Similarities and Differences between Academic Centers for Entrepreneurship, Innovation, and Making

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INTRODUCTION

College campuses are constantly evolving to keep pace with societal changes and to offer learning opportunities that reflect and support external developments. The arrival of innovation centers (circa 2015) is one of the latest additions to the collegiate landscape with such facilities following the arrival of academic makerspaces (circa 2010) and entrepreneurship centers (circa 2000). Distinct from discipline-based initiatives that have a narrower focus, the "center concept" is a popular mechanism for universities to respond to developments in society and industry. Typically, university centers are multidisciplinary in nature and operate as independent organizational units. For example, university-based research centers have been created to accelerate interdisciplinary developments that span multiple academic departments.

The reasons for creating university centers vary with each application at each institution [1]. Often these initiatives are motivated by trends and practices in business and contemporary life. The creation of university centers is a common approach to prepare students to be fully engaged in their professional/personal communities. Centers also provide mechanisms for university members (including research and educational entities) to participate in and accelerate discovery in the topics to which the centers are devoted to. As multi-disciplinary units, university centers serve as independent and unaffiliated locations to work, exchange ideas, advance concepts, and learn.

University centers are distinguished from other campus structures such as initiatives, programs, and working-groups by the resources devoted to and available within the centers. These resources include dedicated space, management, programming, and financial support. It is common for university centers to support curricular, co-curricular, and extra-curricular activities for undergraduate and graduate students. The oversight of university centers typically falls outside the departmental structure, with center organizations commonly overseen by provosts and vice-presidents. University centers include those that address faith, cultural, health, research, and teaching/learning issues. More recently, centers focusing on entrepreneurship, making, and innovation have become components of colleges and universities.

This paper reviews the distinctions of centers devoted to entrepreneurship, innovation, and making. Examples are presented to highlight the purpose of these centers, as well as their organizational and programmatic structures. While some universities integrate entrepreneurship, innovation, and making activities within a single operational unit, others exist as independent entities. Using examples from both integrated and independent centers, a range of operational structures are explored to understand how these distinct models benefit students at their respective institutions.

TERMINOLOGY

Before examining the similarities and differences, it is essential to define the following terms: centers, entrepreneurship centers, innovation centers, and academic makerspaces. Within academia, centers are organizational structures that are generally accessible to all students and faculty while spanning disciplines, departments and schools/colleges. Centers address broad topics associated with the university's research, education, or service missions that benefit the entire university community. Their magnitude typically distinguishes centers from other campus entities such as programs and initiatives. It is common for centers to be independent organizational units under the leadership of a dedicated staff, with assigned space and distinct financial responsibility. The terms centers and institutes are often synonymous (with distinctions pertinent to each institution). With respect to students, centers frequently include curricular (courses and majors), co-curricular (projects and workshops), and extracurricular components.

"Entrepreneurship is the transformation of an innovation into a sustainable enterprise that generates value" in either the economy or society at large [2]. Distinct from activities that produce an invention, "entrepreneurship entails the commercialization (or its functional equivalent) of an innovation." [2] The progression of an invention into wide-spread practice is central to entrepreneurship. Following this pattern, entrepreneurship centers support individuals who are commercializing inventions and creating social enterprises or businesses. Entrepreneurship centers also often support individuals who license their inventions for commercial applications. These goals are achieved at entrepreneurship centers by providing access to courses, programs, networks, and funding mechanisms.

Innovation centers have a broader purpose when compared to entrepreneurship centers. "Advancing cultures of innovation" on college campuses is a popular trend in higher education [3]. According to one report, universities are investing heavily in programs and facilities to explore, develop, and implement new ideas and solutions to real-world challenges. Innovation centers are entities (including personnel, space, programs, and funding) that infuse diverse groups with dedicated resources to support projects. While the scope of innovation centers is wider than venture-focused entrepreneurship centers, it is not

uncommon for both activities to be combined under the joint title of "innovation and entrepreneurship centers" or as unique programs within an innovation center. Though new to academia, innovation centers in industry are well-established mechanisms that assemble diverse teams and converge on solutions [4].

