

Partnerships Within Community-Engaged Design*

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Situating design experiences within the context of addressing human, community or environmental needs has many benefits to enhance the student experience. It provides meaning to the design work that can increase motivation and student interest. The broader context of making a positive impact on people and the environment aligns with research on diversity in engineering. These contexts also provide platforms for students to explore broader issues within our societies that include societal, cultural and policy dimensions from a personal and professional perspective. Partnerships are central to community engaged learning and take many forms. Community partners are critical as they provide the context and real stakeholders that interact with the students. They are the recipients and stewards of the results of the designs. They can be an actual community, leaders from government, non-profits, or non-governmental organizations (NGO's), schools or other organizations that work with people or the environment. The EPICS Program at Purdue University has engaged undergraduates with local and global community partners for 28 years and this paper describes how partnerships are established and nurtured within the program as it has scaled to more than 50 partnerships and 1300 students per year. 40% of the partners have worked with the program for more than 10 years and 84% for more than their original commitment of five years. Lessons learned are shared from the perspective of the program leaders as well as voices from the partners themselves.

Keywords: community engagement; partnerships; reciprocity; service-learning

1. Introduction

Design is a principal practice of engineering and a fundamental part of engineering education [1]. Design educators seek to provide design experiences that will prepare graduates for the types of design work they will encounter in practice. Industry-inspired projects are often used in design classes to provide real design challenges that may be like what they will encounter in practice. Another source of real design challenges is within the local or even global community. Community needs offer a plethora of compelling projects that challenge students in many ways beyond traditional design education, exposing them to the circumstances of the need and its broader and often complex implications. Community-engaged design requires students to interact with the community partners who will be the real users and to learn about the context in which the needs exist and the people who are affected. When the experiences are designed so that the community receives the results of the design, the experience offers students the opportunity to make a tangible impact in their communities. The pedagogy of community-engaged learning or service-learning has gained more acceptance within engineering education over the last two decades as evidenced by the creation of a dedicated Community Engagement Division within the American Society for Engineering Education's Community Engagement Division [2]. It offers opportunities to

introduce design experiences that by their nature integrate human, cultural, environmental and community issues into the design contexts.

Situating designs within a community-based context has been shown to have many benefits and align with research on diversity, especially regarding gender [3, 4], and is supported by the observation that many EWB-USA chapters are nearly gender balanced [5]. The impact of engaged learning has been documented across many disciplines [6–9] and helps achieve a broad array of core knowledge and skills that are critical for engineers [10–12]. Experiences in the first year of engineering have been found to increase retention and motivation to continue in engineering [13–15].

Community engagement also has the potential to address significant issues within engineering education, broadening student perspectives and engagement. Erin Cech investigated students' public welfare concerns and found that they declined significantly over the course of their engineering education [16]. Community engaged learning programs can reverse this trend while providing the multitude of benefits for students as discussed previously. Community engaged learning balances student learning with community impact and value to the benefit of both.

Within engineering, community-engaged learning is often found within design experiences. Lima et al. defined five core characteristics of community-engaged learning within engineering [17].

1. Engagement opportunities that meet the needs of an underserved segment of society and/or contribute to efforts for the common good of the local, regional, or global community.
2. Academic connection between the engagement and the subject material of a course.
3. Reciprocal partnerships where the community members, students, faculty, and other partners each contribute to the experiences and benefit from the collaboration.
4. Mutual learning among all stakeholders, built on a foundation of respect.
5. Reflection, a vital component, where participants are intentionally guided through activities to reflect upon the work being performed, the processes by which the work is accomplished, the implications of the experience on the community and themselves, and how to operationalize learning from these new understandings in the future.

This paper focuses on the ideas of reciprocal partnerships within community-engaged design experiences using the context of a large community-engaged design program that is celebrating 28 years of engaged partnerships. The partnering process and examples are provided and discussed.

2. Models for Engineering Engagement

There are many models that have been proposed for

community-engaged learning [18–20]. However, most of the models are based on placement-based experiences where the students spend time within the community and that time is their engagement. In engineering, the engagement and value being provided to the partners is often a design with a specific deliverable. That deliverable can be a physical project, software or a design or plan that can be implemented by the partner. One model that was created for project-based engagement is shown in Fig. 1 [21]. The deliverable is placed in the center not to show importance but in recognition that within a design experience it is often the focus. In community engaged learning, the engagement includes the design itself as well as the process by which the design is developed. Partners are involved in both and contribute time and resources to each. The resources that are committed are represented by the arrows moving away from each stakeholder. The value received by each is represented by the arrows moving into the respective stakeholder boxes. The figure includes sample stakeholders, but many can be added and evaluated through this lens. The model has been used by groups including the EWB team working in Guatemala [22].

The relationship and manner that stakeholders and partners interact have been characterized by Thompson and Jesiek [23] after examining three community engaged design programs. They found” . . . that some partnerships create distinct

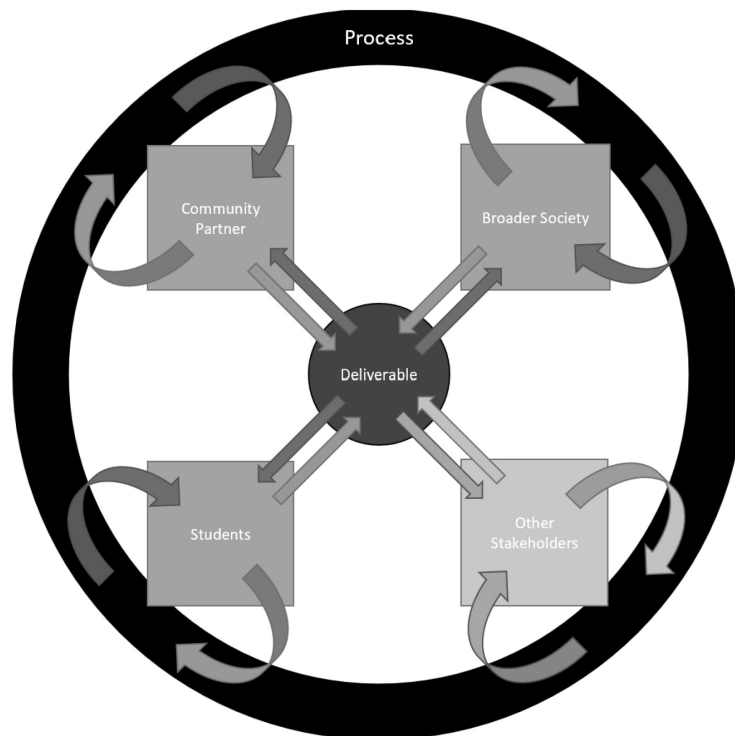


Fig. 1. Project-Based Community Engagement Model [21].

