

Australian Council of Engineering Deans National Award for Engineering Education Excellence 2021

Winner:

Timothy McCarthy

Awarded For:

Sustained contributions and excellence in engineering education, focused on collaborative learning and assessment practices

ACED Award 2021 Nomination statement:

Introduction and context

Experiential learning is the process where students gain knowledge and develop a range of skills from first-hand experiences which do not occur in a normal classroom setting. According to Kolb (1984), experiential learning is “*The process whereby knowledge is created through the transformation of experience. Knowledge results from the combination of grasping and transforming experience.*” Delivering authentic experiential learning is a challenging task.

The Solar Decathlon is the world’s largest sustainable architecture contest. It challenges student teams to design and build highly efficient and innovative buildings powered by renewable energy. Coordinated by the U.S. Department of Energy, it provides a platform to create learning experiences that go beyond the skills associated with engineering and architecture. Figure 1 shows the 10 contests of the Solar Decathlon. The variety is perfect for fostering multi-disciplinary learning. The team is scored on their communications strategy, branding and publicity, innovation as well as engineering and architecture.



Figure 1 The Solar Decathlon contests - Adapted from Solar Decathlon Middle East (2018)



Figure 3 Day 11 of construction in Dubai Nov 2018

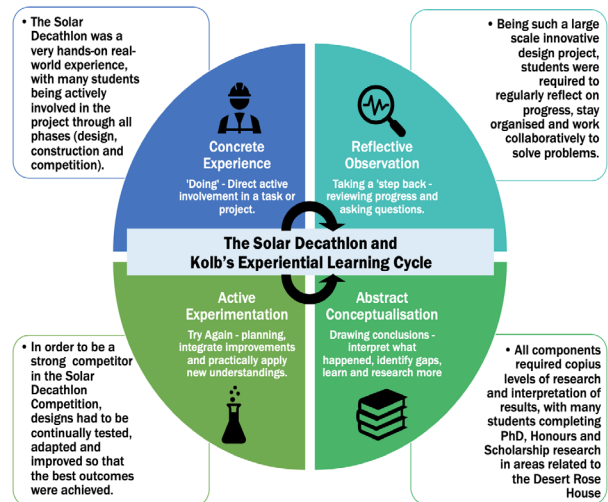


Figure 2 Kolb's experiential learning cycle - adapted by Nero, McCarthy et al (2019)

According to Ortegon (2016), the Solar Decathlon contributes to student outcomes in effective multi-disciplinary teamwork, ethical responsibility, and organisational skills. With reference to Strobel et al's (2012) multi-factor model for authentic problems, I adapted Kolb's experiential learning cycle to guide my running of UOW's Solar Decathlon campaign as shown in Figure 2

Team UOW won overall Gold at the Solar Decathlon China 2013 contest and Silver in the 2018 Solar Decathlon Middle East (SDME2018) in Dubai in 2018. Under my guidance, the students designed, built and shipped their net-zero energy home from Australia to the competition sites. The students assembled their houses in just two weeks and operated them in competition with top universities from around the globe. Our students and staff had a unique and transformative learning experience.

Leadership that has influenced and enhanced learning & teaching and the student experience.

This nomination will focus on the challenges in the development and running of UOW's SDME2018 campaign but will reflect on the learnings from 36 years' in engineering education and, especially, learnings from the 2013 SD China contest which were incorporated in the 2016-2018 campaign

and beyond.

Ten years ago, I led the construction activities in the 2011-2013 campaign and was Deputy Academic Leader. For SDME2018, I was the overall Academic Leader of Team UOW. This involved leading students and teachers from Wollongong, UOW in Dubai and TAFE NSW.

Each Solar Decathlon campaign lasts for over three years. The initial phase for SDME2018 was for me to co-develop with students a successful application including business plan and concept design. Of the 44 entries to SDME2018, 22 were selected for the finale, including Team UOW. Ultimately, 15 university teams successfully completed their houses on the site in Dubai, UAE in November 2018 (Figures 3, 5). The total budget was in excess of \$2 million.

I assembled our student team to design and build the house, raise funds, and organised the relocation of 51 students and staff to Dubai to compete in the Decathlon.



Figure 4 Desert Rose Branded T-Shirt



Figure 5 Team UOW Second Place overall Nov 2018

Influencing cross faculty and cross institutional learning

The 2011-2013 campaign highlighted the challenge of embedding this mega-project in the curriculum and maximising the learning and research opportunities. For SDME2018, I started early and energised my colleagues across the Faculty of Engineering and Information Sciences to set a range of Honours thesis topics to align with the design imperative of what became known as Desert Rose House. Colleagues from Creative Arts set a term project for their second year course to develop a logo and branding (Figure 4). The winning design was selected by the students.

