Atlanta Metropolitan Innovation Ecosystem: A Study of Stakeholder Perspectives

by

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Executive Summary

Cities around the world, including Atlanta, are working to promote high-tech innovation as a means to grow the economy and prosper. The collective actions of the organizations within the city can be understood as the "innovation ecosystem," and many firms, government organizations, academics and consultants are interested in the ways that innovation ecosystems function. The investments of time, money and resources to support innovation are not insignificant, and there are important questions about how innovation ecosystems work and what outcomes are achieved. Further, there are questions about who is responsible for wealth generation, fostering inclusion and addressing public health and making the city livable for all its residents. Those topics motivated this investigation into the organizations that are creating "high-tech" solutions in Atlanta depend upon research and development of nanotechnology, a broad set of enabling technologies that have seen significant investment for over 20 years.

Research Question and Methods

This report addresses the question: Who is doing what to pursue innovation in Atlanta, and why? Over 500 organizations were identified that work directly (and indirectly) to create technological innovations. Interviews with 51 persons in the metropolitan region serve as the evidence for this report. The interviews were conducted in-person between January 15th and March 14th, 2019 with leaders in nine sectors: industry, academia, public funding agencies, government regulators, private funders, consultants and attorneys, media, non-profit organizations, and insurers. The participants offered narratives about the innovation journey and then assigned responsibilities for all the organizations mentioned in the narrative and rated how well those organizations are doing at upholding those responsibilities, as well as noting the perceived barriers facing those organizations.

Key Findings

Innovation activities are concentrated primarily in Information and Communication Technologies (ICT), Financial Technologies, Advanced Manufacturing, Medical Devices, Energy Generation and Agriculture. These industrial sectors demonstrate where nanotechnology research and development are being advanced to serve markets and address societal challenges. A sector not well represented in this data is aerospace and defense, a noted limitation. Geographically, organizations are concentrated in downtown and midtown Atlanta, as well as across northern cities and counties in affluent communities. There is a robust network of organizations with responsibilities for researching, creating and deploying novel technologies to generate wealth and address public health. The large corporate headquarters offers advantages to start-up firms that create solutions for business-to-business transactions and logistics. Atlanta's civic leaders have invested in organizations that span universities and healthcare and attract and support entrepreneurs. Yet, few organizations are were responsible for the inclusion of historically underrepresented groups in science and engineering and addressing environmental challenges.

Recommendations

Maintain investments that support collaborations between local organizations, while enhancing and expanding efforts that support entrepreneurs. Identify legal mechanisms to better transfer intellectual property from academic and government research facilities to entrepreneurs and provide physical infrastructure that can support product development and pilot-scale manufacturing of high-tech devices despite the constraints imposed by academic and large corporate research facilities. Explore public-private partnerships to support entrepreneurs with modular and shared resources equipped to characterize, manipulate and manufacture materials at the nano-scale. Policies are needed to explicitly address the lack of inclusion, both in terms of gender and race, and promote technologies that can address local and regional challenges associated with public health and the environment.

1.0 Introduction

City leaders across the United States and around the world are promoting technological innovation as a way to grow regional economies. Commitment to technological innovation can be traced back to Joseph Schumpeter's work from the early 19th century (Drejer, 2004). Schumpeter suggested that technological innovation yields positive economic gains for a given region, despite the possibility that it may harm other regions or industrial sectors. Robert Solow's 1956 paper, *A Contribution to the Theory of Economic Growth*, which contributed to a Nobel Prize in Economics, built upon Schumpeter's theory and offered evidence that technological innovation is a key factor for economic growth. More recently, Michael Porter's (1990) work, *The Competitive Advantage of Nations,* showed that investments in science and technology can provide numerous benefits including prestige (e.g. space race), military prowess (e.g. nuclear weapons), and economic power (e.g. electronics).

In the past two decades, Ann Saxien (1996) and other scholars have turned their attention to *regional innovation systems* by showcasing the economic growth in Boston and Silicon Valley associated with longstanding investments in science and technology. In another study, Feldman and Florida (1994) isolated four variables within urban regions that contribute to economic growth, including industrial R&D, university R&D, firms in related industries, and business services that foster innovation. In response, many cities offered different funding mechanisms, tax incentives, and funded private-public partnerships in attempts to jumpstart technological development. Around the same time, Leydesdorff and Etzkowitz (1998) posited that dynamic disequilibrium among the "triple helix" of industry, academia, and government can foster innovation by maintaining competition while avoiding collusion and stagnation.

Dan Stokols and colleagues (2019) at the University of California built upon the "triple helix" theory and conceptualized how individuals within organizations connect to funding agencies, private sector partners, and non-governmental organizations. They propose that individuals working within larger teams have are positioned within a node that is connected to the wider ecosystem. The team is surrounded by a working environment that enables (or constrains) their performance based upon organizational and physical features, such as the bureaucratic levels of approval or the spatial configuration of the work environment. Beyond the team's immediate work environment is the institutional context, be it an academic or private firm. The institutional context can be even more complex if the team works within a university-industry partnership, for example. Beyond that institutional context is the broader environment of supporting organizations with whom different individuals within the team need to interact, and those interactions are mediated by their own institutional context.

These studies, among others, often gather evidence and assess the success of cities and states that have enacted policies which directly (and indirectly) invested in organizations pursuing innovation. Cities have supported both public and private organizations by transferring city land to organizations seeking to build new infrastructure or offering zoning easements to science and technology-based organizations. Other cities have tried to generate positive interactions among academic, government, and private industry (large and small) to nurture a regional innovation hub, which can result in the formation of new firms (Avnimlech & Feldman, 2010). Such strategies can be observed in the agendas set forth for past presentations at the US Conference of Mayors (2018) and other venues.

The primary assumption is that any city can become a prosperous innovation hub and sustain economic growth. A program's success is often measured in terms of dollars spent on research and development, expenditures by firms in related industries, degrees awarded, and expenditures for business services that

support innovation, such as patent attorneys. However, some scholars are starting to question if measures of economic growth alone are adequate measures of success for regional innovation policies.

Many scholars, including Bozeman (2002) and more recently Uyarra and colleagues (2019), argue that broader goals and public values can be supported through investments in technological innovation. The rationale is that the process of innovation should not only generate wealth, but also should be broadly inclusive of diverse persons, consider the future implications of technology, and afford opportunities for individuals and organizations to change their course of action. Those public values might well complement the goals of economic growth and offer a more comprehensive set of criteria to assess the outcomes of the innovation process.

This research explores the following question: Who is doing what to pursue innovation, and why? This question affords an opportunity to understand *who* the organizations are that are working on innovation and *what* actions and activities they are taking in that pursuit. The *why* within the question pertains to the motivations and goals that inspire those organizations to take action. To address these questions, this project will rely upon interviews with selected participants from metropolitan Atlanta, detailed in Section 4.0. The participants were drawn from organizations that regulate, fund, advocate, research, and otherwise work with technological innovation. The following section details the scope and boundaries used to frame this research.

2.0 Scope and Boundaries

This research project builds upon, but does not report on traditional, economic measures of innovation within an urban region. Many studies issued by government agencies, industry associations, academic offices and consulting firms often gather a diversity of indicators based upon economic measures of growth. This study does not include those indicators, including the following:

- Firm formation (new entrants)
- Valuation of technology firms (market size)
- Mergers and acquisitions reported (consolidation)
- Research expenditures in private firms and academia (expenditures)
- Licensing agreements (technology transfer)
- Patenting and publication activity (network relations)

Many of these indicators support the Case Context section and offer a backdrop for this project, yet they are not the focus. The research design and methods of data collection are detailed in the next section.

3.0 Case Context

Atlanta became the capital of Georgia in 1868 due to its possession of a more sizeable railway hub than that of the prior capital of Milledgeville (Stevens and Wright, 1901). Today, the metropolitan region of Atlanta is bounded geographically by the U.S. Census (2010) as the “Atlanta-Sandy Springs-Roswell, GA Metropolitan Statistical Area”. This urban region is the most populous in the state with an estimated 4.5 million residents. With over 1.7 million Black residents, Atlanta is second only to New York City in total

Black residents and is called the "black mecca" for the political power, educational opportunities, and employment prospects. Currently, Atlanta is experiencing a reverse migration of highly educated Black persons from more northern states that started after 2000. The upcoming 2020 US Census will reveal more accurate socio-demographic data. Atlanta is geographically distinct and isolated unlike San Diego-Los Angeles or Philadelphia-New York and, despite being engaged in a global economy, people do not routinely commute between cities.

A foundational study by Youtie and Shapira (2008) in the field of innovation studies looks to Atlanta for lessons about how to foster an innovation hub. That research explores the historical antecedents and policies that reshaped the role of academic organizations and their relationship to technological innovation. The university's mission evolved to become a "knowledge hub" that is integrated in the regional economy and develops new capacities in science and technology. Youtie and Shapira (2008) trace the formation and function of key organizations that "span boundaries" between academic organizations and other sectors of the economy. Those organizations perform a variety of functions including:

- attracting research talent and fostering entrepreneurship among research faculty,
- facilitating interactions between academia and industry,
- supporting entrepreneurial activities and ventures,
- identifying research with commercial potential and securing intellectual property,
- conducting targeted research with industrial partners,
- promoting university-industry partnerships and co-locating industry-based research centers within or near the university, and
- offering extension services to local manufacturing and industrial partners.

Atlanta is the global headquarters of many large corporations including Georgia-Pacific, Delta Air Lines, United Parcel Service, Home Depot, and Coca-Cola, to name a few (Supply Chain Digital, 2018).

