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Students as Consultants - The Clarkson Construction Engineering Management Consulting Group

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Abstract

In 2015, the Clarkson Construction Engineering Management (CEM) program launched the Clarkson CEM Consulting Group (C3G). The Clarkson CEM Program has a long-standing commitment to hands-on and co-curricular education to which this in-house capability provides pre-professional consulting in planning, engineering, and construction areas. This business enterprise uses students in an experiential learning mode in order to deliver products that the targeted market segments would not be otherwise able to conduct using professional consulting services. Likewise, these efforts help to build community economic opportunities by jumpstarting projects that would otherwise not be able to be done absent some key preliminary work. The goal has been to generate further professional work and efforts that can aid in the development of a more robust local economy. This paper will discuss the outcomes of this enterprise and its impact on student learning for those that have participated.

Introduction

The award winning Construction Engineering Management (CEM) program at Clarkson University has been a leader in construction higher education for the past decade or longer. There are several markers for this including 100% placement rates over the last 10 years, rising starting salaries starting at $60,410 in 2019 to over $73,220 in 2024 [1], [2], to year over year Associated Schools of Construction (ASC) regional top 3 honors, and national awards. A critical aspect of this success is the robust approach the program has taken to engaging in construction education, through curricular, co-curricular, and extra-curricular activities and elements. This has been driven, largely, thanks to the leadership and partnership of the Clarkson CEM Advisory Board. Through successive, forward-leaning, strategic plans, which have been executed against (rather than sitting on a shelf), the Board has activated and unleashed the program and its participants to "think out to the box" including making a portion of the efforts of the students themselves a revenue source for the program and its numerous efforts.

Learning By Doing – Long-standing Best Practice Pedagogy

Higher education is in an age of increased challenges[3]. For that reason, institutions are looking for ways to improve their position in the higher education marketplace[4]. One approach, brought forward from seemingly timeless pedagogical approaches to learning, has been Problem Based Learning (PBL)[5]. As indicated in Rios et al., this is not a new phenomenon in engineering education in particular, and numerous lessons include: a) "a learning-cantered process requires that both teachers and students assume a more active role, greater shared commitment, and in the particular case of the students, greater responsibility for their own learning", b) "[t]he methodology arouses a spirit of investigation and innovation, creativity for the generation of new knowledge, productive thought, and motivation to learn and solve problems," and "results show the potential of external agents—clients—in improving university teaching models, opening up new spaces for educational innovation with cooperative learning

models based on projects."[5] It has been clear for PBL, therefore, that moving towards "real world" clients for this pedagogy enhances the experience, often being termed "learning by doing"[6]. As offered by Patil and Kamerikar, "[t]he role of the teacher is not just to dispense information, but to become a co-investigator with students, a thinking coach and a facilitator. In project based active learning method, the learning is by means of doing practically."[6] Borrowing from that last idea, "doing practically", the Clarkson CEM program, in creating the CEM Consulting Group (C3G), has taken "learning by doing" to a new level.

Not Just Doing: Performing – Putting Learning by Doing to the Test

By way of background, the Clarkson University Construction Engineering Management (CEM) program is a program within the Department of Civil Engineering. Set-up as a self-funded educational enterprise (other than for the program director's base compensation), it is supported through corporate and individual donations, program revenue derived form a mixture of academic and training programs, as well as other program revenue. In 2015, recognizing several contextual factors, the program established the Clarkson CEM Consulting Group (C3G). C3G is an " … in-house Clarkson University capability that provides pre-professional consulting in planning, engineering, and construction areas. This business enterprise uses students in an experiential learning mode in order to deliver products that the targeted market segments would not be otherwise able to conduct these efforts using professional consulting services." [7] As evidenced on its website, C3G has conducted numerous projects with government, non-profit, and academic partners. Projects have ranges from sidewalk inventories, to facilities assessments, to COVID response, to policy making, and many other efforts in-between. In 2024, this enterprise had gross revenue topping $70,000 doing projects for clients across the north country of New York State. These funds offset the wages earned by the student intern participants as well and help to provide program revenue for the CEM program to send students on field trips, host on-campus co- and extra-curricular events, as well as pay for numerous adjunct instructors that the program relies heavily upon to cover its many course offerings. When it comes to the goals, outside of student educational needs, as stated on the group's website, " … these efforts help to build community economic opportunities by jumpstarting projects that would otherwise not be able to be done absent some key preliminary work. The goal has been to generate further professional work and efforts that can aid in the development of a more robust North Country economy." [7] So when it comes to learning modes, this effort is exceptionally "practical", with a monetary and reputational factor well beyond what any classroom could offer, which has tangible impacts on the community, the students, and the university.

