THE ATLAS OF INNOVATION DISTRICTS

ARETIAN

Urban Analytics and Design

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EXECUTIVE SUMMARY

The way we live and work is undergoing major upheaval. The digital revolution is changing the kind of work we do and the way we do it. More people are choosing to live in urban environments. At a global scale, we see the warning signs of our inability to navigate these changes. Growing income inequality threatens to destabilize our communities. Automation technologies threaten to displace people from the jobs that they rely on to cover their basic needs. Climate change threatens the natural ecosystems we depend on and even our own long-term survival on this planet.

Many people feel powerless to avoid these existential risks because they are the result of the aggregated actions of all organizations - harmful actors with selfish motives as well as altruistic actors with good intentions that lead to unintended consequences. If most organizations contribute to these problems, then each organization holds a responsibility to help prevent them. However, attempts to address these problems have been ineffective because they have failed to understand two key insights. First, the dynamics that underpin large societal problems change depending on the geographic scale at which you analyze them (metropolitan level, district level, and human level). The interactions between each scale are complex and each scale contributes to the total system-wide behavior. Second, the physical urban environment has significant effects on the social and organizational interactions contained within that space.

Analyzing the economic prosperity of a city through this lens has revealed that building Innovation Districts in cities can lead to distributed wealth for the people who live and work there, unlocking the latent potential of a community. The most effective Innovation Districts intentionally develop 3 kinds of networks: networks of talent from composed of individual workers collaborating within the labor force, networks of organizations collaborating together, and networks of the physical urban environment these organizations are distributed across, which host and support the economic fabric. Optimizing the coordination of these networks can add significant value to the communities in which they operate. Through a study of various cities around the US, we identified 5 distinct types of Innovation Districts, each characterized by a specific

kind of foundational institution - for example, an academic center or an industrial cluster. The foundational institution becomes a strong influencing force for the development arc of a district and creates distinct strategic implications for the decisions made by government agencies, real estate developers, and corporations in the area. We also present quantitative methods for measuring the amount of innovation produced by a district overall and for evaluating the level of maturity of an Innovation District. These methods expand traditional economic analysis to include new perspectives on how urban design itself influences the productivity of an area. Ultimately, our analysis indicates that the strategic aggregation of innovation-intensive activities produces nonlinear benefits for the regional economy. This report contains an Atlas of Innovation Districts across the United States with insights for 25 prominent Innovation Districts, intended to help communities learn from one another and to establish best practices for future neighborhood development.

Our methodology is based on complexity science and network theory principles. Beyond innovation, this new approach can provide data-driven decision support tools and insightful design criteria to address a wide array of urban challenges. We also draw inspiration from the ideas of the urban designer Ildefons Cerdà, the architect Louis Durand, and the mathematician Évariste Galois. Beyond the innovation study included in this report, we are beginning to explore the vast array of further applications for this methodology - applications that will reveal the complex relationships at the root of urgent challenges in our societies. With a sharper understanding of how local decisions around urban design and organizational structures shape the environments we live and work in, we can start to take advantage of emerging opportunities to address the world's most pressing problems.

The Atlas of Innovation Districts is based on the methodology developed by Aretian co-founders Jeremy Burke and Ramon Gras in the context of their joint Design Engineering thesis at Harvard University. This report was produced in collaboration with the Opinno Research Center, a think-do-tank member of the global innovation consultancy Opinno, created to develop deeper insight into the main trends shaping tomorrow's society.

Innovation districts activate the dormant capabilities of a community and generate exponential benefits for surrounding neighborhoods and regions.

1. INTRODUCTION

1.1 SOCIETAL CHALLENGES

Our society is facing three major challenges: growing income inequality, sustainability and health concerns due to climate change, and the accelerating effects of a digital revolution that threatens to erode the way we work and relate to one another. Meanwhile, more people are choosing to live in urban environments. As cities confront these challenges, they will need to give careful consideration to issues of urban design, organizational structures, incentive schemes, economic development patterns, and knowledge networks. These areas will present rapidly-emerging risks as well as extraordinary opportunities for achieving growth and prosperity.

Inequality rates are greater than ever before. In the 18th century, the wealthiest nation in the world per capita, the Netherlands, was 4 times more prosperous than the poorest country in the world.[1] In 2019, the wealthiest countries are now 200 times wealthier per capita than the poorest.[2] This dramatic shift of wealth into the hands of a few has led to a reduction in the resources available to plan proper supportive urban environments for large swaths of the world's population. Furthermore, international migration is on the rise. These movements of people are symptoms of social disruption and distress, as people are forced to uproot their lives and search for new opportunities to survive. Without proper living environments, people around the world will lack the foundation on which to build their lives, their economies, and their futures.

Thoughtful design of our urban environments is paramount as we foster and shape our relationship with the natural world and create healthy, sustainable spaces.[3] As the built environment accounts for more than 30% of the total energy use of the planet, it is critical that we consider how best to organize our urban systems to decrease total energy consumption, create walkable and livable neighborhoods, and increase access to desirable amenities and employment opportunities.

Moreover, today's urban design decisions will shape the future of work and the economic vitality of our cities.[4] We can expect today's jobs to change dramatically with the introduction of cognitive automation, artificial intelligence, robotics, and data-driven decision support systems. While these new tools offer many opportunities to help us solve complex problems, they must also be designed and distributed in a way that does not exacerbate the already-severe economic inequality between the richest and poorest in society.[5] Future prosperity will depend on increasing education among the entire population, as well as upskilling and reskilling traditional workers to facilitate their participation in the digital economy. It will take conscious effort to prevent large sections of our society from being left behind as the world moves ever faster toward digital solutions.

1.2 GOAL

With these three societal challenges in mind, we are embarking on a project to build digital twin models

of cities. These models will describe urban phenomena to help politicians, urban planners, companies, and the public make better decisions about how best to build, shape, and grow their communities. At the center of this effort is the first-ever Atlas of Innovation Districts, a tool that we have developed to identify the drivers of economic success and sustainable development: talent networks, meritocratic organizational structures, and urban infrastructure. Future releases of the Atlas of Innovation Districts will provide further information about best practices and risk mitigation strategies - all with the goal of helping cities generate sustained cycles of distributed prosperity.

1.3 PURPOSE AND RATIONALE

In thinking about how to make our cities more prosperous and resilient, Innovation Districts have become an increasingly relevant topic of discussion. From policymakers, urban designers, civil engineers, and architects to technologists, economists, and other professionals, many stakeholders want to understand the drivers of economic growth and how to harness them for the sustainable benefit of their communities.

For decades, the focus for driving innovation in an economy has centered around technology, infrastructure, and buildings that support businesses. It is self-evident that these are critical foundations for the economic wellbeing of our societies, and yet many high-cost, long-term investments in these areas fail to produce the intended benefits. A key reason for these failures is that decision makers have lost connection with the most important element of any Innovation District: the humans who work there. If an Innovation District does not offer equal opportunities to its citizens, it will not sustain a productive ecosystem in the long run. To avoid these pitfalls it is necessary to understand how local problems affect the population. This understanding will position urban planners to evaluate whether a proposed solution will strengthen the ecosystem and accelerate innovation. We define a human-centered economy as one in which design and policy within a district are driven by the long term needs of the people who work there.

We define an Innovation District as a specific geographic location, generally within a city, where high concentrations of people work in knowledge-intensive industries in conjunction with other related companies and institutions. Innovation Districts also provide a mix of attractive amenities, housing options, and public spaces to enhance the desirability of the community.

Until now, there has been no formal, data-driven, rigorous definition of an Innovation District, nor a comprehensive understanding of what makes some Innovation Districts succeed and others fail. There have been no quantitative metrics to describe the characteristics of these communities and the types of activities they host. In short, there has been no systematic study of how Innovation Districts should be designed in the future. The Atlas of Innovation Districts is an in-depth and ongoing study intended to fill this need.

We define an Innovation District as a specific geographic location, generally within a city, where high concentrations of people work in knowledge-intensive industries in conjunction with other related companies and institutions. Innovation Districts also provide a mix of attractive amenities, housing options, and public spaces to enhance the desirability of the community. In total, Innovation Districts enable greater collaboration, create job opportunities, and promote regional competitiveness through their concentrated activities.[6, 7] These contributions unleash the community's latent economic potential and create the conditions for equitably-distributed prosperity.[8]

> Urban design will influence the future of work, our social connectivity, and the future economic potential of our societies.

This report presents our most salient findings about Innovation Districts, the environments that support them, and factors that influence their success or failure.

While we believe strongly in the potential for Innovation Districts to drive equitable prosperity in cities, we must be clear that this is just one illustrative study to demonstrate the capabilities of our analytical method. This study is not intended to suggest that Innovation Districts alone provide a comprehensive solution to income inequality in our societies, nor do we believe that focusing on knowledge- and capital-intensive communities alone is an appropriate strategy for improving the lives of society's most vulnerable. Rather, this study of Innovation Districts is meant to demonstrate the power of our computational methods for understanding the complex dynamics of urban spaces, highlighting the positive externalities and benefits to broader society generated by Innovation Districts. We believe this method will provide equally valuable insights for how we design and manage our cities on other worthy topics, including but not limited to energy efficiency, affordable housing, access to education, social vulnerability mitigation, and urban mobility.

1.4 ORIGINALITY

While previous literature describes Innovation Districts in a qualitative manner, our report introduces the very first comprehensive data-driven classification of 5 types of Innovation Districts, based on a systematic geospatial analysis of knowledge-intensive activities throughout the United States.[9] Each of the 5 Innovation District types we have identified is built around a different kind of anchor institution, which shapes the district's qualities and influences the human experience in the surrounding neighborhood. Districts of the "Local Government" type, for example, tend to feature a more equal distribution of housing, amenities, and job types, but are generally less innovative overall. This contrasts with districts of the "Research & Academic" type, which tend to support clusters of industrial partners located close by, and which foster a greater number of entrepreneurs overall. The 5 types will be discussed in more detail in subsequent sections.

While innovation is challenging to measure, this report presents an original and rigorous methodology to gauge how key performance indicators (KPIs) are affected by location, community, and anchor institution. Some of these KPIs include the amount of new products and services, research and development, patents and processes, as well as the total sales corresponding to each. In addition, the report examines the causal mechanisms and dynamics of innovation. Analyzing the problem at different geographic scales reveals a different dominant causal mechanism that highlights different areas to focus on: 3 phases of innovation at the metropolitan scale, 5 phases at the district scale, 7 phases at the human scale - the scale at which individual organizations, and teams, and people come into focus. Each phase introduces new demands on the urban environment and generates different kinds of employment opportunities for the broader population.

Using this breakdown, the Atlas of Innovation Districts highlights 25 of the top 50 Innovation Districts in the United States and presents the reader with a broad overview of their characteristics and development over time. From this analysis, the reader will gain an understanding of each district's successes, failures, risks, and opportunities, including issues around urban design, demographics, employment, industry specialization, innovation performance metrics, and placemaking. For a complete list of Innovation Districts, including those not found in the media or general literature, please visit the website: **aretian.com/atlas.** Readers are invited to submit their own district for inclusion and to join the network of innovators. The objective of this ongoing project is to help communities learn from one another and to establish best practices for future neighborhood development.

Our methodology uses principles from complexity science and network theory to provide greater information about how local urban design forms impact the performance of organizations and economic development.

2. THE ATLAS OF INNOVATION DISTRICTS

2.1 WHY STUDY INNOVATION DISTRICTS?

If our goal is to promote equitable wealth distribution and sustainable growth in our communities, why focus on Innovation Districts and not some other model of economic growth?

The answer is simple: Innovation Districts generate a unique form of economic growth and vitality that delivers positive economic effects to the broader population. Innovation Districts are not about creating better places for tech companies to work; they are about creating intentional spaces where people gather to tackle complex challenges. They are problem-solving communities that tend to promote meritocratic values, thereby enabling greater upward mobility than non-innovation districts. They create opportunities both in knowledge-intensive roles and in support roles, and attract amenities and services for the benefit of the surrounding area.

The rising tides of automation, artificial intelligence, and globalization create strong trends toward dehumanization in our economies. Economies undergoing dehumanization will see companies marginalizing human workers in response to the growing capabilities of machines. Dehumanization has a strong adverse effect on individual workers but also on the economy as a whole, as it is a major driver of income inequality. When economies become more reliant on machines without transitioning humans to new, productive roles, it gradually destroys the livelihoods of workers while concentrating economic gains among the people who own the technical capital. If our goal is to achieve distributed economic wealth, therefore, we need an economy that is human-centric; that is, an economy that resists the adverse effects of automation by prioritizing the wellbeing of human workers. Human-centric economies provide equitable workplaces, healthy environments, and opportunities for workers to develop and grow their skills. A human-centric economic model would thus generate more evenly distributed prosperity and protect members of all socioeconomic levels of society from the inevitable job disruption caused by technological innovation.

Human-centric economies depend on both the knowledge economy and

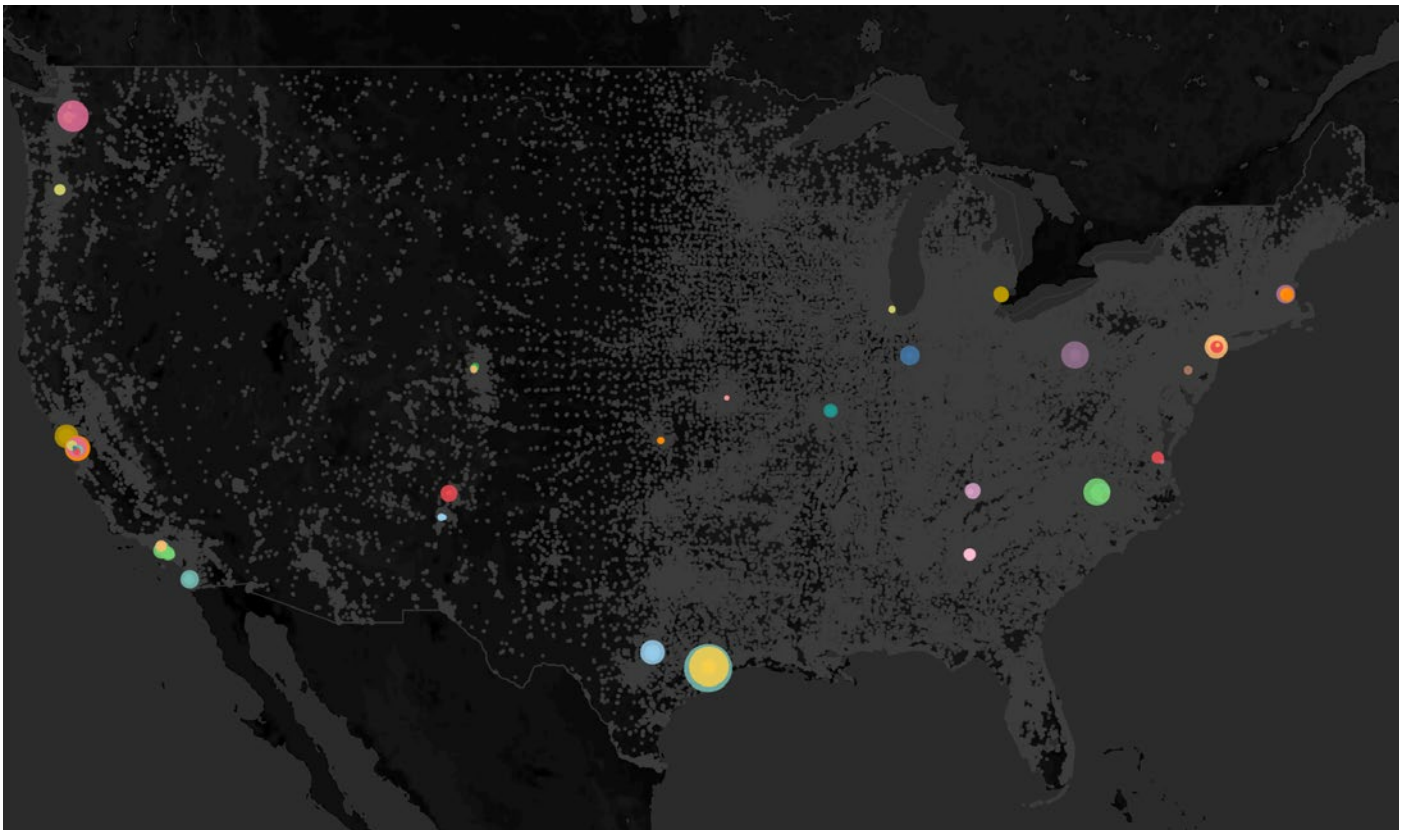


Figure 1 - The Atlas of Innovation Districts, United States
Circles represent the centroid of US Census blocks. Size of bubble indicates employment in knowledge-intensive industries.

physical labor. Both of these types of human economic contributions are threatened by fast-approaching new technologies. While physical labor can be replaced by robotics and globalization, so too can knowledge workers begin to be replaced by Machine Learning and AI. Professions that are not knowledge-intensive are more likely to undergo disruption through automation, AI, and globalization. The knowledge economy encompasses the part of the economy in which humans perform roles that machines cannot. While all communities need to consider the risks of job disruption created by emerging technology, knowledge-intensive communities are likely to be more economically resilient in the face of technological disruption. In their studies of economic complexity at the national level, Hidalgo and Hausmann introduce the concept of "collective knowhow," which they define as the aggregate competence of a community to achieve things that no individual can do in isolation.[10, 11] Communities seeking to build resilient human-centric economies should focus their attention on diversifying and sophisticating the collective knowhow of their local knowledge economy with related complex industries.

It is evident that collective knowhow and a vibrant knowledge economy are important factors in a city's economic health. Yet here we encounter a problem: we live in a world of rapid advancements in knowledge. What can cities do to prevent their collective knowhow from becoming obsolete? The answer is innovation. Innovation is the process of pushing the frontiers of collective knowhow and growing the knowledge economy. Cities have two options regarding innovation; they can leave it to take place organically in a diffused, unsupported environment, or they can concentrate the resources that support innovation in a chosen area and accelerate it. These concentrated areas are Innovation Districts, and they function as engines for healthy, human-centric economies.

> ...areas with an Innovation Intensity of 30% and above have a remarkably low unemployment rate of 2-4%

Our analysis reveals that Innovation Districts tend to generate exponential

benefits to their broader host cities, not just the district itself. Across the top 50 Innovation Districts in the United States, there are currently around 3 million employees, 998,000 of them working in innovation-intensive activities. Research has shown that for each innovation-intensive job an Innovation District supports, it creates an average of 4 to 5 production and service-related jobs.[12] Roughly half of these support jobs are located in the Innovation District itself while the remaining jobs created are dispersed throughout the wider metropolitan area. The benefits of concentrating knowledge-intensive activities in an Innovation District are that new products and services developed within them cascade through the supply chain, where the products and solutions are then produced at scale, benefiting other support industries and suppliers. This intuition can be validated by measuring how these effects manifest in the performance of the entire citywide system. At this macroeconomic scale, we observe a noteworthy inverse correlation between the concentration of innovation activities and a community's unemployment level. Areas with an Innovation Intensity of around 10% have an average unemployment rate of around 10-14%; however, areas with an Innovation Intensity of 30% and above have an unemployment rate of 2-4%. The average United States community has an Innovation Intensity of less than 15%. A more detailed discussion of Innovation Intensity can be found in the next section.

> **Cities have two options regarding innovation; they can leave it to take place organically in a diffused, unsupported environment, or they can concentrate the resources that support innovation in a chosen area and accelerate it.**

Our research also shows that Innovation Districts are highly meritocratic environments. When we use the term "meritocratic," we recognize that the label has controversial connotations in current socioeconomic discourse - nonetheless, we consider it to be an important beneficial feature of Innovation Districts. Some argue that "meritocracy" - particularly in the context of economic development and the technology sector - often masks the fact that minorities lack equal access to opportunities to enter so-called meritocratic professional spaces.[13] We take these critiques seriously. At the same time, we believe that the ideal of truly meritocratic economies is worth upholding as a societal goal. Using data on net worth and net income of individuals working in Innovation Districts and outside of them, we see that workers in Innovation Districts are not bounded in their potential to achieve higher earnings by their net worth. Because individuals with high net worth include those whose wealth was inherited, we interpret this finding as an indication that inherited wealth is less of a determinant of higher income in Innovation Districts than elsewhere. While net worth is an imperfect proxy for inherited wealth, the trend lines for various district types suggest that economic mobility is more common in Innovation Districts than in other non-innovation areas. We interpret this as due, in part, to the influence of meritocratic values in innovation spaces.

In short, a well-designed Innovation District has the power both to leverage the increasing capabilities of machines and to resist the dehumanization of work. Innovation Districts can propel a community's collective knowhow by driving concentrated, accelerated growth. This process promotes the equitable distribution of prosperity and liberates the community's latent human potential. It is possible to align the growth of an economy in a direction that benefits the human ecosystem that drives it, but only if we can analyze the dynamics of innovation at the geographic scale at which these alignment decisions take place.[14]

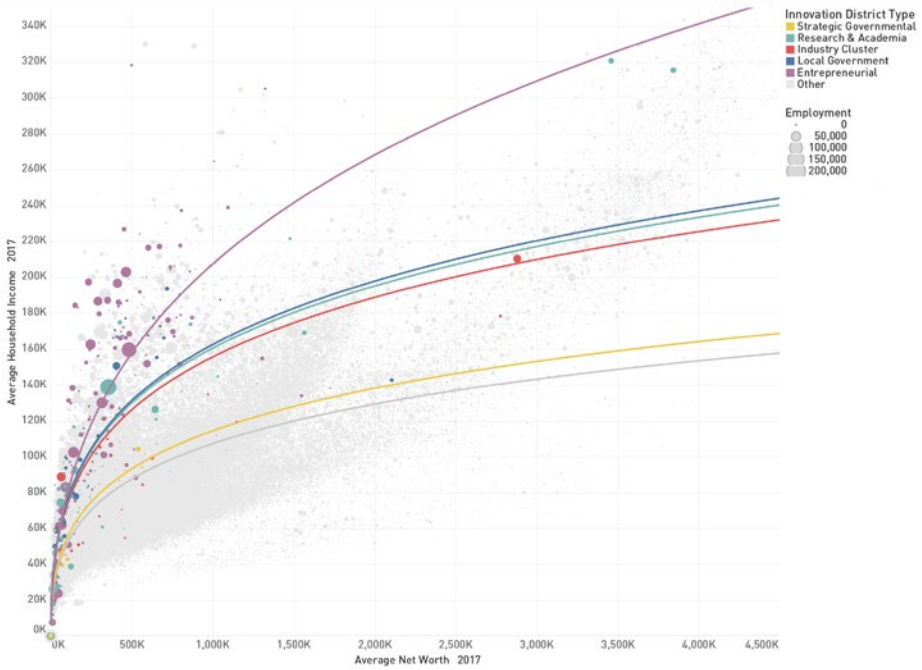


Figure 2 - Meritocratic Nature of Innovation Districts, United States
Each point represents a US Census block group. Lines indicating the relationship between average net worth and average household income for each Innovation District type are based on regression analysis (statistically significant coefficients at the 1% level; R^2 score of 98%).

2.2 A HIGH-RESOLUTION PICTURE OF ECONOMIC COMPLEXITY

One major contribution of the Atlas of Innovation Districts is that it takes Hidalgo and Hausmann's concepts of collective knowhow and complexity modeling at the national level and extends them into smaller scales: the metropolitan, district, and human scales. The development path a city takes is charted by the vast number of decisions made by a multitude of institutions. While a few key decisions are made at the highest metropolitan level, the majority of decisions happen on the ground at the district and human levels. The major contribution of the Atlas is that this new database allows for a majority of the key stakeholders - individuals, organizations, firms, and city managers - to make better-informed decisions at smaller scales focused on communities and individuals. Expanding the scale of analysis of Hidalgo and Hausmann's Atlas of Economic Complexity will ensure that the insights extracted are of an appropriate scope to become inputs for a variety of decision makers, from city mayors to CEOs.

2.3 A NEW METHODOLOGY FOR UNDERSTANDING INNOVATION DYNAMICS

The Atlas of Innovation Districts is the product of a novel methodology for understanding innovation. This methodology employs several core frameworks for classifying Innovation Districts, assessing their level of maturity, and measuring their performance output. These frameworks are as follows.

The 3 Ingredients that Unleash the Innovation Potential of our Cities

Innovation Districts rely on three distinct types of networks:

- First are networks of talent, which are composed of individuals with valuable skills and abilities working in concert to solve complex problems.
- Second are the networks of organizational structures, which serve as the foundation for collaboration and enable merit-based promotion of the best ideas.
- Third are networks of urban infrastructure, which support innovation by keeping the district well connected, desirable, and able to facilitate fruitful human interaction.

Cities must manage all three of these networks to create a holistic environment that supports innovation.

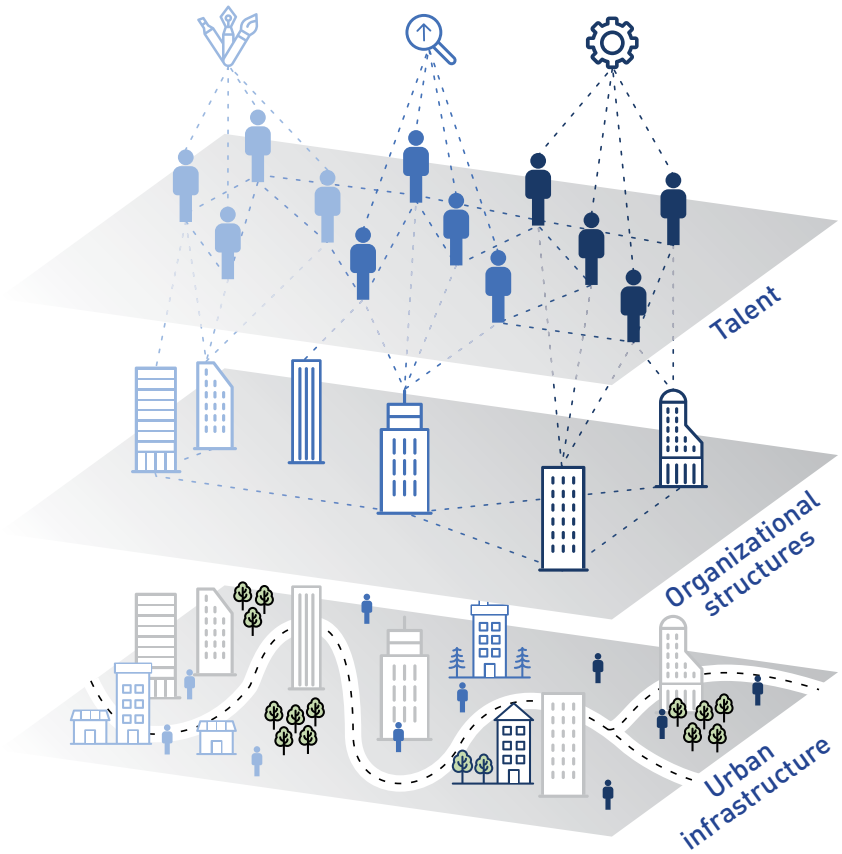


Figure 3 - Networks are the Foundation of Innovation Districts

Figure 4 - Characteristics of Innovation Districts

The Character of our Cities

Districts tend to exhibit similar characteristics depending on the type of institution that functions as a facilitator and anchor for the district. Anchor institutions influence the urban design, nature of industry focus, and organizational structures of the district. These physical structures, mission, and policies help shape the character of surrounding districts, creating effects that ripple across space. This framework may be useful to designers and policymakers in understanding the dynamics specific to their local environment.

Classification of Innovation Districts Based on Anchor Institutions

Our clustering analysis identified five district types based on anchor institution. Each district type features its own ethos and cultural characteristics, which derive from the people who work there and the kinds of innovation activities that take place there.

Local Government: This district type develops where municipal or metropolitan government agencies are the key drivers of innovation. This type of district is characterized by overall better living environments with diverse levels of housing, shops, and amenities, but tend to have lower Innovation Intensity overall. Seattle South Lake Union is an example of this type.

Research and Academic: This district type grows around world-class universities, colleges, technical schools, and research centers. Research and Academic districts are characterized by strong output of scientific articles and patents, some of which transfer into locally-based technology ventures. They tend to be strongly meritocratic environments that produce more radical innovations. Kendall Square/ MIT is an example of this type.

