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Making Maker Spaces a High Impact Experience for Higher Education:

A Case Study on BUILD-IT

INTRODUCTION

Maker Spaces are communal spaces in which students or community members can learn, collaborate, and share ideas or projects. They serve as useful cooperative environments for those who are striving to develop critical thinking skills but lack the means to do so on their own. Sometimes called Innovation Spaces, or Garages, Maker Spaces are created as community gathering points or alternatively, around higher education institutions (HEIs), to provide students with extracurricular outlets and spaces of collaboration between peers and industry stakeholders[1]. Maker Spaces are especially useful in disciplines such as engineering, for which students must learn and demonstrate their abilities in creativity and innovation in order to stay competitive in the current job market.[2]

KEY FEATURES

Location: Vietnam

Theme: The foundation, approach, and recommendations for best practices as a result of the success of BUILD-IT maker spaces in Vietnam

Website: https://builditvietnam.org/

Major Results: The development and impacts from maker spaces as a result of collaboration between USAID/BUILD-IT, industry, and higher education institutions.

Maker Spaces are not new, but saw a renaissance in 2001 as "University Learning Spaces" at the Massachusetts Institute Technology (MIT)[1]. Many Maker Spaces in the U.S. and abroad have influenced a change in the higher education curriculum through the use of the Learning Factory (LF) model[3] which provides a realistic environment for education and training that integrates theoretical and practical knowledge. Studies have shown that designing and developing physical representations of concepts can aid in the further ideation and refinement of processes that might typically be hindered by a lack of space for creativity and critical thinking.[4] Learning Factories can be platforms to disseminate industry technologies, assembly models, and partnership models[5]. Students at HEI's in Vietnam are no different; in fact, the Vietnam government has made it a priority to provide these same types of training and opportunities.

1 Barrett, T., Pizzico, M., Levy, B. D., Nagel, R. L., Linsey, J. S., Talley, K. G., ... & Newstetter, W. C. (2015). A review of university maker spaces.

2 The Engineer of 2020: Visions of Engineering in the New Century. The National Academies Press; 2004.

3 Lamancusa JS, Jorgensen JE, Zayas-Castro JL. The learning factory—A new approach to integrating design and manufacturing into the engineering curriculum. Journal of Engineering Education. 1997;86(2):103-112.

4 Kim MJ, Maher ML. The impact of tangible user interfaces on designers' spatial cognition. Human– Computer Interaction. 2008;23(2):101-137.

5 Leal, L. F., Fleury, A., & Zancul, E. (2020). Starting up a Learning Factory focused on Industry 4.0. Procedia Manufacturing, 45, 436-441.

This case study looks at how the USAID-supported endeavor called Building University-Industry Learning and Development through Innovation and Technology (BUILD-IT) utilizes Maker Spaces to improve higher education in Vietnam in the field of engineering. BUILD-IT supports the first Development Objective in the USAID Country Development Cooperation Strategy (CDCS) "Increased Economic Competitiveness". Within this objective is the need for "improving the business-enabling environment, modernizing higher education institutions, and expanding private sector infrastructure investment"[6] to better serve development at a national level.

This case study also supports questions in the USAID Higher Education Learning Agenda. Specifically, question 6 which asks *"How can higher education systems and higher education institutions (HEIs) play a more active role in developing and strengthening national and regional innovation ecosystems?"* and question 7 *"How can HEIs collaborate most effectively with the private sector to enhance the relevance and quality of teaching and learning, and research and innovation?"* To further explore these topics, please refer to the Higher Education and Industry Collaboration and Higher Education and Innovation Ecosystems primers, both available in the Higher Education Learning Agenda Resource Collection.

