

LESSONS LEARNED IN EFFECTIVE COMMUNITY-UNIVERSITY-INDUSTRY COLLABORATION MODELS FOR SMART AND CONNECTED COMMUNITIES RESEARCH

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WORKSHOP AGENDAS:

Boston MA, July 2017

<https://www.bu.edu/hic/nsf-scc-2017-workshop/july/>

Washington DC, December 2017

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In 2017, the Boston University Hariri Institute for Computing and the Initiative on Cities co-hosted two workshops on “Effective Community-University-Industry Collaboration Models for Smart and Connected Communities Research,” with the support of the National Science Foundation (NSF). These efforts brought together over one hundred principal investigators and research directors from universities across the country, as well as city officials, community partners, NSF program managers and other federal agency representatives, MetroLab Network representatives and industry experts. The focus was on transdisciplinary “smart city” projects that bring technical fields such as engineering and computer science together with social scientists and community stakeholders to tackle community-sourced problems. Presentations, panel discussions, working sessions and participant white papers surfaced operational models as well as barriers and levers to enabling effective research partnerships. To capture the perspectives and beliefs of all participants, in addition to the presenters, attendees were asked to synthesize lessons on each panel topic. This white paper summarizes the opportunities and recommendations that emerged from these sessions, and provides guidance to communities and researchers interested in engaging in these types of partnerships as well as universities and funders that endeavor to nurture them. It draws on the collective wisdom of the assembled participants and the authors. While many of the examples noted are drawn from medium and large cities, the lessons may still be applicable to communities of various sizes.

This white paper seeks to surface levers that workshop participants highlighted as important to fostering trust and, ultimately, building productive, integrated transdisciplinary teams who are contributing to more vibrant, sustainable and equitable communities. Specifically, it offers guidance in response to shared questions raised by those involved:

1. How do academic researchers and city practitioners initiate and invest in productive working relationships with one another?
2. How do universities help motivate and contribute to the formation of multi-disciplinary faculty and student networks?
3. How do cities identify and prioritize their operational and community challenges, and enlist appropriate partners to help tackle them?
4. How can industry position itself to serve as an open and engaged research partner?
5. How do relationships and projects transition to formalized, sustainable partnerships that simultaneously advance science and societal well-being?
6. How can findings and knowledge be disseminated more broadly, beyond the project team and geography?

Collaboration is inherently challenging. Collaboration that draws experts from diverse institutions to tackle urban challenges is no exception. These partnerships require that individuals with differing resources, cultures, incentive structures, schedules and skillsets find each other, identify a shared challenge, agree on roles, secure funding, and stick it out through inevitable hoops and hurdles. As Professor Dan Stokols of UC-Irvine's School of Social Ecology shared during his keynote lecture, transdisciplinary research is labor intensive (requiring more coordination and communication), faces inherent administrative complexities (necessitating formalized agreements as well as increasing the chance of conflict), and has opportunity costs (including career risks — particularly for junior faculty — if it doesn't succeed). Stokols laid out six "readiness factors" that could facilitate more seamless collaboration, including prior experience working together, commitment to collaboration, inclusive leaders, experience in cross-disciplinary team science, institutional support, and environments & technologies that enable collaboration. As he noted, transdisciplinary work requires change on the part of the person, the team, the institution, and the funder. [1]

Yet, when these relationships succeed they can have a tremendous impact both on societal well-being and one's professional fulfillment. Academic researchers are able to contribute sophisticated technical, computational and research expertise, and employ cutting edge tools and techniques from a wide range of disciplines. Cities are places of abundant challenges but also accountable for addressing those challenges and protecting constituent well-being, rendering them both sources of important societal problems and allies in implementing solutions. To say that researchers bring the hammer and cities the nail is to underestimate their respective contributions. Local government officials are invested in serving the public good, and possess intimate knowledge of community values as well as municipal operations. Academicians are devoted to the rigorous advancement of knowledge. Together, they can affect transformative change at scale.

Demand for deeper partnership is coming both from within and outside the academy. Students are eager for experiential learning opportunities and seek impact. Meanwhile, cities are facing ever more complex challenges, from climate change to congestion to water shortages, which require specialized technical and computational knowledge. [2] Partly in response, the academy is evolving — naming, embracing and evaluating new models of engagement between research and practice and across academic silos. "Team science," wherein diverse disciplines come together to address a scientific challenge, has been increasing. [3] Some fields, such as public health, have long engaged in "translational research," where the goal is to deploy research findings in the real world in the interest of improving practice, and other disciplines are now embracing this as a key objective as well. "Transdisciplinary science", wherein academics and practitioners work together to source problems and identify and implement solutions, is still in the early days. The National Science Foundation's cross-cutting Smart & Connected Communities program, which seeks "integrative research projects that pair advances in technological and social dimensions with meaningful community engagement," was only created in 2016. In January 2018, the National Science Foundation's Advisory Committee for Environmental Research and Education issued "Sustainable Urban Systems: Articulating a Long-Term Convergence Research Agenda," [4] providing a prospective roadmap for its investments in integrative research to address compelling problems, including those confronting cities.