An academic makerspace serves as a meeting place for a university's maker community and provides resources to design, fabricate, and evaluate engineered systems. In addition to being physical spaces, makerspaces are operational units that offer education, training, and certification programs to teach new skills. The specifics of each academic makerspace, including focus, access, and staffing, vary with each institution. These spaces typically include traditional and modern manufacturing equipment, as well as digital design tools, to support the academic, extracurricular, and personal design activities of university students, faculty, and staff. In academic makerspaces, community members formally and informally learn from one another in a variety of classroom, workshop, and open-studio formats [5].

While presented as individual activities, elements of entrepreneurship, innovation, and making can be incorporated into the work of a single center or be the sole focus of a center. The following sections present examples where multiple single-focused centers exist at a university as well as cases where elements of entrepreneurship, innovation, and making are integrated into a single center.

ACADEMIC CENTERS FOR ENTREPRENEURSHIP, INNOVATION AND MAKING AS MULTIPLE SINGLE-FOCUSED ENTITIES

Three institutions are presented where multiple single-focused centers support entrepreneurship, innovation, or making. Embedded in this discussion are centers that support startup accelerators and incubators. These terms are somewhat interchangeable but also non-uniformly applied by all institutions. Accelerators generally work with startups for shorter periods of time (for example, up to six months) as the hosted companies raise their first rounds of funding. Commercial accelerators frequently provide capital (for example, $100,000) and are paid for their services with a small (less than 10%) amount of ownership in the company. A startup incubator normally does not provide capital, is generally longer-term (up to two years), and is not compensated with ownership. Incubators are common mechanisms at universities to provide space and mentorship for new ventures.

The ***Schwartz Center for Entrepreneurship at Carnegie Mellon University*** (established in 2015) supports entrepreneurship education, collaboration, and experiential learning opportunities for the entire university community. Led by an executive director and two faculty co-directors, the center provides programs and activities for CMU's students, faculty, and staff. The center assists students who are transforming concepts into startups, provides mentorship and funding resources, and hosts lectures, competitions, and networking events related to innovation and entrepreneurship. Experiential learning programs, including workshops and internships for undergraduates, graduate students, postdocs, and young faculty members, help individuals commercialize products. The center also hosts an incubator and supports academic courses and degrees.

Also servicing the entire university, the ***CMU Integrative Design, Arts & Technology Network*** (IDeATe) provides interdisciplinary courses, space, and resources for CMU's maker community [6]. IDeATe (opened in 2014) is housed in the university library where 10,000 square feet of space is provided for lectures, collaboration, fabrication, equipment use, and program administration. Interdisciplinary courses (without prerequisites) are open to all students. IDeATe supports collaborations with 30 new courses focused on hands-on learning for students from different disciplines. Led by the university librarian and an associate dean (Civil and Environmental Engineering professor), the center includes technical, digital, and design staff members.

The ***VentureLab at the Georgia Institute of Technology*** helps students and faculty create startups based on GA Tech research. The lab (established in 2001) partners with external organizations to provide early-stage funding, offers academic courses in entrepreneurship (where students validate market needs and build functional prototypes), and provides entrepreneurship programming/guidance. The lab uses a five-stage model (ideation, customer discovery, customer validation, customer creation, and company building) as a core process for most of their offerings. The lab is led by a director and does not include departmental faculty in its leadership. VentureLab is a component of the much larger GA Tech Enterprise Innovation Institute, an institute-wide program that promotes business and industry collaborations, technology commercialization, and economic development.

The ***Georgia Institute of Technology Invention Studio*** (founded in 2009) is a student-managed academic makerspace open to the entire university [6]. The studio provides training and access to equipment, serves as a cultural hub for the campus making community, and supports curricular and extracurricular design instruction to increase collaboration and incorporate diverse ideas in problem-solving. A student organization manages and staffs the facility. The students are assisted by faculty members and a professional staff for oversight, logistics support, and equipment maintenance. In addition to training and guidance, the Invention Studio also offers workshops and other outreach activities to teach skills and connect the GA Tech community.