BUILD-IT BACKGROUND

Supported by USAID, the Building University-Industry Learning and Development through Innovation and Technology (BUILD-IT) was launched in 2015 with the intent of linking higher education to the needs of the private sector. BUILD-ITs primary objective is to create a "world-class model to modernize and innovate technology and engineering (T&E) higher education."[7] The Government of Vietnam's Ministry of Education and Training (MOET) formed a partnership with private industry and academia to form the BUILD-IT Alliance. Powered by Arizona State University, this alliance expanded over the first seven years of the program to include university partner campuse in Can Tho, Danang, Ho Chi Minh City, Dong Nai, and Hanoi (see Figure 1). With interventions centered around strategic leadership-capacity building, quality accreditation training, curriculum training, faculty development training (such as Certified Facilitator/Master Teacher Training), and digital pedagogy as well as other areas, BUILD-IT has engaged over 9,300 students in industry curriculum opportunities and experiential learning activities and received nearly $7 million dollars in industry contributions.[8]

Figure 1. BUILD-IT sites and Maker Innovation Spaces.

6 Vietnam, COUNTRY DEVELOPMENT COOPERATION STRATEGY (CDCS) (2020).

7 Vietnam, BUILDING UNIVERSITY-INDUSTRY LEARNING AND DEVELOPMENT THROUGH INNOVATION AND TECHNOLOGY (BUILD-IT) (2021).

8 12-USAID. (2022). Activities: Build-it Vietnam. BUILD. Retrieved April 19, 2022, from https://builditvietnam.org/activities

BUILD-ITS MAKER INNOVATION SPACE APPROACH

Inspired by the laboratories in the United States that serve as both workshops as well as incubators for prototypes, USAID's BUILD-IT sought to create places where multidisciplinary applied projects could be conducted in harmony with Vietnam's public higher education system. Three Maker Spaces have been developed in south and central Vietnam supporting applied learning, collaborative projects with industry, and innovation, and they have been utilized over 17,000 times as of April 2022. To better understand how these spaces can be set up for success, let's take a look at a breakdown of the BUILD-IT Maker Innovation Space Playbook. (see Figure 2)

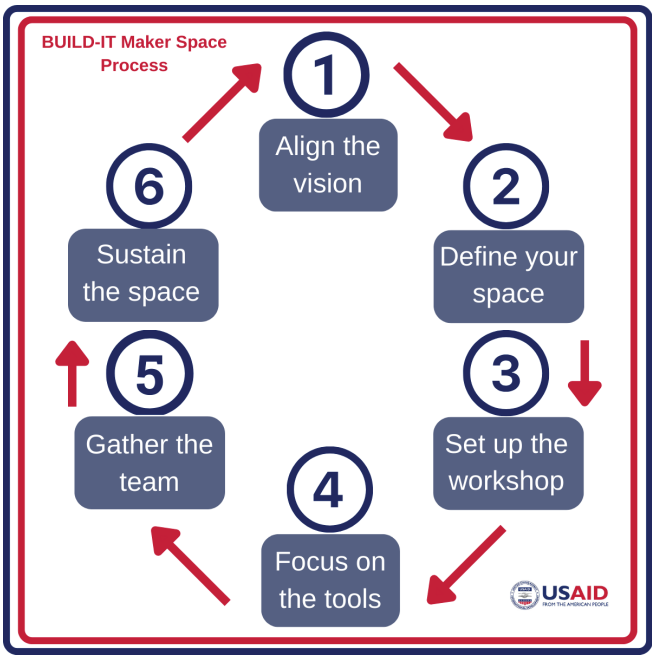

Figure 2. BUILD-IT process.

1 - *Align the vision*

BUILD-IT worked with Saigon Hi-Tech Park (SHTP), University of Da Nang (UD), Can Tho University (CTU), Ho Chi Minh City University of Technology (HCMUT), Ho Chi Minh City University of Technology and Education (HCMUTE), and Lac Hong University (LHU) to create Maker Innovation Spaces (MIS) not in a uniform way, but in a manner in which suits the needs of the specific institution (see Table 1).

2 - *Define the space*

Maker Spaces are for sharing, but given the many demands that will be placed on them from faculty to students, it is critical to devise systems that both reserve spaces and manage them depending on the needs of everyone. BUILD-IT has learned that some Maker Spaces need areas for basic tool training, while others need extremely clean spaces for working with sensitive materials. Most importantly all spaces must be accessible. Maker Spaces are not laboratories or maintenance facilities for repairing university equipment, rather they are reserved for building and testing prototypes.

