The Journey of Establishing and Operating an Innovation Center to Nurture Future Engineering Innovators

Dr. Chun Kit Chui, University of Hong Kong

Dr. Chun Kit Chui serves as the Director of the Tam Wing Fan Innovation Wing in the Faculty of Engineering at the University of Hong Kong (HKU). Innovation Wing aims to unleash students' creativity by entrusting them to spearhead ambitious innovation and technology projects that will shape the future. The iconic facility is located at the heart of the campus, offering 2400m2 of space with state-of-the-art resources and a supportive environment to enhance hands-on and experiential learning for undergraduate students.

He also holds the position of Senior Lecturer in the Department of Computer Science at HKU. His research interests include database and data mining, as well as pedagogical research in computing education. Dr. Chui has received several education awards, including the University Outstanding Teaching Award (Individual Award) at the University of Hong Kong for the 2015-16 academic year and the Faculty Outstanding Teaching Award (Individual Award) in the Faculty of Engineering for the 2012-13 academic year. Additionally, he has been honored with the Teaching Excellence Award in the Department of Computer Science for the academic years 2011-12, 2012-13, 2013-14, 2014-15, and 2015-16. Furthermore, he was a shortlisted candidate for the UGC Teaching Award (Early Career Faculty Member).

Prof. Norman C. Tien, University of Hong Kong

Norman C. Tien is the Taikoo Professor of Engineering and Chair Professor of Microsystems Technology at the University of Hong Kong (HKU). He is also currently the Head of Innovation Academy of Faculty of Engineering and the Managing Director of the Centre for Transformative Garment Production. He served as the Dean of Engineering from 2012 to 2018, and as the Vice-President and Pro-Vice-Chancellor (Institutional Advancement) from 2019 to 2021 at HKU.

Prior to joining HKU, Professor Tien was the Nord Professor of Engineering at Case Western Reserve University, where he was the Dean of Engineering from 2007 to 2011. He previously held faculty positions at University of California at Davis, University of California at Berkeley and Cornell University.

Professor Tien received his Ph.D. from the University of California at San Diego, MS from the University of Illinois, and BS from the University of California at Berkeley. His research interests are in the area of micro and nanotechnology, microelectromechanical (MEMS) systems, and robotics.

The Journey of Establishing and Operating an Innovation Center to Nurture Future Engineering Innovators

Abstract

This practice paper presents the establishment and operation of the Tam Wing Fan Innovation Wing (a.k.a. the HKU Inno Wing), a student innovation center at the University of Hong Kong. The project was initiated in 2016 within the engineering faculty, with the goal of creating a comprehensive workspace that nurtures students' innovation in engineering and technology. To gather valuable insights, we conducted visits to leading universities and makerspaces in the United States, studying their innovative infrastructure designs and program development. We then incorporated these experiences into the design of our center. Since its launch in 2020, the Inno Wing has actively supported Student-Initiated Interest Groups (SIGs) and Student-Initiated Courses (SICs) focused on technology exploration and development. These student-driven initiatives are interdisciplinary and project-based, providing a platform for students to engage in hands-on learning experiences.

To assess the impact of the Inno Wing on students' learning and development, we conducted a study using student surveys and alumni interviews. The results indicate that participation in SIGs and SICs effectively enables students to leverage the resources provided by the center, enhancing their acquisition of core engineering competencies. These competencies include technical skills, innovation, problem-solving abilities, project management, teamwork, and leadership, all of which are essential for future engineers. However, the survey also identified areas for improvement, particularly in terms of networking opportunities and global awareness. Suggestions were made to address these shortcomings.

This study offers practical insights for advancing engineering education through innovative infrastructure and serves as a reference case for planning, executing, and managing similar initiatives in higher education institutions.

Keywords Innovation center, student-centered approach

Introduction

In 2016, the engineering faculty at the University of Hong Kong initiated the Tam Wing Fan Innovation Wing (a.k.a. the HKU Inno Wing) project with the goal of establishing and operating an innovation center at a prominent location on campus. The primary educational objective of the Inno Wing is to empower students, allowing them to unleash their creative potential by spearheading ambitious innovation and technology projects. To support this vision, the engineering faculty secured a generous $12.8 million donation from a donor who shared our enthusiasm. In recognition of this contribution, the physical infrastructure was named after the first donor. Furthermore, multiple donors were engaged, collectively donating $4.9 million to provide a wide range of programs, learning activities, and funding opportunities for student projects. These initiatives are coordinated by the Innovation Academy, which designs and implements extracurricular programs in the Inno Wing to inspire, equip, and showcase students' innovation.

Related works

Numerous universities advocate for transforming students into innovators through engineering education by establishing innovation infrastructures [1]. These initiatives focus on enhancing students' innovation competencies, as summarized in the framework researched in [2], which comprises skills such as problem-solving, design thinking, creativity, project management, prototyping, teamwork, and leadership, etc. One effective pedagogical approach in this regard is challenge-based learning (CBL) [3], which engages students in the identification, analysis, design, and implementation of solutions to open-ended sociotechnical problems [4]. CBL is inherently multidisciplinary, drawing on diverse perspectives and skills required in product development [5] and design thinking [6]. In complement to the traditionally theoretical richness of engineering education, CBL places a strong emphasis on hands-on experiences, fostering a deeper understanding of real-world challenges, and encouraging innovative thinking [7].