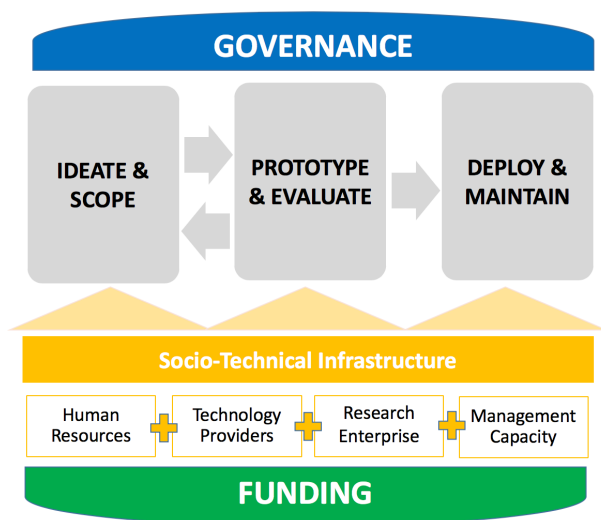
While intention and demand may exist, hurdles to operationalize these relationships abound.

A universal challenge identified via a series of workshops and discussions hosted by Boston University (BU) was the need to build rapport and nurture trust across disciplines and institutions. As one speaker noted "*change happens at the pace of trust*," pointing out both that trust takes time and may also be a precondition for impactful collaboration. Trust between city practitioners, community stakeholders,

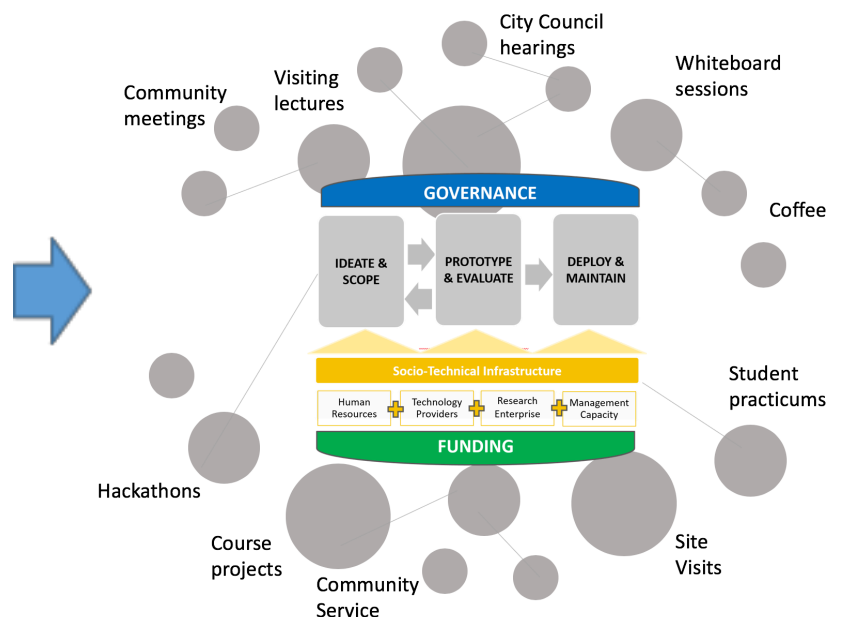
academic researchers and private sector partners is not established via a single event, nor is there a universal prescription. Preconceptions about an institution's motives and values can also color engagements.

To succeed, all parties must focus on the whole relationship not just one project. One ingoing assumption to the workshops, which was quickly dispelled, is that a city/university collaboration “model” is built around a specific, multi-year project. In reality, large-scale smart city research projects often exist in the context of healthy, ongoing relationships between the various stakeholders — including the city government, community organizations, residents, the university, industry, foundations, and other funding agencies. A multi-year project was considered possible, but only once relationships have been initiated and nurtured across many interactions. All players need to think in terms of an ongoing multi-faceted relationship, not a single project.

Idealized Project Engagement Model



Reality: Project Operates in a Context of Dynamic Relationships



1. HOW EARLY RELATIONSHIPS ARE FORMED AND NORMED

How do academic researchers and city practitioners initiate and invest in productive working relationships with one another?

- Leverage existing ties to community to initiate relationships
 - Develop cultural awareness — learn the other's "business"
 - Foster multiple connections within the university and within the city
 - Conduct multiple small, quick turn projects and share results
 - Hold routine face to face meetings
 - Use multiple communication channels
 - Embed students in City Hall
 - Host transdisciplinary events and seminars
 - Develop fluency in and appreciation for a range of research methods
 - Be kind, humble and curious
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While there are numerous barriers to partnerships between cities and university researchers, so too are there many levers. Status quo bias, unconscious bias, busy schedules, limited dollars, mismatched calendars, mismatched interests, legal agreements and politics are just a few of the challenges city staff and researchers said they have encountered. Additionally, some noted the tendency of researchers and private sector partners to follow a "design, announce, defend" model of engagement, which presumes an understanding of community needs and priorities as well as unequal regard for the contributions of others. Yet when these relationships succeed partners on both sides find them intellectually stimulating and tremendously gratifying. Before large scale projects are even considered, there are many steps the various players can take to lay a strong early foundation for partnership.

