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BOARD #135: The 2TO4 Project - Facilitated Transition from 2-Year to 4-Year Electrical and Computer Engineering Studies by Building Student/Faculty Networks (WIP)

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The IEC 2TO4 Project - Facilitated Transition from 2-Year to 4-Year Electrical and Computer Engineering Studies by Building Student/Faculty Networks (WIP)

Abstract

The Innovative Engineering Consortium (IEC) is a nonprofit organization that facilitates collective efforts through equitable partnerships between its 21 MSI core members, 15 PWI affiliate members, 8 corporate members and other collaborating organizations. The IEC 2TO4 Project builds on its Pathways to Success program to support students who begin their studies at a community college (CC) or other 2-year institution by providing financial support, mentoring and other personalized transition support, professional guidance, and community engagement.

The 2TO4 network of CCs consists of 20 sub-networks (nodes) built around the 20 4-year MSIs that are core IEC members. The vision of 2TO4 is to double the total number of students following this pathway to their BS degree in ECE by sharing promising practices and providing robust transition support infrastructure and increased financial support for CC students. Participating CCs become members of IEC and engage in equitable partnerships with 4-year MSIs and PWIs, industry and DoD labs to implement the various building blocks of 2TO4.

During the first year of this multi-year effort, a base version of 2TO4 was created. Program leadership began working through institutional challenges with the 60+ program partners and the first cohort of more than two dozen student participants was selected. Some nodes worked from the beginning, while others presented a steep learning curve for all involved.

During the second year of the project, the number of students participating increased, and support infrastructure and programs expanded. The IEC guiding principles of Asset Driven Equitable Partnerships (aka ADEP, developed by IEC) were used to build connections between 4-year and 2-year institutions by co-creating and co-delivering new learning opportunities.

In the third year of the project, new programmatic elements are focused on the very different and geographic distant student experiences at the 20 local hubs because transfer processes and local support infrastructures vary greatly by institution and state. Supported students will be brought together in-person in March 2025 to build their personal professional networks by working together on mentored teams.

2TO4 assessment is focused on the extent to which each programmatic component is implemented with fidelity and whether the program has built the necessary capacity to support students. Formative feedback from each participant is collected and student progress is tracked. Key to the success of the project is building and maintaining trust and equitable partnerships, along with continuous programmatic improvement. The developing student-faculty networks described above have resulted from the identification of both problems and opportunities.

As this work progresses, the project team is collecting information on promising practices that help recruit and retain both student and faculty participants, that have the potential to sustain this effort beyond the period of DoD funding, that can impact ECE education writ large (not just for CC transfers), and, especially, whether the 2- to 4-year pathway can significantly increase the number of ECE graduates.

The IEC 2TO4 Project - Facilitated Transition from 2-Year to 4-Year Electrical and Computer Engineering Studies by Building Student/Faculty Networks (WIP)

Introduction

The Innovative Engineering Consortium (IEC), a non-profit organization composed of Electrical and Computer Engineering (ECE) programs at 15 HBCUs, 4 HSIs, and 2 TCUs, is working to double the number of community college (CC) students transferring into its 4-year partner institutions or other 4-year schools, always prioritizing the best outcomes for students. Research indicates that the 2-year to 4-year engineering pathway at MSIs is underdeveloped, with historically limited collaboration between IEC MSIs and local community colleges. Despite being among the largest producers of minority engineers, IEC institutions have yet to fully realize the potential of these partnerships to serve local CC students. To address this, IEC is expanding its membership to include key community colleges as equitable effective working partners, creating a nationwide network to support a diverse and sustainable talent pool in electrical and computer engineering.

The **2TO4 Program** aims to establish a clear, informed pathway for CC students pursuing engineering degrees. The program focuses on removing barriers, leveraging existing IEC efforts, and creating scaffolding at the interface between 2-year and 4-year institutions to guide and support students throughout their academic journey.

The program's primary resources support CC students financially on their path to BS degrees in electrical and computer engineering through tuition grants and stipends. Key activities include:

- Publicizing grant and stipend opportunities within the IEC network,
- Collecting and reviewing student applications,
- Interviewing candidates, and
- Selecting recipients and integrating them into the 2TO4 network.

Beyond financial support, the program fosters a community of scholars by:

- Hosting Professional Growth webinars,
- Organizing virtual meetings for scholars to share academic and internship experiences,
- Establishing a Student Ambassador Program for peer mentoring and outreach, and
- Offering opportunities for students to deepen their ECE knowledge while enhancing the learning environment for others.

The project also includes a research component to better understand barriers and opportunities impacting CC-to-4-year transitions. Data collection has been underway since the end of year one, once IRB approval had been attained. For details from the group doing the research for this project, refer to another paper at this conference[1].

