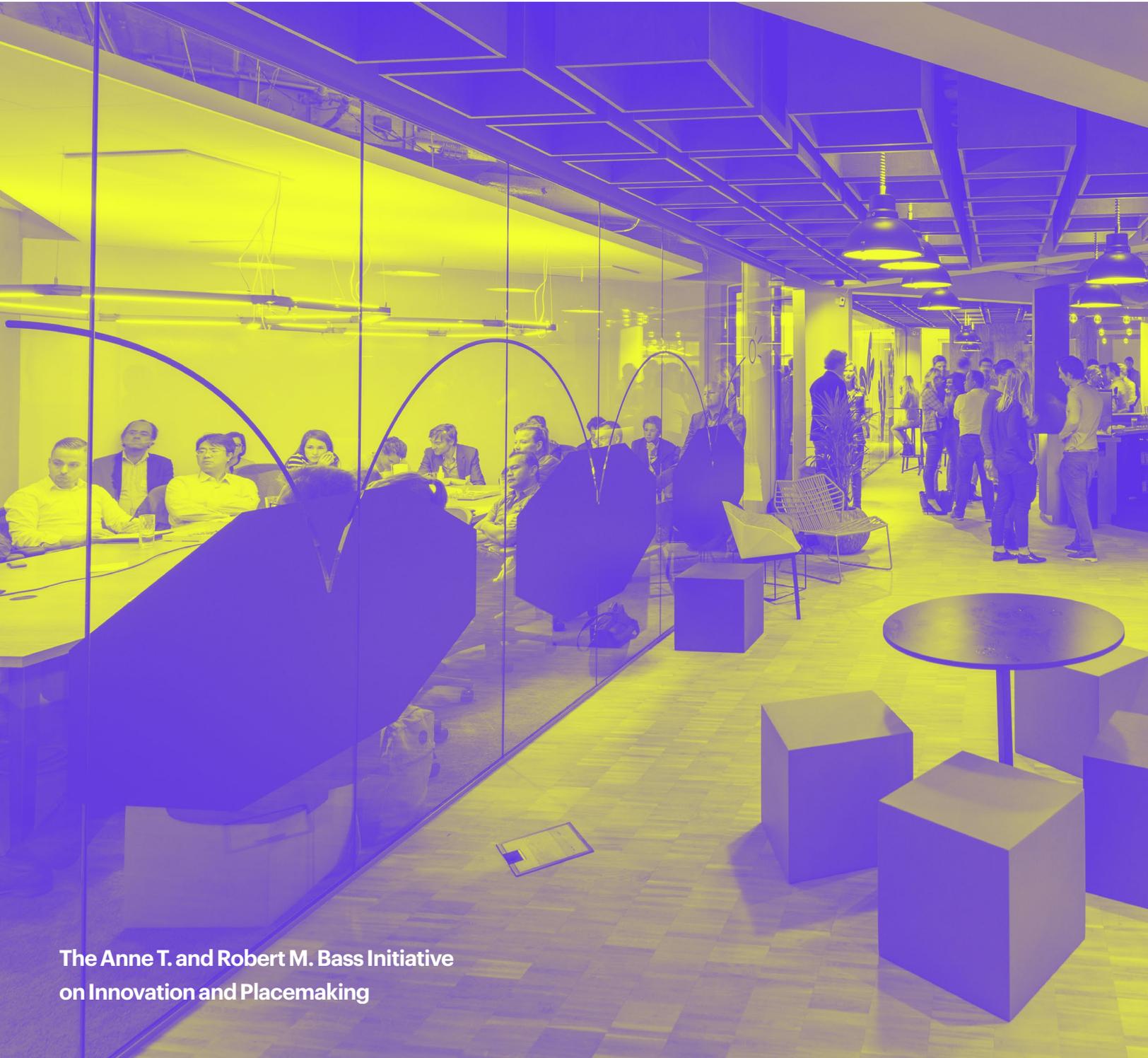


# Innovation Spaces: The New Design of Work

Julie Wagner and Dan Watch

April 2017



The Anne T. and Robert M. Bass Initiative  
on Innovation and Placemaking

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The Anne T. and Robert M. Bass Initiative on Innovation and Placemaking is a collaboration between the Brookings Institution and Project for Public Spaces to support a city-driven and place-led world. Using research, on-the-ground projects, and analytic and policy tools, the Initiative aims to catalyze a new form of city building that fosters cross-disciplinary approaches to urban growth and development.

# Table of Contents

<b>Section 1: Introduction</b>	<b>4</b>
Key findings and insights	7
Why the design of space matters	8
Our approach	8
<b>Section 2: Understanding the rise of innovations spaces</b>	<b>11</b>
What are “innovation spaces”?	11
<b>Section 3: Trends influencing the design of innovative workspaces</b>	<b>16</b>
Trend 1: The increasingly “open” and collaborative nature of innovation is changing the nature of design	18
Striking the balance: Designing for both collaborative and individual work	25
Trend 2: The complexity of innovation is re-valuing face-to-face communication	27
Programming spaces: Unlocking the true potential of people in workspaces of innovation	41
Trend 3: The ubiquitous nature of technology is transforming spaces into “test beds”— experimenting in balancing organizational desires, technological power, and human needs	42
<b>Conclusion</b>	<b>52</b>
<b>About the authors</b>	<b>54</b>
<b>Acknowledgements</b>	<b>55</b>
<b>Appendix A: List of individuals interviewed</b>	<b>56</b>
<b>Endnotes</b>	<b>58</b>

# Section 1: Introduction

From cities to small towns to suburban corridors, innovation spaces are transforming the landscape. Over the past 10 years, these spaces—such as research institutes, incubators, accelerators, innovation centers, co-working spaces, start-up spaces and more—have grown at a considerable pace across the United States and globally. Yet what easily gets missed is that these innovation spaces are physical manifestations of broader economic, cultural and demographic forces, *elevating what matters in today's economy*. At the same time, the ambition to remain cutting edge has driven leaders of industry, and their architects, down the path of creative experimentation in design. In doing so, the last decade of design has embodied a shift away from 'style' and more toward embracing core values aimed to *help people flourish under new economic and demographic conditions*.

Many innovation spaces have evolved from the preoccupation of style to be “slick or cool” to the singular ambition of helping people flourish.

Research from global real estate firm Jones Lang LaSalle identified co-working spaces to be the fastest-growing type in the United States, amounting to 27-million-square feet as of 2016.<sup>1</sup> Accelerators, a nascent but growing innovation

space integrated with programs to accelerate startups, have experienced rapid growth in many countries. In the United States, recent Brookings' analysis found that accelerators grew from 16 to 170 programs between 2008 and 2014.<sup>2</sup> In the United Kingdom, another study found that accelerators grew from 18 to 59 programs between 2010 and 2014.<sup>3</sup> Other places, such as Singapore and Spain, report similar rates of growth for both accelerators and incubators.<sup>4</sup>

## Characteristics of Innovation Spaces:

The growth of innovation spaces is creating real confusion over their differences: what services they provide, how and when they contribute to the process of innovation, and whom they help.

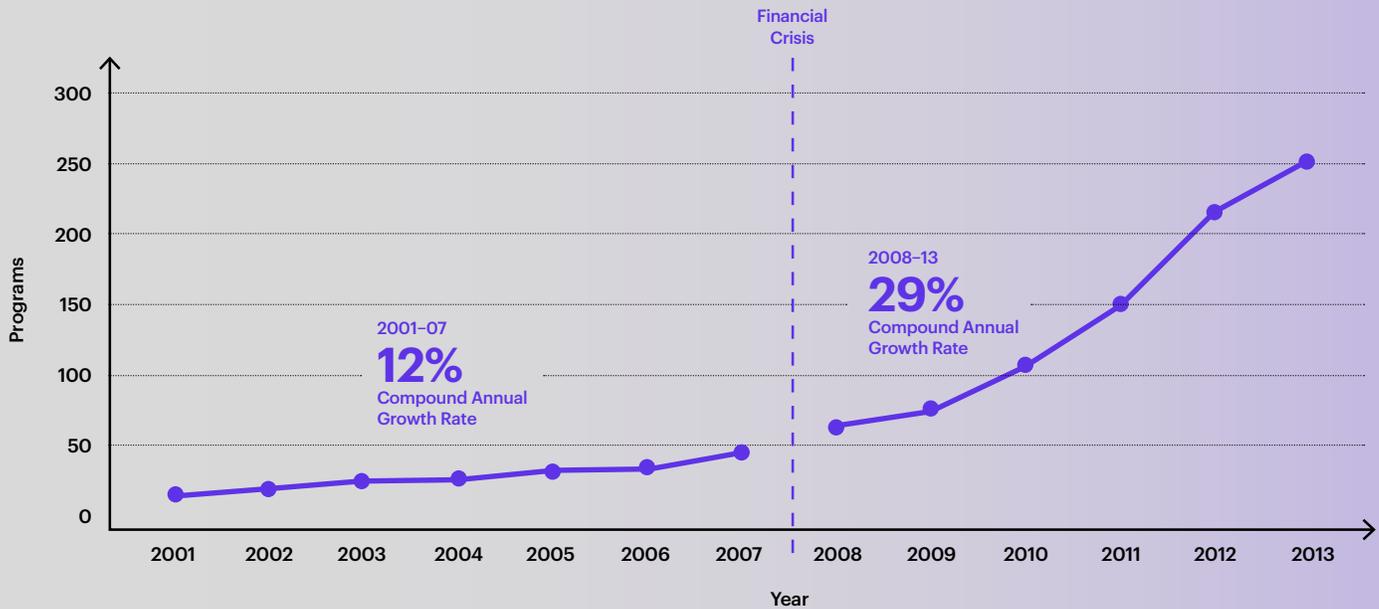
### Incubator

Where startups are supported to “incubate” potentially disruptive ideas at an early stage. Programs can include coaching and networking. Spaces can include wet labs, dry labs and office space.<sup>6</sup> Reduced rent or month-to-month leases are typical. Tech incubators form another new and growing niche.

### Accelerator

Where groups of experienced business owners and investors “accelerate” a cohort of companies through a short but intensive program, such as three to four months, finishing with a “demo” or “pitch” day.<sup>7</sup> Accelerators often invest in cohorts in exchange for a share of equity.<sup>8</sup>

## Growth of accelerator and incubator programs across Europe, 2001–2013



Surveys conducted across 10 European countries found the growth of incubator and accelerator programs to increase after the financial crisis. Source: Telefonica Global Affairs and New Ventures, 2013. Further modified for the Innovation Spaces paper.

At the same time, observed Alexandra Lange for the *New York Times*, universities are shifting their development priorities. “Where once the campus amenities arms race was waged over luxury dorms and recreation facilities, now colleges and universities are building deluxe structures for the generation of wonderful ideas... pouring millions into new buildings for business, engineering and applied learning that closely resemble the high-tech workplace.”<sup>5</sup> Research institutions, where advanced multi-disciplinary research is conducted, also continue to expand globally, such as the Crick Institute in London and CREATE in Singapore.

Increasingly, architects and designers are tasked to redesign spaces to do more than simply house innovation-oriented activities. Their goals are also to “create communities,” “facilitate collaboration” and “create serendipitous encounters.” Through design, architects and business leaders are essentially being asked to re-wire the social, if not organizational culture, as much as to adhere to strict building codes.

And while people believe that architects generally keep to themselves to build shining icons of their utopia, this paper reveals that architects designing innovative spaces—the ones responsible for bridging processes, places and people—are “catch-all generalists.” They are

### Co-working space

An office or working environment shared by people who are self-employed or work for different employers. Most spaces charge monthly rental fees for desks and/or other types of office space and equipment. Many share a goal of creating environments that foster connections and creativity.<sup>9</sup>

### Start-up space

An environment providing startups with the space and resources needed to test and nurture ideas. Many offer different workspaces including labs. Increasingly combined with incubator, accelerator or co-working space.

### Innovation Center

Private (corporate) or public spaces with state-of-the-art technologies designed to advance ideas and product development. Variations exist given: economic focus (e.g., pharma vs. robotics); target audience (e.g., companies, start-ups, students); and integration of other activities (corporate offices, incubators, co-working spaces, shared laboratory facilities).



The creative infusion of large and small spaces, often mixed with programming, is facilitating collaboration. CIC Miami. Photo credit: Alexia Fodere.

intellectually curious, delving into complex innovation processes to better understand their physical implications. They combine both intuitive and analytical insight to solve problems while, at the same time, promoting ideas from workers and researchers that use the space day-to-day. This specific niche of architects is part of a growing group of silo-busters, working across disciplines and hierarchies. Their work has been strengthened, if not guided, by the vision of their clients—the vice presidents, managers or a cadre of board members—who see the big picture.

**Interestingly, innovation spaces are blurring in distinction—offering a range of support or activities that at one time were found in separate spaces.**

Importantly, more than just the occupants are embracing these designs—the market also is adopting, and expanding, these innovative spaces. Office management companies, small developers and large development and investment companies that have both the financing and the might are

extending these attributes from just one building to a cluster of buildings, if not blocks and broader districts. While responding to what the market demands, developers are nonetheless elevating the role of people; acknowledging them as the critical nexus between innovation and place.

#### **Maker Space**

A space where people and startups can develop/test ideas often using shareable manual or automated tools.<sup>10</sup> Resources include a wide range of equipment, infrastructure, materials and expert advisors. Some are industry specific and can be located in libraries, community center, private organization, or on a university campus.<sup>11</sup>

#### **Research Institute**

A space that facilitates collaborative multi-disciplinary research (sometimes between academia, the private sector, and public sector) to speed up the translation of lab discoveries into practical uses. Often located near university buildings to enable researcher-interaction from neighboring faculties.<sup>12</sup>

#### **Innovation Civic Hall**

A new type of dedicated civic space for the innovation community to gather and exchange ideas. Includes open-work and teaching spaces, event space as well as flexible-use spaces.<sup>13</sup>

# Key findings and insights

**Innovation spaces are the physical manifestations of economic, demographic and cultural forces.** The changing nature of innovation is transforming spaces into open, flexible locales where separate professions and disciplines more easily converge. The changing demographic of workers is altering designs to be more comfortable, social and collaborative with technology. For these and other reasons, spaces of innovation help elevate *what matters* in today's economy, making them the *places to watch*, and sending *helpful signals* to cities and suburbs aiming to become more competitive.

Innovation spaces provide important insights:

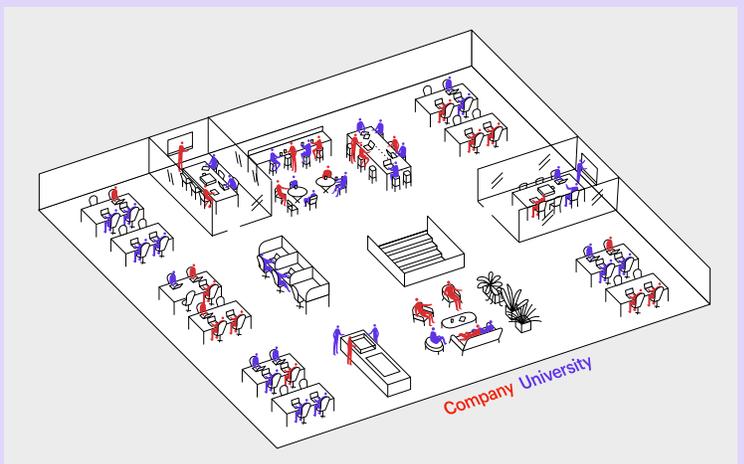
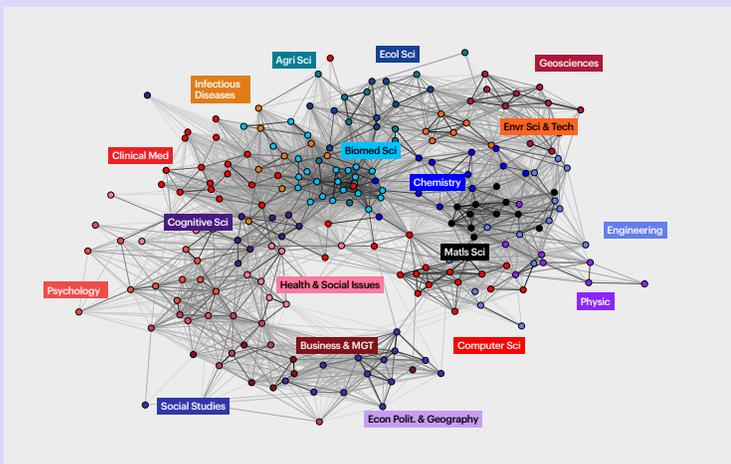
**The “open” and collaborative nature of innovation is changing the nature of design.** Research reveals that innovation is increasingly collaborative, involving two or more people during the process of innovation. Collaboration also importantly underpins “open innovation” and convergence—a trend where disparate sectors and/or disciplines come together as a means to innovate. For the physical design of space, this translates into creating flexible and highly responsive spaces that allow people, in a range of group configurations, to decide what works.

**Face-to-face communication has growing currency.** While collaboration is increasingly central to driving innovation forward, it is a process often mired in linguistic, technical

and organizational challenges. Communication within an innovation setting is even further complicated by the imperative to communicate both tacit and highly complex information. This places a growing currency on face-to-face communication, where architects are reconfiguring the “bones of the building,” creating interactive, sharable spaces and, in a small but growing number of cases, re-imagining the ground floor of buildings. Even with advancements in technology, interviews suggest that the intimacy achieved through in person face-to-face communication remains highly valued.

**The growing pervasiveness of technology is driving firms to experiment in balancing organizational desires, technological power and human needs.** The last 10 years marked a tremendous infusion of technologies into innovation spaces, literally re-wiring how, where and when people connect and communicate. The next decade will offer lessons on how, through trial and error, firms have retained the value of “human-ness” in the midst of such change.

Finally—given the unevenness across innovation spaces in applying post-evaluations on design—leaders and managers of spaces, in interviews, offered an almost unwavering view that design has indeed elevated the level of collaboration and interaction as compared with classic office building design. Their insights are reflected throughout this paper.



The changing nature of innovation, including the acceleration of convergence, is leading to the transformation of spaces where separate professions and disciplines more easily mix. Source: Rafols, Porter and Leydesdorff (2009).

# Why the design of space matters

Everyone engaged in the working world has been influenced in some way by design—whether it has indirectly contributed to the development of new insights or, at another extreme, exacerbated isolation or fear. For this reason, this paper offers interesting insights for a broad cross-section of readers.

**The conventional wisdom is that workplaces with collaborative, informal spaces are now common place ...**

While there is considerable literature on interior design of workspaces, this paper arrives at design through a different path: first by understanding the changing nature of innovation and other broad forces, their influence on human behavior and then, ultimately, how this implicates design. Readers actively working in design will find this paper elevates what still matters. For readers new to this area of study and practice, this paper offers a framework for understanding the broader implications of innovation through design.

This paper also aims to inform business, university, philanthropic and government leaders working to strengthen local ecosystems of innovation, including cities but also innovation districts, science parks, medical districts, and university campuses. Those working to strengthen connections and synergies at these larger scales will find value in learning how broader trends are influencing design at the building scale.