- Leverage existing ties to community to initiate relationships:** There are often institutional avenues that academics can leverage to begin to engage with their community and local governments. Professor Ulrike Passe, of Iowa State University, noted that land grant universities like hers have regional or county offices and "extension agents" that are specifically tasked with making the research and resources of the university available throughout the institution's home state.[5] [6] Meanwhile, public universities often have well established Community Relations teams. Researchers can also embrace opportunities available to them as citizens, by serving on local boards or commissions, attending community meetings or working on a political campaign.
- Develop cultural awareness — learn the other's "business".** There are many ways for academics to understand the business of local government. Reading the local paper, the Mayor's annual State of the City address, and a city's budget and capital plan are easy places to start. Other mechanisms include riding along with city staff going about their workday, regular in person meetings at City Hall, attendance at community meetings or city council hearings, and guest lectures by city officials. All are useful ways to understand the primary job responsibilities of city staff, which rarely have anything to do with research. City officials who want to understand academic culture do not have as many avenues open to them. Still it is worth asking why an academic partner is motivated to work together and what he/she needs from the relationship. It is important to keep in mind that most full-time faculty are paid for 9 months of the year, meaning they need to seek salary funding (also referred to as "summer salary") for the months they are not teaching. Faculty promotion is predicated on a strong track record of academic publications in top journals, teaching scores, and contributions to their academic community such as university or publication review committees. In many disciplines, faculty are not professionally rewarded nor recognized for community centered work, but may be personally motivated by the opportunity for impact and chance to engage students in real world projects.
- Foster multiple connections within the university and within the city.** A single relationship — between one academic and one city staffer — will not be sufficient to sustain a whole partnership ecosystem, nor sufficient to withstand inevitable staff (or political) turnover. One relationship may be the spark, but it will be important to deepen the bench to ensure longevity and sustainability of the collaboration. Professor Sandeep Purao of Bentley College noted that he has relationships with multiple officials in the City of Waltham MA, including City Council members, city staff and the Waltham's Council on Aging, both to gain a deeper understanding of the city's priorities but also as a bulwark against transitions.[7] Engaging with elected officials, civil servants and residents can be useful, as each brings a different perspective to the relationship. Elizabeth Sullivan, the Executive Director of a community organization focused on neighborhood economic development, suggested that researchers: "get out and talk to people. It's as easy and hard as it sounds." [8]

- d. **Conduct multiple small, quick turn projects and share results.** City research needs are often near-term and relatively small scale. Small-scale projects help a relationship to mature, build trust, expose students to the mechanics and priorities of government and address an immediate need facing the community. Universities could leverage an array of mechanisms to help cities tackle these types of projects, including hackathons, course projects, independent studies or practicum placements for students, or summer projects by faculty. The national Educational Partnerships for Innovation in Communities Network (EPIC-N) offers a model for engaging communities via classroom-based research projects specifically. As Professor Tamas Budavari from Johns Hopkins noted, the trend toward open city data has made these projects even easier to accomplish, as publicly available data renders a Memorandum of Understanding or other city/university research agreement unnecessary in order to initiate a project. [9]
- e. **Hold routine face-to-face meetings:** One challenge that was commonly cited was the limited availability and attention of both city staff and researchers. Everyone has multiple demands on their time, which makes it challenging to keep communication channels open. Regularly scheduled meetings, particularly in-person discussions, help nurture relationships and provide continuity. The Metro21 Smart Cities Institute team at Carnegie Mellon meets quarterly with the City of Pittsburgh to stay abreast of needs and identify areas of mutual interest that may yield future research initiatives.[10]
- f. **Use multiple communication channels:** City staff often conduct work face to face or via phone and, if they have an office job, can often be found at their desk Monday through Friday between 9 and 5. Academics use email, are rarely at their desks, need long periods of uninterrupted time in which to write, and routinely work on weekends and at night. If either does not reply to one type of outreach, try another.
- g. **Embed students in City Hall:** Many participants discussed the value of embedding students in municipal departments and agencies, as these types of fellowships or practicums afford numerous benefits. Students develop an insider's perspective on the mechanics of governments, nurture relationships with relevant department staff and leadership, and bring those connections back to the university. Students also contribute important knowledge and expertise to resource-constrained departments. These types of fellowships feed student interest in field work and practice-based learning. Practicums, which afford course credit, as well as funded internships are deployed in various cities, and both are useful. However, funded roles may draw a more diverse socioeconomic applicant pool, as they can be more attractive to students on financial aid. The City of Gainesville partners with the University of Florida to recruit and place a cohort of four students who each complete four eight week rotations with the city during the academic year. [11] The BU Initiative on Cities recruits and places BU graduate and undergraduate students in summer fellowships with the City of Boston and City of Providence and provides a stipend. [12] These fellowships are open to students from any discipline and draw interest from across the university.
- h. **Host transdisciplinary events and seminars:** Most universities are located in a major urban center or are part of a community that may benefit from access to on campus discussions. Wherever suitable, events and seminars should be free, feature speakers from multiple disciplines, as well as practitioners, and be open to the general public. Format can and should vary, as academic lectures, panel discussions and lightning talks will draw different audiences. These types of events create a culture of engagement, raise the profile of on-campus experts, "open" the campus to the community, and foster casual interactions across silos and boundaries. They also help to dispel the notion that

academic knowledge and spaces are not for public benefit. The Myra Kraft Open Classroom at Northeastern University is a university course designed for students but also open to the general public. Classes take place in the evening to facilitate public attendance. Topics, which change each semester, have ranged from “Social Equity in a Just City: Race and Inequality” to the “Rule of Law”.^[13] Guest lecturers have spanned government, academia, nonprofits, journalism and business.

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- i. **Develop fluency in and appreciation for a range of research methods:** Some participants noted that fluency in and appreciation for diverse research methods helps foster mutual respect across disciplines. Fluency in both qualitative and quantitative methods may also help researchers and city officials become more attune to community needs. User experience design, or UX design as it is often referred to, places the user’s experience with an artifact at the center of the design research process. Professor Brenda Bannon from George Mason University noted that it can be a useful method for ensuring community needs are central to any research challenge. ^[14] Community based participatory research (CPBR), which is a model for enlisting community members as expert partners in all aspects of the research process, is premised on respect for the knowledge and perspective of community members. *[CPBR is discussed in greater detail in Section 5.]*
- j. **Be kind, humble and curious:** Strong relationships are built on more than good mechanics. Mutual respect, admiration and genuine appreciation for the other’s role are important elements of any relationship.