boundaries between partnering organizations (*Transactional*), some partnerships involve intentionally working together (*Cooperative*), and others involve deeper and more fluid partnerships that are grounded in common values (*Communal*).” The level and manner of interaction is dependent upon several issues that include the time and resources of the community partners, the time and structure of the design learning experience, and the investment by the faculty and students. As design programs seek partnerships within communities, there may be different levels of engagement with different partners and in different seasons of the partnerships. When designing programs at scale, there are many constraints on the structure of the experiences that also influence the level of engagement [24]. Respectful and reciprocal partnerships are built on communication and trust and can make decisions on the levels of engagement collaboratively. This paper explores the EPICS Program, a large design program that has been working with community partners for 28 years and has been fully institutionalized within a large, research university as a case study.

3. Program Overview

The EPICS (Engineering Projects in Community Service) Program was founded in 1995 by faculty in Electrical and Computer Engineering at Purdue University with the dual missions of preparing students for professional practice and providing access for local community organizations to the expertise of the university [25]. In the subsequent years, partnerships have expanded to include national and international partners and projects. In EPICS, teams of undergraduates partner with local or global not-for-profit community organizations to define, design, build, test, deploy, and

support engineering-centered projects that significantly improve the organization’s ability to serve the community. The approach leverages faculty, university staff and local professionals to create a highly mentored, long-term, team-based, multidisciplinary design experience for undergraduates. The program currently distributes students representing more than fifty majors into 44 divisions with 54 community partners [25–27]. Students include first-year students to seniors, with each taking the course for different types of credit within their respective degree program. Each section has a theme of a common community partner or technology, having an average of 15 students with 2–4 project teams within each section. The large section size helps insure some returning students each semester for continuity of projects across terms. Community partners are engaged with a minimum commitment of five years and many partnerships continue for much longer. In the spring of 2019, 42% of the participants were female, while 43% of the participants were non-Caucasian. First-year students participate through the EPICS Learning Community, which has averaged 43% female over the last seven years [28]. EPICS leads a university consortium that has engaged more than 50 other institutions globally in developing similar course structures as well as a K12 Program that brings EPICS projects in more than 100 middle and high schools in 17 states within the U.S.

With the diverse participation from majors across campus, the program has found it helpful to have a common design framework that is shown in Fig. 2. It allows students to learn and manage their designs through a common framework and to reflect on their progress through the human-centered design process where stakeholders are at the heart of the approach to community-engaged

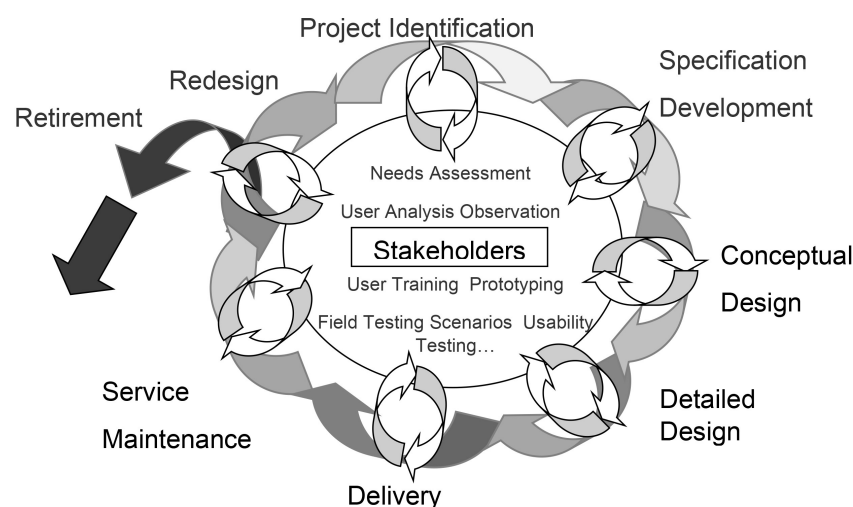


Fig. 2. EPICS Design Process Model [25].

design. Stakeholders include all of those who are impacted by the project, including the direct users, the community partner organization, secondary users (such as teachers, therapists, and people who maintain the project), parents and family members, as well as the broader communities that each of these stakeholders represent. The process begins with understanding the needs of the stakeholders and involves them throughout the iterative design process. EPICS projects often span multiple semesters, and the model offers a mechanism to help students transition between semesters as they manage their project development within the context of their partnerships [27].

The EPICS model was designed to support long-term projects with students participating over multiple semesters. The program structure is also designed to support long-term partnerships with staff as it has become institutionalized. A dedicated team of five full time staff manages the university program with additional staff to manage partnerships with other universities as well as middle and high schools. A faculty director is appointed by the dean of engineering. The size of the staff allows for institutional knowledge to be shared and maintained. Over the years since the inception of the program, all of the founding leaders have retired or left the program and that knowledge has been passed along to the next wave of leaders that includes one former student who returned to campus to help lead the program. The investment of the university, commitment of the partners as well as the energy and dedication of the students provides ingredients for long term success and impact of the program into the future.