C3G's Impact: Community

When it comes to those tangible impacts, it makes sense that we first look at the customers that C3G has served; after all they are the ones paying for the services this group provides. The community and partner impact has been a significant aspect of this imitative and bespeaks the "practicality" of the "learning by doing" that is happening.

A first example is that of the Town [8] and Village [9] of Potsdam working with the St. Lawrence Health Initiative [10]. In the summer of 2018, C3G initiated an effort to develop language for the, then being developed Town of Potsdam Comprehensive Plan. As part of that

effort, an acknowledgement of the need for improved pedestrian, biking, and overall transportation facilities between the western portion of the Village of Potsdam to a commercial cluster area approximately 1.5 miles to the west along US Route 11 (figure 1) [11].

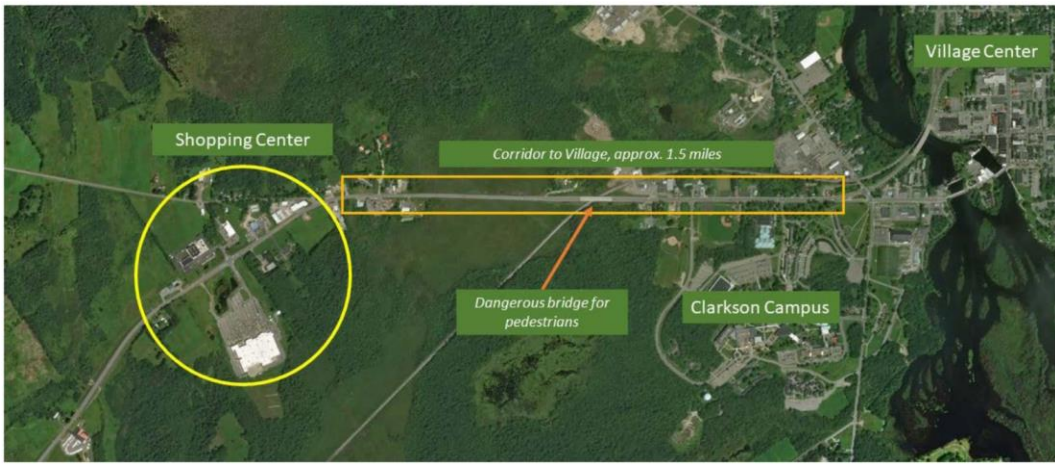


Figure 1. US Route 11 – Identified Area of Needs in the Town of Potsdam Comprehensive Plan [9]

With the approval of the Town's Comprehensive Plan in late 2020 [12], the Health Imitative sponsored C3G to do an initial data collection project in the summer of 2021 in this zone (inclusive of physical surveying and facilities/asset identification). This was followed by a subsequent C3G project to execute a "Complete Street Study" [13] that included "Public Engagement and Study Options Development" which included public surveys, engaging in listening sessions, a national level peer review, and a dedicated public workshop, all facilitated by students in the C3G effort. This study, starting in the summer of 2022 and ending in the fall of 2023, was financially supported by all three parties (see Table 1) and included a public facing website as the project moved forward [14].

Table 1. Town & Village of Potsdam – Western US 11 Corridor Studies by C3G

Project Title	Scope	Investment/Cost
2022-006A Village and Town of Potsdam – US11 Complete Street Study Data Collection	Field data collection providing a horizontal and vertical survey of existing topographic features along Maple Street/US Route 11.	$4,616 (Health Initiative*)
2022-006B Village and Town of Potsdam – US11 Complete Street Study – Public Engagement and Study Options Development	A complete streets inventory and analysis of the study area and development of a concept plan for active transportation and traffic improvements along the corridor.	$16,718 ($6,000 Town of Potsdam, $6,000 Village of Potsdam, & $4,718 Health Initiative*)

*through the Health Initiative's Creating Healthy Schools and Communities Program, which is funded by the New York State Department of Health

This amounted to a $21,334 investment in planning towards a known traffic, walkability, and bike-ability area of concern that only required $12,000 of direct community investment requiring cross jurisdictional coordination and client buy-in. The results of the study were widely hailed as

a success and even garnered regional DOT attention as the primary project to go forward towards federal RAISE grant funding in 2024.