2. HOW UNIVERSITIES CAN CATALYZE INTERDISCIPLINARY, SOCIO-TECHNICAL RESEARCH

How do universities help motivate and contribute to the formation of multi-disciplinary faculty and student networks?

- Invest in cross-discipline research centers
- Create formal programs to match existing skills to specific internal needs
- Curate shared physical spaces
- Create a dedicated seed grant fund
- Facilitate interdisciplinary co-teaching
- Recognize and properly evaluate interdisciplinary work in the tenure or promotion process

Workshop participants highlighted a range of challenges they have encountered in forming interdisciplinary research teams that merge diverse academic expertise. Academia tends to lack reward structures for inter and multi-discipline work, as academicians are evaluated by peers in their domain for tenure, promotion and journal publications. Resources also tend to be siloed by discipline, as individual departments need and want to get credit for securing research funds. Departments, in turn, tend to disburse benefits such as seed grant funding only to their own faculty, and their events and programming tend to draw those already in the fold. Participants also cited implicit (or overt) bias as a barrier, noting the unequal regard for collaboration between certain fields of study or methodologies. Faculty in the social sciences and those in technical fields also tend to speak different “languages” and be trained to value different things. City residents may be viewed as research subjects, research partners, subject matter experts, end users or data points, depending on the discipline engaging with them.

Lastly, it is hard for faculty to identify and then nurture relationships with the right potential collaborators in other disciplines, whether because of lack of awareness, physical distance or competing demands for their time. In work, as in life, it is hard to make new friends.

Still, there are many ways universities can nurture and promote interdisciplinary collaboration on campus. Attendees stressed that it is critical that their institutions help them do so. Tackling contemporary societal challenges requires multiple disciplines and diverse expertise, so these relationships are important foundations for future transdisciplinary partnerships with practitioners and others outside of the institution. Interdisciplinary collaborations can also enrich the student experience, fostering respect for other domain expertise and an appreciation of their roles as societal actors, and exposing them to interesting career prospects.

- Invest in cross-discipline research centers:** Research centers serve an important role as bridge-builders, breaking down domain silos. Centers can also contribute to intellectual collaboration, by facilitating matchmaking or incentivizing the formation of interdisciplinary teams. Small workshops that bring together faculty from different departments to tackle a particular challenge can help lay the foundation, or centers may assemble teams in response to a particular grant opportunity or need. They may also help to administer seed grant funds or facilitate learning communities. Additionally, centers can provide an important access point for community partners and industry, as their online and broader community reach may render them more visible to the outside world than individual faculty members. Full time center staff may also have more time to nurture and sustain external relationships than faculty. The benefits of external visibility are two-fold: visibility may be conferred on the center itself, but also those in its orbit. By featuring relevant faculty from across the university, centers can serve an important curatorial function, surfacing domain experts so outside stakeholders are not forced to hunt through departmental directories to find a potential partner.

Cross-cutting research centers as well as thoughtful spatial planning with regard to departmental locations can help to nurture physical interaction, bringing faculty and students from across the university into closer proximity.

Universities can create centers, or incentivize their formation. Vanderbilt University offers Trans-Institutional Program grants of up to \$100,000 for new initiatives that draw in faculty from at least two schools and colleges and have the potential to become new centers.[15]

- b. **Create formal programs to match existing skills to specific internal needs:** BU's Hariri Institute for Computing identified an unmet need that spanned academic disciplines: software development. There was no shortage of ideas, but faculty lacked the training to bring ideas to fruition. In response, it created the Software & Application Innovation Lab (SAIL), a professional research, software engineering, and consulting lab that acts as both a driver and a collaborative partner for computational and data-oriented research efforts across the university. [16] SAIL provides professional training and mentorship to students and acts as the clearinghouse for software developed by students, thereby allowing the research community to leverage the software development capacity of undergraduate and graduate students.
- c. **Curate shared physical spaces:** Cross-cutting research centers as well as thoughtful spatial planning with regard to departmental locations can help to nurture physical interaction, bringing faculty and students from across the university into closer proximity. A physical space can be an important component of a interdisciplinary research center. Professor Stokols highlighted research pertaining to the interaction of proximity and collaboration. The study, by the University of Michigan, demonstrated that scientists working in the same building were 33% more likely to develop new collaborations than those working in different buildings. Those on the same floor were 24% more likely to form new collaborations relative to those who occupy different floors of the same building and 57% more likely than those in different buildings. [17]
- d. **Create a dedicated seed grant fund:** Seed grants are often thought of as opportunities to initiate a new line of research inquiry or experiment with a particular methodology, but their relationship benefits should not be overlooked. These modest funds can be used to initiate a small scale, near-term project with an outside partner and/or foster relationships across academic disciplines. As previously noted, this can help to nurture trust and build rapport, but can also be helpful in revealing when or where a partnership may face particular challenges. Some seed grant administrators require interdisciplinary teams or mandate that faculty work on community sourced problems. The University of Michigan created Mcubed, housed in its Office of Research, to stimulate formation of a collaborative trio ("cube") of research faculty.[18] Two faculty must come from different campus units and they can request up to \$60,000 to tackle pressing social problems that may not attract immediate support elsewhere. The University of Florida invested \$300,000 in seven research projects to address real world problems affecting the City of Gainesville and its residents. [19]
- e. **Facilitate interdisciplinary co-teaching:** A number of participants referenced the need to begin nurturing interdisciplinary collaboration earlier in academic careers, beginning with current students. Co-taught courses that bring together different disciplines and allow for cross-departmental enrollment were cited as one valuable opportunity. At the same time, participants noted that these courses are time consuming to develop and teach, and wished universities would explore course buyouts or other ways to incentivize their formation. Vanderbilt University Professor Abhishek Dubey shared a new course on "Data Science Methods for Smart City Applications" that is co-taught by faculty in computer science, public policy, mathematics, civil engineering and environmental science. [20] Enrollment is open to students across schools and the course focuses on real world problems in transportation, energy use and pedestrian safety. Faculty are incentivized to create these types of courses via funding grants administered by the Office of the Provost. [21] Workshop participants

