Advances in Engineering Education

FALL 2021

Dissemination and Adaptation of the EPICS (Engineering Projects in Community Service) Model

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ABSTRACT

The EPICS Program was created in 1995 with the dual purposes of improving engineering education and addressing compelling needs within our communities. The model broke with many traditional academic traditions, involving students in multidisciplinary teams of students from first-year to fourth years for multiple semesters or even years on projects with local and global community partners. EPICS has been recognized as a model within engineering education and community engagement. The EPICS model has been adapted by several other institutions at the undergraduate and pre-university settings. There are currently 38 active higher education institutions with each adapting the model to their own institutional culture. This paper highlights the EPICS model and how four institutions that are recognized global leaders in engineering education have collaborated and adapted the model to their own institution's goals and culture.

Key words: Dissemination; Service-Learning; Multidisciplinary Design

INTRODUCTION

The 2018 report on "The Global State of the Art in Engineering Education" (Graham, 2018) identified global leaders in engineering education. Each of the institutions highlighted in the report has unique characteristics and programs. Four of them, Arizona State University, Itasca Community College, Charles Sturt University, and Purdue University, have adapted the EPICS model into their undergraduate or outreach programs. EPICS is a model for community-based design education and was also cited by the report as an influencer in global engineering education. This paper describes how these four leading institutions adapted the EPICS model into their respective institutions and have worked together to disseminate the ideas to other institutions globally.

The origins of the EPICS program date to the mid-1990s, when there were many discussions about developing engineers with a strong technical core along with the broad set of professional skills needed by industry (Dahir 1993, ASEE 1994). In response to these discussions, a team of faculty in Purdue University's School of Electrical and Computer Engineering created an innovative design experience where students could develop their design, technical and professional skills over several semesters or even years. Under the leadership of Professors Edward Coyle, Hank Dietz, and Leah Jamieson, the Engineering Projects in Community Service (EPICS) Program was created to engage student design teams with local community organizations. (Coyle, Jamieson, and Dietz 1996; Coyle, Jamieson, and Summers 1997). Community needs involving technology-based solutions created the compelling design experiences that could engage students over multiple semesters. The approach allowed students the time and context to experience multiple phases of the design process, iterate on designs and see the ramifications of early design decisions. Communities gained access to technology and expertise to improve the community, environment and quality of life of their citizens.

While originally started in Electrical and Computer Engineering, the teams rapidly became multidisciplinary. The inaugural year's teams comprised of 2nd thru 4th year students in Electrical and Computer Engineering and one Mechanical Engineering student who was the roommate of one of the ECE students. Within the first few years, first-year students were added to the teams and participation expanded across engineering and the university. Samples of early successful projects were described by Coyle et al 2005 and are summarized in Table 1.

From 2010–2020 an average of 30 majors participated. The diverse teams and authentic context allow students to apply their disciplinary knowledge and acquire multidisciplinary skills. Students also develop the professional skills needed as graduates, including communication, project management, leadership and teamwork, ethics and understanding of modern societal issues. (Coyle, Jamieson, and Oakes 2006; Zoltowski and Oakes 2014). Since its inception, EPICS has balanced commitments

Table 1. Sample Early EPICS teams (Coyle, Jamieson, and Oakes, 2005).

Community Partner	Year Initiated	Tasks	Disciplines
Wabash Center Children's Services	1995	Develop computer-controlled toys for children with physical disabilities. Develop an artificial sensory environment to provide multi-sensory stimulation and a sense of control to children with physical disabilities. Provide ways for physically disabled children to control their motion and to play with peers.	Comp E, EE, Mat. E, ME, CS, Nursing. Child Development
Purdue Department of Forestry and Natural Resources	1998	Develop and construct a test constructed wetlands area to mitigate agricultural runoff from cattle, dairy, and swine farms and to treat creek water. Develop educational infrastructure to make the constructed wetlands an environmental education center for the community.	CE, EE, ME, Environmental, Chem, Bio, Nat. Res., Ag, Forestry
Greater Lafayette Affiliate of Habitat for Humanity	1996	Design systems, structures, and floor plans to minimize home construction and energy costs. Develop new construction techniques and investigate new construction materials. Design data management systems for local and regional operations.	Civil E, EE, ME, Comp E., IE, CS
Tippecanoe County Homelessness Prevention Network	1995	Design and implement a centralized database that allows agencies to coordinate their services, track their clients, and assemble accurate reports without violating clients' confidentiality.	Comp E, CS, EE, IE, Sociology
Klondike Elementary School	1997	Design custom educational software, multimedia and interactive tools for use in the school. Develop technology-based solutions to school infrastructure problems.	Comp E, EE, ME, Education, Liberal Arts
Wabash Center Greenbush Industries	1998	Develop aids to assist workers with disabilities perform simple manufacturing tasks.	EE, ME, IE, Comp E.