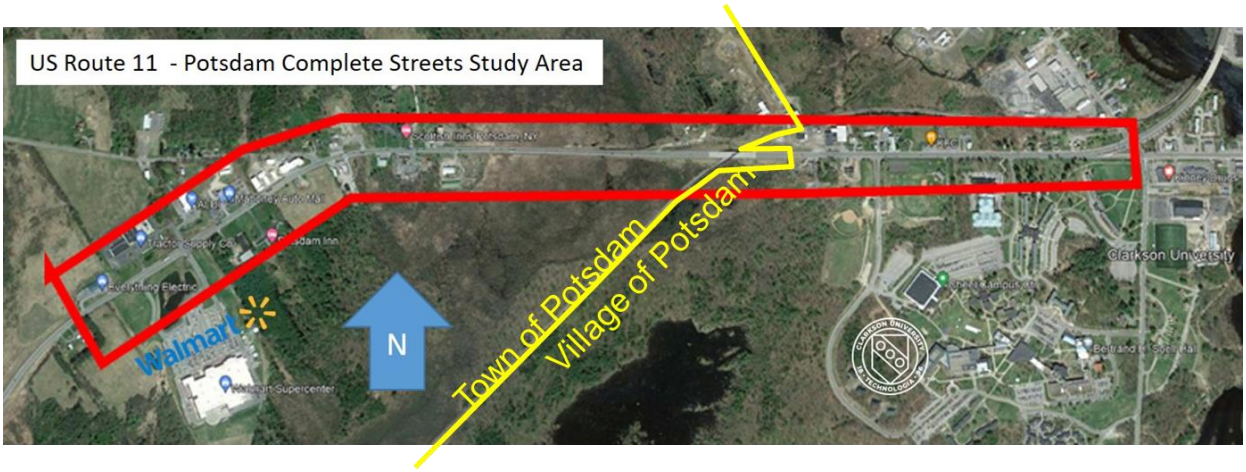


Figure 2. US Route 11 – Potsdam Complete Streets Study Area[14]

While it was not selected for that program, it was the catalyst for the 2024 application for a federal Safe Streets for All (SS4A) grant application, which was awarded in November 2024 to the Town and Village of Potsdam for just over $158,000 which C3G will play a further role in developing this area for safer transportation [15]. It is fairly easy to see how a fairly small investment ($12k) on the part of the ultimate customers, the residents of the Town and Village of Potsdam are able to accomplish a project ten times the size in impact. As offered in an editorial on the decision to make these investments, the "Board members unanimously approved allocating the requested [funds], and they made a wise choice." "This [study] is a good initial step in finding a way to improve vehicular and foot traffic along this stretch of roadway." [16]

Another example of the impact on the community by these efforts comes out of a series of projects related to traffic gardens. Traffic gardens, sometimes also called safety towns or traffic playgrounds, are "scaled-down street network with simplified traffic features where children and new riders can practice, learn, and play in a motor-vehicle-free environment." [17], [18]. Working with the Health Initiative and a local school district, Hammond Central Schools, C3G has successfully constructed two pop-up/temporary traffic gardens [19]. Through these efforts, research group has now formed to better understand traffic gardens in rural contexts, resulting in a collaborative proposal to NSF RITEL by Clarkson University and YYYY University along with the Hammond Central School District [20]. As far as impact, for the community, this quote from a recent press release is probably the best way to explain:

> "The Hammond Central School district is grateful for the partnership with the Health Initiative and Clarkson University over the past year," said Lauren Morley, Superintendent of Hammond Central School District "The collaboration between Clarkson University's students and professors, the Health Initiative leadership, and our district Wellness Committee has been exceptional. We are excited to unveil our Traffic Garden pop-up and witness the benefits on our school campus. While traffic safety and education are primary goals, we believe students will also gain confidence in riding bicycles, social interaction skills, and roadway awareness. This project paves the way for more STEM learning, with future plans

for a permanent traffic garden involving student and faculty input in its design and creation." [21]

Without question C3G and the students that encompass its staff are having a noticeable, positive, impact on the communities they serve.

