority [2, p9]. Sterling [14] suggested that the significant learning challenge to higher education in the transition towards a more sustainable society is not just in terms of **student learning** (**‘designed learning’ as a result of curricula and pedagogy**) but also learning within the wider community including senior management, **academics and support staff** (**‘attendant learning’**). Sterling and Thomas [13] further illustrated a model of staged learning responses to sustainability from the perspectives of societal change and educational change (Table 1). The learning responses to sustainability from the perspective of societal change and educational change follow this staged process. It is in the fourth level that the defining transformation takes place:

1. Where value is placed on the quality of learning (being creative, reflexive, participatory process), and
2. Where inter- and trans- disciplinary approaches are embraced and developed in relation to an emphasis on real-life issues.

**Table 1: Levels of social and education responses to sustainability**

	<b>Sustainability Transition</b>	<b>Response</b>	<b>State of sustainability (societal change)</b>	<b>State of education (educational change)</b>
1	Very weak	Denial, rejection, or minimum change	No change (or token)	No change (or token)
2	Weak	‘Bolt-on’	Cosmetic reform	Education <i>about</i> sustainability
3	Strong	‘Build-in’	Serious greening	Education <i>for</i> sustainability
4	Very strong	Rebuild or redesign	Wholly integrative	Sustainable education

Source: Sterling & Thomas [13, Table 2, p355]

This model of staged learning responses illustrates the emphasis of **sustainability education** “not on desired outcomes as in the term ‘education *for* [sustainability]’, but on the qualities of education itself through which sustainability is manifested as an emergent property” [15, p52]. This emphasis on the quality of learning is recognition of the need to build the individual’s capacity, among others, to think critically, systematically and reflexively – “a shift from content and predetermined learning outcomes towards the nature of learning experience” [15, p52]. Affirming Sterling’s call for transformation, Tilbury [12] has argued that innovation and not integration is required to enable curriculum change for sustainability. Tilbury posits “Education for sustainability is an innovative and interdisciplinary process requiring participative and holistic approaches to the curriculum...it has a transformative agenda that

requires and often leads to professional, curriculum as well as structural change” [4, p15]. Furthermore, Fien et al [16] contend that ‘**teacher education**’ is an especially important area of action in the reorientation of education towards sustainability where reforms would require new attitudes and skills among teachers.

## 1.2 Transforming sustainability knowledge

In building capacity for educators, the unique features and issues of sustainability have a profound effect on the way academic curricula are structured [17]. Miller et al [18] contend that building sustainability knowledge requires a fundamentally different approach to the ways academic institutions organise education and research and relate to society. Thus, **sustainability knowledge** is defined as knowledge that [18, p179]: (1) recognises the complexity of system dynamics; (2) is socially robust; (3) acknowledged by multiple epistemic cultures; and (4) incorporates (contextualised) normative criteria.

This approach of looking at organisational change as necessary in developing education for sustainability is endorsed by Thomas [19] as a strategic approach. Miller et al [18] further suggest that currently generated knowledge however is too static for such a complex adaptive world and as knowledge is an emergent property of social systems, the focus is thus on knowledge processing instead of just knowledge sharing or transfer [McElroy 2006 cited in 18]. Miller et al [18] emphasise that academic institutions must break with the more traditional, disciplinary structure of science to remain adaptive to changing societal needs and co-produce with society the knowledge for sustainability.

In the analysis of the development of sustainability education, Sterling [15] contends that sustainability is “likely to arise depending upon the degree which attention shifts from ‘things’ to relationships, and from a segregated and dualistic view of the world towards an integrative and participative perspective” and further argues that sustainability education is “at heart, an epistemological issue” (p56). Sterling [15] provided a concise summary of what sustainability knowledge and consequently what sustainable education requires (p57-58):

- Implies a **fundamental change of purpose** or, at very least, an additional key purpose of education.
- Implies embedding, embodying and exploring the nature of sustainability as intrinsic to the **learning process**. This is education ‘as’ sustainability – nurturing **critical, systemic and reflective thinking; creativity; self-organisation; and adaptive management** – rather than education ‘about’ sustainability, or education ‘for’ particular sustainable development outcomes.
- Is not prescriptive, but **indicative and purposeful**.
- Affirms liberal humanist traditions in education, but goes beyond them through **synergy with systemic and sustainability core values, concepts and methodologies**.
- Challenges the limiting effects of characteristics of the dominant mechanistic paradigm, such as top-down control, centralisation, managerialism, instrumentalism and the devaluing of humanities and arts.
- Is based on ‘systemics’ rather than ‘systematics’ – that is, the **emphasis is on systemic learning as change**, rather than *systematic control* in response to change.

