

Emergence of a Multidisciplinary Environment through Interdepartmental Alliances Involving a College-Specific Maker Space

Luis J. Martinez¹, Edward Pines, PhD¹, and Patricia A. Sullivan, PhD¹

¹*Department of Industrial Engineering, New Mexico State University, Las Cruces, NM 88003*

Abstract

Academic maker spaces at the college and broader university level are becoming commonplace as campuses strive to foster an environment for technology innovation and entrepreneurship among students and faculty alike. While easier to manage, costs associated with developing college or department-specific maker spaces can often lead to reduced scope, difficulties in maintaining equipment over time, and may even hinder multidisciplinary approaches to innovation. This paper will share the emergence of a cross-departmental multidisciplinary environment developed between engineering and art as two academic entities sought to meet what was initially viewed as disparate student needs. The developed alliance demonstrates effective first steps for fostering cross-departmental maker spaces that encourage multidisciplinary engagement, access to technical services and equipment otherwise not readily available to the broader campus community, and the ability for students to engage in real-world collaborative teams comprised of individuals with disparate perspectives.

Keywords

Interdepartmental Alliances; Maker Spaces; Multidisciplinary

Introduction

University-based maker spaces are becoming commonplace as campuses strive to foster an environment for technology innovation and entrepreneurship among students and faculty alike. Their emergence on university campuses has allowed users to acquire enhanced and more applied learning experiences necessary for the rapidly changing needs required of today's global economy. The interactive and interdisciplinary environments promoted through maker spaces allows students to learn new skills, interact with state of the art equipment, and interact in a platform capable of enhancing their interpersonal and soft skills.

Ongoing popularity of university maker spaces can be seen on campuses across the nation. Morocz et al.¹ expressed that impact could be measured in the forms of retention in engineering majors and idea generation ability. With a positive impact from university maker spaces in their students, comes the need for newer, and better equipment that can be used for more innovative ideas generated through continuous interaction with university maker spaces by frequent users.

One of the most popular services that university maker spaces provide comes in the form of additive manufacturing equipment, more commonly known as 3D Printers. In addition to 3D

printers, microcontrollers such as Arduino or Raspberry Pi are also fairly popular. As the complexity of projects increase, there may be a need for items like CNC machines and laser cutters that may not be available in all university makerspaces. Such equipment may, however, be available within specialized laboratories and/or shops within the institution.

Background

The Aggie Innovation Space (AIS) is a college-based maker space facility at New Mexico State University originally established as a pathfinder project by engineering faculty participating in the cohort-based Pathways to Innovation project led by Stanford University and VentureWell and funded by the National Science Foundation. Following several iterations of management models, the AIS has evolved into a student-run facility staffed by on-campus paid co-op students and overseen by an advisory committee comprised of staff and faculty from engineering, business, art, and the university's technology incubator. The faculty advisory committee serves as a technical and managerial guidance resource for the AIS staff. Additionally, the committee allows AIS staff to promote the resources available to the students and by continuously seeking partnerships with other departments focusing towards strategic growth. The AIS faculty advisory committee approves proposals for equipment purchases, design challenges, and community outreach.

The AIS team of on-campus co-op students serve as technical specialists and peer mentors. Known as Aggie Innovators, the students assist with equipment maintenance, outreach program delivery through pop-up workshops and one-day design challenges, technical mentoring, inventory control, and staffing of the AIS during normal hours of operation. The term pop-up workshop is defined as a one to two-hour activity designed for students to learn and apply the basic principle of an activity of interest such as soldering, design, prototyping, or additive manufacturing. The topics covered in pop-up workshops are decided and delivered by the AIS staff with the overall objective of enhancing the overall experience of the students. Under the current student-management model, the AIS has seen a significant increase in the demand for its services and overall use of the facility, as measured by the increasing number of projects brought to the AIS and the increasing number of students utilizing the facility. Currently, the AIS is equipped with standard maker space equipment such as basic and high-end 3D printers, CNC X-Carve, assorted programmable development boards such as Arduino, Galileo, and Raspberry Pi, oscilloscopes, function generators, power supplies, multimeters, soldering stations, and vinyl cutters. While the AIS' equipment is fully capable of meeting basic prototyping needs, the growing complexity of student projects resulting from a growing interest in technology innovation and entrepreneurship among students has placed a demand on expanding access to higher resolution prototyping equipment. This increasing demand for higher resolution equipment created an opportunity to develop a strategic alliance with the NMSU Art Department.