The ***Yale Entrepreneurial Institute*** (YEI, founded in 2007) helps students and faculty start businesses through mentorship, programming, and funding support. The YEI offers a summer fellowship program where students refine their ideas, conduct market surveys, improve their products, and pursue funding. An innovation fund is available, as well as a mentorship program that connects teams to volunteers. The institute also provides programming focused on entrepreneurship, networking events, and access to legal, branding, and financial services. Yale recently announced the creation of the Tsai Center for Innovative Thinking at Yale, a new university-wide resource to provide programming, guidance, mentorship, and training that will help diverse teams create innovative solutions to challenging problems. The student-focused YEI activities will be one of a few existing programs relocated

to the new center. The new center will be led by an executive director and a faculty co-director.

The ***Yale Center for Engineering Innovation and Design*** (CEID) is an academic makerspace available to all students, faculty and research staff at Yale [6]. The CEID opened in 2012 and offers design classes, workshops, and training sessions that empower users to convert ideas into functional devices. With an open studio, machine shops, meeting rooms, lecture space, and wet lab, the CEID promotes design-based collaborations among its users to support curricular, co-curricular, and extra-curricular activities and projects. In addition to benefitting those in the engineering disciplines, the center has also played a key role introducing engineering as an academic consideration for other disciplines at the undergraduate and graduate levels. A director and staff of two design faculty members and two design fellows, aided by student employees, teach skills, provide guidance, and oversee operations within the space.

ACADEMIC CENTERS FOR ENTREPRENEURSHIP, INNOVATION AND MAKING AS INTEGRATED ENTITIES

Three institutions are presented where centers exist to support a combination of entrepreneurship, innovation, and making. In these examples, a primary focus is established (as indicated in the name or principle description of the space) with the additional function(s) integrated to support the primary function.

The ***Martin Trust Center for MIT Entrepreneurship*** at the Massachusetts Institute of Technology provides the "expertise, support and connections MIT students need to become effective entrepreneurs, serving all MIT students, across all schools and disciplines" [7]. The center (established in 1990) is operated by the MIT Sloan School of Management and offers programs, courses, infrastructure, events, and outreach activities that advance MIT's entrepreneurial activities. The center is led by a managing director and faculty chair/founder. The most significant components of the center are its programs, which include a three-month (summer-long) educational accelerator where students are provided space, stipends, structure, and status to explore their potential market, build prototypes, create partnerships, and find customers. In 2016, 86 students on 17 teams participated in this program.

A collection of programs provides exposure to entrepreneurial activities in the fall and progresses to programs that require increased levels of commitment at the start of the calendar year, followed by a full-time commitment to participate in the center's accelerator program during the summer. Creatively, the center's annual programs begin at the start of the school year with a demonstration festival of the summer-long projects. The center also helps maintain a culture for entrepreneurship on campus by providing guidance and support (such as meeting space) for student-initiated events related to entrepreneurship.

A recent renovation of the center expanded the makerspace facilities within the center in recognition that many of the entrepreneurial projects involve building devices. The space is managed using a dedicated staff that provides training, mentoring, and workshops related to technology located in the space. The presence of this space accelerated the development of an academic course (Introduction to Making) hosted by the center. In this example, we see maker capabilities amplified within an entrepreneurship/innovation space to better support the design, experimentation, and prototyping needs of student startups. Key to this development is the realization that the maker capabilities support the entrepreneurial activities.

Case Western Reserve University's Sears think[box] was established in 2012 to facilitate multidisciplinary collaboration, promote innovative thinking, support making and building, and advance product development and venture creation. The center is open to all students as well as the Cleveland community, with twenty percent of its visitors coming from the local community. Think[box] combines makerspace equipment, collaboration programming, startup guidance, and incubation space within the same physical and organizational structure. The seven floors of the facility have been designed to support meeting and brainstorming, collaborating, rapid prototyping, advanced manufacturing, assembling, entrepreneurship, and commercialization, with a floor dedicated to each step of the process. For example, the 6th floor of the facility will support entrepreneurship education programs, including an intellectual property clinic, and the 7th floor will host incubator spaces for products developed at the facility. Think[box] is led by an executive director (Mechanical Engineering faculty member) and has a faculty director.