The core value of EPICS is around partnerships. The program has been structured and developed around how to engage partners and provide value to the partners. One significant innovation is the

curricular structure to support multi-semester development of designs and engagement with the community partners. The curricular structure includes models for student leadership, transitions between semesters and an assessment process that enables these experiences [29]. Students participate over multiple semesters as illustrated in Fig. 3. With students joining and leaving the teams, overlaps help pass along knowledge of the projects and the partnerships. The result is that the unit of engagement with the partners is not the projects but the partnerships. Projects evolve from partnerships. Because the teams are continuing, fielded projects can be supported within the partnerships.

The concept of long-term partnerships with repeated projects differs significantly from most of the literature and other engagement models within the universities. Marybeth Lima details a model for engagement that has been widely recognized around playground design [30]. In this model a single school or community organization is engaged for 4–5 years on a single project that results in a playground that is designed and installed. One of the largest engineering engagement organizations is Engineers Without Borders (EWB-USA) and Lee, Buchanan and Berg discussed issues of privilege within the programs as they noted the dominant pattern of five-year partnerships with communities that typically focused on one or two large projects [31]. The approach of EPICS has been to engage partners and continue to find ways to meet mutual needs, adding value to the organization and helping to broaden the education of undergraduates.

3.1 Community Partnerships

In the context of the EPICS program, there are five general phases: Identifying a potential partner, evaluating suitability of partnership for all entities, setting expectations, formalizing partnership, and

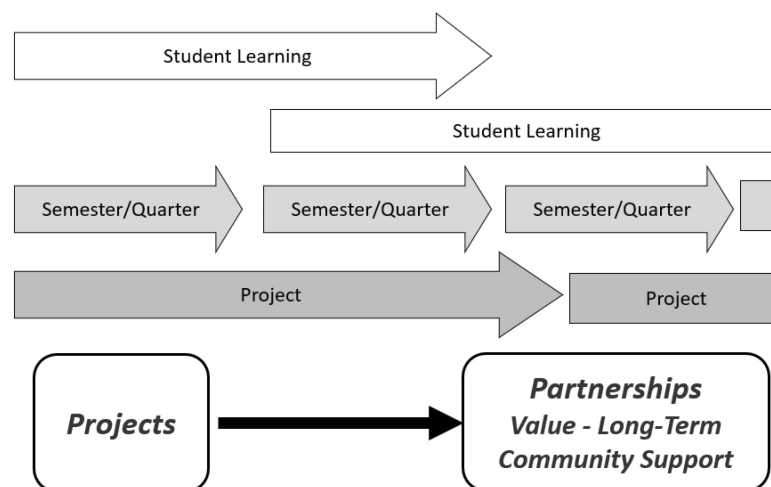


Fig. 3. Long-term Partnership Model.

maintaining partnership. Relationship building is a major component of every phase. Partners are selected based on a set of criteria.

1. The first criteria are the project partner commitment and capacity to work with students. There has to be a person or people who will commit to interacting with students on a regular basis so they can learn how to work with a partner or client in the design. The partners are part of the teaching team and have to be committed to that part of the process.
2. The level of technology has to be challenging enough for students to earn college credit and have the capacity to be classified as a design experience along with being simple enough to be within the capabilities of undergraduates.
3. A potential partnership is considered if there is a match with student and advisor (faculty) populations with respect to their capabilities, expertise and interest on campus.
4. The expected duration of potential projects is also considered and ideally there is a potential mix of short and long-term projects ideas.
5. The significance of the work is considered in the context of benefit to and needs within the community. A lesson that has been learned over time is to not jump to the most significant immediately unless it meets the other criteria.
6. The portfolio of projects based on location of projects and disciplinary involvement is assessed periodically to insure it contains an appropriate mix of projects and partners. The locations are intentionally managed to insure a mix of local, regional and global projects. The mix of disciplines is managed based on demand and interest. Finally, the areas of need are also assessed to ensure that the portfolio reflects the needs of the communities.

Identifying potential partners happens in a number of different ways. In the early years of the program, there was more of an emphasis on seeking out partnerships through umbrella organizations such as the United Way to help identify partners [32]. To start the program, the founders, Leah Jamieson and Ed Coyle, reached out to potential partner organizations and pitched partnerships as a means of helping local organizations implement new technology in their organizations while giving students an opportunity to gain hands-on experience. As the program has grown and become known, more community organizations initiate the first contact with the EPICS program. A partnership request form was developed and posted on the EPICS website to facilitate requests, but many continue to come through direct email or word-of-mouth. There are still occasions when a gap forms

in the overall portfolio of projects, such as strong student interest in an area or an existing partnership coming to retirement, which leads the program to seek new partners in a particular area. For example, for many years EPICS featured projects in environmental sustainability, but the demand for those teams was exceeding space in those course divisions, and so the program solicited partnerships from local parks and recreation departments, forming a fruitful partnership with NICHES, a local land trust.

Another common source of new partnerships is through faculty interest. This can either stem from faculty already working with a community organization through personal or professional interest or when they are seeking an outlet for a broader impact activity for a research grant. In either case, EPICS offers an existing course structure and administrative support that the faculty members can leverage to provide credit to students and ensure sustainability of the partnership. An example of this is the Global Air Quality Trekkers team which partners with AMPATH in Nandi County, Kenya to innovate air quality solutions to reduce Chronic Obstructive Pulmonary Disease (COPD) resulting from inadequate ventilation. This partnership was initiated by a faculty member with a research interest in air quality and has continued to advance the goals of both the partner and the faculty member's research. The program has been integrated into several research grants as part of the broader impacts of the research that has brought new partnerships, faculty, and resources into the program.

One more recent development in partnership formation has come through the integration of student organizations that are partnering with their own community organizations. Integrating these projects into EPICS has allowed the students who were investing significant time into their project work in an extracurricular setting to move them into the curricular setting, allowing them to get course credit toward graduation. The student teams can continue working toward the projects that match their personal interest, while leveraging the established EPICS curriculum, assessment, resources, and administration. Examples of this model include the local chapter of Engineers without Borders (EWB-USA) that has a unique model where students join the EWB-USA club for a semester before formerly joining the EPICS team with the recommendation of the club leadership [33]. Two partnerships are managed within the team with an African partner and an indigenous partner in Louisiana. Another student organization is the American Society of Mechanical Engineers (ASME) that is partnering with the Marion County Indiana Farm

Bureau, allowing the students to work on projects for credit including a new hydroponic system. In both cases the EPICS administration partners with the student organization's leadership as well as the community partner to offer the experiences to the students and community.

