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Article

Creating a Corporate Entrepreneurial Ecosystem: The Case of Entrepreneurship Education in the RTP, USA

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Abstract: Today's dynamic and complex environment means that companies are trying to develop entrepreneurial thinking as a competitive advantage. Universities around the world are simultaneously increasing entrepreneurial training across a broad array of majors. However, the entrepreneurial training is not heavily connected to industry needs. This paper focuses on how industry and universities can cooperate to prepare students for corporate entrepreneurial thinking. The research is based on extensive literature, reports, and in-depth interviews with 28 people from various parts of the RTP (Research Triangle Park), including companies, government agencies, and numerous programs at multiple universities. The major finding from this study is that the strength of entrepreneurial education in the regional innovation system reinforces the companies' open innovation capacity and their performance. To be successful at launching campus-wide entrepreneurship education to increase understanding of corporate entrepreneurship, Corporate Entrepreneurship Education (CEE) must include (1) entrepreneurial leadership; (2) faculty champions; (3) student-focused policies; (4) engagement with the community; and (5) a decentralized, autonomous structure of entrepreneurship programs.

Keywords: entrepreneurial ecosystem; entrepreneurship education; Research Triangle Park (RTP); triple helix model; faculty champions

1. Introduction

In today's turbulent business environment, companies often seek to develop entrepreneurial thinking. At the same time, universities around the world are increasing entrepreneurial training across a broad array of majors. So far, this training has not been tightly connected to industry needs. This article proposes entrepreneurial education programs and identifies exemplars that positively impact industry performance.

Large, mature, capital- and technology-intensive organizations struggle to keep up with global competition, changing demographics, and rapid technology advances. Even more challenging is the ever-increasing complexity of business models, partnerships, value propositions, and a host of other business innovations. Organizational members that are not accustomed to these dynamic developments find it difficult to assimilate this bewildering array of issues to find new competitive directions. These drivers are addressed in entrepreneurial thinking and education [1,2].

Entrepreneurial thinking combines existing resources and methods with new developments and creates new competitive advantages [3]. By blending assets, capabilities, and the installed base with market and technology trends, as well as the competitive landscape and profound insights

into customer needs, entrepreneurial thinking generates innovative solutions to the most pressing challenges faced today. To get people to think entrepreneurially, they need be taught. Therefore, how entrepreneurial instruction takes place should be of great importance to SMEs (small and medium enterprises) and large companies [4]. Few students start new companies right out of college, but they and the companies they go to work for greatly benefit from entrepreneurial thinking. Universities offer a wide array of entrepreneurial programs that range from art entrepreneurship to non-profit companies, as well as family-owned businesses. These are all worthy approaches to entrepreneurial education, but they do not prepare people for entrepreneurial activity in large companies.

Entrepreneurial education in the United States is growing rapidly in a variety of directions [5–7]. To benefit from these innovative concepts of large companies, the entrepreneurial education models must include an understanding of industry challenges and opportunities; working in highly constrained environments; working across organizational boundaries; and the traditional entrepreneurship topics, such as early-stage market research, business plan writing, and developing and producing winning products. Ideally, industry should be deeply involved with university education to help educators understand industry needs to prepare corporate entrepreneurs.

This article examines entrepreneurial education in a unique setting positioned to prepare people for corporate entrepreneurship. The Research Triangle Park (RTP) is situated between Raleigh, Durham, and Chapel Hill, North Carolina, USA, and enjoys a rich tradition of company and university cooperation. The RTP is one of the largest business and oldest technology parks in the world, with a long track record of success. The “Triangle” refers to three major research universities in close proximity. Private parties created a non-profit research park in the middle of the universities to facilitate the interaction between corporations and universities. Unlike some technology-rich areas, the RTP was deliberately created rather than being an artifact of the Cold War. Therefore, it is a unique laboratory that can be duplicated elsewhere. The universities recognize their role in preparing students for large companies, while at the same time being focused on innovation and entrepreneurship. For their part, companies in the RTP are heavily connected with numerous university programs.

The RTP provides a specialized setting to develop entrepreneurial programs relevant to large technology companies. Many universities have multiple entrepreneurial education programs; the RTP universities are no exception. In particular, North Carolina State University’s STEM (Science, Technology, Engineering, Mathematics) focus, its land grant mission, and its Centennial Campus (dedicated to industry/university cooperation) position the university to prepare students for entrepreneurial thinking in large organizations. According to the 11th undergraduate students list at North Carolina State University, students who graduated within the last five years started 104 companies that raised \$365 million. Over the past five years, UNC-Chapel Hill has ranked 15th on the undergraduate list and has raised \$29 million for graduating students [8].

This article focuses on how industry and universities can cooperate to prepare students for corporate entrepreneurial thinking. This article is organized as follows: First, it presents a specific program in North Carolina that will explore the need for entrepreneurship education in the US, explain RTP, and prepare students for corporate entrepreneurship. We then develop a model for corporate entrepreneurship and employ the triple helix concept to make recommendations on how corporations and government agencies can be involved with university’s entrepreneurship programs.