**... a more accurate picture is that most people work in traditional, heirarchical offices that emphasize individual work.**

## Our approach

To gain insight into the changing role of design and architecture, nearly 50 in-depth interviews were conducted with both top architects and users of innovation spaces (such as managers of researchers, executives managing all operations and program managers). Their names and affiliations are listed in Appendix A.

On deciding which innovation spaces to study, this process intentionally selected strong spaces identified by critics, reporters and global experts as advancing innovation.



Researchers engaged in conversation at LabCentral in Cambridge, Massachusetts. Photo credit: Paul Avis/Avis Studio, courtesy LabCentral.

In the first set of interviews, globally oriented architects with extensive experience designing innovation spaces (from research institutes to innovation centers to offices) and top corporate leaders (including AT&T, Haworth, Philips, and Bank of New York) were asked to provide insights on this changing field. Part of the inquiry focused on how innovation spaces have changed over the last 10 years and what they believed to be prompting these changes. To gain insights into future directions, they were also asked: the costs to design and construct the next iterations of innovation spaces as opposed to more traditional layouts; their opinions on building transparency and its affect on the broader area; and the role of the ground floor.

In the second set of interviews, over 35 architects and managers of spaces were interviewed across a range of innovation building types, such as research institutions, incubators, start-up spaces, co-working spaces and innovation centers. These spaces were designed to advance innovation across multiple sectors including bioscience (with an emphasis on applied science), advanced manufacturing, robotics, technology including the burgeoning app cluster and more. The expansiveness in interviewing architects and users across a range of spaces and sectors was intentional, in the quest to distill measurable differences in design. In as many cases as possible, the architect and

end user (CEOs, vice presidents, and managers) of the *same* space were interviewed separately. This again was intentional. As innovation spaces have unevenly applied post-design evaluations, this research turned to managers to reflect on how these spaces are supporting collaboration and innovation.

Lastly, an in-depth literature review, with a particular focus on new research, was completed on a parallel track to surface additional evidence.

# Section 2: Understanding the Rise of Innovation Spaces

## What are “innovation spaces”?

Incubators, co-working spaces, start-up spaces, innovation centers, maker spaces, research institutes—these represent just some of what is now a growing portfolio of workspaces cradling the process of innovation. As their geographic footprint across cities and towns grows, questions arise on what distinguishes the various workspaces. And, while this research identifies some useful distinctions, it is increasingly the case that innovation spaces are blurring in distinction—offering a range of support or activities that at one time were found in separate spaces.

Even with overlapping activities, it is still helpful to clarify specific innovation spaces that seem to be the most confusing to people: start-up spaces versus co-working spaces. Start-up spaces primarily support fledgling firms in “start-up mode,” though some house firms expanding into new areas. These spaces can cater to startups across different clusters, while others are tailored to cultivate just one type of business. Importantly, these spaces provide the workstations and equipment essential to support business growth. A recent trend is for start-up spaces to also include other types of innovation spaces, such as an accelerator or an incubator, creating a highly contextualized layering of support. To many observers, it is this layering that contributes to the confusion over definitions of innovation spaces.

Co-working spaces are broadly considered office spaces for a low-risk, month-to-month fee, complete with wrap-around services.

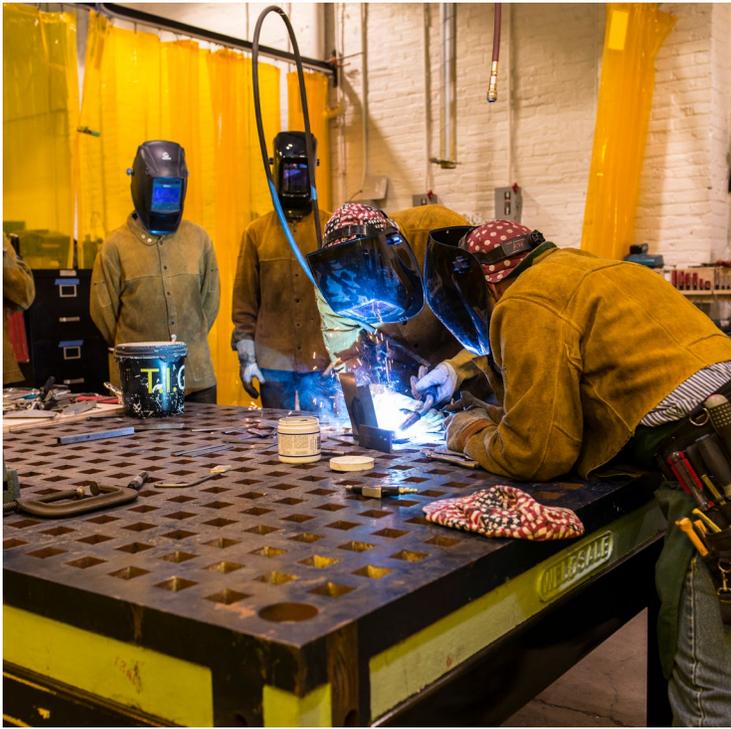


This area of Philadelphia is home to a range of innovation spaces. Map credit: Google Earth.

Start-ups can occupy co-working spaces, as can a wide range of more established firms and organizations. While there is also growing trend for some co-working spaces to become hyper specific, WeWork, a co-working space, is aiming to be more diverse, offering space for law firms, non-profits, service firms, design firms and publishing—again highlighting that variations often prevail even within one type of innovation space.<sup>14</sup>

Innovation centers are also vague, partly because they are so diverse: public or private (corporate) space with state-of-the-art technologies aimed to advance ideas and product development. They are built for specific clusters (such as pharmaceuticals or robotics) and are used by wildly diverse groups (companies, startups, students). Like start-up spaces, innovation centers often include other types of innovation spaces such as incubators or accelerators. The purple column in the introduction highlights some of these distinctions.

With such variation in spaces, this research set out to unearth the design distinctions. The research took a surprising turn, as the greater, more-compelling story became their similarities. The interview questions aimed to separate what is working particularly well in expansive research institutes as opposed to smaller start-up spaces.



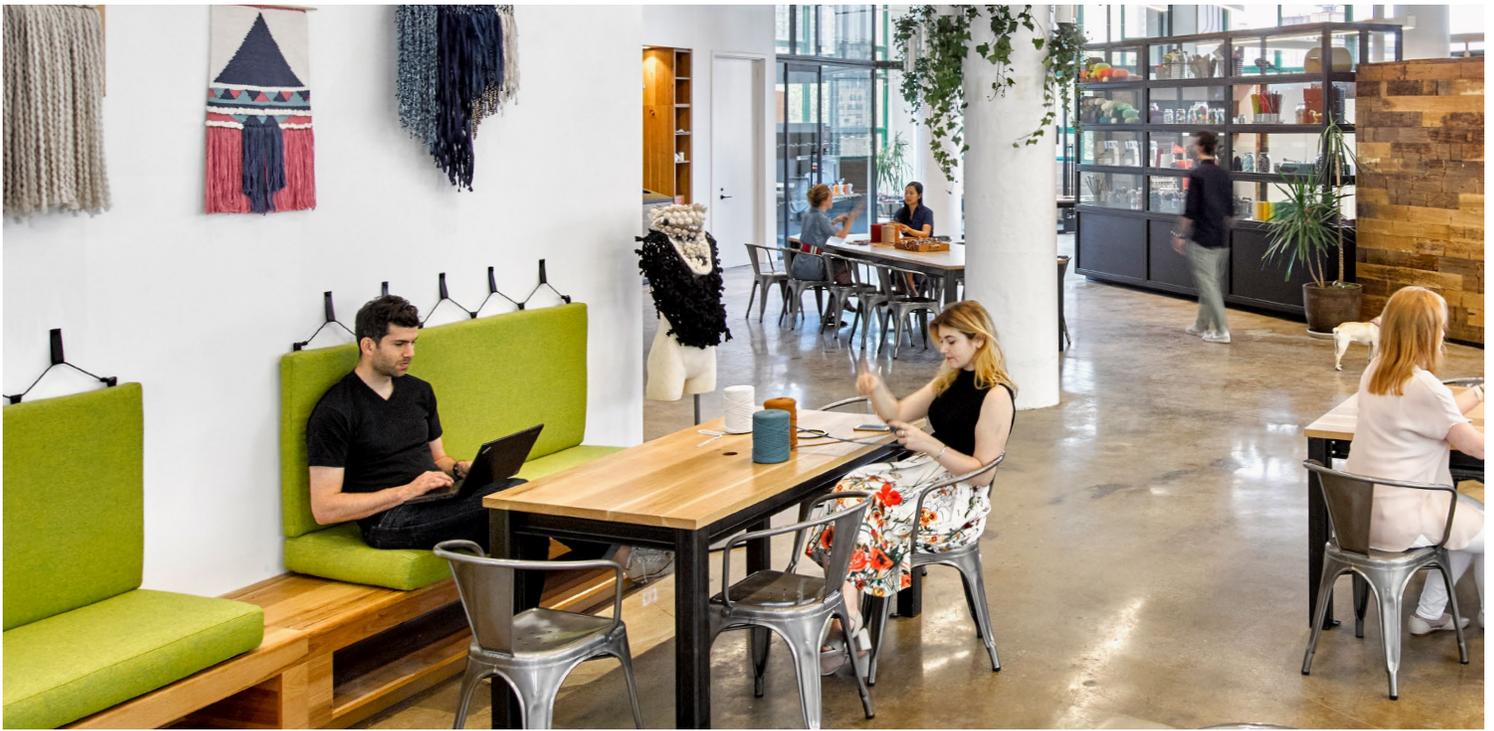
Some innovation spaces are starting to blend uses, such as makerspaces ...



... and co-working spaces. Fablab in Philadelphia. Photo credit by Dr. Evan Malone.

Instead, greater parallels emerged between the two. As the numbers of interviews grew, the answers became increasingly rich and robust. Despite vast differences between these innovation spaces—in whom they serve, where they are in the innovation value chain, and which sectors they represent—the most effective spaces have moved away from style, revisiting core values and re-adapting earlier and imperfect models of design to strengthen “human-ness.”

A cross-section of global-reaching architects on the cutting-edge of practice was asked to define what is considered an innovation space (refer to Attachment A for their names and affiliations). An amalgamation of their definitions included these important attributes: spaces that *strengthen interactions, communication, and collaboration*; and spaces that are *open, transparent and contextually responsive*. In other words, for as much as we have been mesmerized by iconic designs, flashy technology, and the excitement of bold colors on walls and furniture, successful spaces respond to what workers need—as teams or as individuals. Aptly put by one architect: “Innovative spaces do not dictate or restrict process and creativity, but instead open new ways of communication and sharing. It is those new ways that lead to new and exciting ideas.”<sup>15</sup>



Open communal space at Etsy in Brooklyn, New York. Photo credit: Garrett Rowland.

Purpose and function outweigh aesthetics, according to many responses. Architects did not describe the “slick or cool” design traits or characteristics commonly depicted in top architecture or hip innovation-oriented magazines. Jeffrey Morgan, a principal architect at NORR Architects, who designed @3401 in Philadelphia, highlighted a common conception that collaborative spaces are wide-open spaces with an industrial look that include bikes and dogs. “People start thinking about design this way and it just doesn’t work. Successful collaborative spaces thoughtfully consider the range of activities and provide the right kind of spaces to support unique activities,” he said.<sup>16</sup>

When architects were asked how innovative spaces have changed over the last 10 years, they made three broad observations. First, that *technology is more pervasive, connecting people to ideas and to each other in ways not seen before* and (the ever-changing role of technology is discussed later in this report). Second, architects emphasized that *innovative spaces are increasingly more open, transparent and inviting*.

Particularly important given that it underscores all else, the third observation is that *design no longer evolves only from the client or the leaders of an organization*. Rather, the process now includes

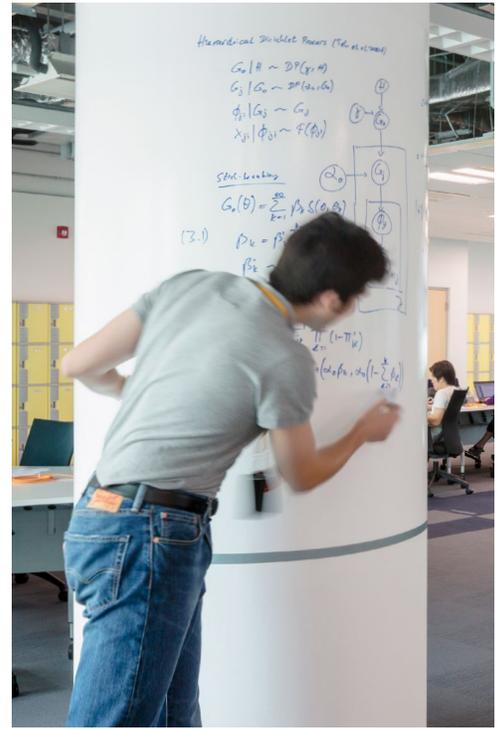


Photo Credits: (left) Bond Bryan Architects, (middle) Betamore, (right) Perkins + Will.

those who will use the space. This, in part, moves us closer to the “democratization” of innovation, where workers are elevated and empowered to articulate how a space should be molded to support their needs and ambitions. Those spaces dubbed to be on the cutting-edge, more often than not, achieved their greatness by aligning organizational ambition, culture and people to produce a supportive, enabling design. “The paradigm has shifted to include

all users, including students and guests,” said Barbara J. Speziale, associate director for academic affairs, Watt Family Innovation Center, Clemson University.<sup>17</sup>

**The ambition of innovation spaces is to help people flourish.**

# Section 3: Trends Influencing the Design of Innovative Workspaces

As described earlier in this paper, innovation spaces, like broader geographies of innovation, are the physical manifestations of broader trends that invisibly steer their development. Depending on their role in advancing innovation, there is a clear imperative for some types of innovation spaces (such as research institutes) to belabor the intricate details on how innovation is changing. For other spaces (such as certain types of co-working spaces), it is useful to understand those insights in ever-broader strokes.

For all types of innovation spaces, it is simply fundamental to be responsive to the changing needs of workers in this highly volatile and dynamic environment.

For the first time, four generations are sharing the same workplace: Traditionalists (pre 1945); Baby Boomers (pre 1965); Generation Xers (pre 1980); and Millennials or Generation Y (post 1980). With a changing workforce comes a change in workplace preferences, attitudes and expectations.<sup>18</sup> A nine-month study on Millennials in the United States set out to understand the shifting demographics in the workplace and how offices might be configured over the next 20 years as a result. The ideal work environment for Millennials, the research found, is spaces that are social, flexible, comfortable, open, spacious, collaborative with technology and environmentally conscious. Of equal interest, it appears that the behavior and work style of Millennials is already creating a tectonic shift in the design of many companies and firms—something that has been embraced by workers across multiple generations.<sup>19</sup>

Many architects interviewed for this research also remarked on how changes in demographics have influenced office design. Several spoke of the power of Millennials in driving design changes, though some offered an important caveat: that older generations view design as a means to connect to this new generation of workers. On reflection, these spaces are valued as being “age agnostic,” creating just the right kind of environment to bring multi-generational groups together.<sup>20</sup>

Given the power of workplace preferences, more companies are realizing that high-quality space design is one way to attract and retain talent. Dougan Sherwood, co-founder of Cambridge Innovation Center in St. Louis, offered his perspective:

... We go through great lengths to be thoughtful of our design. It attracts talent. The tech startup is competing with Google to hire the same talent. What startups have is the ability to argue the ‘unknown upside’ of their work but they can’t have an [expletive] office in the wrong location.<sup>21</sup>

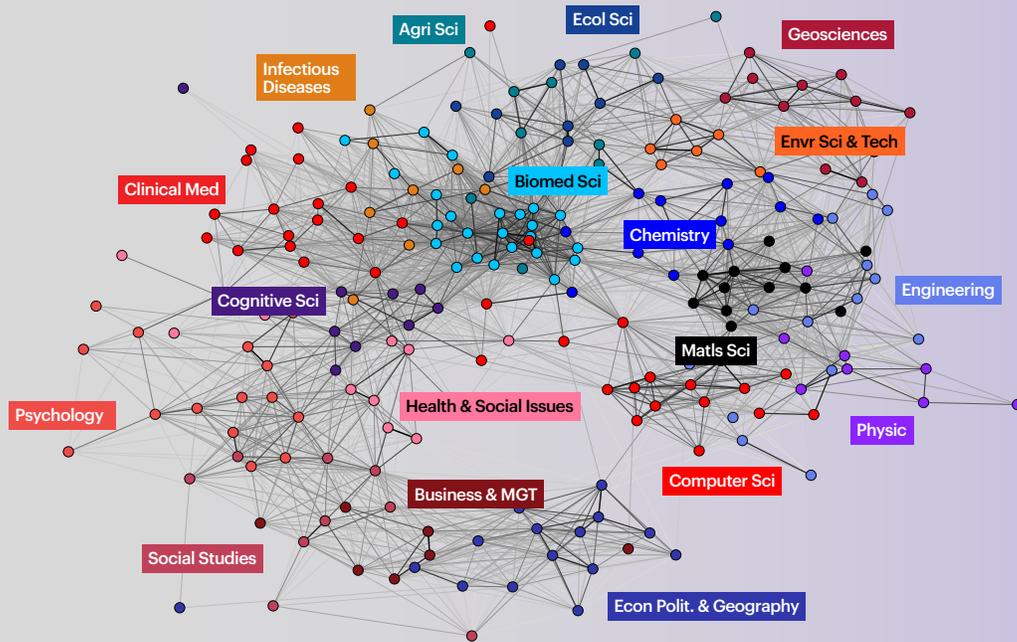
The design of innovation spaces are, in different ways, influenced by at least three other meta-trends, which are described on the following pages.

## Trend 1

### The increasingly “open” and collaborative nature of innovation is changing the nature of design.

We as a society continue to be mesmerized by the visionary “lone wolf” devising breakthrough ideas. Yet innovation is increasingly a collective process, where firms rely on a web of actors to achieve both incremental and disruptive innovation. Case in point is the laboratory, the iconic landscape where scientific studies are designed to solve some of the world’s most plaguing biological challenges. After examining 10 years of data, one study found that patents generated by teams or an organization were “more likely to represent breakthroughs than those from lone inventors,” citing they were 28 percent more likely to be in the 95th percentile of cited patents than those working alone.<sup>22</sup> Another study evaluated 19.9 million papers over 50 years, and 2 million patents, finding that teams dominate individual authors in the development of innovative ideas, contributing to the wise old adage that two heads are better than one.<sup>23</sup>

What happens when three, four, even 25 heads from varying firms contribute to one innovation life cycle? This illustrates the changing nature of our economy, which is embracing a new process called “open innovation.” Coined by Henry Chesbrough, open innovation is a process where companies and firms generate new ideas and bring them to market by drawing on both internal and external sources. One of the latest and more-splashy examples of this is the new collaboration between Google, Facebook, Amazon, Microsoft and IBM to publish research under an open license to explore the complexities of Artificial Intelligence.<sup>24</sup> The expanding knowledge needed to innovate, along with the proliferation of small companies and research and development laboratories, are contributing to a new ethos where collaboration is king.<sup>25</sup> Today, external sources, such as R&D laboratories and small firms, can generate the ideas that are then commercialized internally by a firm, while internal ideas can be commercialized by external start-up companies and entrepreneurs.<sup>26</sup>



A global architect uses a similar graphic to emphasize a top design objective: to facilitate the convergence of different disciplines. Source: Rafols, Porter and Leydesdorff (2009).