Table 1: Individual Maker Innovation Space Focal Areas

Higher Ed Partner	Maker Space Focus
Saigon Hi-Tech Park (SHTP)	Entrepreneurship
University of Da Nang (UD)	Local student access to Science, Technology, Engineering, and Mathematics (STEM) and Project Based Learning (PBL) opportunities
Can Tho University (CTU)	Interwoven into their campus open-working space for inter-curricular use
Ho Chi Minh City University of Technology (HCMUT)	Innovation
Ho Chi Minh City University of Technology and Education (HCMUTE)	Supporting student experience with entrepreneurship, design, ideation and innovations
Lac Hong University (LHU)	STEM Competitions

3 - *Set up the workshop*

A productive and safe workshop is one that blends logistics and clear communication. The recommendations include having both a "protective equipment required" section as well as a "protective equipment NOT required" section to manage who can be in the shop and where. In addition to protection, it is critical to be able to move from one task to another. For this reason, it is essential to set up a workshop with stations that will allow a project to flow depending on the material and task.

4 - *Focus on the tools*

Tools are essential for the space, but can become a burden if not deliberately purchased and regularly maintained. Maintenance tools and protective equipment should be bought first, followed by multi-purpose tools that allow students to begin projects. From there, workshop-specific tools must be provided: for example, welders and CNC machines for a metal shop; drills and saws for wood shops; and laser-cutters and soldering stations for electronics. Special attention should be made to make sure that replacement parts, procurement and servicing are possible in that geographic region. Before opening the shop for use, it is critical that students are trained to safely operate each and every tool. All instruction and safety manuals should be readily available to each member, and an emergency plan displayed in clear sight.

5 - *Gather the team*

BUILD-IT recommends the following positions to structure the start of a Maker Space: a Director (oversees everything from procurement to finance); a Manager (oversees safety and time management); Staff Technicians (oversee day-to-day shop productivity and administer training); Student Technicians (aid the staff technicians); and Users.

6 - *Sustain the space*

From course integration to corporate partnership, it is paramount that Maker Spaces have interest and capital to continue production. BUILD-IT recommends charging for use of some equipment, as well as for outside use, and obtaining institutional and industry sponsorship for programs taking place in the space. These types of income not only bring in money to fund repair and upgrades, but also ensure a community stake in the space.

No Maker Space is complete without a continued effort for the increase of diversity, equity, and inclusivity. In order to normalize effective and engaging spaces, BUILD-IT encourages the participation of women's groups, hiring employees and technicians of all genders and ethnic and racial backgrounds, and generally creating spaces that are welcoming and safe for everyone.

LESSONS LEARNED

Lessons learned from the project have come in the way of formative feedback during events and surveys to participants from years 3 through 6. As of April 2022, BUILD-IT has had over 55,000 participants from academia, industry, and government. More than 12,000 Higher Education personnel have been trained through strategic leadership, quality and accreditation, and curriculum and faculty development programs, and of these 31 percent are women. Furthermore, in Fall of 2021 BUILD-IT received a two-year extension investment from USAID to continue to facilitate accreditation and engagement.

Highlights from the most current reports:

- **Sustainability has taken the form of expanded networks, enhanced University-Industry Partnerships (UIP's), and University Partner (UP) autonomy. BUILD-IT established the MIS Network as a way to foster public-private partnerships with the goal of developing Maker Spaces within Vietnamese public institutions.**
    - Take-Away: New partners in Hanoi, including Hanoi University of Industry (HAUI) and Phenikaa University (PU), have prioritized investing in infrastructure for MIS that supports innovative instructional methods and development and improvement of programs.
- **BUILD-IT is developing and maintaining a MIS network where partners can share ideas, strategies, partnerships, and identify funding opportunities. Over time, the MIS network can continue to support industry programs like start-up and incubator/accelerator programs, as well as academic programs like EPICS and PBL-focused activities and projects.**
    - Take-Away: ASU/BUILD-IT and other existing Maker Spaces are advising new university partners on design and sustainable business and program plan for Automation and MIS, and maintaining a MIS network with a managed plan for sustainability so that each Maker Space can plug into a sustainable network long after BUILD-IT ends.
- **The percentage of women reporting an increase in self-efficacy has grown in the last two years.** Self-efficacy, defined by the exercise of influence over one's own motivation, thought processes, emotional states, and patterns of behavior[9] can influence the success of individuals engaging in the application of a skill. Data from the last four years has shown an increase in self-efficacy of women from 81 to 87 percent. The target threshold for percentage of women reporting an increase is 80 percent according to Key Performance Indicator (KPI) #2.
    - Take-Away: programs that improve the Maker Space experience for women, such as WEPICS (EPICS with women) are working and should be expanded to continue growth and sustained success.
- **The percentage of students reporting a perceived improved learning outcome has grown in the last two years.** Student outcomes, characterized by students identifying their success in gaining new knowledge or skills, has been studied in various contexts[10][11][12] and the results from these surveys of participants in BUILD-IT show not only an increase, but also maintained percentages over the 80% threshold set forth by KPI #8.