2. Literature Review of Entrepreneurship Education

Figure 1 presents the model for connecting industry needs university educational programs and government infrastructure to make recommendations for corporate entrepreneurship education. The examples of the RTP as a corporate-based innovation and entrepreneurship center and North Carolina State University as tightly connected with corporate needs and entrepreneurship are used to identify principles and to make concrete recommendations for corporate involvement in university entrepreneurship education.

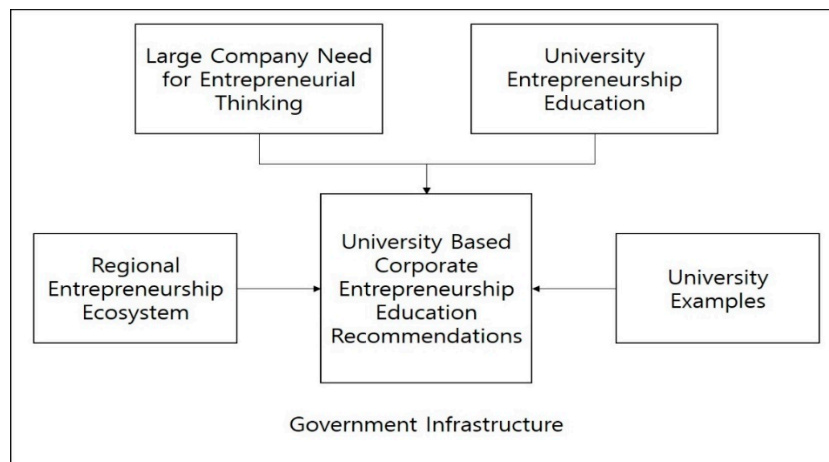


Figure 1. Industry, university, and government involvement in corporate entrepreneurship education.

This model integrates industry, universities, and government roles and responsibilities using the triple helix model [9]. Industry has needs that can be better met by universities and companies working together to develop and offer entrepreneurial educational programs advantageous to both industry and universities. Similarly, government activities are combined to provide support and infrastructure necessary for universities to provide students with skills needed by industry.

2.1. Entrepreneurial Thinking

Startup and corporate entrepreneurial thinking have many similarities, but some critical differences must be understood. Global competition heightens the need for companies to think faster, be nimble, respond to customers faster, and increase the value they add in products and services [10]. Nevertheless, large capital-intensive companies with large installed bases find it particularly difficult to innovate. Efficiently addressing the needs of a large installed base requires specialization in training and equipment. This ability, however, brings with it a reluctance to change. Change necessitates disruption of the present system that the company has worked on for years to perfect. This, of course, results in a very high level of aversion to change.

In traditional entrepreneurial training, students are encouraged to think about creating new value with new products, new business models, and new market segments, without the constraints of an existing company. Thinking of new products and services is adaptive for startup companies with new technologies, but established companies have multiple layers of constraints that must be addressed [11]. In addition to the usual topics of opportunity recognition, early stage market research, forming partnerships, etc., corporate entrepreneurial thinking must include how to innovate in a constrained environment with fixed resources and market approaches (see Table 1).

Corporate entrepreneurs need to know how to get multiple constituents in the same organization to support an idea. This is not completely different from a startup company seeking funding. Startups have to develop business plans that compel investors to write a check. Similarly, corporate entrepreneurs need to produce business plans that compel the appropriate business manager to invest. Entrepreneurial education can meet the needs of corporations to employ more entrepreneurial thinking, but corporations need to participate by providing the large company context to entrepreneurship education.

Table 1. Innovation differences between large established and entrepreneurial companies.

Innovation Characteristics	Established Large Companies	Entrepreneurial Companies
Innovation culture	One right way to innovate	New ideas abound
Resources	Large but already dedicated	Small but able to be deployed flexibly
Personnel	Experienced but narrow. Difficult to replace or add	Inexperienced but broad. Only has to add needed
Policies	Fixed	Flexible
Value creation	Constrained by existing resources	Able to change and move to new opportunities
Bricolage	Assets are functionally fixed	Assets can be used in various ways
Responsive to market conditions	Tries to fit responses to existing capabilities	Can build new customer capabilities
Repositioning	Difficult because of fixed capabilities	Difficult because of limited resources

2.2. Current Entrepreneurship Education

Entrepreneurship education—the teaching of skills and cultivation of talents that students need to start businesses, identify opportunities, manage risk, and innovate in the course of their careers—is now a staple of American higher education [12].

The present entrepreneur education pedagogy seems to be very diverse and eclectic. The entrepreneurship education initiative adopts the traditional small business management approach and the recent high-growth venture creation. Although the lecture and case study approaches are very much evident, there is a growing body of opinion that technology entrepreneurial education can improve learning outcomes with a different content and educational focus than games, simulations, or experiential learning through real ventures [13–15].

At the core of the entrepreneurial education curriculum is the process that is essential to the starting and operating of new businesses (see Table 2). For example:

- Introduction to entrepreneurship;
- Business plan development;
- SME (small- and medium-sized enterprises) financing;
- Legal environment for a new business;
- Case in small businesses;
- Fast-growing company management.