There are three local universities that are engaged in research on nanotechnology: Georgia Tech, Emory University, and Georgia State University. With an annual research budget of between $790,000,000 and $825,000,000 in 2016 and 2017, respectively, it is understandable that Georgia Tech has by far more patents and publications in nanotechnology than the other institutions (AUTM, 2016; 2017). Georgia Tech is the home of the Southeastern Nanotechnology Infrastructure Corridor (NNCI, 2018), which is also one of the National Nanotechnology Coordinated Infrastructure sites funded by the National Science Foundation. This facility offers class 100 cleanrooms that are designed to remove dust and particles from the air and allow for research, prototyping, and small-scale manufacturing at the nanoscale. The National Nanotechnology Coordinated Infrastructure allows academic and industry users to gain access to these specialized facilities in return for fees, which are subsidized by the grant (NNCI, 2018). In 2017, Georgia Tech's Institute for Electronics and Nanotechnology received funding for an Engineering Research Center (ERC) focused on cellular manufacturing at the nanoscale, which maintains active research partnerships with Emory University in biomedical device applications (NSF, 2018). Georgia State University (GSU) has expanded as a research university with new centers of Nano-Optics and biomedical research (GSU, 2018).

Recently, Atlanta started to gain more attention as an innovation hub in the popular press and in many trade magazines. Inc. Magazine (Derballa, 2019) named Atlanta the #18 most "Start-Up Friendly" city in the nation and offered evidence that Atlanta was the #20 ranked city in the United States for patents

issued between 2000-2011 (Belanger, 2014). Forums and discussions about the extent and reach of the innovation ecosystem in Atlanta offer insights into key assets and suggest a vibrant community of government, academics, private firms and non-profits are supporting its growth (Justice, 2018). The Minority Business Development Agency (MBDA, 2017) is seeking ways to afford opportunities in technology-based innovation to all of Atlanta's residents.

The metropolitan region is home to over 55 accelerators and incubators for entrepreneurs, yet some scholars suggest that minorities are underrepresented in the innovation ecosystem (Brown, 2018). ATDC is the oldest one, established in the 1980s, and has supported over $823 million in raised capital and contributed to the creation of over 2,260 jobs. Venture Labs, a newer organization within Georgia Tech, supports early stage commercialization efforts by faculty and attracted over $47.3 million in 2017 for the development of start-ups with roots in academia. Both ATDC and Venture Lab leverage the I-Corp program to help train faculty and graduate students in entrepreneurial skills development (Youtie and Shapira, 2019). The Georgia Research Alliance helps attract top research faculty to Georgia Tech and Emory University with support from the state legislature, private foundations and university foundations (GRA, 2019). It also supports early stage entrepreneurship by faculty with small grants to explore the commercial potential of the faculty's research.

Specific to this study, a systematic search of nanotechnology patents revealed 7,687 patents issued in Georgia between 2013 and 2016, with 3,447 of them issued to organizations in Atlanta. Similarly, Atlanta was the home to authors of over 50,000 academic papers on nanotechnology in 2017 alone. Atlanta was also characterized as "focused/late-entrant" relative to nanotechnology innovation based upon the fact that patenting activity by academic faculty is more prolific than that of specialized textiles, aerospace, and automobile companies (Youtie and Shapira, 2009). Much of that research and patenting activity occurs in two academic organizations, Georgia Tech and Emory University, as well as in the 25 corporate innovation centers, 10 research laboratories, and over 100 start-ups located in Tech Square and along the Midtown expansion area east of Georgia Tech's main campus. This urban corridor to the east of I-85 is experiencing a radical transformation that started in the late 1990s, shortly after the 1996 Olympics were hosted in Atlanta. New buildings such as the Coda Building (with 645,000 square feet of integrated academic and business space) and numerous private residents have transformed the skyline of Midtown Atlanta.

Beyond academic research, Atlanta is the 4th largest telecommunications hub in the nation and home to AT&T and many other firms. Further, 13 of the 20 largest financial technology firms are located in Atlanta. Atlanta remains a transportation hub in roads, rail, and airports that facilitates regional, national, and international trade. Marietta, Georgia (in metro Atlanta) was a manufacturing site of the "Bell Bomber" during World War II and is now home to Lockheed Martin Aeronautical Systems Company, which specializes in producing F-22 and C-131 class aircraft for the Department of Defense and serves as an anchor for other aerospace and defense firms (New Georgia Encyclopedia, 2018). The aerospace sector employs over 100,000 people in metro Atlanta between the headquarters of Delta Air Lines, the operations of the busiest airport in the United States (Hartsfield-Jackson Airport), and the Lockheed Martin facilities in Marietta, Georgia. Atlanta's economy is also closely tied to government agencies and is the second largest host-city to federal employees, due in large part to the CDC headquarters and other research facilities (Atlanta Regional Commission, 2017). The Metro Atlanta Chamber of Commerce, Technology Association of Georgia, and the Georgia Chamber of Commerce support industry-government interactions and foster a business-friendly environment for new and existing firms.

4.0 Research Design and Methods

The research design is informed by an overarching academic theory called innovation ecosystems, which suggests that different organizations and individuals have differentiated and specialized roles that affect the processes and outcomes of technological innovation. Innovation here is defined as the process of ideation, creation, and broad uptake of novel products or manufacturing processes (Foley and Wiek, 2013). This study focuses on nanotechnology innovation, including the manipulation and manufacturing of materials that are below 100 nanometers in size or exhibit novel characteristics at the nanoscale (Roco, Mirkin & Hersam, 2011). The contemporary practices of innovation in the metropolitan area of Atlanta are investigated by asking the question: Who is doing what with nanotechnology and why? That question draws upon *real-time technology assessment* (Guston and Sarewitz, 2002) and *responsible innovation* (Owen et al., 2012).

4.1 Study Population

To catalog the organizations in Atlanta, initially the innovation ecosystem was divided into nine sectors based upon the organizations' functions (see Table 1, below). Each sector was then populated with a list of stakeholders from a variety of sources including publications, patents, grants, websites, and public directories. Persons and organizations were identified if they had issued a patent and/or authored more than five academic journal articles that were pertinent to nanotechnology and based in metropolitan Atlanta. Persons awarded grants related to nanotechnology were aggregated from public funding databases including the Small Business Innovation Research awards, National Science Foundation and National Institutes of Health. Additional parties were identified through web searches, written documents, and web publications issued by governments, consulting firms, industry associations, and academic researchers. Industrial divisions that operated independently, e.g. Cox Communications and Cox Automobile, were treated as separate entities. In a similar fashion, major laboratories and research groups within a university were listed separately. A total of 525 organizations were compiled with at least five from each sector (see Table 1).

Table 1. Atlanta Innovation Ecosystem Population and Sampling. The first column indicates the sectors that were identified. The next columns are labelled as the number of organizations identified, selected (randomly), and directly recruited, as well as the count of interviews completed.

Sector	Identified	Selected	Recruited	Completed
Media	12	4	3	2
Insurers	9	3	2	2
Academic Units	155	51	51	13
Public Funding	16	5	4	2
Private Investors	63	32	28	7
Non-Profits	10	4	4	2
Regulators	7	3	3	2
Consultants, Lawyers & Business Support	64	21	20	7
Industry	172	56	47	13

4.2 Data Collection

Just under 180 organizations were randomly selected for further consideration from the full list of organizations. The research team then worked to identify a leader from each organization selected based upon public information and private conversations. Those individuals were contacted with a request for an interview via phone, email, and in-person requests. Recruitment stopped when 50 interviews were completed across the 9 sectors with an attempt to balance the representation. The interviews were all conducted in-person at the individual's office or in a mutually agreed upon location between January 14th and March 15th of 2019. The interviews lasted 45 minutes to 75 minutes and followed a protocol approved by the Institutional Review Board for Social and Behavioral Sciences at the University of Virginia. Participants were first asked questions that validated the researcher's knowledge of their background. Then participants were invited to share a narrative about nanotechnology innovation in Atlanta and the researcher asked follow-up questions to guide the narrative in a semi-structured manner. The second phase of the interview involved the researcher re-stating the key organizations and individuals in the narrative and asking three follow-up questions. Those questions were:

i) What are the responsibilities of that organization/individual for innovation in Atlanta?

ii) How well are they fulfilling their responsibilities on a scale of 1 (low) to 5 (high)?

iii) What barriers or constraints are affecting the fulfillment of responsibilities by this organization (internally or externally)?

4.3 Data Analysis

The data that largely informs this report were derived from the second half of the interviews, as the narratives will take additional time to curate and analyze for key themes. A data file was compiled including an aggregated list of responsibilities, fulfillment scores, and constraints for each organization mentioned by each participant. The initial analysis identified the most frequently mentioned organizations. The responsibilities and constraints for those organizations were clustered thematically and are reported in the Findings, below. The responsibilities for each of the top 10 parties were aggregated and condensed by general theme, after which they were ranked by frequency from the interviews. The same process was repeated with the constraints identified for each organization. Finally, the average fulfillment score assigned by mentioners was calculated for each organization and sector, and z-scores were calculated to compare the position of individual entities relative to the mean within each group. Using the frequency of mentions between organizations within each sector, an agent network map was built with connections represented by lines of thickness proportional to the average number of times per interview that one sector mentioned a party from the other (connections between those with under 1 cross-mention on average were excluded).

Recurring themes including the most common constraints and successes within the city of Atlanta were identified and specific quotes from the interviews were selected to help give insight into the specifics of the thematic implications. A draft of the analysis was presented to interview participants during two workshops which 17 persons attended in early October, 2019 in Atlanta. The feedback and dialogue generated during that workshop further supported the interpretation of the below findings by validating, reforming and/or offering alternative explanations.

