

Article

What Corporates Can Do to Help an Innovation Ecosystem Thrive – and Why They Should Do It

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ABSTRACT

Given the pace of change in nearly every aspect of society, transformative innovation is imperative. At the same time transformation is very difficult for large established companies. Open innovation – collaboration with outside entities such as startups — is a powerful tool for exploring both business model and technological innovation. A thriving ecosystem provides a healthy environment in which dramatically different types of entities can find each other and the resources they need to explore and ultimately engage in transformative innovation. Given these benefits, corporates can and should play a role in the creation and growth of thriving ecosystems. We describe the work done to create the life sciences ecosystem in Boston/Cambridge through the eyes of Susan Windham-Bannister who was a central leader in that effort. And we describe in detail both the benefits corporates can enjoy, and the role corporates can play in developing a thriving ecosystem.

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INTRODUCTION: TRANSFORMATIVE INNOVATION REQUIRES A THRIVING ECOSYSTEM

INNOVATION SOUNDS LIKE something that happens in a flash of insight on the part of a creative individual. In fact, the process of innovation, especially transformative innovation, is long, expensive, fraught with risk, and requires participation from a wide array of stakeholders. Transformative innovation is less about a genius inventor working alone in a laboratory, and more about the physical, social, financial, and informational environment in which inventors can be effective.

We have argued¹ that transformative innovation practice is imperative for large corporates who intend to weather

crises and prosper in a dynamic world. Transformative innovation is most likely to occur in thriving ecosystems. For us, thriving ecosystems are environments where ideas routinely reach commercialization and impact. In thriving ecosystems, all key players involved in the process of delivering business impact are **present**; actively **exchanging** goods, services, value and information; and where **pathways** to join in and benefit from these exchanges are clear.

In this paper we describe ecosystems that support transformative innovation, both from a theoretical point of view and through examples. We make the case that large corporates can and should play a significant role in the development, maintenance and growth of thriving ecosystems, and explain how that can be accomplished. And we peer into the future of ecosystems.

Author Diana Joseph of this article is a convener of corporate innovators and brings insight from the work of developing systematic connections among corporate innovators, and between corporate innovators and their external constituents such as startups and non-profits.

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Author Susan Windham-Bannister led ecosystem development in the life sciences for the greater Boston area and played key roles in advising the New York and Los Angeles life sciences ecosystems as well. She brings insight on the development journey and the role that corporates can play in creating a thriving ecosystem. Author Mikel Mangold is a social media connector and innovator with experience in separate corporate incubator, accelerator and venture lab programs. He brings on-the-ground perspective on how corporates engage with their ecosystems.

TRANSFORMATIVE INNOVATION

Transformative innovation usually refers to the introduction of a technology that transforms the way we live and work. Transformative innovation can dramatically disrupt, reshape or eliminate existing business models, paradigms and industries.² At the corporate level, fostering transformative innovation means significant architectural change to *both* the business model *and* the technology offered.^{3,4} In prior work, Boni and Joseph (2019) observed that the transformative types of innovation required for organizations to thrive in the long-term are extremely difficult for established incumbents to execute, in part because they have existing businesses to maintain¹ and because the costs and risks are significant. However, in a rapidly changing, dynamic world large corporates must place some bets in the transformative arena — no particular existing technology or business model is guaranteed a successful future, so exploration is imperative. Transformational innovation is most likely to emerge in a conducive ecosystem.

INNOVATION ECOSYSTEMS

In a biological ecosystem, organisms function independently in that their behavior is designed to promote their own survival. At the same time, they are deeply *interdependent* — their individual survival depends on their mutual interactions and exchanges. Similarly, stakeholders in an innovation ecosystem function independently with their own interests at heart... but, at the same time, they can be more successful if they share and cross-leverage resources and expertise, develop formal relationships and collaborative efforts, and engage with other stakeholders in cross-promotion of the ecosystem.

