



DesignIntelligence®
Quarterly

2020
RESEARCH
ISSUE

Q1

DesignIntelligence® Quarterly

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This year, DesignIntelligence Quarterly's theme is **resilience**. We firmly believe the participants in the built environment industry must invest in resilient business and design practices now, before some future economic event challenges the future. (**Editor's Note: As we send this to press, it seems one already has.*)

In our investigation of the recurring, connected nature of things, we seek ideas and practices that adapt, spring back from setbacks, evolve and flourish forward. In 2020, our quarterly issues embrace aspects that look forward concurrently and cyclically.

- **Q1** focuses on Research, an overdue subject in the design and construction industries.
- **Q2** turns to Reframing, the ability to ask the right questions, in context.
- **Q3** investigates Redefinition, a point of departure for firms

wishing to clarify purpose and write new rule sets to determine their futures.

- **Q4** DesignIntelligence Quarterly's Fall/Winter issue concludes the year with a deep dive into Reinvention, a common need for firms across the planet in the new landscape for practice.

These four aspects connect in a cycle-of-life shaped by external forces. Domestic, global, geopolitical, economic, and environmental factors, disruptions, risks, investments, and language convene to result in a "resilience continuum" - a vision of planning, action, and radical change - an ever-adapting, systems-thinking deep dive into the state of the built environment industry, the world, and practice.

The diagram below by David Gilmore captures this vision - our 2020 editorial roadmap. As you digest the content in this issue, perhaps some new-old



2020 EDITORIAL ROADMAP



notions will emerge. As they do, consider bringing them into focus by sharing them with us - and more than a half million readers. Let's connect. Contact us with your ideas and thought leadership in these areas via essay, interview, audio, or video podcast format. Together, we'll collaborate to continue what has been our

mission for more than 25 years: **discovering where business meets the future of design.**

DesignIntelligence Q1 offerings in this issue include thought leadership on research by acclaimed experts. We delve into how research should be approached, formalized, established, and conducted, spanning academia, practice, and manufacturing, including economic and societal perspectives. Barbara Bryson recaps outcomes and action from the recent inter-disciplinary Restruct symposium at the University of Arizona. Renée Cheng outlines research initiatives at the University of Washington and beyond. Scott Simpson's essay looks to the need for, and possibilities enabled by, evidence-based design. Leaders from global giant Jacobs share insight into their search for synergy as they apply their research and innovation initiatives across a global firm. Bob Fisher offers wisdom on research at (your)

scale. Paul Hyett's retrospective on in-firm research in the UK unearths an obvious question. Billie Faircloth's glimpse into Kieran Timberlake's longstanding culture of inquiry and Blaine Wishart and Taylor Hahn's article on research directions span the continuum from past, to present and future. Explore them.

Our hope for you and your organization in 2020 is for you to see more clearly as you research, reframe, redefine, and reinvent for resilience. To that end, and to guide the DI community for the next 25 years, we have refreshed the look and form of our media. We will continue to do so. We hope you find our new web format more accessible, and that you see more clearly.

Michael LeFevre, FAIA Emeritus,
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Towards A Resilient Way

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DAVE GILMORE

President and CEO,
DesignIntelligence

In challenging times, being connected is more important than ever. Relationally, we bounce back. Resilience is a matter of time in the recovery and functional relevance of an organization.

Everything, when it is as it should be, is connected. All nature is designed to be connected. This vast network of interconnectedness is what binds together the world as we know and understand it. When failure and conflict occur it's a matter of disconnectedness. On every dimension, large and small, across all known categories of nature, disconnectedness is the root of failure and conflict.

This is perhaps most true in humanity. Humans were meant to be together. It is an innate dynamic of humanity that we operate across an interdependent reality. It's the basis for economics, commerce, business and effective healthcare. Human cultures are

founded on the principle of interdependence, without which no culture would survive. When we acknowledge and invest in interdependency and interconnectedness, we ensure the future culture.