Entrepreneurial / Bottom Up: This district type develops organically where entrepreneurs and startups come together in a dense environment. Entrepreneurial / Bottom Up districts tend to develop in highly meritocratic urban environments and are characterized by a common culture and values, economic incentive schemes, and fluid circulation of talent. The Austin Innovation District is an example of this type.

Industry Cluster: This district type grows around dominant corporations. It is characterized by strong specialization and concentration of related industries in close proximity to strategic suppliers. The Boeing Aerospace Cluster in Los Angeles is an example of this type.

Strategic Government Agency: This district type develops around high-performance national research and development centers. These districts are often placed in remote locations and are intensely focused on basic science and defense applications. They generate massive technology transfer spillovers in multiple industries that use the new technologies to build out applications for the general public. The Oak Ridge National Laboratories are an example of this type.

So far we have classified each district by one dominant type, but we understand that there may be multiple influencing anchor institutions for any given Innovation District.

Urban Design

Urban design decisions have a major impact on Innovation Districts. Because Innovation Districts must be human-centric, their success or failure will depend in part on whether they provide amenities that make them attractive and livable neighborhoods - including everything from food options to the quality of public spaces and the convenience of transportation connections.15,16,17 Our methodology assesses districts in terms of the quality and density of the amenities they provide. Well-designed districts are able to host high-density networks of talented individuals, organizations, and functional infrastructure. Urban design interventions can serve as a powerful option for boosting an Innovation District that is struggling to reach its full potential.18 By diagnosing elements of the urban environment that are inadequate for the needs of the district, urban designers can unleash a district's latent potential.

Elements of Urban Design

- Aesthetics & Desirability
- Urban Topology
- Urban Morphology
- Urban Entropy
- Richness of Amenities
- Centrality & Gravity
- Connectivity

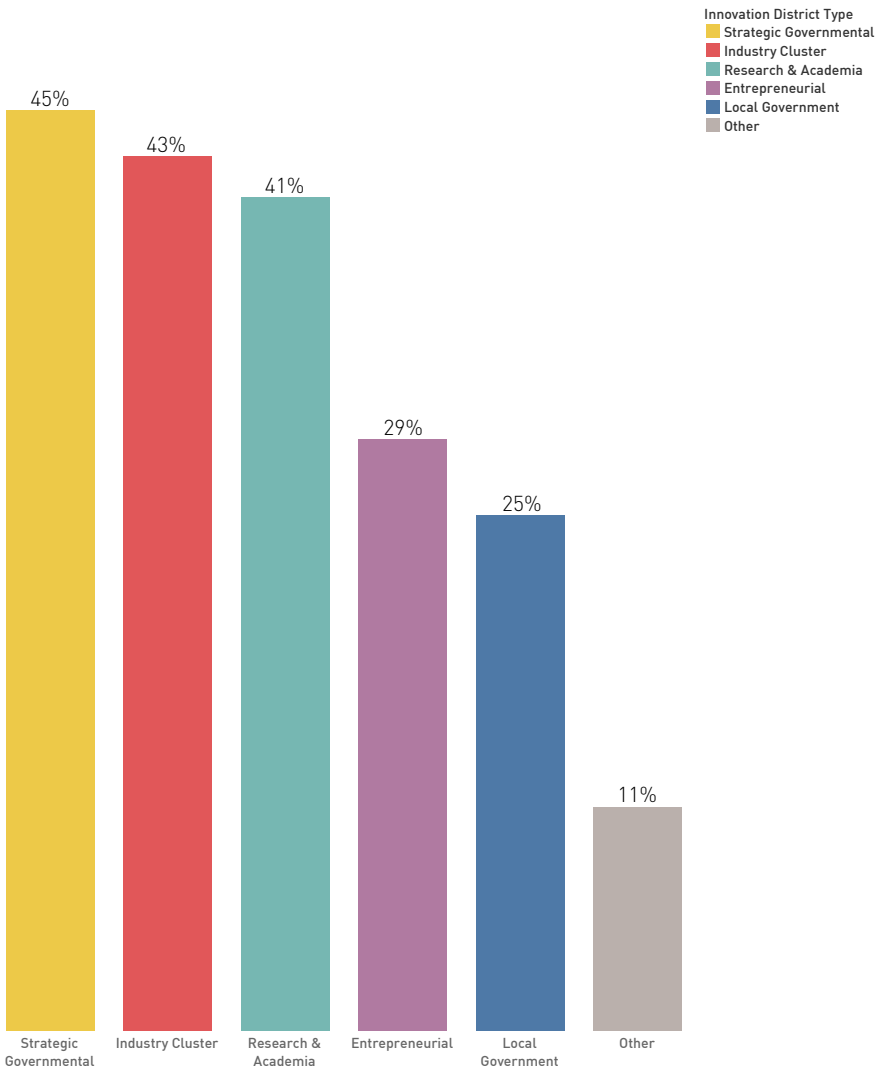


Figure 6 - Innovation Intensity Ranking
Innovation Intensity is the percent of total employment in knowledge-intensive industries.

Key Performance Indicators for Innovation Districts

The Atlas of Innovation Districts employs a series of indicators for diagnosing the performance of Innovation Districts. These Key Performance Indicators (KPIs) aid in measuring the health and maturity of innovation spaces. We use an aggregation of many indicators to produce three overarching KPIs: Innovation Intensity, Innovation Performance, and Innovation Impact.

Geospatial Analysis

The Atlas of Innovation Districts presents economic activity related to innovation at the metropolitan, district, and human scales. This method provides highly detailed insights into the geospatial spread of economic productivity of an urban environment. This perspective can help identify opportunities for future district development that would not otherwise be apparent in traditional analysis.

> By linking perspectives from various scales - from metropolitan to district to human - our methods reveal a more complete picture of the human dynamics beneath complex societal problems.

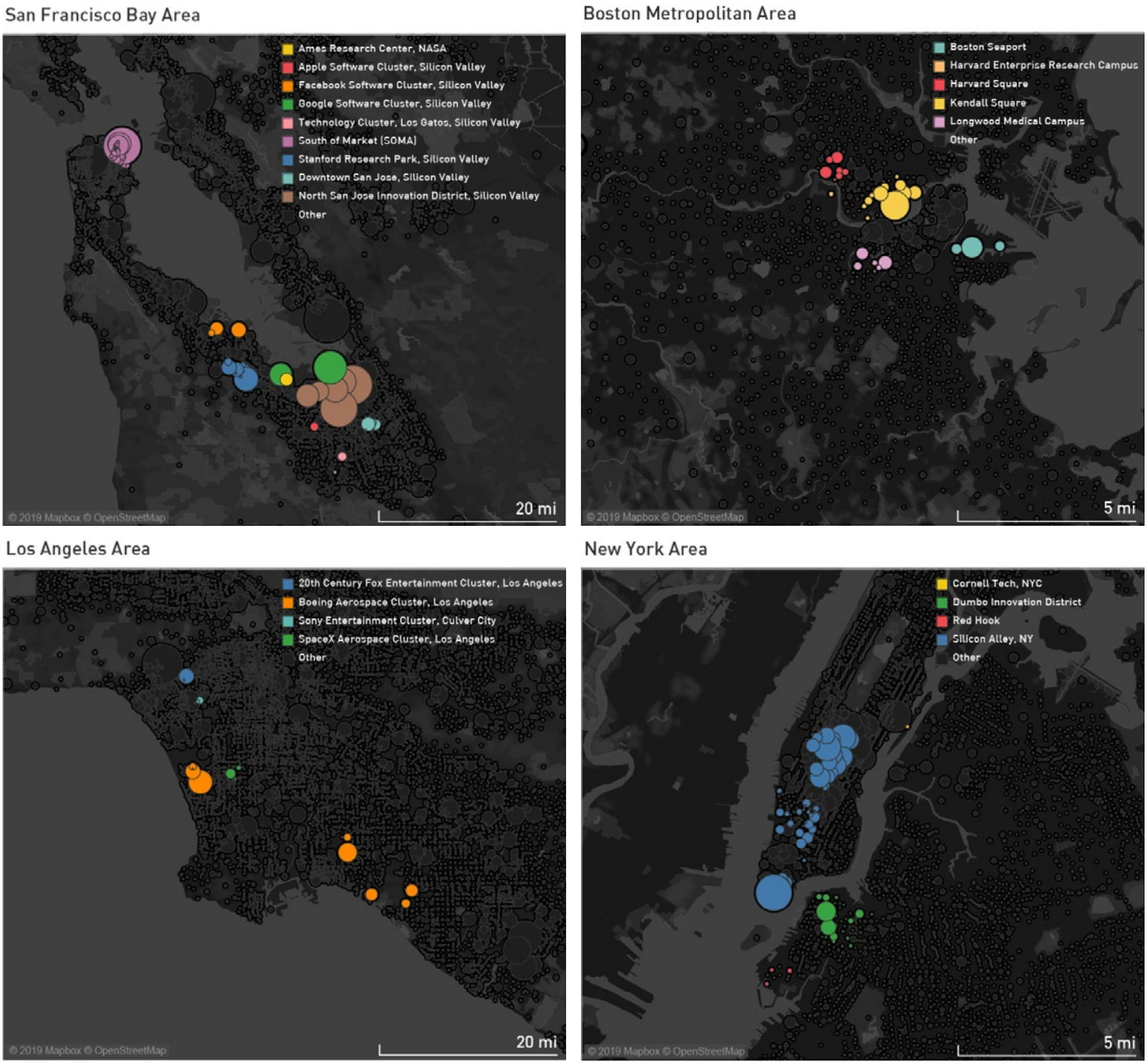


Figure 5. Geospatial analysis

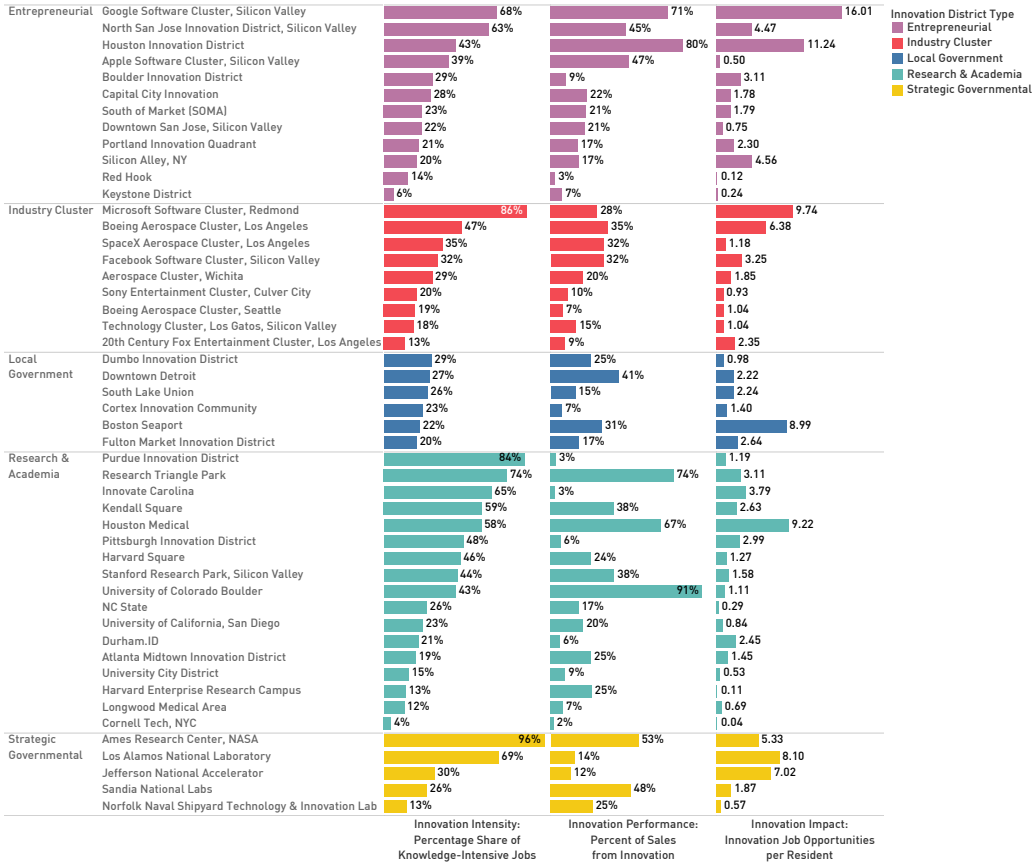
Innovation Intensity measures the collective effort deployed to create knowledge networks. Innovation Intensity is measured as a percentage of employees working on knowledge-intensive activities per geographic unit. Our research shows that the average community in the United States has an Innovation Intensity of less than 15%, while Innovation Districts typically operate at or above 25%. The top-performing Innovation Districts are high-intensity environments: the top 10% have an Innovation Intensity of 50% and above, while the top 1% reach 85-95%.

Innovation Performance measures the tangible outputs of innovation created on an annual basis by the innovation community, preferably at the smallest possible census geographic aggregation level. Innovation Performance measurements reflect the output of new products, services and production processes, new patents and their associated revenues, scientific research papers, and other R&D outputs.

Innovation Impact describes the benefits to the broader community that result from the development of knowledge-intensive activities. Innovation Impact is measured through a variety of contributing indicators, including the number of innovation-intensive employees in the district, the meritocracy index, the prosperity index, the inequality index, measurements of indirect employment generation, measurements of diversity, and industry alignment with the broader metropolitan area. Three types of Innovation Districts - the Research and Academia, Local Government, and Entrepreneurial types - are particularly effective at creating merit-based environments where hardworking and talented individuals have access to high-quality jobs, thus generating distributed prosperity.

...the average community in the United States has an Innovation Intensity of less than 15%, while Innovation Districts typically operate at or above 25%. The top performing Innovation Districts are high-intensity environments: the top 10% have an Innovation Intensity of 50% and above, while the top 1% reach 85-95%.

It is important to note that these KPIs can be applied at all three scales: metropolitan, district, and human. However, because the KPIs relate most directly to activities that occur within an Innovation District, it is at the district level that they provide the most actionable insights.



Entrepreneurial	Google Software Cluster, Silicon Valley	68%	71%	16.01
	North San Jose Innovation District, Silicon Valley	63%	45%	4.47
	Houston Innovation District	43%	80%	11.24
	Apple Software Cluster, Silicon Valley	39%	47%	0.50
	Boulder Innovation District	29%	9%	3.11
	Capital City Innovation	28%	22%	1.78
	South of Market (SOMA)	23%	21%	1.79
	Downtown San Jose, Silicon Valley	22%	21%	0.75
	Portland Innovation Quadrant	21%	17%	2.30
	Silicon Alley, NY	20%	17%	4.56
	Red Hook	14%	3%	0.12
	Keystone District	6%	7%	0.24
Industry Cluster	Microsoft Software Cluster, Redmond	86%	28%	9.74
	Boeing Aerospace Cluster, Los Angeles	47%	35%	6.38
	SpaceX Aerospace Cluster, Los Angeles	35%	32%	1.18
	Facebook Software Cluster, Silicon Valley	32%	32%	3.25
	Aerospace Cluster, Wichita	29%	20%	1.85
	Sony Entertainment Cluster, Culver City	20%	10%	0.93
	Boeing Aerospace Cluster, Seattle	19%	7%	1.04
	Technology Cluster, Los Gatos, Silicon Valley	18%	15%	1.04
	20th Century Fox Entertainment Cluster, Los Angeles	13%	9%	2.35
Local Government	Dumbo Innovation District	29%	25%	0.98
	Downtown Detroit	27%	41%	2.22
	South Lake Union	26%	15%	2.24
	Cortex Innovation Community	23%	7%	1.40
	Boston Seaport	22%	31%	8.99
	Fulton Market Innovation District	20%	17%	2.64
Research & Academia	Purdue Innovation District	84%	3%	1.19
	Research Triangle Park	74%	74%	3.11
	Innovate Carolina	65%	3%	3.79
	Kendall Square	59%	38%	2.63
	Houston Medical	58%	67%	9.22
	Pittsburgh Innovation District	48%	6%	2.99
	Harvard Square	46%	24%	1.27
	Stanford Research Park, Silicon Valley	44%	38%	1.58
	University of Colorado Boulder	43%	91%	1.11
	NC State	26%	17%	0.29
	University of California, San Diego	23%	20%	0.84
	Durham.ID	21%	6%	2.45
	Atlanta Midtown Innovation District	19%	25%	1.45
	University City District	15%	9%	0.53
	Harvard Enterprise Research Campus	13%	25%	0.11
	Longwood Medical Area	12%	7%	0.69
	Cornell Tech, NYC	4%	2%	0.04
Strategic Governmental	Ames Research Center, NASA	96%	53%	5.33
	Los Alamos National Laboratory	69%	14%	8.10
	Jefferson National Accelerator	30%	12%	7.02
	Sandia National Labs	26%	48%	1.87
	Norfolk Naval Shipyard Technology & Innovation Lab	13%	25%	0.57

Figure 7. Summary of Innovation Intensity, Performance, Impact

Cause-and-Effect: Igniting Innovation at Different Scales

Innovation takes place at many levels. There are metropolitan dynamics, district dynamics, as well as human dynamics specific to the teams of people who generate innovative knowledge and products. Our methodology accounts for these differences in scale and uses a different analytical framework for evaluating innovation at each level.

Metropolitan Scale: 3 Phases of Innovation

At the metropolitan level, the Atlas of Innovation Districts evaluates innovation ecosystems according to their activity in 3 phases:

1. Research and Academia
2. Technology Transfer
3. High Value Added Production

In the Research and Academia phase, organizations engage in theoretical innovation, primarily through academic institutions. In the Technology Transfer phase, design, engineering, and technology firms originate or evolve ideas from research and academia, and crystalize them into useful designs, products, and services. In the Production phase, companies that specialize in manufacturing and distribution begin to mass produce new products based on the designs developed during the technology transfer process.

Assessing a region's performance through its activities in these three phases gives a high-level understanding of the innovation landscape. Cities in the process of developing a new innovation ecosystem will need to develop through the three phases sequentially, as the outputs from the Research and Academia phase become inputs for the Technology Transfer phase and outputs from Technology Transfer phase become inputs for the Production phase. A mature innovation ecosystem at the metropolitan level will have diverse, high-functioning players operating at each of the phases, successfully transitioning novel ideas into marketable products and services.

Figure 8. Metropolitan Scale: 3 Phases of Innovation

District Scale: 5 Phases of Innovation

At the district level, the Atlas of Innovation Districts evaluates innovation according to 5 phases. These phases describe how organizational structures, decision making structures, and human dynamics have an impact on greater society.

1. **Inputs for Decision-making, Investment and Design:** strategic decision-making processes
2. **Innovation Intensity:** societal effort to support innovation
3. **Innovation Dynamics:** tactical and operational decision-making processes
4. **Innovation Performance:** tangible results from knowledge-intensive activities, value creation
5. **Outputs for Societal Impact and Benefits:** value created flows to broader society

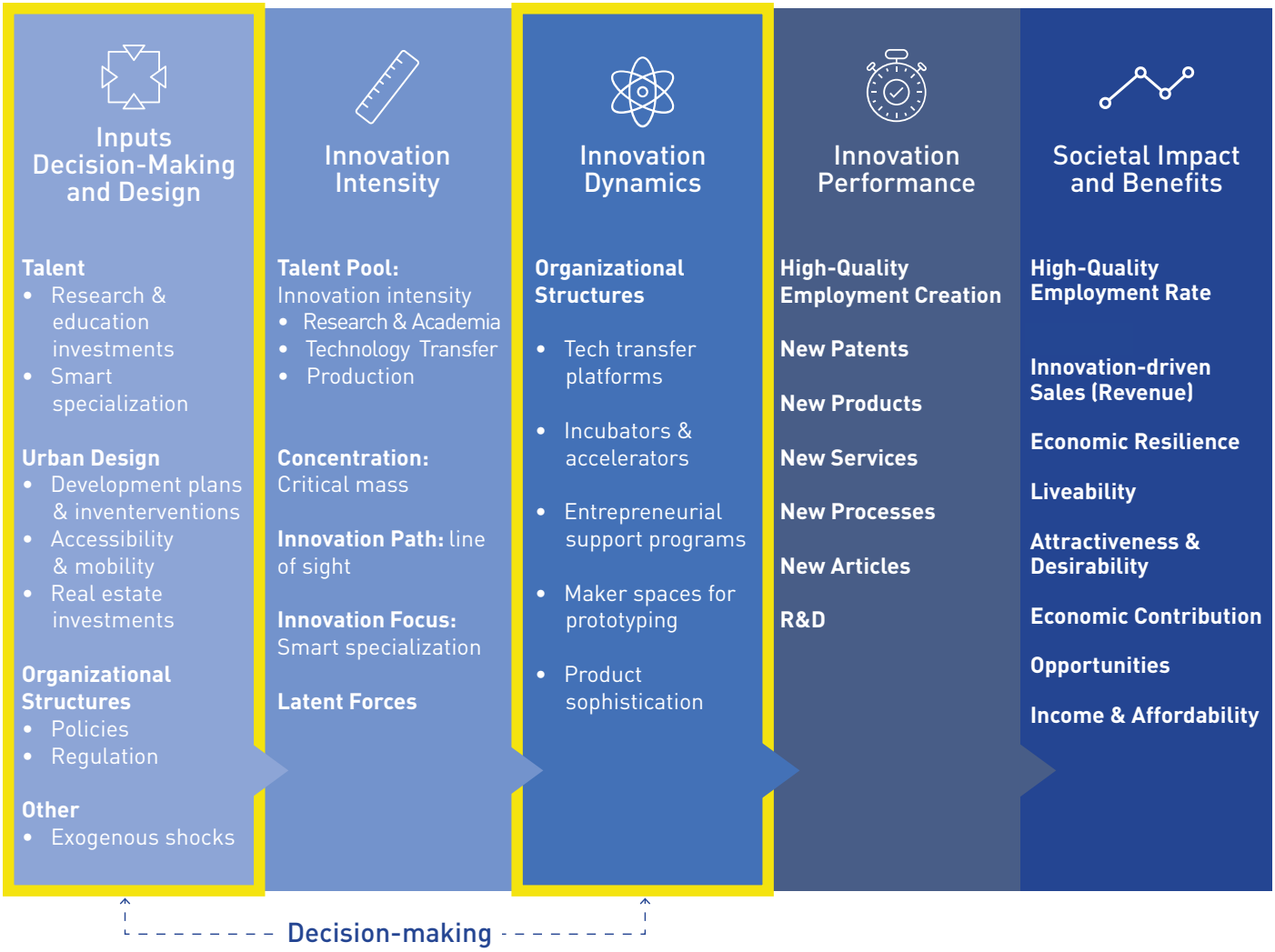


Figure 9. District Scale: 5 Phases of Innovation

Assessing a district's innovation through the framework of these 5 phases provides insights that help leaders of private and public organizations understand how their actions influence the surrounding environment. At both the first step - Inputs, Decision-Making and Design - as well as the third - Innovation Dynamics - organizations can make specific decisions to influence the innovation ecosystem around them. In the first phase, decision makers can change inputs like investment levels, policies, and design principles. These changes to inputs will reshape the innovation ecosystem in the second phase. The third phase gives leaders the opportunity to change the dynamics of team interactions as they work toward new solutions.[19] The fourth phase encompasses output of the innovation ecosystem, including new patents, products, and services. In the fifth phase, the effects of the new products outputs result in the societal impacts, such as high quality employment, economic contribution, and sustainability.

These 5 phases are the most relevant framework for assessing the state of innovation at the scale of an Innovation District. Designers and policymakers seeking to develop their Innovation District may also benefit from assessing whether the district has all components of the Burke-Gras Hierarchy of Innovation Needs. This framework provides a broad set of evaluative criteria from location to the quality of amenities and the innovation performance, all of which are needed to create a thriving urban innovation ecosystem.

Figure 10. Hierarchy of Urban Innovation Needs

Human Scale: 7 Phases of Team Innovation

At the human level, the Atlas of Innovation Districts evaluates innovation according to 7 phases. These phases of team innovation describe the process by which new ideas flow from inception to mass production. Each of the 7 phases represents a step that a team must take in order to develop a successful product, process, or service.

The 7 Phases are:

1. Idea Generation
2. Data Gathering
3. Hypothesis Testing
4. Prototype Creation
5. Validation & Calibration
6. Minimum Viable Product
7. Mass Production & Diffusion

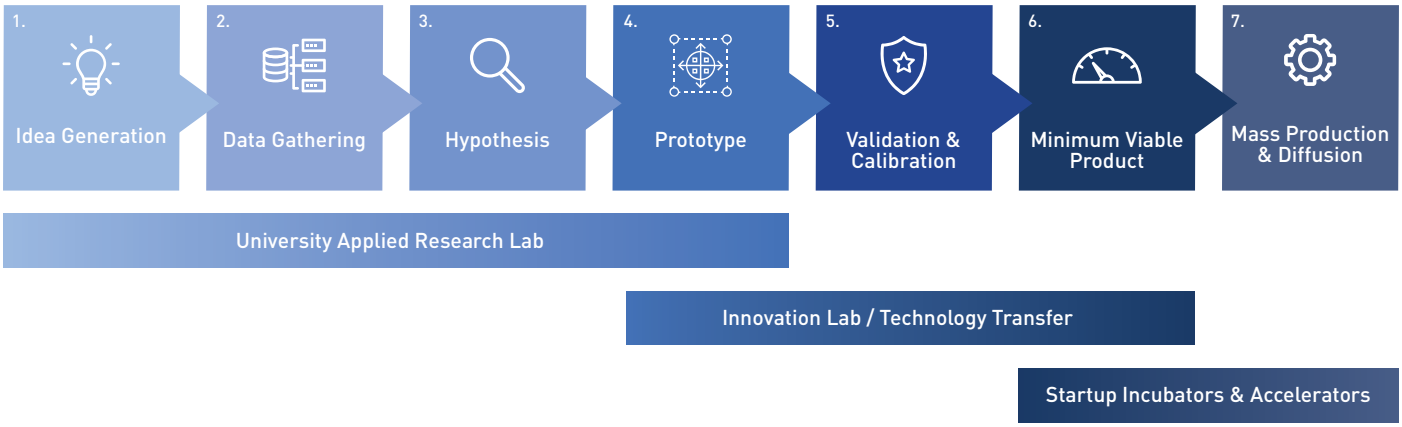


Figure 11. 7 Phases of Team Innovation

The 7 phases also provide a framework for organizations to create innovation support systems, helping their employees remove obstacles and achieve their goals. Highly innovative organizations will create systems to reduce common obstacles and provide support and feedback at each phase. Interventions that support innovative team environments might take the form of conveniently-located maker spaces, mentoring programs, and legal consulting services for guidance on incorporation and IP protection.

The Atlas of Innovation Districts presents analysis of innovation at the metropolitan, district, and human levels. Many of the problems that block innovation ecosystems from reaching their full potential operate across multiple scales. For this reason, to develop a nuanced understanding of the dynamics at play in an innovation ecosystem, it is important to include perspectives from all three scales.

IMPLICATIONS OF THE NEW METHODOLOGY

The Atlas of Innovation Districts provides a new way of understanding innovation. Evaluating Innovation Districts using this methodology reveals best practices from lessons learned, areas for improvement, emerging risks, and more. It allows cities to develop custom plans for helping new and existing Innovation Districts to succeed. Ultimately, the Atlas of Innovation Districts shows that success in innovation stems from concentrating talent, establishing high-performing organizational structures, and creating attractive, sustainable, human-centric environments that support distributed economic prosperity. By analyzing the innovation dynamics at each distinct scale (metropolitan, district, and human), it is possible to identify new variables, correlations, and causations between the inputs to innovation and the performance of the entire ecosystem. This interlinked visibility makes it possible to align the KPIs of a single organization to the KPIs of a city to coordinate intelligent decision making across disparate groups.

> The Atlas of Innovation Districts provides a new way of understanding innovation.