In the world of innovation, we often use the terms ‘cluster’ and ‘ecosystem’ as if they are interchangeable. But a cluster is not enough to support transformative innovation. A cluster is the *inventory* of stakeholders and assets in an innovation community, perhaps including start-ups, well-established companies, workforce, investors, academia, professional services providers,

real estate developers, the public sector, technology and infrastructure. But the mere presence of these assets does not mean that they are highly leveraged.

Thriving innovation ecosystems are well-coalesced, collaborative, supportive environments where there is an active exchange across the members of the cluster. This “value exchange” promotes leverage on resources, creates positive feedback loops, supports the translation of ideas into reality, and creates an environment where success breeds further investment which breeds further success.

A thriving ecosystem also contains all or most of the key stakeholders, enabling factors and resources that support transformative innovation. There is no single “magic bullet” that enables transformative innovation to occur — a bevy of the key enabling factors must be present and must interact. As an example, many formal initiatives to accelerate the pace of innovation in a given geography have tended to focus heavily on just one of the enablers of innovation: *infrastructure*, through investments to create low-cost rental space for start-ups. However, rental space by itself is not enough. In the absence of accessible capital, mentoring for entrepreneurs, availability of operating talent, etc., early stage companies can easily fail, be forced to move to a more supportive geography, or (at best) putter along but never scale. And, without an active pipeline of start-up companies to replace those that do fail or leave, real estate developers and real estate landlords will be disinclined to make future investments in additional infrastructure such as new incubating, co-working, accelerating and commercial lab spaces.

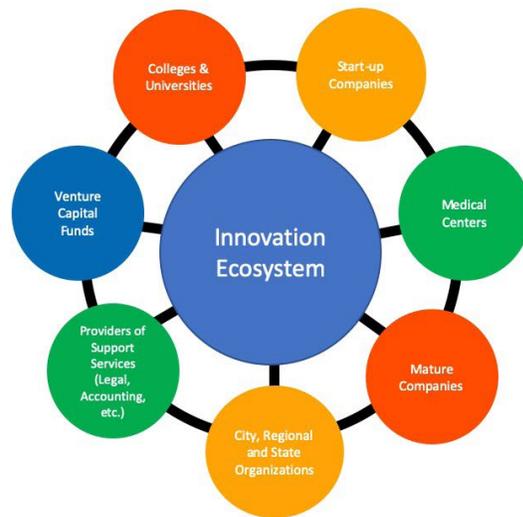
Like biological ecosystems, innovation ecosystems generate extensive variation — each new idea represents a variant that might or might not survive and thrive. Ideas arise, are tested, and either grow or fail, all against a backdrop of an ecosystem. A thriving ecosystem fosters ideas, healthy real-world testing (including evidence-based failure) and growth. In an underdeveloped ecosystem, good ideas may not be nurtured, companies that should have failed early may continue to limp along, and overall growth of the life sciences community may be suboptimal. In a thriving ecosystem, stakeholders share an interest in the health of the ecosystem itself and invest time and treasure to create a generative environment.

Competition in thriving ecosystems provides a “productive” tension that weeds out less-promising ideas, reinvests underused or under-leveraged resources, creates leverage opportunities and strengthens “survivors.” Because innovation ecosystems facilitate this type of resource, talent and idea exchange they enhance opportunities for transformative innovation to occur.

An ecosystem therefore requires both grand diversity *and* collaboration. When these attributes are present, challenges to the ecosystem can be met by the ecosystem



This is a cluster



This is a thriving ecosystem

Figure 1: Adapted from Biomedical Growth Strategies, LLC⁶ and inspired by the work of Linda Booth Sweeney, Toggle Labs.

as a whole, with flexibility and re-organization. Even in a shock, key elements of a highly collaborative ecosystem can remain connected and operating

Granstrand and Holgersson, based on their review of a broad set of the characteristics of innovation ecosystems, compiled this definition: “An innovation ecosystem is the evolving set of actors, activities, and artifacts, and the institutions and relations, including complementary and substitute relations, that are important for the innovative performance of an actor or a population of actors.”⁷⁵

In sum, the assets and stakeholders which define a cluster — organizations, talent and infrastructure — do not by themselves meet the definition of an ecosystem. An ecosystem requires that these institutions, attributes and individuals have relationships, that these relationships are active, producing lively value and resource exchanges and real outcomes. Furthermore, in a thriving ecosystem, these exchange activities result in *emergence*, that is, thriving ecosystems produce behaviors that no individual member or individual pair could possibly produce on their own.