What the goals and strategies mentioned above mean changes from year to year. Some ideas work well, and others do not. In year 1, it became clear that it was necessary to identify at least one key person at each institution and to find ways to facilitate the development of a solid, effective working partnership between the various schools in each node. Students at some CCs got excellent advice preparing them to transfer, most did not. Some faculty at 4-year schools knew someone at a nearby CC, and something about the CC student experience, most did not.

Student interaction, once they were recruited to the project, developed well thanks to regular monthly meetings and industry led Professional Growth Series events.

In year 2, to help educate all faculty involved, a new seminar series was developed on Talking about Transforming Transfer: Re-conceptualizing Engineering Transfer to Broaden Participation in Engineering along with a series of in-person and online facilitated meetings on how dedicated engineering transfer professionals can learn to do their job Better Together. These latter two efforts were led by the 2TO4 research team. IEC's ADEP principles were utilized to build new and strengthen existing partnerships between 2- and 4-year faculty. Some rebudgeting enabled the funding of pilot projects proposed by IEC faculty, each involving instructors from both 2- and 4-year schools.

From the beginning of the project, it was assumed that strong student-to-student relationships could be built through only online interactions. However, the success of the effective working partnerships between faculty suggested that it was time to bring students together in-person. Thus, in year 3, a second rebudgeting made it possible to build common ground between students (and thus build personal networks) by having teams co-develop and co-deliver outreach activities, aided by academic and industry mentors. Activities are spread throughout the spring term, but the key event is an in-person workshop in March. Finally, the hub-model is being implemented by IEC industry members, centered around schools they work with having the potential to attract and retain more diverse students in ECE programs. This latter effort will impact both the quality and sustainability of the 2TO4 project.

IEC projects have demonstrated that effective working partnerships require identification of the assets each person brings to the table and the focused investment of those assets in one another through active involvement in collaborative projects. While this was originally demonstrated through multi-university technical research, the lessons learned seem to apply equally well to educational and mentoring projects involving 2- and 4-year schools. The existence of a solid, working connection between faculty from both types of schools can provide the basis for a successful pathway for CC students to obtain their BS ECE degree or beyond. The pathway gets even better with peer mentoring from students at various stages along the pathway. As the project matures, the transition between high school and either 2- or 4-year studies and from the university to the workplace will grow in importance. The building of personal relationships with participating students and faculty will permit the project team to continue to track graduates as they progress through their careers.

In this paper, the general evolution of the 2TO4 project is described, along with lessons learned and major remaining questions. Projects involving faculty and students from multiple organizations have challenges continuing once initial funding runs out. However, the IEC has from the beginning planned to build the future of 2TO4 around its Pathways program which helps students find good paid internships or similar experiences sponsored by IEC Industry Partners, which will continue to provide direct funding to students. IEC is also developing models that can be adopted by industry and increasing its foundation funding.

Clearly new sources of funding need to be identified. However, there is another feature of this project that will likely play an even more important role in its continuation into the future. The

faculty from both CCs and MSIs typically have very large teaching loads and anything requiring extra effort is very hard to sustain. In fact, it is generally not possible to find faculty with any spare bandwidth, even for a funded project. They must be convinced that participation will be possible while still meeting their other obligations. Of course, their dedication leads them to try new ideas that can improve student achievement, so they are willing to listen. The good news here is that basing this project on effective working partnerships provides opportunities for faculty to seemingly do more. First, working together with colleagues from other schools means they can share the load in their present teaching responsibilities. The circuit project described below shows how this can be done. Faculty can know they will have an engaging, up-to-date course while investing less time in teaching, doing together what is difficult to do alone. Second, the relationships from such co-development and co-teaching can and will lead to joint research proposals and projects that were not possible with just colleagues down the hall. The project team bases its project planning and administration on these concepts.

The Evolution of the 2TO4 Project

Initially, the focus of the project was on reaching potential applicants, encouraging them to apply, evaluating their applications, interviewing applicants and setting up the process for financially supporting the students transitioning from 2-Year to 4-Year programs/institutions. There are a lot of lessons to be learned when one focuses on facilitating the transition from 2- to 4-Year schools in pursuit of a BS degree in ECE. One of the first was that, in the community of MSI ECE programs served by IEC, there was very little general knowledge of the problems and opportunities possible if one attempts to recruit students from community colleges. To address this issue and to educate ourselves on both problems and promising practices for this transition, IEC instituted a seminar series on Talking About Community College Transfer (T^3). Information on the first year of this series can be found on the IEC website (iec.org). In 2025, the series is focused on the five regional community college collaborations like 2TO4 that are funded by DoDSTEM. These groups have done outstanding work and have developed a lot of ideas worth adopting by others.