Echoing the necessity for “capacity building for educators” [17], the change of educational culture requires a deep learning process by educational actors. If higher education institutions are to play a constructive part in the transformation of sustainability knowledge and transition of sustainable education to provide transformative learning experiences, these institutions and educators need to go through a transformative learning experience themselves [15].

## 2 ENGINEERING AND THE BUILT ENVIRONMENT CURRICULUM

In this carbon-constrained world, the importance of the built environment to society places a high level of responsibility on those professionals who plan, design, construct, manage and maintain that environment. Educators in the built environment have become increasingly aware of their environmental responsibilities and the impact of buildings upon the quality of life, health and resource consumption [20] and there is a clear recognition that professional education in the sector for climate change adaptation and mitigation is limited and urgently needed [21], particularly in the built environment sector in Australian university programs. Professionals in the sector generally understand the need for climate change adaptation and mitigation, but not its practical implications [22]. Similarly,

in the UK, Edwards [20] noted that most architecture courses pay little regard to sustainability as a holistic concept and although low-energy design is widely understood, the notion of social sustainability, of life-cycle costing and of alternative technology is given little timetable space (p137).

## 2.1 The ProSPER.Net Project

In focusing on the main issues about applying the principles of sustainability in the built environment and the tensions with regulatory and best practice approaches, a regional approach was adopted for the project. This regional approach took account of international, national, local and sub-regional concerns in relation to sustainability teaching and learning, and expectations of both graduates and the industry. A review of literature was undertaken which formed the background work for the project. This included a desktop research, followed by input from the participating universities and institutions to understand the current programs and course offerings in the built environment curricula. The literature review focused on understanding the elements of sustainability currently being integrated into curricula both from program level and course development perspectives. The desktop investigation also canvassed the academic training and professional development of built environment practitioners in sustainability education.

The core activity of the ProSPER.Net project was a workshop which brought together the participants and shared knowledge and experiences to recommend practical approaches for integrating sustainability issues whilst understanding the theoretical dimensions of sustainability and sharing experiences about what approaches best work for all stakeholders. Thus, participation in the project and workshop was not restricted to just ProSPER.Net institutions, but other universities expected to benefit from attendance to the workshop and the broader outcomes of this project were also invited to participate. The three-day workshop was conducted at RMIT University Vietnam in Ho Chi Minh City, Vietnam from 20 to 22 April 2012. There were nine (9) teaching academics who participated in the workshop. The aim was to select a mix of universities from the Asia-Pacific region because growth in the building and construction sector is expected to occur most in this region, with attendant growth in population. The invited industry participants were selected from a mix of international and national participants in Vietnam.

The universities/institutions who participated in this project were: Asian Institute of Technology (Thailand), Tongji University (China), University of the Philippines (Philippines), National Institute of Advanced Studies in Architecture (India), Universiti Sains Malaysia (Malaysia), Universitas Gadjah Mada (Indonesia), International University, Vietnam National University – HCM (Vietnam), University of Tokyo (Japan) and RMIT University (Australia). Industry participants included: the World Green Building Council, Vietnam Green Building Council, Sino-Pacific Construction Consultancy Co. Ltd (Vietnam) and Vietnam Centre for Research and Planning on Urban and Rural Environment (CRURE)/Vietnam Institute for Architecture and Urban-Rural Planning (VIAP)/Ministry of Construction (MOC).