A *Resilient Way* is marked by relational connectedness, the interconnected, interwoven relationship dynamic of cultural participants. Organizations sustain and flourish in a context of healthy relationships. The idea of *healthy relationships* is naturally marked by unity, togetherness, alignment... connectedness. Far too often we come apart, pull away, and disconnect from one another to find ourselves operating in and through aberrant ways

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Everything has changed and will continue to, faster and faster, until what we dream of is a current reality on the cusp of changing again.

and means. We either feel or become isolated by virtue of this disconnectedness. In a disconnected state we lose perspective, adopt a myopic view, and even become paranoid. These are not the attributes that mark resilience.

Investment in the mechanisms and actions of connectedness ensures that when hits and downsides assault the culture, the culture bounces back, adapts, and springs forward to flourish towards its next iteration.

Throughout the past twenty years much has been written regarding resilience. From medical science and agriculture to societal events and economics to geo-political dynamics, the topic of resilience has become a regular theme across many communication channels. One especially encounters the theme when a newsworthy traumatic event occurs, such as an attack on human life or a major environmental impact.

With the global emergence of the coronavirus and the apparent end of the longest economic recovery in history, it seems clear that the global economy, in particular, the US economy, is entering another cycle of economic turmoil and business disruption directly impacting the built environment industry. If this is true, it's incumbent on business leaders to begin immediately securing their businesses in ways that ensure resilience. Thus, a *Resilient Way*.

Do I have anything new to add to resilience's growing body of knowledge? I have this: I speak to the topic as a concerned business thinker whose career has been focused on both sustainability and fulfillment. And that begs a few other questions like, "What is the best and most inclusive definition of sustainability?" and "How does one most effectively apply fulfillment to a business context?" I'll do my best to

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Humans were meant to be together. It is an innate dynamic of humanity that we operate across an interdependent reality. It's the basis for economics, commerce, business and effective healthcare.



offer insightful responses.

Like no time before, resilience, as a basic quality of business sustainability, is required in the new economic reality. Gone are the days before globalism, ubiquitous connectivity, instantaneous deep, wide access to knowledge, and a set inventory of reliable economic indicators. Everything has changed and will continue to, faster and faster, until what we dream of is a current reality on the cusp of changing again.

In 1981, Buckminster Fuller, wrote his infamous book, Critical Path. In it, he stated that knowledge was changing at unprecedented rates. IBM asserts that knowledge is doubling every 12 minutes due to the nature of internet architecture and its associated oceans of data. As such, it's projected this will accelerate to a velocity of knowledge doubling every minute by 2025.

We have to ask ourselves, "To what end?" The increase in information and the possibilities of knowledge at such rates act as a two-edged sword. On one edge this phenomenon evokes god-like possibilities, breakthroughs in science and creativity that could possibly address the most instinctual of human drives; the drive to survive - and rid the world of mortal diseases, plagues, famines, and death itself.

On the other edge we are cut to the quick by how such knowledge might be used, manipulated, expressed, and executed. We are often obtuse to the "other side of the same coin" when focused on achievement, leaving us exposed to risk - known and unknown, acknowledged and un contemplated.

Regardless of this reality one thing remains true; along the way we will be faced with challenges, troubles, losses, and sometimes traumas. The question

of, "How to keep going?" comes front of mind.

Resilience is the fundamental idea of recovery. Knock me down and in my resilient form I'll recover and get back on my feet. The time it takes to recover is a matter of fitness. In the language of physical fitness, it's the time to recover from exertive exercise that determines the fit from the unfit. In other words, fitness related to resilience is a function of time. And so it is with business. Resilience is a matter of time in the recovery and functional relevance of an organization.

In the Great Recession of 2008-2011, many companies proved to be non-resilient, unfit to recover before they ceased to exist. The hard-hitting unexpected shock to the financial infrastructure of the U.S., and many other countries globally, resulted in thousands of companies going under,



Regardless of this reality one thing remains true; along the way we will be faced with challenges, troubles, losses, and sometimes traumas.