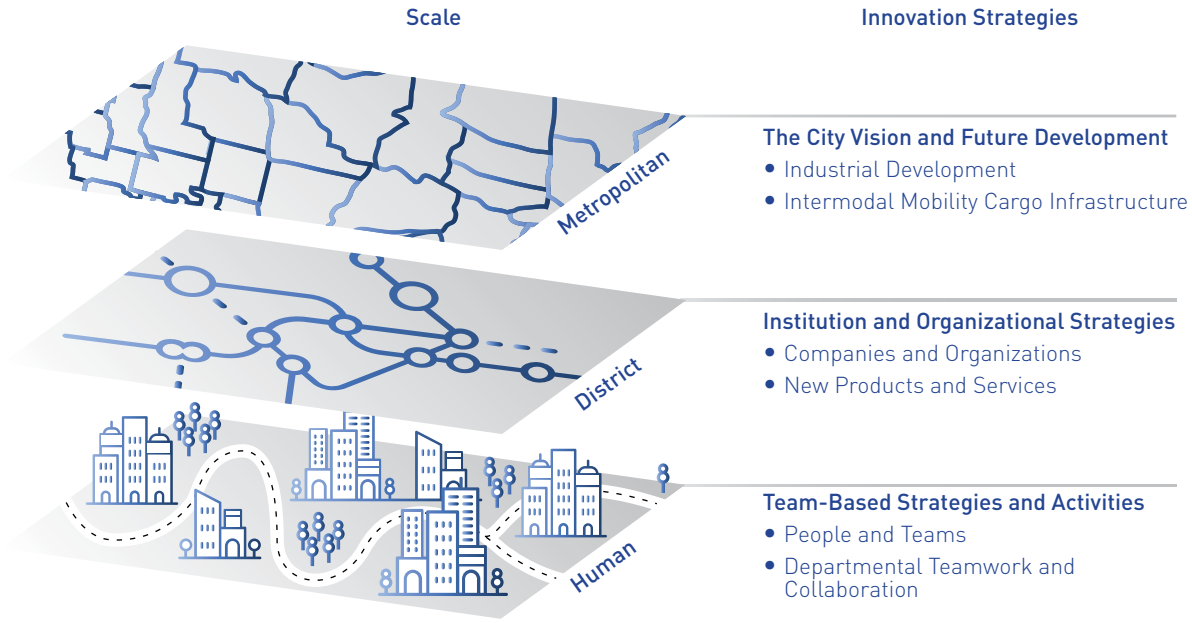


Figure 12. Innovation at the Metropolitan, District, and Human Scales

The factors that promote innovation are discrete, analyzable, and in our control. Innovation is in reach, and as a result, so is distributed economic prosperity. Who will be responsible for deploying these insights?

3. CASE STUDIES IN INNOVATION DISTRICTS

HISTORICAL EXAMPLES OF HOW CHANGE IN INNOVATION PROCESSES IMPACTED COMMUNITIES IN THE UNITED STATES

3.1 PITTSBURGH

Formerly a powerhouse of heavy industry, Pittsburgh's economy went through several decades of hard times following the collapse of the steel industry. The economic renaissance of Pittsburgh over the last two decades illustrates how a city can reignite innovation by tapping into a bygone competitive advantage.

Historical Background

From the 1930s to the 1950s, Pittsburgh, Pennsylvania was an industrial powerhouse with strong specialization in steel production and heavy manufacturing. The steel industry in particular served as the anchor institution that drove the city's economy and development decisions. Industrial materials and manufacturing companies developed in clusters throughout the Pittsburgh region, benefiting from an ample local supply of coal to fuel production processes. During the city's heyday in the World War II era, Pittsburgh's manufacturing capabilities were competitive at the frontier of innovation and made substantial contributions to the American war effort.

Pittsburgh's situation changed when World War II ended, leading to a decrease in demand for steel. During the period spanning from the 1960s through the 1980s, many of Pittsburgh's factories closed and the city lost 40% of its population. By 1983, the city had a 17% unemployment rate and was one of the most economically depressed and environmentally degraded places in the United States.[20] It seemed that all was lost.

The Problem: Underdeveloped Network of Talent

The decrease in demand for steel was the final blow to an economic ecosystem that had gradually become overly focused on production. In doing so, the city had neglected important functions related to research and technology transfer that were necessary inputs for long-term competitiveness. As demand for steel decreased, Pittsburgh's economic engine began to stall, and when large portions of the population moved out, the city suddenly found its network of talent depleted. This became a downward spiral; without its network of talent, Pittsburgh's Innovation Intensity decreased until it could no longer feed the Innovation Performance and Innovation Impact phases of the innovation process. For Pittsburgh to survive, it needed to find a way to rebuild its Innovation Intensity.

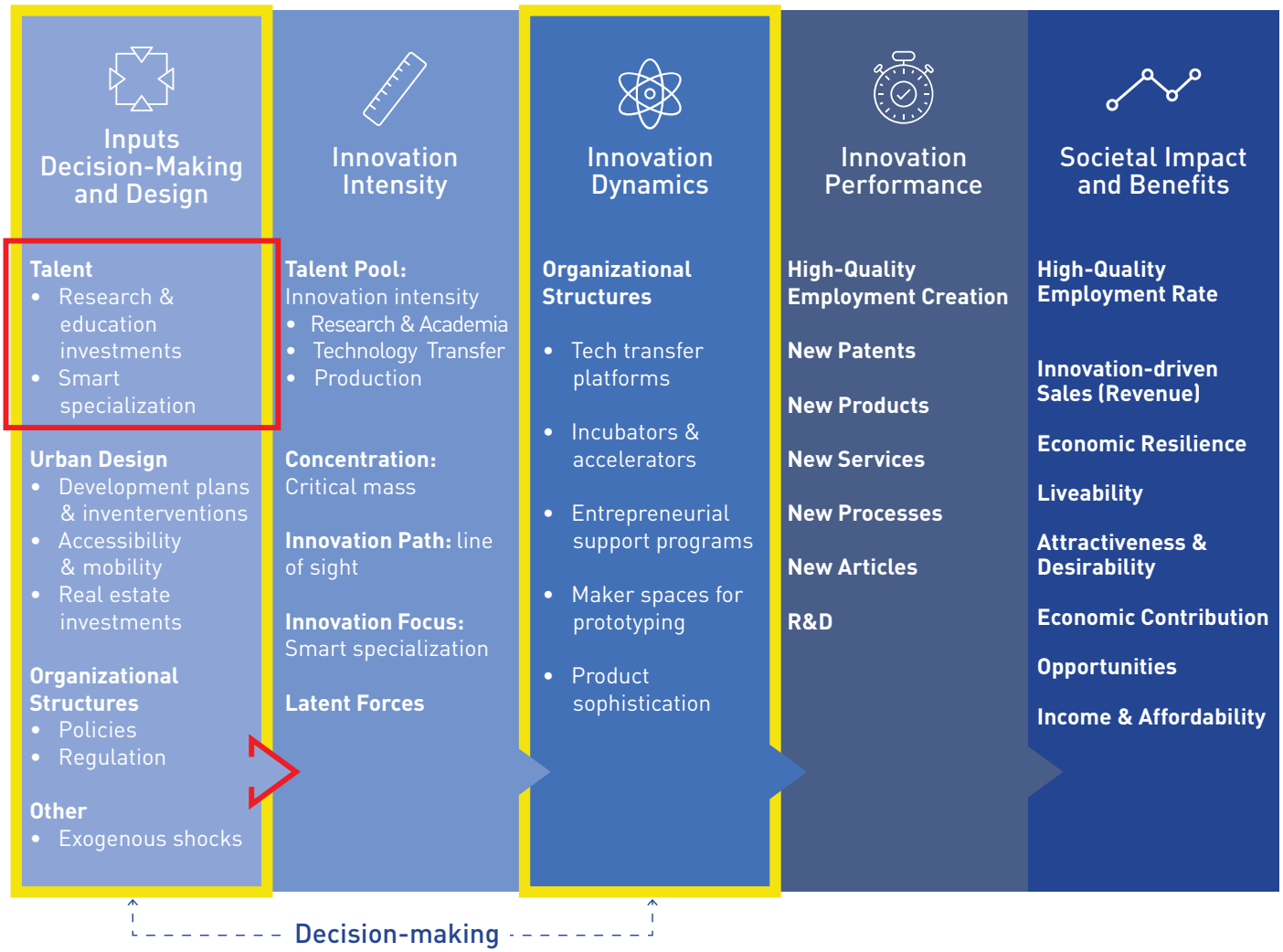


Figure 13. District Scale: 5 phases of innovation in Pittsburgh
A weakening network of talent stalled Pittsburgh's innovation cycle. Pittsburgh's economic collapse was accelerated when disruption in demand for steel caused the city to lose its innovative talent base. Loss of talent at the early stages of the innovation pipeline led to a shutdown of innovation processes downstream.

Insights from Pittsburg

Despite its massive losses, Pittsburgh underwent a resurgence beginning around the turn of the century and is now once again on the path to prosperity. Today, the city is home to one of the world's most important centers of innovation in robotics, advanced manufacturing, and artificial intelligence. In the past 15 years, it has received accolades from multiple publications as one of the United States' most livable cities. What explains Pittsburgh's economic renaissance?

Government officials were facing a challenge at the metropolitan level. The city identified robotics as a potential new area of specialty that would be complementary to their prior expertise in manufacturing and heavy industry. But to become innovators in robotics, they first needed to make significant investments in their Research & Academia talent network to reach the frontier of collective knowledge in robotics. Only then could they push forward into the Technology Transfer phase and ultimately reach Mass Production.

Analyzing Pittsburgh's innovation economy at the metropolitan scale, the ecosystem can be understood through the phases of Research & Academia, Technology Transfer, and Mass Production. To rebuild competitive advantage, Pittsburgh needed to kickstart this process. The city's leading universities, Carnegie Mellon University and the University of Pittsburgh,

made strategic investments with the establishment of a series of new research centers. Leaders throughout the innovation ecosystem correctly identified these institutions as engines for future innovation. The universities' investments gradually rebuilt the local knowledge network, attracted new talent in relevant industries, and created spaces that promoted density and collaboration. Alongside these investments in Research and Academia, the city government made significant investments in the urban environment as well, eventually buying over 1,500 acres of abandoned steel mills for redevelopment as attractive mixed-use urban spaces.[21] Over time, these investments produced virtuous cycles of redevelopment and concentration of knowledge. The city's economic engine was reginited.

The story of Pittsburgh's economic renaissance showcases three particular activities that support the Research and Academia phase of innovation - an essential foundation for healthy networks of talent.

Specialization of Knowledge-Base
First, a city must promote strategic concentration and specialization. This step allows a city to develop its a comparative advantage. It is easier to create knowledge around a pre-existing industry than it is to start from scratch in a field that requires major foundational investments and many years to consolidate. Specialization also allows a city to focus its investments into an area of high impact rather than diffusing investments across many areas and lessening their effect. Pittsburgh made strategic investments to advance knowledge around robotics and advanced manufacturing at its universities. Carnegie Mellon University became a new anchor institution, helping to transition the talent left over from Pittsburgh's past Industrial Cluster anchor into the city's new specialization area: robotics and AI.

Acceleration of Knowledge Development
Next, a city must develop and diversify its areas of competitive advantage to the current cutting edge of knowledge. It can accomplish this by providing academic and professional training for workers as well as by attracting talent from elsewhere and providing incentives for new basic and applied research. In Pittsburgh's case, this process involved creating new educational programs in metal technology, advanced manufacturing, robotics, and AI, all centered around the city's universities.

Diversification and Sophistication of The Collective Knowledge Base
Once the specialty industry has reached the edge of existing knowledge, it is ready to push past the frontier into innovation. In this phase, companies will begin to diversify their products into unique, sophisticated offerings. This process of diversification and sophistication will solidify the city's reputation as an innovative environment and attract additional talent and investment within the area of specialization. Pittsburgh's economic renaissance is the result of pursuing these three activities to maturity.

A city can build its innovation strategy on the legacy of an industrial past. Traditional capabilities can propel a city toward innovation and into a stable position of competitive advantage.

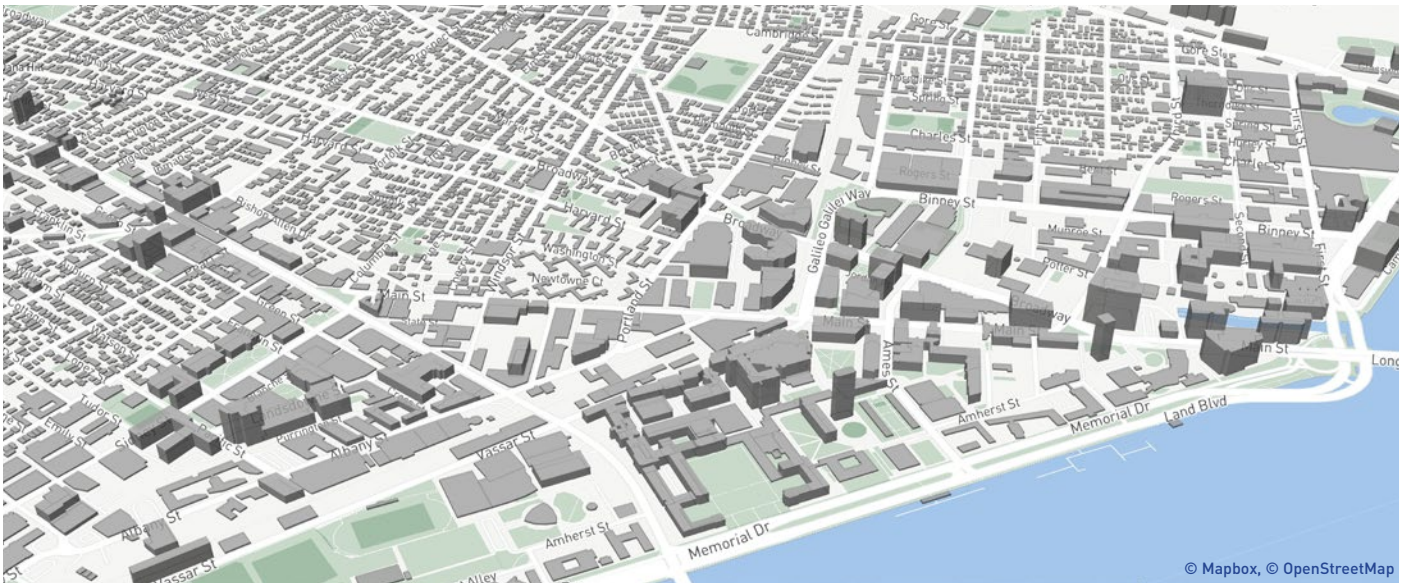


Figure 15. Street Layout of Kendall Square

3.2 KENDALL SQUARE, CAMBRIDGE, MASSACHUSETTS

Formerly an abandoned industrial area, Kendall Square has become one of the nation's most successful Innovation Districts. This transformation was fueled by smart investments in urban infrastructure that laid the foundation for a connected, attractive, and productive environment for innovators.

Historical Background

In the 1960s, President Kennedy designated Kendall Square in Cambridge, Massachusetts as the future home for the NASA campus. This would have anchored Kendall's development to the needs of a Strategic Government Agency. Sadly, President Kennedy was assassinated in 1963 before construction began in Kendall Square. His successor, President Johnson, decided to locate the NASA campus in Houston, Texas instead. For the next 25 years, Kendall Square remained an undeveloped, desolate lunar landscape with few buildings of any kind in the district. Despite its close proximity to the bustling activity of the MIT and Harvard campuses, Kendall developed a reputation as a dangerous neighborhood with a high incidence of crime.

The Problem: Sparse Network of Urban Infrastructure

Kendall's discontinued development plans stunted the growth of its nascent innovation ecosystem. The obvious problem was the near nonexistence of urban infrastructure to house and support economic activity. Despite the loss of the NASA campus, Kendall Square was well positioned to develop organically into an Innovation District. With multiple world class universities located nearby, Kendall Square had strong potential for high Innovation Intensity. City planners just needed to figure out how to approach the problem.

Insights from Kendall

Over the last 20 years, Kendall Square has been the site of a major urban development plan. The district's redesign and subsequent construction projects have made the neighborhood architecturally attractive, well connected to other centers, and a major draw for professional talent. Today, the Kendall Square neighborhood has the lowest real estate vacancy rate of any major downtown market in the United States at just 3.6%.[22] It also has the highest Innovation Intensity of any Innovation District in the Atlas at 94%.

What decisions allowed Kendall to tap into the wealth of resources in its surroundings? The case of Kendall Square showcases actions a district can take to build a strong network of urban infrastructure and create attractive, functional spaces for innovation.

Investment in Public Infrastructure Systems to Increase Accessibility and Desirability

Kendall Square enjoyed a central location near downtown Boston, but the local infrastructure was inadequate for the district's needs. The nearby highway, I-93, was notoriously congested and provided only a slow connection to the rest of the city. This situation improved with the completion of Boston's Big Dig in 2007, which greatly improved the stretch of I-93 between Kendall Square and Boston, providing access to downtown and Logan Airport in less than 15 minutes. City officials also made strategic zoning plans to promote the levels of density optimal for an innovation space: a neighborhood of 5 to 7 story buildings. This type of neighborhood is dense enough for close concentration of people but with buildings low enough for fruitful interactions at a human scale.

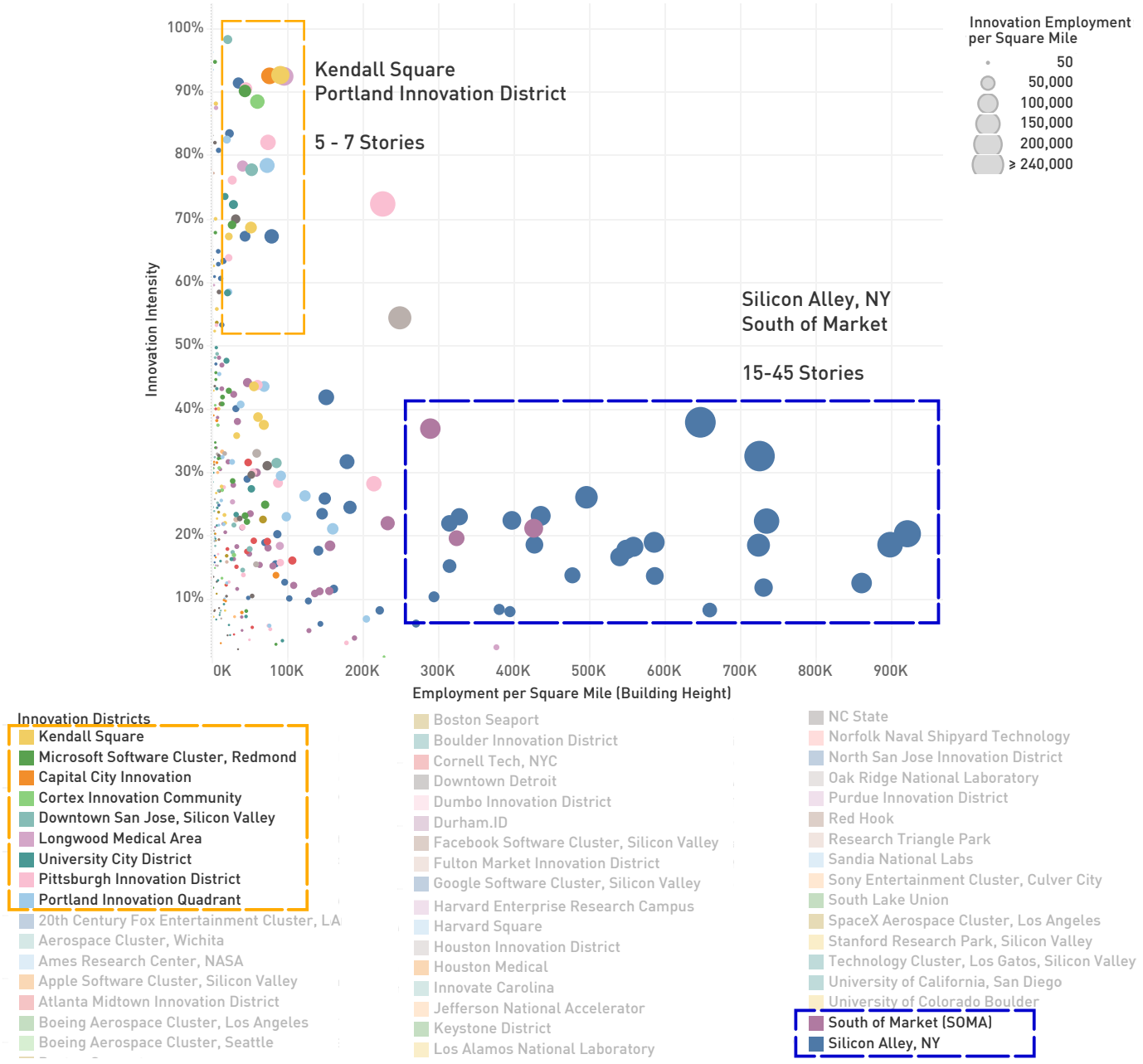


Figure 14. Innovation Intensity vs Building height
Optimal density 5-7 story buildings.

Leveraging Central Location to Stimulate Innovation Intensity

With the advantages of its location, design, and density of talent, Kendall Square became home to many MIT and Harvard innovation initiatives. The neighborhood has subsequently developed into a hub for innovation and startups with global impact.

Distributing Wealth Within Local Communities

Innovation Districts like Kendall Square have a significant impact on the cities in which they are located. Our study of 50 Innovation Districts shows that in comparison to non-innovation neighborhoods, they produce on average a 4x higher intensity of tangible innovations per employee, as well as a 9x higher density of job opportunities, a 15x higher concentration of knowledge-intensive jobs, and 20x more wealth or economic activity per resident. Crucially, for every innovation-focused job the district creates, it generates 4 to 5 additional support jobs. This reduces unemployment and leads to more equitably distributed prosperity. Innovation activity in Kendall Square generated diverse kinds of job opportunities for local community members and for graduating students as they entered the workforce. The recent history of Kendall Square clearly shows the nonlinear benefits of strategically aggregating knowledge-intensive activities in a concentrated area.

3.3 MASSACHUSETTS INSTITUTE OF TECHNOLOGY (MIT), CAMBRIDGE, MASSACHUSETTS

Widely recognized as one of the most influential universities in the world, MIT is a major player in technology transfer. The university's success at transferring innovative ideas to the market is the product of well-designed organizational support systems, which help innovators succeed at every stage of the innovation process.

Historical Background

Each year, MIT affiliates publish around 2000 theses. Only a third of the solutions proposed in these theses, about 700, reach the market as a product or service offering. But the innovation and technology transfer of these 700 theses alone is significant. In fact, if we calculate the economic activity generated by companies founded by MIT alumni since the university's founding in 1861, the dollar value would be equivalent to the GDP of the 9th largest economy in the world.[23] World-changing innovations such as the Internet, satellite navigation, nuclear and renewable energy solutions, medical and pharmaceutical technologies, robotics, artificial intelligence, advanced materials, and more - all developed with contributions from MIT affiliates.

MIT has many advantages that promote innovation. The university itself provides a strong Academic & Research anchor organization for innovation. Dozens of additional universities and research institutions in the greater Boston region enhance the availability and density of talent. MIT's location in Cambridge provides attractive amenities and convenient connections to the surrounding areas. Greater Boston is also home to a significant venture capital industry.

The Problem: Underdeveloped Organizational Structures in Support of Innovation

MIT has long-standing networks of talent and urban design in place, but its network of organization structures in support of innovation are newer to the scene. These organizational structures were introduced gradually and addressed a common underlying need; despite the university's strength in talent and infrastructure, too few ideas were making the transition from concept to product. MIT correctly recognized the need to develop stronger support structures to foster innovation and enable technology transfer.

Insights from MIT

At the heart of MIT's success has been the development of mutually-reinforcing programs to support of innovation. These structures have provided a stable, supportive environment for turning new ideas into marketable solutions. At the core of these programs is the 7-phase approach to innovation at the human level, with support services and benchmarks provided at each phase. This clear, well-supported process brings innovators through the steps of idea creation, data gathering, hypothesis development, prototyping, validation and calibration, the creation of a minimum viable product, and production at scale. Each stage of development presents unique difficulties and risks that the innovator must overcome, and so MIT's innovation environment responds by providing tailored support at each stage with the aim of maximizing the number of successful ventures. Crucial to MIT's success

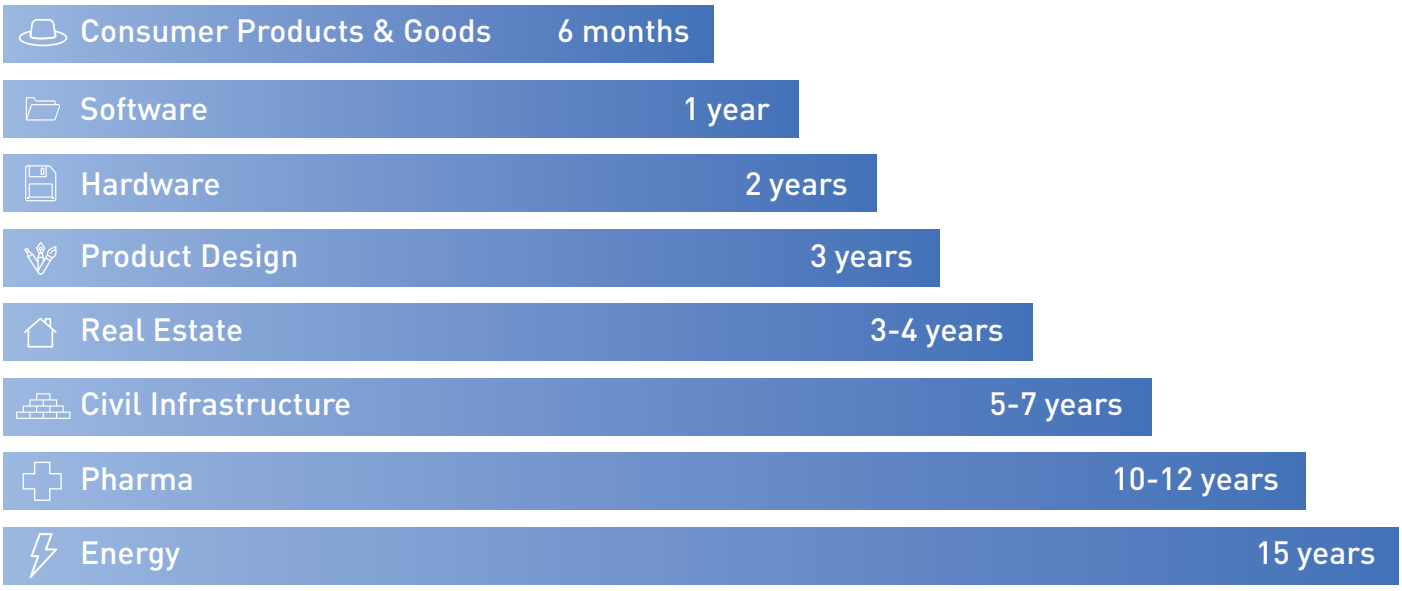
is that it operates with a system of meritocratic incentives, empowering the teams with the strongest ideas to access the resources they need for success.

MIT's organizational support structures in support of innovation operate at all three phases of innovation. At the Research and Academia phase, the university operates a series of Applied Research Labs, including the MIT Computer Science and Artificial Intelligence Lab (CSAIL), MIT.nano, the MIT Center for Transportation and Logistics (CTL), the Center for Energy and Environmental Policy Research, the MIT MediaLab, the Senseable City Lab, the Broad Institute, the Koch Center for Oncology Research, the Water & Food Security Lab, and others. At the Technology Transfer phase, it operates the MIT Industrial Liaison Program (ILP), the MIT Technology Licensing Office, the Lincoln Laboratory, the 100k Entrepreneurship Competition, the MIT Martin Trust Center for Entrepreneurship, the Reap Program, the Legatum Center for Entrepreneurship in Developing Countries, among others. Its programs for the Production phase include a series of incubators and accelerators, such as the DeltaV program, the Engine, and the MIT Venture Mentoring Services program. By flooding the environment with organizational structures in support of innovation, the university greatly improves the chances that new ideas created at MIT will successfully launch as innovative products and services.

> Organizational structures layered on top of intelligent infrastructure can optimize innovation interactions among workers. Unlocking these synergies creates ecosystems that run on virtuous cycles of innovation.

In designing its support structures, MIT needed to be mindful that innovation life cycles take place on varying timescales. For AI and software development, the innovation cycle generally takes 1 year to complete. For hardware and semiconductors, 2 years. Product design takes 2-3 years. Infrastructure innovations take 5-7 years. Pharmaceutical innovations take 10-12 years, and energy systems take as long as 15 years to complete their life cycles.