Equally interesting is how collaboration has been manifesting into something beyond singular projects or engagement in open innovation. Firms and actors across disparate sectors and disciplines are converging.<sup>27</sup> A team of 12 leading Massachusetts Institute of Technology (MIT) researchers, for instance, argues that “convergence is a broad rethinking of how all scientific research can be conducted, so that we capitalize on a range of knowledge bases, from microbiology to computer science to engineering design.”<sup>28</sup>

While not a new phenomenon, what is changing is the extent to which convergence is accelerating and increasingly pervasive. It has extended into sectors such as advanced manufacturing, energy production and distribution, and ICT (information and communications technology). And it is now a philosophy of practice that is helping global companies, such as Ericsson in Stockholm, remain cutting-edge. “If you look at transport or electricity, we are now entering all areas and drastically transforming the way services and products are made,” shared Ulf Wahlberg, Ericsson’s vice president for industry and research relations.<sup>29</sup> Ericsson and other companies are leveraging relationships with government and universities to strengthen convergence. This comports with a recent finding from Michael Crow, president of Arizona State University and William Dabars in their book, *Designing*

*the New American University*, suggesting that university-industry-government partnerships are the strongest avenue to driving innovation.<sup>30</sup>

Collaboration—albeit within singular organizations, through open innovation processes or, increasingly, through the convergence of disparate sectors—is more valued as a means to compete. For a growing share of firms, institutions and organizations, it’s an embedded philosophy, if not ethos, altering the design of companies and workplaces across the landscape.

## Design implications

It would appear—largely based on the media, the movies, if not from the above insights—that workplaces with collaborative, informal spaces are now conventional practice. A more-accurate picture, however, is that most people work in traditional, hierarchal offices that emphasize individual work.<sup>31</sup>

To foster a collaborative work setting requires going back to the basics: taking a hard look at the value that an organization places on collaboration. Organizational culture, commonly described as a company’s set of values, assumptions, attitudes and behaviors, is the invisible code that makes one company soar and another sink. The authors of the book, *Change Your Space, Change Your Culture*, offered particularly sharp observations that, though companies may have departments or teams devoted to innovation, they often lack an innovation culture: “Like rings of a ladder, innovation is tied to collaboration and collaboration is tied to engagement, and the first ring of an innovative culture is an engaging workplace.”<sup>32</sup> So even if companies go to great lengths to express a culture of collaboration, diversity and empowerment, their designed spaces may express hierarchy, control or even fear.

While not everyone interviewed offered such linearity on culture and its relationship to design, an important share spoke of how changing social behaviors and organizational intentions are contributing to how space is designed. Some spoke of how architecture is largely about following social patterns: hierarchy reigned in the 1970s; today, it’s about mixing.



Innovation is an increasingly collaborative process. Photo credits: (left) Ann Coulter, (right) Andrew Curtis.

Others described the changes as a new willingness on the part of organizations and companies to talk about the intention of space rather than just design as a pure aesthetic goal. Others, still, offered how it's not about creating a type of innovation space but, as Kelly Ennis, founding and managing principal of the Verve Partnership, wisely observed, "It's about creating an environment that allows people to thrive."<sup>33</sup>

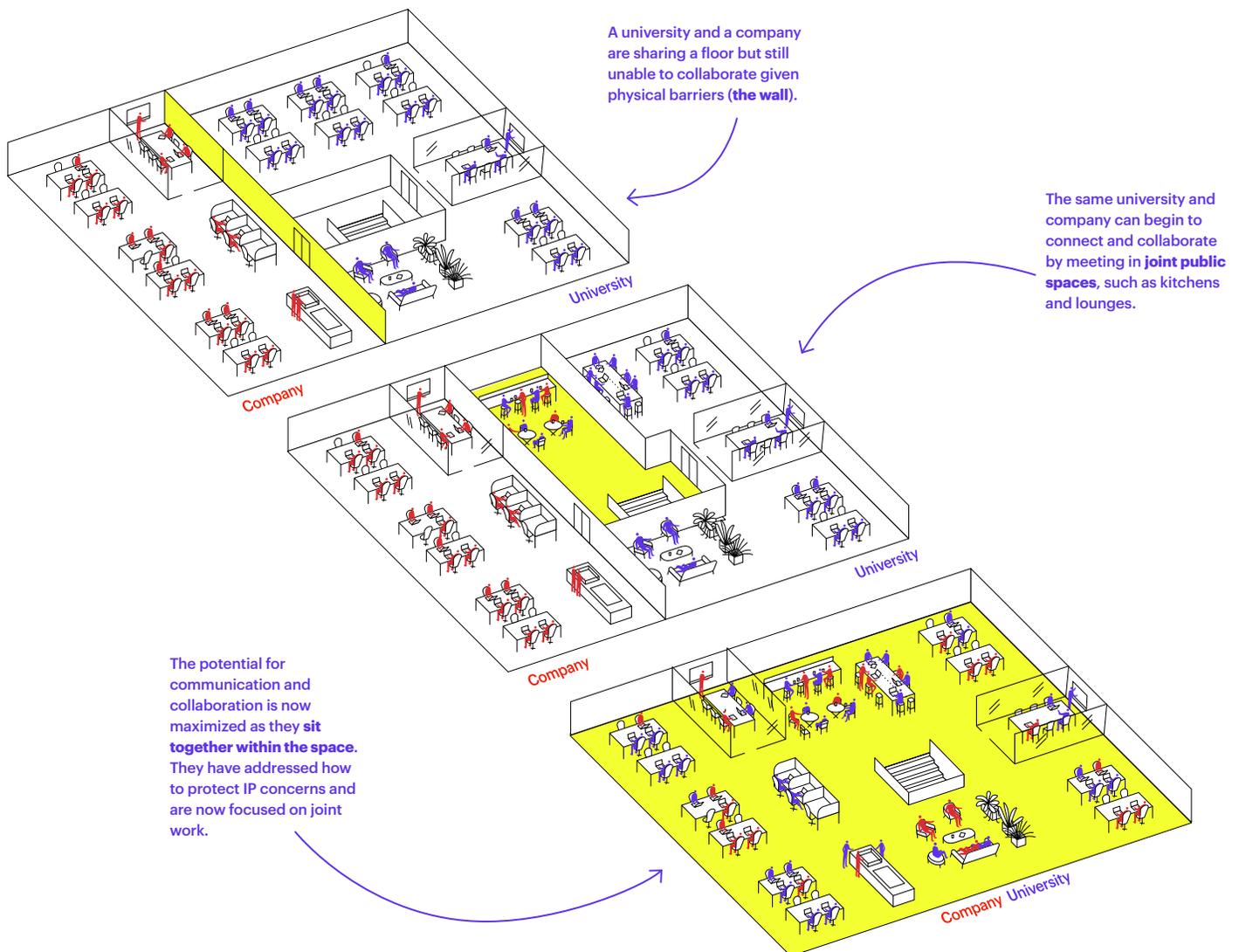
While creating a collaboration-rich environment is a complex, lengthy and iterative process, architects and managers of spaces described their strategies for facilitating collaboration through design as follows:

## A work setting centered on collaborative work

**Team mixing through design:** From research institutes to start-up spaces, architects are applying creative spatial strategies to stimulate both mixing (of people and disciplines) and collaboration (between people and across disciplines) as if it were a seamless act. While it clearly is not, some architects emphasized how physically mixing people in space gives new reasons for people to communicate and

connect—important precursors to any future collaboration. Tully Shelly, the architect for Stanford’s Clark Center, emphasized this point, arguing how successfully designed spaces “accelerate the formation of partnerships between biologists, clinicians, engineers, chemists, physicists, and computer scientists ...”<sup>34</sup> As it turns out, different spaces are applying varying techniques to facilitate both evolution mixing and collaboration.

- Some managers choreograph mixing through the seating chart: grouping together researchers from diverse specializations, if not sectors.
- In some workspaces, researchers are organized into neighborhoods or pods, required to share equipment and supplies as a means to facilitate conversation and side chatter.



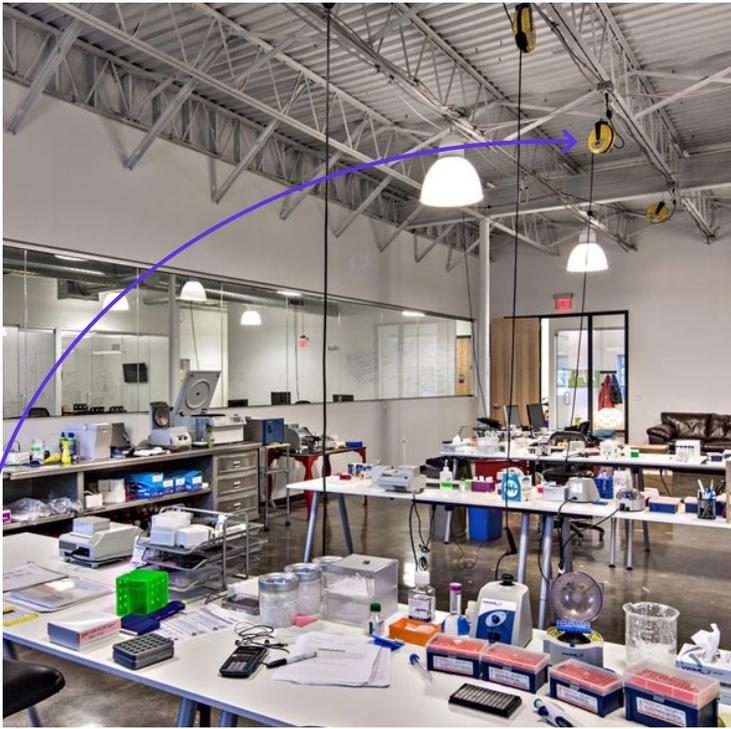
- In other spaces, open work-floor settings are creating what has been described as a “new legibility of landscape,” prompting people to engage in conversations. From advanced manufacturing incubator spaces to maker spaces to the open office setting, managers of spaces offer how tearing down physical barriers are stimulating mixing and collaboration.
- In other cases still, such as at the Clark Center, areas are regularly reconfigured to support new group formations from 22 different departments.<sup>35</sup>

**An underlying system of flexibility:** The example of regularly reconfiguring space at Stanford illustrates another important trend in design—flexibility. While far from new, innovation spaces are re-embracing the notion of flexibility to respond to the changing needs of people and innovation processes in real time. Flexibility requires thinking through all aspects of space, including the application of moveable walls, furniture, machinery and other components at a moment’s notice. Demands for greater flexibility has, for example, given new currency to the wheel in the 21st century. From incubators to co-working spaces, to laboratories, wheels are now commonly affixed to furniture and equipment. And in some spaces, electrical cords are attached to pulleys to create giant extension cords.<sup>36</sup>

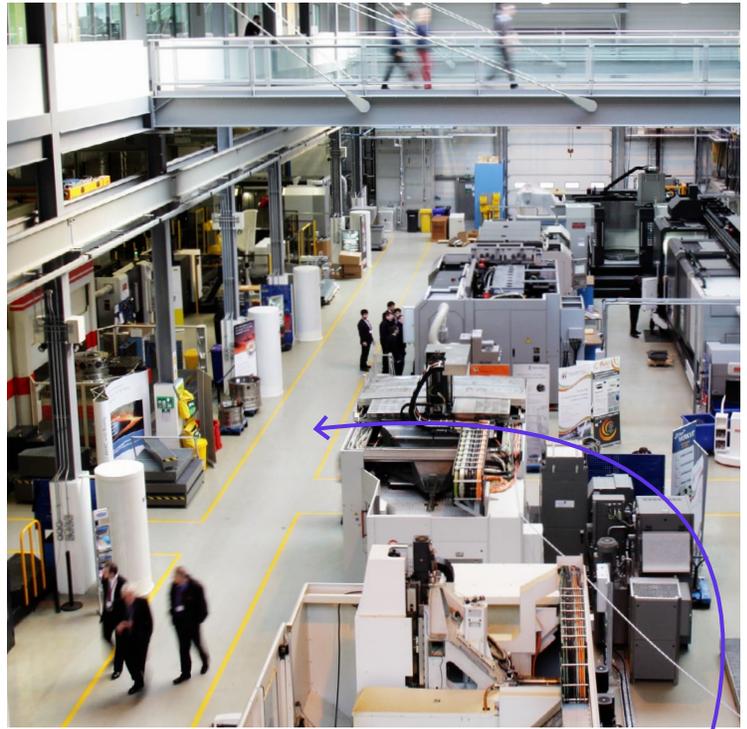
**“The space that you design on moving day will change in 12 months so you better be designing for that fact.”**

Peter Marsh,  
Vice President and Principal Project Manager, Workplace  
Strategies<sup>40</sup>

The Advanced Manufacturing Research Center (AMRC) in Sheffield, United Kingdom translated the concept of flexibility into a core directive by focusing on the floor. The AMRC is a flexible research space designed to allow manufacturing research and development to be conducted on industry-size machines rather than require manufacturers to scale-up later. While traditional manufacturers use fairly lightweight floor slabs because their equipment remains in position for many years, the AMRC installed thick floor slabs to allow machines to be changed regularly. “We wanted a space that was reconfigurable, where equipment could be moved easily with minimum setup time, creating an entirely flexible, digitally monitored and controlled environment.” said John Baragwanath, executive director of the AMRC Group.<sup>37</sup>



As flexibility is paramount in this lab space, electrical cords on retractable coils hang from the ceiling. Workers can move around and still be “plugged in.” Cofactor Genomics in St. Louis. Photo credit: Matt McFarland.



Thick floor slabs make this innovation space highly flexible as heavy machinery can be moved without tearing up the floor. The AMRC in Sheffield. Photo credit: AMRC

While flexibility allows seemingly rigid spaces to bend and move at a moment’s notice, it also engenders worker empowerment. Some research- and learning-oriented spaces are dedicating zones for users to co-opt as their own. North Carolina State University, for example, has a mix of collaborative private rooms, living-room style spaces, classic-style reading rooms and furniture that can be used to devise a personal landscape.<sup>38</sup> It “helps build ownership and engagement,” said Gregory Raschke, an associate director at North Carolina’s Hunt Library. “Variety is essential if you have the resources to offer it.”<sup>39</sup>

Changing up spaces is one way firms are responding to the imperative to collaborate. The rate of change within organizations due to global pressures and the need to revise strategies is yet another reason driving flexibility in design. Several architects spoke of this highly curtailed life span of design spaces.

# Striking the balance: Designing for both collaborative and individual work

**Just about everyone has a surprisingly strong opinion on the layout of workspace—be it an open office design, a closed one or something in between. Some expressed deep, if not raw, emotion about how the right design can magically lead to inspirational teamwork while poor design can reduce teams into ineffectual groups. The following sections offer a few broad observations on office design.**

## Open office design

The ‘open office’ is where desks are divided by low partitions (generally 30-36 inches high) or where no partitions exist at all to allow clear views across the space. Devised by a team of organizational designers near Hamburg, Germany in 1958, the open design model broke up the physical barriers that stymied communication and the organic formation of teams—an important ambition again today.<sup>41</sup> In fact, a large share of those interviewed argued its merits. “The interactions that occur as a result of the open floor plan simply would not take place with a classic, closed design,” argued Jen Meyer, CEO of the Baltimore-based Betamore, a technology and entrepreneurship campus.<sup>42</sup> Comparable with some of the ambitions of 1958, factors favoring an open office in an innovation setting include a reduction of silos and hierarchies, an increased level of interaction and face-to-face communication, increased flexibility, and increased spatial efficiencies. Another reason is cost savings in overall construction costs. By one estimate developed by Perkins + Will, an international architectural firm, companies will achieve over a 50-percent cost savings (furniture, power, lighting, materials) using an open office design compared with designing private offices. There are also greater space efficiencies, saving as much as 100-square feet when converting one private office space to a workstation.<sup>43</sup>

**“The fact is that we’re watching more and more pilgrimages where our people pick up their laptops and wander—wasting precious time—in search for a respite from the roar and a place where they can hunker down and get something done.”<sup>45</sup>**

Howard Tullman, CEO of 1871

But putting savings aside, both architects and users have found tremendous impact through open space design. Let’s take the case of Inmar, a company on the cutting-edge of supply chain and systems management in Winston-Salem, North Carolina. Previously dispersed in a campus-like setting, with buildings filled with cubicles, Inmar leadership found “the physical adjacencies were becoming less and less ideal.” When the CEO expressed the desire that the leaders of each network have a line of sight across their entire organization, this translated into creating what one designer described as the “legibility of landscape ... If you can’t see what’s going on, the opportunity to innovate within teams nosedives.”<sup>44</sup>

Yet the open office design is far from being universally accepted. Many workers complain of increased noise, loss of needed privacy, and being painfully sandwiched between others.

Architects and others have responded, analyzing how to mitigate these impacts through technologically superior, noise-absorbing fabrics, private spaces to enable quiet work

and a greater emphasis on separating uses. One government publication, *Sound Matters. How to Achieve Acoustic Comfort in the Contemporary Office*, is such an example.<sup>46</sup>

## Hybrid (open/closed) office design

Given these and other challenges, some architects are opting toward a hybrid approach where both open and closed spaces are integrated across the floor. Openness and in-

teraction is not for everyone. There is a need for a balance between interactive (social) and private (reflective) space. Even in advanced manufacturing, where an important share of innovation occurs on the open floor, workers at one innovation space found they still needed to carve out quiet spaces to advance them further.<sup>47</sup>

The configuration of public and private spaces varies distinctively and grandly, punctuating in many ways a workspace brand. Some spaces are intentional in creating thick, soundproof walls in key areas to signal the value of privacy and quiet, others liberally apply glass walls to give visual cues of openness, though activities and spaces are segmented. Nearly half of the architects and managers of spaces underscored how powerfully interior glass walls keep everyone visually connected.