to reciprocal community partnerships and student learning and has become a recognized global leader in both community engagement and engineering education.

The early success motivated the creation of a network of universities interested in adapting the model. In 1999, the EPICS National Program was created to support dissemination to other institutions, with support from the National Science Foundation with National Dissemination and Action Agenda grants as well as corporate support from Microsoft and AMD. It was renamed the EPICS University Consortium as global interest increased. There are currently 38 active institutions with each adapting the model to their own institutional culture (Oakes, Zoltowski and Huff 2014). Elements of EPICS programs that are shared by all EPICS programs are referred to as core values and include:

1. EPICS students earn academic credit for participation in team-based design projects that solve engineering, computing, and technology-based needs in the local or global community;
2. EPICS teams provide service to the local or global community by partnering with not-for-profit community organizations, educational institutions, and governmental agencies;
3. EPICS programs support these reciprocal partnerships over multiple years without obligation for remuneration to EPICS.

The pedagogical approaches to implement these core values aligns with modern research in many important aspects of engineering education. The connection with real users and stakeholders is

supported by the research on human and user-centered design (Dym, Agogino, Eris, Fey and Leifer, 2005, Krippendorff, 2006, IDEO, 2011). The reflection integrated into the community engaged learning promotes deeper learning and can develop critical thinking (Eyler, 2000, Giles and Eyler, 1994, Brandsford, Brown and Cocking, 2000). The engagement experience also offers learning related to the core discipline as well as the broader set of skills needed by today's graduates (Bielefeldt, Paterson and Swan, 2010, Pierrakos, et al., 2013, Litchfield, Javernick-Will, and Maul, 2016). Situating the design work within the context of the local or global community is consistent with the literature on increasing diversity (Rosser, 1995, Seymour and Hewitt, 1997, Matusovich, Oakes and Zoltowski, 2013).

Dissemination has involved workshops for interested faculty and administrators along with individual mentoring and coaching from experienced instructors and alums. Workshops allow faculty to explore how the models could be adapted to their own institutions to create a successful and sustainable change. The workshops offer ways for the EPICS leadership to maximize impact by bringing larger groups of faculty together rather than coaching individually. The formats range from one day to one week and have been held at EPICS institutions, hosted by partners including IEEE and in conjunction with engineering education conferences. Experienced faculty from different institutions contribute to the workshops sharing how they adapted the model to their own institutions.

The rich undergraduate experience motivated EPICS alums to pilot the model in a high school (Nation et al. 2005). A national network of EPICS high schools and middle schools emerged from the initial success engaging students in early engineering as they use technology to address needs within their local communities and schools. EPICS High, renamed EPICS K12, has more than 100 schools in 17 U.S. states supported by the EPICS Headquarters or local EPICS institutions.

While each EPICS institution plays a role in the development and dissemination of the model at the undergraduate and pre-university levels, the four institutions identified in the report "The Global State of the Art in Engineering Education" (Graham, 2018) have been selected because of their recognition as global leaders within the report. Each has taken different approaches to the EPICS model to fit into their own institutional contexts and priorities. The intent is to illustrate how leaders in innovation can collaborate, share, and adapt lessons from each other. Highlights of each approach are described below with the emphasis chosen by each institution.