When the facility is fully occupied (the top three floors remain under construction), think[box] will provide the full range of services to transform ideas into companies. This model of facilitating all aspects of the concept to corporation pipeline is unique in scope. In some ways, this facility is analogous to the Martin Trust Center for MIT Entrepreneurship, though making is the driving factor at think[box]. The additional programs in entrepreneurship and startup acceleration are added as a response to the need created from the primary forcing function (making).

The ***Wond'ry at Vanderbilt University*** (opened in 2016) was created to support cross-disciplinary collaboration, innovation, and entrepreneurship. Programs at the Wond'ry partner faculty and students with local corporations to discover innovative business solutions, provide introductory and advanced exposure to the entrepreneurial process, and support social ventures with the assistance of the city of Nashville and local non-profits. The Wond'ry advances the innovation culture on campus by sponsoring workshops, supporting student organizations, and fostering collaborations. The center hosts academic courses (taught by departmental faculty from across the university) on topics related to innovation, entrepreneurship, technology, and making. The center has an executive director and a faculty advisory board.

The facility includes a makerspace that provides tools and equipment needed for innovation. Training and oversight is provided by mentors and making-centered events are held to strengthen the campus making community and to promote idea exchange. Like the Martin Trust Center for MIT Entrepreneurship, the makerspace at the Wond'ry supports entrepreneurial developments, but it also has a primary purpose as a university-wide access point for making. In this example,

the entrepreneurial, innovation, and making functions have unique and defined purposes (as opposed to centers where one aspect is the primary purpose and the other aspects support that primary function). The social venture component of the Wond'ry is especially significant for it signals the wide spectrum of venture activities supported by the center (compared to most other programs that focus on commercial ventures).

ACADEMIC CENTERS THAT COMBINE ENTREPRENEURSHIP AND INNOVATION FUNCTIONS

If the makerspace component is not included when grouping the combined centers, a much larger database of entrepreneurship and innovation centers results. This is driven by the pervasiveness of entrepreneurship centers in academia and an associated collection of entrepreneurship education (including majors, minors, and master programs) and entrepreneurship research activities. Evidence of the significant role of entrepreneurship in academia is also reflected in the number of government studies, journals, non-profit organizations, and books that address these practices at colleges and universities [8,9,10,11]. Innovation centers however are a relatively new arrival on college campuses. These centers can include commercial ventures, social ventures, design thinking, and team-driven problem solving as programmatic elements. Examples abound where innovation and entrepreneurship attributes are combined within a single center.

Some notable programs that combine entrepreneurship and innovation in a university center include the University of Pittsburgh's Innovation Institute, Michigan State University's Innovation and Entrepreneurship Center, Princeton University's Keller Center, and Harvard University's i-lab. In general, these spaces support entrepreneurship and innovation through programming and education. Each of these examples provide multiple paths for student teams (and for some facilities, faculty members) to engage with legal, financial, and consulting partners during their entrepreneurial exploration. Without significant facilities for design, manufacturing, assembly, and experimentation within these facilities, the scope of student projects favors products that do not involve a physical device.

COMMONALITIES AMONG CENTERS FOR ENTREPRENEURSHIP, INNOVATION, AND MAKING

One value of examining the functions of centers devoted to entrepreneurship, innovation, and making is to identify common best practices that can be incorporated into other spaces. The occurrence of six factors establishes a framework for new and existing centers to compare their work to, bolstering programs where needed and ensuring important factors are not dismissed as established programs mature. Best practices common to entrepreneurship, innovation, and making centers include: a clarity of focus; a connected and contributing community; low barriers to entry and a progression of programs; engagement of the members; leveraging resources; and dedicated leadership combined with a committed staff that establish services, support, and structure.