Table 2. University entrepreneurship education programs.

University Entrepreneurial Education	Program/Contents	Authors
New Venture, Start-up	Small business management and high-growth venture creation. Mindset	Rideout and Gray (2013), Kauffman (2013) [12,15]
Family business	Entrepreneurial intentions and perceived desirability	Zhang et al. (2014) [16]
Small business	Financing a small business and cases in small business	Gordon et al. (2012) Kauffman Foundation (2013) [12,17]
Ranking index	Availability of internships, externships, experiential and cooperative learning, and consulting opportunities for small business owners. A company that graduates started in the last five and 10 years. Annual business plan or new venture competition	Princeton Review (2018) [8]

There are now many entrepreneurship programs around the world. The Princeton Review (2018) [8] surveyed over 300 undergraduate and graduate business schools for entrepreneurship provision and ranked them based on three criteria: First, the availability of internships, overseas

systems, experience and cooperative learning, and consulting opportunities with small businesses; second, the number of students enrolled in entrepreneurship provision and the number of graduates who have started a business in the last five and ten years, and how many of them are still engaged in business; and third, whether they have partnerships with other schools that allow access to entrepreneurship programs. Universities host numerous business plan or new venture competitions, hackathons, pitch decks, startup weekends, etc. The Princeton index and these activities are focused on startup and venture creation, and are exclusively oriented toward small businesses, not large companies.

In trying to broaden the definition of entrepreneurship, the Ewing Marion Kauffman Foundation launched the Kauffman Campuses Initiative (KCI) in December 2003 to encourage new interdisciplinary entrepreneurial education programs throughout colleges and universities of the United States. The Foundation has made it a campus-wide experience, helping schools become more entrepreneurial, and making thousands of students on various campuses see their knowledge and resources from more entrepreneurial perspectives [18].

For instance, Babson College was one of the first academic institutions in the world to offer entrepreneurship courses. Since then, Babson has been internationally recognized as a leader in entrepreneurship education. They stated, “Entrepreneurship is not just Babson’s discipline, it’s a way of life. Our faculty and staff recognize the interdisciplinary value of entrepreneurship and frame it throughout the curriculum and co-curricular programs. The skills learned in our entrepreneurship classes are critical to the success of a public or private enterprise, a corporate or nonprofit organization, a local or global business” [19]. Nevertheless, Babson is generally focused on new venture creation and problem solving in the community.

3. Research Scope and the Method

This research is based on extensive literature, records, reports, and interviews with 28 people from various parts of the RTP, including companies, government agencies, and numerous programs at multiple universities (see Table 3).

Table 3. Interviewees (28).

RTP (15)	North Carolina (NC) State University (13)
- A (CEO, Sprout)	
- B (Manager, Quinties)	
- C1 and C2 (Manager, First Flight)	L1 and L2 (Professor, COM)
- D (Manager, RTF)	M1 and M2 (Manager, EI)
- E (Manager, GSK)	N1 and N2(Professor, Textile)
- F (CEO, BRI)	O1 and O2 and O3 (Professor, Psychology)
- G1 and G2 (Manager, CED)	P1(Professor, Art Entrepreneurship)
- H1 and H2 (Manager, HQ Raleigh)	Q1 and Q2 (Director, CIMS)
- I1 and I2(Professor, UNC-Ch)	R (Director, TEC)
- J (Professor, Duke)	
- K1(Manager, NC Biotech)	

Method. Semi-structured interviews were conducted from August 2015 to May 2016. Questions were asked to assess how effective campus-wide entrepreneurship education prepared students for corporate entrepreneurship. Interviews lasted 30–90 min and averaged about 60 min. Careful notes were taken and analyzed immediately after each interview to categorize the content. The categories of content from these interviews are summarized in Table 4.

Table 4. Key aspects or success components of corporate entrepreneurial education.

Key Aspects	Interview Contents
(1) Entrepreneurial leadership in universities	Vision of industry-university collaboration for corporate entrepreneurship. Entrepreneurship vision tied to the university vision/mission. Administrative support to start and sustain funding strategies. This can come from tenured faculty, administrators, or non-tenure track specialists.
(2) Faculty champion	Although leadership can come from anywhere, a strong program will have a faculty champion, ideally with a strong STEM background, academic and industry experience, and entrepreneurial experience. These are exceptional faculties so faculty and program development in multiple colleges is necessary.
(3) Focus on student	Student friendly policies and engaging content and programs need to be focused on involving a wide variety of students. Connect students with a community, teamwork, competitions and co-working accessibility, process, and hands-on program.
(4) Community engagement	Industry–university collaboration culture, identify key stakeholders and partners, corporate participation, angel and investor networks, industry sponsors, mentor in residence, and internship opportunity.
(5) Decentralized/coordinated	Diverse autonomous discipline-based program. Each academic unit may sponsor their own program to meet specific industry needs associated with each discipline. Nevertheless, there is also the necessity for coordinated and collaborated structures.