5.0 Findings

This section offers detailed findings from the interviews conducted in Atlanta throughout the spring of 2019 and is organized in a manner to offer discrete pieces of evidence. The first portion divides the findings by the most prevalent industrial sectors and the patterns of innovation activities within those sectors. That analysis is followed by a map of the ~525 identified organizations within the metropolitan Atlanta region, which suggests the geographic areas in which innovation activities take place. Then, a network analysis of the innovation ecosystem is displayed, which identifies the organizations that are most frequently mentioned and the extent to which those organizations are connected to others. Next, the most frequently mentioned organizations (aggregated and anonymized) are reported, which sets up a detailed review of the key responsibilities, fulfillment level of those responsibilities, and constraints. The evidentiary sources for these findings are limited to the statements and reflections of the participants during the workshop conducted in October 2019.

5.1 Innovation Pathways by Sector

The innovation ecosystem that supports the creation and production of nanotechnology-enabled products and services is clearly present in six distinct economic sectors including Information and Communication Technology (ICT) and Internet of Things (IoT), Medical and Biomedical Technologies, Advanced Manufacturing and Three-Dimensional (3D) Printing, Financial Technologies (FinTech), Energy and Environmental Technologies, and Agriculture (see Table 2). The most prominent of these sectors is ICT/IoT with fifteen (15) participants offering narratives about advances in that sector. This finding is not surprising given that legacy telecommunications companies are headquartered in Atlanta and have given rise to the formation of teams that spin-off and/or spin-out from these large firms. The research enterprise and strategic partnerships among two universities largely support the foundations for innovation in Medical and Biomedical technologies. Nine (9) participants offered narratives about medical and biomedical technologies that converged upon the activity of validation studies as the third phase of the innovation pathway, and then offered pre-clinical testing as the next phase. Materials research within universities and firms is supporting innovation in Advanced manufacturing and 3D printing, and has yielded outcomes in the fifth phase of the innovation pathway, which included the expansion of products offered by the firm, i.e. “expand catalog”, and two narratives stated that their firms were acquired. Not all of the narratives about innovation yielded clear outcomes. For example, out of the 15 participants that spoke about ICT/IoT, only seven shared stories of sales and even fewer spoke about exit strategies, such as an Initial Public Offering (IPO), licensing agreement, or firm acquisition. To one workshop participant it became clear that “acquisition is the goal for most of these innovative firms.” This objective of innovation was discussed and quite a few participants believe that small firms desire to be acquired, rather than attempt to grow and scale the manufacturing in Georgia. It should be noted that participants often chose ‘success’ stories and thus the results in Table X do not reflect a ratio of successful projects to unsuccessful ones.

There are distinct patterns of innovation between the sectors; differences in regulatory structures, commercialization strategies, and regional assets are demonstrated in these data. Innovation within two sectors that are core to the local economy, ICT/IoT and FinTech, originate with existing persons in the Atlanta area that form teams, such as new firms or new groups within an existing firm. In the Fintech sector, every participant spoke about “prior expertise” as the origin of the innovation and noted that knowledge afforded them insights that led to novel concepts and/or prototypes. One workshop participant spoke up quickly, “That driver makes sense to me.” and a discussion about the history and expertise in financial technology in Atlanta confirmed the importance of this sector. These two sectors

might well serve as anchors for future investments by civic leaders seeking to build upon existing assets. The strategical investments and partnerships in MedTech and BioTech have been focused on research and early stage development. While there is an emergent network of support organizations and some funding opportunities to support MedTech and BioTech, most participants stated they needed to look outside of Atlanta for the expertise, funds, and facilities to validate and initiate pre-clinical research. Civic leaders need to strongly consider how to support the transition out of research laboratories and into clinical and non-clinical pathways. While there are incredible resources and knowledge held within government laboratories in Atlanta, there was no evidence that innovative ideas or projects are originating from these facilities. There is therefore an opportunity to form partnerships between entrepreneurs and government laboratories to identify opportunities for innovative solutions.

There were five narratives about nanotechnology-enabled innovation in the energy and environmental sector. Those efforts were scattered across air monitoring, devices to improve energy efficiency, and photovoltaics, and all originated with materials research and then team formation. Those responsible for each innovation sought to overcome the scalability challenges in order to successfully exit via acquisition or licensing agreements. These participants, along with those working in Advanced Manufacturing, often stated, "We were [asked], why are you building things? No one builds things here. You should focus on the software." The heuristic that innovations in manufacturing are "not done here" was discouraging, and the business owners and leaders in those firms did not have a good network of support. As one person stated, "I would go to those trainings for entrepreneurs and the whole thing was about SAAS (software as a service). There was nothing about manufacturing. I don't know if anyone else in the room even made anything." To support continued growth and development in manufacturing research and development, there is a clear need to support entrepreneurs and small firms that are building physical prototypes with programming and resources that are tailored to their needs. Further, connecting entrepreneurs with existing firms facilitate positive knowledge exchanges and mentorship.

The patterns that became evident in each sector included strategic partnerships within the ICT/IoT sector, or "closed collaboration" between small and large firms. The same pattern was evident in the narratives offered about energy and environmental technologies. The MedTech and BioTech innovation pathway suggests a strong "science push" approach to creating new knowledge in the laboratory and driving it through the regulatory process to reach the market. The advanced manufacturing and 3D printing stories followed more of a "market pull" approach that was strongly influenced by the I-Corp program that starts with "customer discovery". In the FinTech sector, the pattern of "spin out / spin up" innovation was evident from the prior work experience and expertise of seasoned entrepreneurs creating new processes and products to support financial transactions. These patterns suggest that policies and programs need to be developed to meet the needs of the different sectors, rather than trying a 'one size fits all' approach to science, technology, and innovation policy in the state of Georgia.

The workshop participants reviewed the dominant economic sectors and the patterns of innovation activities. The emphasis on ICT/IoT, MedTech & Biotech, and FinTech was confirmed, and it was agreed that those sectors are important, especially since this research excluded software as a service (SaaS) innovations. One sector that the participants noted as absent was the Aerospace and Defense sector, which is a large contributor to the state's economy and present in the research and development funding of university research. This limitation was understood to be an artifact of the selection bias of respondents, such that persons involved in research and development associated with national security did not agree to be interviewed. Also, those firms and researchers involved in aerospace and defense offered narratives about the 'dual use' of those technologies for both commercialization within ICT and national defense. Thus, these results need to be understood as unrepresentative of innovation activities in the aerospace and defense sector.

Table 2. Innovation Pathways by Sector. The first column indicates the sectors that were present within the interviews. The next six columns are labelled as phases of innovation and were used to demarcate discrete phases of the participants' narratives about the innovation pathway. Starting with the second row, the sector, such as ICT & IoT (Information and Communications Technology and Internet of Things) is followed by the number of participants' that spoke about innovation in that sector; for example, (n=15) means that fifteen participants shared narratives about innovation in that sector. Reading across the row, the core activities are named, for example, "Firm / Team Formation," with the number of participants that stated it as the first activity in parenthesis (8).

Sector	Phase I	Phase II	Phase III	Phase IV	Phase V	Phase VI
ICT & IoT e.g. Sensors & Chips (n=15)	Firm / Team Formation (8) Research (6) Customer Discovery (1)	Concept Dev / Prototyping (10) Infrastructure Buildout (5)	Pilot Test / Validation (8) Early Adopters (7)	City-wide deployment (5) System Integration (5) Regional (3)	Global Sales (7) Engage other cities (1)	IPO (1) License (1) Acquisition (3)
MedTech & BioTech (n=11)	Discovery / Research (8) Concept Dev / Prototyping (3)	Firm / Team Formation (10)	Prove of Concept / Validation (9)	Pre-Clinical Testing (9)	Clinical Trials (6)	Full Scale Mfg (4) Acquisition (3)
Advanced Mfg & 3D Printing (n=7)	Materials Research (5) Business Expansion (2)	Firm / Team Formation (4) Knowledge Acquisition (2)	Customer Discovery (4) Pilot Test / Validation (2)	Training Clients / Early Adopters (4) Standards Adherence (2)	Expand Catalog (4) Global Sales (1)	Acquisition (2)
FinTech (n=7)	Prior Expertise (7)	Concept Dev / Prototyping (6) Research (1)	Firm / Team Formation (4) Assess Value (3)	Growth Capital (4) License (1) Pilot Test (1)	Global Sales (2) Regional (1)	IPO (1) Acquisition (1)
Energy & Env Quality (n=5)	Materials Research (5)	Firm / Team Formation (5)	Concept Dev / Prototyping (3) Customer Discovery (2)	Demonstrate Scalability (4) Early Adopters (1)	Acquisition (2) License (1) Regional (1)	
Agriculture (n=2)	Research (1) Prior Expertise (1)	Concept Dev / Prototyping (2)	System Integration (2)	Assess Value (2)	Global Sales (1)	