ECOSYSTEM-DEPENDENT REQUIREMENTS FOR TRANSFORMATIVE INNOVATION

In a thriving ecosystem, primary relationships among key individuals at various types of entities relationships massively increase the speed at which information, capital and other resources can be delivered where they are needed. These primary relationships and active resource and produce emergent behaviors conducive to transformative innovation. These behaviors include:

- Win-win scenarios through shared ownership of ecosystem **events** created by diverse players, for example, a venture capital (VC) and a service provider, a corporate host and a university, etc.
- Increased **employment** opportunities. As an outcome of an effective innovation ecosystem, we should see an increase in the number of jobs available, other factors being equal.
- Diverse players across the ecosystem sharing a long-term view. Together, ecosystem players can think more effectively about what comes next, and

how the ecosystem can both shape and accommodate the **future**.

- **Re-mixing and mash-up.** The intersection of different types of experience and expertise is a powerful source of ideation. Facebook occurs when engineering meets university students' social behavior. The iPhone arrives along a path that begins where music meets marketplace development. Modern popular music itself emerged in part from the confluence of African musical composition practice (analogous to software) and European instrument technology (analogous to hardware). New things are very frequently the result of multiple established things coming together. Opportunity for effective mashup is one of the many reasons why diversity of every kind is so important in innovation. Ecosystems invite mashup at the multilayered interfaces between actors.
- Increased customer access and pipelines. At every stage of development, transformative innovation relies on potential **customers**, initial customers, and loyal customers.
- More **accessible supply chains**. Obvious perhaps – transformative innovations need reliable supplies to reach and sustain their impact.
- More accessible **fabrication, manufacturing and publishing**. Ideas are the spark for transformative innovation. They require fabrication that manifests ideas into tangible reality, and manufacturing (or publication/syndication) makes that real product (or service) available in the world at scale.
- More accessible and thoughtfully deployed **capital**. Capital, or lack thereof, makes or breaks transformative innovation. Many excellent ideas have languished or perished due to lack of timely capital. Furthermore, too much capital at the wrong time can cause a mediocre or unready idea to take up time and energy that would be better spent elsewhere. A thriving ecosystem includes multiple options for types of capital, timing of capital, and where that capital can be deployed.
- More **accessible Information**. In addition to knowing the fundamentals of the field or fields from which the transformative innovation emerges, innovators need

easy access to information, for example, about the legal, social, physical and environmental implications and requirements of their work.

- Better-tuned **regulation**, e.g., zoning. Well-crafted regulations can clarify for entrepreneurs what steps to take and where to go to access customers, produce goods, etc.

With the ingredients of transformative innovation in mind, it's not at all surprising that the World Economic Forum calls for an increase in *collaboration between businesses, academia and the public and third sectors*. In essence, they are calling for the development of thriving ecosystems in order to foster transformative innovation.⁷

CREATING A THRIVING ECOSYSTEM THROUGH INTENTIONAL INVESTMENT: THE BOSTON LIFE SCIENCES STORY

In 2008 then-Governor Deval Patrick, together with the Massachusetts legislature, created a 10-year \$1B Life Sciences Initiative to transform Massachusetts from a leading life sciences academic *research* hub to a world leading life sciences *innovation hub*, where new technologies could be translated, developed and commercialized. In 2018, Governor Charles Baker re-capitalized the Initiative for another 5 years at \$500M.

The Initiative and its \$1.5B fund are administered by a quasi-public authority, the Massachusetts Life Sciences Center (MLSC). The MLSC is funded by the state but governed by a Board of Directors and advised by a Scientific Advisory Board. Susan Windham-Bannister led MLSC as its founding CEO, from the Center's inception in 2008 until 2015.