A natural next step after T^3 is a program from the group doing research for 2TO4 called Better Together, which has created working groups focused on faculty, student and policy issues to improve community college transfer. An initial in-person meeting jump-started a continuing series of productive online meetings. In the policy group meeting, discussions led to the realization that there was a new potential partner at one of the IEC core institutions who could dramatically increase student knowledge of and interest in the opportunities offered by 2TO4. A large jump in excellent applicants has resulted. Also, some very good ideas are being discussed for future collaborations, presently focused on Dual Enrollment Associate Degree programs offered to high school students and Reverse Transfer to more efficiently move along a pathway from a community college to a 4-Year BS degree. This group has already justified its name because each participant has been Better Together.

In addition to learning that the project had to build working relationships with people knowledgeable about the 2-Year 4-Year transition at the system level, it also became obvious that the key to creating and sustaining an effective pathway to one of the core MSI schools from their local community colleges was building some kind of working relationships at the ground level between faculty at the two schools. The 2TO4 Project recently began to provide support to for faculty with ideas that can build the kind of connections needed. One such project involved faculty from two DC area schools, one a large community college and one a 4-Year HBCU. They offered a summer workshop for community college students that helped the students understand better the opportunities at their neighboring university and, more importantly, the faculty mentoring the students built the kind of personal relationship that future collaborations can grow on. The second project is much more aggressive, involves twice as many faculty and almost ten times the students. It involves developing and delivering a common Introductory Circuits course at two universities and two community colleges at the same time. This effort is built an exceptionally clever learning platform developed by an HBCU faculty member. Both of these projects are discussed at length in another paper presented at this conference on how to most effectively build such partnerships[2]. There is also a summary of this project in the Appendix.

Student Networking Through Outreach Activities

The reasonably obvious conclusion from the evolution of this project is that building strong working connections between faculty at two different institutions builds useful bonds that help facilitate other joint activities. Put more simply, to reach students at a community college and convince them to consider an ECE career, it works best if one faculty member can call another and ask them to spread the word. For engineers, and probably most people, the way to build a solid relationship is to accomplish something together. Once faculty from two quite different schools got together to make something happen, the schools became much more connected. Students then received the message about the quite valuable scholarship and stipend offered by the 2TO4 project and applications grew. Each of the partnerships developed were made better by the application of what IEC calls Asset Driven Equitable Partnerships (ADEP) which are discussed in another paper at this conference.

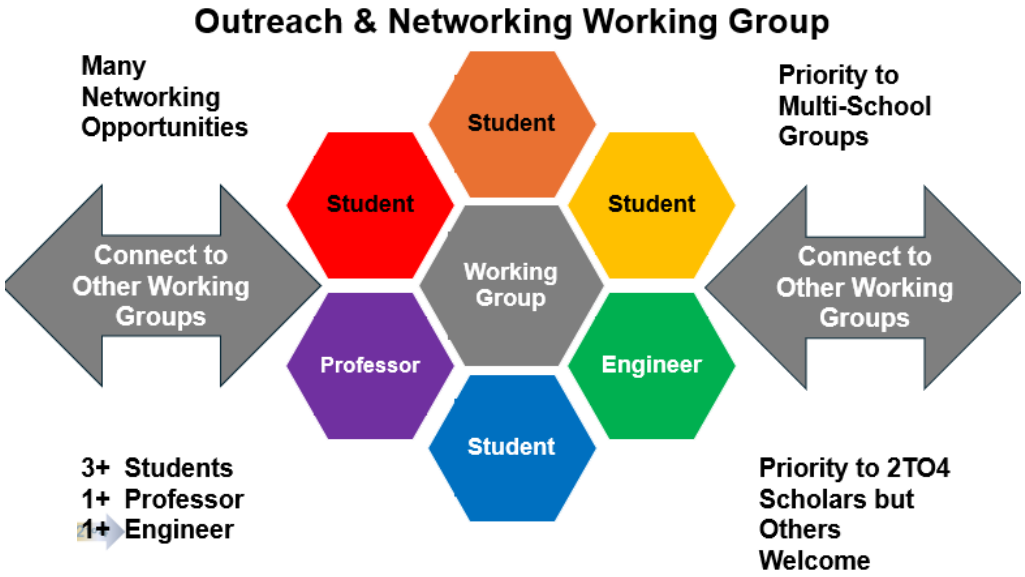
Since equitable partnerships work well for faculty development, they should do as much for students. Recognizing this, all supported 2TO4 Scholars have been organized into teams of 3-6, each with both an academic and industry mentor, to develop and deliver hands-on outreach activities at community colleges. Each group has students from at least two institutions. The groups are being brought together at an in-person workshop in March, where they will interact with one another and additional academic and industry personnel whose background and interests are relevant for their specific outreach activity. Over the spring term, the groups are working on their activity and receiving instruction in professional development to ready them for internships and their first job after graduation. These groups represent the first time IEC has implemented their ADEP principles with student partnerships. It is early days, but the students are responding exceptionally well.