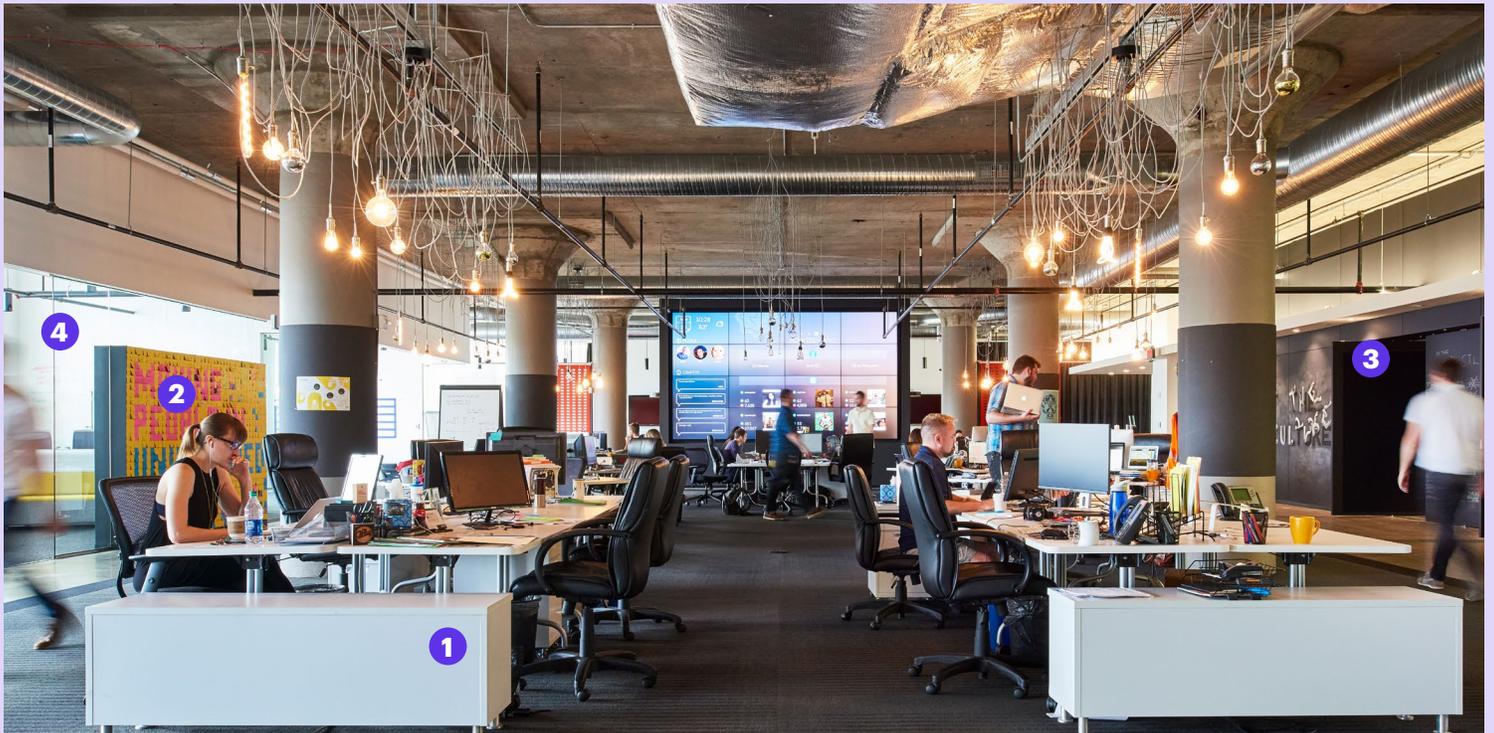
### The re-imagined laboratory

At the beginning of the 20th century, laboratories were constructed using very basic design elements—the lab bench, the fume hood—organized simply in rows for the individual researcher. Even today, the general concept of the laboratory is one of high structure if not rigidity. Like other workspaces, the laboratory has changed.

Architects and managers spoke of how changing design preferences impact laboratories, namely the growing desire to encourage teamwork and collaboration through shared open laboratories. As the composition of research groups are now constantly in flux, many described the need for flexibility and the ability to reconfigure space with minimal disruption and cost. “Because the boundar-

ies between single disciplines are disappearing, designing laboratories for conventional scientific disciplines is becoming obsolete. Research laboratories should now be designed to accommodate a range of research activities and be able to easily adapt to changing needs,” explained TH Chang, the architect that helped design the Crick Institute in London.<sup>48</sup> These ambitions—in a space with intensive, focused research—require striking a balance between inherent flexible, collaborative spaces and not making the environment too disruptive.

The new design components of laboratories include only a few solid walls, glass walls, open labs, plug-and-play workbenches and casework on wheels, smart ceilings (which allow users to easily make changes to lights and other electrical components) and an inviting coffee bar nearby to encourage conversation. Managers of a start-up space for life sciences, which includes wet labs, spoke warmly of how open design of laboratories are increasing interaction and collaboration. In this space, researchers comfortably sit next to each other, learning from each other and not interfering with any intellectual property issues.<sup>49</sup>



A hybrid office space for the company Manifest in St. Louis. (1) A highly flexible and informal open office space. (2) Some people decide to wear headphones to block out any noise. (3) There are also closed spaces where workers can go when they need a quiet space to concentrate. (4) Glass walls keep the space open and visible. Photo credit: Triggs Photography.

## Trend 2

### The complexity of innovation is re-valuing face-to-face communication.

The first trend describes the increasingly collaborative nature of innovation and how collaboration is manifesting within individual firms, between firms, and now across disparate sectors and disciplines. What did not surface in this first trend, however, are the obstacles that come with it.

Some of the more pressing challenges present themselves when people attempt to collaborate across sector or discipline. Research reveals that the pressure points include differences in language and terminology, potentially conflicting sets of experiences, different norms and even expectations.<sup>50</sup> Given these challenges, other researchers examined how converging teams are achieving results. They found that their success relies on a deep “knowledge-meshing capability,” where R&D project teams employ deliberate techniques to integrate knowledge from varying disciplines.<sup>51</sup> In other words, collaborating across disciplines demands greater focus on team building and active problem solving. If not achieved, this alone can lead groups of brilliant scientists to stumble and ultimately fail.

Another challenge is the ability for individuals within innovation sectors to effectively communicate tacit information; that is, more experiential, unstructured and undocumented information. The transfer of tacit information generally requires “rich interactive communication mechanisms, such as face-to-face communication,”<sup>52</sup> such as highly interactive, two-way communication between people to ensure important nuances are grasped. The sharing of tacit information is both easier and less costly to achieve within a firm as opposed to across firms.<sup>53</sup> The geographic clustering of firms, where access to reach other firms is easily achieved, helps reduce this barrier.

Over the last century, a string of economists and social scientists, all giants in their field,<sup>54</sup> have come to conclude that firms, if not larger idea-based economies, have a tendency to geographically cluster

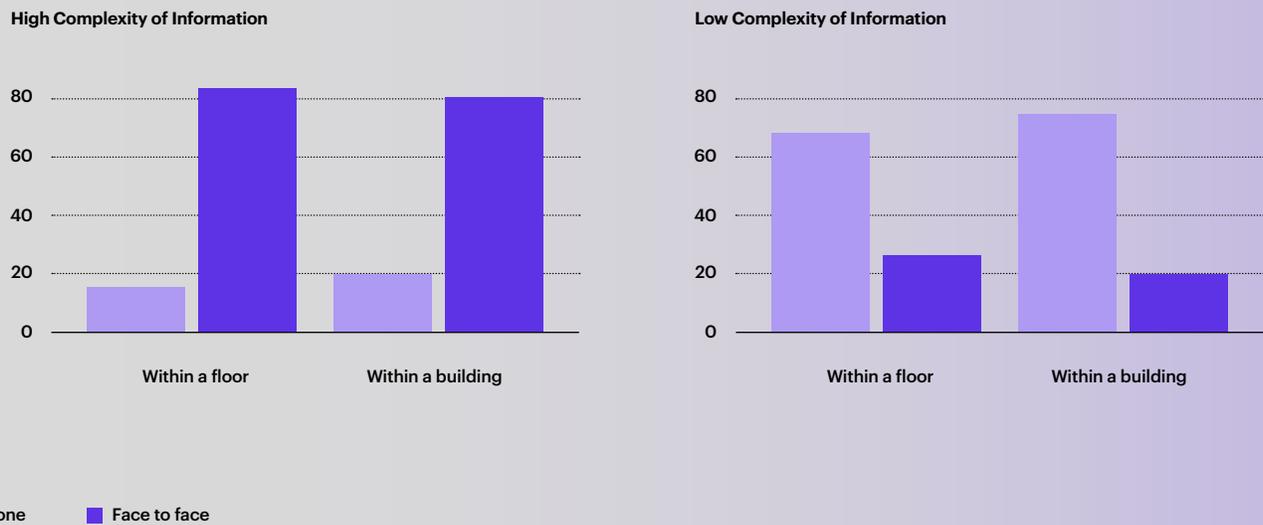
or agglomerate because “*ideas move imperfectly over space*”—an observation aptly phrased by Harvard Economics Professor Ed Glaeser.<sup>55</sup> These imperfections include, in part, the challenges described above: limitations in sharing complex or tacit information and effectively bridging the different language and experiences across sectors and disciplines. While there are many reasons driving firms to locate in close proximity, the ability to share and exchange knowledge is one of them. The clustering of innovation-oriented sectors achieves important benefits given the complexity of information being shared. For example, research reveals that R&D labs in over one-third of manufacturing industries are clustering less than a quarter mile from similar firms that quickly dissipate with distance, further emphasizing their tendency to agglomerate.<sup>56</sup>

Mirroring the reshuffling of space at the regional, city and local scale, the rearrangement of space is even more prolific inside innovation spaces. One of the drives behind new spatial designs is to increase face-to-face communication. “Getting people to talk to each other is the only truly effective way to transfer technical knowledge and advancing the process of information,”<sup>57</sup> observed an organizational management and architect team that instruct firms on how to strengthen their innovation through design. New research continues to affirm the value of face-to-face communication within firms. One study evaluating thousands of sociometric badges (the electronic tags applied to plastic badges or clothing hangers to track and store movement) in workspaces across sectors and in different types of office layouts found that “face-to-face interactions are by far the most important activity in an office.”<sup>58</sup>

Fine-grained analysis indicates that achieving face-to-face communication within buildings is riddled with obstacles. Thomas Allen and Gunter Henn, authors of *The Organization and Architecture of Innovation: Managing the Flow of Technology*, found that the probability for people within one organization to communicate effectively dissipates beyond 10 meters, reaching, what they described as “an asymptotic level” at 50 meters or 164 feet.<sup>59</sup>

Delving deeper, Allen and Henn identified, as illustrated in the graph on the following page, that people have a far greater tendency to

## Mode of communication: Low complexity versus high complexity of information



When the information communicated is highly complex, face-to-face communication becomes a priority. Source: The Organization and Architecture of Innovation.

communicate face-to-face when information is of a complex nature. When information is less complex in nature, as the second graph illustrates, communication via the telephone occurs at a higher rate.<sup>60</sup>

While these findings emphasize acute sensitivities with distance, those working within social sciences, such as sociology, psychology or organizational development, help explain why that is the case. Generally speaking, the need to communicate complex information requires both verbal and nonverbal communication. Hands and other body language are needed to enunciate important points and eye contact is virtually the only way to ensure nuances have been grasped. This is particularly true in an innovative setting where workers need to rely on a range of communication tools to convey arguments with some degree of authority and, in the same setting, to accurately receive information through all the cues. Quantitative studies on nonverbal communication demonstrate that nonverbal cues are fundamental in communication transactions.<sup>61</sup>

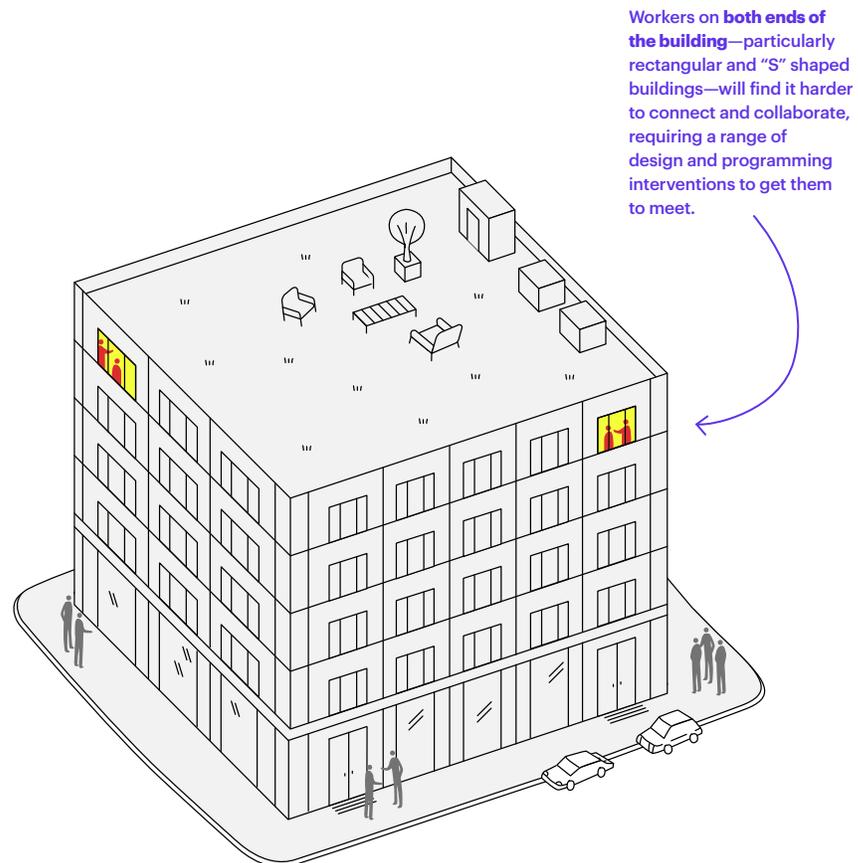
Technology can visually connect people across great distances, with advancements in both software and hardware enabling new forms of face-to-face communication to proliferate across the innovation landscape. Yet, even with these advancements, interviews suggest that

**Organizational boundaries are the biggest barrier to ... [getting people to talk to each other] ... because organization boundaries separate cultures and the ways people think and do things.”<sup>62</sup>**

Thomas Allen and Gunter Henn

the intimacy achieved through in person face-to-face communication remains highly valued. This is best exemplified by how research institutions, for example, are intentionally mixing disciplines and creating the spaces to encourage face-to-face communication.

Design clearly has a role to play in maximizing face-to-face communication. Architects, whether referencing co-working spaces, start-up spaces, or research institutes, convincingly described the imperative to maximize such opportunities for more personal interaction. Understanding the merits of physical proximity has compelled architects to return to the basics, embracing prior concepts such as the central staircase, where passing colleagues can stop, talk and exchange information.



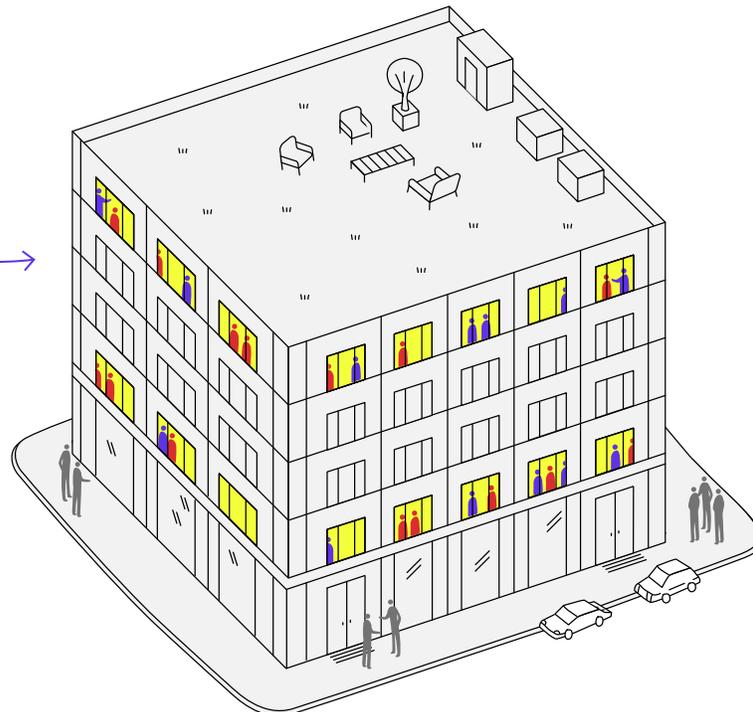
## Design implications

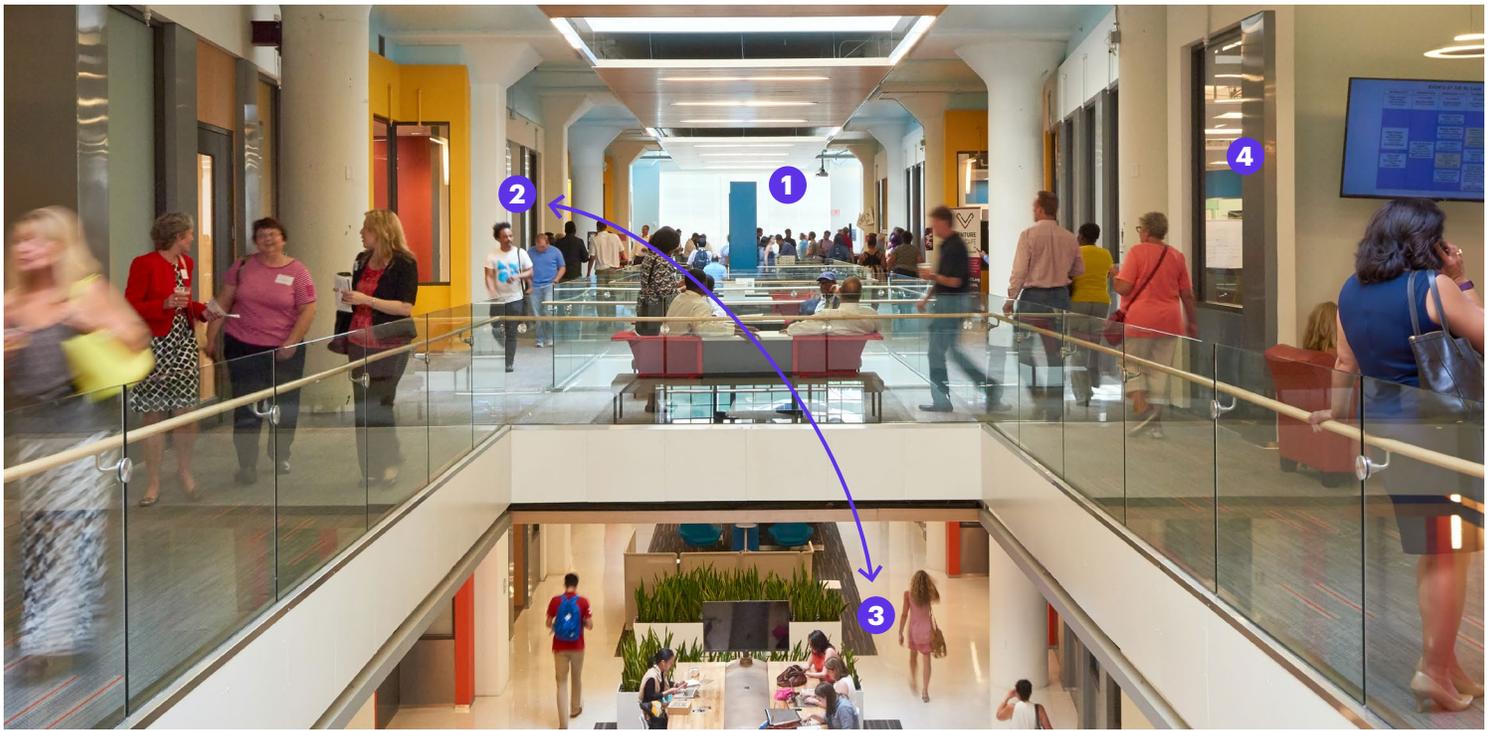
### Using the “bones of the building” to shape how to communicate, collaborate and inspire

Before even stepping inside, the overall building configuration—its shape, size and height—will define the extent to which a company can successfully facilitate face-to-face encounters. Thinking through a building’s physical constraints and how to mediate, if not eliminate, those constraints is fundamental to successful innovation spaces. For instance, a long rectangular or more snake-shape building creates additional barriers for people to meet, given overall distance.