Figure 16 - Cycle Time of Team Innovation for Selected Industries



4. CONCLUSIONS & TAKEAWAYS

4.1 INSIGHTS AND CONCLUSIONS ON INNOVATION DISTRICT DYNAMICS

The Atlas of Innovation Districts establishes a new benchmark for using scientific urban modeling and human-centered design theory to shed light on issues of income inequality, sustainability, and economic growth. The inaugural version of the Atlas is confined to United States due to the ease of access to complete data sources. This version demonstrates that it is possible to measure innovation spatially and establishes a framework for further development in other regions. Key conclusions include:

1. **Strategic Investment in the early phases of an Innovation District's development will have amplified effects in later phases.** In our framework, this corresponds to supporting the Research & Academia space, promoting innovation intensity, and establishing organizational support systems for the early stages of innovation. The effects of these early interventions will be amplified as innovations move downstream, ultimately leading to virtuous cycles.

2. **The location, context, and urban design features of an Innovation District shape its potential for fruitful human interaction and knowledge-intensive specialization.** The highest-performing Innovation Districts achieve focus through specialization. The history and geography of a region will determine which areas of competitive advantage are most appropriate for specialization. Furthermore, the leading institutions within a district have a strong influence on the kind of work produced there - be they industrial manufacturers, academic institutions, government agencies, or others. Location and urban design characteristics (topology, morphology, entropy, desirability, accessibility) also have a dramatic impact on the ability of high-performing teams to collaborate in an Innovation District, and ultimately, on their ability to contribute to the prosperity of the surrounding community.

3. **Organizational structures can make or break an Innovation District.** The MIT case study demonstrates that strong organizational structures can propel good ideas forward, while a lack of organizational structure can obstruct them. Meritocratic systems are crucial for allowing good ideas to flourish while pushing bad ideas out of development.

4. **Networks of talented people are powerful drivers of an Innovation District's effectiveness.** Innovation is a social activity. Contributions from talented people shape the effectiveness of an Innovation District at every phase of its development. It is crucial to attract, retain, and develop talented people within the community to maximize the many benefits of their collaboration.

5. **Innovation districts generate and amplify positive effects that benefit surrounding districts.** We focus our analysis at the district level to understand how to increase innovation within that contained system. The effects of innovation create jobs and wealth that often originate within the district; however, ensuring that the 3 networks driving this innovation are healthy will ensure that opportunities spread to the surrounding areas that interact with the Innovation District.

4.2 FUTURE OPPORTUNITIES

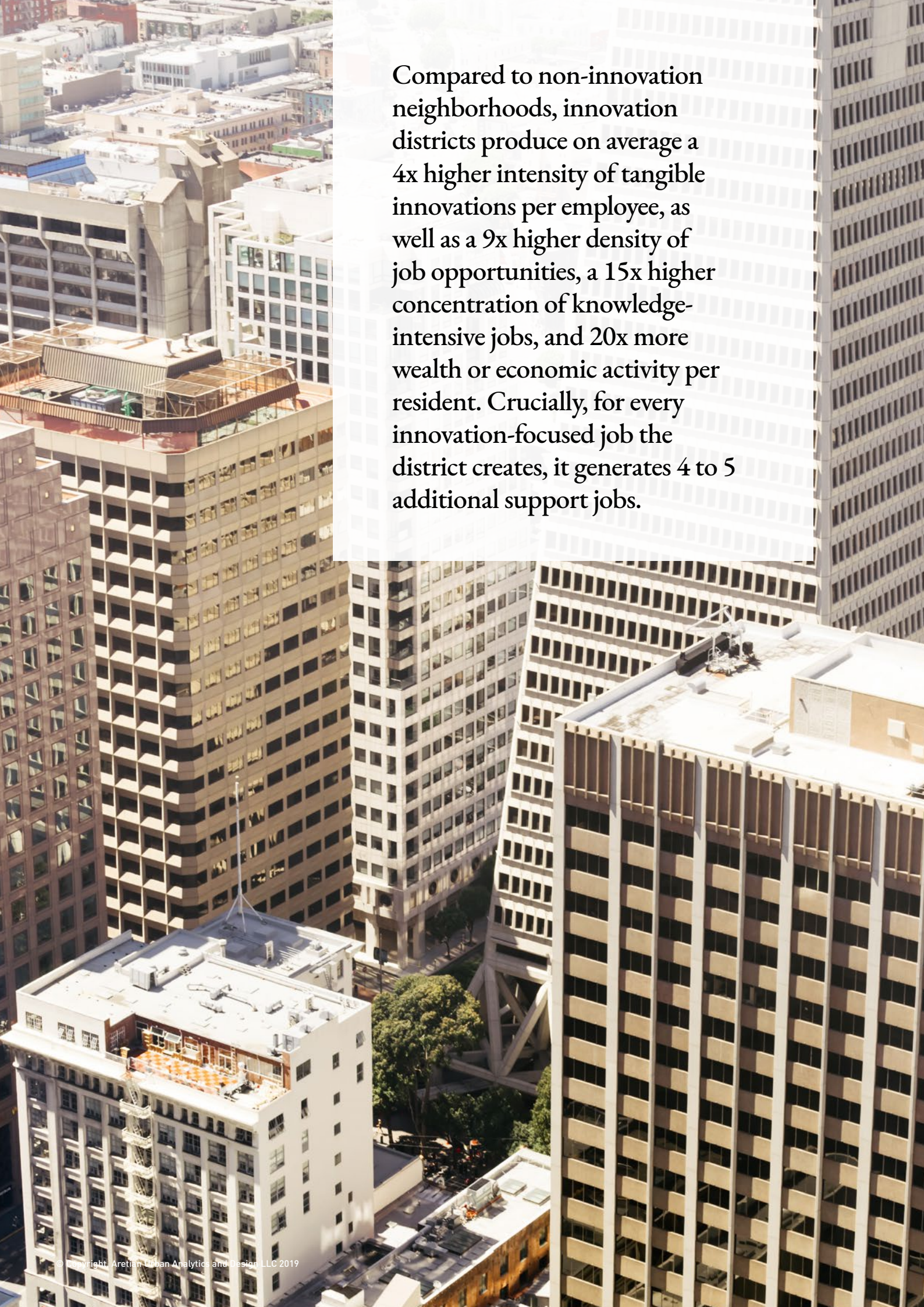
1. **Our new computational methods can uncover many ways to improve our societies at 3 major scales: the metropolitan scale, the district scale, and the human or organizational scale.** The power of the methodology comes from the unique insights that are only revealed after studying a problem across these different scales. Furthermore, this methodology has many potential further applications. It can be used to generate new perspectives on societal challenges beyond economic development, such as studying air quality, planning mobility solutions that strengthen public transportation networks, and exploring strategies to improve access to affordable housing.

2. **Comparing the internal dynamics of cities across regions and countries can shed light on the design principles that support sustainable cities where humans can thrive.** Designing a city for the benefit of its people is a multigenerational experiment with unclear outcomes. Analyzing the cities that are thriving as well as the ones that are close to collapse can reveal patterns and factors that make a city robust or fragile through the test of time.

A deeper understanding of the human ecosystem, now accessible through advanced data science, has implications for decision-makers in a variety of fields. We believe that these new methodologies will provide novel insights to policy makers, urban planners, real estate developers, mobility businesses, industry leaders, and more.

- **Policymakers:** How should I craft my development plans to specialize and capture an economic competitive advantage? What incentives will create an optimal environment for attracting, retaining, and cultivating innovators? What structures and best practices can I implement to maximize distributed prosperity through innovation?
- **Urban planners and designers:** What urban design typologies should I deploy for each specific city to generate easily accessible, attractive, functional, resource-efficient urban environments? What design choices can I make to facilitate fruitful social interaction and induce healthier habits among citizens?
- **Real estate developers:** What kinds of developments does a community need to support a healthy innovation ecosystem? What infrastructure improvements would strengthen the attractiveness of this neighborhood?
- **Mobility businesses:** What latent potential can I unlock by serving an unmet transportation need? How can I make this neighborhood more accessible by different modalities? How will patterns of movement shift as the district matures?

3. **Who is responsible:** Innovation is not an inscrutable, mysterious process beyond our understanding. The truth is quite the opposite: the ability to promote or obstruct innovation is within our power to understand and control. Effective innovation environments are the result of complex relationships between the networks of urban design, talent, and organizational structures. The complexity of these environments may be daunting at first, but a rigorous, data-driven approach can reveal powerful insights. With careful design, coordination, and management, innovation is within reach for communities around the world - and as a result, so is distributed economic prosperity.



Compared to non-innovation neighborhoods, innovation districts produce on average a 4x higher intensity of tangible innovations per employee, as well as a 9x higher density of job opportunities, a 15x higher concentration of knowledge-intensive jobs, and 20x more wealth or economic activity per resident. Crucially, for every innovation-focused job the district creates, it generates 4 to 5 additional support jobs.

5. INNOVATION METRICS

5.1 INNOVATION INTENSITY

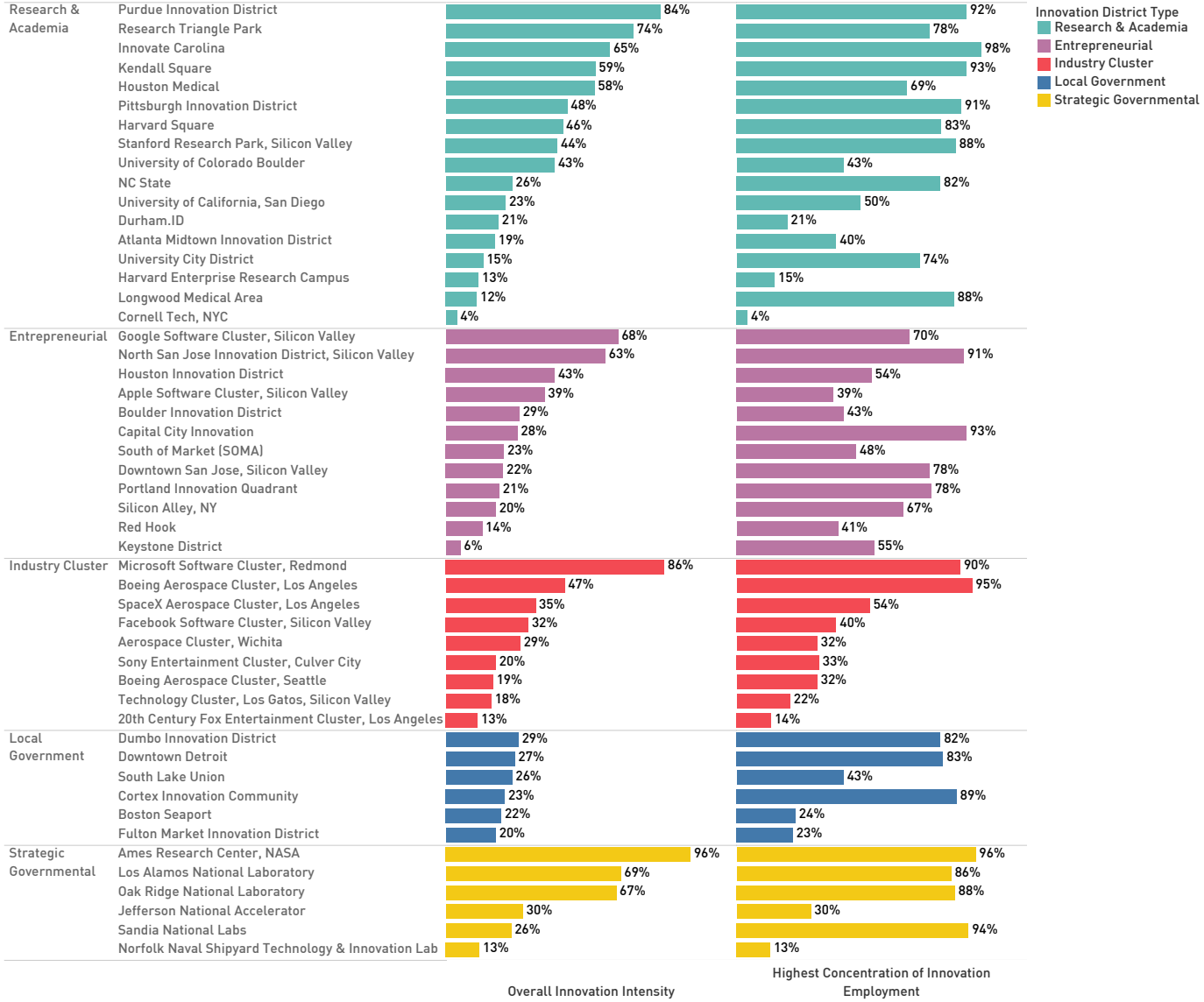


Figure 17. Innovation Intensity. The overall Innovation Intensity KPI describes the compounded percentage of knowledge-intensive jobs versus total employment in an Innovation District. The highest concentration Innovation Intensity is a complementary KPI that describes the peak percentage of knowledge-intensive jobs concentrated at the core US Census block group of each Innovation District.

5.2 INNOVATION PERFORMANCE: SALES FROM INNOVATION

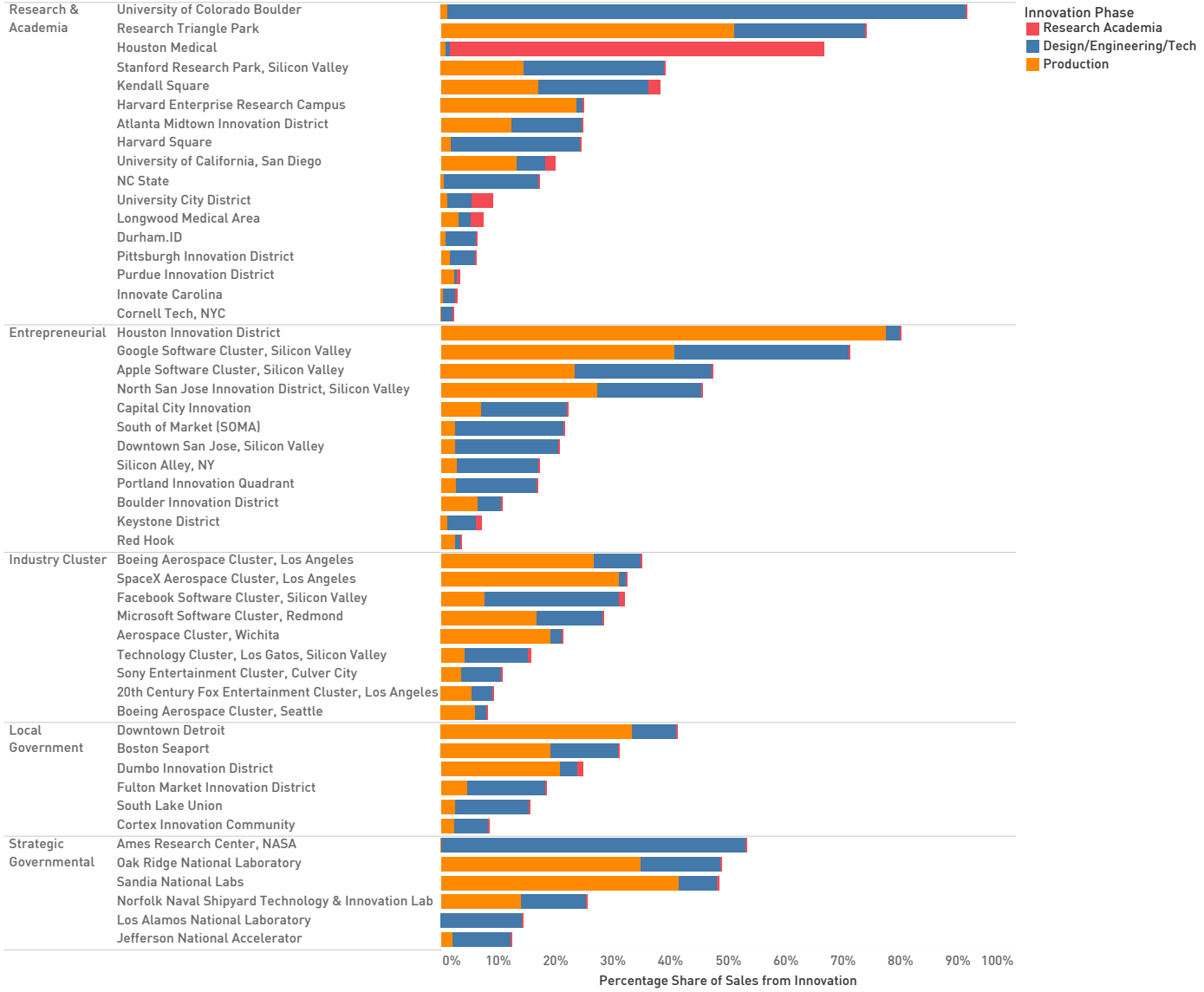


Figure 18. Innovation Performance: Sales from Innovation The Innovation Performance KPI describes the fraction of economic throughput of the district generated by innovation-related solutions (patents, new products, new services, new processes, R&D, and scientific publications,) broken down by each of the three innovation phases: Research and Academia, Technology Transfer, and High Value-Added Production.

5.3 INNOVATION IMPACT: EMPLOYMENT GENERATION

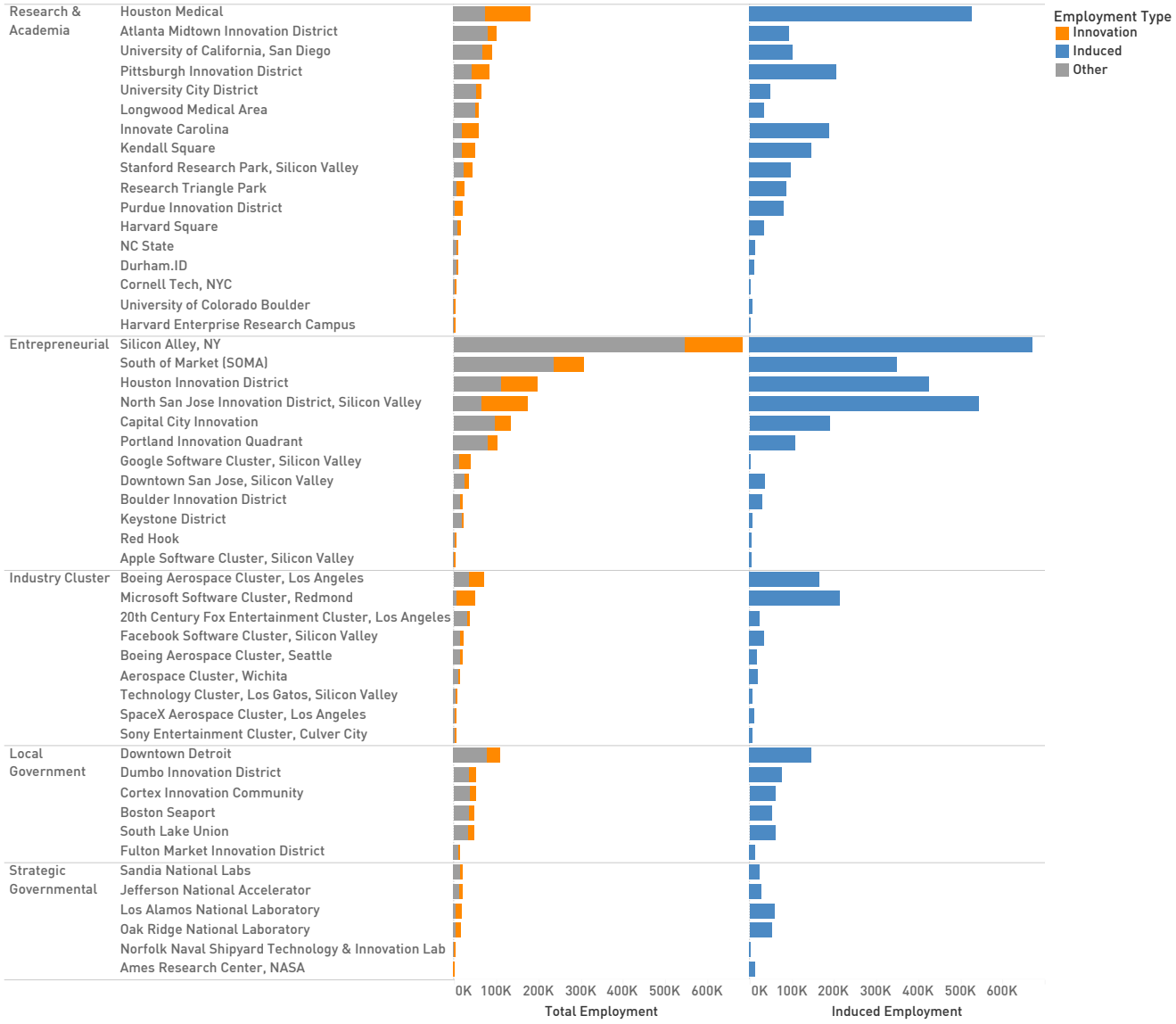


Figure 19. Innovation Impact: Employment Generation The Innovation Impact - Employment Generation KPI describes the nonlinear societal benefits of the geographic aggregation of knowledge-intensive activities in terms of direct employment within the district and an estimate of induced employment generation for the broader community.

5.4 INNOVATION IMPACT: SALES PER EMPLOYEE, SALES PER RESIDENT

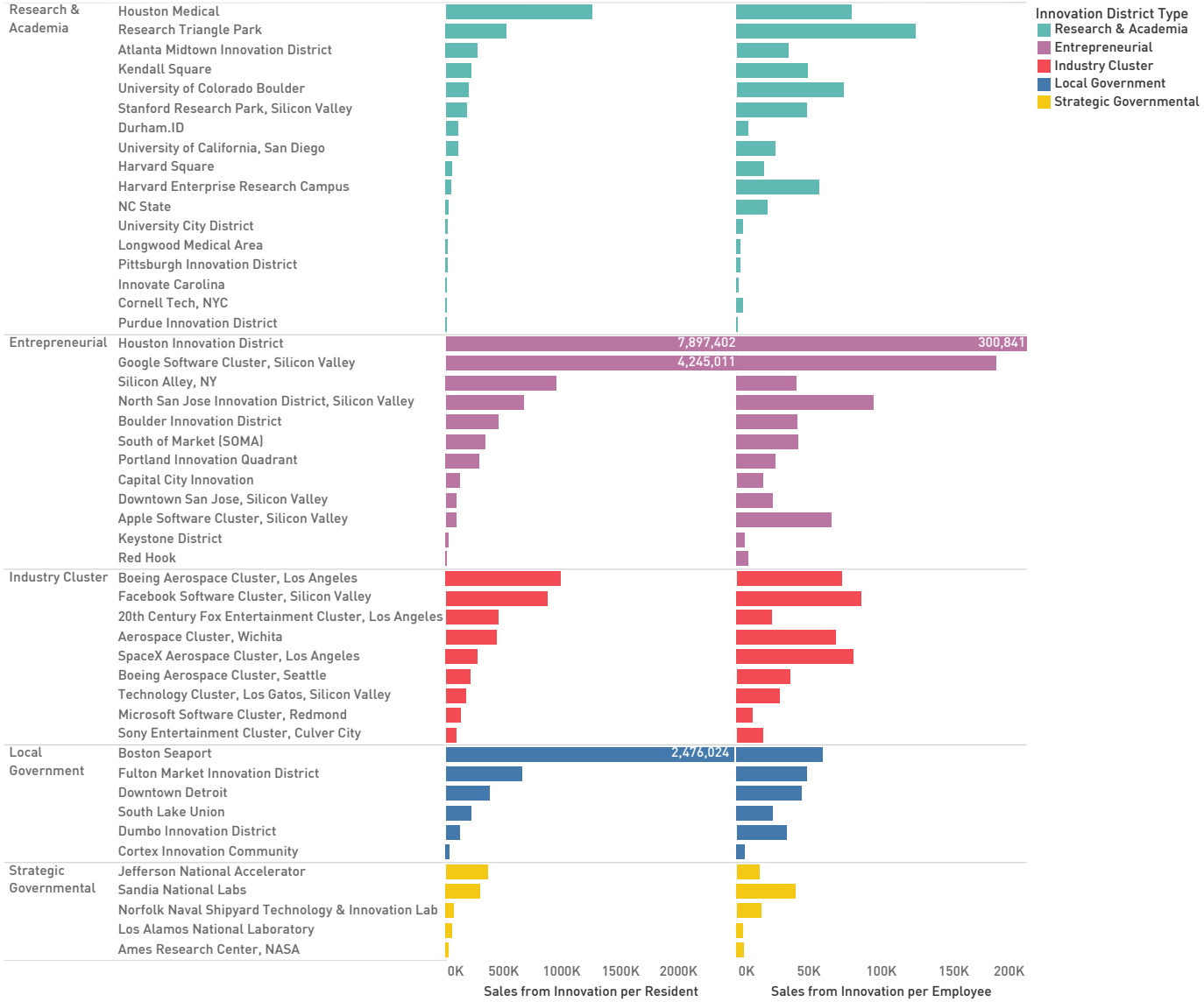


Figure 20. Innovation Impact: Sales per Employee, Sales per Resident The Innovation Impact - Sales per Employee and Resident KPI describes the nonlinear societal benefits of the geographic aggregation of knowledge-intensive activities in terms of economic throughput per employee, as well as per local resident.

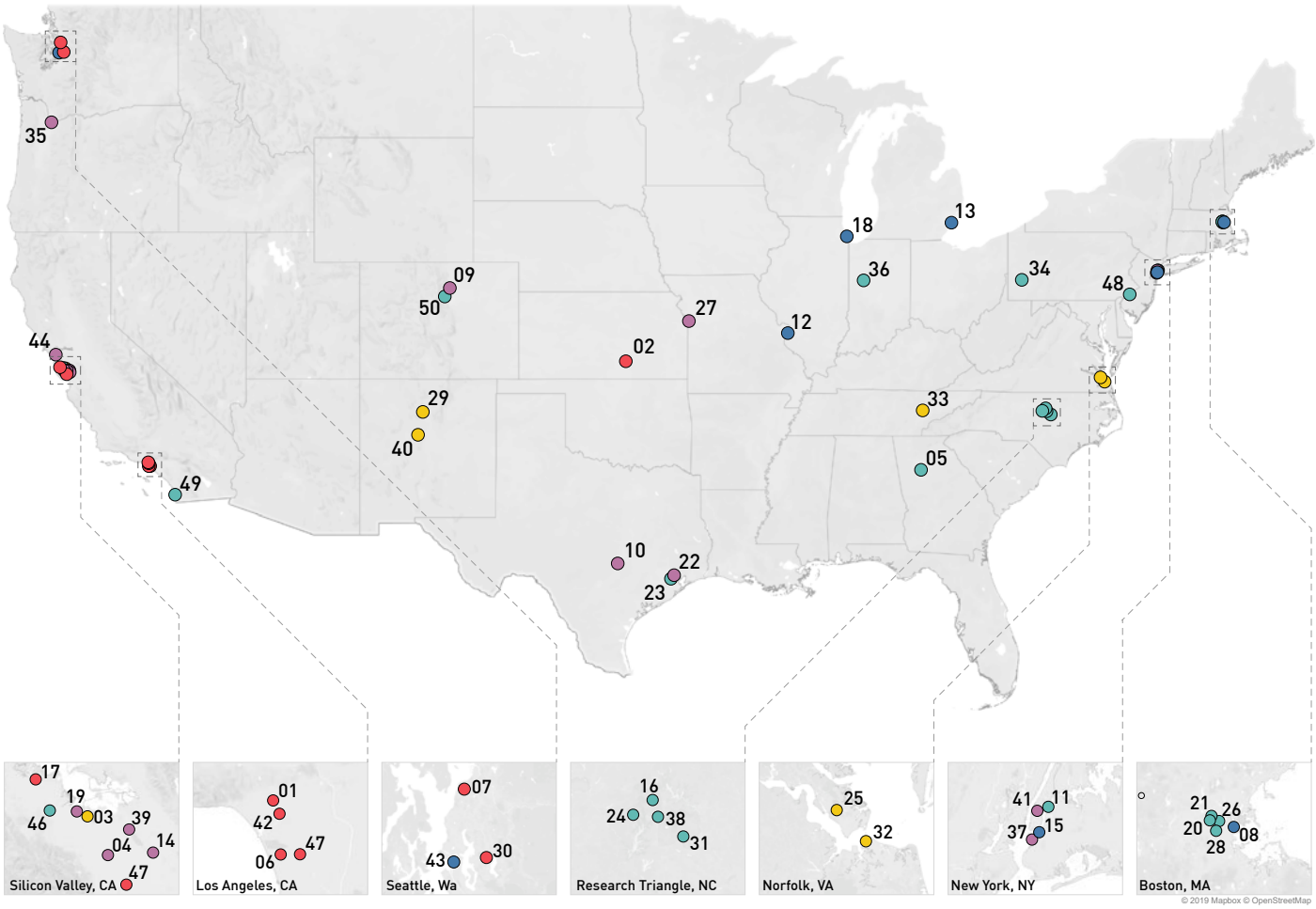
This analytical method has the potential to expand into a wide array of applications, from developing Innovation Districts to improving public health. Where will these opportunities take us?