Academic makerspaces serve as a valuable support to challenge-based learning (CBL) by providing essential prototyping facilities [8], technical expertise, and fostering community engagement [9]. Notable examples include the Jacob Institute for Design Innovation [10] at University of California, Berkeley; the d.school [11] and the Product Realization Lab [12] at Stanford University; the Center for Engineering Innovation and Design (CEID) [13] at Yale University; TechSpark [14] at Carnegie Mellon University; the Sears think[box] [15] at Case Western Reserve University; the HIVE Makerspace [16] at Georgia Tech University; the project Manus [17] at the Massachusetts Institute of Technology; the Olin Shop [18] at Olin College of Engineering; and the Engineering Product Innovation Center (EPIC) [19] at Boston University. These pioneers in academic makerspace initiatives have laid the foundation for the continuous development of these innovative infrastructures, which provide an ideal environment for product development projects [20] and design-thinking courses [21] [22], seamlessly aligning with existing engineering curricula [23] [24].

Furthermore, the innovation infrastructures provide essential support for student-initiated, passion-driven projects beyond formal coursework [25]. These extracurricular initiatives often require dedicated institutional support, such as workspaces, funding, and the involvement of advising staff and mentors [26] [27]. When appropriately nurtured, these initiatives hold the potential to yield significant technological breakthroughs [28] [29] and learning outcomes related to innovation competencies [30] [31] [32] [33] [34]. This presents a valuable opportunity to formalize dedicated support and recognize the intrinsic value of student-initiated, passion-driven extracurricular initiatives in shaping well-rounded engineering innovators - an emphasis of the Tam Wing Fan Innovation Wing project in this paper.

In 2017, we conducted visits to leading U.S. universities' academic makerspaces [10] [11] [12] [17] [19] and innovation infrastructures [35] [36], studying their designs and incorporating their best practices into the development of the Inno Wing.

The journey of establishing and operating the innovation center

1. Establishing the physical infrastructure and the management structure

The design and construction phase of the center was commenced in late 2017. The architectural design of the Inno Wing embodies the guiding principles of transparency, openness, and vibrancy, as depicted in Figure 1. Since the completion of the physical infrastructure in December of 2020, the Inno Wing has quickly become an iconic landmark at the University. It not only provides a state-of-the-art facility for students to innovate and collaborate but also serves as a symbol of the University's commitment to fostering innovation and technological advancement.

Figure 1a. Transparent design connects student innovation in engineering and technology with the public, establishing it as an iconic landmark on campus.

Figure 1b. Openness and vibrant design unite various physical components into a 2,000-square-meter comprehensive innovation center.

Internally, the Inno Wing offers a spacious 2,000-square-meter workspace that comprises five distinct components: the Social Space, Maker Space, Activity Space, Resource Hub, and Thematic Workshops. These components create an all-in-one environment where students can pursue their engineering and technology passions. Figure 2 illustrates the layout and design of the components.

The Social Space (Figure 2a) serves as a vibrant hub for idea generation and sharing. It features an open area and project walls that foster a culture of collaboration among students. This space encourages interdisciplinary interactions and provides a platform for students to exchange innovative ideas. The Maker Space (Figure 2b) is fully equipped with state-of-the-art prototyping tools, a machine shop (Figure 2c), and digital facilities. It offers students the opportunity for hands-on creation and experimentation, enabling them to bring their ideas to life and transform concepts into tangible prototypes. The Activity Space (Figure 2d) provides multipurpose halls and studios that accommodate the testing and deployment of prototypes. This area offers students a dedicated space for refining their projects and conducting experiments, ensuring they have the necessary resources to test the viability and functionality of their innovations. The Resource Hub (Figure 2e) serves as a centralized technical support hub within the center. It provides troubleshooting assistance, technical guidance, and access to project funding, supporting students throughout their innovation journey. Thematic Workshops introduce students to cutting-edge

Figure 2a. Social Space for brainstormng new ideas.

Figure 2b. Maker Space for prototyping.

Figure 2c. Machine shop.

Figure 2d. Activity Space for testing and deployment.

Figure 2e. Resource hub offers troubleshooting and funding.

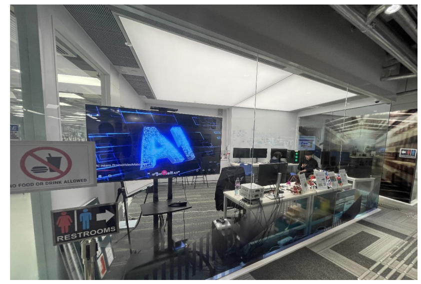

Figure 2f. Thematic workshops for new techs (e.g., gen-AI in 2023).

technologies and equipment related to specific themes. These workshops enable students to learn new technical skills and explore the latest advancements in various fields. For example, in the 2023/24 academic year, a thematic workshop focused on generative AI technologies (Figure 2f) was created to support students' learning in this emerging field [37].

On the management structure, a dual leadership model, strategically focusing on two main aspects of the center: hardware and software, is established. The hardware side oversees day-to-day operations, including the management of state-of-the-art facilities, operational safety, technical support, academic advising, tutor services, workspace coordination, as well as public relations. These responsibilities are overseen by the Director of the Inno Wing. Importantly, the director also guides the strategic development of the center, driving its growth to fulfill the center's missions. On the software side, comprising academic programs aimed at enhancing students' innovation and leadership skills, is led by the Head of the Innovation Academy.