The broad goals of the Life Sciences Initiative are to:

- ✓ Invest in good science *and* good business
- ✓ Strengthen Massachusetts' global leadership in life sciences
- ✓ Accelerate the commercialization of promising new therapies and technologies
- ✓ Create jobs and drive economic development across the state

The MLSC's strategy for achieving these goals has been to strengthen Massachusetts' "innovation capacity" – the ability to translate promising new technologies into the market on a sustained basis. In other words, to ensure that all the conditions are present in Massachusetts to

support the entire innovation life cycle from bench to bedside, especially a strong ecosystem. Through a strategy to build innovation capacity, investments are used to strengthen the platform that supports the full life cycle of innovation. All stakeholders benefit from and can use that platform; and the strategy leverages the strengths of *both* the public and private sectors

The CEO of a large life sciences corporate that has established a major presence in Massachusetts makes the following observation: “Massachusetts has created an environment where innovation can thrive and where large companies must locate and invest in order to get a look at emerging therapies and rub elbows with a vibrant start-up community.”

Innovation capacity depends upon five enablers: Academic culture, entrepreneurial culture (including risk capital), workforce, infrastructure, and crucially: a thriving ecosystem. Dr. Windham-Bannister’s first step as CEO was to conduct a situational analysis to identify where there were major gaps in these key enablers of innovation capacity and how these gaps were hindering Boston/Cambridge, with all of its world class research firepower, from operating as a globally recognized life sciences innovation hub. The situational analysis, including interviews with more than 100 key players, was a first step in developing a shared understanding and recognition of mutual goals among key stakeholders in the life sciences community.⁶

This situational analysis provided the basis for setting initial, stakeholder-driven priorities and targets for investment.

- **Enabler: Academic Culture.**
 - *Gap:* Many of the academic research institutions generally were not participating actively in translational research activities, the formation of new companies, or in academic-industry partnerships.
 - *Targeted investments:* Grants to enable academic institutions to hire Entrepreneurs-In-Residence (EIRs); Grants to junior faculty who were interested in translational research; Funding for incubating spaces on university campuses to enable start-up activity.
- **Enabler: Entrepreneurial Culture and Risk Capital.**
 - *Gap:* The greater Boston region received significant amounts of National Institutes of health (NIH) research funding but much less risk capital was flowing into Boston and

Cambridge to support entrepreneurship. Entrepreneurial culture also was suboptimal.

- *Targeted investments:* Funding for business plan competitions at Massachusetts academic institutions to encourage the formation of start-up companies; Formation of a fund for pre-Series “A” companies to support achievement of key funding milestones, attract subsequent (larger) investment; Assistance to large corporates and investors in getting an expedited, “early look” at promising start-ups and new life sciences technology across Massachusetts.
- **Enabler: Workforce.**
 - *Gap:* While the availability of research talent was strong in the region, there was a smaller pool of operating talent — individuals with the skills to raise capital and grow young companies.
 - *Targeted investments:* Funded Internships at start-up companies to provide training experiences and pathways into the industry for entry-level workers; Funded the development of new curricula that supported the development of skills needed by industry; Funded the creation and build-out of new training facilities.
- **Enabler: Infrastructure.**
 - *Gap:* The region needed a larger inventory of incubating, accelerating, convening and commercial (wet and dry) lab spaces. In addition, the region needed “cutting-edge” research spaces to further strengthen new areas of research and translation where Massachusetts had the opportunity to become a center of excellence.
 - *Targeted investments:* Fund cutting edge, shared research spaces; Fund the build-out of commercial lab space and new co-working, accelerating and incubating spaces for start-ups; Fund incubating and “maker” spaces on the campuses of colleges and universities.
- **Enabler: Ecosystem.**
 - *Gap:* The region lacked a well-coalesced relationship network across, which enabled all stakeholders to connect, find needed resources and leverage the existing expertise.