highlighted the opportunity to broaden this type of course by bringing community members in as student team mentors, class speakers or project judges.

f. **Recognize and properly evaluate interdisciplinary work in the tenure or promotion process:**

One observation made by multiple participants is the fact that inter and transdisciplinary collaborators are the exception rather than the norm. In other words, the people who seek out and enjoy this type of scholarly work are rare. These types of engagements are particularly challenging for junior faculty who are advised to publish and develop a reputation within their discipline, and who manage significant teaching loads. Some recall being actively discouraged from engaging in interdisciplinary work. There are many ways that universities can evaluate and recognize interdisciplinary work during tenure and promotion processes, including: add faculty from outside the scholar's home department to their review committee, acknowledge publications outside a core discipline, recognize interdisciplinary teaching, and gather letters of support pertaining to a candidate's societal impact. More broadly, a university could articulate interdisciplinary collaboration as a key objective in strategic documents and tenure criteria, include it as a priority in job descriptions, and encourage joint faculty appointments in more than one department. [22]

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3. HOW CITIES CAN SUPPORT EXTERNAL RESEARCH COLLABORATIONS

How do cities identify and prioritize their operational and community challenges, and enlist appropriate partners to help tackle them?

- Create a dedicated cross-cutting innovation/research team in City Hall
- Signal city research priorities via a Research Agenda, RFIs and RFPs
- Create opportunities for embedded full-time innovators
- Formally enlist community partners as allies
- Use the city as a technical test bed

As stewards of taxpayer dollars, government is inherently risk averse. They are also led by elected officials who serve at the will of the people and rely on goodwill to get reelected. Cities, like all large organizations (including universities), are bureaucracies with layers of decision makers, systems and processes that may be prone to institutional inertia. Cities are also bound by regulations, both important and onerous, pertaining to issues such as procurement. All of their communications are public record, yet they must also protect resident privacy.

City participants noted that it can be difficult for them to source and prioritize projects, identify appropriate external collaborators, and dedicate city staff time to support projects. Many city research needs also may not match the interests and skills of researchers. Leadership may be skeptical as to the value of external collaboration — particularly the time city staff may need to devote to realizing a partnership — as it often translates to less time available for day-to-day job responsibilities.

Why work together? Universities can be nimble, provide additional financial and human resources, and bring tools at the frontier of scientific knowledge to tackle pressing problems. Further, social scientists may be trained in research methodologies including techniques of community engagement, which is a learned skill. City officials also noted the inherent legitimacy university partners may bring to processes

and outcomes, and their impartiality as to a solution, as they are motivated by the pursuit of knowledge rather than profit. A further benefit is the opportunity to enlist the talents and energies of students now and in the future. Community engaged research is itself a valuable education, but direct work with the city also may help to steer young people to a future in public service.

- a. **Create a dedicated cross-cutting innovation team in City Hall:** Municipal innovation teams take many forms, from those focused only on data and technology to those that define innovation more broadly. They may be housed in the Mayor or City Manager's Office, Technology and Innovation, Budget, or other departments that have broad governance or administrative powers that reach across silos. Some cities prioritize randomized control trials, like the Lab @ DC [23], and there are those that are oriented toward human centered design, such as Oakland's Civic Design Lab [24]. The Boston Mayor's Office of New Urban Mechanics [25] is broadly oriented toward civic research and development while Pittsburgh's Office of Innovation and Performance [26] is more tech-centered. Regardless of the facet of research, methods or solutions on which they focus, dedicated municipal innovation teams that work with and across departments serve as important points of entry and allies to external collaborators. They also play an important role in helping to foster a culture of learning within City Hall, which extends beyond finding insight in existing data. By absorbing risk, innovation teams help to provide traditional agencies with the latitude to experiment.
- b. **Signal city research priorities via a Research Agenda, RFIs and RFPs:** Cities can communicate their research priorities to external partners via a variety of mechanisms. The City of Boston published a comprehensive Civic Research Agenda [27]. Others may use RFIs or RFPs to enlist specific resources. The common dimension of all three is that they are transparent and made accessible to the research community and industry, acting as pathways that invite them to come forward to tackle areas of shared interest. For cities that may not have a research agenda or know where to focus their energies initially, the Ash Center at the Harvard Kennedy School hosts a Catalog of Civic Data Use Cases.[28] The Metro Lab Network's Projects Database also has examples of challenges cities have tackled in partnership with universities. [29]
- c. **Create opportunities for embedded full-time innovators:** Cities can use multiple mechanisms to bring fresh perspective and expertise in-house. Some communities create full-time, year-long fellowships, thus securing a dedicated, nimble resource who is not simultaneously juggling direct line responsibilities. These types of roles may require that distinct jobs be created with discretionary funds, rather than as part of standard operating budgets and/or existing civil service roles. South Bend Mayor Pete Buttigieg created a one year fellowship specifically for recent Notre Dame graduates, who then tackle community problems via tech and innovation programs. Former South Bend CIO Santiago Garces, and now CIO for the City of Pittsburgh, entered city government via this program. [30] Boston's Urban Mechanics team offers a highly competitive one year salaried fellowship to a recent graduate of any relevant master's program from any university. [31] Many current Boston staff got their toehold in government via the program.