Students are not required to pay to use the resources available at the AIS. All that is required for them is to follow a consultation process through their interaction with the AIS and to be willing to acquire a new skill outside of their academic curriculum. Currently, the AIS has seen an increase in non-engineering projects being consulted, which presents an invaluable opportunity

to promote the engineering design process and its benefits in any project regardless of the final deliverables required or overall scope.

The team of Aggie Innovators is selected and initially trained by the faculty advisory committee based on current and long term needs of the AIS. Staff is expected to develop additional training modules for incoming staff in terms of technical resources and internal procedures. Additionally, AIS staff is expected to develop curriculum and activities that can be followed by future staff in years to come. Incoming staff training has recently incorporated the influence of senior Aggie innovators, which are student employees who have been in the AIS more than one year. Senior Aggie Innovators are in charge of training new staff in equipment operation and handling, and the consultation process.

Cross-Departmental Integration

What began as a business-style joint venture between engineering and art, engineering was seeking access to specialized equipment and art needed assistance in maintaining the specialized equipment within their department, unexpectedly emerged into a vibrant cross-departmental multidisciplinary environment for innovation, ideation, and entrepreneurship. The initial objective of leveraging physical and human assets seemed logical and was supported by Barrett et. al.² in a summary of makerspace facilities that found that the most common equipment identified by students seeking to use maker spaces was the 3D printer, which engineering had several of. The second most common type of equipment identified was the laser cutter followed by mention of wood working or metal working capabilities, all of which are common pieces of equipment found in the art department. Barrett, et. al. further reports that electronics and soldering capabilities were frequently noted as desired capabilities within a makerspace. While the inherent applications differed between the two disciplines, soldering capabilities served as a catalyst for the emerging multidisciplinary environment between engineering and art.

As a member of the AIS advisory committee, a faculty member from art was keenly aware of the technical expertise among the various Aggie Innovators and expressed interest in discussing how a cross-departmental collaboration could be created. Following several meetings, an opportunity for strategic growth emerged yielding a satellite location of the AIS within the Art Department. The satellite AIS brought Aggie Innovators from engineering to the Art Department to help refine and maintain equipment and provided engineering students with access to higher resolution prototyping equipment such as a laser and plasma cutters previously reserved for art majors. Kurti et al.³ consider tools such as laser cutters, advanced CAD packages, and CNC routers as highly desirable advanced tools capable of producing more aesthetically pleasing or artistic products. Reciprocally, art students were given open access to the AIS and its vast 3D printers and other equipment. The cross-departmental alliance was not only cost-effective but it provided immediate access to additional prototyping equipment by both groups of students.

In addition to shared access to equipment, the cross-departmental collaboration focused on developing a multidisciplinary environment between the two disparate academic units. The outcome of this effort has resulted in joint offerings of pop-up workshops on common skills such as soldering, CAD modeling, 3D printing, and programming, with an underlying goal of promoting multidisciplinary technology innovation, ideation, and entrepreneurship. The blending

of engineering and art has proven effective in enhancing both the quality and functionality of student projects while retaining the creative and discipline-specific idiosyncrasies of the respective students.