Following the successful collaboration at the 2013 contest, Team UOW once again incorporated students and staff from TAFE NSW from the outset. I initiated a recruitment drive at TAFE to find painters, decorators, plumbers, electricians, carpenters, riggers and a chef! I worked with TAFE teachers to integrate their learning modules with the needs of Desert Rose House. Team UOW students did White Card Site Safety training at TAFE. Key team members were trained to work at heights and 15 became qualified first aiders.

Challenging the overall academic, social and cultural experience of higher education

My experience at Solar Decathlon China 2013 highlighted gaps in the engineering curriculum. At that time we were still teaching 2D CAD, while the contest required the latest 3D software. I established a new subject, CIVL201 Computer Modelling in Civil Engineering in 2016. It introduces 3D Building Information Modelling (BIM). It is popular with students who appreciate its relevance and it provided the BIM skills for SDME2018.

Table 1 Student comments in 2019 CIV201 Subject evaluation

<i>"subject content relevant to industry"</i>
<i>"More modelling subjects [like this] are needed – these softwares (sic) are important in the real world"</i>
<i>"The skills learnt have significantly increased the chance of me (sic) getting work experience"</i>

Ensuring that students received credit in whichever degree they were enrolled was a challenge for the Solar Decathlon China contest in 2013. For SDME2018 I made a concerted effort to recruit colleagues to adopt the contest in their curricula. Table 2 lists the main UOW subjects, across all 4 faculties, that incorporated SDME2018 as a theme or assessment item. The Solar Decathlon was recognised by UOW as an approved co-curricular activity. Student leaders acted as managers for Business Interns undertaking COM391. This was an opportunity for our leaders to supervise a 12 week part-time placement and a chance to recruit volunteers for Team UOW.

“The solar decathlon inspired me to try new things and gave me an opportunity to expand my education beyond my degree...I moved from business...to work health and safety where I...employ what I learnt through the solar decathlon in my current role in managing WHS in construction.” Brittany Ryan B.Comm student

“Somehow Tim managed to not only motivate and inspire our entire team but also connect with all of us at an individual level and work with us to discover our own potential as engineers creating change in this world”. Meg Cummins B Eng Civil and Environmental (Hons) now Water Engineer at AURECON.

Sample quotes from Team UOW members.

HAS348 Social Innovation and Entrepreneurship	ENGG940 Advanced Project (Masters)
ENGG255 Professional Options	COMM391 Professional Experience in Business
ENGG371 Dean’s Scholar Project	CAGD203 Graphic Design Studio
ENGG452/ENGG453 Engineering Honours Thesis	CAGD390 Graphic Design Major Project
ENGG456 Engineering Project	UOWX – Co-curricular awards.

Table 2 Subjects with Solar Decathlon Content.

A House for Life – Innovative learning and teaching in different contexts

To add greater purpose, principles of dementia friendly design formed a theme for Desert Rose House. In consultation with UOW’s Dementia Training Australia Group our students ran co-design workshops with people living with dementia. This inspired a colleague in the School of Health and Society to develop a subject (HAS348) linking engineering students with social scientists to co-design solutions for societal problems.

“Tim’s leadership has influenced my skills in the development of this interdisciplinary subject while his interpersonal skills inspire me to develop an ethics of care and compassion approach to student success and wellbeing.” K Kariippanon Subject coordinator HAS348 Social Innovation and Entrepreneurship

By incorporating a wicked health topic in the design we formed a strong bond between engineers, nurses and social scientists. Engineers needed to provide solutions that encouraged wellbeing rather than just seeking a technological answer. The Architecture Jury at SDME2018 gave Team UOW a special commendation for this inclusive co-design process and awarded maximum marks for Innovation in Architectural Design.

Monitoring and evaluating student learning

Over the whole campaign approximately 250 students became involved for a significant time. At any one time, there were 50-60 students from every faculty in the university and every school at TAFE immersed in the project – undertaking subjects and/or volunteering significant hours. 41 students and 10 staff formed the Finals team, spending up to 7 weeks in the UAE from Oct– Dec 2018.

The Dubai build was a success and the team experienced the highs and lows of elite competition. Overall, Team UOW and Desert Rose won 2 Gold medals (Innovation and Comfort Conditions), 3 Silvers and 2 Bronze and came Second overall. The Team also won a Gold medal for

Interior Design and the Creative Solutions prize.