C3G's Impact: Student Participants

While certainly the impacts the customers are achieving are important, another core goal of C3G is to enhance the student experience and education through these efforts. Since its inception, 50 or more students at the undergraduate and graduate level have participated in C3G. Each one has had a significant career enhancement as a result. For instance, one recent student was struggling to find direction with regards to their academic career in mechanical engineering, upon joining C3G for a summer, she opted to change majors and join the CEM program, and is now looking at an exciting internship this coming summer with a construction firm. Every single one of these students, as they seek employment or graduate education, can accurately attribute their efforts to a tangible real-world effort that they undertook, which sets them apart in an exceptionally positive light. Table 2 provides demographic information to for the participants in C3G as of January 2025. Particular attention has been made by the leadership of C3G to make sure that ample opportunities are provided to a diverse and inclusive set of students.

Table 2. Demographic Data of C3G Student Participants (through January 2025)

Measure	Data	Measure	Data
Gender Identification	Male: 33 (66%, Inst. Avg.*: 66%) Female: 17 (34%, Inst. Avg.*: 34%)	Academic Major	Civil Engineering: 30 (60%, Inst. Avg.*: 9%) Data Science: 3 (6%, Inst. Avg.*: 0.05%) Business: 2 (4%, Inst. Avg.*: 10%) Construction Engineering Management: 2 (4%) Computer Science: 2 (4%, Inst. Avg.*: 5%) Engineering & Management: 2 (4%, Inst. Avg.*: 7%) Environmental Engineering: 2 (4%, Inst. Avg.*: 1%) Mechanical Engineering: 2 (4%, Inst. Avg.*: 21%) Biology: 1 (2%, Inst. Avg.*: 3%) GIS**: 1 (2%) Planning**: 1 (2%) Public Policy**: 1 (2%) Sustainable Energy**: 1 (2%)
Race/Cultural Alignment	Caucasian: 34 (68%, Inst. Avg.*: 72%) Indian/South Asian/East Asian: 6 (12%, Inst. Avg.*: 4%) Hispanic: 4 (8%, Inst. Avg.*: 12%) Black/Jamaican: 4 (8%, Inst. Avg.*: 4%) Native American: 2 (4%, Inst. Avg.*: 0.06%)		
Other	Undergraduate Students: 42 (84%) Graduate Students: 8 (16%) Disabled Students: 2 (4%)		

*Source: Clarkson University Data Digest, for undergraduate students only, accessed on 15 January 2025 [22]
**Not a major offered at Clarkson, representing students that participated from partnered institutions.

Another example is the impact that happens to students who then depart Clarkson University and move into their careers. As an example, here is an excerpt from a recent unsolicited email received by one of the authors from a former C3G student participant (used with permission):

"I thought you might also want to hear where I am at now a year and half or so after graduation. I continued working for Pike on the Canton Potsdam Hospital until June 2024 where I got asked to join a new project for Pike and move to Minnesota. So I am out here in the Midwest working on a Walmart distribution center. This project is huge! It's ~$400 million, 600,000 square feet, and will be fully automated. I'm really enjoying this experience so far and we're still so early on in the process!"

"I still credit C3G for getting me to where I am now. I truly believe that and wouldn't have changed a thing!" [23]

While anecdotal, this is demonstrative of how every participant has garnered some positive learning from the experience with C3G. Within 18 months of graduation, former students are leading construction projects valued in the hundreds of millions of dollars; now that is impact.

Case Study: Lake Placid Electric Department

In the early Spring of 2019, C3G was contacted by the Lake Placid Municipal Electric department to discuss the possibility of C3G students helping to modernize the way the utility stores and maintains electrical infrastructure in the municipality. Many small-town government departments such as highway, planning, engineering, public works, etc., still do not have the technical capability or monetary resources to upgrade the software and database systems for managing infrastructure. Lake Placid was no exception, however the department head had heard of GIS and was hopeful C3G could assist.

To start the project, we hosted a kickoff meeting with our students and the utility managers, assigning a student project manager. The student project manager led a team of students through the process of converting legacy CAD data into an online interactive GIS database of electrical infrastructure in the town of North Elba (the township in which Lake Placid resides). The project involved the following tasks:

- Converting CAD to GIS
- Digitizing missing features
- Creating a database containing the elements below:
    - Utility Poles
    - Wires
    - Circuits
    - Light poles
    - Transformers
    - Pads
- Building the GIS data schema to include voltage, wattage of lights, switch ratings, etc.
- Field work to verify quality of results
- Presentation, hand off and training of the department staff

Figure 3 is an example of data students created for the municipality.