From the beginning of the 2TO4 project students have been asked to act as ambassadors and mentors, providing information to students at the former 2-Year institution, helping recent transfers learn the ropes at their new school and generally sharing promising ideas with one another at regular online meetings. This new initiative takes this responsibility one step further and also provides outstanding opportunities for students to build their person technical network. One of the primary reasons for asking students to be ambassadors is that it helps them to develop a confident personal view of themselves as electrical or computer engineers. This new effort built around the in-person workshop is significantly more formal than anything students have experienced previously. In addition to having access to at least two regular mentors, one academic and one industrial, they are also given a richer context for the hands-on activities they are developing, based on a series of questions that any student should answer as they learn what a widely applicable profession like electrical or computer engineering entails and what specific aspects of it they would hope to focus on.

Outreach and Networking Working Groups

As noted above, each working group consists of several students and should have a simple, clear focus on a *specific ECE outreach activity* and involve students from more than one university. Both the development of an outreach activity and personal networking are equally important. Networking include working with peers, mentors and other experts.

Figure 1



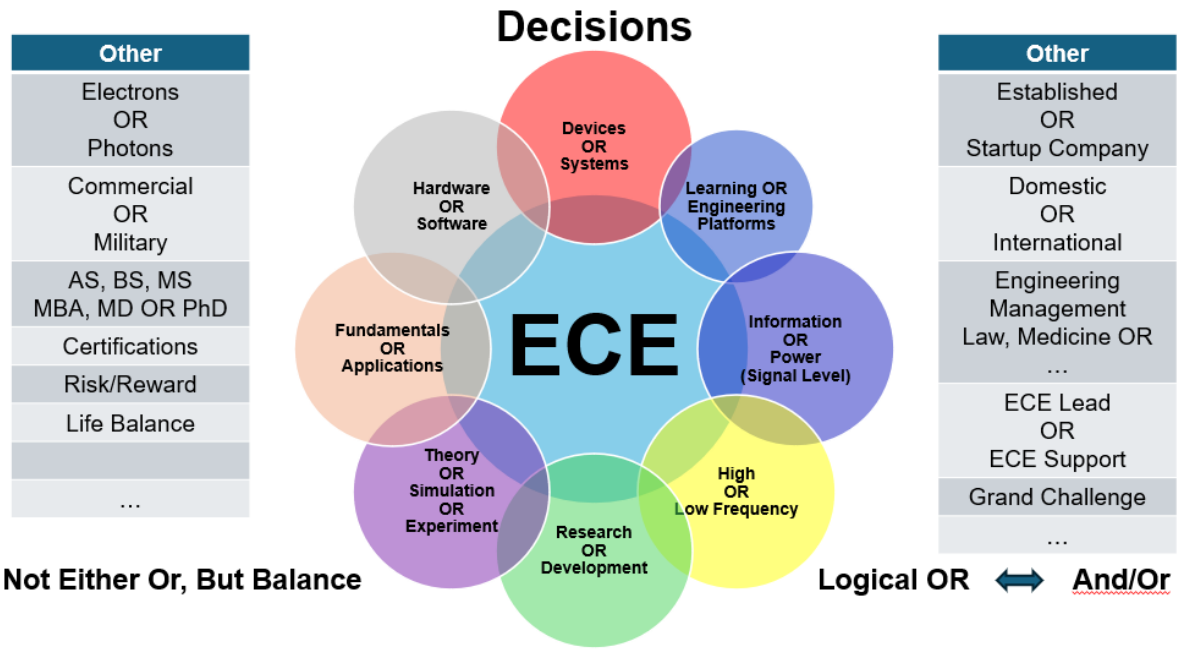
Working Group Guidelines

Topics to be Addressed in Outreach Activities

There are a lot of decisions that students need to make when planning out their ECE career pathway. These often seem like ‘this or that’ choices when the answer is generally some of each.

Thus, for each decision, students should decide on a percentage for each choice; that is, where they think they sit on a spectrum from all one to all the other. That is why the choices are connected with a logical OR operation (thinking like an ECE or CS person here) which includes one or the other or both as choices. Percentages will change along the pathway, so regular reflection on these issues should be part of any outreach activity and each activity should be classified by addressing at least each of the topics that are part of the ECE Venn diagram below.