For cities that may not have a research agenda or know where to focus their energies initially, the Ash Center at the Harvard Kennedy School hosts a Catalog of Civic Data Use Cases. The Metro Lab Network's Projects Database also has examples of challenges cities have tackled in partnership with universities.

- d. **Formally enlist community partners as advisors:** While not a specific focus of this workshop, it is worth noting that cities have ample models to formalize resident engagement. Collaborative governance has a long-standing tradition in cities. Community advisory boards are often enlisted to advise local governments on issues as wide ranging as youth, historic preservation, participatory budgeting, zoning, urban farming, immigrant inclusion and women's advancement. Community or multi-sectoral advisory councils specifically devoted to smart city projects are currently rare, but perhaps fertile ground for further exploration.

"Making a Civic Smart City," a playbook published by The Engagement Lab at Emerson College, explores effective civic engagement strategies for smart city endeavors. It includes a practical guide for a day long symposium that engages diverse stakeholders in envisioning smart cities projects, along with benefits and barriers.

- e. **Use the city as a test bed or living lab:** Pittsburgh's PGH Lab, which is run by the City's Innovation and Technology team, solicits private sector startups to test certain technologies in the city that align with their interests. [32] Projects are solicited in cycles as focused cohorts. On a smaller scale, the planned community of Sterling Ranch, just outside Denver, CO is a testbed for smart city technologies. [33] The developer, a Vanderbilt University alumnus, partnered with that university to allow students to leverage the well instrumented community and its wealth of new data streams as a laboratory. It is worth noting that workshop attendees struggled to define and differentiate between the ideas of "test bed" and a "living lab". The main suggestion here is that a city consider developing a process and governance structure that allows others to experiment with or deploy new technologies on city-owned assets. Cities have an opportunity to lead this work themselves, as in Pittsburgh's case, or co-create a third party such as Envision Charlotte and Chicago's UI Labs City Tech Collaborative. The latter examples are discussed in greater detail later in this report.

4. HOW INDUSTRY CAN PARTNER ON RESEARCH

How can industry position itself to serve as an open and engaged research partner?

- Create visible, externally engaged staff positions that are outside of sales
- Devise intentional student engagement strategies

Industry officials, as well as the cities and universities who have worked with them, noted specific barriers to engaging in research initiatives. Private sector partners tend to be accountable for quarterly earnings goals, so it can be difficult to free up human capital to dedicate to non-revenue generating activities. While intuitively valuable, it can be difficult for those involved to predict and measure return on collaboration and non-traditional research investments.

Two opportunities emerged from the sessions. While not exhaustive of the many ways in which industry can best support smart city research, they are still useful to share here.

- a. **Create visible, externally engaged staff positions that are outside of sales:** Microsoft's Cities Team-Civic Engagement is a dedicated group of staff members who engage with city and community partners. Their goal is to leverage Microsoft's expertise and resources to make a sustainable, scalable impact on pressing issues in the cities where they work. [34] Areas of focus include economic

development and innovation, smarter and more sustainable cities, data and openness, and 21st century education and opportunities. The Cities Team is distinct from, but works with, Microsoft Research, which supports academicians engaged in data intensive scientific research and advanced computing.

- b. **Devise intentional student engagement strategies:** A key observation related to industrial engagement is the importance of identifying underlying incentives from the partnership that could be sustainable, which may well be unrelated to the socio-technical challenges or subject matter. One specific example is access to and impact on student talent. Given students' increased interest in "smart city" applications, industry partners could leverage curricular and extra-curricular activities to introduce students to their technology platforms and/or to provide experiential learning opportunities through funded internships and course projects. BU Spark!, an innovation, entrepreneurship, and experiential learning initiative for BU students, developed the eXperiential learning Lab (X-Lab). [35] X-Lab matches real-world problems submitted by corporations, startups, non-profits and cities, with student course projects in data mining, data mechanics, machine learning, mobile computing, and computer vision.

5. TRANSDISCIPLINARY PROJECT MANAGEMENT — PUTTING ALL THE PLAYERS TOGETHER

How do relationships and projects transition to formalized, sustainable partnerships that simultaneously advance science and societal well-being?

- Ask integrative questions
 - Routinize and professionalize community engagement
 - Invest in community capacity
 - Develop an annual collaboration plan collaboratively
 - Consider an MOU or contract
 - Create a third party that brings together government, industry, community and universities
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The foundational components noted above all help prime political leadership, community leadership, city staff, faculty, students, administrators and industry experts for transdisciplinary collaboration. They lay important groundwork by signaling priorities, opening communication channels and pressure testing partnerships. But when engagements transition from ad hoc to multi-year or from the modest seed grant scale to seven figure financial investments involving many stakeholders, it is critical to align interests and formalize expectations in writing.