To contextualise the current state of sustainability integration in the existing built environment curricula in the Asia-Pacific region, the ProSPER.Net workshop participants have provided a list of programs and attendant courses currently taught in their respective universities and institutions. The preliminary information provided formed part of the desktop literature review. The final information collated from the participants underpinned the framework of the workshop and demonstrated the need for the definition and resolution of the issues identified in the literature review on:

- Curriculum design and structure;
- Capacity building for academics in transforming sustainability knowledge;
- Sustainability pedagogies;
- Pedagogical implications in the engineering and built environment disciplines;
- Learning outcomes – student experiences;
- Industry input – students as employable graduates; and
- Challenges to professionals in the field of built environment, their institutional structures and boundaries.

To achieve the objectives of the research project and guided by these overarching workshop activities, an action research framework was adopted [23]. The workshop functioned as a participatory action research process, whereby progressive problem solving (in this case, curriculum development) occurred with participants working with others in teams or as part of a "community of practice" to improve the way they address issues and solve problems. Using participatory action research [23] in collaboration with the industry practitioners, the workshop identified how best to integrate sustainability



### 3 INTEGRATION AND INNOVATION IN SUSTAINABILITY EDUCATION

From the growing number of studies on how to integrate sustainability in higher education, and broad and general frameworks for its integration into curricula, the approaches can be summarised as follows: (1) an incremental approach whereby small groups can start out and if successful can be expanded throughout the university [24]; (2) the need to think strategically about integrating sustainability into higher education [25, 26]; and (3) the need for a broad and general approach [27].

The literature indicates that the many core principles of integrating sustainability into higher education require substantial shifts in thinking and practice. Some may be out of reach of the individual lecturer and more challenging for some disciplines than others. Table 2 illustrates the magnitude of change and transformation required in teaching sustainability.

**Table 2: Integration of sustainability within higher education implies shifts**

<i>From</i>	<i>To</i>
• Transmissive learning	• Learning through discovery
• Teacher-centred approach	• Learner-centred approach
• Individual learning	• Collaborative learning
• Learning dominated by theory	• Praxis-oriented linking theory and experience
• Focus on accumulating knowledge and a content orientation	• Focus on self-regulative learning and a real issues orientation
• Emphasis on cognitive objectives only	• Cognitive, affective, and skills-related objectives
• Institutional, staff-based teaching/learning	• Learning with staff but also with and from outsiders
• Low-level cognitive learning	• Higher-level cognitive learning

Source: Sterling [15, Table 4.3, p58]

Sterling [15] further argues that moving towards a sustainable education paradigm is not a choice between these opposites (Table 2), but a “change of weighting that moves away from the dominance of the old paradigm” and the transformation and conservation of “some of the characteristics rather than abandoning them in their entirety” (p57).

#### 3.1 Learning Outcomes

Learning outcomes are the point at which education principles and other principles meet [28]. As the literature review for this project uncovered, the workshop discussions similarly revealed that sustainability pedagogies is rife with the need for the different approaches to teaching and navigating the difficult transformative changes to higher education curricula. However, there is limited parallel discussion on the learning outcomes associated with these approaches [29, 30]. The workshop discussion on what would be the educational responses and focus of a curriculum in the built environment which espouses sustainability education, the academic and industry participants outlined their expectations on the learning outcomes and anticipated attributes of graduates (Table 3). For the learning outcomes that weighed heavily for the academics, it was interesting to note that while professional competence was considered to be important, so also were softer skills. This is aligned to trends observed in Australia [6, 13, 31]. From the expectations of what industry has identified as key needs and attributes of the graduates who would fill the requirements of the marketplace, the responses show that learning outcomes are not all about professional competence.

**Table 3: Learning outcomes and anticipated student attributes (ProSPER.Net Workshop)**

<i>Learning outcomes and anticipated attributes</i>		
	<i>From academics</i>	<i>From industry</i>
1	• Genuine concern	• Motivation to make change
2	• Discipline / competence / sustainability	• Life-cycle thinking
3	• Good team player	• Open to other disciplines
4	• Right attitude	• Environmental / social / economic implications of their work

Perhaps learning outcomes would have to be dealt with individually in specific programs and courses. Sterling and Thomas [13, p363] argue that “the principles of sustainable development are ideally best explored with students where these principles are infused in the curriculum that is currently used in the discipline area”. Sterling and Thomas [13] contend that taking the discussion on education for

sustainability further, necessitates knowing what the learning outcomes desired from the students – what are the capabilities, abilities or competencies to be achieved. Some examples of studies on crafting capabilities have been outlined by Sterling and Thomas [13, pp359-366] identified three categories of capabilities as being requirements of education for sustainability (Table 4).