Within the building, other considerations must be weighed. Single story or same floor locations are preferred over multiple stories as research shows that vertical separation has a more severe effect on separation than horizontal.<sup>63</sup> Architects and users spoke favorably of specific strategies of manipulating the physical to strengthen connections between people, including the following:

Workers on different floors will simply not bump into each other as compared to workers on the same floor, requiring a range of design interventions.





This atrium creates new connections between two floors @4240 in St. Louis. (1) Natural light can reach lower floors; (2&3) Workers and visitors on different floors are much more connected to each other; (4) Open spaces allocated for quiet work should not be located near an atrium. Photo credit: Romondo Davis.

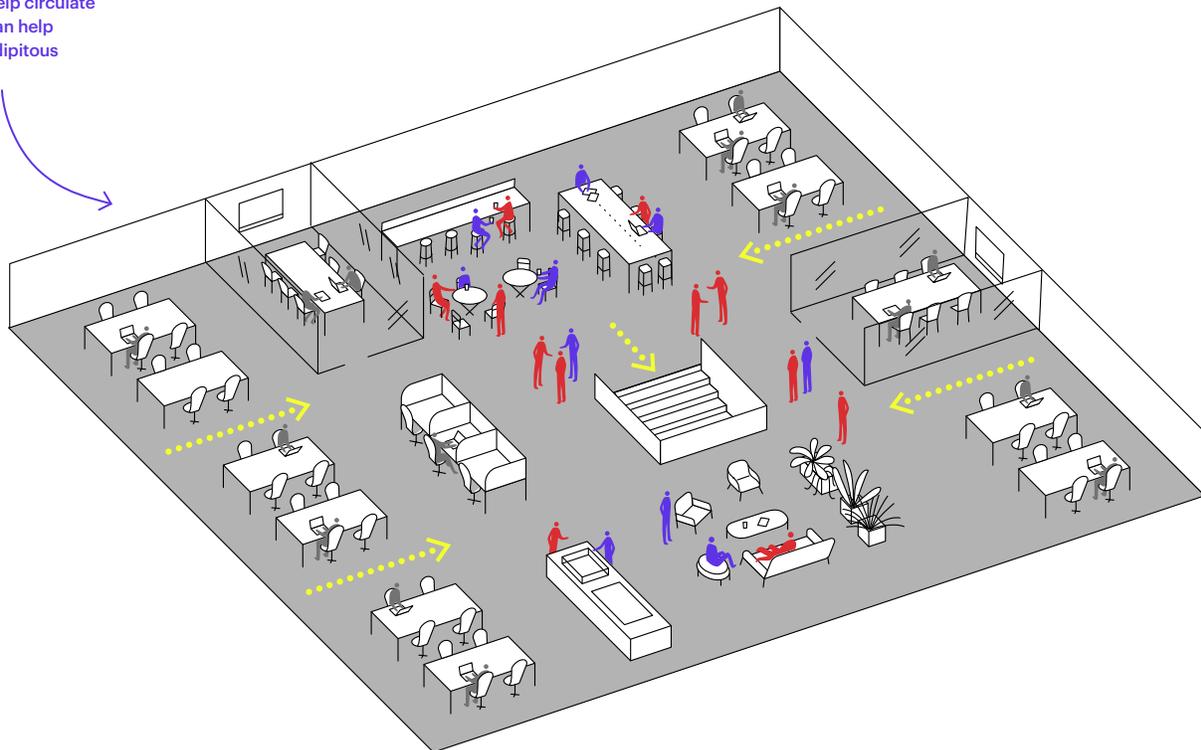
**The Atrium:** An often effective but expensive approach to reducing barriers across floors, where part of the floor section, often the core, is removed. When designed well, an atrium can be an important leveler. “The atrium not only provided important daylight, it created important visual connectivity between spaces,” recounted Lance Cage, managing principal at HOK.<sup>64</sup> Others agree. Jessica Tsymbal, head of facilities at the Media Lab, for example, described how they placed greater emphasis on the atrium as opposed to the office spaces given its strength as a connector.<sup>65</sup> The design details associated with an atrium are crucial for it to be a welcomed connector. In some cases, uses placed on the atrium’s perimeter led to noise conflicts that hurt the buildings overall ecosystem. In the design of an atrium, like all interventions to strengthen the bones of the building, details matter.

**Internal staircases:** Another design strategy from the past, the grand internal staircase, has become a smaller, neglected version of its prior self—physically moved to the edge of floor plates and far away from any real activity. In its revived constitution, staircases are located centrally in buildings offering both the depth and decoration to facilitate encounters and interaction as people traverse floors. “It’s another way for people to bump into each other,” shared one manager of an innovative space.<sup>66</sup> To create this kind of magnetism, stairs

need to be wide enough for at least two people to comfortably talk, be aesthetically pleasing and, if possible, showered in natural light.

**Corridors:** Another circulation strategy where corridors are redesigned or spatially reconfigured on the floor to orchestrate where people move and coalesce. For many architects, corridors are the crucible of opportunity, highlighting three common strategies. First, corridors can be designed to create serendipitous encounters. An innovative space in Sheffield and another in St. Louis designed corridors connecting to a central space, requiring people to circulate through it. “We find that this is where serendipitous meetings happen,” said Darren Southgate, studio director of Bond Bryan Architects of the space in Sheffield.<sup>67</sup> Second, corridors can help funnel people away from specific zones to minimize noise for workers needing to concentrate. Third, some corridors evolve into unstructured gathering places. “Something as mundane as the placement and dimensions of a corridor can dramatically activate a space and increase social interactions,” added Architect Andrew Gilles of CannonDesign.<sup>68</sup>

Well-placed corridors can do more than help circulate people—they can help facilitate serendipitous encounters.



# The importance of public gathering spaces

Through trial and error and highly studied approaches, architects have found the real potency in strategically placing public spaces throughout a building. When a writer from the *Atlantic* magazine toured Silicon Valley to cover interior designs of innovation spaces, he acutely observed the potency in creating interactive spaces. Naeem Zafar wrote: “It is not trivial to carefully consider the location and configuration of the water cooler and the social area where people informally meet to chat during the coffee break.”<sup>69</sup> In fact,

a fairly pertinent reason gives these spaces newfound importance. While economists and those in innovation circles talk loosely about creating “accidental collisions” or “serendipitous encounters,” the notion is coveted as they spark *communication for inspiration*. Coined by Thomas Allen, a management professor at MIT, he found communication for inspiration to stimulate creativity, an important precursor for innovation.

**“The café is the magnet. Not only is it non-territorial, because it’s not someone’s personal space, everyone behaves differently when they are there.”**

Jeffrey Morgan  
Principal at NORR Architects<sup>75</sup>

Such communication for inspiration is usually spontaneous and, importantly, “often occurs between people who work in different organizational units, on different projects, while drawing on different disciplines,” he observed.<sup>70</sup>

The mixing of different types of people from different backgrounds and fields occurs most advantageously in informal public spaces designed as neutral territory for everyone in the building.

The notion of interior public gathering spaces is far from new. Ray Oldenburg, author of *The Great Good Place*, powerfully conveys how public gathering places are one of the three spheres of life: the first place being the home; the second, the workplace; and the third, public places that host “regular, voluntary, informal and happily anticipated gatherings of individuals beyond the realms of home and work.”<sup>71</sup>

Many innovation spaces are creating a home-like atmosphere by placing even greater emphasis on kitchens and living rooms. Others are creating an atmosphere of public life by designing cafés and coffee bars. In many spaces, the boundaries between the three individual spheres of life are intentionally blurred to draw people together and



1. 1871 in Chicago, photo credit: Antuany Smith; 2. @4240 in St Louis, photo credit: Matt McFarland w/ M Studio West; 3. LabCentral in Cambridge, photo credit: Paul Avis/ Avis Studio, courtesy LabCentral; 4. Innovation Dock Rotterdam, photo credit: Theo Peekstok, Grossman.

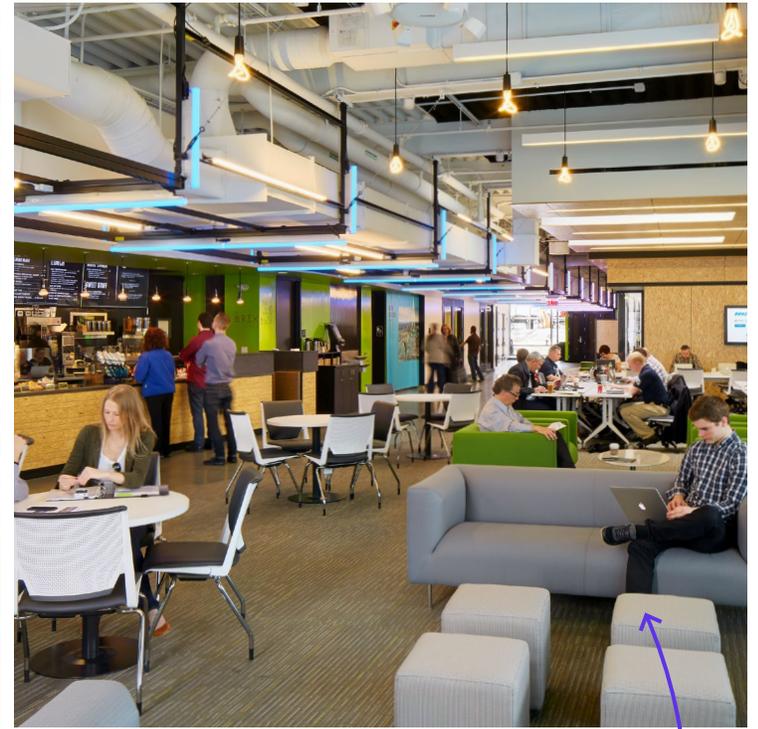
help them relax. Research conducted at the Google office in Zurich found relaxation “to be crucial to innovation and stimulating original thought.”<sup>72</sup>

The growing emphasis placed on informal, communal spaces translates into increased planning and design work. Some architects claimed to have as many as 25 meetings just about the break rooms.<sup>73</sup> The short sections below highlight areas both architects and users frequently mentioned as important places:

Many innovation spaces are finding their own creative way to design kitchens or coffee shops... even high up above a port-oriented innovation space.

**The kitchen/café:** Over half of the interviewees described well-designed kitchens or cafés as the heart of the innovation space. Considerable thought goes into the offerings in kitchens, including different food and drink options on each floor to encourage people to circulate. “Shared kitchens and amenities on every floor facilitates social interactions,” according to managers of the Edney Innovation Center in Chattanooga.<sup>74</sup>

**Lounge/adaptive space:** Others spoke eloquently of the re-purposed lounge as adaptable, interstitial spaces. Woven together by various types of seating, a combination of colors, patterns, and textures, and



District Hall in Boston. Photo credit: Bruce Martin.

inspirational light fixtures, lounges have become an important locus for human interaction. WeWork, which provides co-working spaces, has found their lounges to be the hub of every location, offering beer, coffee and even desk materials.<sup>76</sup> Other adaptable spaces are found outside, such as internal courtyards designed to spur teamwork.

Part of the charm and vitality of these spaces is their inherent flexibility. Matt Arnold, an architect with Hacin and Associates who designed District Hall in Boston, offered that “sometimes this space is an office party. Sometimes it’s filled with people on computers. Sometimes it’s a mix of things going on at once. I am continuously amazed at how much this space can be transformed.”<sup>77</sup>

**The Re-imagined Role of the Ground Floor:** The imperative for face-to-face communication is no longer an isolated act deep inside buildings. As firms and disciplines converge, public spaces are now an important locus for people to mix and mingle. Interviews suggest that the role of public spaces was absent from the discourse of innovation spaces 15 years ago. Today, a growing number of architects are viewing public spaces as a means to breed innovation.

The natural place for public spaces and innovation spaces to overlap is the ground floor, including the lobbies of buildings. These spaces are commonly designed to reflect power and dominance, often punctuated with soaring ceilings and grand gestures of openness. In the large majority of cases, this translates into spaces of sterility and inaccessibility.

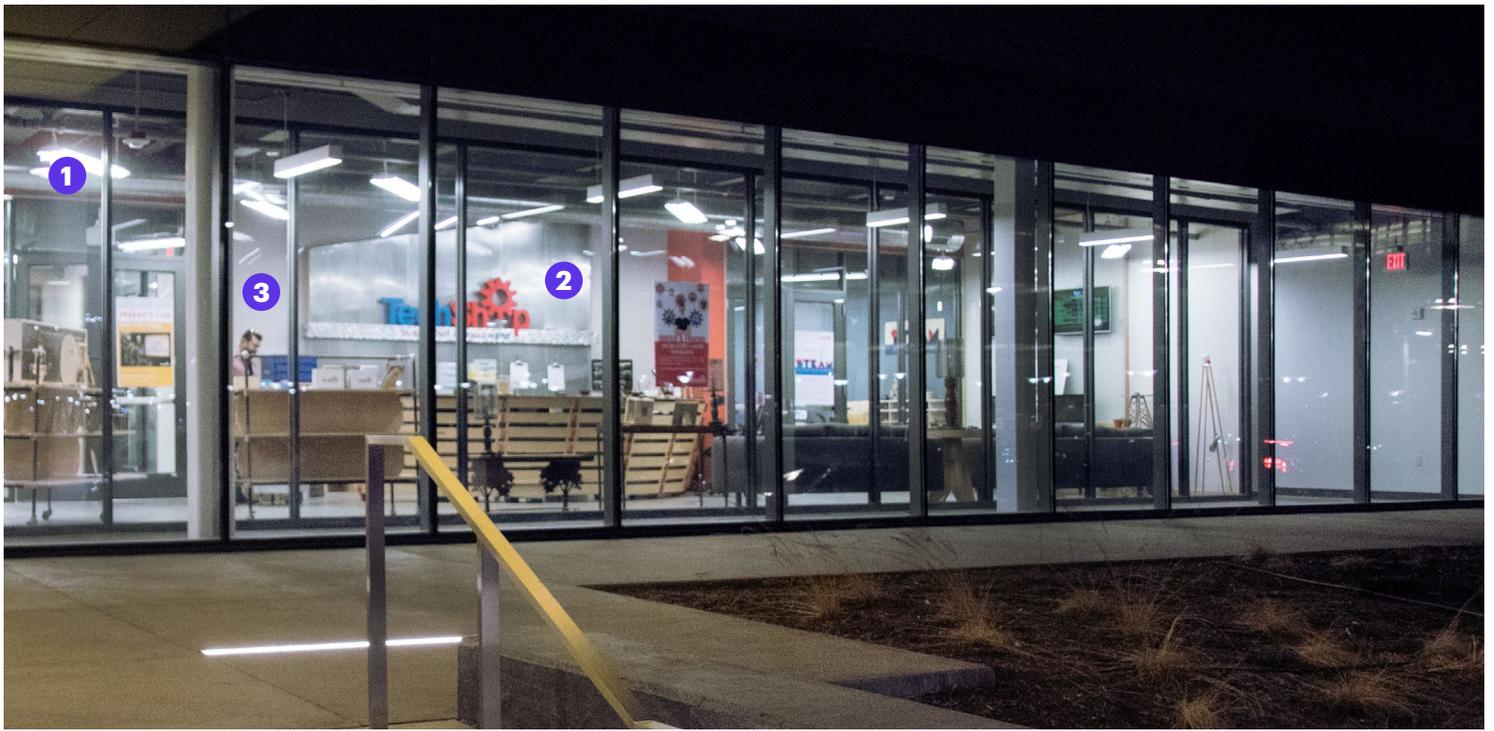
Functionally, the spaces include a waiting area, a set of bathrooms, the elevator core, public facilities, and, often, a reception or security desk. The rest of the ground floor—be it office, research, classrooms, or retail—is separated by drywall and visually inaccessible. While innovation spaces are changing to reflect new realities, the ground floor is sorely out-of-date, failing to be porous, permeable and people-oriented spaces.

This research reveals that this is starting to change.

Interviews with architects and real estate investors focused on strengthening innovation ecosystems indicate a small, but growing, practice of re-imagining the ground floor into community magnets that creatively draw like and unlike people together. “Re-making the lobby or first floor can create a real connection point—a space where you start to break down barriers,” emphasized Kelly Ennis of the Verve Partnership.<sup>78</sup> Other research supports this shift. Outlined in the *Journal of Open Innovation*, the authors point to a growing imperative of social permeability—one that blurs the “boundaries between the living, working and playing” through a mix of uses, strengthened physical connections (such as pathways and plazas), and increased transparency.<sup>79</sup>

There are at least two ways that ground floors are being reconceived to create a valued interstitial space between the public and private realms:

*To create visual transparency—visually connect people outside with the uses and activities inside:* When architects were asked whether building transparency helps, hurts or makes no difference in creating a broader innovation environment, most responded that transparency should be the default design decision. In St. Louis, the recent construction of a new innovation space to house TechShop, a



If designed and programmed well, transparency can help extend the ‘energy of innovation’ into the public realm. (1) Floor to ceiling windows show off this makerspace; (2) Equipment visibally on display; and (3) People working at night keep it activated. Techshop in St. Louis. Photo credit: Romondo Davis.

restaurant and offices, led the architect to design grand floor-to-ceiling windows on the ground floor. This decision created “a billboard to the community, putting the tenant’s innovative workspace on display;” shared Andrew Gilles, an architect with CannonDesign.<sup>80</sup> Others shared that efforts to create transparency should be a focus for the first two floors, as both can be viewed easily from the street.