ARIZONA STATE UNIVERSITY (ASU)

Arizona State University (ASU) is one of the largest and most diverse EPICS Programs integrating the model into their undergraduate and K12 outreach missions (https://epics.engineering.asu.edu/). The ASU EPICS program started in 2009 and has since grown to approximately 300 students per

semester. All student teams are multidisciplinary, composed of students from all engineering degree programs and academic years, first-year to seniors. As of Fall 2019, the program has 20 community partners and 40 active multi-semester projects across the four main project themes: sustainability, education, health, and community development. The program offers two EPICS courses: 1) a 100-level introduction to EPICS and the human-centered design process and 2) a 400-level design and build course. Each project team is assigned an industry mentor for weekly technical and team management support. Teams present two design review presentations per semester to a panel of judges from academia, industry, and the community to further advance their project; they also complete a design document detailing the progress of the project. EPICS students at ASU were comprised of 38% female, 18% first generation, 45% non-white, and 35% honors students. Corporate sponsorship, grants, and student fees fund the program to allow students to prototype, test solutions, and deliver the final solution. In summer 2019, ASU piloted its first EPICS study-abroad program in partnership with universities in Vietnam. Other new and future opportunities include introducing an internal funding track for top student projects, a defined avenue to enter the ASU entrepreneurship program, a continuation of research into the benefits of multidisciplinary and diverse teams (Gillespie, et al. 2019), and integration of real-world, service-learning projects into the introductory engineering courses at ASU.

EPICS High, for high school students, was started in the ASU engineering school in 2012. Based on demand the program was extended to middle schools in 2016, creating a pathway from middle school to high school and to ASU. With outside funding support, EPICS K12 provides resources that support teachers, students, and community partners. Teachers receive access to an online curriculum, annual week-long training, and skill sessions designed to enhance technical skills for both teachers and students. Students receive access to on-campus events, engineering undergraduate and industry mentors, a project showcase, and a Pitch Funding competition to support the development and delivery of their projects. Community partners assist student teams in understanding stakeholder needs and work with students throughout the development and delivery of their projects. Industry mentors serve as Pitch Funding reviewers providing technical expertise and industry experience. In 2018–2019 EPICS High worked with:

- 16 high schools in 22 classrooms
- 4 middle schools in 2 clubs and 5 classrooms
- 55 community partners

EPICS High participants were comprised of 41% female, 31% first-generation, and 56% non-white populations. EPICS High received 49 pitches resulting in $22,000 in funding with 31% of funding going to teams from Title 1 schools which are identified by the Department of Education as serving low-income students. Over the past two years, the EPICS High team has developed four interactive

online task assessments to specifically measure learning outcomes related to EPICS High – identifying stakeholder needs, adapting to stakeholder feedback, and understanding of the EPICS design process. The assessment was piloted in the 2019–2020 school year.

ITASCA - EPICS @ ICC

Itasca Community College (ICC) (https://www.itascacc.edu/) is a small (800 First-Year Engineering students), rural, two-year college located in Grand Rapids, in northern Minnesota. It was founded in 1922 and has held accreditation with the North Central Association Higher Learning Commission since the mid-1970s. ICC is a member of the Minnesota State Colleges and Universities system (Minn State) as well as a member of the Northeast Minnesota Higher Education District (NHED). The college is exceptionally known (regionally and nationally) for its associate of science engineering transfer program (Johnson, Ulseth, Savela, Hansen, Kennedy, 2011). Students who complete ICC's engineering program transfer to a variety of ABET-accredited institutions across the Midwest to complete their STEM degrees.

Project-based learning and service-learning style projects have long been a staple of the ICC Engineering program (Johnson, Ulseth, Savela, Hansen, Kennedy, 2011). Historically, these projects have included working with area elementary schools to provide STEM projects and experiences with young students. Other service projects have included building playground equipment for a local homeless shelter, creating an electric device to collect wood samples for the ICC forestry department, and designing of a footbridge to provide better access to a trail system from campus. Since the inclusion of the EPICS curriculum at ICC, projects have evolved to include development of an original computer monitor mounting device through a project with the IT department, creation of demonstration equipment for the local SME chapter, and development of a tracked wheelchair device for a young child with spinal muscular atrophy. The EPICS model has allowed enhancement of the existing ICC service and PBL curriculum.