In contrast to operating as a standalone support unit, the Inno Wing actively leads engineering departments in advancing undergraduate pedagogy through its innovative infrastructure. To establish a supportive network, the faculty has formalized an executive committee, overseen by the Associate Dean of Engineering (Student Enrichment). As depicted in Figure 3, the committee comprises the Heads of engineering departments as members, whose responsibility is to monitor and provide guidance regarding each department's contribution to supporting the day-to-day operations and activities of the center. In particular, departments will assign academic staff to provide advice on student-initiated projects. Technicians from departments will also collaborate with the center, forming an interdisciplinary technical expert team for enhancing the hands-on

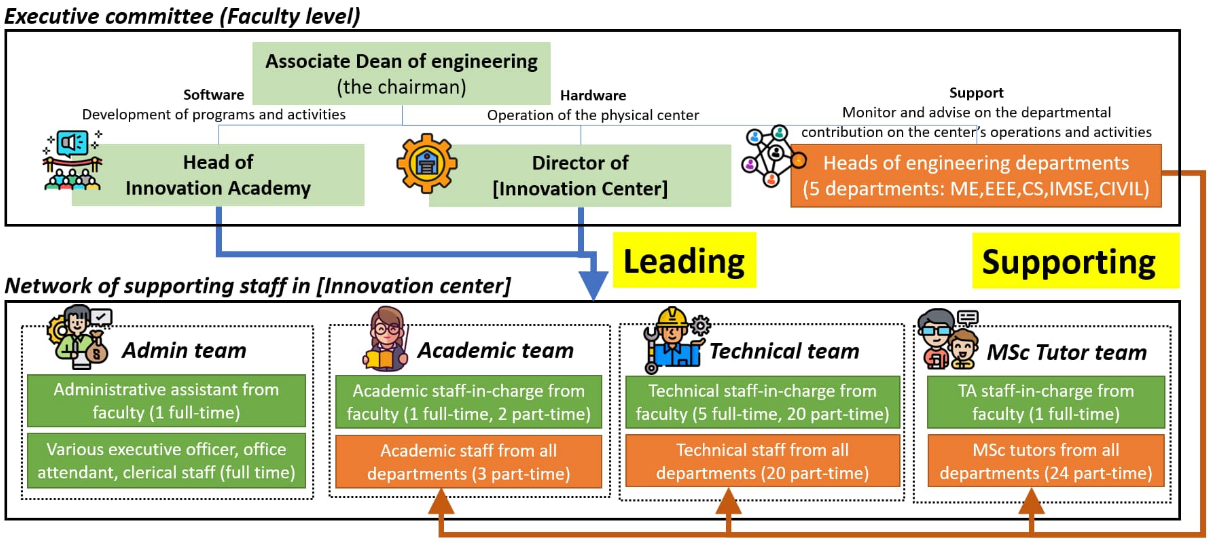

Figure 3. The executive committee (faculty level) and the network of supporting staff in Innovation Wing.

competencies of the students [38]. Masters' tutors will also be hired by departments and trained in the center [39], forming a mature and knowledgeable supportive network to foster an inclusive, diverse, and equitable workspace [40].

2. Nurturing student-initiated interest groups (SIGs)

Since the center commenced operations in 2020, it has been hosting the Student-Initiated Interest Group (SIG) program [41], which aims to onboard project teams that are both student-initiated and student-led to the center. This initiative integrates the project team into the center's framework, enabling them to leverage its resources for technology exploration and development. Figure 4 illustrates the growth in the number of SIGs, with 24 established SIGs in the center as of 2022/23. Figure 5 showcases the diversity of student interests within the SIGs in 2022/23, highlighting a wide range of contemporary topics, including AI, robotics, VR/AR, smart technologies, blockchain and more.

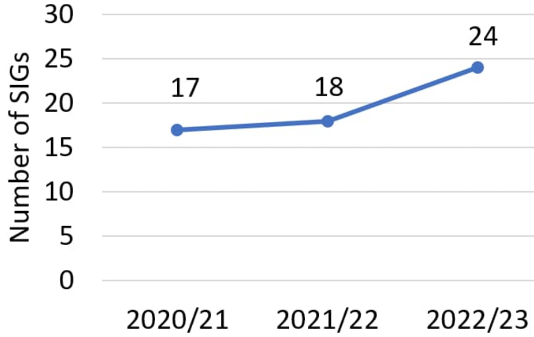

Figure 4. Number of SIGs.

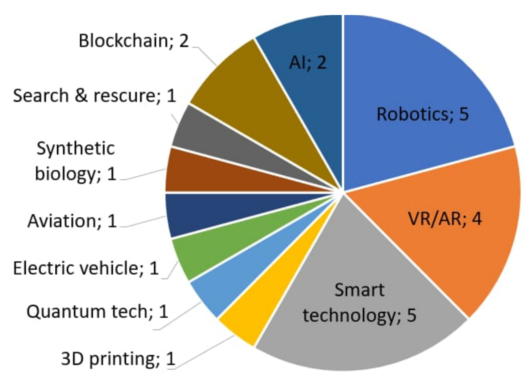

Figure 5. Technology topics of the SIGs in 2022/23.

On the academic diversity, Figure 6 reveals the increase of non-engineering participants, rising from 34 in 2021/22 to 126 in 2022/23. This suggests that the SIGs have attracted students from diverse academic backgrounds to engage in interdisplinary collaboration. Figure 7 further reveals the academic diversity of teams in 2022/23 by counting the number of unique study programs among the teammates of each SIG. We observe that 11 out of 24 teams comprise students from three or more study programs. This result is encouraging, demonstrating that the SIGs offer rich interdisciplinary learning opportunities.