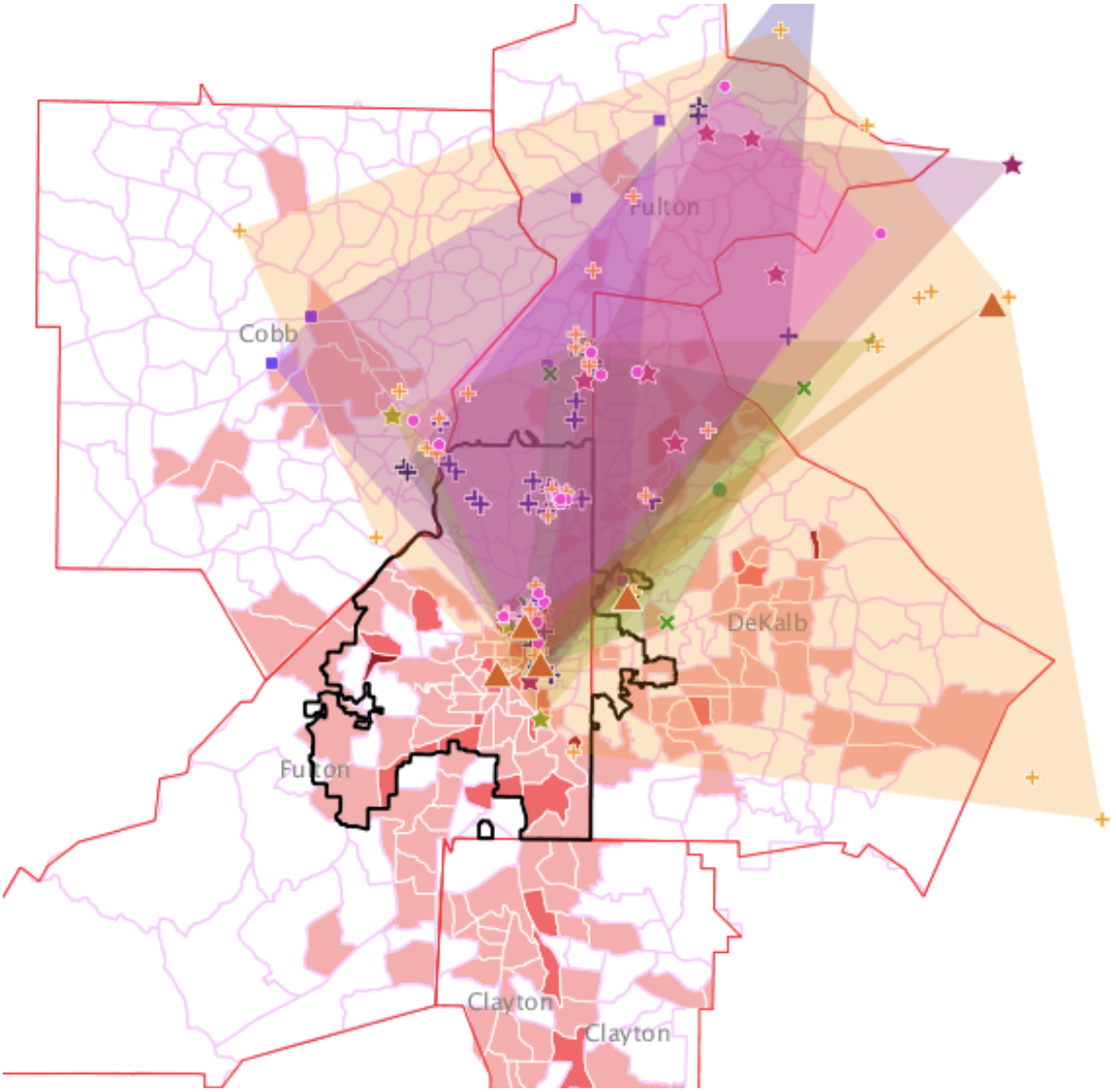
5.2 Urban Innovation Ecosystem, Map of Atlanta by Sector

In the metropolitan Atlanta region, there is a clear geographic area in which organizations that directly and indirectly support technological innovation are located. There is a cluster of organizations in downtown and midtown Atlanta as well as firms located near the I-75 and I-85 corridors and along the I-285 corridor that connects I-75 and I-85. The area in which there is a high density of organizations is shaded (Figure 1). This map is interactive and each organizational type can be isolated, yet almost all of the organizations fall within this specific area. There is an inverse relationship between the presence of technology firms and poverty. This finding suggests that innovation activities within the city are not creating opportunities for residents in impoverished communities. As many workshop participants stated, "It makes sense, and I think you would find consensus around metro Atlanta about this."

Workshop participants viewed this map and reflected upon the history of Atlanta. The discussion ranged from perspectives on legacy housing and socio-economic divides within the city to the emphasis on the concentration of firms within "Atlanta's Innovation Corridor". One participant remarked, "How do you undo the past? This map is not surprising, but how do you affect change at this scale?" As one participant recounted, "Forty years ago there was the White Flight north to Gwinnett, Sandy Springs, Alpharetta and Marietta, but now we see people returning to Midtown. What needs to change is for people to have the skills and access to tech jobs in the rest of the city." The participants discussed opportunities for the city leaders and state government to bring more focus to training and preparing people for employment in the technology sector.

Another participant brought up the new incentives offered by the federal government to stimulate investment in south Atlanta and the promise of economic growth and urban revitalization in that area. During this discussion, one participant remarked that, "This simply shows how the wealth created by innovation is benefitting a limited few and not creating opportunities for everyone. Just look at where the jobs are and the poverty rates are high." Another person said, "Nobody has openly solved this problem and many know it is an issue. This hyper co-location is a clear trend." These challenges were, of course, not resolved during the workshop, but the findings evident in the map were clear to the participants. Many participants wanted to see a more focused study on the influence of the Atlanta Beltline (2019) initiatives and how that was transforming the city in terms of residential development and businesses relocating to that corridor.

Figure 1. Innovation Ecosystem in Metropolitan Atlanta. This map was populated with the ~525 organizations that were identified by the research team. The organizations were categorized into one of nine groups: academics, consultants, industry, insurers, investors, media, non-profits, public funders, and regulatory agencies. The red zones indicate areas of relatively greater poverty. An interactive version of this map can be accessed at https://worldmap.harvard.edu/maps/AtlantaEntrepreneurs/d0S



5.3 Stakeholder Network Analysis

The core organization types within the innovation ecosystem in metropolitan Atlanta are industry, academic, and government funders and support agencies (see Figure 2, below). This is not surprising and neatly fits with the "triple helix" theory of innovation offered in the introduction. These three types of organizations have strong connections to one another in terms of reciprocal mentions as reflected in underlying data tables, Tables 3 and 4. Secondly, private investors, consultants and attorneys, and the media are well represented and connected to these three core segments. Private funders have the second most connections behind industry, and are frequently mentioned within narratives on innovation. Consulting and legal firms are strongly connected to private and public funding organizations, and also have strong connections to industry and academia. Those three second-tier organizations are well understood to support innovation and facilitate access to resources, knowledge, and relationships with other organizations. The least frequently mentioned organizations are government regulators (only connected to industry), insurers (connected to private funders and industry), and NGOs (connected to public funders and industry). Those three organization types are typically understood as important for risk management.

Workshop Reflections

The conversation among the workshop participants looked at the strength of connections between the "triple helix" actors, including industry, academia, and government funders and support. A few people noted that the strong connection that private funders have to industry indicates the business-to-business approach. One participant stated, "Academics have hypnotized the rest of society to think that innovation starts with them and their research." Others argued about the roles of academics to publish, educate, and create novel prototypes, yet rewards remain focused on publications and grant. Many participants felt the number of self-references among academics contributed to a sense that the contributions of academics to innovation were, at times, overstated.

Another participant noted the "small network" that government regulators have and how they are isolated to connections with only industry. Another participant said, "Support entities (regulators, insurers, media, NGOs) are not as networked as Industry-Academia-Funders." This sparked discussion about the "core" group and those at the periphery of the innovation ecosystem. It was agreed that it wasn't a 'bad' thing for the core to have stronger connections. Yet, one participant offered that the media is "following the money and often only reports on large grants, acquisitions or venture capital deals." Someone else reflected on the absence of reporters on the "Tech Beat" at the local media outlets.

Figure 2. Network Analysis. The nine different organizational types are indicated with circles, while the lines indicate connections between the actor categories. Note: Circle size is proportional to the frequency of mentions by any actor, and line thickness is proportional to the reciprocal mentions between any two actors. The absence of a line means that the average reciprocal mention rate was smaller than one (<1.0) (see Table 4 below).