In 2017, ICC began a service-oriented high school outreach program by partnering with Purdue University and Arizona State University to bring EPICS to northern Minnesota. The EPICS model is utilized for four reasons: (1) build community mindset and real-world engineering skills through service-oriented projects; (2) develop engineering identity in students; (3) enhance relationships with partnering high schools and faculty; (4) provide value-added outcomes for students such as SolidWorks CSWA Certification and fabrication lab equipment for project use. There are 10 active schools with more than 200 students from the region involved in community-based projects.

The ICC regional model of EPICS outreach has a unique focus on the development of long-term relationships with area high schools and helping curate a high-quality engineering experience. As part

of the EPICS experience, ICC faculty work with high school faculty to provide engineering-related professional development opportunities, provide students with an EPICS mini-project experience on campus, visit high school classrooms multiple times per year, and facilitate industry-related experiences. Identified regional industry partners work with faculty and students to provide career exploration opportunities including guest speakers, business tours, industry projects, shadowing or internship/apprenticeship placements, etc. ICC has partnered with the Applied Learning Institute (ALI) to secure funding for EPICS projects as well as SolidWorks software and certification and fab-lab equipment.

Current EPICS outreach project partnerships have produced mapping and signage for a local municipal disc golf course, the design and construction of an outdoor classroom in a school forest, development of a video game console for the local boys and girls club, and an ambitious design and build project for a portable and heated ice fishing house for disabled veterans.

Incorporating EPICS in northern Minnesota high schools has inspired students to pursue engineering education by providing a mechanism to tackle real-life problems and create working solutions. It has the potential to increase pathways into engineering for a broader and more inclusive student body while addressing important issues within the rural communities that are home for the students.

CHARLES STURT UNIVERSITY

Charles Sturt University (CSU) created a new model for Civil Engineering education at the campus in Bathurst, New South Wales, Australia with no traditional courses (https://www.csu.edu.au/engineering/home). CSU welcomed its first class to the program in 2016. Its Project Based Learning strand combined with the "engineer from day one" philosophy of CSU Engineering is certainly compatible with the ethos of the EPICS program. While CSU only has Civil Engineering students, the authentic community partners and the commitment of the program to sustained partnerships aligns with the EPICS core values. Student engineers undertake a series of semester-long projects during the three face-to-face sessions of their time with CSU Engineering, in part to help prepare them for the Cadet Engineer phase of their careers (where they work for real clients, with real jeopardy, and for real money). The EPICS model adds diversity to the portfolio of project-based experiences available to all students. It also provides a framework to engage strategic partners including the local Aboriginal Elders.

The first of these projects is an introduction to Humanitarian Engineering and is a part of the Engineers Without Borders Australia national design challenge (ewbchallenge.org). The EWB challenge works with different community-based partner organizations, and the project undertaken by the student engineers

is to assist in the development work of the partner organization. For example, the 2016 challenge was in partnership with the United Nations High Commissioner for Refugees (UNHCR) field office in Zambia to develop "engineering and technical solutions to assist with this integration and the creation and/or support of sustainable livelihoods, engaging with former refugees in the resettlement area, current refugees in the Mayukwayukwa refugee settlement, and/or the local Zambian host communities."

The second project undertaken by CSU Student Engineers is for a virtual client (a member of the CSU Engineering teaching team acts as project manager and liaison to the client) and allows them to learn to deal with the chaos introduced by changing conditions and clients changing their minds without the jeopardy attached to a real project. These second projects are often built as virtual versions of real projects, and these projects can and do include community service projects. Each year community projects are included in the offerings of projects. The virtual projects can be authentic projects and in the case of community service projects they are often developing the plans or recommendations that would be implemented by the community organizations or by a follow-on team in the third project. One example was the caravan park project for Bathurst Heritage Park, completed in conjunction with the local Wiradyuri Traditional Owners Central West Aboriginal Corporation. This project is an example of one of the ways CSU partners with the local Wiradyuri Elders.

The third project is a project for a real (often nonprofit) client and helps student engineers transition to the real world whilst also helping their client achieve a near-final design for their vision (it must still be signed off by a qualified engineer). The clients for these projects can be community groups, as well as private- and public-sector engineering organizations. Student projects have included new water bubblers for providing safe drinking water to a local high school, the environmental and heritage sensitive redesign of a viewing deck in a nearby national park, and the development of a referee's box for a local go-kart club. Each of these clients brings additional human-centered design challenges to the projects, requiring the student engineers to think beyond design into the implementation and maintenance phases of the product life cycle.