SELF-AWARENESS



RESILIENCE

never to return. The fallout was so deep and wide that tens of thousands of people in the U.S. lost their jobs.

At the professional practice level of architecture, engineering, and construction, by 2014 the newly configured AEC landscape reported dramatic work backlogs amounting to billions of dollars. Still, the questions remain, “What has changed in these practices to build resilience into their firms? What fundamental work and cultural habits have been altered to prevent a repeat of the Great Recession’s devastation at the base professional practice level?”

Do traditional architecture, engineering, and construction remain as they are, morphing incrementally, or is there a ubiquitous transformation necessary in these professions to dismiss the obnoxious question of relevance and position the professions at the front of

the “Smart World” movement?

Relevance is a matter of awareness. Being aware of the multiple contexts we practice within and those we interface with. But like resilience, relevance is an ever-changing dynamic.

New models for the professions and the business of the professions are critical. A new resilience must be introduced as opposed to that of hopeful endurance. Resilient organizations are quick to recover from setback. Rapidly yet intelligently they adapt to the altered context of business dynamics and stride forward with exemplary confidence to flourish where others languish.

How do we get there from here? What are the firsts and seconds of successful, effective change? Too often we rush in hoping to change things, believing that action is the answer, but resulting in

frustration, expectation failures, and backwards momentum.

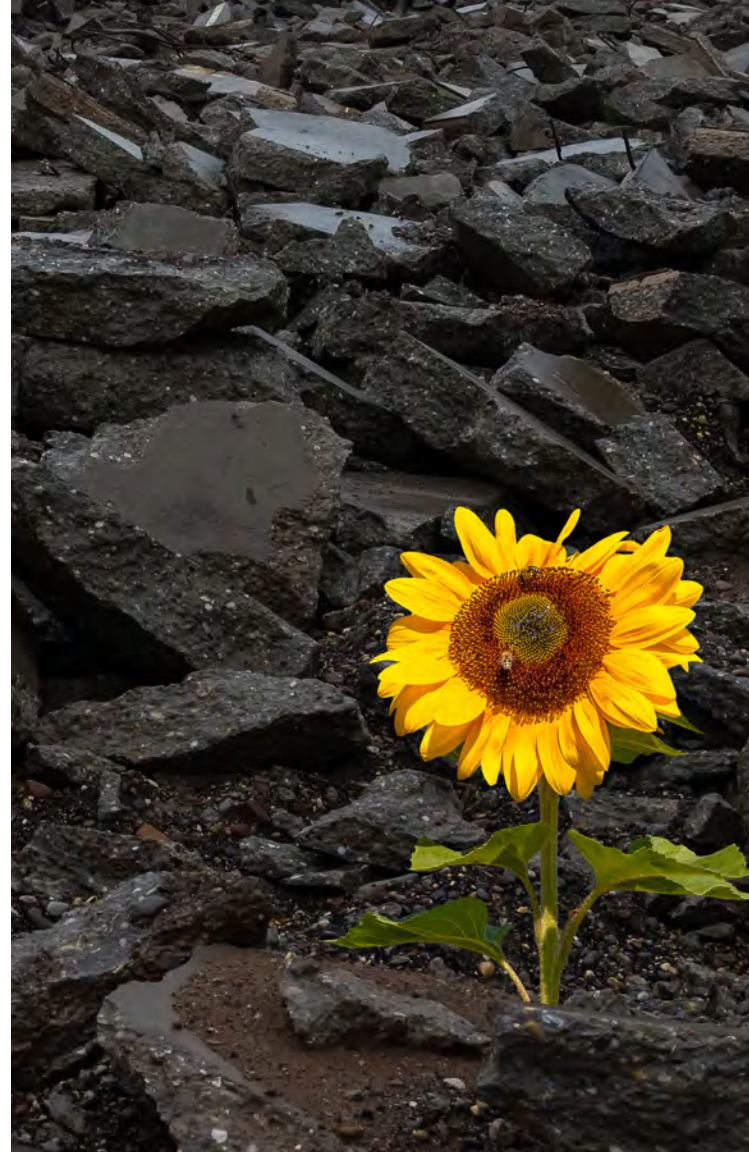
Moving towards resilience begins with honest self-awareness. As a professional firm, this means coming to an understanding of where each leader is and how they relate to one another. Absent this, the firm struggles in the fog of uncertainty simply because the leaders aren't sure of one another, establishing doubt and suspicion as their interaction model.