Real-World Experience

The AIS satellite location has required the Aggie Innovators who are staffing the AIS and the satellite facility in art to be cognizant and accepting of non-engineering approaches to innovation and ideation. The experience has proven invaluable in developing leadership, team building, and communication skills among the AIS team. Additionally, students from engineering and art have been provided a unique opportunity to collaborate in a real-world environment that allows contributions and viewpoints from disparate disciplines towards both shared and/or complementary objective.

Lagoudas et al.⁴ report that with an increasing global competition, students need to be exposed to an environment that promotes project-based learning and entrepreneurship. University maker spaces often cover these requirements, but by an emerging multidisciplinary alliance, more university students can be exposed to this environment while having a more realistic team experience that may resemble an industry setting.

Challenges of Alliance

One of the primary objectives of the AIS has been to promote design-thinking and the engineering design process to students. This is accomplished through an open and exploratory environment with available tools and peer mentoring sessions. In order to effectively balance peer mentoring of student projects with responsible use of resources, a vetting and training process has been adopted by the Aggie Innovators to ensure AIS users are trained on the use of equipment within the AIS and satellite facilities. Intake and consultation processes are used to track vet projects that are ready to advance to a higher resolution prototyping phase

Currently, the consultation process takes into account the usage of basic equipment such as 3D printers in specific iterative stages focused on prototyping and validation. In some cases, projects may obtain a functional prototype through conventional 3D Printers. In other cases, advanced equipment may be required to allow projects to obtain higher-quality prototypes or finished products. The biggest challenge for the AIS lies in the ability of Aggie Innovators to adequately integrate the use of more advanced tools while continuing to promote an open environment. Teams requiring the use of advanced equipment available at the satellite location are being encouraged to undergo a vetting process before transferring to the satellite location to maximize effective use of high-resolution equipment.

Preliminary Results

In addition to integrating cross-disciplinary engagement among engineering and art students, ongoing promotion is underway to continue expand multidisciplinary projects among the students. Pop-up workshops are being hold to orient students in multidisciplinary areas such as

soldering, metal fabrication, and digital foundation. The AIS has observed a direct relationship between technical pop-up workshops and the use of the services and equipment within the AIS.

Since inception of the cross-departmental alliance in fall 2016, the AIS has hosted three technical pop-up workshops focused on engaging art students within the AIS and introducing the satellite facility to engineering students. Following the recommendations from Bartlett et. al. concerning desired capabilities within a maker space, a soldering workshop was the first oriented workshop conducted in the satellite location. This was done to introduce students to potential collaborations with art students. Additionally, metal working and a clay forming workshops were held as additional multidisciplinary outreach efforts.

Since the beginning of the cross-departmental alliance, the AIS has been successful in advancing high-resolution prototyping abilities among two high-profile student organization projects and two engineering capstone projects. Prior to the alliance, the such projects were dependent on off-campus resources to complete their projects. Specifically, the Design, Build, Fly, and Steel Bridge student organization projects were able to benefit from access to the newly available laser cutter at the satellite facility in order to meet their objectives in a timely fashion. The newly available equipment allowed the teams to expedite design and prototype of their respective projects and having access to an AIS mentor allowed the students to utilize the advanced equipment safely.

Engineering senior capstone projects also benefitted from the newly available equipment within the art facility location. Under the cross-departmental alliance, two capstone projects have transitioned from the main location of the AIS to the satellite location for advanced manufacturing capabilities.

Additionally, the Aggie Innovators have witnessed a growing number of art students utilizing 3D printers within the AIS. Art students are also spending time in the AIS to learn how to program various development boards, primarily Arduino, and various CAD software programs as they expand their artistic designs and products.

Most importantly, multidisciplinary engagement has grown organically in both the AIS and satellite locations. Students are expanding their perspectives to innovation and ideation, which in turn are leading to new entrepreneurial opportunities for the university's student incubator.

Replicating Partnership

In terms of additional resources for maker space users, the partnership with the art department has proven highly effective. It is strongly recommended that university maker spaces create interdepartmental alliances with other departments through an advisory committee. This would allow maker spaces and department become aware of available resources while informing university students about the services available to them in a maker space.