The community-engaged projects are evaluated using the holistic approaches used across the CSU experiences. Students are expected to meet the expectations for the project as well as further the relationship that CSU has with their community partners. Success is measured in the projects' direct impact as well as the relationships between the partners and CSU engineering.

PURDUE UNIVERSITY

The Purdue EPICS program (www.purdue.edu/epics) has been institutionalized as an academic program under the College of Engineering. In the 2019–20 academic year over 1100 students were

enrolled ranging from first-year to seniors and from across engineering and the university from more than 30 majors. All students at Purdue can use the EPICS courses for some type of credit towards graduation, with every engineering major allowing at least technical elective credit and four allowing capstone design credit. Students take EPICS for 1 or 2 credits per semester with the intention that they continue with a project for multiple semesters. First-year students use a two-semester Learning Community structure to substitute EPICS for the traditional first-year engineering course (Oakes, Hsu, and Zoltowski 2015). 8650 students have participated in the Purdue EPICS Program since its inception, delivering over 400 projects to their community partners. In the Fall semester 2020 there were 127 active projects that have or will impact 50,000 people in the local or global community.

The course is divided into 44 divisions that are each run by a student project manager with oversight from a faculty, staff or industry advisor along with a graduate teaching assistant. Each division or team has 8–24 students and typically has 3–4 projects in design simultaneously with their community partner. Funding for projects comes from donations by corporate partners and university engagement funding.

While the weekly activities are managed by the students, the community partnerships are identified and maintained by the program administration. A five-year MOU is signed before a student team begins work and covers liability of delivered projects and intellectual property. Many of the active partners have been with EPICS for more than 10 years, some for over 20. Fielded projects are supported by the teams as they develop new designs. At the beginning of the program, all partners were in the local community so that students could meet with them during their lab time. As the program has grown and video conferencing become more widespread, regional and global partnerships were added, with the current portfolio including partnerships with a Native American College and communities in Puerto Rico and nine countries. The EWB-USA chapter has been integrated into EPICS so that EWB students can earn credit for their design work (Oakes et al., 2015).

EPICS K12 is supported by staff at Purdue and regional hubs including Itasca and ASU. Teacher trainings are conducted over the summer. Curriculum is distributed free of charge through a centralized website. The materials are designed so they can be adapted into existing courses or provide the foundation for a dedicated course. Student participation has consistently been more than 50% female and over 50% participation from populations traditionally under represented in engineering. Over 30,000 students have participated in EPICS K12 projects since the inception of the program.

CONCLUSIONS

Collaborating across institutions has great potential as leaders adapt and integrate innovations from other institutions into their own contexts. Efficiency can be achieved when models are revised

rather than being reinvented and lessons relearned along the way. To achieve a truly broad and significant global impact it is necessary to learn from our respective successes and challenges. The four cases described illustrate how the EPICS model has been integrated and modified by global leaders within engineering education. EPICS was developed at a time when industry was asking for a broadening of the professional skills as well as technical depth. At that time, there were very few examples of engineering community engagement. EPICS has become known as an international model within engineering education, including being recognized by the U.S. National Academy of Engineering with the Bernard M. Gordon Prize for Innovation in Engineering and Technology Education. EPICS has also been recognized as an exemplar within community engagement receiving the top awards from Campus Compact and others. A key contribution of EPICS has been the idea that while we revolutionize engineering education, we can also address needs within our local and global communities.

As EPICS has expanded through a consortium of universities and colleges, each has benefited and learned from others. Early dissemination focused on the U.S. but expanded internationally with global interest. A strategic partner in global expansion has been IEEE and specifically the EPICS in IEEE committee and the IEEE Foundation support for EPICS in IEEE as a signature program (Dandekar, Sinha, and Ampofo-Anti, 2011).