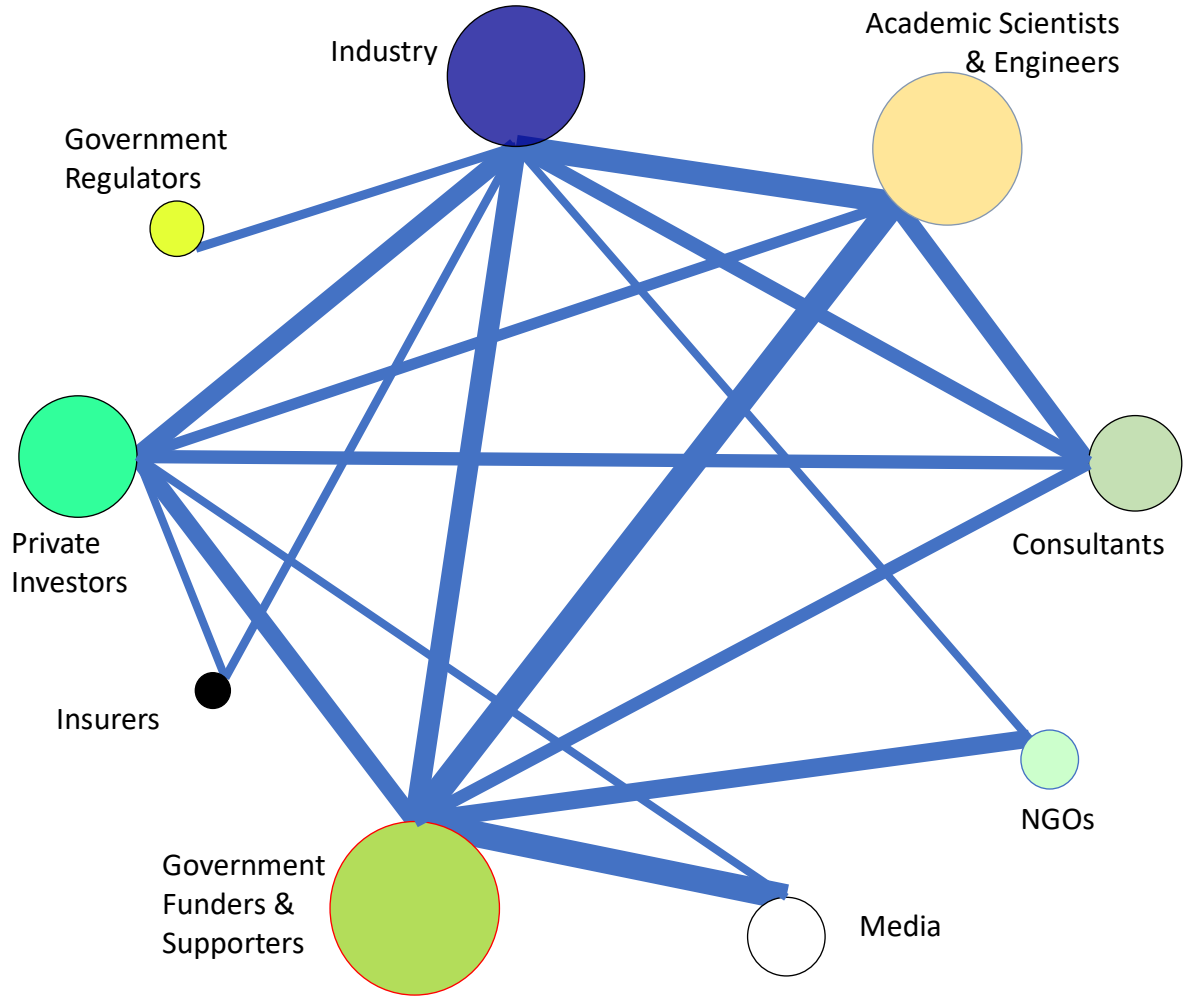


Table 3. Directional Data Table for Network Analysis. This table shows all the mentions of other organizations, as well as self-referential mentions by the participants. The actor groups (left hand column) are listed and the number of participants that completed this portion of the interview is indicated in parenthesis (n =). The frequency of mentions is divided by the number of organizations to indicate the average frequency at which an actor is mentioned by another actor. The activity summary is the average frequency at which an actor spoke about any another actor and the passivity summary is the average frequency at which an actor was mentioned by any other actor. This data informs the size of the circles shown in Figure 2, above. Note: Actor categories are abbreviated in the table below, Ind = Industry; Con = Business Consultants and Attorneys; Ins = Insurers; PrFund = Private Funding; Aca = Academic; PubFund = Public Funding and Support; Reg = Government Regulators; NGO = Non-governmental organizations; Med = Media.

Actors	Ind (n=13)	Con (n=7)	Ins (n=2)	PrFund (n=6)	Aca (n=13)	PubFund (n=2)	Reg (n=1)	NGO (n=2)	Med (n=2)	Active Score
Ind (n=13)	2.8	1.2	0.1	0.6	2.4	0.9	0.5	0.0	0.1	8.6
Con (n=7)	2.0	2.3	0.0	1.3	1.6	1.0	0.3	0.0	0.0	8.4
Ins (n=2)	2.0	0.0	2.5	1.0	0.5	0.0	1.0	0.0	0.5	7.5
PrFund (n=6)	1.5	0.7	0.0	2.0	2.0	1.5	0.5	0.0	0.2	8.3
Aca (n=13)	1.2	0.3	0.0	0.8	4.3	1.5	0.4	0.2	0.1	8.8
PubFund (n=2)	1.5	1.0	0.5	1.5	1.5	3.5	0.0	0.0	0.0	9.5
Reg (n=1)	2.0	0.0	0.0	0.0	0.0	1.0	2.0	1.0	0.0	6.0
NGO (n=2)	2.5	1.0	0.0	1.0	0.5	1.0	0.0	0.5	0.5	7.0
Med (n=2)	2.0	1.0	0.0	1.5	1.5	2.5	0.0	0.0	0.5	9.0
Passivity Score	17.6	7.5	3.1	9.7	14.3	13.0	4.6	1.7	1.8	

Table 4. Reciprocal Data Table for Network Analysis. This table shows the average reciprocal mentions between different organizations. The line connections between actors in the network analysis (see Figure 2) are generated from this data table. If the average reciprocal mention is below one (<1.0), then no line is shown in the diagram. Note: Actor categories are abbreviated in the table below, Ind = Industry; Con = Business Consultants and Attorneys; Ins = Insurers; PrFund = Private Funding; Aca = Academic; PubFund = Public Funding and Support; Reg = Government Regulators; NGO = Non-governmental organizations; Med = Media.

Actors	Ind (n=13)	Con (n=7)	Ins (n=2)	PrFund (n=6)	Aca (n=13)	PubFund (n=2)	Reg (n=1)	NGO (n=2)	Med (n=2)	Activity Summary
Ind (n=13)	2.8									26.2
Con (n=7)	1.6	2.3								15.9
Ins (n=2)	1.0	0.0	2.5							10.6
PrFund (n=6)	1.1	1.0	0.5	2.0						18.0
Aca (n=13)	1.8	0.9	0.3	1.4	4.3					23.1
PubFund (n=2)	1.2	1.0	0.3	1.5	1.5	3.5				22.5
Reg (n=1)	1.2	0.1	0.5	0.3	0.2	0.5	2.0			10.6
NGO (n=2)	1.3	0.5	0.0	0.5	0.4	0.5	0.5	0.5		8.7
Med (n=2)	1.0	0.5	0.3	0.8	0.8	1.3	0.0	0.3	0.5	10.8

5.4 Aggregated Organizations – Top Ten

The social network data above suggests that industry, academia, and public funding agencies are at the core of the innovation ecosystem in Atlanta. This is reinforced by the frequency of specific organizations within those broader categories. Large corporations and entrepreneurs are the most frequently mentioned organizations. This reflects an essential tension between small firms seeking to grow and larger firms that have the resources to manufacture, market, and engage in global sales. The prevalence of Fortune 500 headquarters in metropolitan Atlanta is widely recognized, and entrepreneurs in the city seek to develop processes and products that can support those large firms.

Atlanta is also home to one of the oldest academic accelerator and incubator programs in the nation at Georgia Tech, which was been featured in publications on creating innovation hubs, for more details see Youtie and Shapira (2008). This program and others like it at neighboring universities and colleges were frequently mentioned by academics and non-academics alike. This recognition of academic accelerator and incubator programs and university administration and directors coincides with the findings by Youtie and Shapira (2008) that academic organizations can play a powerful convening role within an urban region, especially where there is one dominant university. Interestingly enough, faculty researchers are mentioned with less frequency and, looking back at the social network analysis, they are the most self-referential. This means that most mentions of academic researchers are by other researchers and not by outside groups; thus, their importance might be amplified through references of other academics.

Private funders appear twice on this list, with venture capital and angel investors garnering almost the same number of mentions. The attention paid to private funding should not be understated, as the narratives that did not mention private funders often pertained to large firms with internal research and development budgets or university-industry collaborations. Also frequently mentioned was a state-based research support organization which offers small grants and facilitates early stage funding for faculty researchers who want to explore an entrepreneurial opportunity based upon their research. Another type of support organization that was frequently mentioned was the chambers of commerce present in the region, and for this analysis a number of different chambers of commerce are aggregated for this report. The final organizations that were frequently mentioned were the university contracting and technology transfer offices that control external research awards. The key responsibilities of each of these organizations are shared in the next section.

The workshop participants discussed the emphasis on large corporations, and one person interpreted the findings to indicate that, “Start-ups are dependent on academia/industry, more so than on business groups designed to support them.” The role of the chambers of commerce in supporting small firms was discussed at this point, with one person saying, “Small firms are not supported by the chambers, they are there for the big companies.” Another person said, “I am not with the chambers, but the [specific] Chamber is there to support larger firms that impact the whole city. The smaller chambers should be doing a better job of connecting with those start-ups.” The interpretation that entrepreneurs are supported strongly by academia goes back to the creation of accelerator and incubator programs within the university, which was discussed as a ‘good’ thing. Yet, others questioned how entrepreneurs can get more support from other organizations.

Table 5. Top Ten Organizations. The frequency at which organizations were mentioned is reported.

Organization	Frequency
Large Corporations	30
Entrepreneurs	23
Academic Accelerator and Incubator Programs	18
University Administration and Directors	18
Venture Capital	14
Faculty Researchers	13
Angel Investors	13
State Research Support Organizations	11
University Contracting and Technology Transfer Offices	11
Chambers of Commerce in Atlanta	11
Other	252

5.5 Key Responsibilities for Top Organizations

The following lists start to reflect the distribution of responsibilities held by the most frequently mentioned organizations in metropolitan Atlanta. Participants involved in this study each assigned responsibilities to other organizations as well as to themselves. At first, the data seem overwhelming and difficult to interpret. Yet, the important findings become evident when the organizations are viewed as a network. First, there is a broad range of responsibilities across these organizations, which indicates strong heterogeneity in the network, meaning that there is almost always more than one organization that is responsibility for an activity, such as economic growth or diversity. Second, the responsibilities listed reflect profit-seeking values, as expected, but there are other core values stated, including diversity, 'values of the city', adaptivity, mentorship, collaboration, risk management, and storytelling. These lists generated high levels of deliberation within the workshop sessions, and some of those statements are shared below. The responsibilities start to extend the metaphor of an innovation "ecosystem" by detailing the work performed by the different organizations within Atlanta. Much like a forest ecosystem, an urban innovation ecosystem is comprised of various organizations that perform various interrelated activities that are differentiated and affect different outcomes.

