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Reinventing an Innovation Ecology with New Models for Research and Research Parks

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Abstract

A novel effort to reinvent the innovation ecology of the Charlotte region is described. The methods and approaches are particularly relevant for restarting both local and global economies. Addressing requirements for faster innovation and more diverse innovation cycles, the research enterprise of the University of North Carolina at Charlotte, the Charlotte Research Institute, the University Research Park, and a diverse collection of partners are working together to recast university research models and research park paradigms. Best practices are discussed for technology transfer based on interdisciplinary applied research. A novel collaboration model developed by the Charlotte Research Institute is described. Guiding principles for the master planning and redevelopment of a forty year old research park are presented. Connections to a diverse collection of regional partners are also described to characterize the evolving partnerships that define the innovation ecology of the Charlotte region.

Introduction

Innovation is broadly considered to be the process by which intellectual property is transformed into a product or service that generates significant economic and social benefit. Ecosystem is a term first created to describe the interdependent system of plants, animals and micro-organisms that co-exist and evolve in a physical environment.^{1,2} An innovation ecosystem is a network of public and private enterprises that operates adaptively to create new products, services, and processes.

While some innovation ecosystems are created and studied at the enterprise or sector level,^{3,4} our interest is in multidiscipline, multiple cluster, ecosystems that operate in geographically defined locations.⁵ Silicon

¹ *Ecosystem*. 2009. Wikipedia. <http://en.wikipedia.org/wiki/Ecosystem>.

² Christopherson, R. W. 1996. *Geosystems: An Introduction to Physical Geography*. Prentice Hall Inc.

³ Adner, Ron. 2006. *Match Your Innovation Strategy to Your Innovation Ecosystem*. *Harvard Business Review*. April: 98-107.

⁴ Iyer, Bala and Thomas H. Davenport. 2008. *Reverse Engineering Google's Innovation Machine*. *Harvard Business Review*. April: 1-11.

Valley in California and Route 128 in Massachusetts exemplify large scale innovation ecosystems of this type.

Our motivation for fostering innovation comes directly from the benefits expected. Eric von Hippel's studies on innovation⁶ show a distinct number of cases where innovating firms generate higher profits than noninnovating firms. We conjecture that this higher profit also translates into more prolific and robust businesses and hence, greater benefits to the economic and social community. This is particularly relevant as our world works to restart and sustain local and global economies.

The Charlotte, North Carolina, region in the Southeast United States has steadily evolved through a variety of economic models;⁷ Starting as a crossroads trading city of the 18th century, growing to a manufacturing center in the early 20th century, and then achieving present day status as an international center for financial and logistical services, the Charlotte Region is now an aspiring knowledge economy with focus on biosciences and medicine, energy and sustainability, and security and defense.⁸

A research university and research park⁹ were developed over the last sixty years with varying foci to support economic growth with an early emphasis on established stable regional companies and growth of regional strengths across the nation.

The University of North Carolina at Charlotte, a public research university, is the fourth largest campus among the 17 institutions in the University of North Carolina system and it is the largest institution of higher education in the Charlotte region. The University offers 18 doctoral programs, 62 master's degree programs, and 90 programs leading to bachelor's degrees. Fall 2008 enrollment exceeded 23,300 students, including almost 5,200 graduate students.

The University Research Park (URP) in Charlotte was first organized in 1966 and has grown to a 2200 acre (900 ha) business park with research, office and light industrial uses. Located less than three miles (5km) from the University of North Carolina at Charlotte and the Charlotte Research Institute, the URP has over 10,000,000 square feet (929,000 square meters) of offices and well over 20,000 employees.

Regional planners and key stakeholders recognize that local public well being and economic health are significantly tied to the international community and the global economy. This interconnectedness drives a need for faster innovation and more diverse innovation cycles that are highly dependent on tighter integration and broader teams of interdisciplinary talent.

Addressing these requirements, the research enterprise of the University of North Carolina at Charlotte, the Charlotte Research Institute, the University Research Park, and a diverse collection of regional partners are working together to reinvent the university research model and the research park paradigm that has guided activity in the Charlotte Region.