Maker spaces should implement regular pop-up workshops to enhance student awareness and interest in a multidisciplinary approach in their personal or academic projects. Through pop-up workshops, it is intended for the students to learn the basics of engineering oriented activities

such as soldering or microcontroller programming. And for them to possibly implement them in their projects with the objective of increasing their overall quality.

Initial activities in an interdepartmental partnership should come in the form of equipment training, maintenance, and troubleshooting for maker space staff. Additionally, implementing a series of pop-up workshops focusing on the operation of available equipment such as laser cutters can serve as a great marketing tool to make students aware of the availability of new resources. Lastly, a disciplined consultation process should be implemented to ensure that all student projects follow the engineering design process. This will ensure that available resources are being used effectively and students are interacting with equipment adequately. A disciplined consultation process ensures that maker space staff selects the proper equipment needed for specific projects. Maker space staff should be in charge of vetting and authorizing the use of available resources while continuing to promote an open and inviting environment for all students.

Conclusion

Preliminary results and feedback from engineering and art students support continued growth of the developed alliance. Personnel and equipment have been leveraged to effectively enhance innovation, ideation and entrepreneurship within two desperate academic units. Furthermore, a multidisciplinary environment has emerged.

The outcome of this cross-departmental alliance has been positive, with efforts underway to develop survey instruments to determine specific programmatic successes including multidisciplinary innovation measured via transition to the university student incubator, continued growth in multidisciplinary participation among engineering and art students, and value of experience on employability following graduation. Faculty from both academic units are engaged in discussions for multidisciplinary grant and curricular opportunities. Lastly, engineering has committed to hiring art students as Aggie Innovators as openings arise to ensure sustainability of the emerging multidisciplinary alliance and create a positive student experience regardless of academic major.

References

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Luis J. Martinez, New Mexico State University

Luis is a graduate assistant for the Engineering New Mexico Resource Network in the College of Engineering at New Mexico State University where he is pursuing a Master of Science degree in industrial engineering. He has a bachelor's degree in engineering technology-mechanical from New Mexico State University. In his role as a graduate assistant, Luis is working to integrate capstone projects from the college of engineering within the college's maker space and explore opportunities for technology acceleration.

Dr. Edward Pines, New Mexico State University

Edward Pines is Department Head and Associate Professor of Industrial Engineering at New Mexico State University. He is a co-team leader of NMSU's Pathways to Innovation team and is serves on the Faculty Advisory Board for NMSU Engineering's Aggie Innovation Space.

Dr. Patricia Sullivan, New Mexico State University

Patricia A. Sullivan serves as Associate Dean for Outreach and Public Service and is Director of the Engineering New Mexico Resource Network in the College of Engineering at New Mexico State University. She received her PhD in industrial engineering and has over 31 years' experience directing statewide engineering outreach services that include technical engineering business assistance, professional development, and educational outreach programs. She is co-PI for a National Science Foundation (NSF) grant to broaden participation among minority engineering students through engagement in innovation and entrepreneurship and a co-PI for an i6 Challenge grant through the U.S. Economic Development Administration (EDA) to foster regional economic development through innovation and new business start-ups. She is institutional integrator for the Partnership for the Advancement of Engineering Education (PACE) at NMSU. She is also co-lead for a NSF funded Pathways to Innovation cohort at NMSU with a focus on integrating innovation and entrepreneurship into the engineering curriculum through a blending of industry and educational experiences. Patricia serves as a commissioner for the Western Interstate Commission for Higher Education (WICHE), is a member of the executive committee for the NM Consortia for Energy Workforce Development, a past member of the board of directors for BEST Robotics Inc., and a member of the board of directors for Enchantment Land Certified Development Company (ELCDC – a program that certifies SBA 504 loans that foster economic development.) She has extensive experience in public-private partnerships particularly efforts that enhance employment opportunities for engineering students.