The following list shares the top ten organization types along with the most frequently mentioned responsibilities for each and the number of respective mentions in parenthesis.

1. Large Firms
    - Grow profitable firm (18)
    - Support external R&D (17)
    - Support internal R&D (13)
    - Reflect values of city (11)
    - Commitment to Diversity (10)
    - Create vision & strategic plan (7)
    - Assess risks associated with tech (7)
2. Entrepreneurs & Founders
    - Fundraising to support firm growth (10)
    - Hire and train employees (10)
    - Engage clients, and create brand awareness (10)
    - Mentor and manage staff (8)
    - Identify trends, pivot and adapt (7)
    - Establish values of firm (5)
3. Academic Accelerator and Incubator Programs
    - Support Startup Companies (12)
    - Create Network for Startups (11)
    - Provide Affordable Space (10)
    - Provide Training (8)
    - Assess Product - Market Fit (8)
    - Attract Investors to ATL Firms (5)
    - Provide Mentorship (4)
    - Manage Corporate Relations (3)
    - Support Diversity (1)
4. University Administration and Directors
    - Develop STEM Talent (16)
    - Support Innovation Ecosystem (9)
    - Connect Industry and University (8)
    - Develop New Collaborations (6)
    - Support Researchers (3)
    - Consulting for Small Businesses (2)
5. Venture Capital
    - Fund Company Growth (13)
    - Create Networks in City (4)
    - Coach / Mentor (4)
    - Ensure Successful Investments (3)
    - Promote Tech Innovation (3)
    - Avoid Risk (3)
    - Evaluate Academic Projects (1)
    - Support Operations (1)
6. Faculty Researchers
    - Mentor / Advise Students (13)
    - Manage and Conduct Research (9)
    - Secure Funding (9)
    - Identify Product Opportunities (7)
    - Publishing Results (6)
    - Develop Research Networks (4)
    - Service to Profession and Academic Institutions (4)
    - Outreach and Community Support (3)
    - Teach Courses (3)
7. Angel Investors
    - Invest Capital and Gain Returns (12)
    - Provide Connections / Resources (7)
    - Identify Upcoming Opportunities (6)
    - Provide Strategy & Direction (5)
    - Coaching / Mentoring (4)
    - Due Diligence (4)
    - Believe in Firm (2)
    - Take Risks (1)
    - Be Generous (1)
8. State Research Support Organizations
    - Funding Projects (11)
    - Attract Research Leaders (5)
    - Support New Technologies (4)
    - Promote Bioscience Field (4)
    - Create Connections (3)
    - Provide Business Advice (2)
    - Create Vision for Community (2)
9. University Contracting and Technology Transfer Offices
    - Administer Grants (6)
    - Execute License Agreements (5)
    - Oversee Contracts (5)
    - Filing and Managing IP (4)
    - Address Conflicts of Interest (4)
    - Ensure Compliance (3)
    - Acquire and Manage Assets (2)
    - Earn Money for Services (2)
10. Chambers of Commerce in Atlanta
    - Fostering connections among technology leaders (9)
    - Supporting economic development and company growth (6)
    - Provide information and macro-economic data (3)
    - Telling compelling stories (2)
    - Creating an inclusive environment of technology leaders in region (1)

Workshop Reflections

The participants reviewed the responsibilities assigned to large corporations and interpreted them as "corporate investment growing over time versus federal spending." The responsibilities were understandable for both large corporations and entrepreneurs. As one participant stated, "That is exactly what the entrepreneurs need to be doing; they need to balance those top priorities." Comments circulated about whose responsibility it is to "tell stories of innovation" in the changing media landscape. One participant said, "[Company] has over 200 patents, more patents per employee than [large corporation], but we have been focused on patenting and not on telling that story. Even internally, we are trying to do a better job of getting our own story out to customers. We are too focused on tech and not marketing." Another participant added, "The types of stories are very important; we need to tell the whole story – how hard it is. Often the stories are too simplified and glorified. This is doing students and the community a disservice. We want more realness and truth - still optimistic, but not simplistic."

The role of the chambers of commerce in Atlanta with respect to "telling compelling stories about region" was a central topic. One participant stated, "for this to be a low priority is a problem" and two other participants immediately agreed. Another participant then said, "This is a good conversation, but for chambers of commerce to tell the story, they need to know the stories in the first place." Another participant said, "this is not surprising, storytelling came up when [Consultant] reported this as an objective to work on. Atlanta's issue is not bragging enough about what's in our backyard." One person said, "In the economic development world, naturally Atlanta looks to others for best practices, but many in the [tech] industry and community are not aware of the storytelling that is happening." The comments returned to the lack of media presence, "As someone new to the area, I am not sure where to get information about technology and to hear stories." This discussion highlighted the fractured media landscape and the lack of attention afforded to technology innovation in Atlanta and the role that it plays in the economy.

In regards to the colleges and universities, a participant asked what types of persons were interviewed to reflect the university administration. The participants included directors of research centers, department chairs, and persons in the central administration, but are not broadly representative of that group. Another participant noted that the leaders in the colleges and universities need to communicate core values associated with innovation and to promulgate those among their faculty, staff, and students. As far as the responsibilities for academic researchers, there were some surprises among the participants. One person commented, "It is sad that teaching is so low on the list." This was understood as an artifact of hiring wage faculty or adjunct faculty to teach courses, thus allowing researchers to spend more time in the laboratories conducting research. Another commented that they were surprised that publishing wasn't far and away the most frequently mentioned responsibility.

The role of the academic incubator and accelerator programs was also a topic of much debate. One participant spoke about the "lack of experience" among academics that want to become entrepreneurs and the clear need to support their efforts. Another person, however, felt the focus on "minimal viable products" was not supporting the growth and development of academic-entrepreneurs and that it instead seemed to facilitate "quick hand-offs to others with business experience." One participant stated, "The lean start-up model is good for us [academics]. We need that push; we need to talk to people and do the customer discovery and get out of the lab." The role of the state research support organizations in supplementing that process was seen as key. The levels of mentorship, accountability, and focus were important factors when the academic accelerator programs and other support organizations worked to support entrepreneurs with academic training.

5.6 Fulfillment of Responsibilities

This section assesses the fulfillment level of the top ten organizations and thus offers what one participant called a "360° review" of each of these organizations. The following two Figures 3 and 4 are supported by the data presented in Table 6. Participants assigned fulfillment ratings for other organizations as well as for themselves, with 1 being the lowest score (responsibilities not at all fulfilled) and 5 the highest score (responsibilities completely fulfilled). The state research support organizations and chambers of commerce in metropolitan Atlanta were assigned the highest mean fulfillment scores. Those organizations are well regarded and maintain positive working relationships with organizations throughout Atlanta. The university administration and research directors as well as the Academic Accelerator and Incubator Programs were also assigned relatively high scores. This reflects numerous sentiments about the positive contributions made by academic leadership and the academic programs that support entrepreneurs in Atlanta. The lowest scores were assigned to University Contracting and Technology Transfer Offices. These charts were the subject of vigorous discussions among the workshop participants. The following section shares the constraints and barriers that are preventing these organizations from performing at higher levels.

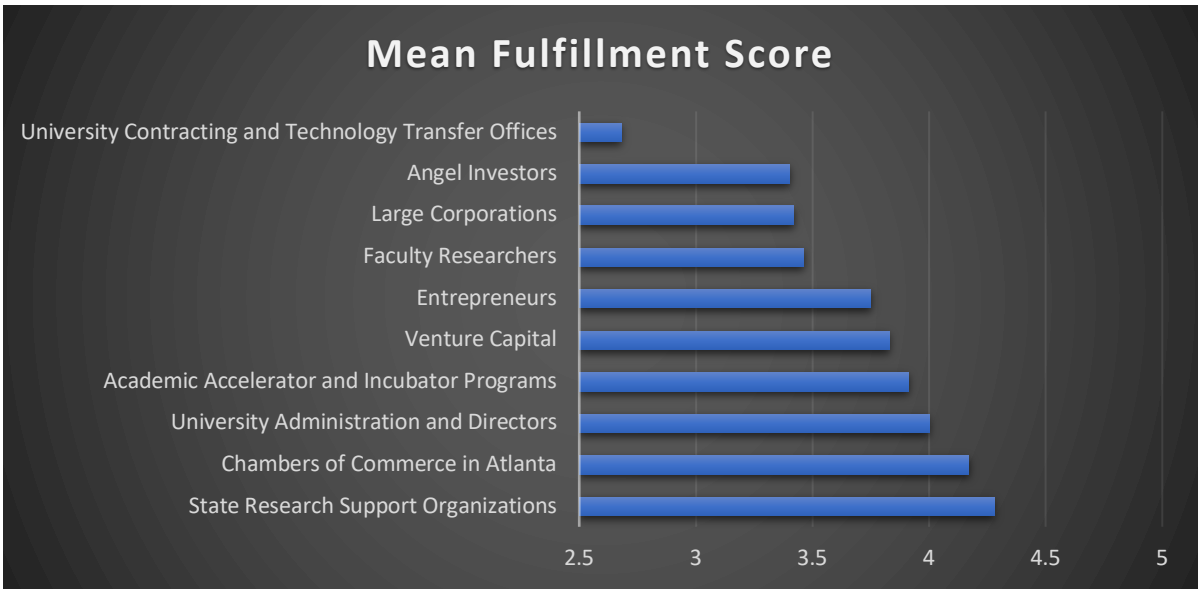


Figure 3. Mean Fulfillment Score. This graphic depicts the mean fulfillment score assigned to the top ten organizations mentioned. The fulfillment score assigned by participants to other organizations and to themselves was on a 5-point scale: 1=not at all; 2=slightly; 3=somewhat; 4=mostly; 5=completely.