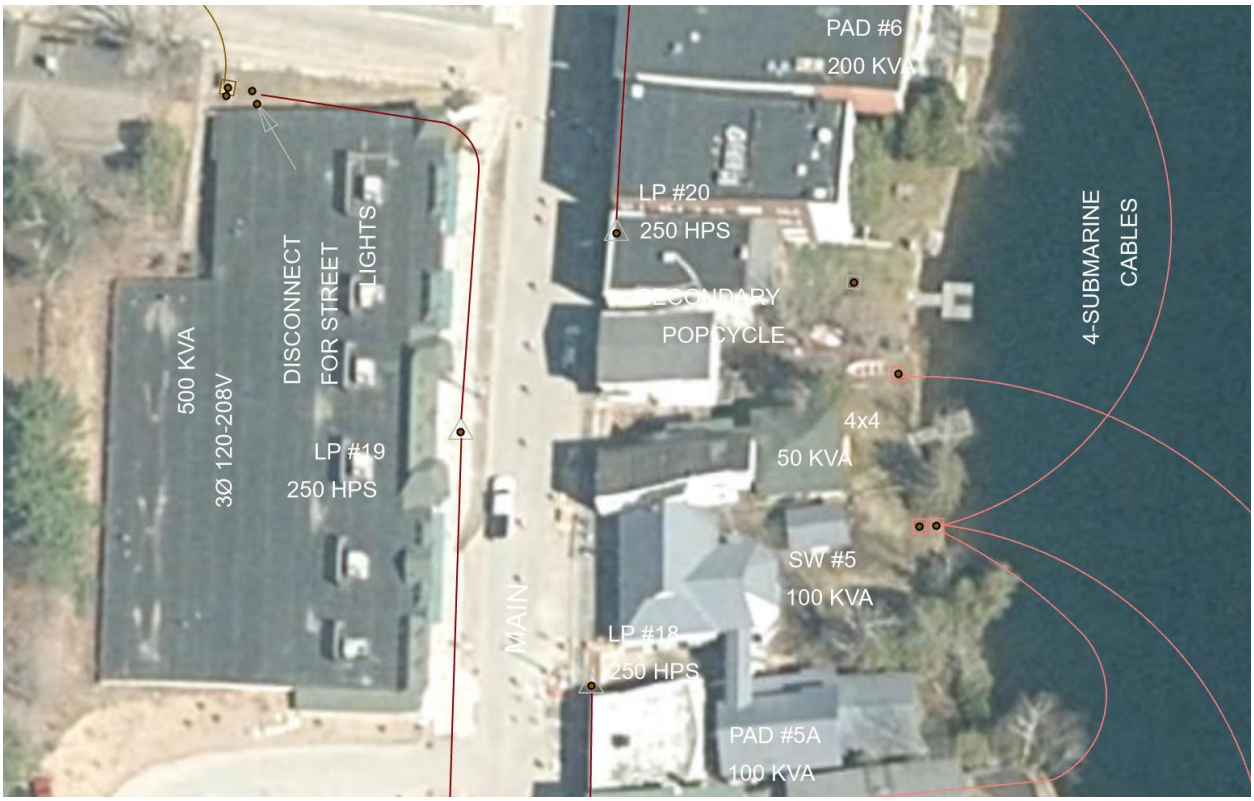


Figure 3. Electric infrastructure in the Village of Lake Placid.

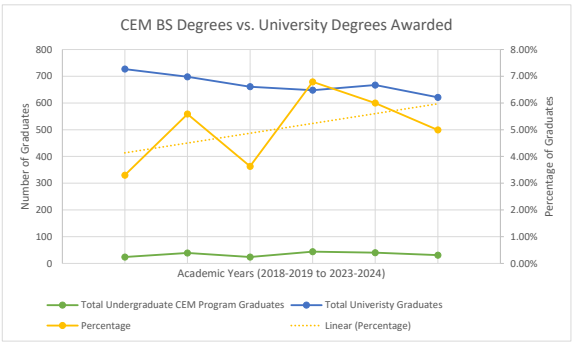
Overall, the project was a huge success, and the students learned the importance of accurate mapping and how to work with local government officials and utility managers. The project manager ended up being hired and working for the utility as a full-time GIS and engineering technician upon graduating.