Analysis. Interview data were used to identify and categorize the key aspects or success components for Corporate Entrepreneurship Education (CEE). Recognizing the practical differences in entrepreneurship between large and small companies (Table 1) and the focus on small company entrepreneurship education in Table 2, this research focused on understanding educational needs for corporate entrepreneurship. The interviewees (Table 3) produced a variety of suggestions and observations about what is needed for corporate entrepreneurial education. The content of these interviews was categorized by the authors into five key aspects, as presented in Table 4.

Interviewees indicated that universities that are successful at creating entrepreneurially-minded students for the corporate world must have an administration aware of this need and embed it in the mission and vision of the university. The interviewees recognize the necessity for faculty attuned to the entrepreneurial needs of corporations. The interviewees strongly recognized that there must be a focus on student development that goes beyond classroom settings and that actively engages with a variety of companies in the business community. Finally, while these activities must be encouraged and supported by the administration, programs and faculty are evaluated and live in their home units. This means that academic units must each establish their own vision, reward faculty for participation, create a student focus, and promote community engagement at the department level from the perspective of open innovation. Therefore, to be successful campus-wide, Corporate Entrepreneurship Education (CEE) must include (1) entrepreneurial leadership; (2) faculty champions; (3) student-focused policies; (4) engagement with the community; and (5) a decentralized, autonomous structure of entrepreneurship programs (see Table 4).

Identifying specific suggestions made by the interviewees and consistent with the CEE principles derived from across all the interviews, we make the follow suggestions for a university-based corporate entrepreneurship program. The program should contain the following:

- An educational process that covers all topics in corporate entrepreneurship;
- Deep connection and cooperation with multiple corporations;
- Corporate entrepreneurship projects that allow students to get first-hand experience of trying to be entrepreneurial in a large company;
- Corporate mentors that can guide students to develop a compelling business plan for use inside existing corporations;

- An internship and jobs connection so students can gain experience and view the job opportunities in large companies;
- Competitions for corporate entrepreneurship projects to call attention to and increase competition and innovation in corporate entrepreneurial thinking;
- Establish a Corporate Entrepreneurship Clinic that works with existing companies and matches students with projects and mentors connected to their interests; and
- Executive education programs and short courses to help educate existing managers and executives about what entrepreneurial thinking is and how to promote it within the organization.

These features may be contained in a wide variety of academic programs, for example, MBA programs may include a corporate entrepreneurship course as part of an existing entrepreneurship program. We also identified successful entrepreneurial programs across the university that could include corporate entrepreneurship. A separate concentration may also be offered with support from area corporations. An even more ambitious approach would be starting a Master of Science degree focused on corporate entrepreneurship. At the undergraduate level, courses may be offered, similar to the MBA level. A minor in corporate entrepreneurship may be offered for non-business majors to expand job opportunities.

The benefits for corporations to participate in corporate entrepreneurship programs will include more thought and creativity on the part of the faculty to solve pressing corporate innovation and competitive issues. Students from both business schools and other majors will be better able to understand the challenges and to formulate solutions for corporate challenges. Student projects will result in actual project work being done and new thinking being applied to old problems, as well as companies getting a close look at potential new hires. Executive and other professional courses will help existing managers to develop and manage in a more entrepreneurial way. Finally, participation in these types of programs gives companies a positive venue to present themselves to potential employees and benefits the hiring and retention of an entrepreneurially thinking workforce.

Universities also benefit from providing corporate entrepreneurship programs by offering programs of interest to students, job placements, internship opportunities, connection with area corporations, potential research opportunities, and a positive venue to present the university as helping the local economy by responding to the educational needs of area employers.

4. The Case of the RTP

4.1. Regional Entrepreneurship Ecosystem

Although the RTP is one of a few technology-start-up locations, we focus on how entrepreneurial education is utilized by companies in the RTP. The presence of corporations in the RTP often occurs in the form of development divisions. They are often tasked with creating new value. Therefore, they have a strong need for entrepreneurial thinking. NC State is uniquely positioned as a land grant university with a new campus that co-locates companies and academic units. NC State is in the top ten universities supported by corporate grants. This combination of development-based innovation in both RTP companies and universities makes it a unique location to study corporate entrepreneurship. Before making corporate entrepreneurship education recommendations, we include examples of regional entrepreneurship ecosystems and university examples. These give concrete examples in which companies can participate and guide.

4.2. Research Triangle Park (RTP)

Governments seeking to establish economic engines and companies wanting to target their participation in corporate entrepreneurship should study the RTP. Unlike some other larger technology areas, the RTP is the result of careful planning from the very inception. The RTP did not just happen, nor is it a happy circumstance left over from military funding during the Cold War. Due to the

deliberate and well-documented actions of the founders and subsequent managers, the RTP is uniquely replicable in other areas [20].