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9 Bandura, A., & Wessels, S. (1994). Self-efficacy (Vol. 4, pp. 71-81).

10 Eom, S. B., Wen, H. J., & Ashill, N. (2006). The determinants of students' perceived learning outcomes and satisfaction in university online education: An empirical investigation. Decision Sciences Journal of Innovative Education, 4(2), 215-235.

11 Caspi, A., & Blau, I. (2008). Social presence in online discussion groups: Testing three conceptions and their relations to perceived learning. Social Psychology of Education, 11(3), 323-346.

12 Blau, I., Shamir-Inbal, T., & Avdiel, O. (2020). How does the pedagogical design of a technology-enhanced collaborative academic course promote digital literacies, self-regulation, and perceived learning of students?. The internet and higher education, 45, 100722.

- Take-Away: Maker Spaces are fostering learning in harmony with industry-linked programming over multiple years. Programs in place should continue to be funded and run with an intent of expansion and continued improvement to better serve the needs of corporate partners and student participants.

- **The constituent perception of BUILD-IT validity has increased in the last year but is still down from the first year.** Many factors can explain the variability in the perceived validity of the BUILD-IT model according to KPI #7 and more evaluation should be done to describe trends and impacts on this data. The Accreditation Board for Engineering and Technology (ABET), amongst other avenues, is currently utilized for validating the preparation of students to enter the field.

  - Take-Away: more research and communication of the positive impact of Maker Spaces should be put forth in order to improve the image of and garner more support for graduates of the program.

- **Student engagement peaks in the first two quarters of each year that BUILD-IT operates.** Each year the engagement of students participating in applied industry-based/PBL programs has increased. Total engagement sits at over 9,300 people, with men representing the majority, and includes industry-sponsored curriculum and experiential learning opportunities (co-op's, internships, etc.)

  - Take-Away: programming is tied to semester schedules, but efforts to push programming to increase participation, especially with women, should be employed in the latter quarters of the year to continue usage and prevent drop-offs.

The positive and constructive learning experiences that BUILD-IT has provided to date are a testament both to the power of partnerships between industry and academia, as well as to the potential impact on a country in need when these stakeholders come together. BUILD-IT is still in progress and while millions of dollars have been put to use to engage tens of thousands of students and stakeholders, there are still ways in which the alliance between USAID, ASU, and BUILD-IT can change and improve upon its strategy. In the coming years, BUILD-IT will:

- **Coach** Maker Spaces and applied projects leads using a variety of tools and mindsets to help them sustain their programs. This coaching will emphasize how the collaboration between industry and community partners can lead to further funding.

- **Continue** to employ industry-relationship transfer strategies like activating Industry Advisory Board activities at each school; document bi-lateral commitments and investment to continue BUILD-IT initiated activities; and record industry tools and resources now included in the curriculum and schedule of revisions.

- **Expand** into the entrepreneurial and innovation ecosystem by such programs as hosting hackathons and the IOT Start-up Competition (where young entrepreneurs/start-ups from incubation centers are connected with university students to share experiences and which inspire students' engagement in innovation).

This case study was developed by Carson Letot (The Pennsylvania State University), a graduate student participating in the 2021-2022 academic year Virtual Student Federal Service internship program.

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