The adaptations of EPICS across institutions have varied as each set of faculty adapt the approach to fit their own institutional context. There are common factors influencing success and most are tied to factors commonly associated with academic change including faculty leadership, administrative backing and broad buy-in from faculty (Oakes, Zoltowski, Drummond, 2014). The focus of this paper is to document how some of the leading global innovators have extended the EPICS model in new ways. The ASU program created a two-step course sequence that has allowed the program to scale within the ASU culture. ASU has also been a leader within the EPICS network of integrating entrepreneurship and EPICS. The EPICS K12 schools in Arizona are supported by ASU and guided by their EPICS approach. Similarly, the EPICS K12 schools in Minnesota are guided by the Itasca approach as they have created a model that scales in rural areas. The new engineering program at CSU has no traditional courses but was influenced by EPICS and other community engagement programs. They adapted EPICS principles into their innovative program to support long-term partnerships with local and regional community partners. Each of the innovators has contributed to further dissemination activities including workshops and faculty mentoring as the network expands. It has proven valuable that each institution has adapted and institutionalized in their own way. In an interview one of the teachers in EPICS K12 in Arizona was surprised that EPICS started at Purdue. To them EPICS and ASU were synonymous. This is a strength of the dissemination process. It has not been taking a model and simply replicating but rather adapting ideas to integrate into individual

curricular structures. As the engineering education community looks to revolutionize our field, we can build on and share lessons learned by each other and adapt them to our own contexts.

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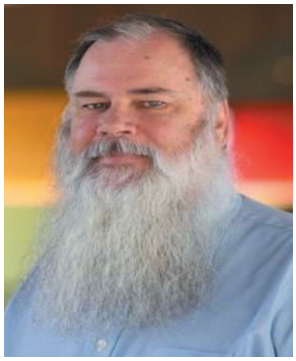
Leah H. Jamieson is the Ransburg Distinguished Professor of Electrical and Computer Engineering at Purdue University, John A. Edwardson Dean Emerita of Engineering, and holds a courtesy appointment in Purdue's School of Engineering Education. She is a past president and CEO of IEEE. Jamieson is co-founder and past director of the EPICS program, for which she was a co-recipient of NAE's Gordon Prize for Innovation in Engineering and Technology Education. She was an inaugural recipient of the NSF's Director's Award for Distinguished Teaching Scholars and has been recognized with the IEEE Education Society's Harriet B. Rigas Outstanding Woman Engineering Educator Award, the IEEE James H. Mulligan, Jr .Education Medal, and the Anita Borg Institute's Women of Vision Award for Social Impact. Jamieson holds an S.B. in mathematics from MIT, Ph.D. in electrical engineering and computer science from Princeton, and honorary doctorates from Drexel and NJIT. She is a member of the National Academy of Engineering and the American Academy of Arts and Sciences and a Fellow of IEEE and ASEE.

Bart M. Johnson is the Provost and Senior Academic Officer of Itasca Community College (ICC). One of the program developers of the ICC Engineering program. He is a co-founder of the Iron Range Engineering program, which was the ABET 2017 Innovation Award winner and identified in recent MIT report on the emerging world engineering education leaders, and a co-founder of the BELL program. His nine years of classroom experience include introduction to engineering, solid modeling, professional and design development, and engineering mechanics courses. Bart is active in engineering education research especially in PBL and professional competency development. Prior to Itasca, he was a design engineer in John Deere's Construction and Forestry Division. Johnson holds a B.S. mechanical engineering from North Dakotas State University, M.S. mechanical engineering from University of Michigan, and Ph.D. in project-based learning from Aalborg University in Denmark.

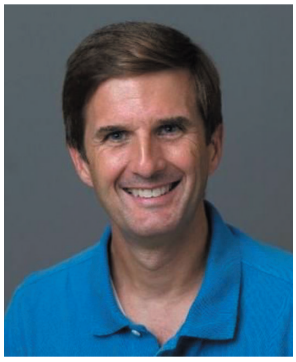
Euan Lindsay brought immense experience and passion for engineering to the establishment of CSU's Bachelor of Technology / Master of Engineering (Civil Systems). Euan's background is in mechatronic engineering, and he completed a PhD in Engineering Education, exploring how students learned while controlling equipment remotely via the internet. During his academic career, Euan has held senior roles as Program Leader and Senior Lecturer / Associate Professor within the Department of Mechanical Engineering at Curtin University, and Dean of

the School of Engineering and Technology at Central Queensland University, before joining CSU as the Foundation Professor of Engineering. He is a Fellow of the Royal Society of New South Wales, a Fellow of Engineers Australia, and a Fellow of the UK Higher Education Academy. Prof Lindsay was the recipient of a 2007 Carrick Award for Australian University Teaching. In 2005 he was named as one of the 30 Most Inspirational Young Engineers in Australia. Euan has also authored or co-authored well over 100 journal articles and conference papers.