A ***clarity of focus*** within a center for entrepreneurship, innovation, or making is needed to define the center's purpose. The concept of a clear organizational mission is not unique to these centers. The center's mission must describe the types of problems it helps members solve and explain the center's value to the university. A center's clarity of focus articulates the role it plays meeting student and faculty needs that are otherwise not addressed by existing programs at the departmental, school/college, or university levels.

By establishing an unambiguous purpose, the center is better prepared to complement (and not compete with) other existing programs. A center's focus becomes the framework to build the infrastructure, programs, and services that support the defined purpose. While the mission needs to be well defined, the center's programs and activities must not be rigid. Flexibility, nimbleness, and an ability to accommodate new needs (that fall under the center's purpose) expand the utility of the organization on campus.

The clarity of focus is not limited to the center's purpose, but also extends to the center's constituents. It is important to specify which segment(s) of the university population the center serves. For example, some centers are defined as student-facing while others are open to the entire university community. Clearly stating the intended user-base clarifies the center's purpose.

While a physical location establishes the center's existence, a ***connected and contributing community*** creates the center's value. The center's physical space serves as a magnet that attracts individuals interested in the center's mission. Diversity of thought, backgrounds, and experiences are essential to develop new ideas, approaches, and solutions. As such, these centers are generally accessible to wide audiences and are often accessible to all university community members.

A common attribute in successful projects at these centers is the relationship between the diversity of team members and the uniqueness of their thoughts and solutions. A diverse community of members who are connected to and interacting with each other leads to a rich environment for learning. Based on this premise, these centers are commonly multi-disciplinary in membership and purpose.

In a review of university-based makerspaces as a source of innovation, Farritor expands on the value of a diverse community (that in turn produces a diversity of ideas) using the terms density and mixing [12]. These insights are applicable to successful entrepreneurship, innovation, and making centers where individuals and teams are located near each other (i.e. high density), without barriers between groups. Opportunities to exchange ideas (i.e. mixing) maximize the value of having teams with diverse members work near each other. By creating mechanisms to interact and share knowledge, the community benefits as members contribute to the work of others. Diversity, density, and engagement are fundamental components of connected and contributing communities.

The important role of the community in these centers helps establish a campus-wide culture for the respective purpose(s) (entrepreneurship, innovation, or making) on each campus. An active and involved community is essential to create a valuable network of individuals, as well as a thriving ecosystem of programs, with similar (but distinct) purposes at each institution. The value of the community is exponential, as each

member brings additional skills and experiences to the center's ecosystem.

Low barriers to entry and a progression of programs are required to continually build and develop a center's community. Low barriers to entry are common at centers where all feel welcome to participate in programs, explore options and pursue opportunities. Centers must be designed and supported with mechanisms for individuals to become familiar with the center's purpose and their potential involvement in that work. An open and inviting environment eliminates barriers for new community members who might otherwise be hesitant to explore these areas. Introductory programs are often crafted to fill this need and provide information to new members.

Equally important are efforts to increase visibility of the center's purpose and programs throughout the college or university. Outreach activities including newsletters, workshops, information sessions, displays, and events, as well as tapping into existing social media sites/email-lists, are tools to attract new members and engage current members. Since the student population is cyclical, it is necessary to maintain these awareness activities on an annual basis.

In addition to minimizing barriers, centers need a progression of programs to engage users across a spectrum of interests. Basic programs on introductory topics related to the center's work (such as idea generation, design thinking, or electronic circuits) are needed for new members while advanced exposure (in content and member commitment) is required to meet the needs of experienced users. A progression of program offerings is important to provide guidance to the wide range of center users. This range of users includes members with little familiarity to those who are fully committed to make the most of the center's resources. Appropriate programming and resources need to be available at each level of this personal development spectrum.