- *Targeted investments:* Fund grants and activities that required collaboration; Cost-share with industry on sponsored research with academia; Fund convening spaces and convening activities; “Connect the dots” across the cluster; Promote a shared vision.
- The Initial Public Offering (IPO) market also remained strong, with seven IPOs from Massachusetts biotechnology companies in the first half of 2020, representing 1/3 (33%) of all US-based biotechnology IPOs, and raising an average of \$187 million.¹²

A thriving ecosystem is a dynamic environment. As stakeholders grow, arrive or change, and as new behaviors emerge, the ecosystem shifts, potentially creating new opportunities and challenges. A key responsibility of the MLSC was to monitor and respond to the needs of the ecosystem by expanding its portfolio of programs and investments to better support the ecosystem as it evolved, address emerging gaps and barriers, and enhance emerging strengths and opportunities. Examples include creating funding for “step out” companies (in addition to the funding for Pre-Series A companies), expanding workforce programs that promote greater diversity and inclusion in the life sciences workforce, and creating infrastructure for biomanufacturing.

EVALUATION

The MLSC commissioned independent impact evaluations in 2014 and 2018. Some key findings of these evaluations:⁸

- **Employment:**
 - Massachusetts now ranks #1 in the U.S. in total life sciences employment, controlling for population size.⁹
 - The life sciences sectors have proven to be a major economic engine for the Commonwealth both in terms of its direct job creation and the indirect and induced jobs it has fostered.
 - Growth in the Life Sciences Sector helped bring the Massachusetts’ economy out of the recession, when little employment was being generated elsewhere in the state’s economy.¹⁰
- **Venture Capital:**
 - For every dollar of NIH funding, Massachusetts attracts \$2.19 of venture investment. As of 2018 the greater Boston area is now second only to the Bay area in VC investment.¹¹
 - The Massachusetts biopharma industry raised \$2.1 billion in VC investment in the first half of 2020, despite economic uncertainty created by COVID-19.

CORPORATES AND ECOSYSTEMS

We have argued¹ that open innovation is a required activity for corporates that intend to survive and thrive in the long run. Ecosystems are a powerful, and perhaps required, foundation for open innovation.

At the Corporate Accelerator Forum (CAF), run by Diana Joseph, corporate leaders come together to discuss and jointly investigate challenges and opportunities that emerge from engaging in open innovation with startups. This is in and of itself an ecosystem activity – entities in the same role in different companies and industries are learning from each other in order to benefit themselves and the system. Furthermore, each corporate participant in CAF is involved directly with some group of startups; this link between a corporate and startups can be, we argue, a powerful component of a thriving ecosystem.

Through their work together at CAF, Members have described a variety of ways they benefit from startup engagement. We describe some of these benefits, and then suggest how corporates can get more out of their ecosystems by contributing more.

Corporate innovators have a special role to play in fostering innovation with startups, and special benefits to gain.

Where traditional venture capitalists primarily provide money and relationships, corporations also have specialized technical domain knowledge. Where traditional equipment or lab service providers have space and tools, corporations also have expanded supply chain relationships. Where traditional design and engineering firms have skills, corporations also have customers. Corporate brands and products can be of great value to startups.

Startups bring great value to corporations as well, as generators of financial return on investment (ROI), and perhaps more importantly as idea, technology and market testers. Further, transformative innovation is extremely difficult in a corporate context¹ – startups can explore far more broadly.

Corporations certainly generate ideas and technologies and test them, however, corporations are constrained by a variety of considerations from which startups are generally released. While all idea generators in the biotechnology space must hew to Food and Drug Administration (FDA) regulations and achieve reimbursement outcomes, large public companies are further constrained by

Securities and Exchange Commission (SEC) requirements, large-company Human Resources (HR) obligations and huge numbers of stakeholders in diverse categories (board, employees, vendors, customers, shareholders, etc.), holding diverse and sometimes divergent goals. One important answer to these constraints, as we have previously argued¹³ is open innovation. Partnering with other organizations, large and small, allows corporations to enrich their knowledge, resource and talent in ways that are simply not available to a single organization operating alone. Open innovation allows corporates to foster innovation in the broader ecosystem more effectively, and to participate more effectively in idea generation themselves. Corporates can engage with each of the other members in an ecosystem to drive powerful emergent behavior and innovation.