Figure 2



Questions for Students to Ask to Determine Their ECE Pathway

The following provides some information on each of the topics in the figure above. Again, all outreach activities should address:

- **Information or Power** – this is largely signal level. All signals require power, but power levels are low for signals carrying information and high when the purpose is to provide the power necessary to run other systems. Mathematically, this is signal amplitude or magnitude. Communication is mostly signals, but signals do not happen without power. Electricity generation and transmission is power but signals are playing an ever larger role as everything becomes smarter and more complex.
- **High or Low Frequency** – Information is usually carried at higher frequencies, but not always. This characterizes how fast signals change with time or time-dependence. Sometimes high frequency is also high power, as in high power microwaves for plasma heating, etc. The concept of high and low in engineering is not arbitrary but is tied to whether or not wave propagation phenomena are important.

- **Research or Development** – Everyone does at least a little of each, sometimes both equally.
- **Theory or Simulation or Experiment** – It is not uncommon to have equal amounts of each, as IEC core members have shown in their Experiment Centric Pedagogy project. All three are necessary to fully characterize something, with the greatest emphasis on what is most effective for the individual doing the work. Very few technical teams work well unless at least one person is productive at all three.
- **Fundamentals or Applications** – The emphasis at a university is usually on the former while the latter is key for industry. Percentages change with degree level.
- **Hardware or Software** – Again, usually both are important. This is an area where some balance is usually the goal. Hardware/software co-design is growing dramatically in importance.
- **Devices or Systems** – At least at universities, the division between the two can be rather dramatic. Some balance is usually, again, best.
- **Learning vs Engineering Platforms**
    - Using personal instrumentation to empower student learning anywhere and anytime is very effective, but such devices have limited specs (e.g., dynamic range, frequency range, number of simultaneous measurements, etc.). However, they generally have the same general functionality that can be found in both academic and industrial labs (e.g., oscilloscope, function generator, spectrum analyzer, network analyzer, logic analyzer …) The focus of most outreach projects should be on using inexpensive, small, mobile hardware and software (anywhere/anytime) so that hands-on learning is central to the student learning experience.
    - The question of how the learning experience is expanded when more capable benchtop instruments are used at either the 2-year or 4-year schools in undergraduate labs should be addressed. This can be done with a demo or video. If a fully equipped lab is available at the school being visited, that can be used.
    - Research labs at universities and industrial labs have even more capable (and very expensive) equipment available, usually requiring extensive training to utilize. Activities and support materials should also address the impact of such equipment.
    - The Working Group should put their activity in the context of this complete spectrum of approaches to making measurements to develop and test ideas in the lab, from the simplest and cheapest options students will be using at the low end

to integrating test equipment on chips designed to be faster than any presently available equipment.

- Finally, most aspects of engineering practice experienced in college or university coursework are simplified in some way from what students will experience when they enter the workforce. In addition to the laboratory tools available in industry, software tools are much more powerful (and expensive) and, of course, the knowledge base of engineers is much deeper and wider than it is for students. These differences should be addressed so that students know where they are on the pathway to becoming an engineering expert. Also, opportunities to find out what engineering is like away from the classroom should be presented, such as undergraduate research, internships, co-ops, etc. Students should be encouraged to engage in such opportunities as part of their educational pathway.

- **Other** – These are also important, but are generally less so than the topics in the Venn diagram
    - Electrons or Photons – traditionally the answer has been electrons, but photons are becoming more and more important, so both may be best.
    - Commercial or Military – there are two types of decisions to be made here. First, students should consider whether they want to work for a company focused on defense or commercial customers. It is likely that most students never address this issue; they just want an interesting job that pays well. There is a second, less obvious, issue buried in this decision that all students should address: high reliability/mission critical vs commercial (consumer). High reliability engineering encompasses, in addition to military applications, aerospace, automotive, medical and others where life safety is paramount. For many engineers, this is rarely an either/or choice but mostly a both/and exercise. (Thanks to Doug Mercer, who shared his personal experiences at ADI.)
    - AS, BS, MS, MBA, MD, PhD – whatever the ultimate goal, the necessary degrees must be obtained. Degree level impacts all other choices. This topic probably could be included in the Venn diagram group.
    - Certifications – historically less important at universities but becoming part of the story at this point in time. Industry likes them.
    - Risk/Reward – this is pretty obvious with risk usually larger early in one's career, or at least after one's expert skillset is established.
    - Life Balance – something that people in the US usually do not do very well. Engineering, especially, can work against this.

- Established or Startup Company – again, the latter is usually more the focus early in one's career, but not too early.
- Domestic or International – something that many students do not think about. Most companies have opportunities to work in many countries.
- Engineering, Management, Law, Medicine … something that needs a lot of planning. Combining engineering with others can be great but hard.
- ECE Lead or ECE Support – companies have different cultures
- Grand Challenge – what are the big societal problems of interest?