Successful entrepreneurship, innovation, and making centers have fully engaged members who serve as advocates and enthusiasts for entrepreneurship, innovation, and making across the university. Such high levels of ***engagement of the members*** results when individuals experience a sense of ownership in the center. Their personal identities become associated with the center's activities and their advocacy draws others into the center's work. The center's impact often results from the work produced by these highly-engaged members, with their stories of success celebrated and shared as exemplars for others to learn from and be motivated by.

High levels of engagement result from personal motivation and self-guided learning. Using terminology suggested by Farritor, engaged members are intrinsically motivated and driven by their own sense of accomplishment [12]. Often the pursuit of a solution to a self-identified problem is central to this engagement. Engaged members contribute to the broad collection of center programs and initiatives and share their experiences with others. Engaged, self-motivated members are autonomous in their actions and create a personal development path to make the most of the center's resources. Offering a robust collection of center programs, training, education, and other accessible resources is fundamental to develop engaged members.

Leveraging resources, including people (members, mentors, faculty, and staff), programs, space, and financial support, is common practice for entrepreneurship, innovation, and making centers. The participation of a large cadre of external supporters is a technique that allows a small number of staff to address the needs of a large number of users. For makerspaces, this leveraging is apparent in informal peer-to-peer exchanges where members share their experiences and knowledge with fellow users. It is also realized in more formal training events such as member-directed workshops on technology and design practices. For entrepreneurship and innovation centers, the use of external mentors is an example of leveraging the participation of others in the center's work. In this case, individuals with prior experience establishing social ventures or creating companies consult with teams who are pursuing similar ideas. The mentors and external advisors are often volunteers, many with alumni connections to the institution.

Beyond individuals, centers can also take advantage of existing groups to educate members about entrepreneurship, innovation, and making. For example, serving as a meeting site for student organizations related to the center's work, such as student design groups or student-led entrepreneurship organizations, draws team members into the space and adds to the center's collective impact. Complementary programs between individual centers can also benefit members. It is plausible that a student team may learn about design thinking in a workshop at an innovation center, develop a working prototype in a makerspace, and participate in a startup boot camp hosted by an entrepreneurship center.

Connecting the center's members with support resources is important to efficiently leverage connections. Events such as open-houses, pitch sessions, hackathons, and formal sessions to introduce members to volunteer mentors are examples of methods to connect members with resources. Facilitating access to financial resources, such as seed grants to advance concepts into the first stages of reality, is another service commonly provided by these centers. While the centers may not direct these funding programs, they can provide information and guidance about external funding streams.

These best practices are not organic but rather result from the work of ***dedicated leadership combined with a committed staff that establish services, support, and structure***. One of the primary roles and responsibilities of the center's leadership and operations team is to create, deliver, and maintain high quality programming. Programs such as workshops, training sessions, and social functions attract users to the center and facilitate a member's sense of belonging to this community. Given the member-facing roles of these positions, center staff must care about students and view themselves as educators. Dedicated leadership requires that individuals have the administration of the centers as a primary responsibility and professional interest. An inviting and welcoming staff is essential to create effective entrepreneurship, innovation, making centers.

DIFFERENCES BETWEEN CENTERS FOR ENTREPRENEURSHIP, INNOVATION, AND MAKING

Another value of examining this collection of centers is to

identify areas of practice relevant to specific types of centers. Four distinct operating practices exist for these units: creation of artifacts, time scale for projects, integration of academic courses, and the role of mentors.

The ***creation of artifacts*** is the primary distinguishing feature of centers for making. Individuals work in an academic makerspace to design and construct physical or digital devices. To accomplish this, they need access to equipment, training, and raw materials. This distinction is important because it highlights the production aspects of academic makerspaces and suggests the wider range of services that these centers need to provide. This distinction is important should one compare the staff responsibilities, capital investments, and operating budgets of specific centers.