**Table 4: Capability requirements for Education for Sustainability**

<i>Knowledge and understanding of</i>	<i>Skills in:</i>	<i>Values and attitudes:</i>
<ul style="list-style-type: none"> <li>• Social justice and equity</li> <li>• Diversity</li> <li>• Globalisation and interdependence</li> <li>• Sustainable development</li> <li>• Peace and conflict</li> </ul>	<ul style="list-style-type: none"> <li>• Critical thinking</li> <li>• Ability to argue effectively</li> <li>• Ability to challenge injustice and inequalities</li> <li>• Respect for people and things</li> <li>• Cooperation and conflict resolution</li> </ul>	<ul style="list-style-type: none"> <li>• Sense of identity and self-esteem</li> <li>• Commitment to social justice and equity</li> <li>• Value and respect for diversity</li> <li>• Concern for environment and commitment to sustainable development</li> <li>• Belief that people can make a difference</li> </ul>

Source: Sterling and Thomas [13, p361]

These capability requirements resonate well with the academics' expectations on the learning outcomes and anticipated attributes of graduates and correlates with industry requirements (Table 3).

### 3.2 Pedagogical Methods

Based on the prioritised expectations on the learning outcomes and the marketplace requirements for built environment graduate attributes discussed in the workshop, the ideas and suggestions for the integration of sustainability into the curricula (Table 5) interestingly echoed those approaches and models outlined by Thomas et al [28] and Thomas and Nicita [6] (Table 6).

**Table 5: Development and changes to built environment curriculum (ProSPER.Net Workshop)**

<i>How educators will make the change</i>	<i>How to engage industry</i>
<ul style="list-style-type: none"> <li>• Change teaching content</li> </ul>	<ul style="list-style-type: none"> <li>• Continuing professional education</li> </ul>
<ul style="list-style-type: none"> <li>• Research collaboration</li> </ul>	<ul style="list-style-type: none"> <li>• Open lectures / seminars open to all in the university rather than just within the program</li> </ul>
<ul style="list-style-type: none"> <li>• Sharing / networking lessons learned</li> </ul>	<ul style="list-style-type: none"> <li>• Research collaboration</li> </ul>
<ul style="list-style-type: none"> <li>• Best practice examples / case studies used where possible</li> </ul>	<ul style="list-style-type: none"> <li>• Form partnerships: students and industry through conferences such as with Green Building Councils, etc.</li> </ul>
<ul style="list-style-type: none"> <li>• Dialogue / discussions with industry</li> </ul>	<ul style="list-style-type: none"> <li>• Getting industry speakers</li> </ul>
<ul style="list-style-type: none"> <li>• Invite industry to: student presentations, faculty presentations</li> </ul>	<ul style="list-style-type: none"> <li>• Accreditation considerations</li> </ul>
<ul style="list-style-type: none"> <li>• Dialogue / discussions with other university staff / officials</li> </ul>	<ul style="list-style-type: none"> <li>• Organise activities with industry (e.g. conferences, seminars, etc.)</li> </ul>
<ul style="list-style-type: none"> <li>• Keep looking for funding</li> </ul>	<ul style="list-style-type: none"> <li>• Send graduates to individual companies</li> </ul>
<ul style="list-style-type: none"> <li>• Lobbying politicians</li> </ul>	<ul style="list-style-type: none"> <li>• Mentoring</li> </ul>
	<ul style="list-style-type: none"> <li>• Alumni tracking – surveys</li> </ul>
	<ul style="list-style-type: none"> <li>• Advisory boards</li> </ul>
	<ul style="list-style-type: none"> <li>• Adjunct professors</li> </ul>
	<ul style="list-style-type: none"> <li>• Feel good stories / testimonials</li> </ul>

Thomas and Nicita's [6] outlined this range of approaches (Table 6) on how environmental literacy and sustainability education have been adopted and introduced in Australian universities. Drawing from the workshop discussions and insights offered by both the teaching academics and industry representatives, to address and effect targeted learning outcomes invariably require the use of multiple approaches.