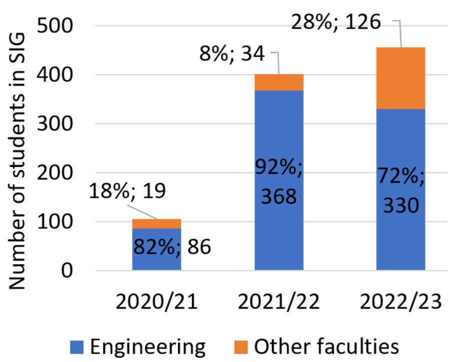

Figure 6. Number of students in SIGs. (Break down by engineering and other faculties).

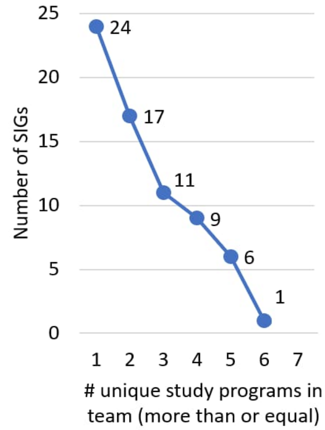

Figure 7. Number of unique study program in team composition in each SIG in 2022/23.

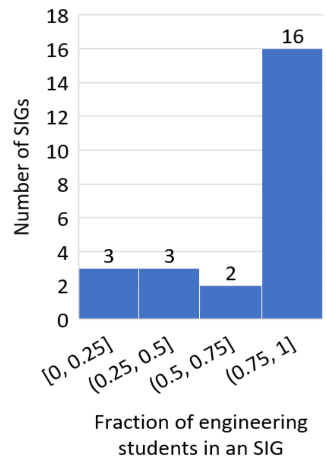

Figure 8. Fraction of engineering students in each SIG in 2022/23.

However, we also discover that not all SIGs are collaborating with students crossing faculty boundaries. Analyzing the fraction of engineering students in each of the 24 SIGs for 2022/23, as presented in Figure 8, highlights the extent to which engineering students engage in cross-faculty teamwork. The results indicate a skewed distribution towards the 0.75-1 spectrum, revealing that 16 out of the 24 SIG teams are engineering-dominated. Three of the teams fall in the 0-0.25 spectrum, indicating minimal or zero engineering students' involvement. This distribution reveals there is room for improvement to increase collaboration among engineering students and students from other faculties, leading to the introduction of Student-Initiated Courses (SICs).

3. Developing student-initiated courses (SICs)

Since 2021/22, we introduced the Student-Initiated Course (SIC) program to empower mature SIGs to design, develop, and teach semester-long courses on technology-related topics for other students. Inspired by the DeCal program [42] at the University of California, Berkeley, this initiative engages senior and experienced students to lead active peer learning of technical skills for other students. Figure 9 shows the hands-on learning experience within an SIC organized in Inno Wing, where senior student instructors share their practical knowledge and skills with other student learners. In recognition of this out-of-classroom learning, the center awards special credits, listed on participants' transcripts, for both student instructors and learners.

Table 1. The Student-Initiated Courses in 2022/23 on Robotics and AI theme.

SIG	Student-Initiated Course	Participants	Percentage of cross-disciplinary learners	No. of unique study program
A	Introduction to Mechanical Design for Robotic System	27	66.7%	12
A	Introduction to Robotics - Electronics System and Software	30	66.7%	6
B	Mechanical Training Program	21	95.2%	11
B	Hardware Training Program	34	82.4%	13
C	Bio-inspired Robotics - Introduction to Robotics	24	70.8%	9
D	AI and Robotics: An Introduction by Astar	23	100%	5

In 2022/23, four SIGs offered six courses on topics related to robotics and AI, as outlined in Table 1, for a combined enrollment of 159 student learners. Delving into the syllabuses of these SICs, as outlined in [43], reveals a diverse range of topics, including mechanical engineering skills such as CAD drawings and practical machining, electronic engineering concepts including electronic systems and firmware, as well as computing topics like programming and machine learning.

We analyzed the study programs of each participant and classified him/her as a "cross-disciplinary learner" if the skills taught in the courses were not covered in his/her academic program. The data demonstrates that at least two-thirds of the participants in the SICs are cross-disciplinary learners, originating from diverse academic backgrounds. Remarkably, these SICs, entirely designed and taught by undergraduates in the SIGs, are open to students from all academic programs. This inclusivity is advantageous as it allows SIGs to attract and train potential new members, while providing students from diverse backgrounds with an entry pathway to learn and engage with SIGs. Consequently, this fosters more cross-disciplinary collaborations.

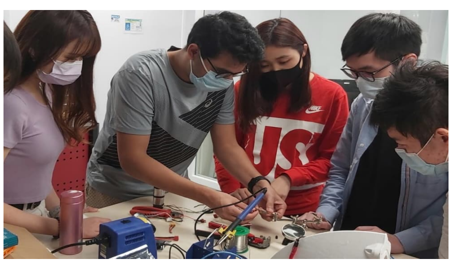

Figure 9. "*Student-initiated Courses*" - senior and experienced students facilitate active peer learning.

Figure 10. "*Pitch Your New Idea*" - students present tech ideas, recruit teammates, and receive feedback.