Related to the purpose of each center (for example the creation of artifacts, businesses or social ventures) is the ***time scale for projects***. User experiences in innovation and entrepreneurship centers most likely have an extended time frame. At these centers, the most engaged users are on a multi-year journey from an initial idea to an implemented venture. For academic makerspaces, individual projects have a much shorter time scale generalized as a period of a few months. In these cases, the time between an original idea and the physical or digital artifact rarely spans more than one semester. It is noted that projects can be modified and improved continually. Engaged undergraduate users in making centers often create a portfolio of projects over the course of their four-year education. Similarly, less than fully-engaged members may use the makerspace for a single project, thereby making use of the center for only a short period. This time scale distinction suggests a wider range of training resources are needed in academic makerspaces to allow engaged members to continually acquire and refine skills.

The ***integration of academic courses*** into the collection of supported programs is unique to each center and not particular to any single type of center. For example, the Martin Center for MIT Entrepreneurship hosts its own courses and serves as a connection point to all courses at the institute related to entrepreneurship. Similarly, the Keller Center is a conduit to design and venture creation courses and also supports certificate programs in information technology (partnering with the university's Center for Information Technology Policy) and energy (partnering with the Andlinger Center for Energy and the Environment). Both programs are intended to unify the efforts of students majoring in technical and humanities/social science disciplines. The Yale Center for Engineering Innovation and Design hosts a collection of design-based courses that are open to all members of the university community based on the awareness that the discovery of unique solutions is accelerated by the formation of diverse teams. These programs demonstrate how academic study can be incorporated into a center's purpose.

The ***role of mentors*** is distinct for each type of center. For entrepreneurship and innovation centers, volunteer mentors commonly augment the staff's efforts to provide guidance and direction to teams. These mentors share broad experiences as innovative and entrepreneurial practitioners. Mentors in these facilities guide the team's long-term journey as they navigate many new issues and challenges. The concept of mentorship takes a different form in academic makerspaces where peers provide mentorship (i.e. guidance and training) to other members. Rather than sharing broad experiences, peer mentors share specific equipment, process or problem-solving knowledge with other users. In this context, the exchanges not only have a sharper focus but are also shorter in duration.

OBSERVATIONS

This review identified three models for institutions to advance entrepreneurship, innovation, and making through centers. One approach, referred to as the ***multiple single-focused centers model***, establishes unique centers for each function. With this model, cooperation and collaboration between centers benefits members who have interests that span the entrepreneurship, innovation, and making domains. With multiple centers on one campus, it is important the scope of each center is limited to its primary mission area to eliminate duplicative programs and to maximize the use of resources available at each center.

The second model addresses the case when more than one of the entrepreneurship, innovation, and making domains are the mission of a single center. In this ***primary and supporting mission model***, a center focuses on one domain and adds programming in the other domains to support the primary focus. For example, a center may specialize in entrepreneurship and add a makerspace to facilitate work in that primary area. It is important to recognize that some aspects of the secondary functions may be limited in comparison to centers that focus on this single area. Continuing this example, the makerspace within an entrepreneurship center may limit its accessibility to product development associated with entrepreneurial pursuits rather than serve as a creative resource for the entire campus.

The ***single center model*** describes institutions that establish one entity to address interest in entrepreneurship, innovation, and making. In this case, no single domain is the primary focus of the center. Instead, all three domains have equal emphasis with respect to the center's space allocation, access, programming, and funding. This approach needs careful planning and oversight to ensure equity in each area and to create a community that benefits from the center's combination of purposes.

The involvement of faculty in the center's work is essential for widespread acceptance and sustainability of these programs. Reflecting the need to engage faculty members, most centers include a formal role for a faculty director within their leadership structure. Faculty need not be immersed in the center's work, but they should be active participants in the center's activities. Where appropriate, these interactions include teaching academic courses, using the center for research projects, and participating in center activities as individuals pursuing entrepreneurial, innovation, and making projects.

This review addresses the intersection and uniqueness of centers for entrepreneurship, innovation, and making and identifies developing trends. Similar comparisons can also be made to other campus activities, such as design programs, to identify additional best practices that enhance student learning.

Another intersection to examine is the role of a university's technology transfer office with these activities. As illustrated in this review, there is no single model for administering these related programs, but there is great value in examining how similar programs are administered, delivered, and sustained.

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