After the project partner is identified, the EPICS administration meets with the partner to determine if the partnership is a good fit for all parties. Attention is paid to ensuring that partnerships are reciprocal, benefiting all parties. EPICS seeks long term partnerships, lasting at minimum five years, with partners that are likely to have multiple projects over a significant period. The projects must have design components to meet the academic outcomes of the EPICS course and not be strictly service projects. The projects should be at an appropriate technology level for undergraduates. This is not trivial for many partners, as they do not always understand initially that undergraduates are novice designers and not experienced professionals. The EPICS administration also looks to make sure that appropriate students and mentors are available to advance the types of projects requested by the partner, as engaging a partner without a high probability of a successful delivery makes the partnership a drain on the partner's resources instead of a benefit. Similarly, project scope and requirements are outlined and both partners must agree that the goals align with capabilities. Students typically take EPICS for one or two credits, limiting the pace of projects, so for example a large project that would require intense effort for a short period is a poor fit. Another important area to set expectations is in communications between the team and partners. Project partners are expected to meet with the student group on average three times per semester, whether in-person or virtually, and to respond to email or phone calls every week or two.

Once the general parameters of partnership are agreed upon, the partnership is formalized through a Memorandum of Understanding (MOU). The standard MOU outlines the partnership's values for both parties, such as professional development opportunity, cultivation of critical thinking, and inclusiveness. The initial MOU covers five years,

renewable. The MOU indicates that EPICS will provide funding for the design, development, and deployment of the projects at no cost to the partner, barring the excess beyond the program's fiscal constraints. Both partners commit to routine collaboration and communication and set understanding of each parties' roles and responsibilities. It covers intellectual property and shared liability where the partners assume responsibility for insurance with limited liability of the program, except in the case of negligence or other fault of EPICS.

While the formal partnership agreement is with the overall EPICS Program and the partner, the primary responsibility for maintaining the partnership and operationalizing the design relationship is with the student leaders on the EPICS team with their advisor (EPICS term for instructors who can be faculty, staff, or local volunteer professionals) as shown in Fig. 4. The students work with the partner on the initial concepts identified during the partnership development and build on those ideas to identify needs and develop solutions to those needs. The EPICS administration maintains regular contact each semester or year with the partner and conducts partner satisfaction surveys annually and at each project delivery to ensure the partnership is healthy and proceeding successfully, and interceding if either the team or partner are dissatisfied with the relationship. The administration also maintains a gate on project delivery, ensuring that every project delivered is assessed by the staff for quality and completeness. Challenges sometimes arise when students or faculty do not follow the program protocols. The program staff communicates with the partners on a periodic basis, typically once a semester or annually. When issues arise between these times it can create challenges. The partners respect and understand the commitment of the program and the partnerships and when issues arise usually will reach out to the program.

The portfolio of partnerships and projects is managed and evaluated by the EPICS leadership team on a continual basis. The leaders of EPICS do not believe that there is an optimal set of partners. It is recognized that there is always more that could be done than is in our capacity to meet needs and we

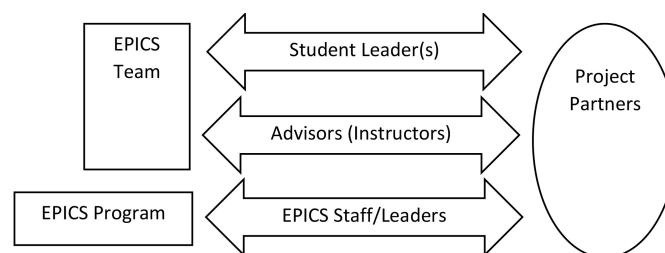


Fig. 4. Relationship responsibilities for Partners.

seek to make an impact on those who are engaged with the program. Existing partnerships are evaluated for mutual benefit in regards to student learning and the impact on the partners as well as the program's capacity to meet needs. When there is an imbalance or challenges in any of the components, the partnership is evaluated for correction or in some cases termination of the partnership. This evaluation and discussion are done with the partners and typically when a partnership needs to be ended it is by mutual agreement.

3.2 *Sample Partnerships*

Three example partnerships are provided as illustrations of the partnership arcs taken by long-term engagement with different types of partnerships.

The first example is HPN (Homelessness Prevention Network), which was one of the original partnerships that started EPICS. The HPN was with a group of human service agencies that worked with homeless people and those at risk of being homeless. When the team started in 1995, there were no commercially available products to help agencies coordinate services between agencies. Privacy was a critical issue, and the commercial products were not readily available that provided needed privacy constraints and the ability to easily share data. A team began working with the agencies under the director of Professor Ed Coyle, one of the EPICS founders. It collaboratively developed a distributed secure database system that six agencies used to track and document their clients. The software was customized so the agencies could choose what data to share with the other agencies. The software was developed in close collaboration with the agencies. Because the agencies used the software for their daily operation, support of the deployed system was a significant part of the team's work as well as rolling out new versions. Students created a support plan during winter and spring breaks. Over the summer, the program paid one of the students to be on call for the agencies to support the systems. The result was that the local community was among about two dozen communities nationally that had the ability to track clients across agencies. The U.S. Department of Housing and Urban Development saw the benefits and created regional databases that were supported by corporations. The HPN team was celebrated and retired in 2004. Some of the agencies that worked with HPN have been part of other teams and continued to collaborate with the EPICS Program.