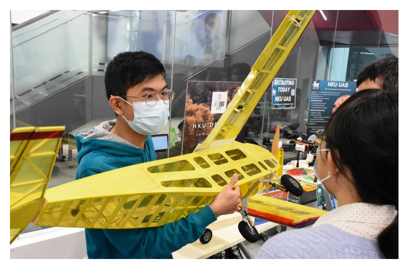

Figure 11. "*InnoShow*" - opportunity to showcase innovative projects and network with others.

To scale up participation in SIGs and SICs, the center develops activities aimed at inspiring, equipping, and showcasing students' innovation. As depicted in Figure 10, it organizes regular pitching events to provide a platform for proposing and refining new ideas, followed by invited seminars that enrich students' understanding with academic and industry insights [44]. Hands-on workshops equip students with technical skills for prototyping. Finally, the project exhibition events, as shown in Figure 11, celebrate achievements, offering networking opportunities for growth. This holistic approach motivates students to participate in or initiate new SIGs and SICs in the Inno Wing.

Evaluation of the impact on students' learning and development

Methodology

To assess the center's impact on student learning, we conducted an online survey study. Respondents were asked to rate the center's influence on selected engineering competencies using a 5-point Likert scale, ranging from "Strongly disagree" (1) to "Strongly agree" (5). The survey was open for three months, collecting 138 responses, of which 59 were participants of SIG/SIC and 79 were other students who utilized the centers' facilities but did not participate in any SIG/SIC. We report the average scores of these two groups of students in Table 2.

The survey also included qualitative questions, allowing students to elaborate on how the center influenced their personal learning and development, and provide feedback on strengths and areas for improvement. The qualitative questions are analyzed using a coding scheme described in [45]. No predetermined themes were set in the analysis, and the uncovered themes emerged from the data itself. The initial coding process was an open exploration, and the data were subsequently annotated. Words and sentences under each criterion were unitized and labeled as mutually exclusive categories [46]. Subsequent readings allowed for the emergence of themes and observations.

To assess the center's longer-term impact on students, we interviewed two recent graduates who spearheaded the bio-inspired robotics SIG. This group successfully designed and constructed robotic fish, setting Guinness World Records for the world's fastest 50m swim by a robotic fish in 2020. The interviews aimed to reveal how their experiences at the Inno Wing influenced their personal growth and future career development.

1. Online survey – assessing the impact on students' learning

Table 2. Average scores of n=138 responses (SIG/SIC students = 59, other students = 79) from an online survey. "Other students" refers to those who utilized the center's facilities but did not participate in any SIG/SIC activities.

Item	Description	SIG/SIC students	Other students
1.	The center enhances technical proficiency in engineering and technology.	4.5	4.3
2.	The center fosters students' creativity and innovation.	4.6	4.3
3.	The center improves students' problem-solving skills.	4.4	4.2
4.	The center develops students' project management abilities.	4.3	3.8
5.	The center promotes students' teamwork and collaboration skills.	4.3	4.1
6.	The center improves students' leadership skills	4.2	3.9
7.	The center embraces interdisciplinary diversity.	4.1	3.7
8.	The center promotes a culture of lifelong learning.	4.4	4.0
9.	The center provides opportunities for students' networking and exposure.	4.1	3.5
10.	The center increases students' global awareness.	4.0	3.4

Comparing the two groups of ratings, SIG/SIC participants consistently demonstrate higher ratings across all aspects. This suggests that participation in these programs effectively enables students to utilize the center's resources for better achievement of those competencies compared to those who did not participate. The trend is particularly notable in the areas of project management, teamwork, leadership, interdisciplinary learning, and lifelong learning (items 4-8), which received reduced ratings for other students. The student-led, project-based, and interdisciplinary nature of SIG/SIC provides an authentic learning environment for students to acquire the aforementioned generic skills, significantly improving ratings on these items by an average score of 0.2-0.5.

Regarding the lowest-rated aspects of networking opportunities and global awareness (items 9 and 10) for other students, these were attributed to the slower resumption of networking and global outreach programs following the regional impact of the pandemic on the institution. The pandemic significantly affected operations in 2020/21 and Semester 2 of 2021/22, resulting in the suspension of face-to-face learning from January 2021 to May 2021 and a pause in hands-on activities. However, participation in SIG/SIC has shown a modest improvement of average score of 0.6 in these areas. This improvement can be partly attributed to the center's activities, such as pitching sessions, seminars, and showcase exhibitions, which provide opportunities for SIG/SIC participants to network with fellow students, academics, and industry innovators, including visitors from overseas. These findings suggest that expanding SIG/SIC and the aforementioned center's activities to reach more students would be worthwhile.

Furthermore, as an ongoing measure to address the lack of networking opportunities and global awareness, a global outreach program was implemented in the academic year 2023/24 to enhance students' global awareness in an authentic manner. This program includes organizing study trips that send students on exploration trips to research labs and tech companies overseas, allowing them to gain insights into the latest technology developments from a global perspective. These initiatives are accompanied by networking experience sharing activities for students who have participated in the outreach program. These students have the opportunity to share their experiences with their peers in the Inno Wing, thereby fostering a collaborative and knowledge-sharing environment within the center.