6. 25 OF THE TOP 50 INNOVATION DISTRICTS

Figure 21. The Atlas of Innovation Districts

This report presents an overview of 25 prominent Innovation Districts, including their defining characteristics, key performance indicators, and context for their development over time. The full Atlas of Innovation Districts provides this information about an additional 25 districts as well. The full list of districts is included below and can be explored though an interactive map at **aretian.com/atlas**.

In this first release of the Atlas of Innovation Districts, Aretian has developed a new framework and set of metrics for analyzing innovative spaces. In later releases, we plan to update and refine our understanding of the geographic boundaries of the current districts and to expand the geographic territory covered in the Atlas beyond the United States. We have done our best to represent the districts as accurately as possible and we look forward to working with representatives from these districts in the future to build increasingly precise and accurate models of these spaces.



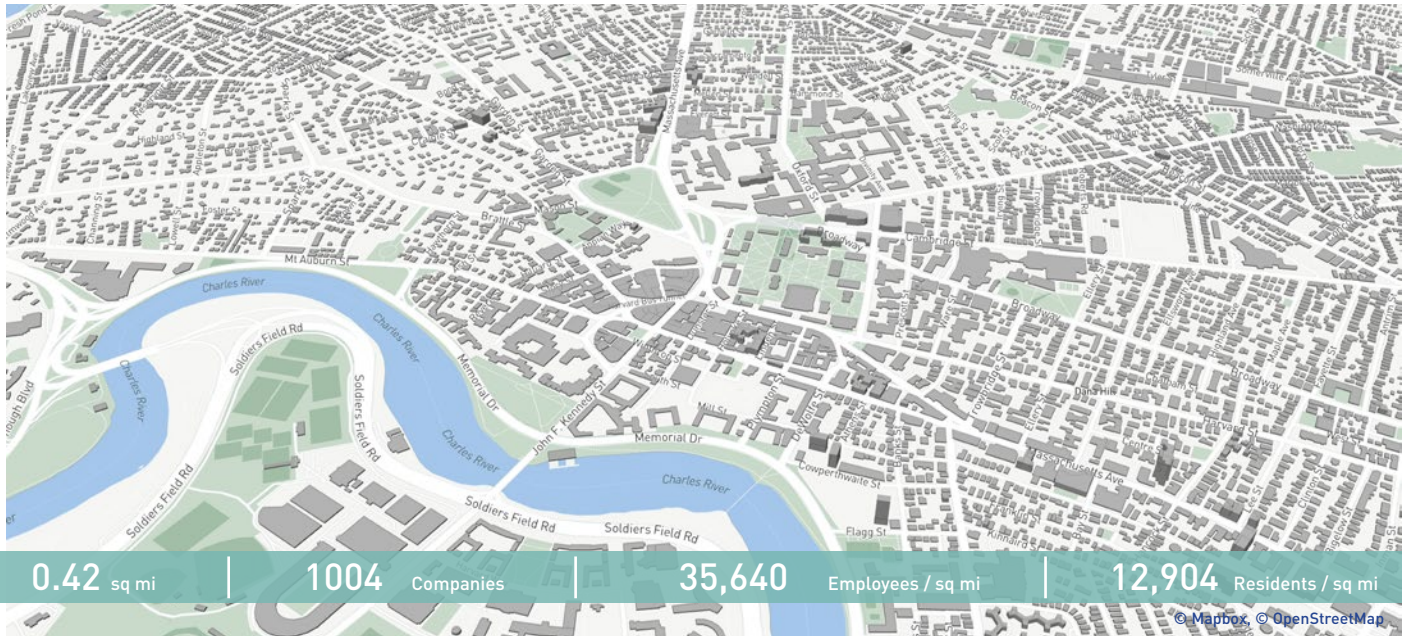
01 20th Century Fox Entertainment Cluster, LA, CA
02 Aerospace Cluster, Wichita, KS
03 Ames Research Center, NASA, CA
04 Apple Software Cluster, Silicon Valley, CA
05 Atlanta Midtown Innovation District, GA
06 Boeing Aerospace Cluster, Los Angeles, CA
07 Boeing Aerospace Cluster, Seattle, WA
08 Boston Seaport, MA
09 Boulder Innovation District, CO
10 Capital City Innovation, Austin, TX
11 Cornell Tech, NYC, NY
12 Cortex Innovation Community, MO
13 Downtown Detroit, MI
14 Downtown San Jose, Silicon Valley, CA
15 Dumbo Innovation District, NY
16 Durham.ID, NC
17 Facebook Software Cluster, Silicon Valley, CA
18 Fulton Market Innovation District, IL
19 Google Software Cluster, Silicon Valley, CA
20 Harvard Enterprise Research Campus, MA
21 Harvard Square, MA
22 Houston Innovation District, TX
23 Houston Medical, TX
24 Innovate Carolina, NC
25 Jefferson National Accelerator, VA
26 Kendall Square, MA
27 Keystone District, KS, MO
28 Longwood Medical Area, MA
29 Los Alamos National Laboratory, NM
30 Microsoft Software Cluster, Redmond, WA
31 NC State, NC
32 Norfolk Naval Shipyard Tech. & Inno. Lab, VA
33 Oak Ridge National Laboratory, TN
34 Pittsburgh Innovation District, PA
35 Portland Innovation Quadrant, OR
36 Purdue Innovation District, IN
37 Red Hook, NY
38 Research Triangle Park, NC
39 San Jose Boomerang, Silicon Valley, CA
40 Sandia National Labs, NM
41 Silicon Alley, NY
42 Sony Entertainment Cluster, Culver City, CA
43 South Lake Union, WA
44 South of Market (SOMA), CA
45 SpaceX Aerospace Cluster, LA, CA
46 Stanford Research Park, Silicon Valley, CA
47 Tech. Cluster, Los Gatos, Silicon Valley,CA
48 University City District, Philadelphia, PA
49 University of California, San Diego, CA
50 University of Colorado Boulder, CO

Entrepreneurial (12)
Industry Cluster (9)
Local Government (6)
Research & Academia (17)
Strategic Governmental (6)

Harvard Square

Cambridge, MA | 42.37309, -71.11894

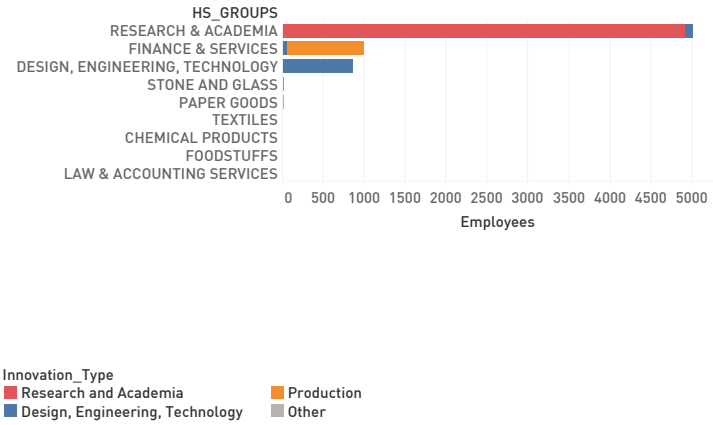
ID Type: Research & Academia



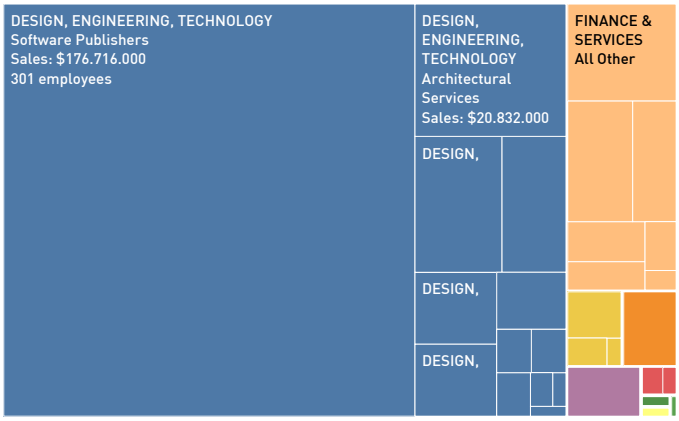
INNOVATION INTESITY	14,981 Employees	6,884 Employees in Innovation	82.5% Max (%) of knowledge-intensive job concentration	46.0% Innovation Intensity (%) innovative employment	32.9% Research & Academia Innovation Focus
INNOVATION PERFORMANCE	24.3% Percent of sales from innovation	3.5% Percent of sales from R&D (estimate)	44.9% Percent of sales from patents (estimate)	11.9% Percent of sales from new products (estimate)	36.1% Percent of sales from new services (estimate)
INNOVATION IMPACT	$215,563 Total Sales from Innovation per resident ($)	$78,046 Total Sales from Innovation per employee ($)	3.7% Unemployment Rate (%)	34,420 Induced Jobs (additional support jobs created in the economy)	0.62 Meritocracy Index: Avg Household Income/Avg Net Worth

The Harvard Square Innovation District, anchored on the university with which it shares a name, is home to a large number of research centers, and a variety of ventures in software, medical technology, and communications. Harvard has also laid the groundwork for an extensive new Innovation District on its Allston Campus, located adjacent to Harvard Business School and the Harvard School of Engineering and Applied Sciences. The new district is in the early stages of development.

Employment: Phases of Innovation



Sales: Industry Breakdown



Houston Medical

Houston, TX | 29.70394, -95.39777

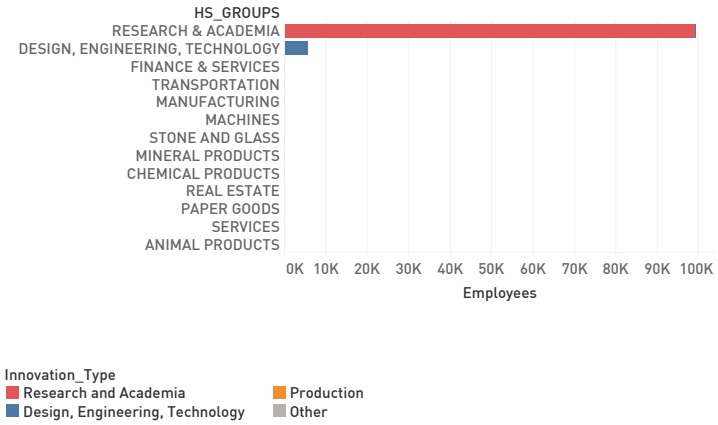
ID Type: Research & Academia

4.06 sq mi	1,887 Companies	44,375 Employees / sq mi	2,807 Residents / sq mi

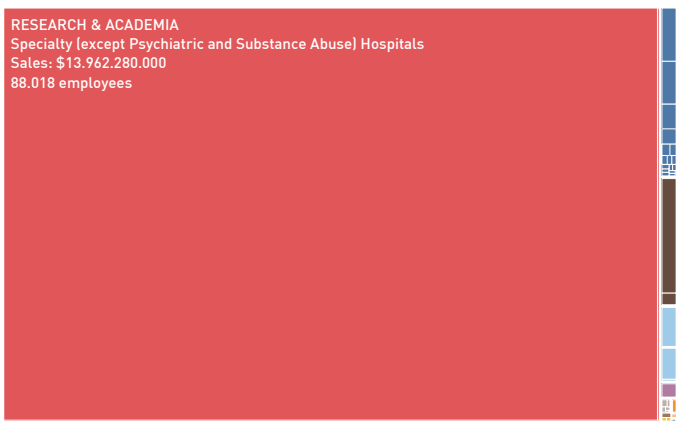
INNOVATION INTESITY	180,373 Employees	105,245 Employees in Innovation	68.6% Max (%) of knowledge-intensive job concentration	58.4% Innovation Intensity (%) innovative employment	54.9% Research & Academia Innovation Focus
INNOVATION PERFORMANCE	66.6% Percent of sales from innovation	0.7% Percent of sales from R&D (estimate)	34.0% Percent of sales from patents (estimate)	7.2% Percent of sales from new products (estimate)	24.7% Percent of sales from new services (estimate)
INNOVATION IMPACT	$1,883,462 Total Sales from Innovation per resident ($)	$119,133 Total Sales from Innovation per employee ($)	4.4% Unemployment Rate (%)	526,225 Induced Jobs (additional support jobs created in the economy)	0.18 Meritocracy Index: Avg Household Income/Avg Net Worth

With the anchor institutions of Texas Medical Center and Rice University, Houston's innovation ecosystem is one of the world's most productive. The presence of Texas Medical Center in particular generates large quantity of innovation-intensive employment in the region, with a particular focus on cutting-edge medical research. The city's innovation corridor is supported by a unique nonprofit institution - Houston Exponential - which serves, organizes, and champions innovative growth in the region.

Employment: Phases of Innovation



Sales: Industry Breakdown



Kendall Square

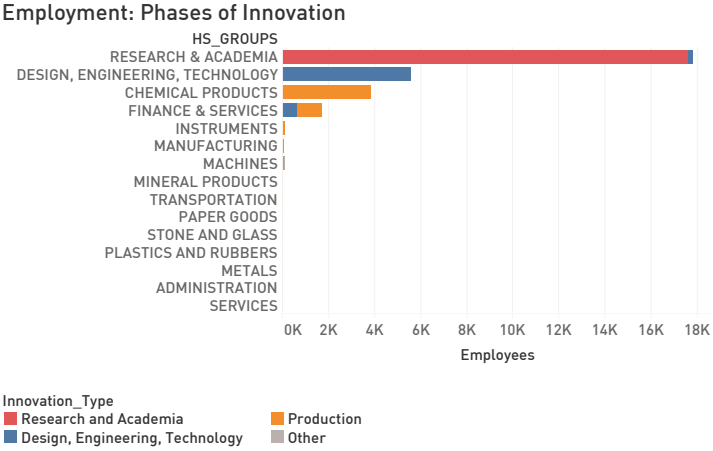
Cambridge, MA | 42.35959, -71.09212

ID Type: Research & Academia

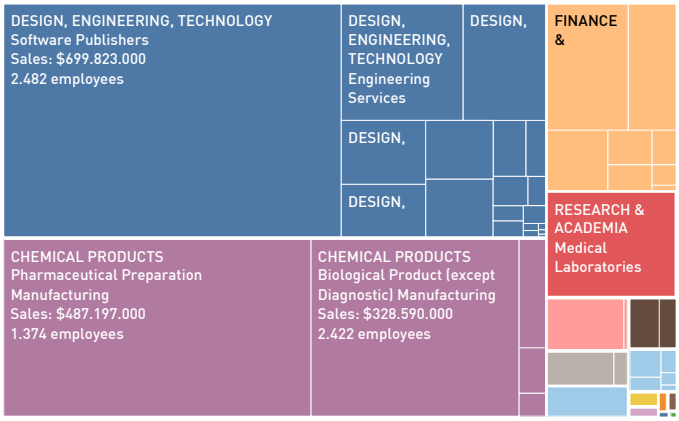
INNOVATION INTESITY	49,834 Employees	29,349 Employees in Innovation	92.8% Max (%) of knowledge-intensive job concentration	58.9% Innovation Intensity (%) innovative employment	35.4% Research & Academia Innovation Focus
INNOVATION PERFORMANCE	38.2% Percent of sales from innovation	3.1% Percent of sales from R&D (estimate)	47.1% Percent of sales from patents (estimate)	14.1% Percent of sales from new products (estimate)	35.5% Percent of sales from new services (estimate)
INNOVATION IMPACT	$575,836 Total Sales from Innovation per resident ($)	$128,758 Total Sales from Innovation per employee ($)	4.9% Unemployment Rate (%)	146,745 Induced Jobs (additional support jobs created in the economy)	0.42 Meritocracy Index: Avg Household Income/Avg Net Worth

Formerly an undeveloped industrial neighborhood, President Kennedy intended to build NASA's headquarters in Kendall Square. When his successor, President Johnson, moved the NASA campus to Houston, Kendall Square was left abandoned until the 1980s, when the square's location near downtown Boston and the MIT and Harvard campuses began to attract development. Concerted investments since that time have turned Kendall Square into an innovation hub of global importance, with a remarkably high concentration of startups and quality of innovation across a wide range of industries.

Employment: Phases of Innovation



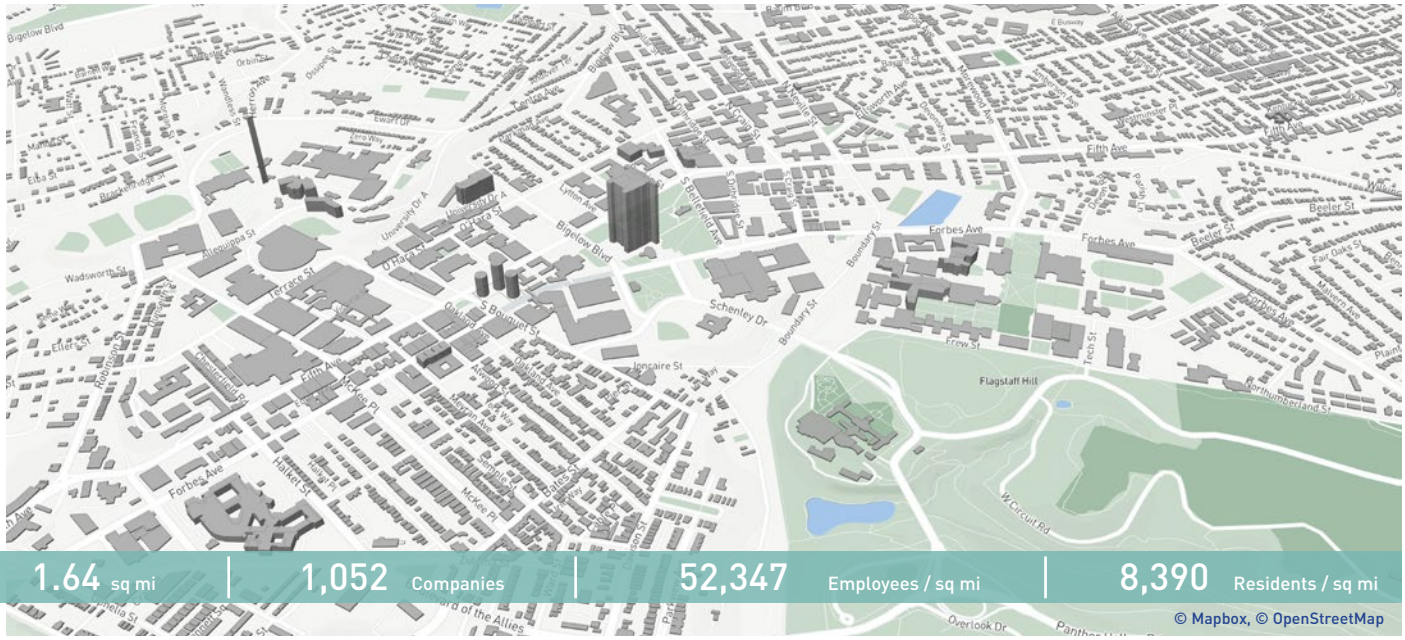
Sales: Industry Breakdown



Pittsburgh Innovation District

Pittsburg, PA | 40.44201, -79.95129

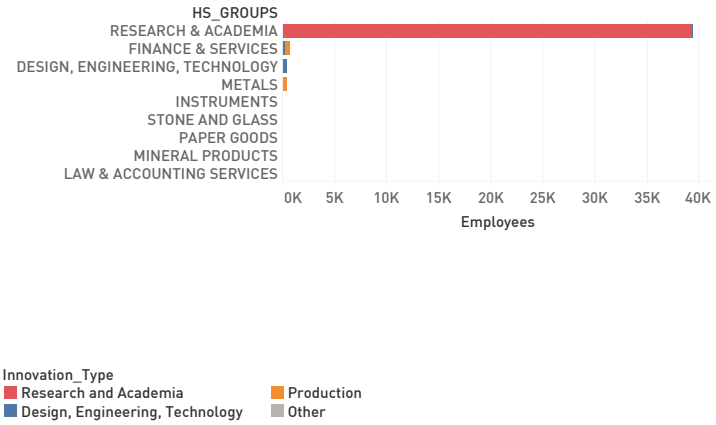
ID Type: Research & Academia



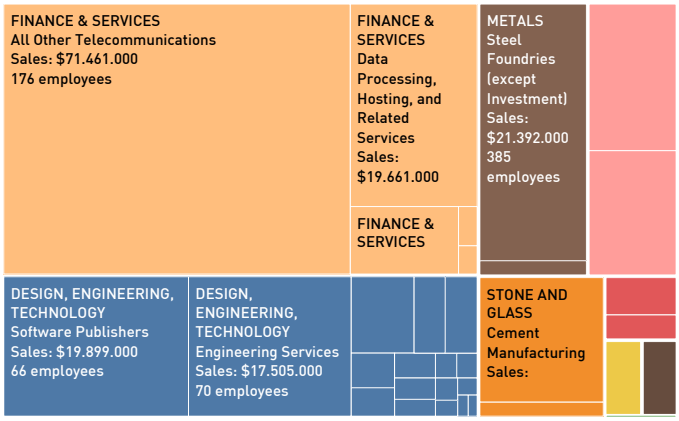
INNOVATION INTESITY	85,603 Employees	40,999 Employees in Innovation	90.6% Max (%) of knowledge-intensive job concentration	47.9% Innovation Intensity (%) innovative employment	45.9% Research & Academia Innovation Focus
INNOVATION PERFORMANCE	6.0% Percent of sales from innovation	2.3% Percent of sales from R&D (estimate)	38.0% Percent of sales from patents (estimate)	10.2% Percent of sales from new products (estimate)	30.1% Percent of sales from new services (estimate)
INNOVATION IMPACT	$239,205 Total Sales from Innovation per resident ($)	$38,339 Total Sales from Innovation per employee ($)	8,5% Unemployment Rate (%)	204,995 Induced Jobs (additional support jobs created in the economy)	0.40 Meritocracy Index: Avg Household Income/Avg Net Worth

The Pittsburgh Innovation District has its roots in the city's industrial past as a center of the US steel manufacturing industry. With deep industrial knowhow and strong academic anchor institutions in Carnegie Mellon University and the University of Pittsburgh, Pittsburgh has built itself into a leading innovator in robotics and hub for major technology companies. Following the collapse of the steel industry in the late 1970s and early 1980s, Pittsburgh's economic resurgence can be credited in part to the city's systematic efforts to support an innovation ecosystem.

Employment: Phases of Innovation



Sales: Industry Breakdown



Purdue Innovation District

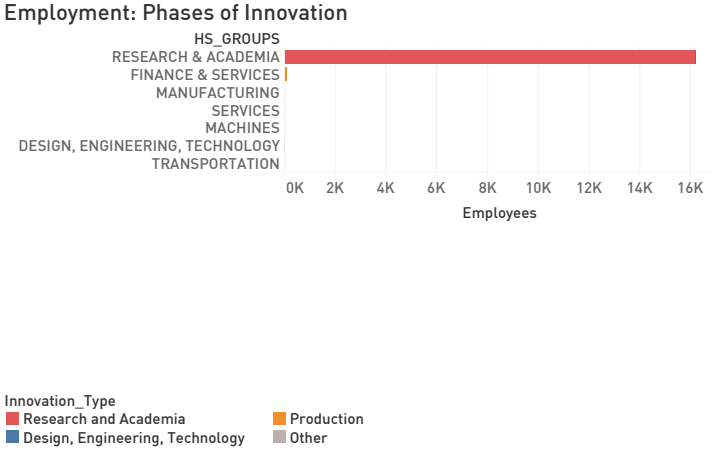
West Lafayette, IN | 40.42427, -86.91628

ID Type: Research & Academia

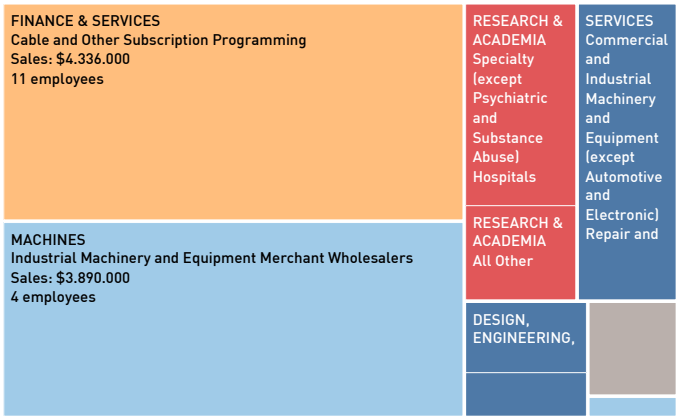
INNOVATION INTESITY	19,309 Employees	16,290 Employees in Innovation	92.5% Max (%) of knowledge-intensive job concentration	84.4% Innovation Intensity (%) innovative employment	83.7% Research & Academia Innovation Focus
INNOVATION PERFORMANCE	3.3% Percent of sales from innovation	1.2% Percent of sales from R&D (estimate)	20.3% Percent of sales from patents (estimate)	4.0% Percent of sales from new products (estimate)	14.0% Percent of sales from new services (estimate)
INNOVATION IMPACT	$15,197 Total Sales from Innovation per resident ($)	$10,732 Total Sales from Innovation per employee ($)	4.7% Unemployment Rate (%)	81,450 Induced Jobs (additional support jobs created in the economy)	2.04 Meritocracy Index: Avg Household Income/Avg Net Worth

The Purdue Research Park and Discovery Park District at Purdue University form a major multidisciplinary research area with numerous centers and institutes. After its first buildings opened in 2004, it took the district only 10 years to surpass a $1 billion milestone in research investments and impact. Its focus areas include bioscience, nanotechnology, quantum science and engineering, global health, sustainability, security and defense, and computer science, among others.

Employment: Phases of Innovation



Sales: Industry Breakdown



Research Triangle Park

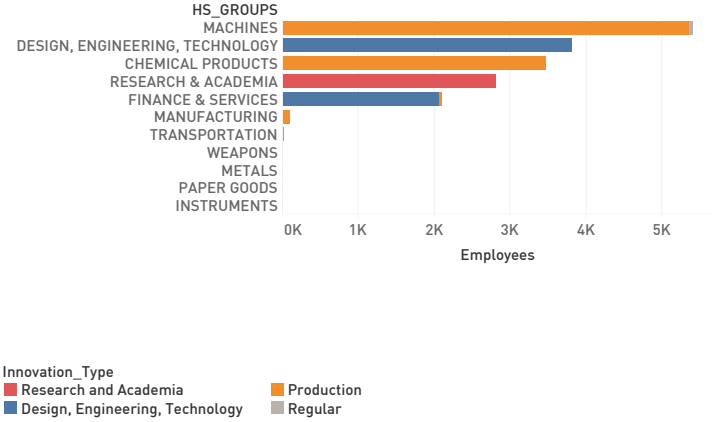
Durham, Morrisville, NC | 35.89832, -78.86202

ID Type: Research & Academia

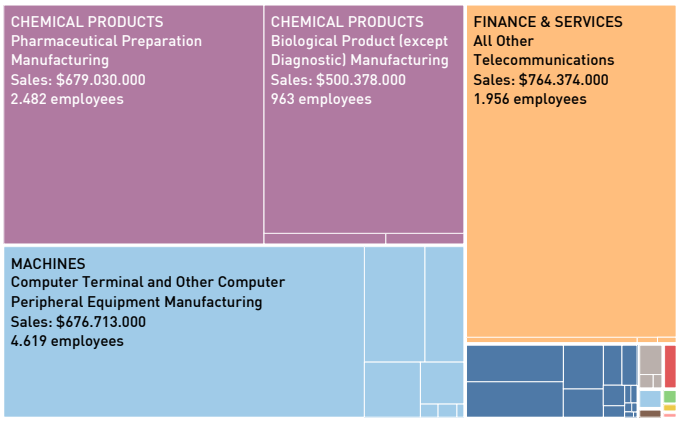
INNOVATION INTESITY	23,966 Employees	17,713 Employees in Innovation	77.9% Max (%) of knowledge-intensive job concentration	73.9% Innovation Intensity (%) innovative employment	37.7% Production Innovation Focus
INNOVATION PERFORMANCE	74.1% Percent of sales from innovation	5.2% Percent of sales from R&D (estimate)	82.3% Percent of sales from patents (estimate)	23.8% Percent of sales from new products (estimate)	53.6% Percent of sales from new services (estimate)
INNOVATION IMPACT	$702,309 Total Sales from Innovation per resident ($)	$166,654 Total Sales from Innovation per employee ($)	18.0% Unemployment Rate (%)	88,565 Induced Jobs (additional support jobs created in the economy)	0.33 Meritocracy Index: Avg Household Income/Avg Net Worth

Following WWII, North Carolina's economy hung in the balance; it could no longer depend on traditional industries like agriculture and textiles as a foundation for economic growth. In response, academics at North Carolina State University, Duke, and Chapel Hill created a centrally-located research park to increase collaboration and innovation in the area. The resulting Research Triangle Park has since become one of the most prominent high-tech research and development centers in the US and a recognized leader in life sciences research.