The basis for successful effective leadership is relational trust. It's that quality of interaction marked by an open, intelligent vulnerability, inviting input from the trusted and being humble enough to know you don't know. This is part of professional maturity; knowing you don't know as opposed to not knowing you don't know.

When leaders adopt a mutual

self-awareness, it allows them to turn inside-out and become others-focused. This is because they've stopped obsessing about themselves and are now focused on the people and clients they serve. Focusing in an interdependent context on the essentials of interconnectedness ensures the deep foundations of resilience we will need to call upon in the challenging days ahead.

Now more than ever before, we are calling the professions towards a *Resilient Way*.



On Research

DesignIntelligence®
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**MICHAEL LEFEVRE**

Managing Editor,
DesignIntelligence

In a world full of data, designers, owners and builders can no longer rely solely on intuition: we need to know what has come before — and use the wisdom of others.

When I was in school in the 1970s, we didn't do research. We were taught that great design simply emanated from our brains. That's what we were responsible for — original creations. When we were inclined on rare occasions to do research, we didn't have things like the Internet or Wikipedia. In those days we relied on manual labor. We read hard copies of books in the library, painstakingly extracted individual ideas that seemed relevant, and hand wrote them on 3 x 5 cards in hopes we'd reuse these "information bits" later. Research was little more than occasionally wandering into the library to look at the work of other great architects. Oscar Niemeyer had some sumptuous modernist forms. Ludwig Mies Van Der Rohe tested pure

functionalism. Phillip Johnson borrowed from all of them. (Personal research via a visit to his studio in New Canaan confirmed this method: his desk and favorite architectural monographs were still there.)

But there was little in the way of the written word or actionable data. We were architects, not scientists. Even if there had been, we had no way to find or aggregate it. We didn't have keywords, tags, hashtags or hyperlinks back then — only memory, experience, and hoarding our favorite fragments.

No wonder we didn't want to do research. Research was little more than the set of old blueprints we had from

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When we were inclined on rare occasions to do research, we didn't have things like the Internet or Wikipedia. In those days we relied on manual labor.



Phillip Johnson Studio, New Canaan

Desk, Phillip Johnson



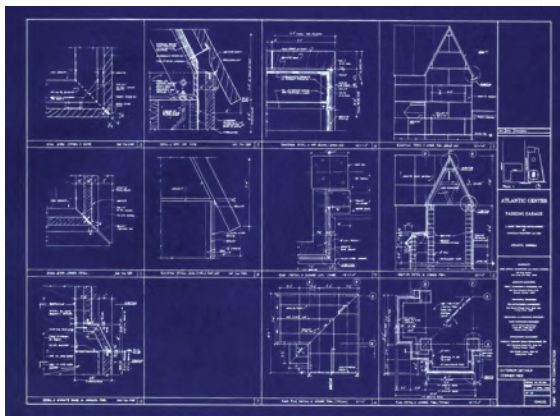
Library, Phillip Johnson



past projects, or the personal libraries of coffee table architectural monographs designers had to fuel their imagery. Luminary Thom Mayne was lovingly known as the “piece thief” for his penchant of borrowing, adapting, and reusing elements in his form-making. A section of a grille from a Pontiac Bonneville, a detail from an electrical generator — all had the potential to reappear in new manifestations in his expressive works. But where could those who sought non-visual expertise and references look?