Workshop attendees noted a number of key challenges that need to be addressed as partnerships are formalized. Pacing, products and privacy were three areas which were stressed. With regard to pacing, communities tend to have urgent immediate/near-term needs, while academicians tend to be focused on long-term scholarly gains and knowledge generation. Product needs will vary tremendously, as a city may want a short non-technical report or beta version of tool or application, an academic is more likely to be focused on a journal publication, and industry may be most concerned with who owns intellectual property that emerges as the result of a collaboration. Legal complexity increases when private data changes hands and/or new technologies are created and tested. Privacy needs and data security may also be paramount.

- a. **Ask integrative questions:** The basis of a formalized partnership needs to be integrative questions or challenges that require a transdisciplinary, mixed methods approach to tackling them. Participants noted that it is important that the issue a team seeks to tackle is one in which all team members have a vested interest and where they are able to contribute knowledge and expertise.
- b. **Routinize and professionalize community engagement:** As multiple speakers noted, community engagement is a competency. During his keynote remarks, Bill Elwood of the National Institutes of Health, defined community engagement as "the process of *working collaboratively* with and through

groups of people affiliated by geographic proximity, special interest or similar situations to *address issues that affect the well-being of those people*.” He noted that researchers must first define the community they intend to engage, and then map the full scope of their roles in all aspects of the project, which may include research design, project implementation, data analyses and knowledge dissemination. Engaging communities in multiple ways, early and formally, mitigates the risk that researchers first devise solutions in the lab and only later attempt to apply them to community problems. [36] NIH Environmental Health Sciences now mandates that university researchers engage with their target community via Community Engagement Cores. [37] Bidirectional communication, education and a formal engagement plan are requisite.

- c. **Invest in community capacity:** Elwood was careful to note that community engaged processes, such as design charrettes or focus groups, should not be conflated with community-based participatory research (CPBR). The latter trains community members as researchers helping to shape research questions, gather data, make sense of findings, and gain new knowledge. [38] Inherent in CPBR is respect for the knowledge and capacities that community members can provide. Respect for time is also key: community members and organizations should be compensated for their involvement. Community researchers are trained staff and should be paid accordingly, and community organizations that are investing time and resources to support a project should be treated as subcontractors. Researchers and academic institutions need also respect the fact that community partners typically operate on limited budgets and cannot wait months to be paid. Small organizations may also struggle to manage arduous financial audits, and may consider these hurdles when deciding whether to partner with a university.
- d. **Develop an annual collaboration plan collaboratively:** An annual collaboration plan should be developed together with key stakeholders. While components may vary to meet the needs of those involved, some core components may be particularly beneficial:
- Agree on key objectives of the project, including research objectives, service delivery, service improvements or any other goals sought by those involved
 - Develop a governance structure, which may include a steering committee and subcommittees, and agree on frequency of meetings and whether sessions will be open or closed, in person or via phone. Governance structures are important for information flow, but also provide forums to negotiate disagreements as they arise.
 - Agree to any other routine, bidirectional communication throughout all phases of the project, including grant writing, project scoping, research, analysis, publications and presentations.
 - Identify near-term written products, which may include quarterly or annual progress reports, policy memos with preliminary findings, or presentations
 - Identify long-term written products, including academic journals or public facing reports

“How to Write a Collaboration Plan” is a useful resource authored by Dr. Kara Hall (NIH), Dr. Kevin Crowston (formerly NSF), and Dr. Amanda Vogel (Leidos Biomed) in 2014. It was initiated as part of an investigation into Team Science spearheaded by the White House Office of Science and Technology Policy’s (OSTP) Networking and Information Technology Research and Development Program. .

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of an investigation into Team Science spearheaded by the White House Office of Science and Technology Policy's (OSTP) Networking and Information Technology Research and Development Program.

- e. **Consider an MOU or contract:** Session participants noted that a Memorandum of Understanding or other formal agreement signed by the various parties engaging in smart and connected research are uncommon, but this does not suggest they are unnecessary or should be overlooked. MOUs may be critical in instances where data is changing hands and privacy is a central concern, or where projects reach sufficient scale as to require extensive resource commitments from multiple partners. If a project hinges on active participation of a particular party or access to a particular resource, an MOU should be authored with the guidance of legal counsel, co-signed and retained. Further, an MOU is an opportunity for all parties to agree in writing as to what information will get released and under what circumstances, ensuring that subsequent academic journals, white papers, community presentations or op-eds receive formal consent up front.

- f. **Create a third party that brings together government, industry, community and universities:**

A number of invited speakers discussed the value of forming an independent third party that brings together the city, universities, corporate interests, utilities and civic partners. Representatives from Chicago's UI Labs City Tech Collaborative [39](formerly City Digital) team and Envision Charlotte [40] revealed these alternative models for leveraging the city as living laboratories. Both organizations function as city scale "lab managers," coordinating activities and interests of multiple partners. UI (University + Industry) Labs City Tech Collaborative effort was launched in 2015 and holds an MOU with the City of Chicago that allows it to use city streets as a test bed. It operates as a fee-based member organization for corporations and foundations, while also enabling academic researchers to conduct grant-funded pilot projects. The team meets regularly with the City of Chicago to understand their priorities and engages industry by discussing strategies, ideas and "hunches" they want to test. They coordinate intellectual property rights up front. Envision Charlotte was formed in 2011 as a "public private plus collaborative" that leverages the city's downtown as a living laboratory to test ways to reduce energy usage, as well as efforts relating to waste and water management, and air quality. It brings together corporations, the local utility, UNC Charlotte and the City of Charlotte. A three-year Department of Energy grant brought together various stakeholders to identify capital improvements, management efficiencies and programs to incentivize behavioral change with the goal of reducing energy usage in two hundred buildings in Charlotte. As the speakers noted, because they sit outside of government these third parties can more easily endure political transitions. They also provide staff capacity that is external to the city and provide expertise in issues such as intellectual property that are not the usual domain of city legal staff.