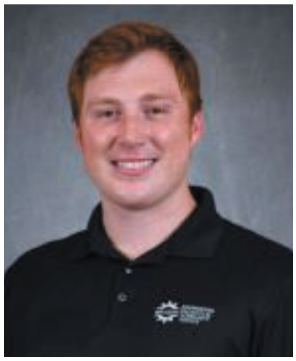
Joshua Loughman is a lecturer in Academic and Student Affairs at the Ira A. Fulton Schools of Engineering at Arizona State University, director of the Engineering Projects in Community Service (EPICS) program and a Senior Sustainability Scientist at the Julie Ann Wrigley Global Institute of Sustainability. He is a 2020 Resilience Fellow at ASU's Knowledge Exchange for Resilience and is an Expert on the Future of Energy for the World Economic Forum's Expert Network. Prior to lecturing at Arizona State University, he spent 10 years in the aerospace and defense industry as a systems engineer. He has a B.S. in aerospace engineering and a Masters in Engineering in systems engineering from Arizona State University.



Jim Morgan P.E., CPEng, Charles Sturt University Jim Morgan is the father of two daughters and the spouse of an engineer. Before joining Charles Sturt University as Professor of Engineering and Inaugural Course Director in 2015, he was on the faculty in civil engineering at Texas A&M for over 30 years. Jim was active in the freshman engineering program at A&M for nearly 20 years; was an active participant in the NSF Foundation Coalition from 1993 to 2003; also received funding for his engineering education research from the Department of Education FIPSE program and from the National Science Foundation CCLI program. He is active in the American Society for Engineering Education, is past chair of the Freshman Programs Division, and has served on the FIE steering committee. In addition to his teaching in engineering, Jim served several years as Co-Director of the Eisenhower Leadership Development Program in the Center for Public Leadership at the George Bush School of Government and Public Service; and also served as director of Aggie STEM with funding from the Texas Education Agency and the Texas Higher Education Coordinating Board.



William C. Oakes is a 150th Anniversary Professor, Director of the EPICS Program, Professor of Engineering Education at Purdue University and a registered professional engineer in the U.S. He is one of the founding faculty members in the School of Engineering Education having had courtesy appointments in Mechanical, Environmental and Ecological Engineering and Curriculum and Instruction in the College of Education. He was the first engineer to receive the U.S. Campus Compact Thomas Ehrlich Faculty Award for Service-Learning. He was a co-recipient of the U.S. National Academy of Engineering's Bernard Gordon Prize for Innovation in Engineering and Technology Education and the recipient of the U.S. National Society of Professional Engineers' Educational Excellence Award. He is a fellow of the American Society for Engineering Education and the National Society of Professional Engineers.



Jared Schoepf is the Director of Operations for Engineering Projects in Community Service (EPICS) at Arizona State University. Jared received his PhD in Chemical Engineering at ASU, developing a tiered approach to rapidly detect nanomaterials in the environment and consumer products. Jared has been a lecturer of EPICS since 2017, mentoring over 200 teams. Currently he teaches introduction to engineering, EPICS, and core chemical engineering classes. He has a passion for teaching and mentoring students, aiming to help each student achieve their goals.

Crystal Smith co-coordinates and instructs in the Itasca Community College engineering program in Grand Rapids, MN. She has developed and led many multi-disciplinary engineering design projects through the ICC engineering model since she began teaching in 2011. She successfully led the development and implementation of the Engineering Design Sequence and coordinates the curriculum for 150+ students. In 2015, she partnered on an international research project on developing high-quality teams, work which had a great impact on the development of the Design Sequence. Her areas of interest include PBL engineering design, student professional development, women in engineering, and community service. Prior to teaching at ICC, Crystal worked on a variety of design and construction management projects as a civil engineer for the City of Iowa City.