A healthy ecosystem creates multi-directional links between multiple active players and multiple connectors. We briefly describe how corporates can move into this more complex multi-dimensional practice, informed by innovation models described in our prior work.¹³

One-dimensional relationships. In traditional corporate scouting in the absence of a thriving ecosystem, outreach to potential startup partners tends to be outbound. That is, scouts reach out to startups whose profiles appear in industry publications or VC funding lists, or who show up at known events such as a pitch day or meet-up. This outreach activity is valuable and necessary, but it moves along a single familiar vector which is genericized by common use – every corporate and venture scout in the industry is reaching out to the same relatively small set of startups, namely those within easy access or those with a strategic focus on publication. This makes it very difficult for a scout to see a big idea in its early stages, and it means that competition for a “famous” startup’s attention is high. This “crowdsourcing” effect also means that energy is poured into a relatively small number of relatively familiar relationships – great ideas and great teams can easily be missed simply because they do not travel in the right (visible) social circles. A thriving ecosystem promotes the discovery of more complex ideas, more diverse founders, and valuable rare finds, because startups and corporates know how to reach each other, and other parties in a position to make introductions know who can benefit by meeting whom.

Attracting attention from startups. In a thriving ecosystem, corporates can create conditions that invite contact from startups, for example, hosting a regular meet-up or maintaining a lively online forum for startups. This two-way communication may improve ability to find startups before the crowd. A more complex approach with innovation benefits in addition to relationships is creating a corporate accelerator – this generates still deeper relationships with startups, and puts the corporate on the radar of other founders in the

ecosystem. Depending on the design, a corporate accelerator can access a variety of types of startup partners – not only acquisition targets, but also future customers, suppliers, etc. Corporate accelerators and other direct innovation approaches (corporate incubator, corporate VC, etc.) can also provide ground for strong lasting and supportive relationships between startups, with results such as easier access to talent, company housing, etc.

Adding startup relationships through 3rd parties. Many corporates leverage third parties such as Techstars or Plug and Play to identify relevant startups. This indirect approach¹³ provides a one-to-many linkage: Through the 3rd party, the corporate gets access to more startups that are (a) more relevant because of the 3rd party’s filtering service, and (b) higher quality because of the 3rd party’s development support. These third parties provide clear offerings to the corporate innovation market, and therefore are quite straightforward to engage even for corporates that have not yet developed strong innovation capacity. Like in-house startup accelerators, they also provide a setting for relationships between startups.

Adding relationships with peers. Corporations can form consortia or alliances with others as a pathway to transformative innovation. Consider for example the alliance between the automotive industry in Detroit, high-tech in Silicon Valley, and robotics in Philadelphia¹⁴ – these three types of players come together to propel the development of self-driving cars. Such consortia provide access to a much greater number of relationships with idea-makers in partner corporates, in Universities, and in startups as well as other entities.

Full ecosystem participation. By engaging actively in ecosystems, corporates take advantage of the rich variety of relationships and resource pipelines that emerge in such a setting. For example, Verizon, Kaiser and Wells Fargo sponsor the Alliance for SoCal Innovation’s work to develop a broad ecosystem across industries, and across a region from the California-Mexico border to Santa Barbara, and from the Pacific Ocean to the Inland Empire. Through this activity corporates are able to reach respondents for their questions about their own innovations as well as an audience for their innovation work. The ecosystem directly benefits from the corporates, both through the learnings and resources shared by the corporates, and from access to the broader set of relationships that corporates bring to the table (Diana Joseph is a facilitator for this work and Susan Windham-Bannister an expert host). This setting includes corporates and startups and the relationships among them. It also includes many other types of players: Service providers, 3rd party incubators and accelerators, non-profits, government, universities, development agencies and others. The many different types of relationships here increase the opportunity for resources and information to flow to where they are most useful.