The qualitative section of the survey, capturing insights into the center's impact on students' personal learning and development, received 54 responses. Among these, 52 responses conveyed a positive influence, which were analyzed with a coding scheme, resulting in four themes. The primary theme highlighted the positive impact of center's facilities and resources enabled the exploration and learning of technology. For instance, one student shared, “*I learned useful machines and tools from tutors and friends,*” Another noted, "*I learned to build a customized AI chatbot from student instructors; they are amazingly talented and helpful,*" The second theme centered on the teamwork experience. Examples included, "*I cherish the time our team worked day and night and finally brought our prototype to life!*". The third theme highlighted the activities organized by the Innovation Academy. For instance, a student noted, "*…inspiring to see many innovative projects in the InnoShow!*" Another expressed, "*…inspiring to learn about advanced robotics technologies … developed my passion to use robots to improve human's life.”* Remaining responses were categorized into miscellaneous themes, generally referring to the creative environment and the students' bonding with the community, including student peers, MSc tutors, and the Director.

Two student responses stand out as criticism. One student mentioned, "*I learned how bad my time management skills are*," while another shared, "*Handling budget and reimbursement are tedious and a nightmare*." These responses reveal the challenges and pressures faced by students heavily involved in SIG/SIC, such as tight deadlines, time constraints, financial acumen, and conflict resolution. Consequently, it highlights the importance of providing timely mentoring support to students in the center.

Regarding qualitative feedback on the center's strengths, major comments highlighted the provision of state-of-the-art equipment (48%), availability of project resources (44%), comfortable student space in a prominent location (24%), and support from peers, tutors, technicians, and admin staff (28%). In terms of areas for improvement, respondents predominantly commented on equipment management (74%), covering aspects such as maintenance, operational support, and new equipment requests. Space management issues (29%), including storage and project space requests, and staff performance (8%), with an emphasis on having more available and active tutors, technicians, and admin staff.

2. Alumni interview – exploring influence on personal growth and future development

Figure 12. The bio-inspired robotics team achieved two Guinness World Records for the fastest robotic fish swim. Two leaders shared their insights on Inno Wing's impact on their personal growth and future development.

We conducted interviews with recent graduate students who held leadership roles in the bio-inspired robotics SIG, as depicted in Figure 12. This team serves as an exemplary instance of a successful project with technological breakthroughs achieved by students within the center. The project, entirely extracurricular, originated from the shared interest of engineering students exploring underwater technology. Initially conceptualized as a technology exploration project rather than a profit-making start-up, the team found its home in the Inno Wing, where it grew into a cross-disciplinary team with students from diverse academic backgrounds. The success of this project leads to potential life-saving and ESG (Environmental, Social, and Governance) applications, showcasing its positive impact on both society and sustainable practices.

Student A founded the SIG as a mechanical engineering undergraduate in 2017. Student B, an undergraduate in computer engineering, took up the leadership in 2020. Both students have graduated and pursued distinct paths. Student A is now pursuing a Ph.D. in robotics, and Student B is now the CEO of a tech startup in AI. The interviews aimed to explore the lasting impact of the Inno Wing on their development. When reflecting on the impact of the center during their studies, both students emphasized its role as a unique infrastructure supporting students' innovations and prototyping. Student A articulated, "*It supports students' engineering explorations and crazy ideas. We put our theoretical innovations of robotic fish design into implementations here…,*".

Regarding the perceived value of the Inno Wing, both students referred to it as a hub where engineering enthusiasts, great ideas, and achievements converge, creating a stimulating and attractive space in the institution. Student B expressed, "*It establishes an ecosystem for diverse students to collaboratively work on large-scale projects within well-designed facilities.*" Student A also stressed the importance of collaboration, stating, "*Here the team evolved from a mechanical focus to a cross-disciplinary approach, with everyone contributing to project success. We have students in mathematics for fluid dynamics, electronic engineering for circuit design, computing for control, and business for project finance.*"

In terms of longer-term development and career impact, Student A views it as a platform providing opportunities and exposure for undergraduates, as he shared "*At this place, students have the opportunity to interact and to showcase innovative designs to industry experts and renowned researchers.*" When elaborating on experiences influencing his research career, he highlighted the development of problem-solving abilities "*We encountered numerous challenges, both in terms of theoretical complexities in design and technical feasibility in the building of the world's fastest robotic fish. We learned to systematically address engineering problems, involving cycles of data collection, analysis, reengineering designs, and continuously improving until we achieved success. This training is invaluable and applicable throughout a lifetime.*" On the other hand, Student B's focus was on team leadership "*As the project is student-run, I developed leadership skills by managing and leading my team. This involved actively listening to individual feedback, emphasizing individual growth opportunities, and, most importantly, fostering team dynamics and building trust through articulating the project's values and purposes.*" When delving into the specific learning aspects most impactful to his start-up career, he shared, "*Beyond technical knowledge, the most important skill I acquired here is the ability to communicate with diverse stakeholders and convincingly convey ideas with confidence.*"

At the end of the interviews, both students expressed appreciation for the Inno Wing and confirmed its unique influence on personal growth. Student A emphasized the importance of technical skills and shared "*An idea without execution is just a concept. I believe the center will continue to uplift the technical competencies of future students, which the majority of them are still lacking at the current stage. As I embark on my Ph.D. research in another institute overseas, I am committed to contributing to the continued growth and development of the center on the global stage.*" Meanwhile, Student B highlighted the importance of nurturing innovative mindsets among students, and he concludes "*A dream becomes a goal when written, and a plan when timelined. I envision the center to excel in nurturing students' innovative mindsets and cultivating their sense of urgency, direction, and responsibility. I am happy to back and contribute anytime.*"

Conclusion

This practice paper outlines the establishment of an innovation center designed to support student-initiated and student-led projects and education. The center serves as a central hub for hosting Student-Initiated Groups (SIGs) and Student-Initiated Courses (SICs). Participation in these initiatives has proven to be effective in enabling students to leverage the center's resources, thereby enhancing their acquisition of core engineering competencies. These competencies include technical skills, innovation, problem-solving abilities, project management, teamwork, and leadership, all of which are essential for the future success of engineers.