RTP is one of the world's largest high-tech research parks. The founders saw the potential for collaboration among universities, industry, and government in 1959. Today, RTP has more than 200 companies employing over 50,000 employees with expertise in microelectronics, telecommunications, biotechnology, chemical, pharmaceutical, and environmental sciences. The park has a large headquarters of the following organizations: IBM; GSK; Biogen Idec; Syngenta; United Therapeutics; Cisco; Bayer CropScience; Eisai; BASF; the U.S. EPA; NIH's National Institute of Environmental Health Sciences (NIEHS; the only NIH institute/center outside of the DC metro area); and the first research institute to help launch the park, RTI International [21].

The RTP can be considered a "Moneyball" area; its success ignores traditional wisdom. The RTP region has attracted more corporate investments than traditional venture capital. Corporate investment seeks relevant strategic technologies and promising opportunities. Entrepreneurial outcomes are more likely to be acquired by a large company than initial public offerings (IPO). In the RTP region, corporate R and D, mergers, and acquisitions have led to greater employment growth than venture capital investment in the region. The acquiring company has recognized that the value of the assets acquired was more valuable in its place than in dismantling operations. Acquisitions often make additional investments in the region [22]. In 2014, the CED reported 59 mergers and acquisition (M and As) and six IPOs. Large corporate investments and entrepreneurial startups in the RTP share similar end points. This natural link between startup and acquisition is one aspect that helps integrate corporate and traditional entrepreneurship.

Research Triangle Foundation. The Research Triangle Park Foundation manages RTP and operates three buildings. These three buildings are the Frontier, the Lab, and the Archie K. Davis Conference Center. The Frontier is an innovative and collaborative space that was first opened in January 2015. The Lab is a full service lab and office space with several research and development companies. The Archie K. Davis Conference (AKD) Center is a 6800 square foot event space. The AKD Conference Center is also home to the Research Triangle Park Foundation headquarters. There are numerous programs for large and small companies sponsored by the RTF (Research Triangle Foundation), for example, "RTP 180" invites speakers from three founding universities, local companies, and the community at-large. The TEDxRaleigh series draws between 250 and 300 people on the Foundation's third Thursday evening.

Frontiers. The RTF also runs a centrally located branch of RTP to plug in and collaborate and plan the next big move. The Frontier is the main building of the Park Center and is an important step for redevelopment efforts. It includes free collaborative work and drop in meeting space, mixed-use space including a third-floor tenant office, and event space. As a part of the free offerings, Wi-Fi, counter-culture coffee, the community garden, and programs are all free of charge and open to everyone. The success of the Frontier depends on the community to create a vibrant and rich space with innovative ideas. Weekly features and programming, such as Happy Hour, RTP/Fidelity Food Truck Rodeos, 1 Million Cups, and RTP 180 lighting talks are held in this place.

Council for Entrepreneurial Development (CED). A mainstay of entrepreneurship in the RTP is the CED. Established in 1984, the CED is the largest corporate support organization in the United States, with more than 5000 members representing more than 1100 companies. Located in AU (American Underground) since 2010, CED's Board of Directors (64 people) are committed to the Triangle's entrepreneurial future. CED is based on an entrepreneurially inspired individual and business community and is a network of national networks that helps Triangle entrepreneurs build and grow successful businesses. CED provides education (or training), mentoring, and capital formation resources to technology-based, high-growth entrepreneurs. Activities include the CED Life Science Conference (March), the CED Tech Venture Conference (September), the CED Venture Mentoring Service, entrepreneur-only workshops, and investor introductions.

Co-working Space. Old buildings in downtown Raleigh and Durham City of RTP have been changed into a co-working space and space for entrepreneurship education, such as American Underground and HQ Raleigh.

American Underground. In 2010, the basement of the American Tobacco Campus—hence the name American Underground—bloomed into two spaces in Durham and one in Raleigh, one of which has 240 founders with 70 employees in a solo entrepreneurial business.

HQ Raleigh. It opened in 2012 in the downtown warehouse known as Raleigh. In 2015, it added an additional 5000 square feet of space across the street and acquired an adjacent site, where it plans to build a new 43,000 square foot building, which will more than triple its current space. Currently, 128 startups are housed in the HQ Raleigh space. American Underground and HQ Raleigh are clearly the bold newcomers that have made a large impact on the entrepreneurial scene, fostering dense clusters of startups that are unprecedented in the region.

The RTP, together with the many programs and organizations to support existing and entrepreneurial companies, as well as many technical specialties, form the ecosystem that companies of all sizes can leverage for growth.

4.3. North Carolina State University

The RTP is a major corporate, university, and government research and technology center. North Carolina State University (NC State) has a number of characteristics that make it an attractive model for companies that want to partner with universities for corporate entrepreneurship and entrepreneurial thinking. NC State is the largest STEM (Science, Technology, Engineering and Mathematics) institution in North Carolina and one of the largest in the Southeastern US. The STEM orientation is derived from being a land grant institution originally chartered in 1881 to focus on agriculture and mechanics, both technical and designed to interface with industry.

According to the Association of University Technology Managers, NC State is #1 in licensing to companies, beating MIT, Berkeley, Stanford, and all other notable universities, and #6 in attracting corporate funding. This is not just due to an effective technology transfer office, but rather reflects the long-standing relationships developed over decades between NC State and the business community. Faculty, staff, students, and administrators are all deeply immersed in relationships with large companies.