Group Outcomes

- Hands-On Activity to be Developed for ECE Outreach, Based on Low-Cost, Small, Mobile Components (e.g. Personal Instrumentation [like ADALM1000]), Quick and Easy to Set Up, Targeted at Community College Students in STEM-based AS Degree Programs.
- For Context, Address Issues in Venn Diagram and (If Appropriate) Any Relevant 'Other' Issues
- Write Instructions for Students and Instructors Participating in Outreach Activity. (Include a Bill of Materials [BOM] with Sources and Prices)
- Create Video of Activity and (if possible) Deliver Activity at a Community College
- Either Write or Record a Discussion of How the Activity is Properly Geared Toward Community College Students Interested in Engineering Careers and Share Ideas on How to Modify the Activity for Other Communities (e.g. High School, Elementary School, General Public ..)
- Reflect on the value of this activity in developing each team member as an engineer.

Overall, more than 50 students, 20 faculty and 20 working engineers will be engaged in this Outreach and Networking project, with 50 students and 15 faculty funded to attend the in-person workshop. Each of the participants has been asked to provide continuous feedback on the questions from the Venn diagram. Two items have already been modified – the Military vs Commercial choice has been expanded, and the differences between Learning and Engineering Platforms has been added. Another topic is under discussion – Deterministic vs Probabilistic Systems, especially because the latter has substantially increased in importance with the growth of AI/ML tools.

Note that, while this Outreach and Networking project is meant to help CC students navigate the pathway to an ECE BS degree, the entire process is relevant for all ECE students. CC students

need a more structured approach to career and degree program planning because they have little access to ECE expertise until they transfer. The availability of 4-year faculty, through joint programs, helps, but there is no easy way to stop by someone's office for a chat or, generally, even a way to hang out with other students in a research lab. The hands-on activities being developed will be useful for showing any potential student the value of an ECE career, no matter what their educational level. The 2TO4 scholars have access to many activities that have already been used for such purposes.

Evaluation

Methodology To evaluate the attainment of the project's goals, a multi-phase, mixed methodology approach using participatory stakeholder-based evaluation was employed. Key stakeholders included participating: students, educators, administrators, project staff, and collaborating higher education faculty mentors, as well as ECE and industry members served by the project.

Participants/Demographics of 2TO4 Scholars The overall makeup of the multiple cohorts of scholars includes 26 scholars in first cohort, 14 scholars added in the second cohort, and 18 scholars in third cohort, as interviews continue for Cohort 3 (see Table 1). Additionally, 5 students have graduated from undergraduate study and are no longer in the program. Of the current 58 student group 13 (22%) are female and 45 (78%) are male.

Table 1
2TO4 Scholars

Cohort	Academic Year	Number of Current Scholars
Cohort 1	2022-2023	26
Cohort 2	2023-2024	14
Cohort 3	2024–2025	18

*At this time additional students are being added to this cohort.

As of September 2024, 63 students who have been accepted into the program (5 students have graduated) and 58 students are currently supported by scholarships. During the grant years 2022 through 2024 a total of 138 students have applied; there have been 79 conversations and 18 students transitioning. Applicant demographics include Community Colleges:11; HBCUs: 56; HSIs: 5; and TCU: 1. There have been 21 new applications since July of 2024.

The overall goal of the IEC Scholar Workshops is to identify specific needs of student participants focused on the essential transitions in educational pathways. These workshops support cohorts among faculty from the IEC to address these transitions effectively (see Table 2).

The September 2024 IEC Scholars meeting focused on students' experiences transitioning from community colleges to four-year institutions. Scholars shared insights into the aspects of the transition process and the challenges they faced. Current community college students also

provided updates on their own transition journeys, discussing their progress and preparation for the shift.

The October 2024 IEC Scholars meeting provided an opportunity for students to engage with guests from the NASA Blue Skies Competition and the Sandia's Critical Skills Recruiting (CSR) program. These guests introduced new pathways and resources for students, encouraging them to explore additional opportunities for hands-on experience and professional development. During the meeting, students shared updates on their progress, reflecting on the semester's achievements and challenges. Many highlighted successes in coursework and skill-building, while also discussing obstacles such as balancing workload and mastering new technical concepts.

Table 2
September 2024 Workshops

Date	Number of Attendees
9/25/24	21
9/29/24	19
10/23/24	26
10/25/24	24
11/ 22/24	31*
11/25/24	17*

*registered

The ongoing faculty project is with FAMU-FSU and UTEP. Dr. Petru Andrei (FAMUS-FSU) and Dr. Jesus J. Gutierrez Vega (UTEP) are working on curriculum planning with faculty at their corresponding Community Colleges (El Paso Community College and Tallahassee Community College) to integrate Circuits U platform into the Intro to Circuits course for students at community college to help with their transition to their university.