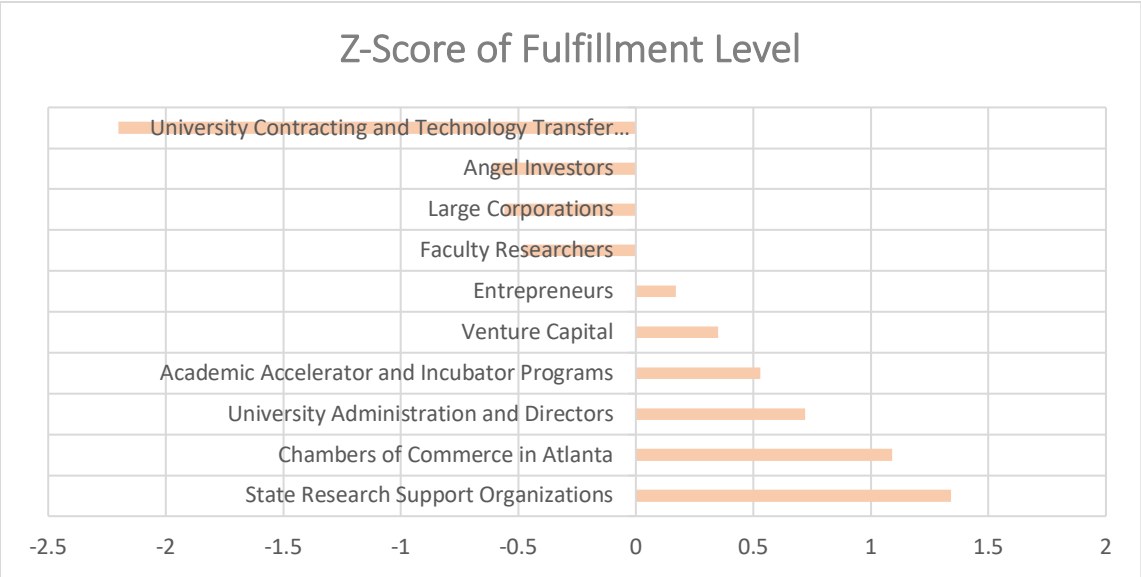


Figure 4. Z-Score of Fulfillment Level. This figure illustrates the differentiation between the organizations that scored highly (above 0) and those that scored lower (below 0). Note: Z-Score is a statistical value comparing a given measure to the mean of a group of values and is measured in terms of standard deviations from the mean.

Table 6. Fulfillment of Responsibilities. This table reports the mean fulfillment score assigned by participants to other organizations and to themselves (1=not at all; 2=slightly; 3=somewhat; 4=mostly; 5=completely). The mean fulfillment scores were then analyzed using a z-score. Note: Note: Z-Score is a statistical value comparing a given measure to the mean of a group of values and is measured in terms of standard deviations from the mean.

	Organization	Mean	Z-Score
1	Large Corporations	3.42	-0.56
2	Entrepreneurs	3.75	0.17
3	Academic Accelerator and Incubator Programs	3.91	0.53
4	University Administration and Directors	4.00	0.72
5	Venture Capital	3.83	0.35
6	Faculty Researchers	3.46	-0.48
7	Angel Investors	3.40	-0.61
8	State Research Support Organizations	4.28	1.34
9	University Contracting and Technology Transfer Offices	2.68	-2.20
10	Chambers of Commerce in Atlanta	4.17	1.09

5.7 Constraints and Barriers for Top Organizations

The following lists enumerate the constraints and barriers facing the most frequently mentioned organizations in metropolitan Atlanta. Participants involved in this study each stated the constraints and barriers, which could be either internal or external to the organization, for others as well as for their own organization. These data, when layered on top of the previous findings, point to areas that require the time and attention of civic leaders in Atlanta who are promoting technology-based innovation. While the scope and boundaries for this study are limited and temper the findings, the data suggest opportunities for investment, greater programmatic development, and strategic planning.

Based on the constraints identified by the interview participants, large firms need better connection to community and to conduct greater outreach and STEM development in historically disadvantaged communities. Further, executive leadership changes created radical shifts in strategy and investment levels in research and development, which negatively affected internal research teams and effectively discontinued relationships with entrepreneurs who were working on targeted research and development for a given firm. Entrepreneurs need to focus more on business strategies and avoid obsessing over technical perfection. At times, entrepreneurs are neither responsive nor open to advice, which leads to an inability to pivot and adapt products to fit the market need. Entrepreneurs in Atlanta are also likely to hire their friends rather than evaluating talent from the broader labor pool in Atlanta, which can result in unconscious bias during the hiring process. The chambers of commerce in Atlanta lack strong engagement with entrepreneurial technology firms. They can be too bureaucratic and focused on serving the large corporations at the expense of smaller firms.

Among the academic organizations, the different units faced different challenges. Academic accelerators and incubator programs place strong emphasis on software firms, and need to showcase more successes in the life sciences or materials science. They need a strategy to grow their impact and continue to serve metro Atlanta and Georgia for decades to come. University administration and directors can be inefficient and slow to address the evolving needs of businesses and to recognize how to work with city and state leaders. They need to address the lack of leadership in the diversity initiatives in metro Atlanta and Georgia more broadly. While some schools are designed to handle this challenge, others remain focused on elites and are inaccessible to more diverse communities. Faculty researchers are not good at conveying research to the outside world beyond their specialized domain or discipline. They are also unable to connect or communicate with business leaders. The group with the most challenges and which scored the lowest in the fulfillment level among the top ten was the university contracting and technology transfer offices. Persons both within and outside of academia stated that licensing issues are rampant. Many stated that licensing offices froze their accounts and delayed even small projects for months, requiring intervention from senior administrators to get a response from the organization.

Venture capital is not welcoming to nontraditional firms, and focuses on software and quick exits rather than manufacturing products that can take upward of a decade to pay off. Angel investors can also be too traditional in their investments, overly focused on business-to-business software, and unable to invest in hardware or novel products. Publicly funded research organizations that give out small loans and introduce entrepreneurs to private investors don't have enough resources for deep impact. They do have strong programs and resources to encourage some people to get started, but are hard-pressed to support entrepreneurs after that first phase. Recent policy changes within the Georgia legislature created a shorter leash on investments and allocated less money to state-based research organizations that foster entrepreneurship.

The following list shares the top ten organizations and the most frequently mentioned challenges for each, with the number of mentions in parenthesis. Selected quotes have been included to give more tangible examples.

1. Large Corporations
    - Little Interaction w/ Smaller Firms (11)
    - Lack of Strategy (9)

    "Change of corporate leadership is really challenging for project continuity."
    - Management / Personnel (6)
    - Risk Aversion (5)
    - Resources (4)
    - Lack of Diversity (4)

    "They need to shift diversity from a special office to a broader organization responsibility."
    - Lack of Experience (1)
2. Entrepreneurs
    - Lack of Experience (8)
    - Not Open to Advice / Change (6)

    "They can be so stubborn and don't listen."
    - Lack of Strategy (4 mentions)
    - Management / Personnel (5)
    - Resources (3)
    - Lack of Diversity (3)

    "Tendency to hire friends and not identify and evaluate other people with more expertise."
    - Risk Aversion (2)
3. Academic Accelerator and Incubator Programs
    - Limited scope: Focus on Georgia Tech and Atlanta (5)

    "Create more partnerships to other schools: Kennesaw State, GSU, UGA and others."
    - Lack of Strategy (5)

    "External facing and trying to lead the pack, but the question is what is the next generation of [university incubator]?"
    - Lack of Experience (2)
    - Not Personal (2)
    - Management / Personnel (1)
    - Risk Aversion (1)
    - Lack of Diversity (1)
4. University Administration and Directors
    - Management & Personnel Challenges (3)

    "Internal politics and priorities are challenging for outsiders."
    - Slow Moving (3)
    - Lack of Diversity (2)
5. Venture Capital
    - Not Accessible (5)
    - Risk Aversion (3)

    "Local capital is still connected to real estate and tradition investments, need to shift from growth of land area to growth of tech and business sector."
    - Poor Relations with Entrepreneurs (3)
    - Resources (2)
    - Lack of Experience (2)

    "Too few in Atlanta, and few companies building prototypes for manufacturing."
    - Rules / Policy (1)
6. Faculty Researchers
    - Management and personnel oversight are key weaknesses (4)

    "Didn't understand sense of urgency or deadlines and they were terrible manager of graduate students."
    - Limited scope and focus on academic research (4)
    - Lack of strategy (4)

    "Not entirely prepared for the diversity of roles."
    - Resources, especially time is limited (3)

    "It is hard to maintain the attention and attract the faculty's time."
    - Lack of experience in business (2)
7. Angel Investors
    - Management / Personnel (5)
    - Limited Scope (5)

    "Limited investments for non-software related technology firms, there are only a few non-software success stories."
    - Risk Aversion (4)
    - Lack of Entrepreneur Engagement (4)

    "Many are searching for quick wealth generation, but need to understand they are investing in people."
    - Resources (2)
    - Rules / Policy (1)
    - Lack of Experience (2)
    - Lack of Strategy (2)
8. State Research Support Organizations
    - Rules / Policy (4)
    - Inability to Stick with Companies (3)

    "Inability to stay with and go deep with select companies."
    - Management / Personnel (2)

    "Was a 5, but lost public and legislative support recently. Needs to re-establish position as leaders and coalition builders."
9. University Contracting & Technology Transfer Offices
    - Slow Moving (5)

    "Lack of timeliness with agreements is hurting our research opportunities."
    - Rules / Policy (5)

    "We have spent more money on attorney fees to negotiate the license than on the technology development."
    - Management / Personnel (4)

    "They need a restructuring of decision-making, no one is empowered to make decisions."
    - Lack of Experience (3)
    - Lack of Transparency (3)
    - Risk Aversion (2)
    - Lack of Strategy (2)
10. Chambers of Commerce in Atlanta
    - Stuck in Old Ways (4)

    "Chose ATL program a change to the old ways of doing things."
    - Not Accessible to smaller firms and organizations (3)

    "No response, they are only there for the big companies in Atlanta."