⁵ PCAST, The President's Council of Advisors on Science and Technology. 2004. *Sustaining the Nation's Innovation Ecosystems*. https://www.dodmantech.com/pubs/FINAL_PCAST_IT_Manuf_Report.pdf

⁶ von Hippel, Eric. 1988. *The sources of innovation*. New York: Oxford University Press.

⁷ Morrill, Dan L. 2006. *Historic Charlotte: an illustrated history of Charlotte & Mecklenburg County*. San Antonio, Tex: Historical Pub. Network.

⁸ *Charlotte Regional Partnership*. 2009. <http://www.charlotteusa.com/>

⁹ Colvard, Dean W., Douglas Milton Orr, and Mary Dawn Bailey. 1988. *University Research Park: the first twenty years*. [Charlotte]: Urban Institute, University of North Carolina at Charlotte.

The university's approach to research targets interdisciplinary applied research and places high value on technology transfer and industrial collaboration. An interdisciplinary culture is fostered by a strong recruitment philosophy, mechanisms for cross discipline work activity, and a research funding model that favors research that spans academic departments and colleges. UNC Charlotte's Office of Technology Transfer (OTT) has a well defined and successful model for the commercialization of university research and intellectual property. For the seventh consecutive year, UNC Charlotte has placed very high in national rankings published by The Association for University Technology Managers (AUTM) annual survey.

The Charlotte Research Institute is the portal for business-university partnerships at UNC Charlotte. Regionally, CRI works with the community and the campus to accelerate technology commercialization and the growth of entrepreneurial ventures. Globally, CRI develops intellectual capital through collaborations with industry, government and academia. New business and research ventures, university partnerships with regional and national enterprises, and CRI spin-off companies all draw research and businesses to the region and spur economic growth. Innovation and entrepreneurship are strongly supported by CRI's Ben Craig Center business incubator (BCC). The incubator program, business advisory services, and education events offered by the BCC support dozens of companies each year. BCC focuses on community businesses and University startups that benefit most directly from proximity to expertise, services, and equipment that the BCC and the University can provide. Science and engineering ventures at CRI are driven by the internationally known results of its research centers in Precision Metrology, Visualization, and Optoelectronics. CRI's research vision continues to grow with emerging research initiatives that include bioinformatics, biomedical engineering systems, energy production and infrastructure, information security, motorsports and automotive engineering, nanoscale science, and translational research. With facilities on the Charlotte Research Institute Campus and at the North Carolina Research Campus in Kannapolis, CRI helps companies initiate new partnerships at UNC Charlotte and offers a variety of opportunities to engage talented faculty and make use of specialized resources available at UNC Charlotte.

The University Research Park in Charlotte, North Carolina, operates currently in a steady-state mode while beginning new master planning efforts to draw growth through redevelopment. The research park houses both research and development enterprises as well as engineering and service centers for a variety of companies in energy, financial, optoelectronics, and transportation sectors.

Broader connections through regional, national and international networks are employed to emphasize diversity and international collaboration. Regional and national networks are formed by using research centers of excellence to both pull in expertise and also push regional strengths beyond borders. A similar approach is taken for international networks with additional focus on regional resources for international companies and incentives for intellectual and corporate partnerships. An extended business incubator model offers a first location opportunity for local startups and for international businesses establishing a presence in the Charlotte Region. A broad array of State-wide and regional partnerships including the North Carolina Research Campus, the North Carolina Biotechnology Center, the North Carolina Research Park Network, the Carolinas Micro-Optics Triangle, and Innoventure all offer strong opportunities for international partnerships.

In summary, the goals of this integrated partnership are to reinvent our current innovation ecology and to be a strong partner in the international community and the global economy. In the following sections, current approaches, best practices, and new challenges for this effort are discussed in more detail.

Faster and Diverse Innovation Cycles

In developing an innovation ecosystem, we look for strategies to increase innovative behavior. One such strategy is eluded to by von Hippel in his observation that “informal know-how trading” is a sufficient condition to spur innovation. This is consistent with Lambert’s conclusion¹⁰ that “proximity matters.” Eric von Hippel also observes that the source of innovation can be shifted by changing the distribution of profit expectations.