The second example is the HFH (Habitat for Humanity) partnership which began in 1996 with the local affiliate of Habitat for Humanity. The start of the partnership had mixed results and it took the team and the partner a couple of years to identify

how their design work can effectively add value to the mission of Habitat. The early projects did not align with the needs of Habitat and included technology that was too cutting edge and not readily available to homeowners. While the prototypes worked well, questions about maintenance and replacements prevented implementation. After honest conversations with the partner that explored options that included terminating the team, the team and partners identified a new need and the team shifted to digitizing the home plans. In addition to the digital models, estimated costs of maintenance and utilities were created using engineering modeling that were added to the models allowing the new homeowners to take the costs into account with their design options. The analyses were also used to change the Habitat policies when a study of window air conditioners and central air showed significant savings for central air systems. The definition of affordable housing was changed to include central air conditioning. The relationship with the local affiliate changed so much that they recommended that the team explore projects with the national organization and a few projects were done at the national level. The team continued to work with the local affiliate and a grant was co-written to fund a model sustainable home and the team and the affiliate co-developed a statewide conference for all affiliates on sustainable building practices. In 2023, the team and partnership are still in operation and currently focused on improving the construction process. The main contacts with the partner have changed over the years rotating between the Executive Director and other staff or volunteers as the partnership moved between the phases of transactional, communal, and transformational based on the needs of the partners and opportunities for the team.

The third example is an international partnership. The original community partnerships were all local so that students could visit their partners during their two-hour lab time. One of the earlier global partnerships was the GAPS (Global Active Problem Solving) team as started in 2010. It leveraged a larger partnership with the College of Engineering and the government of Colombia. The GAPS team began as a collaborative partnership with a Colombian university and Purdue University working with a local school in Medellin, Colombia. The school was in an outer region of the city that was remote and underserved. The teams worked on the design for a solar power system to supplement the main power supply that was subjected to periodic outages that impacted the operation of the school. The close partnership involved a study abroad program where Purdue students visited the school in Colombia along with the Colom-

bian students. A second partnership was added to the team when a faculty member from Anthropology approached the EPICS Program about assistance with providing power to an indigenous community in the Amazon within Brazil. The expertise of the GAPS faculty and students aligned with that need and the tribal partner was added to the team. The synergies with the projects added dimensions to the existing relationship in Colombia by bringing expertise from Anthropology and international engagement. This new partnership included a summer study abroad course through Anthropology. The Colombian partnership shifted to a new university partner after a change in faculty and administration at the original partner university and is still under Purdue University's Colombian partnership. During COVID, there was no travel to the countries and all the work was done remotely. Both partnerships have continued through the pandemic and visits have restarted.

4. Results and Lessons Learned in Partnerships

Through the course of three decades and well over a hundred partnerships, the EPICS program has learned many lessons on what factors may result in a successful partnership. One lesson has been that partners who are committed to being part of the educational process tend to be more engaged than those who are solely interested in the product deliverable. A partner who has a general interest in students, or in some instances even has education as part of their organizational mission, tends to be more willing to regularly meet with students and share their time than those who do not. While this characteristic is an advantage, it is not a requirement for success and many partnerships without this aspect are still successful.

Another significant factor that seems to contribute to a successful partnership is a balanced portfolio of projects that includes both short and long-term projects. When all projects with a partner are highly complex, long-term projects, the partner is required to wait a long time to see the fruit of their investment in the partnership. By ensuring that the team has short term (1–2 semester) as well as long term (3+ semester) projects, the partner will receive deliverables at a regular interval, helping them to feel the time invested is worth the results. Having regular project deliveries also serves a continuous improvement function, as the students receive feedback on their work and learn more about their partner's preferences, and therefore can improve future deliveries.

The most critical component of a good partnership is routine and forthright communication.

Every phase of design requires the student team and community organization to communicate, from establishing the project scope to agreeing on requirements to approving design decisions. Without frequent communication, the student team is likely to make inaccurate assumptions, fail to understand the community needs, or create poor deliverables. Communication is also key to keeping students motivated, as they work much harder on projects when the impact of that project is apparent. In addition to frequency, communication must be honest and based on mutual respect and trust. When students are not up front about their capacity or abilities, they partner is likely to come away with inaccurate expectations, and similarly when partners are overly polite and do not provide honest feedback, the students are likely to continue down erroneous design paths and create unusable deliverables.

The partner engagement mode, using the Thompson and Jesiek framework [23], can vary from partnership to partnership, depending on the needs and interests of the partner, and can also vary over time within a given partnership. Some partners do not have the time or resources to devote to Communal or even Cooperative relationships and may desire a Transactional mode of partnership for a season or even for the long term. This gives them the ability to leverage the university resources and student work, while not over-burdening their staff or volunteers time or distracting them from their core mission. An example of this might be the partnership with the National Kidney Foundation (NKF). The NKF has partnered with an EPICS team in the development of an app to track dietary metrics for individuals with kidney disease. The NKF provided design inputs and feedback on the progress, but was not directly involved with the development of the app. In this instance, a Transactional relationship is appropriate and productive. Other partners seek a different level of engagement with their team and are willing to invest more resources into the partnership and can become Cooperative or occasionally Communal. An example of this is the partnership with the NICHES Land Trust. NICHES has partnered with an EPICS team to build trail bridges, educational pieces, and conservation technology, including an automated compost tumbler. In this case, the staff of the land trust work closely with the students on a weekly basis to co-design and co-build the products, with partner staff and students working side by side on every step of design.