From an economic perspective, NC State has a disproportionately large impact on the state through both entrepreneurial and corporate activities. Figure 2 shows the relative contribution of NC State compared with all the other state universities in North Carolina (UNC).

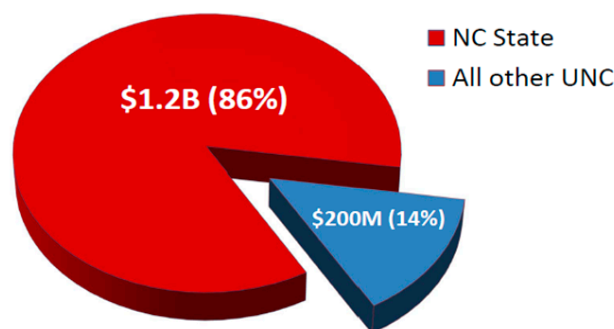


Figure 2. UNC system statewide business startup impact 2012–2013. [23].

Business start-up impact. NC State creates an exceptional environment for innovation and entrepreneurship, proven by the number of startup companies associated with NC State in the region. In FY 2012–2013, a university-based startup company generated \$1.1 billion in additional regional income for the Economic Development Partnership Region economy, equivalent to creating 4984 jobs.

Impact of Spin-off Companies. Spin-off companies include businesses created by faculty, students, or graduates at NC State, as well as start-up business development through NC State's programs. In FY 2012–2013, the combined impact of spin-offs associated with NC shares was \$596.4 million in additional regional income, corresponding to 10,166 new jobs. This impact is important because it constitutes a significant part of the regional business environment.

Centennial Campus. This state-of-the-art campus provides proximity like no other research campus in North America. Corporate tenants and university departments co-exist in the same campus and even in the same buildings. This university, industry, and government partnership provides a powerful environment for entrepreneurial education to include the needs of corporations. The first land of 385 acres (1.6 km²) was handed over to North Carolina State University in 1984 by North Carolina Governor James B. Hunt, Jr. Another 455 acres (1.8 km²) was submitted to NC State in 1985 by Governor James G. Martin. Claude McKinney, dean of the School of Design, developed the Master Plan and in 1989, the first building was completed and occupied. ABB first moved in 1991. In the same year, the College of Textiles moved to the Centennial Campus. In 2000, the Centennial Biomedical Campus was established. Since 2002, the College of Engineering has started moving to the Centennial Campus. The Centennial Campus added a fourth dimension to the trinity of teaching, research, extension, and partnerships with the private sector in pursuit of the public good.

Approximately 70 companies, governments, and non-profit organizations are located on the Centennial Campus with academic departments. To lease space for property, prospective "partners" must be programmatically linked to NC states, such as through conducting joint research with faculty or the use of students for internships or part-time jobs. About one-third of our partners are venture companies or early stage companies and are located at Centennial's Technology Incubator. Another 20% are research and development departments of large enterprises, and the rest are small businesses, state and federal agencies, and nonprofit organizations. Current partners include ABB, GlaxoSmithKline, the US Department of Agriculture, and the Regional Office of the National Weather Service.

STEM Focused. NC State has the fourth largest engineering undergraduate program in the U.S., one of the oldest computer science departments in the U.S., and is the fourth largest in terms of graduate degrees awarded. It is the only NSF (National Science Foundation)-funded smart grid research center in the U.S., and one of the world's largest biomanufacturing training and educational facilities. Additionally, it has the third highest ranked veterinary college in the U.S., the largest textiles college program in the U.S., the only next generation wireless test bed system in the U.S., and the only research park in North America with a world-class research library (complete with an automated book retrieval system and about 100 technology-equipped group study spaces).

Intellectual Property Management. Of the 164 individual institutions responding to the 2014 Licensing Activity Survey conducted by the Association of University Technology Managers (AUTM), NC State ranked 6th in terms of the number of Licenses and Options Executed. In fact, OTT (Office of Technology Transfer) of NC State consistently ranks among the top 10 technology transfer offices at universities without medical schools in terms of invention disclosures (6th), US patents issued (7th), startups formed (5th), and licenses and options executed (1st). The university has engaged multiple corporations in unique intellectual property management agreements and can accommodate a wide variety of corporate needs.

Sponsored Research. NC State provides a one-stop shop environment for industry and governmental partners. NC State ranks 6th in industry-supported research among peers. The university provides a positive environment for corporations to engage with faculty and university programs at all levels. The combination of sharing space and sponsored research provides benefits to faculty, students, and corporations engaged in joint projects.

Chancellor's Faculty Excellence Program. This program is committed to the interdisciplinary endeavor of NC State University and is committed to addressing the most important issues in the world. Following a strong strategic plan and an aggressive vision, the cluster recruiting program has added 77 new faculty members in 20 disciplines to add to the breadth and depth of NC State's

already strong efforts. For example, faculty clusters are bioinformatics, carbon electronics, data-driven science, emerging plant disease and global food security, environmental health science, forensic science, geospatial analytics, and synthetic and systems biology.