However, during our assessment, we also identified a shortage of networking opportunities and global awareness for students within the Inno Wing. To address these shortcomings, the Innovation Academy has introduced the "*Reconnecting with the World*" program in the 2023/24 academic year as a future work of this practice paper. This program aims to revitalize international collaboration following the impact of the pandemic. To facilitate this, scientists and innovators from around the world are being invited for extended visits, fostering cross-institutional collaborations and partnerships on a global scale.

The HKU Inno Wing not only seeks to introduce innovative pedagogical initiatives in engineering across institutes but also strives to extend its support and collaboration to educators worldwide, benefiting students in a global arena. By actively engaging with educators and institutions internationally, the center aims to create a dynamic and inclusive learning environment that prepares students to excel in a rapidly evolving global landscape.

Acknowledgement

We would like to acknowledge the support provided by the Tam Wing Fan Innovation Wing, Faculty of Engineering, University of Hong Kong. We are grateful for the support received from the Faculty of Engineering, HKU, as well as the Tam Wing Fan Innovation Fund and the Philomathia Foundation Innovation Fund. Additionally, we extend our heartfelt gratitude to the founding staff of Inno Wing, including Professor Norman C. Tien, Mrs. Wendy Ma, and Professor Leslie George Tham, as well as the colleagues and students involved in the SIGs and SICs. Their dedication and contributions have been the key driving force behind the remarkable success of the project. We would also like to acknowledge the Estates Office of the University of Hong Kong for granting the authorized use of Figure 1a and Figure 1b in this practice paper.

Ethical approval

Ethical approval for this study was obtained from the University of Hong Kong, with HREC reference number EA230632.

References

[1] T. W. Barrett, M. C. Pizzico, B. Levy, R. L. Nagel, J. S. Linsey, K. G. Talley, C. R. Forest and W. C. Newstetter, "A review of university makerspaces," in *ASEE Annual Conference & Exposition*, 2015.

[2] Charosky, G., Hassi, L., Papageorgiou, K., & Bragós, R. (2022). "Developing innovation competences in engineering students: a comparison of two approaches." *European Journal of Engineering Education*, 47(2).

[3] Malmqvist, J., K. K. Rådberg, and U. Lundqvist. 2015. "From Problem-based to Challenge-Based Learning – Motives, Examples, Outcomes and Success Factors," *the 11th international CDIO conference*, 2015.

[4] Taconis, Ruurd, and M. M. Bekker. "Challenge Based Learning as authentic learning environment for STEM identity construction." *Frontiers in Education.* Vol. 8. Frontiers Media SA, 2023.

[5] Albers, A., Matthiesen, S., Bursac, N., Rapp, S., Hölz, K., & Eisenmann, M. (2018). "PGE-Product Generation Engineering in Engineering Education: Real-World Problems for Beginners in Student Projects," In DS 93: *Proceedings of the 20th International Conference on Engineering and Product Design Education (E&PDE 2018),* Dyson School of Engineering, Imperial College, London. 6th-7th September 2018 (pp. 68-73).

[6] Charosky, G., Leveratto, L., Hassi, L., Papageorgiou, K., Ramos-Castro, J., & Bragós, R. (2018, June). Challenge based education: an approach to innovation through multidisciplinary teams of students using Design Thinking. In 2018 XIII *Technologies Applied to Electronics Teaching Conference (TAEE)*. IEEE.

[7] Gerardou, F. S., Meriton, R., Brown, A., Moran, B. V. G., & Bhandal, R. (2022). "Advancing a design thinking approach to challenge-based learning," In *The Emerald Handbook of Challenge Based Learning* (pp. 93-129). Emerald Publishing Limited.

[8] Culpepper, Martin L. "Types of academic makerspaces, their import to the education mission, and the characteristics of their culture and community." in *International Symposium on Academic Makerspaces (ISAM).* Cambridge 2016.

[9] V. Wilczynski, "Academic makerspaces and engineering design," in *ASEE Annual Conference & Exposition*, 2015.

[10] Jacob Institute for Design Innovation, University of California, Berkeley. https://jacobsinstitute.berkeley.edu/

[11] Stanford d.school. Stanford University. https://dschool.stanford.edu/

[12] Product Realization Lab, Stanford University. https://productrealization.stanford.edu/

[13] Center for Engineering Innovation and Design, Yale University. https://ceid.yale.edu/

[14] TechSpark, Carnegie Mellon University. https://engineering.cmu.edu/techspark/index.html

[15] Sears think[box], Case Western Reserve University. https://case.edu/thinkbox/

[16] HIVE Makerspace, Georgia Tech University. https://hive.ece.gatech.edu/

[17] project Manus, Massachusetts Institute of Technology. https://project-manus.mit.edu/

[18] Olin Shop, Olin College of Engineering. https://machineshop.olin.edu/

[19] Engineering Product Innovation Center (EPIC), Boston University. https://www.bu.edu/epic/

[20] Wilczynski, Vincent, Joseph Zinter, and Larry Wilen. "Teaching engineering design in an academic makerspace: Blending theory and practice to solve client-based problems." in *ASEE Annual Conference & Exposition* 2016.