The simultaneous presence of all of these relationship types are prerequisite for the emergent outcome effects we expect to see in thriving ecosystems. These entities working together produce common assets, shared infrastructure, new resources, favorable norms and new capacity that no single entity or pair could possibly generate.¹⁵

HOW CORPORATES CAN FOSTER AND ENHANCE ECOSYSTEMS

At a recent CAF panel¹⁶, Alex Tepper of Techstars highlighted the crucial role that ecosystems play in the success of corporate engagement with startups. Techstars has focused on creating such ecosystems globally, and written about their approach.¹⁷

The classic entrepreneurial ecosystem in Silicon Valley arose organically and relied on the foundational efforts of corporates who needed each other to move forward. An organic ecosystem takes 25 years at minimum to materialize and comes with significant undesirable side effects. For example, the classic form of venture capital that emerged in Silicon Valley relies heavily on subjective pattern-recognition to select fundable companies. The consequent funding can prop up lower-quality ideas just long enough for an exit, resulting in both painful losses for participants caught up in the process, and painful opportunity costs where the capital might have been more effective. This approach can starve good companies that don't match a familiar pattern. Intentionality can bring better, faster results.

Furthermore, ecosystems that develop without intentionality can miss key players and be less resilient as a result. Consider Detroit when GM faltered, taking rubber, battery and other supplier companies with it. A thriving ecosystem might have had more entrepreneurs and more entrepreneurial behavior that might have allowed the system to flex more effectively. Silicon Valley itself is now seeing significant exodus of capital and expertise. Perhaps a more intentional Silicon Valley ecosystem would be (will be!) able to address the brittleness of baked-in behaviors — for example, by developing more ways to evaluate startups, beyond the traditional patterns.

When players create ecosystems with purpose and discipline, the system can develop faster, and in a healthier way. New York's biotechnology ecosystem, for example, began with corporates who followed a fairly similar path as Boston/Cambridge – research to identify gaps, creation of enablers, investment. We discuss New York in further detail below.

Imagine an alternative origin story for an ecosystem like biotechnology in Boston/Cambridge – what if the original spark of imagination comes from corporate

players, rather than from the state? How might corporates proceed in fostering an ecosystem? What if an alliance of corporates used the Boston example as a manual? Here's how this might look:

- I. Identify the gaps around key enablers. This is a research project, essentially. This work could be done by research team made up of investigators from a group of non-competitive companies in a region. Or, it could be done by researchers from a single company in partnership with local non-profits and startups. Or, corporates could sponsor 3rd party research, for example Dr. Windham-Bannister's work in New York.
- II. Invest. Corporates have multiple tools for investment, including literal financial investment as in the case of venture capital, as well as the investment of energy, intelligence, advice, "hard" resources such as lab space, influence on other ecosystem players, and more. These investments can serve each of the enablers:
 - a. Talent development. For example, SAP employees mentor young women engineers through Technovation¹⁸, and ThermoFischer Scientific sponsors the Bay Area Bioscience Education Community.¹⁹
 - b. Capital for startups – Deploying corporate venture capital in an ecosystem-friendly way is one method. Choosing venture partners who are ecosystem-focused is another.
 - c. Incentives for job creation – job creation is a goal generally left to government entities. Even so, corporates have a role to play in the ecosystem – both in hiring on their own behalf, and in engaging with startups who have an opportunity to grow.
 - d. Building a culture of entrepreneurship. Corporates can develop entrepreneurial behaviors within the company²⁰, and they can contribute to entrepreneurial culture in the broader ecosystem. For example, literal entrepreneurs whose companies are acquired might value the opportunity to stay in the entrepreneurial ecosystem by acting as mentors in a corporate accelerator.

- e. Shared resources and infrastructure. Corporates can invest together with other entities in the ecosystem to create spaces like QB3, a life science and innovation institute that provides startups with incubation space, guidance, events and relationships.²¹

III. Evaluate. Crucially, thriving ecosystems take their own temperature on a regular basis, and re-tune accordingly. For example, consider an ecosystem where angel investors have been the primary source of capital for very early stage companies. As more investors join that ecosystem and share risk, angel investors may now choose to reduce their risk exposure by targeting companies with more proof points. Overall, this could mean that even as more capital is invested in the region overall, less capital would be available for seeding ideas that need very small amounts of capital, such as step-out companies emerging from the University. A thriving ecosystem would recognize this new gap through regular formative evaluation and could take steps to address it.