Employment: Phases of Innovation



Sales: Industry Breakdown



Boulder Innovation District

Boulder, CO | 40.03511, -105.22078

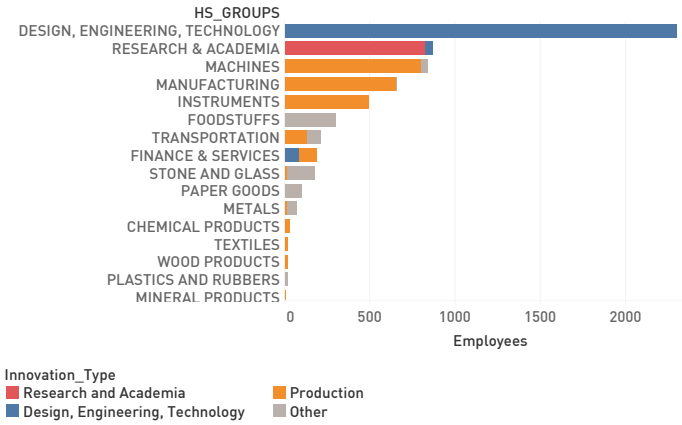
ID Type: Entrepreneurial

9.10 sq mi	1,200 Companies	2,250 Employees / sq mi	209 Residents / sq mi

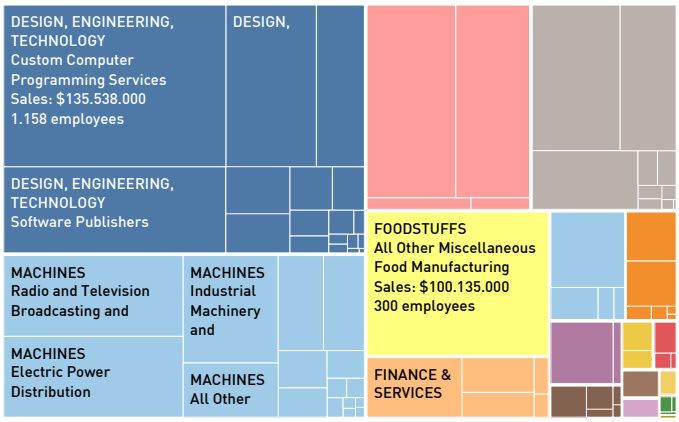
INNOVATION INTESITY	20,467 Employees	5,908 Employees in Innovation	43.2% Max (%) of knowledge-intensive job concentration	28.9% Innovation Intensity (%) innovative employment	12.9% Production Innovation Focus
INNOVATION PERFORMANCE	9.4% Percent of sales from innovation	1.7% Percent of sales from R&D (estimate)	68.4% Percent of sales from patents (estimate)	14.8% Percent of sales from new products (estimate)	50.8% Percent of sales from new services (estimate)
INNOVATION IMPACT	$4,818,660 Total Sales from Innovation per resident ($)	$447,092 Total Sales from Innovation per employee ($)	3.8% Unemployment Rate (%)	29,540 Induced Jobs (additional support jobs created in the economy)	0.10 Meritocracy Index: Avg Household Income/Avg Net Worth

Boulder has received considerable attention in recent years as a center for entrepreneurship, with a high density of technology startups and a consistently strong output of patents per capita. The city is home to a series of interconnected innovation clusters working in the areas of aerospace, bioscience, cleantech, software development, natural products, and outdoor recreation. These startups also benefit from the technology transfer program at the University of Colorado and a dense network of entrepreneurial support organizations and accelerators.

Employment: Phases of Innovation



Sales: Industry Breakdown



Google Software Cluster, Silicon Valley

East Palo Alto, Moffett Field, CA | 37.42156, -122.08441

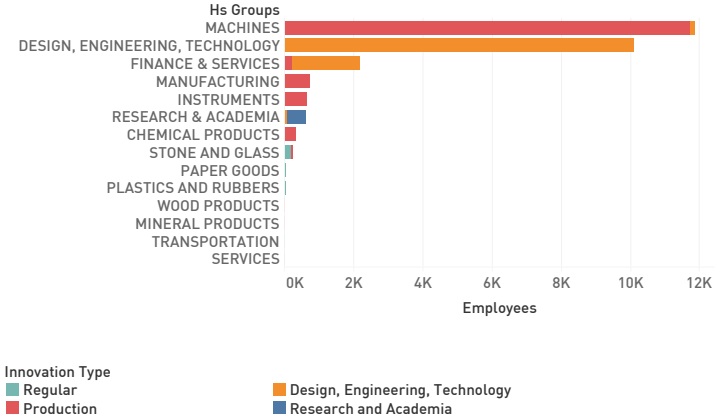
ID Type: Entrepreneurial

31.03 sq mi	1,276 Companies	1,264 Employees / sq mi	53 Residents / sq mi

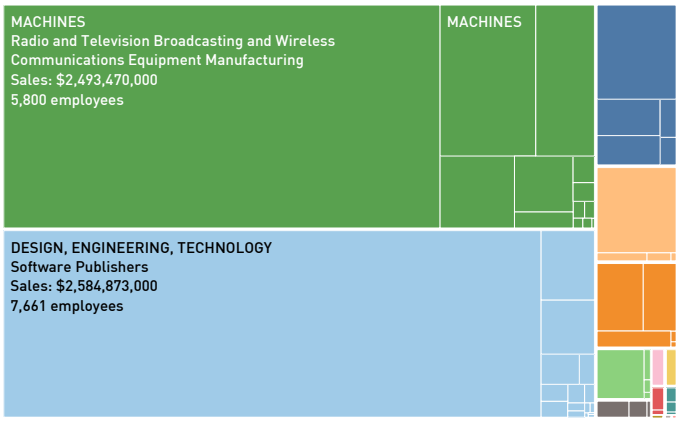
INNOVATION INTESITY	39,208 Employees	26,509 Employees in Innovation	69.6% Max (%) of knowledge-intensive job concentration	67.6% Innovation Intensity (%) innovative employment	35.1% Production Innovation Focus
INNOVATION PERFORMANCE	71.0% Percent of sales from innovation	6.5% Percent of sales from R&D (estimate)	78.0% Percent of sales from patents (estimate)	39.9% Percent of sales from new products (estimate)	58.7% Percent of sales from new services (estimate)
INNOVATION IMPACT	$5,976,93 Total Sales from Innovation per resident ($)	$252,408 Total Sales from Innovation per employee ($)	5.4% Unemployment Rate (%)	132,545 Induced Jobs (additional support jobs created in the economy)	0.23 Meritocracy Index: Avg Household Income/Avg Net Worth

In 2013, San Francisco overtook Silicon Valley for most venture capital funding. This flood of investment is due to the key resources present in their ecosystem. Proximity to academic institutions like Berkeley attracts strong talent to the area. Google has invested heavily to nurture these entrepreneurs through mentorship, education, and community events hosted from their Launchpad accelerator. Their commitment to maintain a thriving ecosystem has even led to their 2019 announcement that they would invest $1 billion to develop new residential housing for the community.

Employment: Phases of Innovation



Sales: Industry Breakdown



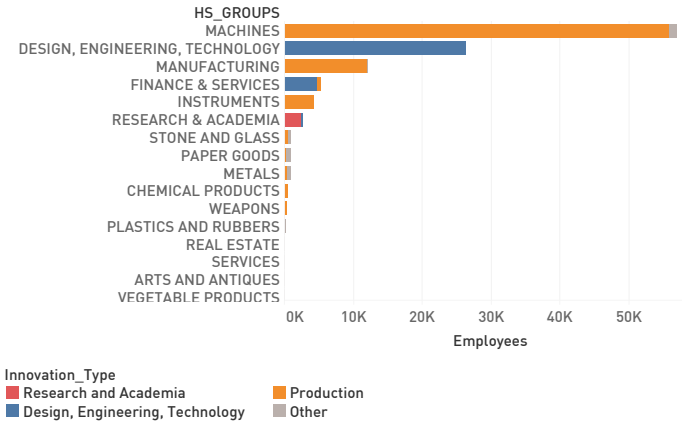
San Jose Boomerang, Silicon Valley

San Jose, Santa Clara, Sunnyvale, Milpitas, CA | 37.38411, -121.94675 ID Type: Entrepreneurial

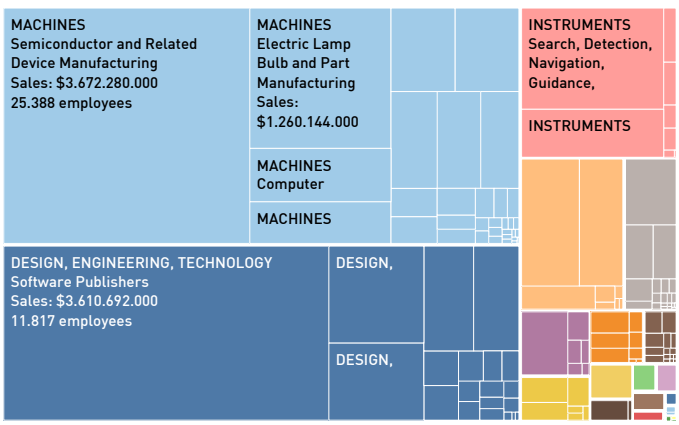
INNOVATION INTESITY	173,434 Employees	108,748 Employees in Innovation	91.5% Max (%) of knowledge-intensive job concentration	62.7% Innovation Intensity (%) innovative employment	43.2% Production Innovation Focus
INNOVATION PERFORMANCE	45.4% Percent of sales from innovation	4.1% Percent of sales from R&D (estimate)	66.4% Percent of sales from patents (estimate)	21.0% Percent of sales from new products (estimate)	48.6% Percent of sales from new services (estimate)
INNOVATION IMPACT	$1,482,844 Total Sales from Innovation per resident ($)	$208,233 Total Sales from Innovation per employee ($)	4.2% Unemployment Rate (%)	543,740 Induced Jobs (additional support jobs created in the economy)	0.33 Meritocracy Index: Avg Household Income/Avg Net Worth

San Jose is the core of Silicon Valley. It is home to major global tech companies, including Adobe, eBay, Oracle, and Cisco, to name a few. In addition to their established tech industry that fuels innovation with a high volume of new patents, various supporting organizations create connections between startup founders and business professionals through community events and conferences. Startup incubators enable early ideas to mature into stable companies. This region attracts 35% of all venture capital investments in the US.

Employment: Phases of Innovation



Sales: Industry Breakdown



Silicon Alley, NY

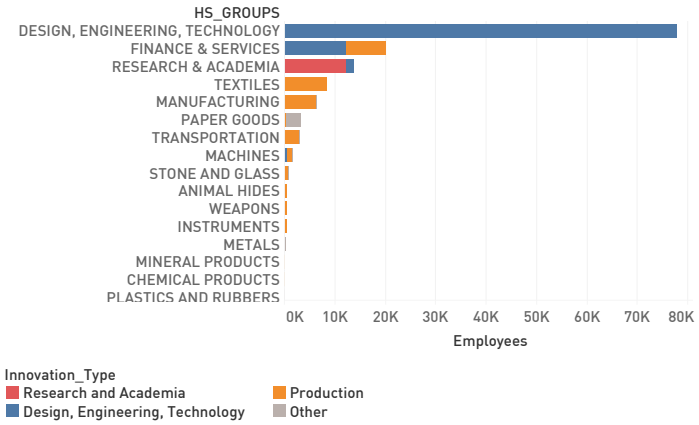
New York, NY | 40.75070, -73.98884

ID Type: Entrepreneurial

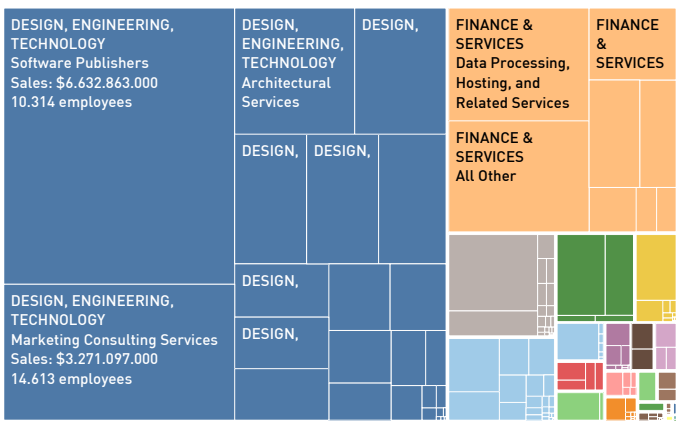
INNOVATION INTESITY	681,472 Employees	134,152 Employees in Innovation	67.3% Max (%) of knowledge-intensive job concentration	19.7% Innovation Intensity (%) innovative employment	13.5% Tech Transfer Innovation Focus
INNOVATION PERFORMANCE	17.1% Percent of sales from innovation	2.5% Percent of sales from R&D (estimate)	44.7% Percent of sales from patents (estimate)	9.7% Percent of sales from new products (estimate)	34.1% Percent of sales from new services (estimate)
INNOVATION IMPACT	$5,575,890 Total Sales from Innovation per resident ($)	$240,726 Total Sales from Innovation per employee ($)	2.3% Unemployment Rate (%)	670,760 Induced Jobs (additional support jobs created in the economy)	0.34 Meritocracy Index: Avg Household Income/Avg Net Worth

The dot-com boom fueled rapid growth of tech companies in the 1990s. The following bust and recession slowed this growth but New York's vision to be an innovation hub remained. In 2011 the city invested $2 billion to reinforce its homegrown applied research capabilities. Key industry investments followed when Google built its 2nd largest office and Verizon finished a $3 billion upgrade to the city's fiber optic infrastructure. Silicon Alley is a thriving entrepreneurial hub with a large tech workforce and billions in venture capital.

Employment: Phases of Innovation



Sales: Industry Breakdown



Aerospace Cluster, Wichita

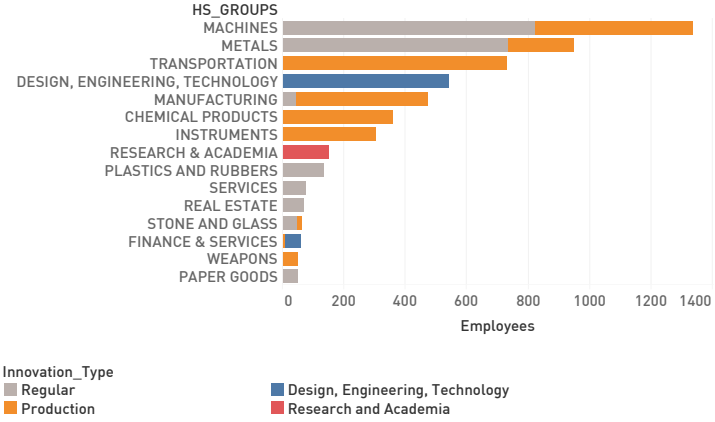
Wichita, KS | 37.65966, -97.38573

ID Type: Industry Cluster

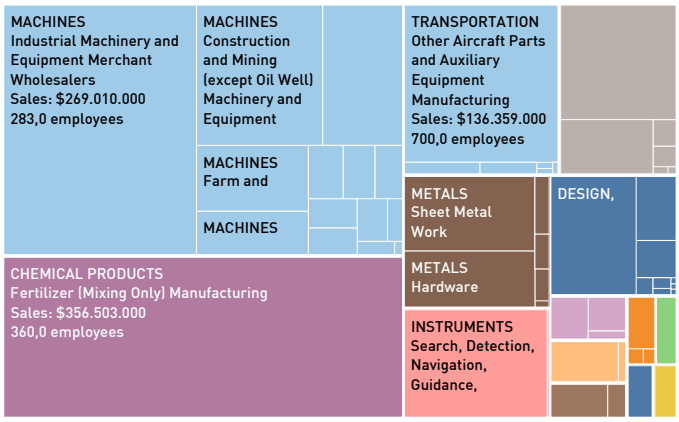
INNOVATION INTESITY	13,994 Employees	4,086 Employees in Innovation	32.4% Max (%) of knowledge-intensive job concentration	29.2% Innovation Intensity (%) innovative employment	23.9% Production Innovation Focus
INNOVATION PERFORMANCE	19.8% Percent of sales from innovation	1.0% Percent of sales from R&D (estimate)	56.5% Percent of sales from patents (estimate)	14.3% Percent of sales from new products (estimate)	45.2% Percent of sales from new services (estimate)
INNOVATION IMPACT	$2,213,586 Total Sales from Innovation per resident ($)	$348,473 Total Sales from Innovation per employee ($)	3.2% Unemployment Rate (%)	20,430 Induced Jobs (additional support jobs created in the economy)	0.25 Meritocracy Index: Avg Household Income/Avg Net Worth

Wichita has been a center for aerospace engineering and manufacturing since 1917, when Cessna began production of its airplanes there. This specialization has grown over the last hundred years and the city is now a major aerospace manufacturing hub. The cluster benefits from the presence of Boeing, Airbus, and Spirit AeroSystems, as well as Wichita State University's National Institute for Aviation Research. Beyond aviation, Wichita has built a specialty in advanced manufacturing techniques, driving innovation in supply chain management, automation, and workforce development.

Employment: Phases of Innovation

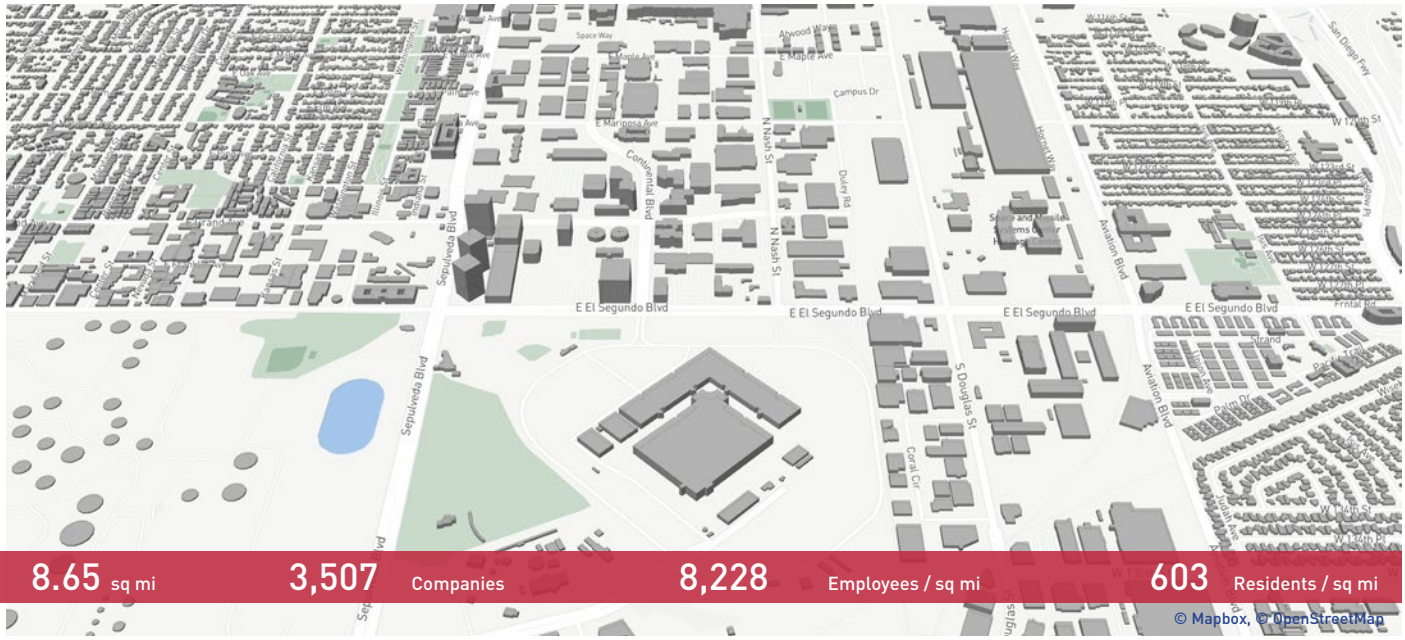


Sales: Industry Breakdown



Boeing Aerospace Cluster, Los Angeles

Long Beach, El Segundo, Seal Beach, Huntington Beach, CA | 33.91634, -118.38929 ID Type: Industry Cluster

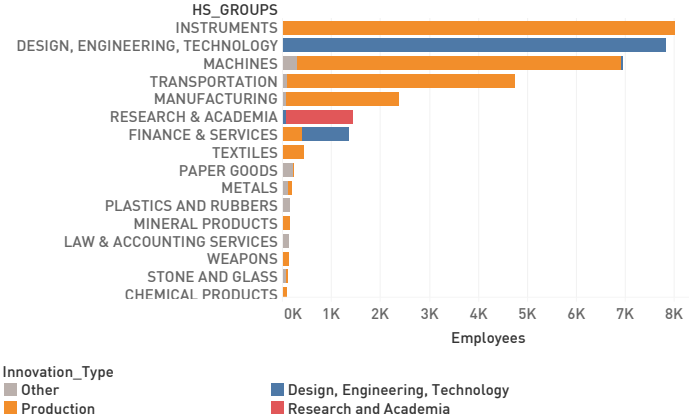


8.65 sq mi	3,507 Companies	8,228 Employees / sq mi	603 Residents / sq mi

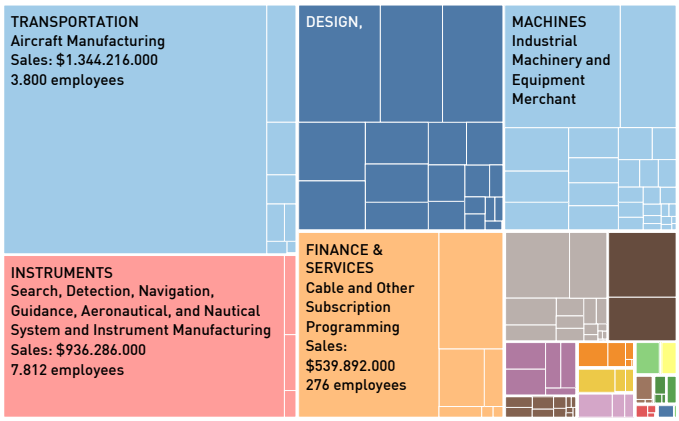
INNOVATION INTESITY	71,187 Employees	33.248 Employees in Innovation	94.8% Max (%) of knowledge-intensive job concentration	46.7% Innovation Intensity (%) innovative employment	32.3% Production Innovation Focus
INNOVATION PERFORMANCE	34.7% Percent of sales from innovation	1.7% Percent of sales from R&D (estimate)	54.4% Percent of sales from patents (estimate)	12.8% Percent of sales from new products (estimate)	39.6% Percent of sales from new services (estimate)
INNOVATION IMPACT	$2,857,421 Total Sales from Innovation per resident ($)	$209,288 Total Sales from Innovation per employee ($)	3.0% Unemployment Rate (%)	166,240 Induced Jobs (additional support jobs created in the economy)	0.20 Meritocracy Index: Avg Household Income/Avg Net Worth

Southern California's status as a leading player in the US aerospace industry dates back to its pivotal role as manufacturing center during World War II. Today, that legacy continues: Boeing has a major manufacturing footprint in Los Angeles, where it benefits from synergies with the region's broader aerospace industrial cluster. Boeing's manufacturing plants in the region support an ecosystem of suppliers, innovators, and knowledge-workers in the aerospace industry.

Employment: Phases of Innovation



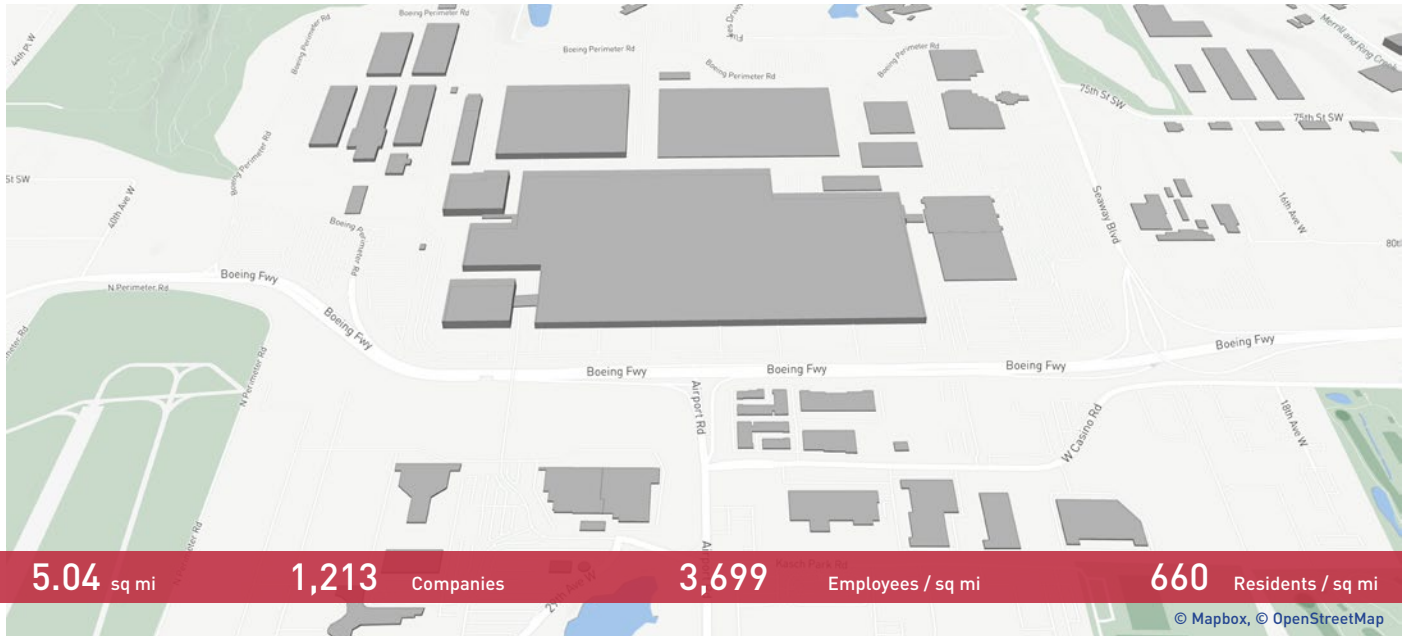
Sales: Industry Breakdown



Boeing Aerospace Cluster, Seattle

Seattle, Tukwila, WA | 47.92364, -122.27173

ID Type: Industry Cluster

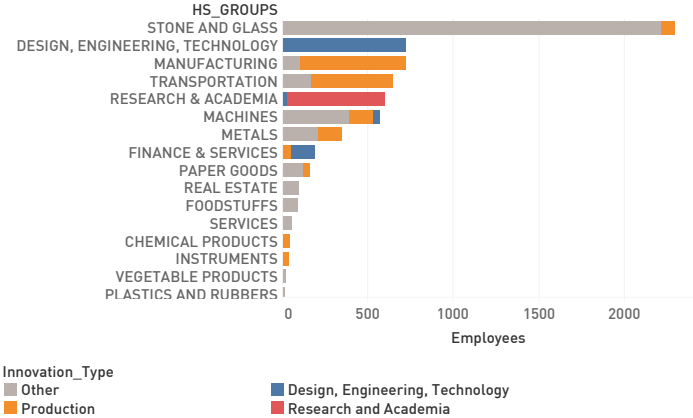


5.04 sq mi | 1,213 Companies | 3,699 Employees / sq mi | 660 Residents / sq mi

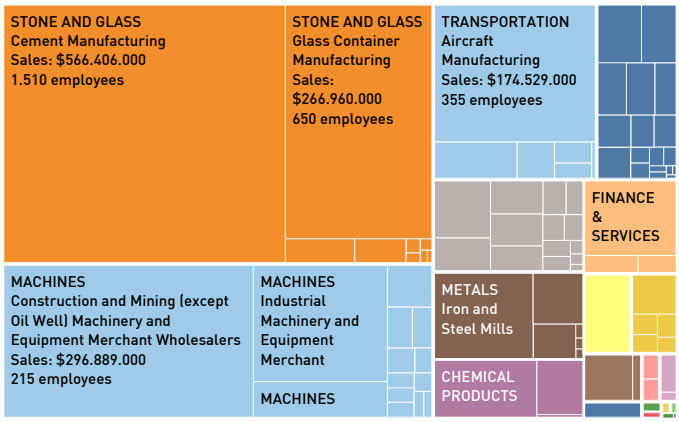
INNOVATION INTESITY	18,631 Employees	3,450 Employees in Innovation	32.3% Max (%) of knowledge-intensive job concentration	18.5% Innovation Intensity (%) innovative employment	10.5% Production Innovation Focus
INNOVATION PERFORMANCE	7.3% Percent of sales from innovation	0.7% Percent of sales from R&D (estimate)	53.1% Percent of sales from patents (estimate)	12.6% Percent of sales from new products (estimate)	42.8% Percent of sales from new services (estimate)
INNOVATION IMPACT	$2,840,210 Total Sales from Innovation per resident ($)	$507,033 Total Sales from Innovation per employee ($)	4.1% Unemployment Rate (%)	17,250 Induced Jobs (additional support jobs created in the economy)	0.26 Meritocracy Index: Avg Household Income/Avg Net Worth

Boeing operates a cluster of production facilities around Seattle. Its Everett Factory, home to the world's largest building by volume at 13,385,378 m3, is where the wide-body Boeing 747, 767, 777, and 787 planes are assembled. Nearby, the Renton Factory produces the 373 MAX series. Boeing's presence in Seattle sparked the development of an aerospace industrial cluster, where innovators and suppliers create cutting-edge aerospace composites, avionics systems, alternative fuels, advancements in plane engines, rockets, and unmanned flight systems.