A few enlightened souls conducted literature searches to see what had gone before. They found little. Others organized comparable facilities visits — still a fine tactic in building common team experience, reference points, and compressing data into mutually understandable preferences. But most learning accomplished using these methods was held closely for internal firm or project use, not shared across firms or the industry. Few of these undertakings could qualify as research.

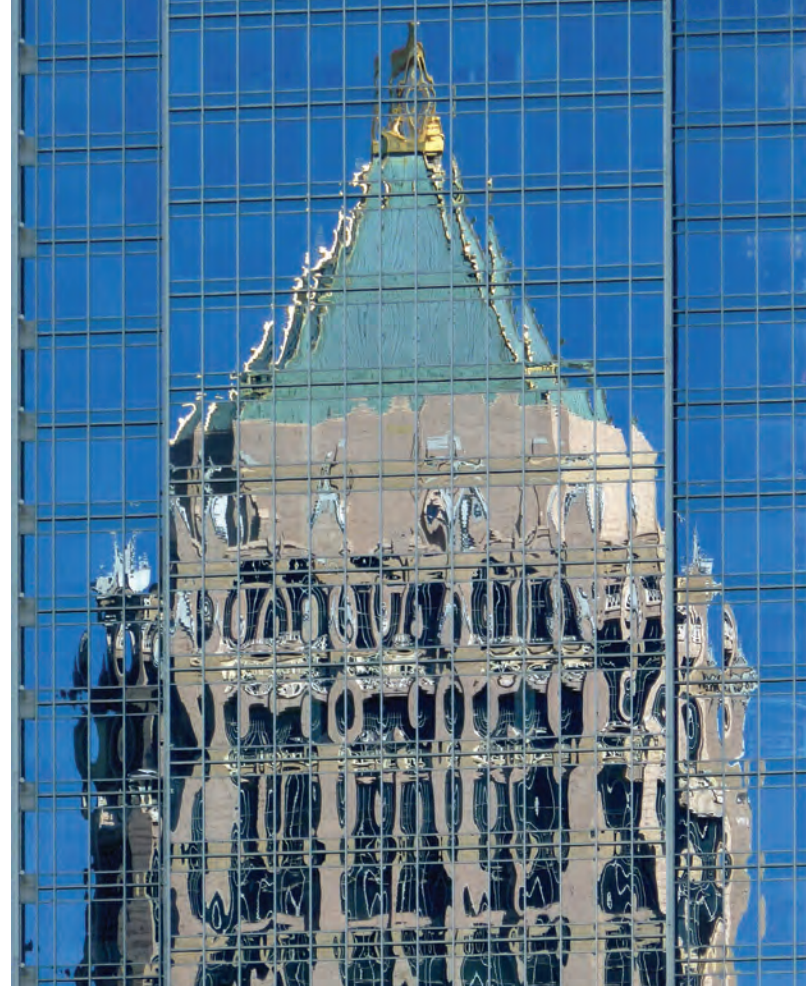
Things have changed. A local library just announced they are doing away with the Dewey Decimal system. Why? Because we no longer need to classify information into a hierarchical, subject-based categories. Everything is connected, tagged, searchable and linked. Everything is available. Now we have a much broader set of tools at our disposal. Things like computers, laptops, mobile devices and this iPhone into which I'm dictating this thought