Data from our partners' satisfaction surveys have been very positive. In the early days of the program, satisfaction rates were very high [24] and they continue to show high satisfaction with 100% of

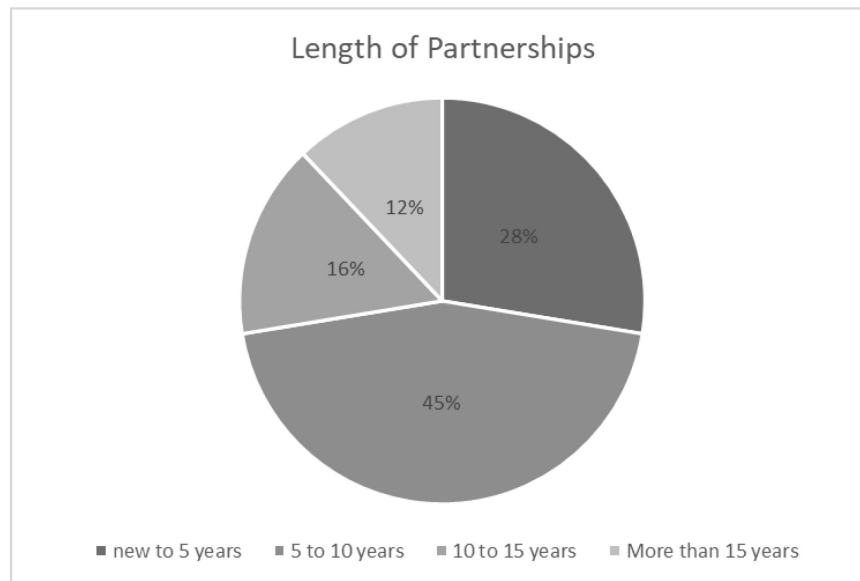


Fig. 5. Length of Community Partnerships, n = 58.

partners responding to the program's survey indicated that they were satisfied with the partnership. Another indication of their satisfaction is the longevity of the partners. As noted in the example partnerships, some have a finite life based on their technological needs, changes of mission or changes in personnel. Fig. 5 shows the length of the current 58 project partners. Only 28% of the partners are still within the first agreement period of 5 years. 72% saw enough value to create a new agreement and 28% have been with the program for more than 10 years. The longevity and commitment of the partners was seen during COVID when physical visits to sites was very limited. Recognizing that the partners were also under stress, we offered for them to take a pause with the program and reengage after the pandemic. None of the partners took this option and all agreed to stay engaged but with limitations of contacts and communication.

5. Partners' Insights into the EPICS Partnership

As part of the partnership evaluations, partners are asked why they choose to partner with EPICS and about the value that their partnership with EPICS brings to their organization. For this study, two long-time partners who had either retired or moved away from the area were included in the sample along with three active partners for a total of five. The authors reviewed the comments and identified similarities and representative comments that are included in this section. When asked why they partner with EPICS, some of the longer relationships talked about how the goals of the program

aligned with their organization and added value. The former executive director of the Imagination Station, a hands-on science museum, with more than a decade of involvement with several EPICS teams talked about these aspects.

"Most importantly, for the organization and me, EPICS's mission, 'To inspire and prepare students for the future while improving their communities,' aligns perfectly with Imagination Station's mission and values as a community STEM education outreach organization . . . Partnership with EPICS has added significant value to Imagination Station, allowing Imagination Station to advance our mission to bring quality informal STEM education to the greater Lafayette area through new exhibits, but also new partnerships with Purdue students, faculty, and even shared community partners." [ISD]

Similarly, the retired Executive Director for a non-profit partner who worked with EPICS for over 20 years reflected that:

"Managing a not for profit as 'problem challenged' as the day-to-day operations of Habitat for Humanity—I saw EPICS as a resource that had the desire, time, and ability to deep dive into some of those problem issues—especially in the area of construction. Typically, most volunteers only want to do manual volunteer labor opportunities. With EPICS they want to be involved in the problem-solving side of the organization—which is a rare commodity as it relates to volunteering." [HFHD]

Partnerships have seasons that can vary in the engagement with partners. One partnership between the Imagination Station, a local hands-on science museum, and EPICS began in 1997 and intensified under the direction of a full-time executive director. After losing some major funding

sources, the museum had to reduce staff and move to a parent-led structure that created communications issues and challenges. When the leadership was re-structured and a new parent took the role of volunteer executive director, the relationship increased, and he reflected on this time.

“I wanted Imagination Station to partner with EPICS for a few reasons. First, I knew that EPICS and Imagination Station had a long history that had fallen on awkward times, and I wanted to reestablish that partnership. Second, Imagination Station was in no position to pass on an opportunity to partner with Purdue.” [ISD]

The value that the program brings to the partners has been reflected in different comments on the projects and capabilities added to the organizations. In some cases, it was specific projects that emerged from the partnerships such as

“The EPICS teams have helped create new tools for our clients that we serve in order to promote learning, sharing, and meaningful interactions with others. We are so thankful to be a part of such an amazing program.” [HFHD]

A large children’s museum’s director also talked about specific projects:

“They have delivered multiple projects that we have used in the museum’s STEM Lab, including a bioreactor for microorganism culturing, models of the knee-jerk reflex, and miniature windmill generators.” [ICM]

A similar quote was given by another partner that works with children with disabilities in the local schools:

“The mount and toy teams have both made excellent products and great progress towards awesome solutions. Their solutions have been able to save a lot of money instead of purchasing commercial solutions.” [WCCC]

In some cases, the impact is beyond the projects that were delivered and the impact has been felt at the organization level as well. The Director of Habitat for Humanity cited some areas of impact:

“EPICS significantly impacted many program decisions. For example, HFH Lafayette made a major change in insulating practices due to EPICS research and study. Examples such as this are numerous in their ability to influence change in how we build and design our homes. Another major area in which EPICS has helped HFH Lafayette is in the organization of tools and materials. We have become a better organization because of EPICS.” [HDHD]

One partner who has become part of the teaching team is a faculty colleague from Anthropology brought a project into the GAPS team as described earlier that integrated her own work with an indigenous community in the Amazon with EPICS. She talks about the benefits of the partner-

ship with EPICS from the perspective from a discipline outside of engineering:

“EPICS provides a sustainable and reliable program to work with highly motivated Purdue students to engage in community-based work with project partners. In my case, it has provided a curricular ecosystem and infrastructure to support an ongoing research and engagement project with an Indigenous Filmmaking Collective in the Brazilian Amazon. The EPICS work within this project specifically focuses on the media center design, software recommendations, and solar power system recommendations. The EPICS program makes it easy (and enjoyable) for faculty to be an advisor to projects and focus on the design process and student professional development. It also has facilitated different cross-university and multidisciplinary conversations, ties, and co-advising experiences. I have benefited from co-advising with faculty who have been in EPICS for a while or have leadership positions in EPICS and have appreciated the collegial relationship and ways they listen to feedback about the program and about the team. I also appreciate that the team meets on the same day/time each semester, which makes it easy for my other course planning.” [AFC]

She describes the partnership model with several benefits:

“I value that EPICS helps to facilitate and sustain an ongoing collaborative community partnership. Collaborative community partnerships are grounded in long-term ties and trust as well as evidence-based outputs that provide value to the community and provide an actionable example of a bidirectional and horizontal collaborative relationship.” [AFC]

The overwhelming data from partners has been positive and they also identified challenges and issues with the partnerships. The major theme in this category centered around working with students. At the start of the partnerships, there is an explicit discussion that the partnership is one that includes student learning. The partners recognize that they are part of the teaching team and the learning process. The balance of adding value to the partnerships while students are learning does create tension, as noted:

“One tension that I have noticed is that in efforts to support students to develop leadership skills and heightened responsibility for their decisions and design process, they can become too eager to move ahead with a project. I have seen this especially in reaching out to possible vendors or other external stakeholders, without consulting project advisors.” [AFC]

Other comments related to student learning centered around the transition between semesters and the students’ ability to create the appropriate documentation to support the transition:

“Fundamental components to any engineering project are communication and documentation. EPICS often relies on young future engineers whose excitement to use their skills sometimes outpaces their understanding of the importance of communicating with the community partner, and, crucially, reading previous project

documentation and/or properly documenting their efforts for future students working on the project.” [ISD]

Another partner voiced a very similar concern:

“One thing I have regularly reminded teams over the past 5 or 6 years is to leave excellent documentation for the folks taking over the project. A lack of documentation can cause new teams to go back to the drawing board because they do not understand how the project got to where it is.” [LTA]

Issues of scheduling with students was also noted by some partners:

“Sometimes it is difficult to plan things around busy student schedules. Longer projects (that engage multiple groups over a period of time) sometimes have knowledge lost between groups. Neither issue was major.” [UCP]

A final category that emerged with challenges is the drawn-out timeline for project completion. This can impact the partners as noted by one partner:

“The only issue that was sometimes a hindrance to Habitat was the timeliness of deliverables. But due to the nature of working with students over the course of a semester or two, I am not sure an improvement of that concern can be improved.” [HFHD]

A major innovation of the program is the long-term nature of the projects and partnerships. Students take the course for only one or two credits per semester that encourages them to be enrolled in multiple semesters. One of the top issues that arises is that the projects can extend longer than desired and delay completion. It is a challenge that with new students who come onto the team have new ideas and that when large percentages of students turn over between semesters, momentum can be lost. Programmatic support for the transition of projects is in place and new approaches are being developed to mitigate these challenges to better serve the partners.

6. Conclusions

Over the course of its nearly three decades facilitating community-engaged design work between university students and community organizations, the EPICS program has evolved and grown significantly in size and geographic coverage of its partnerships. It has retained the dual areas of focus of student learning and community partnerships. The unit of engagement is the partnership with projects emerging from the partnerships over the lifespan of the partnerships. While individual projects or pri-

mary contact people may change over time, the commitment between organizations can be sustained and leveraged over a period to make a significant impact on both students and the community. The relationship formation process was described, as well as the maturation process through which partnerships move from infancy to becoming long-term commitments. These relationships are often dynamic, changing with the needs of the partner, the broader landscape of technology, and societal changes. These changes are often mundane, such as a key stakeholder moving out of the community, or can be paradigm shifting, such as the COVID-19 pandemic or massive shifts in digital technology over the past decades.

The model of long-term partnerships has proven to sustain engagement over multiple years. With a five-year initial agreement, many partnerships last much longer. Partners have expressed that their desire to partner initially and maintain the partnerships is the access to the capabilities of the program’s students, faculty and advisors, the commitment of the program to engage long-term and their desire to help influence the future leaders of our communities. The engagement model allows all stakeholders to contribute to and benefit from the products of the design as well as the development and partnership process. Creating reciprocal partnerships has been key to maintaining engagement over extended periods of time and has been successful with 84% of current partnerships being in excess of five years old, and 40% being greater than ten years old. When long-term community partners were queried on their experiences, themes emerged that included valuing the access to technology-savvy students and problem solvers, as well as an exploration of some of the challenges faced when working with students, including personnel turnover and poor documentation practices.

The value provided by the partnerships include student learning and the results of the projects that the students developed. The impact on the partnerships includes the results of the designs with the community partners. In some cases, the impact has been felt at the organization level with project partners. The tension of balancing student learning and adding value to the partnerships is very visible and an aspect of the partnerships that is managed over many years. The engagement model has been shown to scale in terms of numbers of students, community partners and longevity of partnerships at the local and global levels.

References

1. C. L. Dym, A. M. Agogino, E. Ozgur, D. D. Frey and L. J. Leifer, Engineering design thinking, teaching, and learning, *Journal of Engineering Education*, **94**(1), pp. 103–120, 2005.