A more procedural approach to innovation described by Goldberg¹¹ brings a different view to the necessary and sufficient conditions for innovation. Goldberg considers the innovation process as an evolutionary algorithm and posits that diversity and many mutations or cycles are required to generate robust innovations. The key necessary condition for this innovation process is a community that creates, possesses and accesses intellectual property. In addition, this community must be open to exploring a broad range of domains, opportunities, and applications. Goldberg refers to an “ecology-like process where different digital species co-evolve through an intricate mix of competition and cooperation”. Innovation is then driven by opportunistically matching intellectual products with product opportunities; Goldberg speaks of a procedure for “discriminating bad solutions from good solutions”. Facilities and capabilities for efficient design, fabrication, and testing must be in place to support rapid generation and evaluation of solutions. Finally, the evolutionary process can only be enabled by rapid mutation or cycling of the opportunity-solution process. We conjecture that this ability to rapidly and repeatedly cycle is the most important requirement for innovation.

As Dr. Charles Wessner of the National Academies has commented in many presentations, “Innovation is hard to plan but it can be encouraged.” From these observations and our experience, the following broad strategies are useful in seeding and sustaining the innovation ecosystem.

- Arrange proximity and connectivity among knowledge workers.
- Co-locate multiple academic disciplines and multiple business clusters.
- Continually initiate informal “events” that generate communication.
- Offer strong incentives and support for application of research and business startup.
- Co-locate idea creation activities and prototype and testing facilities.
- Reward speedy innovation cycles regardless of success or failure.
- Emphasize restart when initiatives fail and consider rewarding some aspects of failure.

These strategies are particularly relevant in the current economy. Multi-location innovation is expensive and our approach of working in a geographical location is less so. Multi-location innovation, by definition, generates diversity while our approach drives diversity by actively co-locating sectors and disciplines. As we have stated, we believe that rapid cycles of innovation are key to a successful ecosystem. Our strong emphasis on rapid cycling and restart are especially applicable to the current economy.

Working from these broad strategies, we have defined particular approaches and tactics in technology transfer, research collaboration, and redevelopment of the research park as described in the following three sections.

¹⁰ Lambert, Richard. 2003. *Lambert review of business-university collaboration: final report*. London: HM Treasury.

¹¹ Goldberg, David E. 2002. *The design of innovation: lessons from and for competent genetic algorithms*. Boston: Kluwer Academic Publishers.

Technology Transfer and Interdisciplinary Applied Research

While it has been common for universities to create technology transfer strategies to align with well established research strengths, as a new and growing university, UNC Charlotte has had the opportunity to create research programs that are strongly aligned with technology transfer goals. In its sixty plus years of operation, UNC Charlotte has always attracted creative innovative scholars. Still, significant efforts of creating a research enterprise and Ph.D. programs did not begin at UNC Charlotte until the early 1990s.

The university's approach to research targets interdisciplinary applied research and places high value on technology transfer and industrial collaboration. From the very beginning, the university emphasized applied research and recruited faculty members with an enthusiasm for interdisciplinary work in teams. With the first Ph.D. programs created in applied mathematics and engineering, early research faculty at UNC Charlotte had a bias toward working on practical problems of interest to industrial partners.

Early successes brought more growth in applied research areas and the university quickly identified opportunities for research excellence, innovation, and regional development as reflected in the following excerpt from the 1998 and 2002 strategic plan for UNC Charlotte.

The University clearly understands the strong connection between research excellence and economic development, and realizes the importance of a research university as an engine of economic development and in establishing "knowledge clusters." Our mission in this area is to foster long-term strategic industry-academic relationships in order to achieve objectives of public dissemination of information and improved economic development of the region and the state of North Carolina. These relationships inherently promote commercially based leading-edge innovation through collaboration in research, and further enable the transfer of new technological advances to the private sector.