Some described how transparency invites inclusion. “The way to create inclusion is to de-mystify the building. The only way to do this is to make it transparent—where public and private meet;” said Tom Osha of Wexford, a real estate development and investment company.<sup>81</sup> The link between transparency and social inclusion was voiced in different ways. Some described transparency as the first step to inviting other people—people who often feel excluded—into a space. This was the case at Yale University and their innovation center. “Our building is located between humanities and the sciences. How do you encourage non-engineers to come in? Transparency is the greatest advertising;” explained Joe Zinter, assistant director for the Center for Engineering Innovation and Design at Yale University.<sup>82</sup> Others spoke of using transparency to entice a specific audience. “Science is not always accessible at the street level ... we are trying to create a transparent space on the ground floor that can help invite community into the building;” added Wexford’s Osha.<sup>83</sup>

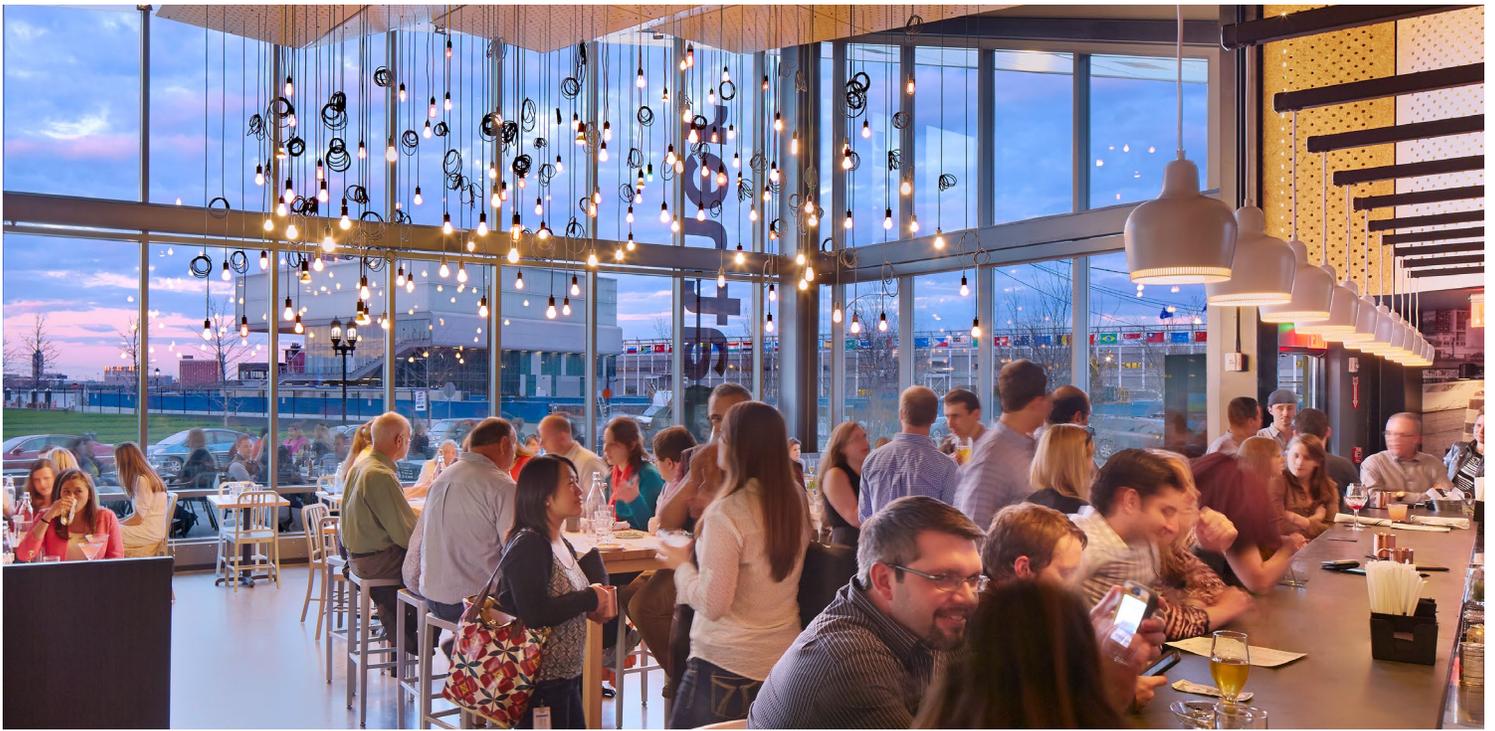


One innovation space designed a coffee shop on the ground floor given its power as a gathering space. CIC Boston. Photo credit: Downtown Boston BID.

*To create permeability—spaces where people are willing to enter and own:* True inclusion means creating spaces where anyone feels they can own the space. Research finds that this principle of design creates economic permeability, where the activities and opportunities inside buildings are for all people.<sup>84</sup>

This is the ultimate aim of the re-imagined ground floor—to essentially blur the private and public spaces, creating a safe neutral space that everyone owns. “The lobby is the front door for every single building. There are real opportunities to create to make this space more socially oriented,” offered Verve’s Ennis.<sup>85</sup>

In some cases, a public café or coffee shop designed into the lobby or ground floor is the easiest, if not best, approach. In other cases, the infusion of free, fast and pervasive wireless technology combined with more lounge-like spaces has transformed ground floors into working hubs. “When we designed the ground floor, we envisioned a space containing comfortable seating groups and convenient technology, such as fast, free WiFi. Today, it has become a place for people to collide and collaborate.” shared HOK’s project designer Michael Browning regarding an innovation space in St. Louis.<sup>86</sup>



Well designed ground floors successfully blur public and private space. Photo credit: Bruce Martin.

While re-imagining the ground floor of a building creates an avenue for reclaiming the lost vitality and authenticity of space, there are important obstacles to be addressed. Of particular importance is security. More often than not, lobbies and ground floors are barricaded by security desks and staff—hardly the environment to cultivate a blurring between people, between public and private, and between work and leisure.

District Hall’s unwillingness to securitize the space is exactly why this space is so approachable. “It’s that first floor ... the fact that you didn’t have to go through security, but you just walk right in, takes the energy off the street inside the building,” described Brian Dacey, president of CIC.

At the same time, the ability to transform a sterile space into a magnetic hub requires attention to the details. While transparent conference rooms and workspaces on the ground floor can be action-packed during the day; after work, these spaces are rooms with empty desks and chairs—hardly a way to contribute to street-level vibrancy. Nate Storringer of Project for Public Spaces argues that details such as the level of glass reflectivity, the extent to which windows are covered with vinyl signage, and the proximity of objects to the window, can make all the difference.<sup>87</sup>

# Programming spaces: Unlocking the true potential of people in workspaces of innovation

This paper would be wholly and undoubtedly incomplete without highlighting the role of programming as part of spaces of innovation. There is a deeply held philosophy that cultivating people and ideas requires programming, such as mentoring, social and cultural events, trainings and meetups. “If you complete a design layout and don’t do the programming that bring the people together, but all you have is layout—a cool space—you don’t have an innovative space,” shared Tom Osha, senior vice president at Wexford Science and Technology.<sup>110</sup> Wexford has successfully teamed up with universities, other anchor institutions and innovation district leaders to strengthen their innovation potential.

A chorus of architects and managers interviewed for this research agree, reflecting how today’s innovation spaces are a seamless integration design and programming. “It is both architectural and programmatic design that builds a community and a collaborative environment. It’s the bal-

ancing of the right amount of public and private spaces and selecting the right events, both informational and social, that really create a special environment,” shared Johannes Fruehauf, executive director and co-founder of LabCentral, an applied science start-up space.<sup>111</sup>

**Programming helps strengthen skills, build new networks ... and give people a reason to relax.**

This twinning of design and programming can be found across many types of spaces. The Cambridge Innovation Center in the St. Louis innovation district, for example, estimate that, due to programming, approximately 800 to 1,000 people a week enter their space. This level of foot traffic, and interaction that comes with it, has transformed their relatively small space into a magnet and important heart of the district. A similar story is playing out in Chattanooga at the Edney Innovation Center. They have happy hours, hack nights and professional development opportunities, which they argue has both strengthened and built important new networks.<sup>112</sup> Programming, if designed well, can be transformative.



1. Betamore, photo credit: Betamore; 2. Betamore, photo credit: Betamore; 3. 22@Barcelona, photo credit: Barcelona City Council; 4. CET Biogenerator, photo credit: Jennifer Korman.

## Trend 3

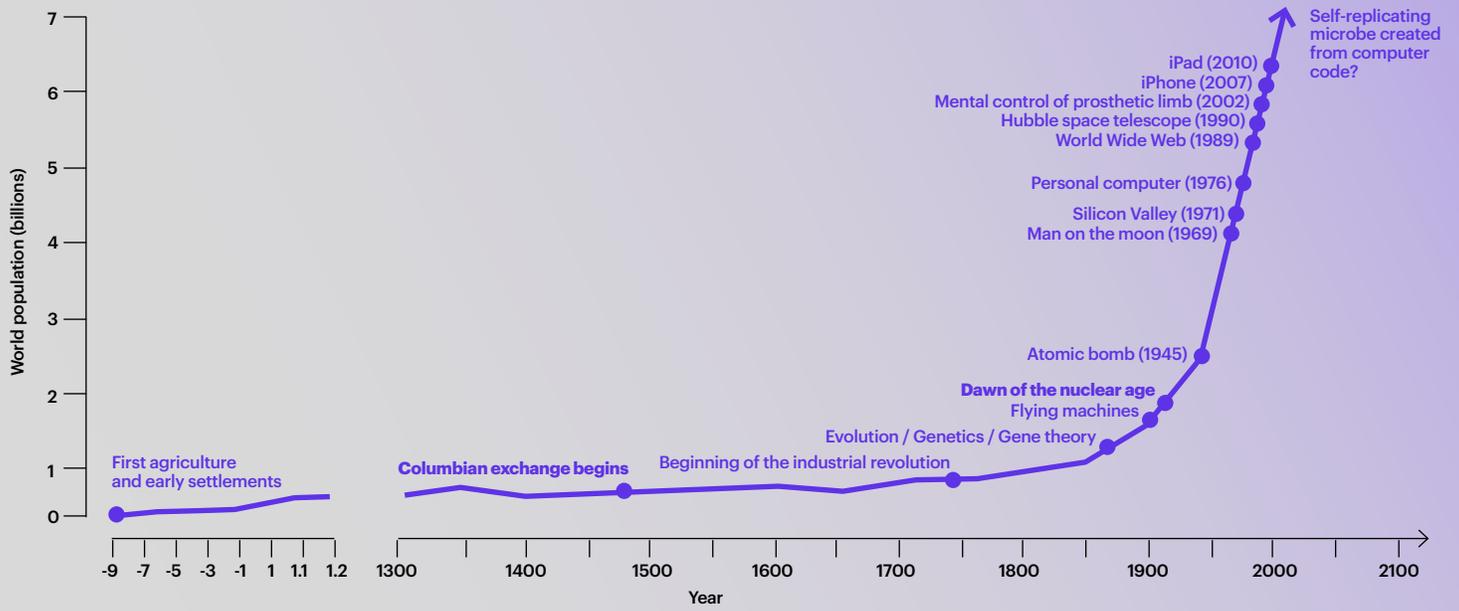
**The ubiquitous nature of technology is transforming spaces into “test beds”—experimenting on the act of balancing organizational desires, technological power and human needs.**

In 2013, the McKinsey Global Institute identified 12 disruptive technologies—including the Internet of Things, cloud technology and first generation genomics—that have the potential to transform life and business as we know it.<sup>88</sup> Eight of the twelve are directly used or applied by innovation spaces, revealing the pervasiveness of technology in innovation processes and the spaces that support them. It also dovetails with what architects observed to be one of most powerful ways innovation spaces have changed over the last 10 years: the integration of “tech.”

While great variation exists on the level of technology found in innovation spaces, technology, on the whole, is influencing office behavior, creating patterns of work that are less obvious or predictable. One clear example of this is how technology has increased the overall mobility of workers, enabling them to work from various locations and still be “plugged in.” A recent worker survey, as part of a process for renovating a large governmental space, found people to be far less tied to a workstation than anticipated, given their mobility. This finding gave sufficient reason to reduce the amount of fixed workspaces, providing only one workspace for every two workers and achieving significant cost savings.<sup>89</sup> While not every worker embraces the implications of spatial shrinkage, the expansion of virtual space is unquestionably changing the rules of the game.

The pervasiveness of technology raises real questions about the extent to which face-to-face communication still matters. And even after culling through reams of research, there is no simple answer. The answers themselves are embedded within each individual space—partly answered by distinctive organizational cultures, partly

## Journey of *Homo innovaticus* since the dawn of agriculture highlighting recent advances in technology and bioscience



Source: William Hoffman and Leo Furcht with the assistance of James Hudak, Oxford University Press, 2014. Modified from Figure 1 of Fogel (1999). Further modified for the Innovation Spaces paper.

answered by the preferences and values of its workers, and partly by the complexity of work and what is needed to improve outcomes.

As a cautionary tale to those who believe technology easily supplants face-to-face interaction, the survey also found that workers come to the office as a means to connect with others and collaborate, ultimately placing greater emphasis, not less, on spaces for people to meet in groups.<sup>90</sup> An essential ingredient to successfully identifying and integrating technology in spaces is not to make broad generalizations around technology, but to undergo an incremental and experiential learning process.

In the end, the only real certainty with technology is its level of uncertainty. Knoll Workplace Research, for instance, observed the lifecycle of many technologies to be roughly 18 to 24 months.<sup>91</sup> The changing nature of technology naturally leads to real challenges in predicting how technologies will change the workplace, leaving even the most sophisticated designers guessing. “We don’t know what’s next. Telepresence rooms [rooms using virtual reality technology] are taking off but not for everyone,” shared Janet Pogue, a principal at Gensler Architects.<sup>92</sup>

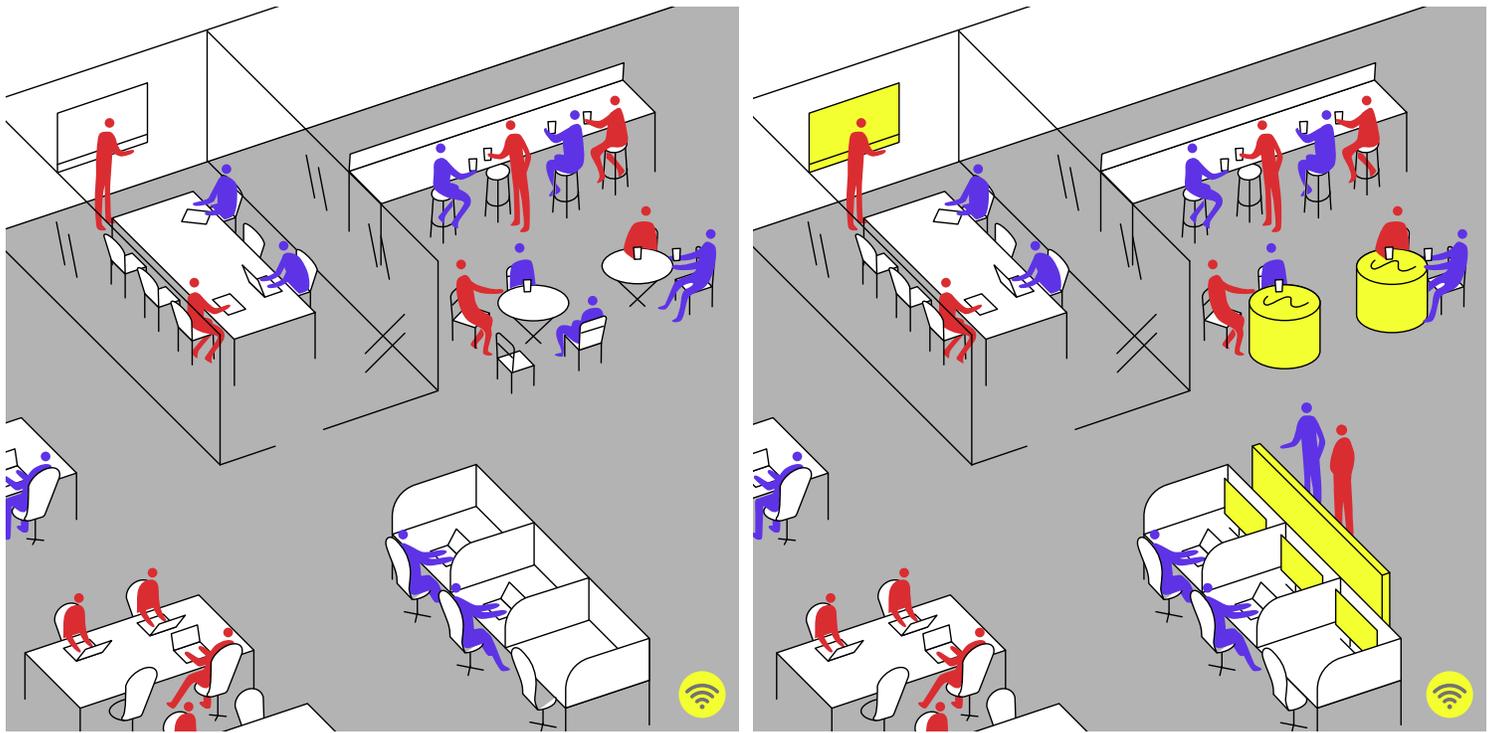
In the midst of change, a few broad trends in technology are nonetheless shaping how innovation spaces are designed.

- First, computer workstations are being replaced with more functional smaller devices, such as laptops and tablets. These smaller, more-efficient size devices are transforming how businesses run, classes are taught and how spaces respond. McKinsey Global Institute reports a six-fold increase in smartphones and tablets since the 2007 launch of the iPhone.<sup>93</sup>
- Given this, workers need, and increasingly demand, access to fast, robust and reliable networks. While greater focus has shifted from wired to wireless networks allowing greater mobility and flexibility, certain innovation spaces still need to account for wired systems.
- Cloud technology, where computer applications can be delivered over a network or the Internet, is another important platform for effective innovation spaces. In fact, cloud technology is one of the 12 disruptive technologies outlined by McKinsey. Although data, software and experiences increasingly live in the cloud, meaningful data analysis still requires dedicated hardware and a physical environment to use technology. In short, the cloud has not replaced the need for space.<sup>94</sup>

**In the end, the only real certainty with technology is its level of uncertainty.**

As these last 10 years marked a tremendous infusion of technologies into innovation spaces, the next 10 years will offer lessons on how—through trial and error—they retain the value of “human-ness.” Their sensitivities to broad economic, demographic and cultural trends, place innovation spaces on the frontlines of change. They offer a window into what is possible, if not likely, for many types of workspaces in the future as they are in essence the social laboratories for how organizations (in a variety of sizes and constitutions), workers, researchers and technologies can achieve the right equilibrium.

Design’s role in all this is central. Just as buildings have been built up, only to be reconfigured and re-imagined to reflect changing priorities, buildings have also been re-wired. In some innovation spaces, technologies are unquestionably pervasive, as is the case of



Innovation spaces can vary quite significantly in the amount of tech they want incorporated into their space.

the Watt Family Innovation Center described later in this section. At the other end of the spectrum are entrepreneurs who come to spaces temporarily, introducing new technologies. On the whole, however, interviews reveal that technology is an increasingly ubiquitous and an important niche for innovation spaces.

Technologies found in innovation spaces can be collapsed into three general classifications: technology as a collaboration and communication tool; technology as a research and/or production tool; and technology as a display and showcase tool.<sup>95</sup> The sections on the following pages offer some insights into each.