Center for Innovation Management Studies. This center is involved in the creation, synthesis, and dissemination of industry-related information on innovation management and the development of current and future generations of innovation management researchers and industry workers. In addition, the center connects industry needs and university resources and has been sustainable since 1984.

4.4. Entrepreneurial Education Programs

The university uses both coordinated and decentralized programs of entrepreneurship, as follows:

Entrepreneurship Initiative (EI). The NC State Entrepreneurship Initiative was established to promote student innovation and entrepreneurship. At NC State, EI strives to create unique learning opportunities for students to grow into leaders and job-generators of the next generation. As a program, EI takes an interdisciplinary approach to learning. Faculty and staff come from a variety of backgrounds and industries, and actively recruit students from across the campus. The desire is to build a community within and outside of the university where everyone is thriving with creative and immersive entrepreneurship. Several levels of involvement are offered, depending on individual interests and entrepreneurial goals [24];

Technology Entrepreneurship and Commercialization. The Technology Entrepreneurship and Commercialization program (TEC) was initially developed at the College of Management, from 1994 to 1999. Development was supported by the National Science Foundation, the Kenan Institute for Science and Engineering, and a number of corporate sponsors. The TEC program engaged MBA and technical graduate students to create viable business cases for new technologies [25,26];

E-Clinic. The Entrepreneurship Clinic is held in collaboration with the Poole College of Management at NC State. This clinic is designed to help business college students build a hands-on experience by conducting projects submitted by start-up companies within the HQ. NC State E-Clinic is a place where students, faculty, entrepreneurs, and service providers are teaching, learning, and building the next generation of business at Raleigh, inspired by a model of university teaching hospitals. "For years, faculty, students and entrepreneurs have been working together to envision a physical space in which to learn from each other, and ultimately to develop commerce and create special value for the North Carolina economy", said Lewis Sheats, the NC State E-Clinic Executive Director: "HQ Raleigh's collaborative workspace is an ideal place to provide these resources to Triangle's entrepreneurial community".

Wolfpack Investor Network. With an estimated 30,000 accredited investors in the alumni base, the Wolfpack Investor Network (WIN) provides a new mechanism for engaging these individuals with NC State's entrepreneurial ecosystem. Investors, many of whom are corporations, support technologies that come to the market after technical and business proofs of concept are demonstrated. These technologies can then become available to corporations. Students and faculty are engaged in preparing commercialization plans that meet targeted industrial needs.

The RTP companies and universities have grown up as having symbiotic relationships with each other. Relationships and funding mechanisms provide mutual support. The RTP is a specialized example of how universities, government, and industry partners work together to create value through technical innovation. A large part of that is conducted through corporate entrepreneurship.

5. Discussion and Conclusions

The main result of this study is that the strength of entrepreneurial education in a regional innovation system reinforces the open innovation capability and performance of companies. It has been shown that entrepreneurship specifically promotes open innovation in companies involved in new value creation [27–31].

This paper has studied the case of RTP, which is one of the largest research parks in the world. The RTP provides a specialized setting to develop entrepreneurial programs relevant to large and SME technology companies. In particular, North Carolina State University's STEM focus, its land grant mission, and its Centennial Campus (dedicated to industry/university cooperation and openness) position the university to prepare students for entrepreneurial thinking in SMEs and large organizations.

Corporate entrepreneurship education recommendations are collaboration between the regional ecosystem and university's entrepreneurial programs. The interviews from the RTP and NC State identified program policies and activities at universities that support the corporate entrepreneurship needs of companies. The successful program "Campus Wide Entrepreneurship Education" (CWEE), which is defined at the university level, includes several schools and colleges that are interconnected and diverse student teams that consist of and are directed by professors and mentors, and is important for the diverse corporate needs of entrepreneurial thinking. We found that CWEE must include the five factors of entrepreneurial leadership, faculty champions, student-focused policies, engagement with the community, and a decentralized, autonomous structure of entrepreneurship programs. CWEE has a close relationship with different kinds of industry, large companies, and human and capital resources.

In conclusion, we can sum up the five success components by applying the triple helix model to categorize the interview results by university, industry, and government.

The first is **entrepreneurial leadership**. University entrepreneurial leadership from the administration and faculty is very important for the ecosystem. The leadership of administration and faculty provides a top-down and bottom-up approach to campus-wide entrepreneurship education. Entrepreneurial leadership creates a culture for industry involvement and administration support for cooperative programs. Faculty engages in programs, course creation, and charges of thought leadership and skills training. We have identified the RTP case, where university leaders have made a vision and culture, and provided them to members of the community and university. A faculty champion makes a road to entrepreneurship education and supports corporate entrepreneurship. At NC State, the president provides a vision of entrepreneurship, "Think and Do", and supports the recruitment and funds for the excellence of research and implementation. Several faculties have made an excellent program of entrepreneurship in diverse disciplines, businesses, engineering, textiles, and art, and have tried to coordinate them through Entrepreneurship Initiatives (EI).