Workshop Reflections

The constraints facing entrepreneurs included a lack of resources, which was only mentioned three times but was surprising to some participants who thought entrepreneurs would not be so resource-constrained. Based upon many of the interviews, access to capital was not a frequently mentioned constraint, though some did struggle to raise capital. One participant, who works with women and minority businesses, said, "Access to capital is usually the number one issue for the entrepreneurs that I work with." This may suggest that access to capital is influenced by the social networks and relationships within different populations in the city. One person suggested the chambers of commerce could be "connectors that create places and environments" for start-ups to meet large corporations. Another said, "The influence of the chambers has trickle-down effects, [with] huge impacts that help small businesses. Tell [startups] they don't need to be members to be helped, they can come anytime."

The conversation moved on to venture capital. Many agreed that the emphasis of venture capital investors who were based in Atlanta or had satellite offices in the city was more so on software and quick exits than on developing products that would support the growth of manufacturing firms. One participant asked, "you found VCs in Atlanta that invest in nanotech?" (with surprise in their voice). Many venture capital funds have local satellite offices staffed by one person working out of their home, and that person invests in companies across the Southeast. Given the airport and regional hub of Delta, those firms have access to Boston, New York, or San Francisco, and cities in the Southeast Region.

The discussion returned to the various constraints facing academic organizations. One participant felt that the two comments about lack of experience among faculty researchers was, "summarized above" in the other constraints. As another participant stated, "I agree with the lack of experience of faculty researchers, they have no way to knowing how to approach commercialization." However, based upon the fulfillment scores (see section 5.6 above) and the statements on constraints, the main challenge was in the universities' contracting and technology transfer offices. In terms of coming to working agreements between universities and private firms, one participant took this further and stated, "I have found in talking with leaders at big corporations that working with universities is very difficult with respect to licensing agreements." A participant added, "I was at a meeting last month where the leaders of numerous firms discussed avoiding working with universities in Atlanta because the process of agreeing on terms is too onerous. We work with a [German] university and have great relations with them." A participant from industry said, "It's like pulling teeth for all that licensing and contracting." As one participant said, "Around here academia is a one-way door for innovation, once you get it out of the university you never want to go back." Another shared, "I believe that we spent more money on attorney fees [to address the contract issues] than on the tech development." Yet another added, "I would be more invested in university research if the road was smoother. We don't do it because it is too painful." One person suggested that the University Regents "should take over the implementation processes" and discussion then focused on how to harmonize the process across all of the state universities.

6.0 Key Takeaways

The closing points of this report are divided into the positive assets that emerged from this research and the deficits and challenges that face civic leaders in Atlanta. The comments below are brief and supported by representative quotes to emphasize and clarify the meaning. This research in no way aims to be demeaning. Rather, it offers a reflection of the current state back to the civic leaders in Atlanta and other cities that are aspiring to cultivate a vibrant innovation ecosystem. The job of the analyst in this research is to bring clarity to that reflection, even while understanding that there are myriad perspectives.

6.1 Key Assets

Small Business Support

There are tremendous resources for new and existing businesses in Atlanta. From firms' formation to expansion, Atlanta offers strong support for the members of the business community. This business-friendly environment encourages persons to take the risk and create a new company.

> "If you can't find help starting your business, you haven't asked anyone or you just don't know who to ask."

Heterogenous Network

There are a number of organizations providing a wide variety of services to technology-based firms, from incubators and accelerator programs to corporate research centers and business-to-business conferences. There are ample business support organizations available for consultation and contracted services in many different sectors from FinTech to MedTech and many organizations supporting ICT/IoT.

> "I have built up my business by partnering with [an incubator] and making connections with the founders of those companies."

Strong Foundations and Philanthropy

There are numerous private foundations with deep roots in Atlanta that are committed to the establishment and growth of world-class research, healthcare, and economic development. The headquarters of many multi-national corporations are located in Atlanta and those organizations support local universities, healthcare, and other technology ventures.

> "We wanted Atlanta to be a place where people came for world-class healthcare. Not Cleveland or Rochester or Boston."
>
> "We know that research doesn't always result in jobs, but it certainly attracts smart people and sometimes they start companies. We want them to start companies here."

Cross-Sector Collaboration

There are a number of organizations that are designed to work across sectors and support collaboration among academics, large industry, and entrepreneurs. Even within academia there are strategic partnerships between local universities that afford benefits to both schools and the broader innovation ecosystem. Further, the relocation of many technology firms to Midtown Atlanta is creating greater opportunities for collaboration between private firms and academics.

> "We are a complex organization and that structure lets us do things with private and academic researchers."
>
> "The goal for us is to help connect the companies building new tech with the government agencies and other organizations that might need it."

6.2 Key Deficits and Challenges

Infrastructure

There are tremendous resources for conducting high-tech research and development within the universities and large companies, yet small firms are challenged to find facilities outside of academic organizations to prototype, validate, and scale up manufacturing, especially with regards to cleanroom operations needed for medical devices and electronics.

> "Once you leave the university, you never want to go back to them for anything and deal with the contracts and IP issues … but where do you go?"
>
> "I just needed a facility outside the university to scale the manufacturing, but nothing was available, so the investors moved the manufacturing to [European Country]."

Investors and Business Model

There are few technology-based success stories, excluding software. If you isolate software, there are very few firms that even people who grew up in Atlanta recognize. There is greater experience in traditional investments including real estate, retail, and business infrastructure, which limits the resource pool for technology start-ups. The technology investors in Atlanta often steer entrepreneurs to consider business-to-business opportunities rather than direct sales.

> "Atlanta is America's Back Office"
>
> "We are a B-B town and people get pushed to pivot towards that model."
>
> "No one has enough experience with B-C."

Some workshop participants felt that to move away from the business-to-business relationships would be to avoid the "ease of access and connections" that foster growth in the technology sector.

University Contracting and Technology Transfer

There seems to be a strong consensus that something is dysfunctional within the university contracting and technology transfer offices. This organization creates constraints for other organizations that want to license, contract research, or enter into partnerships with the university.

> "I have 20 pages documenting the issues related to that grant. It was for $50K and we had almost every senior administrator in the room. That must have cost us more than the grant was ever worth."
>
> "I believe that legislative action needs to be taken to address the situation. It is unbelievable."
>
> "My job is to create conflicts of interest. Their job is to manage it. They can't do their job."

Legislative Orientation

The legislature occasionally debates and proposes topics that discourage and dissuade firms from relocating to Atlanta. There is an apparent tension between the urban-centric and technology-based

economy of metropolitan Atlanta and the rural-oriented, agricultural and manufacturing roots of Georgia. At times, sentiments from the workshop participants expressed frustration with the topics taken up by the state legislature.

> "If they could just avoid driving away prospective companies that would help."
>
> "Georgia is business friendly. Why undermine our success with these crazy bills?"

Diversity and Inclusion

The persons involved in the Innovation Ecosystem in Atlanta remain predominately skewed to white males and to men with ethnic and racial ancestors from India. This challenge was expressed by and for numerous organizations, and the map of technology firms offers evidence that there is a clear divide within the city. In a city with one of the largest Black / African American populations in the nation, there was little evidence that Black persons, be they entrepreneurs or patent attorneys, are involved in technology innovation in Atlanta.

> "White and Indian males do not make it a diverse group of people."

7.0 Future Research and Closing Thoughts

This study, while focused on Atlanta, will be compared to other cities in the United States that are working to foster technology innovation. In the months following my time in Atlanta, I traveled to the Twin Cities metropolitan region in Minnesota. There, I completed a comparable set of interviews and later conducted a workshop with those participants. That research will be directly compared to the findings from Atlanta and similarities and differences will be identified. This research is distinct, as it doesn't rely upon economic measures of success. Rather, it conducts an accounting of the innovation ecosystem from the ground up and invites people involved in the creation of novel technologies to share their stories and to reflect upon their responsibilities and the responsibilities of other organizations within the city.

This approach might well serve to highlight gaps in the current innovation ecosystem that would not be identified by simply counting the number of university graduates or venture capital dollars secured. The aim of this research is to facilitate reflection among civic leaders and to help them identify the assets and deficits present in the innovation ecosystem. For Atlanta, the growth and expansion of the technology sector has been transformative in Midtown Atlanta, in communities along the Beltline, and in the cities along the I-285 corridor. Taking stock and reflecting on what has been accomplished and what remains to be addressed is also important as civic leaders look toward the future.

As one workshop participant stated, "This is fascinating information, very targeted analysis, and consistent with my interpretation." Another participant offered the following feedback, "Great follow up and briefing of the current state of innovation" in Atlanta and when asked if they learned anything the reply was, "I did." Another participant left this comment in their notes, "Very interesting to see the challenges and opportunities for the ecosystem in Atlanta. This was time well spent." In drafting this report and working to share this information back with the civic leaders in Atlanta, I hope that your time spent reading this document was also well spent.

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