Excerpted from Strategic Plan for Research (2002 Update of 1998 Plan), The University of North Carolina at Charlotte

In 2000, UNC Charlotte established an Office of Technology Transfer (OTT) that quickly defined a successful model for the commercialization of university research and intellectual property. Initial efforts emphasized early disclosure of inventions and provided support for startup companies based on university research results. The interdisciplinary research culture, a strong emphasis on early invention disclosures, and support for generation of startup companies provided an environment that offered diversity of ideas and incentive for fast and multiple innovation cycles. Further development of the technology transfer program brought more training programs on best practices for invention, patenting, licensing, and business startup.

As the number of startup companies began to grow, the technology transfer office built strong relationships with the business community and created both business ideation programs and a business plan competition. Now strongly established, these programs have been integrated into the entrepreneurial activities of the Charlotte Research Institute.

These strategies have fostered innovation behavior among faculty and students at UNC Charlotte and resulted in regularly high performance in the AUTM benchmarks¹² and recognition by the National Science Foundation as an exemplar university for Technology Transfer.¹³

¹² AUTM, The Association of University Technology Managers. <http://www.autm.net>.

¹³ Palmintera, Diane. 2007. *Technology Transfer and Commercialization Partnerships*. Reston VA: Innovation Associates.

Key contributors to the success of the UNC Charlotte Technology Program include the following tactics.

- Use targeted funding as an incentive for interdisciplinary research.
- Recognize industrial funded research at the same level as federal peer review funded research.
- Reward high reputation peer reviewed publications that result from industrial research.
- Recognize invention disclosures and patents as part of faculty members intellectual output.
- Use recognition of business startup to shape the research culture.
- Actively educate students, faculty, and staff on best practices for invention, patenting, licensing, and business startup.
- Leverage business community resources to support startup companies.
- Involve students in the startup process via experiential learning.

While these tactics were developed in a young evolving university, they have equal applicability to many different environments. Most can be pursued incrementally with very small scale funding. More importantly, they generate outcomes and behaviors that will be useful as regions work to restart economic activity.

CRI Collaborative Model

Academic and business enterprises often organize in a hierarchical fashion. Businesses are commonly structured as a hierarchy of departments, product divisions, and groups while universities are organized as departments or faculties within schools or colleges. This hierarchical organization lends to efficiency and economy of scale but often separates parts of the business or academy that should be collaborating to create innovation. In the business world, a matrix approach to project or product management is often employed to break out of the strict hierarchical organization and synergistically build a diverse team. In the academic setting, a similar outcome is achieved by creating interdisciplinary centers that bring together investigators from multiple disciplines to focus on particular opportunities and applications.

The CRI collaboration model extends these traditional approaches in the following four ways.

1. The CRI organization spans all of the interdisciplinary research centers at UNC Charlotte that focus on science and engineering topics.
2. CRI draws business partners to the academic campus and encourages academic researchers to work closely with businesses through an active program of marketing, informal and formal gathering events, and sales pipeline management.
3. CRI operates a specialized campus that locates academic researchers and business partners in close proximity according to their research and product interests.
4. CRI promotes collaboration with a nearby satellite location at the NCRC and connectivity to the nearby University Research Park

CRI spans and engages with research centers addressing topics ranging from energy production and infrastructure to bioinformatics and medical research. CRI is also the first point of contact for business partners seeking research collaboration. Centers operate in distributed fashion and sometimes parallel to CRI. Incentives for mixing and mutation come as CRI resources that are competitively allocated to both targeted research center activity and to collaborative research that spans centers and outside partners. This approach yields more diversity in both intellectual and business communities and offers significantly

larger opportunities for the ecology-like process we discussed earlier that depends on both competition and cooperation.

While CRI is an organizing entity, it is also a defined location. The Institute's campus, a geographically distinct part of The University of North Carolina at Charlotte, was created in 2002 to further the university's teaching, research, and service mission as well as to enhance the economic development of the region. The CRI campus is a Millennial Campus, as defined by North Carolina legislation, and offers special opportunities for collaboration with private sector partners. In particular, partner companies may contract for use of research capabilities or facilities on the Millennial Campus, contract for sole-use space, and construct and manage privately owned buildings. The Charlotte Research Institute manages all activities of the Millennial Campus.