After reviewing applications, students were assigned a level for their research and degree path. Level A received a $5,000 stipend, while those on Level B received $10,000. Criteria for both levels are outlined below:

Table 3

Scholar Level (up to $5,000 in finds)

Current School	CC	#of students
Tallahassee Community College	Tallahassee Community College	2
San Jacinto Community College	San Jacinto Community College	2
Nashville State Community College	Nashville State Community College	1
Montgomery College	Montgomery College	2

Table 4

The IEC 2TO4 Project - Facilitated Transition from
2-Year to 4-Year Electrical and Computer Engineering Studies by Building Student/Faculty Networks (WIP)

Ambassador Level (tuition and stipend support up to $10,000 in funding)

Current School	CC	#of students
University of Maryland Eastern Shore	Delaware Technical Community College	1
The University of Texas at El Paso	El Paso Community College	1
El Paso Community College	El Paso Community College	1
Tallahassee Community College	Florida A&M University	2
Montgomery College	Howard University	1
Prince Georges Community College	Howard University	1
Florida International University	Miami Dade College	2
Morgan State University	Montgomery Community College	1
Prairie View A&M University	Lonestar community college	3
Prairie View A&M University	San Jacinto College	2
Prairie View A&M University	Collin College	1
Southwestern Indian Polytechnic Inst.	Southwestern Indian Polytechnic Institute	1
Tennessee State University	Houston Community College	1
Tennessee State University	Nashville State Community College	4
Tennessee State University	Metropolitan Community College	1
Tennessee State University	Benedict College	1
The University of Texas at El Paso	El Paso Community College	7
Tuskegee University	Bishop State Community College	2
Tuskegee University	Wallace Community College	1
University of Houston	San Jacinto Community College	2
University of Maryland Eastern Shore	Delaware Technical Community College	1
University of Maryland Eastern Shore	Prince Georges Community College	2
University of Maryland Eastern Shore	Baltimore City Community College	1
University of the District of Columbia	Montgomery College	1
University of the District of Columbia	Prince Georges Community College	2

The IEC 2TO4 Project - Facilitated Transition from 2-Year to 4-Year Electrical and Computer Engineering Studies by Building Student/Faculty Networks (WIP)

Virginia State University	Reynolds Community College	1

Summary The overall vision of the IEC DOD 2TO4 program focuses on community college students, especially those from underserved communities and particularly on first-generation students with support from the DoD vision of a diverse and sustainable talent pool in electrical and computer engineering. The overall makeup of the multiple cohorts of scholars includes 26 scholars in first cohort 14 scholars added second cohort and at present, 6 scholars in third cohort as interviews continue for the completion Cohort 3. Additionally, 5 students have graduated from undergraduate study and are no longer in the program. Of the current student group 28% are female and 72% are male. A total of 46 students have been accepted into the program. The application process for the 2024-25 academic year cohort is underway. The students recently added to the summer Cohort 3 program include students from San Jacinto Community College, Tallahassee Community College, Nashville State Community College and Germanna Community College. Scholars who were part of the summer cohort were supported by Summer 2024 Awards including 15 tuition awards and 13 stipend awards. Total support was $70,000 in awards for summer scholars. Students participated in several summer workshop sessions focused on the 2TO4 programs Professional Growth Series and content supported by faculty.

Engineering Courses at Community Colleges

2TO4 scholars begin their studies in some type of engineering associate degree program at a variety of community colleges in states throughout the southern part of the US. The goal of these programs is to prepare students for transfer to a four-year engineering school where they can pursue a BS degree in engineering. The 2TO4 scholars take the route that prepares them best specifically for electrical engineering, computer engineering or a similar degree (e.g. electronic engineering or engineering with a focus on electrical and/or computer engineering). All community colleges offer the math, science, and gen ed classes necessary to complete BS degrees in ECE fields. They also offer some kind of computer science or programming basics. However, it is all too often the case that courses like Introduction to Engineering, Electric Circuits, Digital Systems, etc., are not available. These courses appear in the first two years of BS degree programs at four-year schools. For ECE, the first Circuits or Linear Systems course is the foundation of degree programs. Without it, students cannot take other disciplinary courses when they transfer.