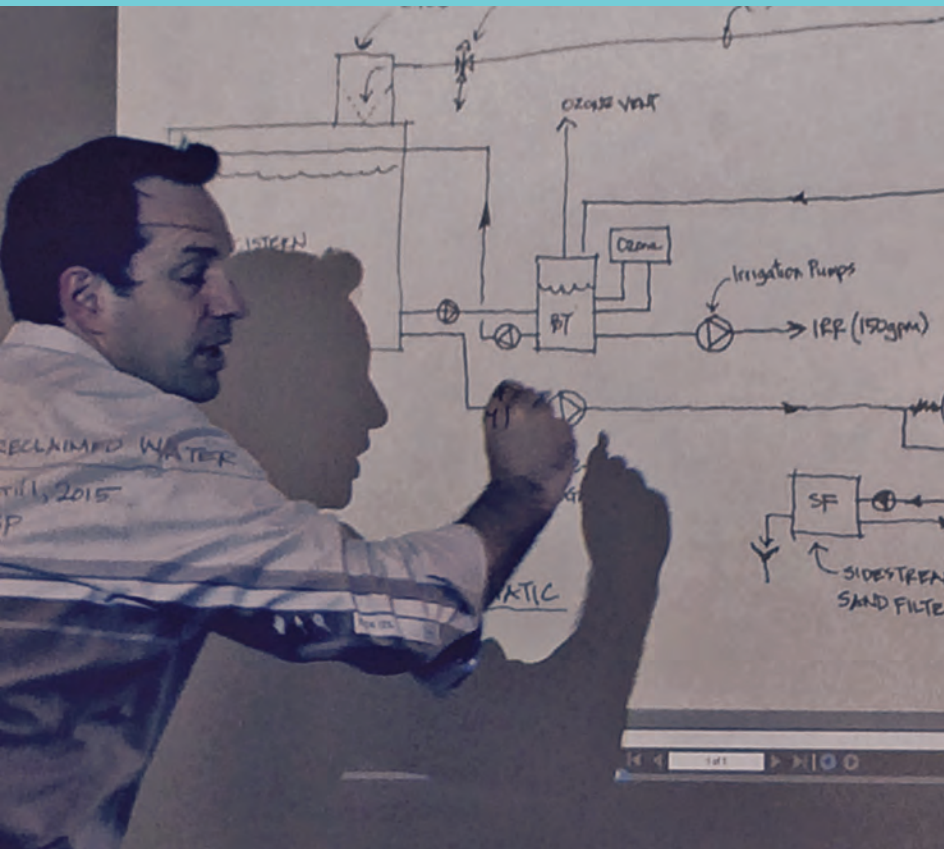
Construction Documents, IBM Tower Parking Garage

give us anywhere, anytime access to everything. Most importantly, because we're connected digitally, we can share and access information. Rule sets, protocols and filters make it useable. Now, our problem is having too much of it — even to the point of disinformation, sometimes malicious. We must rely on researchers' fact checking and validating the veracity of vast amounts of data as they convert it to wisdom, knowledge and action. But despite these caveats, we can be more powerful and knowledgeable now. And we should be.

The problems we face now are so much bigger than the individual buildings we used to create from our individual minds. The architect's mandate has become more than one-off form making. Now, the issues we face in creating built environments are ones of infrastructure, environment and connectedness: our own sustainability.



IBM Tower, Phillip Johnson / John Burgee Associates



The implications of our actions are vastly greater than those we faced in the 1970s, during the heyday of modernism, the age of anti-establishment, and the dawn of postmodernism.

I hope current students and practitioners have a greater appreciation for the importance of research than we did — that is, looking again, or looking for the first time — at the work of others. We need to be smarter. Our own brains are no longer enough. The problems are simply too big and too connected. These kinds of wicked problems dictate our working together to learn from history. We need to know what has come before — and we need each other.

As I reflect on research (and how little of it we did in my day), my hope for future practitioners is twofold. First, that they avail themselves of these new mindsets, skillsets, systems, and toolsets to use, create, and share the

intelligence now available to create in smarter, more sustainable ways. Second, is that the inherent messiness of serendipity, random discovery, and the cyclical, explorative nature of design process will never be lost. Machines, shared, and artificial intelligence will help, but there's an art — a human art — to deciding what to filter and what to include to create meaningful, beautiful, sustainable work.

I hope designers and builders of the future do these things in ways I never could.

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Our own brains are no longer enough. The problems are simply too big and too connected.