Although CRI does engage national and international partners, our emphasis is on local collaboration at our campus, at company sites, and at nearby enterprises like the North Carolina Research Campus (NCRC) and the University Research Park (URP). In some cases, like the NCRC, collaboration is fostered by operating a satellite office and laboratory that have ongoing research and service offerings. To promote connectivity with the URP, marketing and gathering events typically held on the CRI campus are rotated to different locations in the URP.

Summarizing the approach we have discussed, we employ the following tactics in our CRI collaboration model.

- Organize across clusters and disciplines.
- Operate a continuing cycle of gathering and marketing events that span disciplines and clusters.
- Continually poll past business partners and researchers for new opportunities.
- Reorganize space regularly to locate innovation teams as closely together as possible.
- Emphasize local collaboration.
- Maintain strong presence at satellite locations to sustain collaboration.

The local bias of this approach is especially relevant in leaner economic times. It is worth reiterating that many opportunities for collaboration can be found in past partners. As well, even past collaboration failures can be a source of many new opportunities. The innovation cycle approach that we discussed earlier is strongly relevant to the initiation and growth of new collaborations.

Redeveloping the Research Park

The University Research Park (URP) in Charlotte North Carolina was first organized in 1966 and has grown to a 2200 acre (900 ha) business park with research, office and light industrial uses. Located less than three miles (5km) from The University of North Carolina at Charlotte and the Charlotte Research Institute, the URP has over 10,000,000 square feet (929,000 square meters) of offices and well over 20,000 employees. The park houses over 190 companies that include Duke Power, EDS, Fifth Third Bank, Electric Power Research Institute, AREVA, IBM, Michelin, Polymers Center of Excellence, Speed Channel, TIAA-CREF, and Wells-Fargo.

While the park has been quite successful over its 40 year life, regional planners have targeted the park for redevelopment to continue this success by attracting more research tenants, growing a more diverse business community, and creating a highly integrated live-work environment. This redevelopment will follow national trends where research and office parks are evolving from single-use parks that depend

highly on automobile travel to pedestrian and bike friendly mixed use communities. The redevelopment is also intended to create an environment that is conducive to the growth of our innovation ecosystem.

In 2008 an initial study was done by the Urban Land Institute in partnership with URP, the City of Charlotte, the University City Partners municipal services district, and key stakeholders in the University City area. Key recommendations from this study address sustainability, density, complimentary use, and collaboration.

The URP is located in striking forested setting that offers a unique opportunity to create new live-work spaces within a conservation area. Stands of hardwood trees are found throughout the park and an extensive greenway system supports pedestrian travel and recreation. Pursuing this sustainability theme will be attractive to new companies and the knowledge workers that they employ.

While the park offers many walking opportunities, increased density is needed to create a walkable community and also to preserve the conservation areas. Density will also encourage mixing between sites in the park and increase the opportunity for research and business collaboration.

While business and research will continue to be the dominating activities of the URP, complimentary uses must be implemented to achieve a live work environment. Creative-class housing, accessory retail space and cultural amenities will be added to diversify the park, offer a more appealing environment for knowledge workers, and, by minimizing driving in the park, reduce the carbon footprint.

The final initiative for the URP will focus on increased collaborative activity with UNC Charlotte and the neighboring business community. Some aspects of this were addressed earlier in the paper. Future efforts will focus on increased experiential learning opportunities at URP enterprises and improvements in the lateral transportation paths that link URP and UNC Charlotte.

Summarizing the redevelopment approach, we will pursue the following goals in the University Research Park.

- Focus on sustainability and create a conservation community.
- Increase density to promote synergies and improve walkability.
- Introduce complimentary uses to produce a live-work environment that is attractive to knowledge workers.
- Pursue experiential learning and transportation improvements to promote collaboration.

These goals present several good options for development in challenging economic times. They offer incremental paths that can quickly show results and also drive toward a more sustainable and diverse community.

Conclusions

We have described an ongoing effort to reinvent the innovation ecology of the Charlotte region and position this economy as a strong global partner. Our approach to innovation and innovation ecosystems has been presented and demonstrated as a basis for planning and development. Key strategies and tactics have been discussed for efforts in technology transfer, research collaboration, and redevelopment of a research park. Early results suggest that this approach yields significant results and that it is quite robust and applicable in the current challenging economic conditions.