We conducted an evaluation of the student learning outcomes and personal development achievements of the participants. Of the 75 student blogs, which had been posted as part of the competition, over 77% were analysed in NVIVO to be moderately to very positive about their experience. Some quotes are:

“I had such a fantastic experience that I wanted to do it all over again!”
“My teammates are incredibly hard-working and all did their part to make sure the day was a success.”

The students were surveyed with 25 questions. The responses in Table 3 show very positive outcomes, ones that are difficult to achieve through traditional engineering curricula.

Table 3 Sample Student responses to questionnaire (adapted from Nero et al 2019)

Statement (1=strongly disagree, 7 = strongly agree)	Option Mean
The competition encouraged me to step out of my comfort zone.	6.5
The Solar Decathlon enabled me to think creatively.	6.3
I feel that I have become more confident	6.0
This experience has shown me the value of working in multidisciplinary teams	6.5
This experience has shown me the value of working in a diverse team	6.4

External recognition by the Engineering Profession and Educational Organisations

Team UOW won cash prizes totalling AU\$325,000. Many Team UOW students have won individual UOW and external awards based on their contributions to the Desert Rose House (See Table 4). The overall project and the building design have been recognised with state, national and international awards. I gave the keynote presentation at CSEE18 in Hungary, host of Solar Decathlon Europe 2019 (McCarthy et al 2018). The Green Globe award is the NSW Government’s top award for excellence in sustainability. This, the Australian Engineering Excellence award and the AIB award are in competition with major commercial projects and have national influence on the engineering profession. The significance in the educational sphere is evidenced by the Australasian Green Gown Award for student engagement and my 2014 AAEE award.

Table 4 External Individual and Team awards (Shaded = student individual awards)

Robert Hope Memorial Prize 2020 UOW’s top award for a graduate. Meg Cummins BEng	Vice Chancellor’s Award for Workplace Health and Safety 2020 Clayton McDowell	Australian Institute of Refrigeration, Air Conditioning and Heating 2019 Top Student Award - Brendan Banfield
Australian Institute of Building – Building Professional of the Year 2019 Clayton McDowell	Australasian Green Gown Award for Student Excellence Clayton McDowell	Robert Hope Memorial Prize 2018 UOW’s top award for a graduate. Dan Simpson
Australian Institute of Refrigeration, Air Conditioning and Heating 2019 Award for Excellence in HVAC Research	Green Gown Australasian Award for Student Engagement 2019	Green Gown International Highly Commended 2020 for Student Engagement
Australian Engineering Excellence Award 2020, Sydney	Green Globe Built Environment Award 2019 – NSW State Government	Green Globe Regional Sustainability Award 2019 – NSW State Government
Australian Institute of Building NSW and National Award 2019 Residential Construction < \$1m	SafeWork NSW 2019 Awards – Highly Commended	2014 AAEE Award for Student Engagement, Prof Tim McCarthy for SD China Project

Sustaining the initiative

Running a major project, such as this, not once but twice, over a 10 year period from 2011 to 2021 demonstrates a sustained effort to deliver authentic experiential learning to our students and to share with the Engineering Education community. Since 2006, I have had over 20 papers presented at AAEE conferences on a range of collaborative projects, including the Solar Decathlon.

Both Solar Decathlons have demonstrated strengths and weaknesses of the engineering curriculum at UOW. From SD China 2013 we developed one new subject which paid dividends with SDME2018. From both campaigns we saw the need to link the sustainable engineering with the architecture from the outset. I successfully established a new Bachelor of Architectural Engineering degree with UOW's Sustainable Buildings Research Centre, where I became Director in Feb 2021. This degree accepted its first intake in 2020 and more than doubled its intake in 2021.

As a result of SDME2018 I obtained funding to run the Intervarsity Sustainable Homes Challenge hosted by UOW and involving 28 students from 9 universities across Australia. The student leader of Team UOW, Clayton McDowell is now a Post-Doc researcher with me working on an in-depth evaluation of the Desert Rose Project and the feasibility of hosting Solar Decathlon Australia.

Experiential learning with authentic, problem based, activities creates an environment for student development and allows us to assess the efficacy of curricula to deliver engineering graduates for the future.

The Desert Rose House now stands as a living laboratory at our campus. It is also a visitor centre and learning resource to inspire all. Over 30 students have used the solar house in their Honours theses, MPhil, PhD and other research since 2018. Visitors have the opportunity to spend the night and experience the net zero feeling.

"Tim has a... passion for delivering exceptional educational experiences... he helped enable and support a one of a kind learning experience that provided the opportunity for students to grow beyond their standard curriculum and work side-by-side with students from other faculties...and technical trades students from TAFE NSW." Clayton McDowell Team UOW Student leader – now Post-doc research fellow.

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