[21] Wilczynski, Vincent, et al. "The value of higher education academic makerspaces for accreditation and beyond." *Planning for Higher Education* 46.1 (2017): 32-40.

[22] Hughes, J., Morrison, L., Kajamaa, A., & Kumpulainen, K. (2019). "Makerspaces promoting students' design thinking and collective knowledge creation: Examples from Canada and Finland," In *Interactivity*, *Game Creation, Design, Learning, and Innovation: 7th EAI International Conference*, ArtsIT 2018, and 3rd *EAI International Conference*, DLI 2018, ICTCC 2018, Braga, Portugal, October 24–26, 2018, Proceedings 7 (pp. 343-352). Springer International Publishing.

[23] Taheri, Pooya, Philip Robbins, and Sirine Maalej. "Makerspaces in first-year engineering education," *Education Sciences* 10.1 (2020): 8.

[24] Friessnig, Matthias Helmut, et al. "Development of an educational program using capabilities of (academic) makerspaces," Proceedings of the 1st *international symposium on academic makerspaces (ISAM)*, Cambridge 2016.

[25] Forest, Craig R., et al. "The Invention Studio: A University Maker Space and Culture," *Advances in Engineering Education* 4.2 (2014): n2.

[26] Mohamad Sari, N., and Ahmad Esa. “Factors affecting students’ participation in extra-curricular,” *Psychology* 107 (2017): 6960-6962.
[27] Iucu, Romita, and Magdalena Platis. “Extra-Curriculum Activities - Challenges and Opportunities,” *Procedia-Social and Behavioral Sciences* 46 (2012): 4249-4252
[28] Byers, Tom, et al. " Entrepreneurship. Its role in engineering education," *The Bridge* 43.2 (2013): 35-40.
[29] Dalrymple, Odesma, and Demetra Evangelou. “The role of extracurricular activities in the education of engineers,” *International Conference on Engineering Education*. 2006.
[30] Lagoudas, Magdalini Z., et al. “Assessing impact of maker space on student learning,” in *ASEE Annual Conference & Exposition*, 2016.
[31] Gerber, Elizabeth M., Jeanne Marie Olson, and Rebecca LD Komarek. “Extracurricular design-based learning: Preparing students for careers in innovation,” *International Journal of Engineering Education* 28.2 (2012).
[32] Fisher, Dara Ruth. “Educating engineers for the 21st century: a framework for skill development through co-curricular and extracurricular involvement,” 2013. *PhD Thesis. Massachusetts Institute of Technology*.
[33] R. J. Morocz, B. Levy, C. Forest, R. L. Nagel, W. C. Newstetter, K. G. Talley and J. S. Linsey, “Relating Student Participation in University Maker Spaces to their Engineering Design Self-Efficacy,” in *ASEE Annual Conference & Exposition*, 2016.
[34] Passow, Honor J., and Christian H. Passow. “What competencies should undergraduate engineering programs emphasize? A systematic review,” *Journal of Engineering Education* 106.3 (2017): 475-526.
[35] Sutardja Center for Entrepreneurship & Technology, University of California, Berkeley. https://scet.berkeley.edu/
[36] Harvard Innovation Labs, Harvard university. https://innovationlabs.harvard.edu/
[37] Chun Kit Chui, Lei Yang, Ben Kao. “Empowering Students in Emerging Technology: A Framework for Developing Hands-on Competency in Generative AI with Ethical Considerations,” in *ASEE Annual Conference & Exposition* 2024.
[38] Ryan Chan. “Closed Loop System in Technical Training – How to Initiate and Maintain a Student-Led Makerspace,” Proceedings of the *international symposium on academic makerspaces (ISAM).* Pittsburgh, PA. 2023.
[39] Natalie Chan. “Scaling Up Student Tutor Programs in Academic Makerspaces: Best Practices and Challenges,” Proceedings of the *international symposium on academic makerspaces (ISAM).* Pittsburgh, PA. 2023.
[40] Natalie Chan, Chun Kit Chui. “Embrace Diversity and Inclusion in Academic Makerspaces with a Network of Tutors (Work in progress),” in *ASEE Annual Conference & Exposition* 2024.
[41] Match WL Ko, Chun Kit Chui. “Nurturing Student Innovation and Leadership through Student-Initiated Interest Groups,” in *ASEE Annual Conference & Exposition* 2024.
[42] The DeCal Program, University of California, Berkeley. https://decal.berkeley.edu/about/decal-program
[43] The Student-Initiated Courses 2022/23, organized by the Innovation Academy at the Tam Wing Fan Innovation Wing, the University of Hong Kong. https://innoacademy.engg.hku.hk/2022_sic/
[44] Ryan Chan, H.H. Cheung, Match WL Ko, Chun Kit Chui, Lei Yang. “Preparing Students for Successful Industrial Collaborations in Engineering (Work in progress),” in *ASEE Annual Conference & Exposition* 2024.
[45] Creswell, John W., and Cheryl N. Poth. Qualitative inquiry and research design: Choosing among five approaches. Sage publications, 2016.
[46] Schamber, L. (2000). Time-line interviews and inductive content analysis: their effectiveness for exploring cognitive behaviors. Journal of the American society for Information Science, 51(8), 734-744.

* URL are retrieved on April 29, 2024