Acknowledgments

While hundreds of dedicated faculty members and community leaders have significantly influenced the development of UNC Charlotte, we particularly want to acknowledge the visionary and persistent work of Chancellor emeritus James Woodward, Dean emeritus Robert Snyder and Dean emeritus Schley Lyons. Equally, Chancellor emeritus Dean Colvard championed the early progress of the University Research Park. Robert Hocken, Beth Hardin, Peter Sidebottom, Harry Leamy, and Deborah Clayton laid much of the groundwork for the Charlotte Research Institute. Mark Widowik created the UNC Charlotte Office of Technology Transfer and it is now being brought to even greater levels of effectiveness by Carl Mahler.

Significant portions of the CRI program have been funded by an endowment from the Duke Energy Foundation and the Wachovia Foundation. Some of the newer initiatives described here have been supported by the “Open for Business Project” funded by The University of North Carolina System. More details of this initiative will be described in a future paper.

Author Biographies

Robert G. Wilhelm

An experienced educator, researcher, engineer, and businessman, Dr. Robert G. Wilhelm is executive director of the Charlotte Research Institute at UNC Charlotte and Associate Provost for Strategic Research Partnerships. He leads university-wide efforts for research and university/business partnerships and manages business access to the campus.

The Charlotte Research Institute is the portal for business-university partnerships at UNC Charlotte. Regionally, CRI works with the community and the campus to accelerate technology commercialization and the growth of entrepreneurial ventures. Globally, CRI develops intellectual capital through collaborations with industry, government and academia. New business and research ventures, university partnerships with regional and national enterprises, and CRI spin-off companies all draw research and businesses to the region and spur economic growth.

Wilhelm is a Professor of Mechanical Engineering and Engineering Science in the William States Lee College of Engineering. Earlier, Wilhelm worked at the Palo Alto Laboratory of Rockwell Science Center and at Cincinnati Milacron. He co-founded a high-technology manufacturing company, OpSource, Inc., in 2001. Wilhelm holds a BSIE from Wichita State University, an MSIE from Purdue University, and a doctorate in mechanical engineering from the University of Illinois at Urbana-Champaign. As a Rotary Foundation Fellow, he studied the history of science and technology at the University of Leicester, Great Britain and the Ironbridge Gorge Museum. Dr. Wilhelm serves on a number of regional, national, and international advisory boards for arts & culture, scientific research, engineering, community and economic development, and philanthropy.

Dr. Barry L. Burks

Dr. Burks is currently Associate Director of the Charlotte Research Institute, University of North Carolina at Charlotte. He has over 30 years experience leading research, technology development and systems fabrication projects for the nuclear, environmental, and defense industries. At CRI he focuses on development of university-industry partnerships, development of buildings and research facilities on the Millennial Campus, and growth of campus research activities. Prior to joining CRI he was President of TPG Applied Technology, an engineering, fabrication, and construction services company in Knoxville, TN. Prior to start up of TPG he worked at the Oak Ridge National Laboratory, Oak Ridge, TN. At ORNL he held a variety of technical leadership and management positions in the Physics Division, Engineering Physics and Mathematics Division, Central Management Organization, Instrumentation and Controls Division and the Robotics and Process Systems Division. He previously worked in the Radiochemistry Division of the Babcock and Wilcox Lynchburg Research Center.

He earned Ph.D. and M.S. degrees in Experimental Nuclear Physics from the University of North Carolina at Chapel Hill and a B.S. in Physics and Mathematics from Lynchburg College, Lynchburg, VA. He taught Physics and Mathematics at Guilford College and taught Observational Astronomy and Physics Laboratory courses at UNC-Chapel Hill.

He is a member of several professional societies but is most active in the American Nuclear Society, where he is past Chair of the Robotics and Remote Systems Division and has been active in the organization of numerous international conferences. He has authored or co-authored 193 publications including topics in nuclear physics, robotics, remote systems, environmental remediation, sensor development and instrumentation.