2. Community Engagement Division, American Society for Engineering Education, <https://sites.asee.org/ced>, accessed 21 April 2024.
3. H. M. Matusovich, W. Oakes and C. B. Zoltowski, Why women choose service-learning: Seeking and finding engineering-related experiences, *International Journal of Engineering Education*, **29**(2), pp. 388–402, 2013.
4. W. C. Oakes, M. C. Hsu and C. B. Zoltowski, Insights From a First-Year Learning Community To Achieve Gender Balance, *Proceedings of the 2015 Frontiers in Education Conference*, El Paso, Texas, October 2015.
5. K. Litchfield and A. Javernick-Will, Investigating Gains from EWB-USA Involvement, *Journal of Professional Issues in Engineering Education and Practice*, **140**(1), 4013008, 2014.
6. J. Eyler, Reflection: Linking Service and Learning – Linking Students and Communities, *Journal of Social Issues*, **58**(3), pp. 517–534, 2000.
7. D. E. Giles and J. Eyler, The impact of a college community service laboratory on students' personal, social, and cognitive outcomes, *Journal of Adolescence*, **17**, pp. 327–339, 1994.
8. J. Eyler and D. E. Giles, *Where's the learning in service-learning?* San Francisco: Jossey-Bass, 1999.
9. A. W. Astin, L. J. Sax and J. Avalos, J. Long-term effects of volunteerism during the undergraduate years, *Review of Higher Education*, **22**(2), pp. 187–202, 1999.
10. J. L. Huff, C. B. Zoltowski and W. C. Oakes, Preparing Engineers for the Workplace through Service Learning: Perceptions of EPICS Alumni, *Journal of Engineering Education*, **105**(1), pp. 43–69, 2015.
11. A. R. Bielefeldt, K. Paterson and C. Swan, Measuring the value added from service learning in project-based engineering education, *International Journal of Engineering Education*, **26**(3), pp. 535–546, 2010.
12. K. Litchfield, A. Javernick-Will and A. Maul, Technical and professional skills of engineers involved and not involved in engineering service, *Journal of Engineering Education*, **105**(1), pp. 70–9, 2016.
13. W. C. Oakes, J. Huff, C. B. Zoltowski and D. Canchi, Impact of the EPICS model for community-engaged learning and design education, *The International Journal of Engineering Education* **34**(2), pp. 734–745, 2018.
14. L. Piket-May and J. Avery, Service-learning First Year Design Retention Results, *ASEE/IEEE Frontiers in Education Conference*, Reno, NV, October 10–13, 2001.
15. B. Ropers-Huilman, L. Carwile and M. Lima, Service-learning in engineering: a valuable pedagogy for meeting learning objectives, *European Journal of Engineering Education*, **30**(2), pp. 155–165, 2005.
16. E. A. Cech, Culture of Disengagement in Engineering Education?, *Science, Technology, & Human Values*, **39**(1), pp. 42–72, 2014.
17. M. Lima and W. C. Oakes, *Service Learning: Engineering in Your Community*, 2nd ed., Oxford Press, 2014.
18. R. Sigmon, The Problem of Definition in Service-Learning, In Sigmon et al., *The Journey of Service-Learning*, Council of Independent Colleges, 1996.
19. A. Furco, Service-Learning: A Balanced Approach to Experiential Education, In B. Taylor and Corporation for National Service (Eds.), *Expanding boundaries: Serving and learning*, Corporation for National Service, pp. 2–6, 1996.
20. T. K. Stanton, D. E. Giles and N. I. Cruz, *Service-Learning: A Movement's Pioneers Reflect on Its Origins, Practice, and Future*, Jossey-Bass, 1999.
21. P. A. Leidig and W. C. Oakes, Model for project-based community engagement. *International Journal for Service Learning in Engineering, Humanitarian Engineering and Social Entrepreneurship*, **16**(2), pp. 1–13, 2021.
22. P. A. Leidig and W. C. Oakes, Engagement in Practice: Model for Project-Based Community Engagement Engineers Without Borders Guatemala Case Study” *Proceedings of the 2022 ASEE Annual Conference*, Milwaukee, Wisconsin, USA, June 2022.
23. J. D. Thompson and B. K. Jesiek, Transactional, Cooperative, and Communal: Relating the Structure of Engineering Engagement Programs with the Nature of Partnerships, *Michigan Journal of Community Service Learning*, **23**(2), pp. 83–99, 2017.
24. A. L. Pierce, W. C. Oakes and N. Abu-Mulaweh, Changes in student perceptions of course-based service-learning at large scale: EPICS at 23 years old, *ASEE Annual Conference & Exposition*, Tampa, FL, June 2019.
25. E. J. Coyle, L. H. Jamieson and W. C. Oakes, EPICS: Engineering Projects in Community Service, *International Journal of Engineering Education*, **21**(1), pp. 139–150, 2005.
26. W. C. Oakes, A. L. Pierce and N. Abu-Mulaweh, Engagement in Practice: Scaling Community-based Design Experiences, *Proceedings of the 2018 ASEE Annual Conference*, Salt Lake City, UT, 2018.
27. C. B. Zoltowski and W. C. Oakes, Learning by Doing: Reflections of the EPICS Program, *Special Issue: University Engineering Programs That Impact Communities: Critical Analyses and Reflection*, *International Journal for Service-Learning in Engineering*, pp. 1–32, 2014.
28. W. Oakes and S. Dustker, Community-Engaged First Year Learning Community, *Proceedings of the 2022 First Year Engineering Experience Conference*, East Lansing, MI, July 31–August 2, 2023.
29. W. Oakes, P. A. Leidig, A. Pierce and J. Martinez, Assessing Multidisciplinary, Long-Term Design Experiences, *Proceedings of the 2022 ASEE Annual Conference*, Milwaukee, Wisconsin, USA, June 2022.
30. M. Lima, *Building playgrounds, engaging communities: Creating safe and happy places for children*, LSU Press, 2013.
31. T. Lee, E. Buchanan and D. R. Berg, Issues of Privilege in University Service-Learning, *International Journal for Service Learning in Engineering, Humanitarian Engineering and Social Entrepreneurship*, **14**(3), Special Issue, pp. 1–13, 2019.
32. E. J. Coyle and L. H. Jamieson, EPICS: Service Learning by Design, *Projects that Matter: Concepts and Models for Service-Learning in Engineering*, E. Tsang, Editor, American Association for Higher Education (AAHE), pp. 59–74, 2000.
33. E. C. Oakes, C. B. Zoltowski, K. Schmotzer and A. P. Valenca, Integration of Curricular and Extra-Curricular Learning Through Service, *Proceedings of the 2015 ASEE Annual Conference*, Seattle, WA, 2015.

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