Imagine a coalition of corporates participating, or even leading, the work to develop the metrics for this kind of health check. An example can be found in Los Angeles where the LA Incubator Network meets regularly to share evaluation metrics.

The MIT D-Lab¹⁵ proposes that vibrant innovation ecosystems depend upon (1) a shared purpose, (2) key actors, resources and contextual elements, and (3) relationships and interconnections between actors, resources and elements. Hoffecker raises an additional consideration: The importance of a backbone organization that can strengthen the system through coordination, information-sharing and facilitation. In Cambridge, MLSC played the role of backbone organization.

Currently in New York, coalitions of corporate actors, through collaborations such as the Partnership Fund for New York City, have taken steps toward the development of a thriving biosciences ecosystem. They have worked with 3rd parties (including Dr. Windham-Bannister) to identify gaps and woo key actors such as VCs to the region. Connections have been forged with city and state government, universities and hospitals. Together, these entities have developed a shared purpose around economic development in the life sciences, and are poised to create a sustainable ecosystem. Time will tell whether these coalitions can form or spin off a

backbone organization that will take ongoing responsibility for coordination of the ecosystem. We expect that a backbone organization will be required in order to further awaken the fledgling innovation ecosystem in New York.¹¹

Los Angeles, by contrast, has put forward a coordinating backbone organization in Biosciences LA, for which Dr. Windham-Bannister serves on the governing board. As the shape of the ecosystem firms up, we look forward to seeing what might unfold in Los Angeles as corporate players step up to participate actively.

SUMMING UP

In our view, a thriving innovation ecosystem is required to establish the creativity and resiliency required for transformative innovation. Transformative innovation is itself required in order to anticipate and respond to the speed of change — environmental, social, economic and technological change — that is the hallmark of our time. Corporates play a key role in making an ecosystem hum, and the ecosystem gives back by creating a generative environment for new ideas and new innovators to emerge, be tested in the real world, and grow (or be pruned off).

Waiting around for a thriving ecosystem to emerge organically is one approach. It is entirely possible, faster and healthier to create a purposeful ecosystem that produces relationships, pipelines, and pathways for the transfer of resources and information. Through the example of the Massachusetts Life Sciences Center, we outlined a process for creating a thriving ecosystem. In the simplest terms, the process requires: identification of ecosystem gaps, enablement and investment in solutions, and ongoing, iterative, formative evaluation. Corporates can and should participate in the development of thriving ecosystems, building on assets already in place in context. An ecosystem is not merely a collection of actors, it has structure, purpose, and multi-layered connections between actors and resources. A place to start: Forming an organization that can play the role of backbone.

THE FUTURE

We are living in or tightly tied to California – living directly in systems that must re-organize in response to new forces, including a pandemic, new travel and immigration rules, intense refreshed focus on racial justice in the United States, complex electoral politics globally, and global climate change manifesting as massive wildfires that we experience directly in each breath as we write. The year 2020, with the sudden shift to work from home

and the attendant digital transformation, sudden impact on the health care system, education system etc., etc. drives home the need for rapid innovation, going forward. Entrepreneurial ecosystems are critical to the innovation life-cycle, and we have more clarity than ever before about the value of intentional efforts to create and enhance such ecosystems. Partners such as governments, academic institutions, non-profits, young companies and other entities can see the value of participating with corporates in a thriving ecosystem.

The pandemic itself is driving the creation new ecosystems focused on solutions to the pandemic. The pandemic is also driving new formats. Since online work has replaced travel, ecosystems can be global – locality provides much less privilege when even local colleagues are doing most of their collaboration online. While we have focused on regional ecosystems in this paper, industry-based and problem-based global ecosystems can be powerful settings for open innovation as well. This time of intense change will ultimately tell us how ecosystems in places like Silicon Valley, Southern California, New York and Boston manage disruption – what ecosystem features will prove most important in providing the flexibility reorganize effectively in the face of these new forces?

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