Employment: Phases of Innovation



Sales: Industry Breakdown



Microsoft Software Cluster, Redmond

Bellevue, Redmond, WA | 47.63888, -122.13482

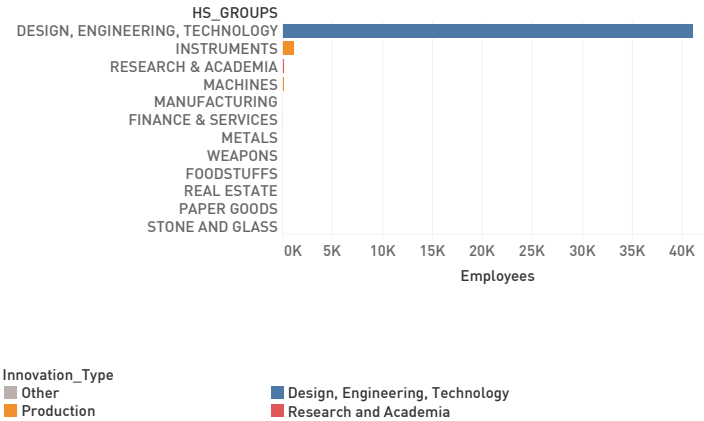
ID Type: Industry Cluster

2.25 sq mi	663 Companies	22,199 Employees / sq mi	1,953 Residents / sq mi

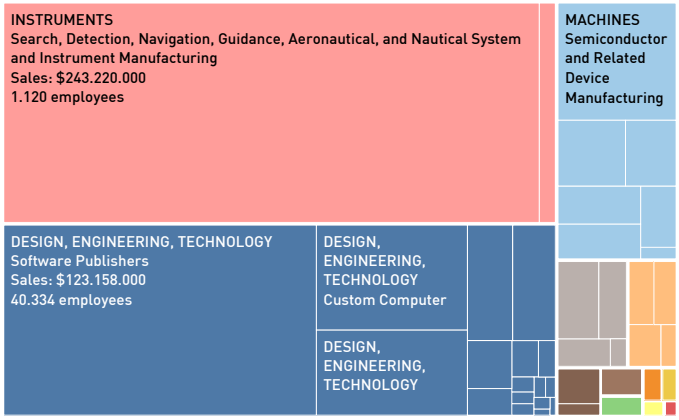
INNOVATION INTESITY	49,876 Employees	42,736 Employees in Innovation	90.2% Max (%) of knowledge-intensive job concentration	85.7% Innovation Intensity (%) innovative employment	82.4% Tech Transfer Innovation Focus
INNOVATION PERFORMANCE	28.0% Percent of sales from innovation	2.6% Percent of sales from R&D (estimate)	47.2% Percent of sales from patents (estimate)	14.5% Percent of sales from new products (estimate)	37.2% Percent of sales from new services (estimate)
INNOVATION IMPACT	$448,892 Total Sales from Innovation per resident ($)	$39,484 Total Sales from Innovation per employee ($)	3.9% Unemployment Rate (%)	213,680 Induced Jobs (additional support jobs created in the economy)	0.60 Meritocracy Index: Avg Household Income/Avg Net Worth

Microsoft's Redmond campus near Seattle is home to the company's headquarters. It is also the center of an innovation partnership zone for interactive media and digital arts. Anchored by Microsoft's presence, this cluster is a major center for software and gaming platform development and works in collaboration with regional universities to accelerate technology transfer and commercialization. There is also significant collaboration between this digital arts cluster and the area's aerospace companies, which recruit talent from the interactive media and digital arts industry to support their work.

Employment: Phases of Innovation



Sales: Industry Breakdown



SpaceX Aerospace Cluster, Los Angeles

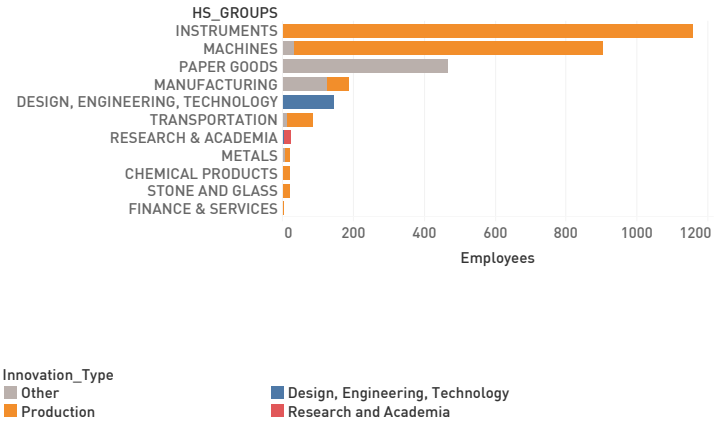
Hawthorne, CA | 33.91686, -118.32988

ID Type: Industry Cluster

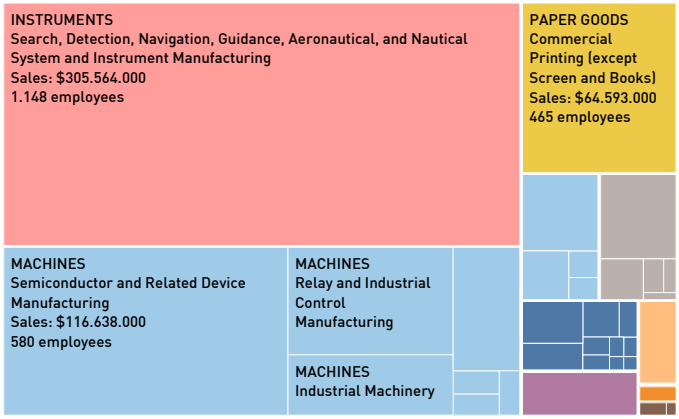
INNOVATION INTESITY	6,761 Employees	2,384 Employees in Innovation	53.6% Max (%) of knowledge-intensive job concentration	35.2% Innovation Intensity (%) innovative employment	32.8% Production Innovation Focus
INNOVATION PERFORMANCE	32.4% Percent of sales from innovation	1.2% Percent of sales from R&D (estimate)	42.8% Percent of sales from patents (estimate)	10.8% Percent of sales from new products (estimate)	31.0% Percent of sales from new services (estimate)
INNOVATION IMPACT	$836,922 Total Sales from Innovation per resident ($)	$250,420 Total Sales from Innovation per employee ($)	4.6% Unemployment Rate (%)	11,920 Induced Jobs (additional support jobs created in the economy)	0.23 Meritocracy Index: Avg Household Income/Avg Net Worth

SpaceX is a pioneer in the pace in aerospace industry, founded in 2002 with the goal of reducing space transportation costs to enable Mars colonization. Its presence in Los Angeles has encouraged the growth of a high concentration of aerospace companies and thousands of industry suppliers. This aerospace cluster produces a self-reinforcing cycle with regard to talent: as aerospace engineers concentrate in the city seeking job opportunities, the city becomes an ever more attractive location for industry companies.

Employment: Phases of Innovation



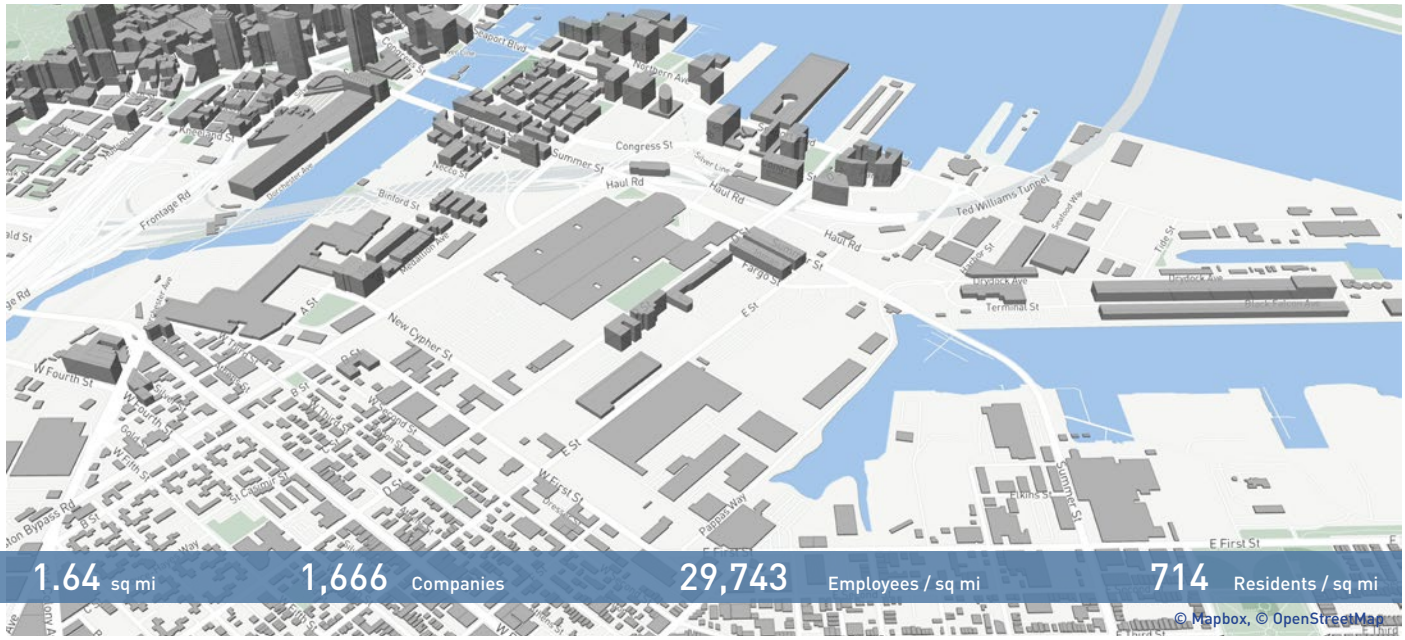
Sales: Industry Breakdown



Boston Seaport

Boston, MA | 42.34375, -71.04344

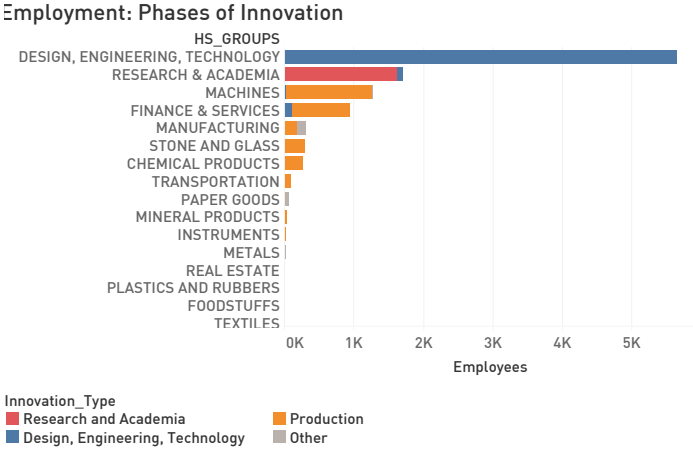
ID Type: Local Government



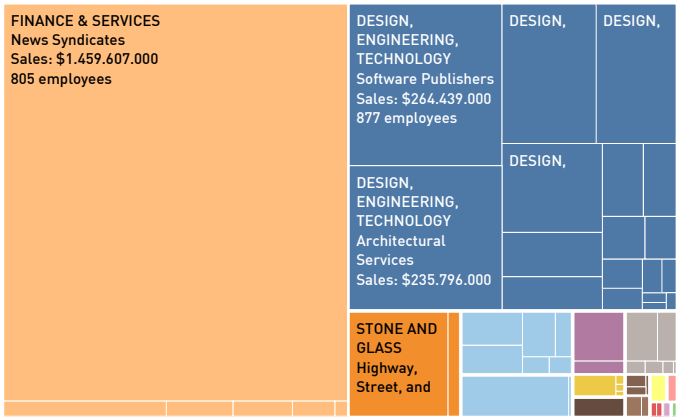
INNOVATION INTESITY	48,638 Employees	10,505 Employees in Innovation	23.7% Max (%) of knowledge-intensive job concentration	21.6% Innovation Intensity (%) innovative employment	12.1% Tech Transfer Innovation Focus
INNOVATION PERFORMANCE	30.8% Percent of sales from innovation	3.4% Percent of sales from R&D (estimate)	57.2% Percent of sales from patents (estimate)	13.5% Percent of sales from new products (estimate)	44.5% Percent of sales from new services (estimate)
INNOVATION IMPACT	$8,014,473 Total Sales from Innovation per resident ($)	$192,461 Total Sales from Innovation per employee ($)	1.9% Unemployment Rate (%)	52,525 Induced Jobs (additional support jobs created in the economy)	0.45 Meritocracy Index: Avg Household Income/Avg Net Worth

The Boston Seaport Innovation District was launched in 2010 by then-Mayor Thomas Menino with a vision of creating a hub for knowledge workers and creative jobs. In this vision, the city of Boston itself was to play host to a dense cluster of innovators, entrepreneurs, accelerators, and related services. Based on the example of 22@, the first innovation district conceived in Barcelona, Catalonia, Spain, the Seaport development has already led to the creation of over 5,000 new jobs, 200 new companies, and over a thousand new housing units in the area.

Employment: Phases of Innovation



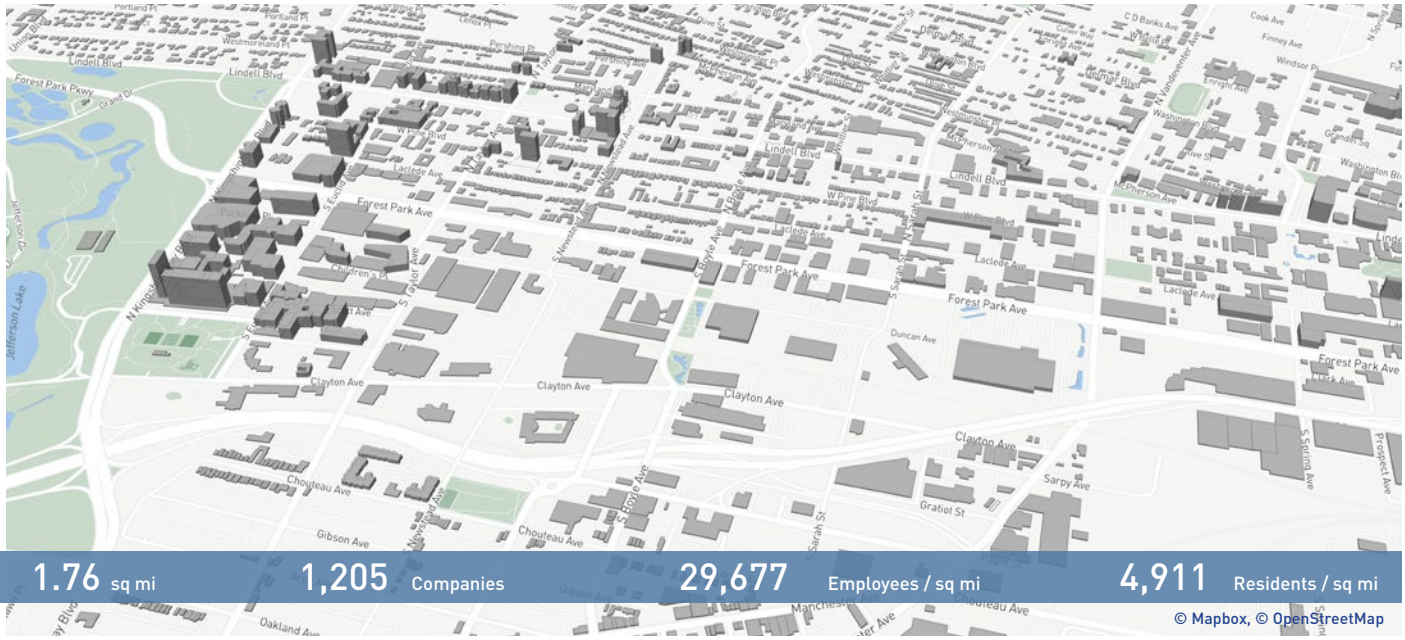
Sales: Industry Breakdown



Cortex Innovation Community

St Louis, MO | 38.63507, -90.25206

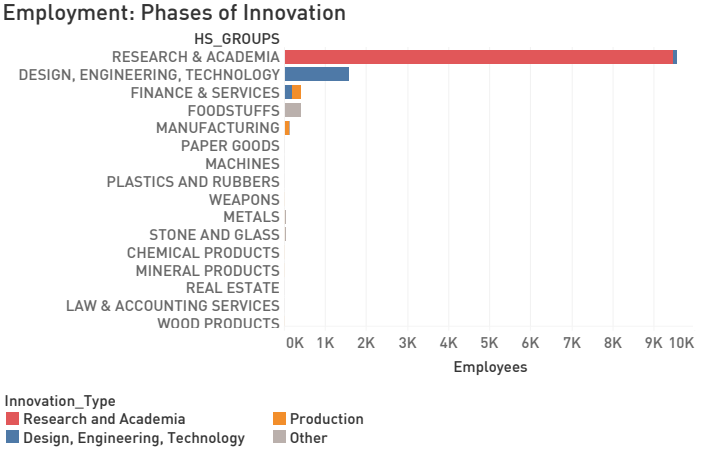
ID Type: Local Government



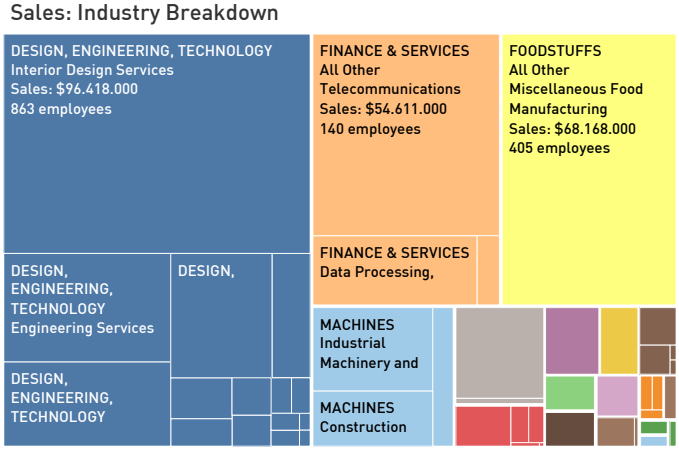
INNOVATION INTESITY	52,350 Employees	12,138 Employees in Innovation	88.5% Max (%) of knowledge-intensive job concentration	23.2% Innovation Intensity (%) innovative employment	18.1% Research& Academia Innovation Focus
INNOVATION PERFORMANCE	6.8% Percent of sales from innovation	1.3% Percent of sales from R&D (estimate)	36.9% Percent of sales from patents (estimate)	8.6% Percent of sales from new products (estimate)	31.2% Percent of sales from new services (estimate)
INNOVATION IMPACT	$486,713 Total Sales from Innovation per resident ($)	$80,542 Total Sales from Innovation per employee ($)	5.5% Unemployment Rate (%)	60,690 Induced Jobs (additional support jobs created in the economy)	0.46 Meritocracy Index: Avg Household Income/Avg Net Worth

The Cortex Innovation Community in Midtown Saint Louis is a major hub for technology and biological science research, development, and commercialization. Founded in 2002 as a collaboration between several of the city's universities, health care institutions, and other leading organizations, the location was selected because of its attractive central location. It has been credited with attracting over $500 million of investments and the creation of at least 3,800 technology jobs.

Employment: Phases of Innovation



Sales: Industry Breakdown



Downtown Detroit

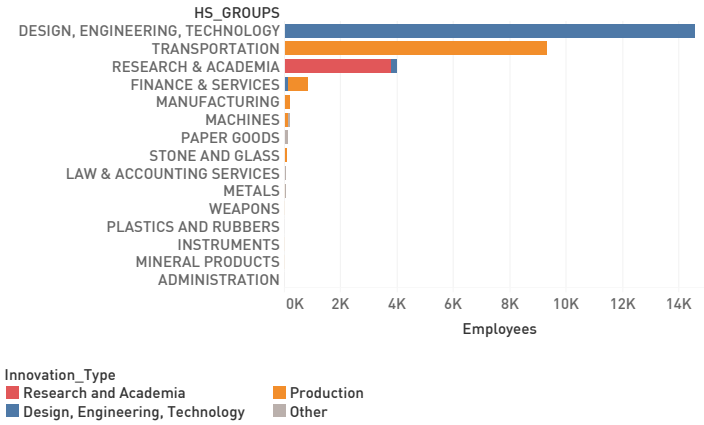
Detroit, MI | 42.33069, -83.04873

ID Type: Local Government

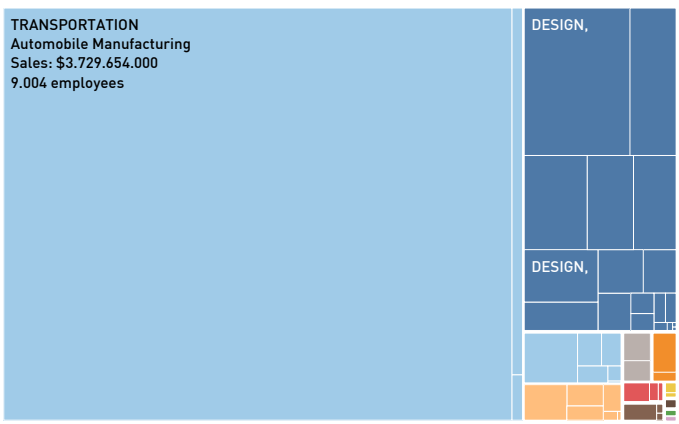
INNOVATION INTESITY	108,386 Employees	29,174 Employees in Innovation	83.2% Max (%) of knowledge-intensive job concentration	26.9% Innovation Intensity (%) innovative employment	13.7% Tech Transfer Innovation Focus
INNOVATION PERFORMANCE	41.1% Percent of sales from innovation	1.4% Percent of sales from R&D (estimate)	41.0% Percent of sales from patents (estimate)	9.1% Percent of sales from new products (estimate)	30.8% Percent of sales from new services (estimate)
INNOVATION IMPACT	$901,674 Total Sales from Innovation per resident ($)	$109,238 Total Sales from Innovation per employee ($)	14.0% Unemployment Rate (%)	145,870 Induced Jobs (additional support jobs created in the economy)	1.01 Meritocracy Index: Avg Household Income/Avg Net Worth

With deep roots in the automotive industry, Detroit has a strong historical connection to innovative design and manufacturing. The city was hit hard by deindustrialization in the late 1970s and unmanaged urban blight in the years that followed, which led to four decades of decline. In recent years, however, Detroit has seen the beginning of an economic resurgence. City leaders recognized the need for coordinated planning to create a space where innovators could meet, collaborate, and discover synergies.

Employment: Phases of Innovation



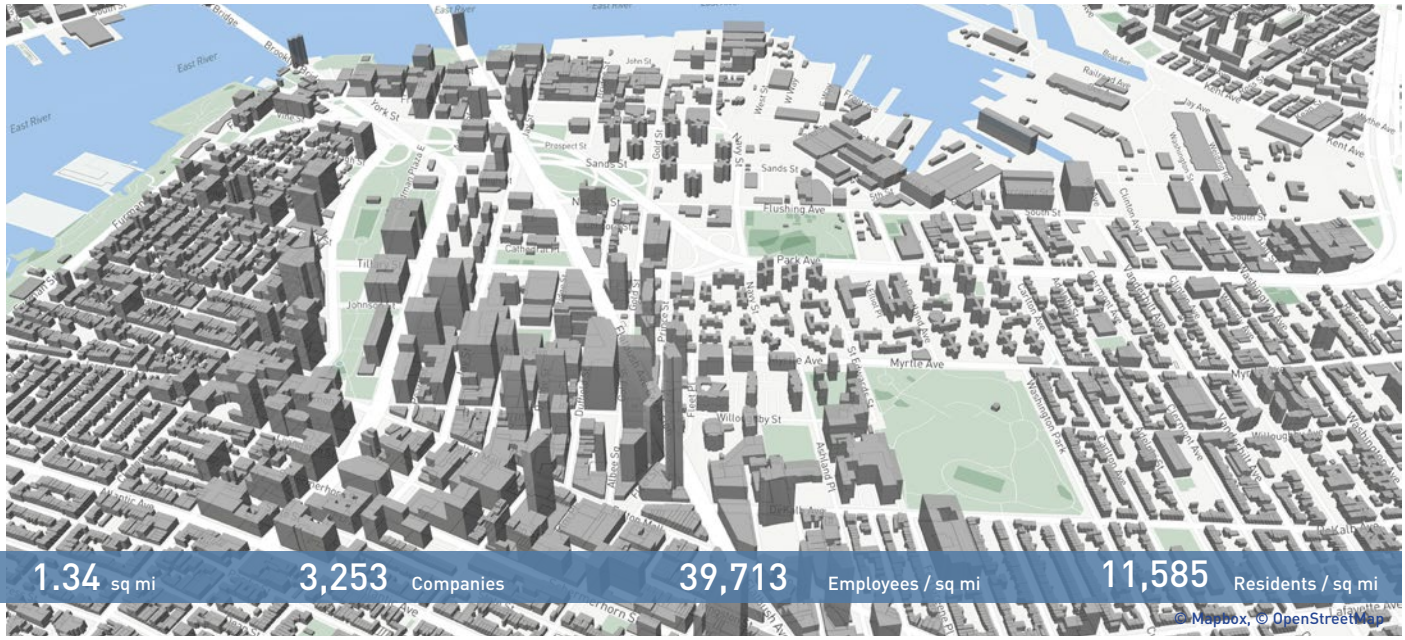
Sales: Industry Breakdown



Dumbo Innovation District

Brooklyn, NY | 40.69487, -73.98146

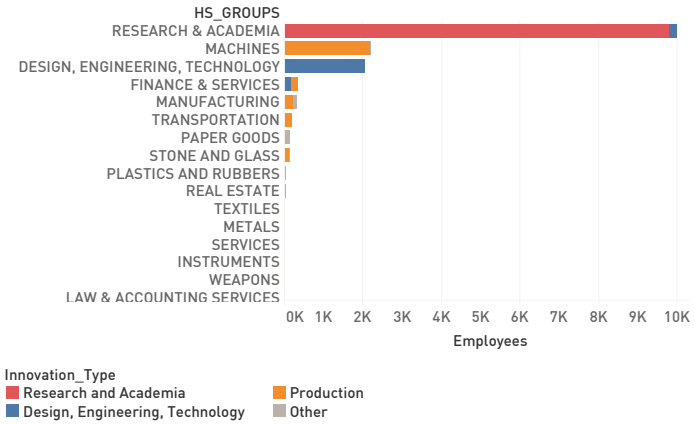
ID Type: Local Government



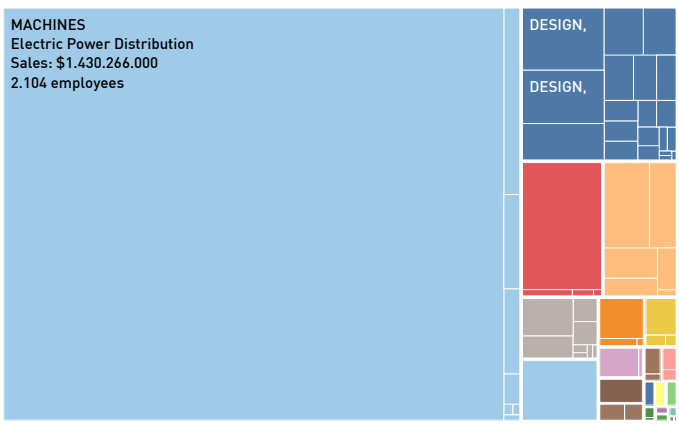
INNOVATION INTESITY	53,286 Employees	15,205 Employees in Innovation	82.1% Max (%) of knowledge-intensive job concentration	28.5% Innovation Intensity (%) innovative employment	18.4% Research & Academia Innovation Focus
INNOVATION PERFORMANCE	24.6% Percent of sales from innovation	0.7% Percent of sales from R&D (estimate)	38.9% Percent of sales from patents (estimate)	7.4% Percent of sales from new products (estimate)	28.3% Percent of sales from new services (estimate)
INNOVATION IMPACT	$481,628 Total Sales from Innovation per resident ($)	$140,495 Total Sales from Innovation per employee ($)	6.2% Unemployment Rate (%)	76,025 Induced Jobs (additional support jobs created in the economy)	0.36 Meritocracy Index: Avg Household Income/Avg Net Worth

Located in Brooklyn just across the East River from Lower Manhattan, Dumbo got its start as a cluster of dot-com era startups in search of affordable rent in artist lofts. In the two decades that followed, Dumbo has become a major economic engine in the borough, where a high density of startups, creators, accelerators, and service providers come together in a vibrant innovation ecosystem. Many of the startups in Dumbo tap into Brooklyn's lifestyle appeal as a way to attract top-notch talent.