Industry leadership can make a cornerstone for the corporate entrepreneurship through the deep involvement and role of champions. They can lead the university and government, especially through champion proposals for university engagement with a company. Industry entrepreneurial leadership initiates the creation of corporate entrepreneurship programs at universities. It connects leading corporate entrepreneurs with university programs, faculty, and students.

A government entrepreneurial leader has an important role as a policy champion. They commission research and economic development studies and policy champions for tax and regulatory issues. Additionally, these leaders initiate and fund technical and business programs in emerging areas of strength and opportunity, for instance, NC Biotech Center (NCBC).

The second is **student focus**. The student is a core asset of corporate entrepreneurship and the university has to develop and provide a corporate entrepreneurship program to students at an adequate level for their undergraduate and graduate degree. Universities should offer corporate entrepreneurship education opportunities (courses, curriculum, majors, minors, certificates) and extracurricular activities (games, visits, competitions). The student has a career vision and is a key member of development programs. Students can establish clubs and activities to increase corporate entrepreneurship confidence.

Industry should collaborate to create corporate entrepreneurship programs and host visits by university students. It should also establish hiring and promotion criteria for corporate entrepreneurship and develop job descriptions for corporate entrepreneurs so students can see the new window of opportunities. This includes the opportunity of internships so that students can experience the real issue and the gap between the theory-based classrooms and practical large companies' activity can be narrowed.

Governments expand internship programs with government agencies (SBDC, SBA) to include corporate entrepreneurship opportunities. They create education-funding programs (I-Corps, STEM training programs) and craft policy to include women and minorities.

The third is **faculty champion**. University faculties are often hesitant to become involved in entrepreneurship education because of their interests, time constraints, traditional evaluation criteria, and sometimes ignorance of the industry. Faculty identify and support corporate entrepreneurship for students and corporate businesses. Universities provide time and leave policies to participate with industry and make entrepreneurial-friendly evaluation criteria. They need course development support and to provide faculty corporate entrepreneurship funding. For instance, Arizona State University provides a faculty leave system for start-ups. Faculty should have time to develop new courses on corporate entrepreneurship.

Industry participates in course development and assigns mentors (or Executives in Residence) to courses and projects. They provide access to company projects for courses and also provide “faculty internships” at companies. Industry can create professorships in corporate entrepreneurship.

Governments can sponsor economic development studies and provide funding for positions to hire and retain high-profile faculty. They support centers and institutes for university/industry cooperation and corporate entrepreneurship development. They integrate economic development infrastructure between universities and industry.

The fourth is **community engagement**. Community engagement is the process by which community interests and individuals form a lasting and permanent relationship to apply the collective vision for community benefit. Communities create joint programs, such as speakers, games, and competitions, with university and university extension services for corporate entrepreneurship. They contribute to regional economic development and establish entrepreneurship clinics and project spaces.

Industry can act as a sponsor and enable joint programs, such as speakers, competitions, and visits to companies. It convenes technical and business user groups and makes job creation programs integrated within university training in corporate entrepreneurship. It also supports community entrepreneurship programs.

Governments create and sustain business relationship agencies and include universities. They support places for faculty, students, and industry to meet, for instance, Frontiers of RTP. They pass tax policy to encourage industry and university involvement and create SBIR (Small Business Innovation Research), co-investment funds, etc. State governments recruit companies to the region.

The fifth is **de/centralized structures**. Structure makes a corporate entrepreneurship education sustainable. Universities establish central support for decentralized programs for sustainability. They encourage corporate entrepreneurship programs across the entire university and provide corporate entrepreneurship portals for communications between the university and industry collaborators.

Industry creates a university involvement office and sponsors corporate entrepreneurship centers and programs in different departments around campus. It emphasizes involvement from a diverse major and population base. Governments support structures for university involvement in government economic development projects. They create grants for entrepreneurship structures at universities and provide corporate entrepreneurship training programs for university faculty, students, and administrators for industry cooperation.

Large, mature, capital- and technology-intensive organizations struggle to keep up with global competition, changing demographics, and rapid technology advances. Universities are offering a wide array of entrepreneurial programs that range from art entrepreneurship to non-profit companies, as well as family-owned businesses. These are all worthy approaches to entrepreneurial education, but they do not prepare people for entrepreneurial activity in large companies. Start-ups and corporate entrepreneurial thinking have many similarities, but some critical differences must be understood.

This research suggests that there is interest in corporations for a variety of entrepreneurship training not presently taught in universities. While this may be interesting, additional research from a variety of business communities around the world is needed to establish generalizability. It may be

that the RTP area is unique and cannot be replicated. This research has focused on what universities need to do to create corporate entrepreneurial education, but has not established what corporations must do to be as involved as we see in this sample. It is likely that both university and corporate development efforts must be built simultaneously in order to accelerate success. Finally, additional research is needed to establish the nature of students participating in these programs. This research did not assess the prior preparation, motivation, or expectations of the students. University, corporate, and student aspects of corporate entrepreneurial education must be simultaneously addressed in order to assure success.

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