**Table 6: Approaches for presenting environmental literacy / sustainability education**

<i>Approach</i>	<i>Method</i>	<i>Modes for delivery</i>
1. Addition	<ul style="list-style-type: none"> <li>• Introduction of new subject or modules which deal with environmental / sustainability issues relevant to the host discipline</li> </ul>	<ul style="list-style-type: none"> <li>• Seminars</li> <li>• Work placement</li> </ul>

<i>Approach</i>	<i>Method</i>	<i>Modes for delivery</i>
2. Incorporation	<ul style="list-style-type: none"> <li>Integration of environmental / sustainability themes into existing subjects</li> </ul>	<ul style="list-style-type: none"> <li>Guest speakers</li> <li>Projects</li> <li>Group work</li> <li>Field / site visits</li> <li>E-learning / online forums</li> <li>Lectures / tutorials</li> <li>Participation in relevant voluntary groups</li> </ul>
3. Engagement	<ul style="list-style-type: none"> <li>Integration of an environmental / sustainability component into most or all subjects within a course/program</li> </ul>	

Source: Adapted from Thomas and Nicita [6, p483]

## 4 DEVELOPMENT AND FRAMEWORK FOR THE GUIDE

Informed by the literature review and the workshop outcomes, the framework of the curriculum guide draws on key seminal and foundational reports and key text references which focus primarily on the built environment and construction sector and point to sustainability education in the built environment:

- Guidelines on Education Policy for Sustainable Environments [32]
- Shifting Towards Sustainability: Education for climate change adaptation in the built environment sector [21]
- AGENDA 21 on Sustainable Construction [33]

Drawing insights from the International Council for Research and Innovation in Building and Construction (CIB) – Agenda 21's [33] strategies and actions for sustainable construction which outlines the “process of continual improvement in the built environment sector from unsustainable practices to positive ones” [32, p13], this framework for the guide for university academics and curriculum developers in the built environment disciplines emphasises the integration of sustainability thinking and practice into the built environment curricula and the key role the professions play in the creation of sustainable developments.

With the view of facilitating rather than directing change, the curriculum guide is structured as follows:

- Section 1 – A framework outlining the priorities in the professional development program; contextualising these priorities and strategies for capacity building for the different stakeholders.
- Section 2 – The broad framework established and developed in Section 1 provides a rationale for the guiding principles for teaching and learning issues, identifying learning aims and developing learning outcomes; transformative sustainability approaches and methods; repository of references and useful resources; presentation of best practice and case study examples, and monitoring and closing of feedback loops.
- Section 3 – Platform for curriculum dissemination and distribution. This section outlines the available knowledge networks for faculty development and provides a platform for reporting and monitoring progress and evaluation.

## 5 FUTURE DIRECTIONS AND IMPERATIVES

Taken overall, the general direction of education for sustainability is moving increasingly toward integration and innovation [21, 22]. However, the slow progress of the integration of sustainability in the built environment curricula maybe have been due in part to the practice-led approach which is a hallmark of the discipline and by the assumption that sustainability already permeates the curricula by its nature [34, 35]. In looking across built environment education, Bradley et al [34] posit that sustainability is being addressed at four levels:

1. Sustainability as knowledge.
2. Sustainability as process.
3. Sustainability as practice.
4. Sustainability as paradigm.

The diverse experiences of the academics and industry representatives in the ProSPER.Net workshop point to these issues which are key to professional education for sustainability:

1. Pedagogical implications in the built environment discipline
2. Learning outcomes – student experiences
3. Interdisciplinary rather than discipline based
4. Industry input – students as employable graduates



5. Challenges to the professionals in the field of the built environment, their institutional structures and their boundaries.

To successfully introduce sustainability concepts into course and curricula, educators must understand the process of change [29] and “capacity building of educators” must then be considered the cornerstone of transforming universities to become effective in empowering students to become change agents for sustainability [17].

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