## Technology as a collaboration and communication tool

In an interview, Dan Levin, the COO of Box, shared how worker productivity can increase by a magnitude of 10 to 20 percent, especially for mobile knowledge-worker populations.<sup>96</sup> The “freeing up” of workers previously tied to the workstation has been largely enabled by the technologies aimed to strengthen collaboration and communication. Some of the current technologies using software platforms include Bluejeans, Webex, and Skype and can work on small smartphones up to full-scale teleconferencing-type spaces.

There is a long parade of technologies aimed to strengthen collaboration, including project management software programs, workflow system support, and cloud collaboration software. Yet downloading a collaboration app and expecting results misses an important part of the story. Evan Rosen, author of *The Culture of Collaboration*, argues that “unlocking the value of tools happens only when an organization fits tools into collaborative culture and processes. If the culture is hierarchical and internally competitive, it will take more than tools to shift culture.”<sup>97</sup> This takes us back to an observation raised as part of the first trend that organizational culture and design need to be in alignment to be impactful. This equally applies to technology.

## Technology as a research and production tool

Technologies are transforming processes of innovation—particularly the phase of research and development—in ways that even a decade ago would seem unimaginable. In the bioscience field alone, technologies are allowing researchers to edit genes, control the growth and differentiation of cells, and create “microbial factories” that develop new medicines, chemicals, and fuels.<sup>98</sup> In analyzing the expanding sector of bioscience, William Hoffman, a prolific writer and observer in this space powerfully posits how cutting-edge tools “are poised to revolutionize bioscience productivity.”<sup>99</sup> The advances made in technologies aiding and advancing bioscience is emblematic of

a broader trend across a range of innovation sectors where they are providing essential functions in R&D.

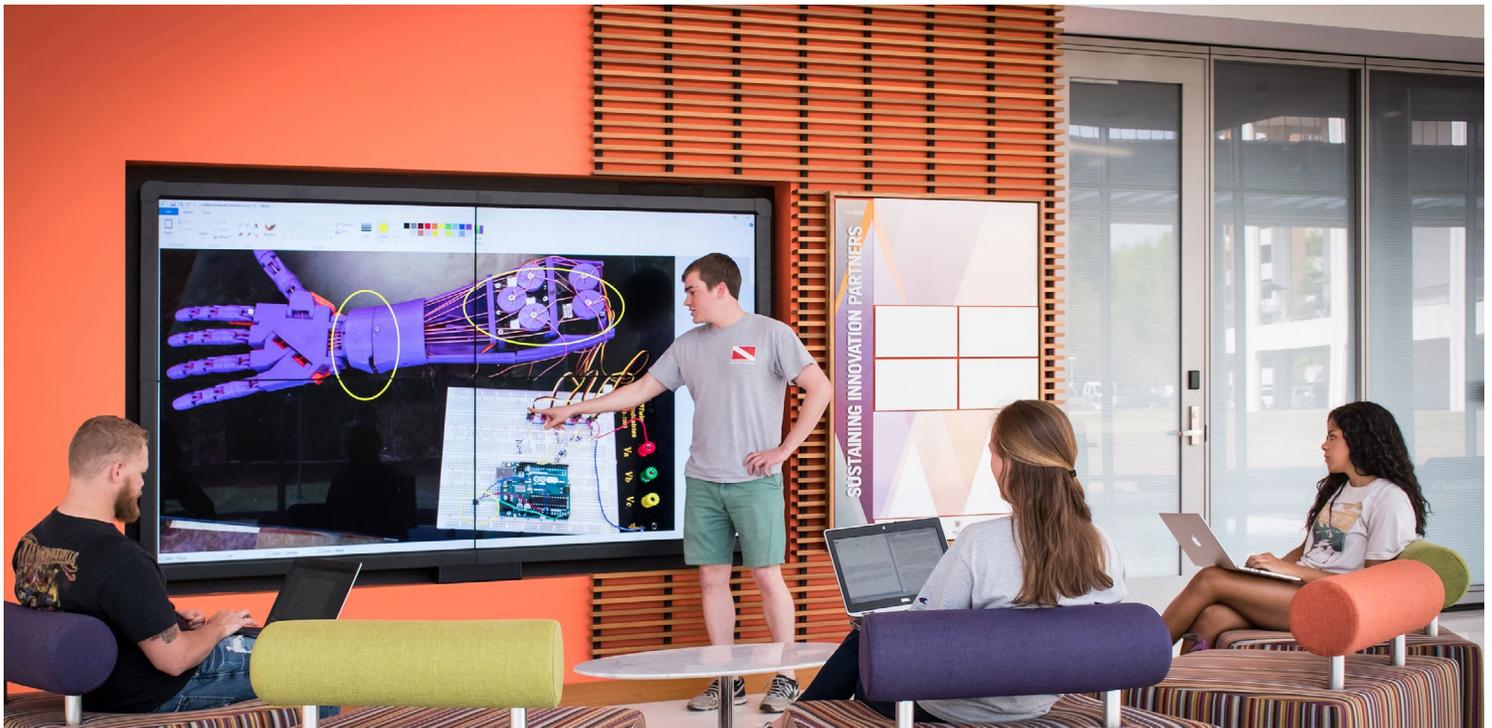
While most innovative sectors can point to highly specialized technologies that are contributing to advances in innovation, the section below highlights only two technologies that have powerfully transcended sectors, igniting innovations in fields ranging from engineering, aeronautics, nanotechnology and many more.

*3D printers:* From small-batch manufacturing to robotics to engineering, 3D printers, or additive manufacturing, have become the “silver bullet” behind countless single-sector and converging-sector innovations. Christine Furstoss, General Electric’s global technology director, emphasized the benefits of 3D printing as “a research tool because you can manipulate quickly and combine different materials without disrupting an existing setup.”<sup>100</sup>

Given its powerful transcendence across fields and specializations, 3D printers are equally pervasive across a wide range of innovation spaces, including incubators, research institutes and maker spaces. For research institutes and other bioscience laboratories, 3D printers led to the production of biosynthetic organs, as was the case with a team of Chinese scientists who used a 3D printer with ink from stem cells to “print” blood vessels.<sup>101</sup>

The boundless potential of 3D printers has generated an entire category of startups simply through their application of this technology. Reports from Asia to Europe to other global regions are monitoring the “top 3D printer startups to watch.”<sup>102</sup>

*In-situ visualization:* Like 3D printers, the transcendence of in-situ visualization illustrates the magnitude of possible impact across the innovation landscape. From biosciences to astronomy to engineering, in-situ visualization enables researchers to couple simulation with visualization without involving storage resources, limiting challenges with data transfer bottlenecks. Particularly in circumstances that require large-scale simulations, in-situ enables researchers to analyze larger data sets than with other technologies. In-situ was applied, for example, in modeling how climate change could be impacting



Clemson University's Watt Family Innovation Center incorporated large format multi-touch screens along corridors and in project rooms, classrooms and teaming areas. Photo credit: Clemson.

nutrient and carbon cycles in the Mediterranean Sea.<sup>103</sup> It has also been used successfully in aeronautic propulsion and modeling the global neocortical network of the brain.<sup>104</sup>

## Technology as a display and showcase tool

With innovation increasingly a collaborative process, the ability to display and showcase information becomes all the more important. There is now a growing stock of technologies supplanting the traditional bulletin board and office signage.

*Interactive LED video walls:* These walls showcase employee innovations and company initiatives that keep everyone informed of the innovative projects underway within innovation spaces. What this signage importantly sparks, especially in spaces where entrepreneurs and firms don't know each other, is the motivation to reach out to others to discuss projects underway. It is this first gesture that can ultimately grow into future relationships, if not collaborations.

*Digital whiteboards:* Whiteboards allow users to instantly digitize their notes, markups and drawings, eliminating the extra step of



Interactive table. Photo credit: Perkins+Will.

transcription. They can be moved easily or attached to walls like a traditional blackboard.

***Interactive Screens:*** Driven by daily interactions with smartphones, tablets and laptops, our changing culture now has a desire to touch and experience content. Interactive displays, which allow us to touch, move, press and drag content, while interactive screens produce and distribute the information. Clemson University’s Watt Family Innovation Center incorporated large format multi-touch screens along corridors, in project rooms, in classrooms and in teaming areas. As students and faculty see each other in passing, they stop, talk, share ideas and, when desired, turn to interactive screens nearby to display information.<sup>105</sup>

***Interactive tables:*** Some innovation spaces are incorporating interactive tables—yes literally tables—that function like a large iPad where users can swipe and move information across the table. Often used in innovation centers, interactive tables are found in medical science environments where gross anatomy tables display the body in three dimensions.



As technologies change, become more efficient and smaller in size, storage areas will need to be reconfigured. Photo credit: NCState.

## Design implications

***Flexibility:*** The velocity of change with technology, combined with flux of work and team configurations further builds the case for innovation spaces to be inherently flexible. Specific to technology, this includes designs that allow workers to quickly switch out equipment and wiring, give workers a range of moveable benches to “plug and play,” and even the flexibility to use personal technologies in the workplace.

***The storage of equipment:*** Technological advancements are not solely new products; an important share of advancements is in making existing technologies faster, more energy efficient and smaller. As equipment shrinks in size, the demands on storage will change, requiring innovation spaces to think through new configurations. One of the architects that designed the Crick Institute also spoke of how advanced technologies are increasingly flexible to vibration, explaining that this has required certain equipment to be located in basements.<sup>106</sup>

***The new world of sharing:*** Sharing workstations, shareable spaces, and sharing equipment. The ubiquitous nature of technology—where more workers are increasingly mobile or using their own technologies—spatially translates into the design of fewer dedicated workstations.

This trend, further supported by a greater emphasis on collaborative, shareable spaces, has had a profound impact on space. By some estimates, 30-percent less office space is now needed compared with 10 years ago.<sup>107</sup>

*The need for different types of meeting spaces:* Workspace dynamics are changing due to the infusion of technologies. Meetings are now happening at the desk, where an individual can be immersed in collaborative work with remote teams. The implication of this shift is that individual workspaces no longer equate to quiet production space. These advancements require innovation spaces to evaluate quiet study and work space differently and develop new strategies for eliminating the noise and distraction of a technology-enabled collaboration.

# Conclusion

As our global economy continues to place greater value on innovation as a means to grow new sectors and new jobs, the role and value of innovation spaces will equally rise. Not only do they give people the freedom and focus to experiment, innovation spaces, in their own

right, have become a locus of experimentation in design. Having the ability to react and respond, to test and try, to make mistakes and move on, make them first-line experimenters that advance both a practice and pedagogy.

**Innovation spaces offer important insights for a large body of thinkers and leaders aimed to strengthen local competitiveness.**

**The question that remains is whether they will learn from what can be found in their own backyards.**

While there is great unevenness in the evaluation of innovation spaces, this research has found that, in the end, it's the users—the leaders, researchers and other workers—that signal if design has achieved its ambitious undertaking. Interviewees for this paper expressed their enthusiasm in such words: “The impact has been huge ... night and day. You simply do not get the same type of interaction in classic office building designs.”<sup>108</sup>

The last 10 years of design indicate a renewed imperative to both appreciate *human dynamics* and strengthen *human interaction* as a means to innovate. It has led local leaders and architects to move away from the preoccupation of style and toward a broader re-valuing of human-ness. “We cannot overemphasize the role of design in creating a collaborative environment,” offered leaders from a start-up space for applied sciences in Cambridge. “This is one of the things that we have learned simply by working closely with people.”<sup>109</sup>

Drawing on the discoveries in design from the past decade, the next decade will importantly reconcile new and emerging issues. The increasingly ubiquitous nature of technology, for example, will transform these spaces into test-beds for how distinct spaces, in distinct sectors, can balance technology with the valued processes of human interaction and engagement. These spaces will likely wrestle with how to support and enable the process of convergence—the cross-disciplinary nature innovation—and the challenges it creates. And lastly, these spaces could likely scale concepts such as blending the programming of people and the design of space, which are commonly conceived at separate phases of development.

These and other areas of future discovery embody an evolving, and value-laden practice of helping people flourish in the competitive, chaotic, fast-paced 21st century.

# About the authors

**Julie Wagner** is a nonresident senior fellow and co-director of the Anne T. and Robert M. Bass Initiative on Innovation and Placemaking at the Brookings Institution. This paper is a follow-up to the 2014 Brookings paper she co-authored, “The Rise of Innovation Districts: A New Geography of Innovation,” which identifies how the changing nature of economy is shaping a new geography of innovation. She has contributed to a wide-range of Brookings’s projects and research aimed to strengthen the global reach of cities, including the Brookings’ Global Cities Initiative and comparative analysis between European and U.S. cities. Julie was also the Deputy Planning Director for Washington, DC, where she led the development of city-wide and neighborhood-specific plans.

**Dan Watch** is a global leader in laboratory design. Dan is an author of four books, a designer of over 12 million square feet of research facilities in four continents, and a leader of six award-winning international design competition teams. He helps educate university and government leaders globally on smart and sustainable design and is a regular speaker at Harvard’s Graduate School of Design, offering insights on Healthy and SMART Design solutions. His collective work over the years on advocating sustainability has educated thousands of students, practitioners and policy makers. He has spoken at conferences across the United States on designing innovation spaces.

Watch is a principal at Perkins+Will, a multi-disciplinary architecture firm. Perkins+Will did not provide financial support for this paper.

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## **About The Anne T. and Robert M. Bass Initiative on Innovation and Placemaking**

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# Appendix A

## List of individuals interviewed

### Interview Group 1

#### Architects interviewed to discuss the changing nature of innovation spaces

**Lin Borong**, professor and assistant to the Dean School of Architecture at Tsinghua University in Beijing, China, March 13, 2016.

**Chad Chalmers**, architect with Wildman Chalmers Design, LLC, March 18 and 23, 2016.

**Dennis Lester**, research professor, Watt Family Innovation Center, April 1, 2016.

**Angela Nixon**, public affairs, Clemson University, April 1, 2016.

**James Lu**, architect and managing director, Perkins+Will Shanghai Office, March 22, 2016.

**Jeff Reushal**, global director of design & innovation, Haworth, Holland, Michigan, April 8, 2016.

**Jeff Richards**, principal member of technical staff, Lab Operations, AT&T Innovation Center in Atlanta, March 18 and 20, 2016.

**Barbara Spieziale**, Barbara Spieziale, associate director of academic affairs and director of Creative Inquiry, Clemson University Watt Family Innovation Center, December 15, 2016, January 20 and February 14, 2016.

**David Vargo**, managing principal consultant at BrightTree STUDIOS, December 16, 2016.

**Greg Warwick**, campus architect, Duke University, March 9, 2016.

**Jeff Williams**, senior project designer, Perkins+Will, March 15, 2016.

**Michael Warsaw**, vice president & officer, Global Design & Innovation, Haworth, Holland, Michigan, April 7, 2016.

**Dr. Charles Watt**, interim dean, College of Business and Behavioral Science, November 11, 2015.

**Joseph Zinter**, assistant director, Yale University Innovation Center, March 13 and May 10, 2016.

### Interview Group 2

#### Architects and leaders of innovation spaces to discuss specific projects

**Matt Arnold**, architect, Hacin and Associates, interview regarding District Hall, June 22, 2016.

**John Baragwanath**, OBE, executive director of the AMRC Group, interview regarding the Advanced Manufacturing Research Centre (AMRC), Sheffield, June 25, 2016.

**Zara Bosnic**, architect, Roldán and Berencqué Architects, interview regarding Barcelona Activa in Barcelona, July 4, 2016.

**Lance Cage**, managing principal, Eli Hoisington, Design Principal, Margaret McDonald, Director of Interiors, and Michael Browning, associate architect, HOK, interview regarding @4240 in St. Louis, June 30, 2016.

**TH Chang**, independent laboratory planning expert, interview regarding the Francis Crick Institute, August 1, 2016.

**Brian Dacey**, president, CIC, interview regarding District Hall, July 6, 2016.

**Josh Emig**, head of product research, WeWork, interview regarding We Work, June 6, 2016.

**Kelly Ennis**, founder and managing principal, the Verve Partnership, interview regarding Betamore, July 27, 2016.

**Johannes Fruehauf**, executive director and co-founder; Margaret O'Toole, vice president, Operations, LabCentral, interview regarding LabCentral, June 30, 2016.

**Eamon Gallagher**, program director, IC@3401; Chris Laing, vice president, Science Center - University City Science Center; Keith Orris, senior vice president, Corporate Relations and Economic Development, Drexel University, interview regarding IC@3401 in Philadelphia, June 27, 2016.

**Andrew Gilles**, architect, CannonDesign, completed survey regarding@4260, Cannon Architects, Summer 2016.

**Gert de Graff**, director; Lous Hagg, architect, Groosman Architects, interview regarding the Innovation Dock in Rotterdam, August 3, 2016.

**Key Hays**, president and CEO; Ann Coulter, strategic planning consultant, The Enterprise Center, completed survey regarding the Edney Innovation Center in Chattanooga, Summer 2016.

**Todd Heiser**, consumer goods practice area leader; Leah Ray, public relations manager, Gensler Architects, interview regarding 1871 in Chicago, June 29, 2016.

**Anna Majo**, director of the Promotion of Strategic Sectors and Innovation, Barcelona City Council, interview regarding Barcelona Activa, August 5, 2016.

**Dr. Evan Malone**, president, NextFab in Philadelphia, interview regarding NextFab, June 20, 2016.

**Christy Maxfield**, CET director of Entrepreneur Development Services, Cortex Innovation Community, discussion on St. Louis Cortex Biogenerator in St Louis, July 26, 2016.

**Jen Meyer**, CEO, Betamore, interview regarding Betamore, July 27, 2016.

**Jeffrey Morgan**, AIA, Principal, Architecture & Interior Design, NORR Architects, discussion on IC@3401 in Philadelphia, August 4, 2016.

**Tom Osha**, senior vice president, Innovation and Economic Development, Wexford Science and Technology, interview regarding a range of innovation spaces across the United States, July 5, 2016.

**Gregory Raschke**, associate director for Collections and Scholarly Communication, NCSU Libraries, interview regarding Hunt Library at North Carolina State University, September 22, 2016.

**Megan Ridgeway**, principal, ARCTURIS, interview regarding CET in St Louis, June 30, 2016.

**Tully Shelly**, principal, MBT Architecture, interview regarding Singapore CREATE and the Clark Center at Stanford, July 1, 2016.

**Dougan Sherwood**, co-founder, managing director-CIC St Louis, interview regarding @4240 and CIC St Louis, August 3, 2016.

**Jim Smith**, director of research, Francis Crick Institute, interview regarding the Francis Crick Institute, July 28, 2016.

**Darren Southgate**, studio director, Bond Bryan Architects, interview regarding the Advanced Manufacturing Research Centre (AMRC), Sheffield, July 27, 2016.

**Barbara Spieziale**, associate director of Academic Affairs at Clemson University Watt Family Innovation Center, interview regarding the Clemson Innovation Center in South Carolina, July 21, 2016.

**James Stem**, principal, West and Stem Architects; Peter Marsh, vice president, principal project manager, Workplace Strategies, interview regarding Inmar, July 27, 2016.