Employment: Phases of Innovation



Sales: Industry Breakdown



South Lake Union

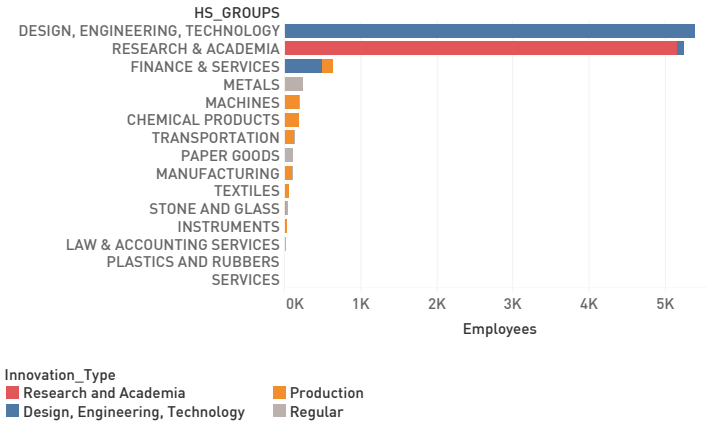
Seattle, WA | 47.62040, -122.33716

ID Type: Local Government

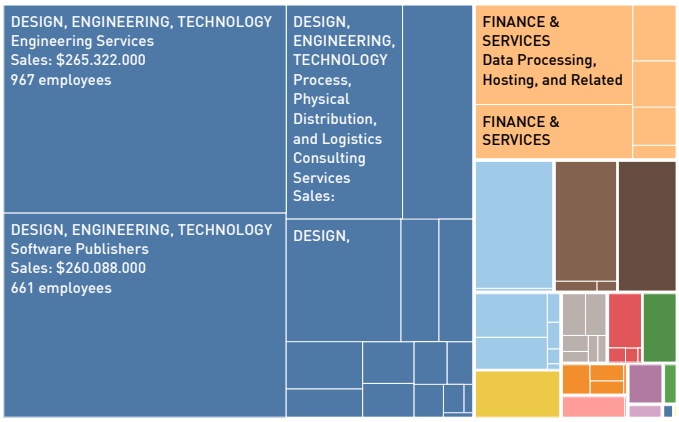
INNOVATION INTESITY	47,071 Employees	12,219 Employees in Innovation	42.9% Max (%) of knowledge-intensive job concentration	26.0% Innovation Intensity (%) innovative employment	12.7% Tech Transfer Innovation Focus
INNOVATION PERFORMANCE	14.9% Percent of sales from innovation	2.6% Percent of sales from R&D (estimate)	44.7% Percent of sales from patents (estimate)	11.4% Percent of sales from new products (estimate)	39.2% Percent of sales from new services (estimate)
INNOVATION IMPACT	$1,443,702 Total Sales from Innovation per resident ($)	$167,585 Total Sales from Innovation per employee ($)	4.2% Unemployment Rate (%)	61,095 Induced Jobs (additional support jobs created in the economy)	0.52 Meritocracy Index: Avg Household Income/Avg Net Worth

The South Lake Union in Seattle was a derelict warehouse district until efforts to redevelop the neighborhood began in the mid 1990s, spearheaded by Microsoft co-founder Paul Allen. Seattle has gradually developed the South Lake Union into a successful mixed-use neighborhood, with attractive green spaces, housing options, and a variety of businesses - including a number of major technology companies. The city plans to further develop South Lake Union into a life sciences and biotechnology hub in the coming years.

Employment: Phases of Innovation



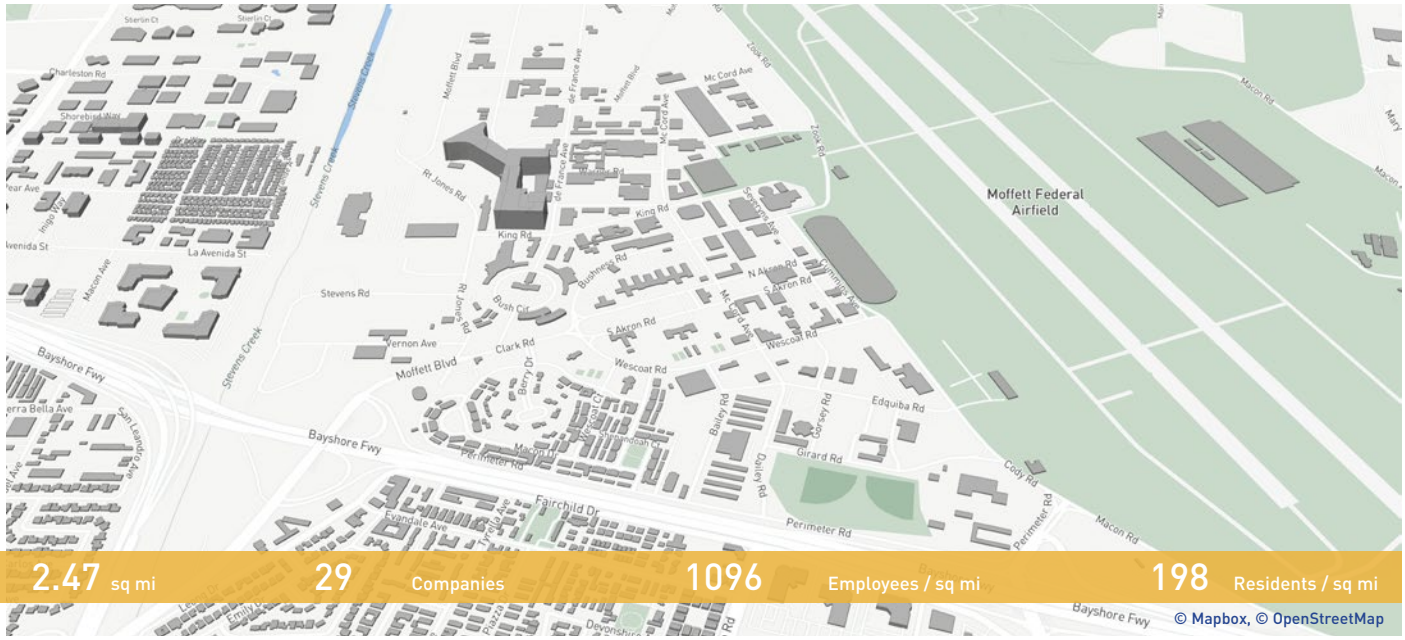
Sales: Industry Breakdown



Ames Research Center, NASA

Sunnyvale, CA | 37.41124, -122.05777

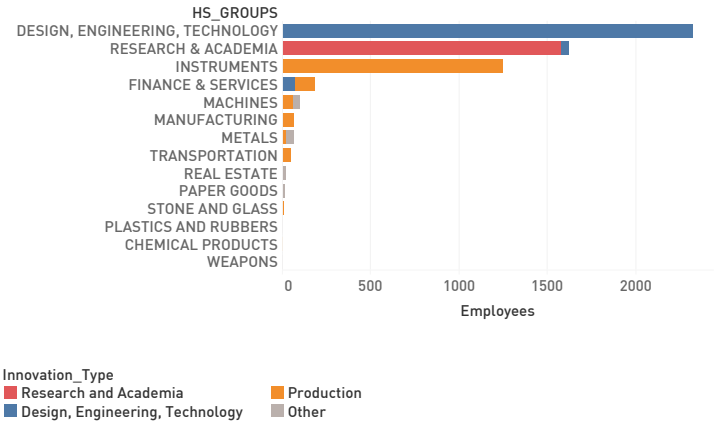
ID Type: Strategic Governmental



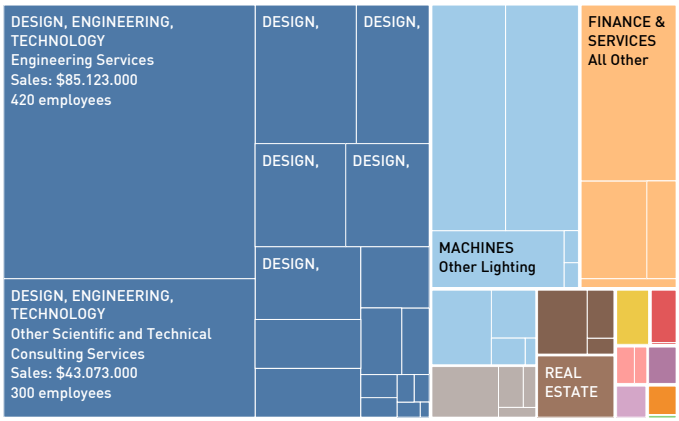
INNOVATION INTESITY	2,711 Employees	2,611 Employees in Innovation	96.3% Max (%) of knowledge-intensive job concentration	96.3% Innovation Intensity (%) innovative employment	94.6% Tech Transfer Innovation Focus
INNOVATION PERFORMANCE	53.1% Percent of sales from innovation	1.2% Percent of sales from R&D (estimate)	30.6% Percent of sales from patents (estimate)	9.6% Percent of sales from new products (estimate)	37.2% Percent of sales from new services (estimate)
INNOVATION IMPACT	$26,796 Total Sales from Innovation per resident ($)	$4,843 Total Sales from Innovation per employee ($)	13.0% Unemployment Rate (%)	13,055 Induced Jobs (additional support jobs created in the economy)	2.19 Meritocracy Index: Avg Household Income/Avg Net Worth

The NASA Ames Research Center, located in Silicon Valley, CA, was founded in 1939 to conduct wind-tunnel research on the aerodynamics of propeller-driven aircraft. Since then, the scope of its research has expanded considerably, providing leadership on topics from astrobiology to robotic exploration and supercomputing with an annual budget of $860 million. NASA Ames also conducts significant technology transfer, including the technologies used for automatic air traffic control and high-fidelity flight simulation.

Employment: Phases of Innovation



Sales: Industry Breakdown



Jefferson National Accelerator

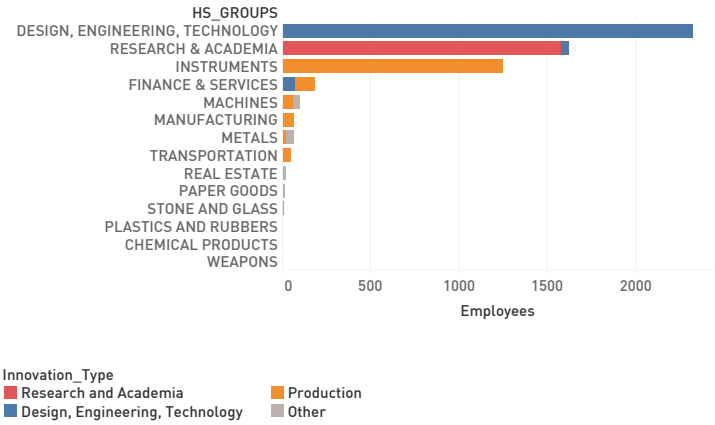
Newport News, VA | 37.09512, -76.48378

ID Type: Strategic Governmental

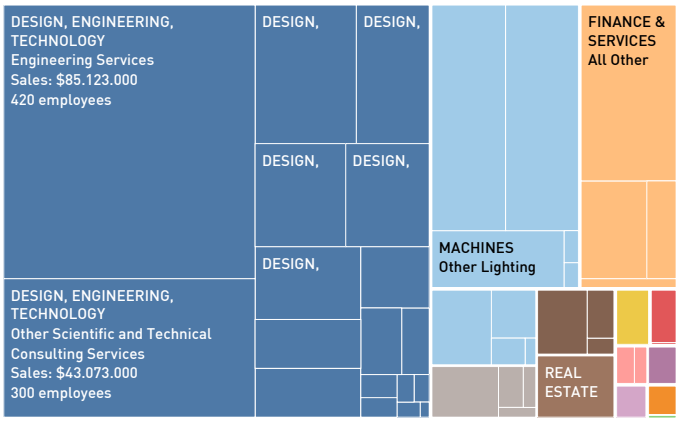
INNOVATION INTESITY	18,622 Employees	5,621 Employees in Innovation	30.0% Max (%) of knowledge-intensive job concentration	30.2% Innovation Intensity (%) innovative employment	13.1% Tech Transfer Innovation Focus
INNOVATION PERFORMANCE	12.1% Percent of sales from innovation	1.2% Percent of sales from R&D (estimate)	48.7% Percent of sales from patents (estimate)	9.3% Percent of sales from new products (estimate)	39.2% Percent of sales from new services (estimate)
INNOVATION IMPACT	$2,958,077 Total Sales from Innovation per resident ($)	$127,238 Total Sales from Innovation per employee ($)	0.3% Unemployment Rate (%)	28,105 Induced Jobs (additional support jobs created in the economy)	0.68 Meritocracy Index: Avg Household Income/Avg Net Worth

The Jefferson Lab in Newport News, VA, is a US Department of Energy, Office of Science National Laboratory dedicated to researching the fundamental structure of nuclear matter. While the lab's primary mission is to conduct basic science research, it is also works actively to promote technology transfer into the marketplace. Successful technology transfers based on Jefferson Lab research have been completed in the areas of medical imaging, biofuels, nanomaterials, and cryogenics, among others.

Employment: Phases of Innovation



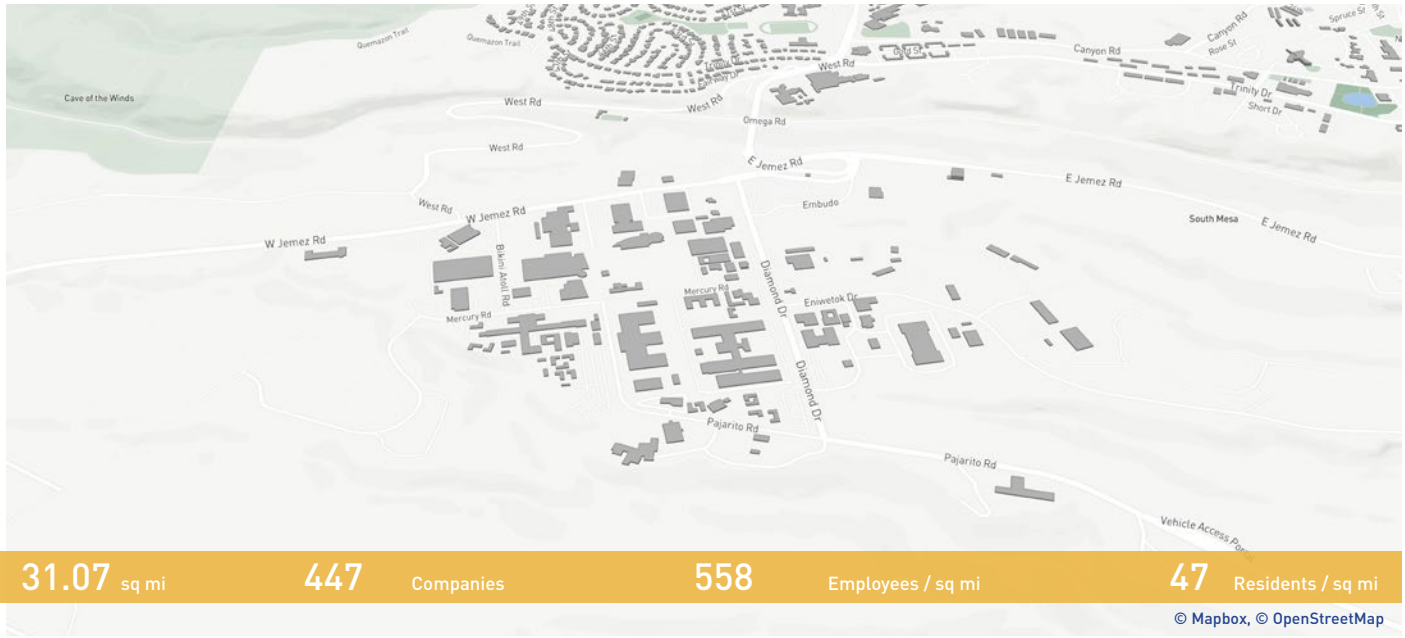
Sales: Industry Breakdown



Los Alamos National Laboratory

Los Alamos, NM | 35.87269, -106.32310

ID Type: Strategic Governmental

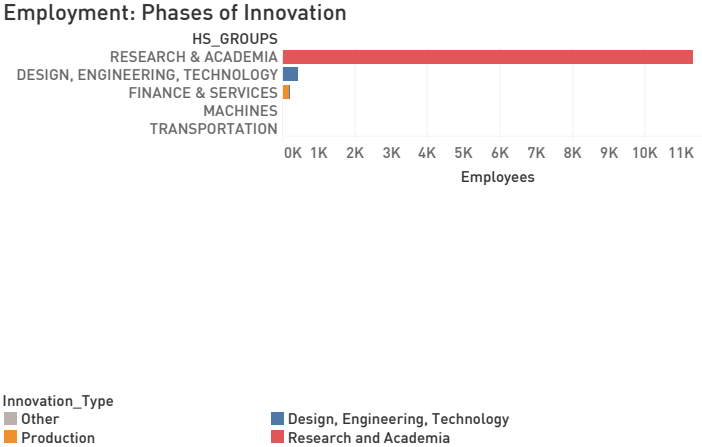


31.07 sq mi	447 Companies	558 Employees / sq mi	47 Residents / sq mi

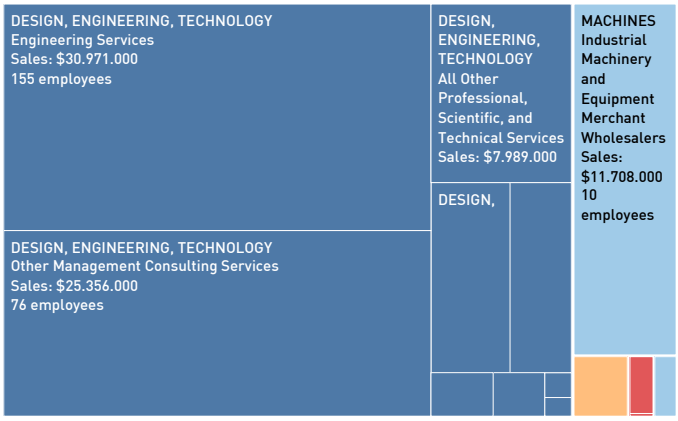
INNOVATION INTESITY	17,345 Employees	11,916 Employees in Innovation	86,3% Max (%) of knowledge-intensive job concentration	68.7% Innovation Intensity (%) innovative employment	65.2% Research & Academia Innovation Focus
INNOVATION PERFORMANCE	14.4% Percent of sales from innovation	0.9% Percent of sales from R&D (estimate)	34.2% Percent of sales from patents (estimate)	7.6% Percent of sales from new products (estimate)	27.7% Percent of sales from new services (estimate)
INNOVATION IMPACT	$361,206 Total Sales from Innovation per resident ($)	$30,645 Total Sales from Innovation per employee ($)	3.0% Unemployment Rate (%)	59,580 Induced Jobs (additional support jobs created in the economy)	0.16 Meritocracy Index: Avg Household Income/Avg Net Worth

The Los Alamos National Laboratory is the senior laboratory in the US Department of Energy National Laboratory System. Its work encompasses a variety of strategic goals, spanning nuclear security, intelligence, defense, emergency response, nonproliferation, counterterrorism, energy security, emerging threats, and environmental management. While its primary focus is on research, Los Alamos National Laboratory operates on the principle that the success of the lab depends on successful technology transfer to industry partners.

Employment: Phases of Innovation



Sales: Industry Breakdown



Oak Ridge National Laboratory

Oak Ridge, TN | 35.92666, -84.31502

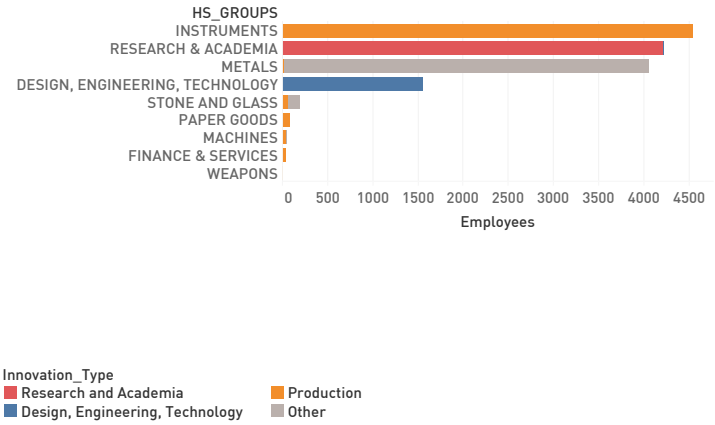
ID Type: Strategic Governmental

52.12 sq mi | 122 Companies | 304 Employees / sq mi | 0 Residents / sq mi

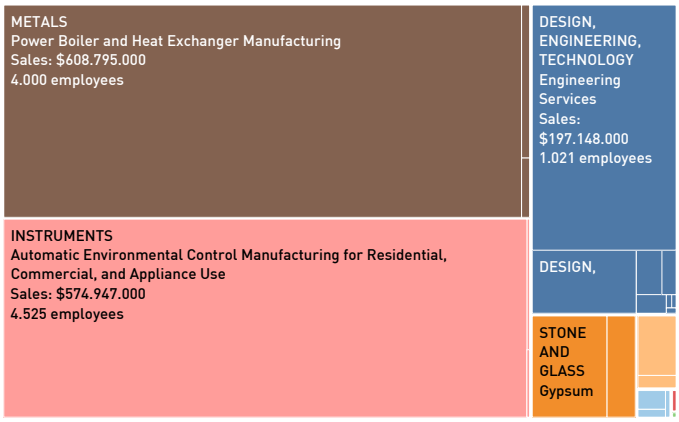
INNOVATION INTESITY	15,838 Employees	10,592 Employees in Innovation	88.0% Max (%) of knowledge-intensive job concentration	66.9% Innovation Intensity (%) innovative employment	30.5% Production Innovation Focus
INNOVATION PERFORMANCE	48.4% Percent of sales from innovation	2.9% Percent of sales from R&D (estimate)	54.0% Percent of sales from patents (estimate)	19.5% Percent of sales from new products (estimate)	54.6% Percent of sales from new services (estimate)
INNOVATION IMPACT	N/A Total Sales from Innovation per resident ($)	$112,751 Total Sales from Innovation per employee ($)	N/A Unemployment Rate (%)	52,960 Induced Jobs (additional support jobs created in the economy)	N/A Meritocracy Index: Avg Household Income/Avg Net Worth

The Oak Ridge National Labs near Knoxville, TN is a technology national laboratory sponsored by the US Department of Energy and operated as a federally-funded research and development center. It is the largest science and energy national laboratory funded by the DOE. Its research programs span a variety of topics, ranging from materials, neutron science, and systems biology, to energy, high-performance computing, and national security. Oak Ridge is also home to several of the world's fastest supercomputers.

Employment: Phases of Innovation



Sales: Industry Breakdown



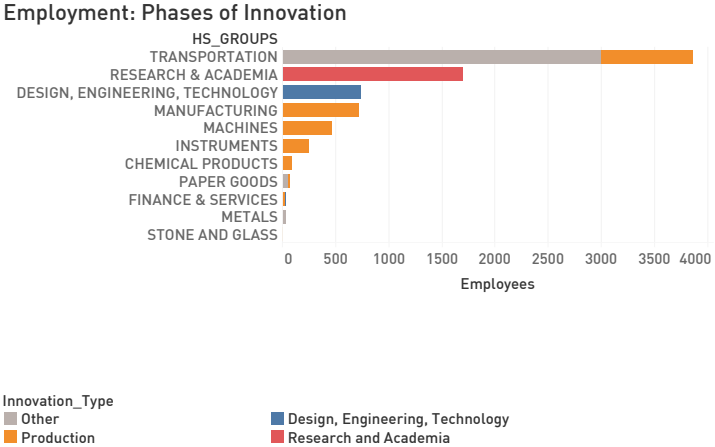
Sandia National Labs

Albuquerque, Kirtland Air Force Base, NM | 35.05188, -106.53496 ID Type: Strategic Governmental

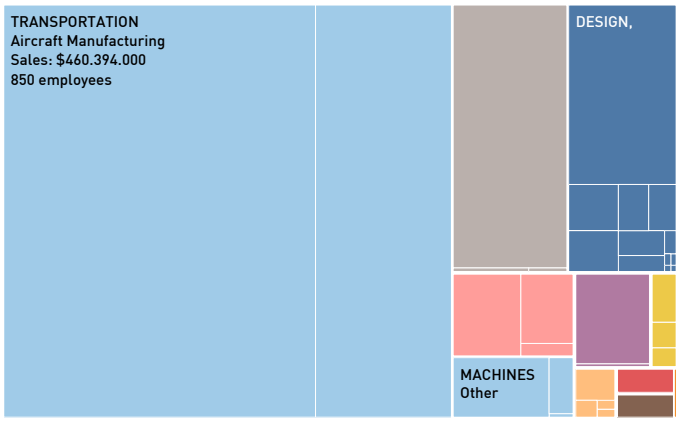
INNOVATION INTESITY	19,180 Employees	4,907 Employees in Innovation	93.5% Max (%) of knowledge-intensive job concentration	25.6% Innovation Intensity (%) innovative employment	12.9% Production Innovation Focus
INNOVATION PERFORMANCE	48.1% Percent of sales from innovation	4.4% Percent of sales from R&D (estimate)	55.6% Percent of sales from patents (estimate)	18.8% Percent of sales from new products (estimate)	39.8% Percent of sales from new services (estimate)
INNOVATION IMPACT	$618,600 Total Sales from Innovation per resident ($)	$84,598 Total Sales from Innovation per employee ($)	7.2% Unemployment Rate (%)	24,535 Induced Jobs (additional support jobs created in the economy)	0.46 Meritocracy Index: Avg Household Income/Avg Net Worth

Sandia National Labs is a federally-funded research and development center sponsored by the US Department of Energy's National Nuclear Security Administration and specializing in national security and nuclear science. With locations in Albuquerque, NM and Livermore, CA, Sandia Labs is a cluster of technology development centers and research foundations dedicated to addressing challenging national security issues related to nuclear weapons, defense systems, energy and climate, and global security.

Employment: Phases of Innovation



Sales: Industry Breakdown



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