The Associate degree programs taken by 2TO4 scholars fall into three general categories. The first is the very traditional pre-engineering program that offers just math, science, gen ed and, possibly, programming courses. This is the case in Alabama (see alabamatransfers.com), where they recognize the limitations of this approach by encouraging students to complete their associate degree by reverse transferring at least a couple of engineering courses once they transfer to a 4-year school. The use of reverse transfer does not seem to be common and four-year schools in the state generally encourage students to complete their degree at their community college. This information can be found by navigating alabamatransfers.com.

A second type of program addresses the issue of Electric Circuits as the first course in ECE by offering the same type of Circuits course that students at the four-year school take. They also have some kind of introductory programming course for engineers. These courses are generally well done but are often taught by instructors without ECE backgrounds and they cannot easily find out how well they are preparing their students for what they will be taking at a four-year school. The Tennessee Transfer Pathway (tntransferpathway.org) is quite good and does require Circuits with Lab and makes clear that courses from engineering technology programs will not be accepted. In Florida, one of the largest community colleges in the country has Intro to Engineering, but nothing specific to ECE, in their standard program, so they are better than the no-engineering programs. The importance of the first Electric Circuits course is also discussed in another paper at this conference and is summarized in the Appendix[3].

The third type of program includes everything or nearly everything students experience at four-year schools. In addition to circuits and programming, there are Intro to Engineering, Digital Systems, Digital and Analog Electronics, etc. This seems to be the standard in Texas and Maryland, at least in the schools that maintain specific associate degrees for ECE. In the schools with only a degree that covers all of engineering, one finds Circuits, Programming, and Intro to Engineering. As with Tennessee, the offerings are standardized across the state. Even the same course numbers and descriptions are used. It is the schools with an ECE degree from this third group of community colleges that educates the largest fraction of present 2TO4 scholars. These schools also tend to be larger with more students.

ECE programs at most universities will be better able to increase transfers to ECE programs who should successfully complete their degree program in about two years if they focus on the schools with associate degrees specific to ECE and the schools that at least have a solid Circuits course and good programming courses. Students from these schools should be well prepared, which, of course, assumes that the level of learning is the same, which is not consistently the case. Again, there is more on this topic in another paper presented at this conference and summarized in the Appendix[2].

Continuing Challenges and Conclusions

One of the key motivations for the Outreach and Networking Workshop is to address the difficulties in building a true community of students who are studying in nearly 40 different institutions. Connections can be made online, but nothing works better than in person interactions. It is anticipated that this effort will be successful, but the meeting is limited to two days, which may be barely adequate. The great promise of the collaborative activities of the groups of faculty working together should show the value of the ADEP principles developed by IEC. Once people begin to see what they can accomplish together, they will continue to partner on future endeavors. The big, unspoken roadblock here is that universities are nearly always loath to reward their faculty who focus on improving their discipline, and thus the country, and not just their local programs. The faculty reward structure works against such an approach. Is it possible to find ways to promote and tenure a colleague who has improved learning at 100s of other schools rather than just their own? Another promising outcome from the past year is the

decision of Keysight to adopt the 2TO4 model. Again, the devil is in the details and the program could end up helping no one this year. Overall, the number of students being supported is growing and likely to achieve the goal of doubling the number of transfer students at IEC core MSI schools. Past numbers have been small in most places, so this goal is more achievable than it appears. However, this continued growth requires continued funding, which is not a given.

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Appendix

Co-Development and Co-Teaching at 2-Year and 4-Year Schools

Possibly unique to ECE, there is one course that is critical for student success – Electric Circuits. This course should be completed in the second year of a student's studies if they are to proceed quickly to their degree. Recognizing this, most community colleges that are invested in what has traditionally been called pre-engineering associate degrees try to offer a high quality version of this course, along with an equally good lab. The 2-Year/4-Year school pairs that have the largest number of 2to4 Scholars generally offer Electric Circuits. However, the quality of the courses is uneven and often leads to delays in time to degree for transfer students. An exciting new project is being piloted by the IEC 2TO4 Project that brings together faculty from two of its larger core partners along with faculty from the local community college that sends the most students for their BS degree in electrical or computer engineering. They are co-developing and collaborating on the delivery of Circuits courses at all four institutions. The project is built around a new online homework system developed at an IEC HBCU. In the Fall 2024 term, 131 total students were enrolled in these classes, 28 of whom were at community colleges.

Two major objectives were identified by the lead faculty:

1. Foster and increase collaboration between the two universities and the local community colleges by constant communication in scheduled virtual regular meetings in which they discuss curriculum-related activities at each institution, using Circuits-U as a platform for both institutions to teach the same subjects at the same level.
2. Design a common shared curriculum that both the universities and community colleges are following in teaching the circuits courses (this shared curriculum would go as far as having the same platform (Circuits-U) with the same topics covered in both institutions, even including the same homework assignments)

This pilot project is continuing during the Spring 2025 term.

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