6. KNOWLEDGE DISSEMINATION: EXTENDING REACH AND IMPACT

How can findings and knowledge be disseminated more broadly, beyond the project team and geography?

- Produce non-technical presentations and white papers
 - Work together to develop a media strategy
 - Leverage multiple communication channels
 - Select the best messenger for each channel
-

For partners that seek impact beyond their immediate team, project or geography, it is important to clarify how findings will be disseminated and to whom. It will likely be important to use multiple channels, with consideration given to accessibility, timeliness, and format.

Workshop attendees discussed the challenges of the academic publication process for those who seek community level impact. Peer reviewed publications typically have long review times, as well as extensive periods in which researchers may revise and resubmit a publication for reconsideration. If an academic journal declines to publish a paper, a researcher may revise it further and seek to publish it in a different journal. These processes may mean that research findings are not formally published until two years (or more) after a project has concluded.

A number of attendees also noted the bias of many journals toward a single discipline, which may make it difficult for them to evaluate (or value) inter or transdisciplinary research. Even once published, most academic journals are subscription-based, which means the findings are “gated” and thus unavailable to the general public. The format of a standard academic publication, which includes extensive context of prior academic literature, methodology and technical language, renders it less useful to time constrained city officials or community members who are concerned with immediate policy or programmatic implications.

Fortunately, there are vast array of alternative dissemination channels available, including a number that focus on urban issues and are well known among local government officials. Alan Bush, with the University of South Florida, reminded workshop attendees to ask themselves: What knowledge is useful to whom? In what form is that knowledge useable?

- 1. Produce non-technical presentations and white papers:** Non-technical presentations to community organizations and city officials afford opportunities to disseminate information as well as receive feedback. They can also be produced on far shorter timelines than an academic publication, and be structured to meet the needs of both. City officials are more concerned with results and implications than methodology, so it is important for researchers to focus on the “so what?” and the “what now?” In other words, put findings in the context of people’s lives and community priorities.
- 2. Work together to develop a media strategy:** Cities, universities and industry all have public relations teams with preexisting relationships with reporters and a range of media outlets. It may be useful to arrange conference calls and enlist the assistance of the respective press teams to align interests and agree on the media pitch to generate “earned” media. A city may care about a wide array of media outlets, including national online and print online media outlets, the daily newspapers, weeklies, neighborhood papers, and those tailored to specific groups such as Chinese or Spanish-speaking residents. It can be important to agree on timing as well, as city officials may want to align coverage with an event or some other aspect of the political calendar rather than the date of an academic publication. When working with elected officials, it can be wise to operate on a “no surprises” rule. Collaborators need to consider whether they are publicly exposing problems at inopportune times or highlighting problems political leadership may not yet be equipped to address. Researchers must also balance the priorities of others with their obligation to share what they have learned.

3. Leverage multiple communication channels: Beyond earned press coverage, there are a wide array of additional communication channels available today. Intimate channels include closed-door meetings and policy memos, keeping in mind the latter will likely become public record once given to the city. Public community meetings have a broader reach, but are still largely for the benefit of local residents, as are op-eds and media coverage in a local newspaper. Social media is now commonly being used as a dissemination channel for academia. As the author of this report noted in conference closing remarks, there are also many media outlets interested in urban issues. Governing, Next City, Government Technology (GovTech), City Lab and Route Fifty are online media outlets that focus on urban issues and local government, often cover academic research projects, and have both domestic and global reach. MetroLab Network, a national city/university collaborative focused on civic innovation, has partnered with Government Technology on a MetroLab Innovation of the Month Series, which highlights impactful tech, data, and innovation projects underway between cities and universities. [41] The Conversation is a global online publishing platform available only to academics who author their own editorials, which any media outlet is free to publish under the creative commons license.[42] Lastly, Medium is a free online publishing platform for anyone who wishes to self-publish. Researchers should consider multiple methods to disseminate findings or shine a spotlight on a project, as one media mention is unlikely to reach all desired audiences.

MetroLab Network has partnered with Government Technology on a MetroLab Innovation of the Month Series, which highlights impactful tech, data, and innovation projects underway between cities and universities.

4. Select the best messenger for each channel: Pride of ownership is a strong impulse. It often means that the first instinct is for the lead researchers to be the primary authors on any “publication” related to a project. It is important to consider the experience, role and reputation of contributors and type of outlet when selecting the most suitable messenger. A community partner may be the ideal messenger in the context of a community meeting, a city staffer is the best author of an internal city policy memo, while an academic is most appropriate author for a piece published via The Conversation.

CONCLUSION

This white paper synthesizes the collective experiences and lessons learned of more than one hundred researchers and research partners. The assembled participants were drawn from across the US from cities and universities of all sizes. Some, but not all, have been the recipients of funding from the National Science Foundation or worked as part of an NSF-funded collaboration.

The two workshops that provided the material for this report were thorough but not exhaustive. Further work is needed to adequately understand the opportunities that exist for funders, including foundations and federal funding agencies, and industry partners that seek to support inter and transdisciplinary research devoted to smart cities. Nevertheless, the hope is that the lessons captured here can help to inspire respectful collaborations in pursuit of societal well-being.

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