Closing Loops
Cross-Discipline Research:
Wicked Problems and Valued Futures

DesignIntelligence®
Quarterly



RENEE CHENG

Dean of the College of Built Environments at the University of Washington

Renée Cheng was recently named dean of the College of Built Environments at the University of Washington. She spoke with DesignIntelligence about AEC industry challenges, research adoption, knowledge loops, transdisciplinary work, and possible dystopian and utopian futures facing professionals.

DesignIntelligence (DI): What differences have you seen from a cultural, resource, institutional, or regional perspective compared to your former life?

Renée Cheng (RC): Great things were happening at the University of Minnesota — in particular, the research efforts through the Master of Science and Research Practice program but I saw an opportunity to expand that at University of Washington's College of Built Environments. I'm in position now to be working across disciplines focused around the built environments.

It's rare in our world to have these disciplines — architecture, landscape architecture, urban design planning, real estate and construction management — in one college. Often, construction management is found in the engineering school, real estate might be in the business school. That's not to say you can't collaborate across boundaries. But having all the disciplines in one college about the built environments helps.

One lens I'm using as I transition here is understanding how a research-based set of degree programs working with a

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as we increasingly rely on our ability to advise clients based on our own proprietary knowledge and experience, we are trading only on our reputations — asking them to trust that we have the expertise simply based on past projects.

multi-disciplinary set of firms in the Puget Sound, or the Pacific Northwest region, differs from my previous setting, which was predominantly architecture-focused. Here, we can tap students from a wider range of disciplines and cross over to have a construction management student working for an architecture firm, or a landscape architecture student working for a planning firm, et cetera. You can cross-link students and firms to create different opportunities.

Working with the other UW deans has been fantastic. We have a group of 21 deans and chancellors at the university. Quite a number of us are new, and the culture is actively trying to explore and collaborate. We are all sharing ideas and asking questions around higher education and the wicked problems that face our region and planet. Seattle, in particular, has urgent challenges due to the speed of the growth and eco-

nomic activity here. It's a great laboratory.

DI: What are architects and designers missing by continuing to practice traditionally, without research as an integral part of their process? What limits and roadblocks constrain that evolution? And what is the cost of not moving in that direction?

RC: It's broader than just designers, it's the whole AEC industry. I use the CIFE/Paul Teicholz industry productivity graph from the Bureau of Labor Statistics that shows industry productivity. On a global scale, all industries since 1964 have more than doubled in productivity, but the AEC industry is flat or declining. The industry has, for a very long time, not been able to take advantage of innovation, globalization or the different goals other industries have used to increase effectiveness. There has long been a sense that



architects are willing to work for low fees because they love design — that, for them, it's not about the money. I don't disagree with that, but as we increasingly rely on our ability to advise clients based on our own proprietary knowledge and experience, we are trading only on our reputations — asking them to trust that we have the expertise simply based on past projects. We are missing the opportunity to explain or expand our value, and so we end up competing on fees alone.

DI: Our historic aversion to talk about these issues has, as an unintended consequence, put us precisely in the place where fees have been commoditized. That strategy has had unintended consequences.

RC: We have self-created this low value proposition for our work as designers

in an industry that is not highly functional. When an owner sees projects chronically not meeting budget and schedule goals, not having clear design outcomes met relative to their business goals, they are skeptical about designers. Contractors can point to errors and omissions in the drawings to show why costs are rising. We end up with an antagonistic set of circumstances and relationships, and designers' credibility — the value we provide — are largely going to be based on our fees and the type of service.

What if we could start to promote our ability to provide services that have specific value maybe its saving on the energy bill or the functioning of the buildings we produce? What if architects could become willing and confident enough to base their services and fees on performance — not just energy performance, but potentially the

success of the business outcomes relative to the owner's goals when they build the building? In that case, architects can potentially take a small percentage of the personnel savings or the productivity gains, or other kinds of business outcomes the building design has ties to.