C3G's Impact: The University

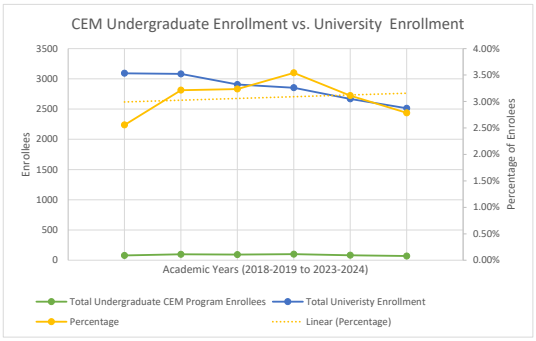
The last demonstration of impact is on the program and institution itself. Without question one of the critical needs of any higher educational institution is to maintain a positive town-gown relationship with its host community. Thus, the fact that C3G is particularly community and non-profit organization supporting, gives the institution a very tangible mechanism to point to as a bulwark of its contributions to the community. This is particularly notable when community clients, such as Ms. Morley or Mayor Jacobs-Wilke above, willingly and publically provide accolades for the institution and what C3G projects have done for them.

Another way to measure impact for the program and university is to look at the performance statistics of the CEM program which houses C3G. As was indicated in introduction there are many accomplishments including regional and national ASC awards, a $12,000 increase in starting salaries over the last 5 years, and 100% placement for over a decade. Beyond, this

however, there are some other notable statistics that demonstrate how C3G is helping the CEM program, and thus the university. The following two charts present enrollment and graduation data in the CEM program as compared with the overall university from academic year 2018-2019 through to 2023-2024 (Figure 3a and 3b).



3a



3b

Figures 3a & 3b. Clarkson CEM Graduation and Enrollment compared with the University*
*Data Sources: The Clarkson University Data Digest and the 2019-2023 & 2023-2027 CEM Program Strategic Plan Scorecards

While C3G cannot be said to be the only or proximate cause for the trends in improving both graduation and enrollment for the CEM program, it certainly is a contributor. When the university is seeing declining enrollment (Figure 3b) any program that is growing against those headwinds, is of benefit to the whole. Thus, an initiative like C3G is having an overall impact on the CEM program for sure, and the university as a consequence.

Conclusions and Lessons Learned

The Clarkson University Construction Engineering Management (CEM) Consulting Group (C3G) is an in-house capability that provides pre-professional consulting in planning, engineering, and construction areas within the university, non-profit organizations, and communities in New York State. This ongoing part of the CEM program is having positive impacts on the communities served, the students that are a part of the program, and the university itself, as indicated by the initial data presented in this paper.

While achieving success in many facets of having students as consultants, applying learning by doing principles in a heightened fashion, there are several lessons learned. First, the transient nature students that staff C3G requires considerable time and effort on the part of the faculty. This has included creating an annual “boot-camp” at the start of each summer, to ongoing training or re-learning on topics that are not covered in core curricula or available course electives, to chaperoning student interns as they present to public agencies or municipalities. Second, while C3G does bring in significant revenue, there are significant expenses. The student participants are paid interns year round (part-time during the academic year and full-time in the summer) requiring bi-weekly draws necessitating a significant forward funded cash flow. This is coupled, in the summer, by the program covering the cost of housing, at the very start of the fiscal year. Nested within the overall CEM program, which operates outside of the university fiscal year, C3G has been able to manage the cash flow challenge and also net positive revenue on an annual basis. As such an effort like this, standing alone would not be able to sustain itself

as C3G has for almost a decade. Lastly, the need for efforts like C3G is significant. The CEM program did not do any specific marketing for the C3G effort and the work that has come to C3G has been by "word of mouth" and by virtue of university press releases. As of this writing, C3G has almost $80,000 in backlog work as well as several other requests for proposals/projects that it is addressing in the near term that it is certain to capture. Being aware of this demand is a signal for other academic engineering programs that there is a tangible and mutually beneficial opportunity to replicate the C3G model in other places and at other forward leaning institutions.

In conclusion, the success of C3G using students as consultants, is a potential model that engineering educators can learn from in order to put learning by doing to the test

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