**Jessica Tsymbal**, head of facilities, Massachusetts Institute of Technology, interview regarding the MIT Media Lab, June 30, 2016.

**Howard Tullman**, CEO, 1871, interview regarding 1871, July 29, 2016.

# Endnotes

- 1 “Shared Workspaces” (Jones Lang Lasalle, 2016).
- 2 Ian Hathaway, *Accelerating Growth: Startup accelerator programs in the United States* (Washington: Brookings Institution, 2016).
- 3 Killian Fox, *The Rise of the UK Accelerator and Incubator Ecosystem* (London: Telefonica UK, 2014).
- 4 Note that specific numbers are not included as the definitions between incubator and accelerator were not reconciled through this research. Sources to determine relative growth rates of accelerators and incubators in Spain and Singapore include: Tom Evans, “Starting up in Spain: The Survey 2015”; “[List of Startup Accelerators and Incubators in Singapore](#),” *Fintech News Singapore*; and Jacquelyn Cheok, “[Accelerators- too much of a good thing?](#)” *The Business Times*.
- 5 Alexandra Lange, “The Innovation Campus: Building Better Ideas,” *New York Times*, last modified August 4, 2016.
- 6 International Business Innovation Association, last accessed January 22, 2017, <https://inbia.org>.
- 7 Darren Dahl, “How to choose a small-business incubator” *The New York Times*, last modified January 26 2011, <http://www.nytimes.com/2011/01/27/business/smallbusiness/27sbiz.html>.
- 8 International Business Innovation Association, <https://inbia.org>.
- 9 International Business Innovation Association
- 10 International Business Innovation Association
- 11 “7 Things You Should Know About Makerspaces,” ELI, last modified April 2013, <https://net.educause.edu/ir/library/pdf/ELI7095.pdf>.
- 12 John Timmer, “Starting from scratch: How do you build a world-class research lab? Starting with nothing and aiming for Bell Labs,” *Ars Technica*, August 7, 2015.
- 13 District Hall is a new type of innovation space. Here is their website: [www.districthallboston.org/about/](http://www.districthallboston.org/about/).
- 14 Personal communications with Josh Emig, Head of Product Research, WeWork, June 6, 2016.
- 15 Personal communications from David Vargo, Managing Principal Consultant at BrightTree Studios, December 16, 2016.
- 16 Personal communications from Jeffrey Morgan, Principal, Architecture & Interior Design, NORR Architects, August 4 2016.
- 17 Personal communications from Barbara Spieziale, Associate Director of Academic Affairs, Clemson University Watt Family Innovation Center, January 20, 2016 and February 14, 2016.
- 18 “Generations at work: A war of talents: innovating to integrate an emerging generation into the workplace.” (Business Interiors: UK).
- 19 “Gen Y United States” (Steelcase: Grand Rapids, 2011) p. 57.
- 20 Personal communications from Barbara J. Speziale, Director, Creative Inquiry, Clemson University, December 15, 2015.
- 21 Personal communications from Dougan Sherwood, Co-founder, Managing Director-CIC St Louis, August 3 2016.
- 22 Mary Disis and John Slattery, “The Road We Must Take: Multidisciplinary Team Science,” *Science Translational Medicine*, last modified March 10, 2010. <http://stm.sciencemag.org/content/2/22/22cm9.full?sid=d7e1dd2a-9ae6-45a3-9f47-6ba23b1c53df>.

- 23 Stefan Wuchty, Benjamin Jones, and Brian Uzzi, "The increasing dominance of teams in production of knowledge," *Science*, last modified May 18, 2007, <http://science.sciencemag.org/content/316/5827/1036>.
- 24 Alex Hern, "Partnership on AI formed by Google, Facebook, Amazon, IBM, Microsoft," *The Guardian*, last modified September 28, 2016, <https://www.theguardian.com/technology/2016/sep/28/google-facebook-amazon-ibm-microsoft-partnership-on-ai-tech-firms>.
- 25 Bruce Katz and Julie Wagner, "The Rise of Innovation Districts" (Washington: Brookings Institution, 2014).
- 26 Henry Chesbrough, "The Era of Open Innovation," *MIT Sloan Management Review* 44 (3) (2003): 35-41.
- 27 Sources that describe the phenomenon of convergence include: William Hoffman in "The Shifting Currents of Bioscience Innovation," *Global Policy* 5 (1) (2014): 76-83; a team of 12 scientists at MIT that issued the White Paper, "The Third Revolution: The Convergence of the Life Sciences, Physical Sciences and Engineering" in 2011; the work underway at the Stockholm Life innovation districts where they are intentionally converging sectors in life sciences and tech, as described by Ylva Williams in personal communications on April 2, 2014; and personal communications from Ulf Wahlberg, Vice President, Industry and Research Relations, Ericsson AB Group, December 12, 2014.
- 28 "The Power of Convergence," *MIT News*, last modified January 4, 2011, <http://news.mit.edu/2011/convergence-0104>.
- 29 Personal communications from Ulf Wahlberg, Vice President, Industry and Research Relations, Ericsson AB Group, December 12, 2014.
- 30 Michael Crow and William Dabars, *Designing the New American University* (Baltimore: Johns Hopkins University Press, February 2015), p. 169.
- 31 "Engagement and the global workplace" (Steelcase: Grand Rapids, 2016).
- 32 Rex Miller, Casey M., and Konchar M., *Change Your Space, Change Your Culture: How Engaging Workspaces Lead to Transformation and Growth* (New Jersey: John Wiley & Sons, 2014), p. 37.
- 33 Personal communications from Kelly Ennis, Founder and Managing Principal, the Verve Partnership, July 27 2016.
- 34 Personal communications from Tully Shelley, Principal, MBT Architecture, July 1, 2016.
- 35 Tully Shelly
- 36 Personal communication from Megan Ridgeway, Principal, ARCTURIS, St Louis, June 30, 2016.
- 37 Personal communication from John Baragwanath, OBE, Executive Director of the AMRC Group, June 25, 2016.
- 38 Personal communications from Gregory Raschke, Associate Director for Collections and Scholarly Communication, NCSU Libraries, September 22, 2016.
- 39 Gregory Raschke
- 40 Personal communications from James Stem, Principal, West and Stem Architects and Peter Marsh, Vice President, Principal Project Manager, Workplace Strategies, July 27 2016.
- 41 Stewart Brand, *How Buildings Learn* (New York: Penguin Books, 1994).
- 42 Personal communications from Jen Meyer, CEO, Betamore, July 27 2016.
- 43 Perkins+Will, drawing on the design and construction they managed for workspaces in the United States, conducted an analysis and identified these figures for this report. This analysis was conducted in December 2016.
- 44 Personal communications from James Stem, Principal, West and Stem Architects and Peter Marsh, Vice President, Principal Project Manager, Workplace Strategies, July 27 2016.

- 45 Howard Tullman, "The Case Against Open Office" *Inc.*, last modified March 3, 2015, <http://www.inc.com/howard-tullman/the-case-against-open-offices.html>.
- 46 General Services Administration, Public Buildings Service, "Sound Matters: How to achieve acoustic comfort in the contemporary office," 2011. The paper is available online at [https://www.gsa.gov/portal/mediald/172515/fileName/GSA\\_Sound\\_Matters\\_\(Dec\\_2011\)\\_508](https://www.gsa.gov/portal/mediald/172515/fileName/GSA_Sound_Matters_(Dec_2011)_508).
- 47 Personal communication from John Baragwanath, OBE, Executive Director of the AMRC Group, June 25, 2016.
- 48 Personal communications from TH Chang, independent laboratory planning expert, August 1, 2016.
- 49 Personal communications from Johannes Fruehauf, Executive Director and Co-founder and Margaret O'Toole, Vice President, Operations, LabCentral, June 30 2016.
- 50 Janine Nahapiet and Sumantra Ghoshal, "Social capital, intellectual capital, and the organizational advantage," *Academy of Management Review*, 23 (2) (1998): 242-266.
- 51 Melissa Appleyard, Beverly Tyler, and John Carruthers, "Knowledge Meshing through Interdisciplinary R&D: The Case of the U.S. NIH Nanomedicine Development Centers," Paper presented at the DRUID 2011 on Innovation, Strategy, and Structure at the Copenhagen Business School, Denmark, June 15-17, 2011.
- 52 Barbara van Schewick, *Internet Architecture and Innovation* (Cambridge, Massachusetts: MIT Press, 2010), p. 174.
- 53 van Schwick
- 54 Edward Glaeser and Joshua Gottlieb cited an important list of thinkers that have led to the conclusion that idea-based economies have a tendency to agglomerate as "ideas move imperfectly over space." This includes Alfred Marshall, who wrote the book *Principles of Economics* in 1890; Jane Jacobs, in her 1969 book, *The Economy of Cities*; and Robert Helsley and William Strange, who authored "Matching and Agglomeration Economies in a System of Cities" in 1990.
- 55 Edward Glaeser and Joshua Gottlieb, "The Wealth of Cities: Agglomeration Economies and Spatial Equilibrium in the United States" (Harvard University: Cambridge February 26, 2009), p. 31.
- 56 Carlino, et al. "The agglomeration of R&D labs," Working paper for the Federal Reserve Bank of Philadelphia, September 2011.
- 57 Thomas Allen and Gunter Henn, *The Organization and Architecture of Innovation: Managing the Flow of Technology* (New York: Architectural Press, 2007), p. 62.
- 58 Ben Waber, Jennifer Magnolfi, and Greg Lindsey, "Workspaces That Move People," *Harvard Business Review*, last modified October 2014, <https://hbr.org/2014/10/workspaces-that-move-people>.
- 59 Thomas Allen and Gunter Henn, *The Organization and Architecture of Innovation: Managing the Flow of Technology* (New York: Architectural Press, 2007), p. 56.
- 60 Described in the *Organization and Architecture of Innovation: Managing the Flow of Technology*, the authors speak to research completed by Oscar Hauptman, where he monitored the communication among sites of a geographically dispersed computer manufacturers to determine the need for face-to-face communication. The work of Hauptman referenced is TJ Allen and Oscar Hauptman, "The Influence of Communication Technologies on Organization Structure: A Framework for Future Research," *Communication Research* 14(5) (1987): 575-587.
- 61 The literature on qualitative virtues of nonverbal communications is expansive as it continues to be an important area of study for the fields of sociology, psychology, organizational development, business management, and others. The *Sage Handbook of Nonverbal Communication* (2006) has compiled an extensive range of studies on nonverbal and their influences on formal, work settings versus more informal settings. The Handbook includes, for example, a study that demonstrates how nonverbal cues to be up to 4 times more important in determining the superiority vs. inferiority position of the communicator. Given the imperative to

exchange information and learn in an innovation setting, another quantitative study in a university learning setting demonstrated the extent to which nonverbal communication strengthens overall learning and the grasping of important concepts. This 2015 research is described in, “Nonverbal immediacy’s role on student learning” in *Journal of Media and Communication Studies*.

62 Thomas Allen and Gunter Henn, *The Organization and Architecture of Innovation: Managing the Flow of Technology* (New York: Architectural Press, 2007), p. 62.

63 Thomas Allen and Gunter Henn

64 Personal communications with Lance Cage, Managing Principal, Eli Hoisington, Design Principal, Margaret McDonald, Director of Interiors, HOK, June 30, 2016.

65 Personal communications with Jessica Tsymbal, Head of Facilities, MIT Media Lab, June 30 2016.

66 Personal communications from Dougan Sherwood, Co-founder, Managing Director-CIC St Louis, August 3 2016.

67 Personal communications from Darren Southgate, Studio Director, Bond Bryan Architects, July 27 2016.

68 Personal communications from Andrew Gilles, Architect, CannonDesign, Summer 2016.

69 Naeem Zafar, “How office spaces in Silicon Valley inspire a culture of innovation,” *The Atlantic*, last modified October 04, 2011, <http://www.theatlantic.com/business/archive/2011/10/how-office-spaces-in-silicon-valley-inspire-a-culture-of-innovation/246021/>.

70 Thomas Allen and Gunter Henn, *The Organization and Architecture of Innovation: Managing the Flow of Technology* (New York: Architectural Press, 2007), p. 28.

71 Ray Oldenburg, *The Great Good Place: Cafes, Coffee Shops, Bookstores, Bars, Hair Salons and Other Hangouts at the Heart of a Community* (Philadelphia: De Capo Press, member of Perseus Books Group, 1999), 16.

72 “Google EMEA Engineering Hub,” ArchDaily, last modified November 22, 2009, <http://www.archdaily.com/41400/google-emea-engineering-hub-camezind-evolution>.

73 Personal communications from James Stem, Principal, West and Stem Architects and Peter Marsh, Vice President, Principal Project Manager, Workplace Strategies, July 27 2016.

74 Personal communications from Key Hays and Ann Coulter regarding the Edney Innovation Center, Summer 2016.

75 Personal communications from Jeffrey Morgan, Principal, Architecture & Interior Design, NORR Architects, August 4, 2016.

76 Personal communications from Josh Emig, Head of Product Research, WeWork, June 6, 2016.

77 Personal communications with Matt Arnold, Hacin and Associates regarding District Hall in Boston, June 22, 2016.

78 Personal communications from Kelly Ennis, Founder and Managing Principal, the Verve Partnership, July 27 2016.

79 Pancholi et al. “Public space design of knowledge and innovation spaces: learnings from Kelvin Grove Urban Village, Brisbane,” *Journal of Open Innovation: Technology, Market, and Complexity* 1 (13) (2015): 2-17.

80 Personal communications from Andrew Gilles, Architect, CannonDesign, Summer 2016

81 Personal communications from Tom Osha, Senior Vice President, Innovation and Economic Development, Wexford Science and Technology, July 5, 2016.

82 Personal communications from Joe Zinter Assistant Director, Center for Engineering Innovation and Design, Yale University, October 16, 2016.

83 Personal communications from Tom Osha, Senior Vice President, Innovation and Economic Development, Wexford Science and Technology, July 5, 2016.

- 84 Pancholi et al. "Public space design of knowledge and innovation spaces: learnings from Kelvin Grove Urban Village, Brisbane," *Journal of Open Innovation: Technology, Market, and Complexity* 1 (13) (2015): 2-17.
- 85 Personal communications from Kelly Ennis, Founder and Managing Principal, the Verve Partnership, July 27 2016.
- 86 Personal communications from Michael Browning, Associate Architect, HOK, June 30, 2016.
- 87 Personal communications from Nate Storing, Communications Associate, Project for Public Spaces, January 13, 2017.
- 88 James Manyika et al, "Disruptive technologies: Advances that will transform life, business, and the global economy," McKinsey Global Institute, last modified May 2013, <http://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/disruptive-technologies>.
- 89 William Matthews, "Building for the Future: How Tech is Reconfiguring Office Space," *GovTech Works*, last modified February 9, 2016, [https://www.govtechworks.com/building-for-the-future-how-tech-is-reconfiguring-office-space/#gs.yEWT\\_Wk](https://www.govtechworks.com/building-for-the-future-how-tech-is-reconfiguring-office-space/#gs.yEWT_Wk).
- 90 William Matthews
- 91 Michael O'Neill, "Engaging Workspace with Technology: A planning approach to future-proof your investment," (Knoll Workplace Research, 2013).
- 92 William Matthews, "Building for the Future: How Tech is Reconfiguring Office Space," *GovTech Works*, last modified February 9, 2016, [https://www.govtechworks.com/building-for-the-future-how-tech-is-reconfiguring-office-space/#gs.yEWT\\_Wk](https://www.govtechworks.com/building-for-the-future-how-tech-is-reconfiguring-office-space/#gs.yEWT_Wk).
- 93 James Manyika et al, "Disruptive technologies: Advances that will transform life, business, and the global economy," McKinsey Global Institute, last modified May 2013. <http://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/disruptive-technologies>.
- 94 Personal communications from David Vargo, Consultant, BrightTree Studios, December 16, 2016.
- 95 David Vargo
- 96 Barr Seitz, "How technology is creating a new world of work," McKinsey & Company, last modified March 26, 2016, <http://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/how-technology-is-creating-a-new-world-of-work>.
- 97 Jeffrey Rayport, "Technology will Make Collaboration Your Next Competitive Advantage," *MIT Technology Review*, last modified March 1, 2011. <https://www.technologyreview.com/s/423159/technology-will-make-collaboration-your-next-competitive-advantage/>.
- 98 William Hoffman, "The Shifting Currents of Bioscience Innovation," *Global Policy* 5 (1) (2014): 76-83.
- 99 Ibid, p. 79.
- 100 Bridget Butler, "GE's Christine Furstoss: Cohesive 3D Printing Ecosystem Must Exist Before There is a True Manufacturing Revolution," last modified July 24, 2016. <https://3dprint.com/143231/ge-christine-furstoss-3d-printing/>.
- 101 Yuan Yang, "Chinese scientists implant 3D printed tissue into monkeys," *Financial Times*, last modified, December 14, 2016. <https://www.ft.com/content/3e86b47a-c1fd-11e6-9bca-2b93a6856354>.
- 102 TechEU, for example, lists the 10 European 3D startups to watch. Refer to <http://tech.eu/features/4319/can-make-10-european-3d-printing-startups-watch>. Quora also describes some of the 3D startups in India. Refer to <https://www.quora.com/What-are-some-Indian-startups-in-the-3D-printing-industry>). Finally, another group, ASME, lists what they see as the top startups globally in 3D printing. Refer to <https://www.asme.org/engineering-topics/articles/manufacturing-design/7-startups-driving-innovation-in-3d-printing>.

103 Peter Valenta, "In Situ Visualization Technique," blog on PRACE Summer of HPC, last modified August 3 2016, <https://summerofhpc.prace-ri.eu/in-situ-visualization-technique/>.

104 Marzia Rivi, et al, "In-situ Visualization: State-of-the-art and Some Use Cases," Partnership for Advanced Computing in Europe. Refer to [http://www.prace-ri.eu/IMG/pdf/In-situ\\_Visualization\\_State-of-the-art\\_and\\_Some\\_Use\\_Cases-2.pdf](http://www.prace-ri.eu/IMG/pdf/In-situ_Visualization_State-of-the-art_and_Some_Use_Cases-2.pdf).

105 Personal communications from David Vargo, Consultant, BrightTree Studios, December 16, 2016.

106 Personal communications from TH Chang, independent laboratory planning expert, August 1, 2016.

107 Personal communications from David Vargo, Consultant, BrightTree Studios, December 16, 2016.

108 Personal communications from Jen Meyer, CEO, Betamore, July 27, 2016.

109 Personal communications from Johannes Fruehauf, Executive Director and Co-founder and Margaret O'Toole, Vice President, Operations, LabCentral, June 30, 2016.

110 Personal communications from Tom Osha, Senior Vice President, Innovation and Economic Development, Wexford Science and Technology, July 5, 2016.

111 Personal communications from Johannes Fruehauf, Executive Director and Co-founder and Margaret O'Toole, Vice President, Operations, LabCentral, June 30, 2016.

112 Personal communications from Key Hays and Ann Coulter regarding the Edney Innovation Center, Summer 2016.

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