This is a completely different value proposition — and it takes research. No architect or designer would feel confident tying fees to client outcomes unless they have reliable research. The Landscape Architecture Foundation has great case studies on landscape performance that includes health and business objectives. It talks about storm water savings to infrastructure and tree cover related to school test scores.

DI: Can you characterize research penetration in the built environment? On a scale of one to 100, where do you

think we are?

RC: I would hope to be at 100, yet I think we're probably at an eight. In healthcare, we're maybe at 15. In sustainable aspects, we're maybe at a 20. In the productivity and human factors, we're at a two.

We can get better incrementally, but more than that I hope we are able to make leaps through partnering with other disciplines, finding funding beyond current margins. The National Science Foundation really moved the needle with its funding for Smart and Connected Communities programs. Once you get larger federal programs and international work, we start to see noticeable differences. Otherwise, at the current pace, if we rely only on private funding by firms, we won't get there.

DI: How do we get this to stick? How

do we get traditional practitioners motivated – those who don't have a top-down directive to adopt a research mindset?

RC: I don't think it's a motivation problem. I think there are a ton of firms that would love to do research, but they just don't have the financial model to do it. It's a struggle to figure out where research fits in the current business model, because it's not purely marketing, and it's often not directly billable. Some firms might be aware of the R&D tax credit, but that depends on whether they are set up to take advantage of that, where they can do a direct write-off of the hours that go into sustainable design research. Moreover, not every firm qualifies based on their business structure. We need funding to be able to support and recruit students, get the faculty involved, do the matching process. Some firms are more able to figure out

how to do that, and it tends to be the larger firms that have the margins or have traditionally set aside money for different types of things this could fall under.

DI: Is it a chicken and egg question? Fixing the value proposition or getting paid in a different way to fund it versus activating research first?

RC: It's definitely chicken and egg. You have to be able to say research works, and to have the expertise and methodology to do it. You have to show the value not just of the research in general, but also say, "We have found that pre- and post-occupancy comparisons yield much better satisfaction and allows different effectiveness. Here's the story of how we picked up on some things we wouldn't have noticed if we hadn't done this methodology. We build this cost into our pre-programming services, and you'll get a report

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“We can’t always take the long shots. We also have to have some low-hanging fruit.”

that measures these things.” I’m working with students to structure their research in such a way to show the value in ways that are applicable to other projects in the future. Then, they can start to build in research aspects of the work into the fee because it’s increasing overall value.

Moreover, the approach needs to be cross-disciplinary. Start to fold in the planners who are a part of earlier pre-design decisions. Look at the contractors, the developers and landscape architects to draw a larger boundary around possible benefits and values.

Serial owners are likely to see more benefit because if you do research on Project One, you likely won’t see the benefit on Project One. The benefit might accrue to Project Two, Three, or Four. KieranTimberlake is a great example, particularly their green roofs

or smart facades, which took place over a series of projects. They used a series of projects to understand the micro-climates within a green roof or the potential for the printed circuitry for smart skins.

DI: What’s your stance on incremental change for firms and organizations? Since we’re facing wicked problems, does it have to be radical, transformative, on a bigger scale, or is it okay to chip away at it?

RC: James Timberlake said, “Massive change is only accomplished through small incremental steps.” We can’t always take the long shots. We also have to have some low-hanging fruit that provides success, not only because it gets discouraging to try to solve enormous problems where it’s hard to measure any progress, but also because you need some incremental sub-goals within a large framework. Incremental

change is needed, especially if it has intentionally built in structural and cultural change. Yet if you focus only on incremental change, you feel like you're making progress, but you might be taking one step forward, two steps back. You won't know unless you have clear, transformative goals to track against.

DI: As you look to your transdisciplinary work on bigger issues, what does the profession look like in 10 years?

RC: When I imagine the future, there are dystopian and utopian versions. The dystopic future scenario came from the "Change or Perish" speech Thom Mayne gave years ago. He envisioned a future where architects become exterior designers — cake decorators. They create the composition of the façade, and everything else is handled by contractors or building-owner representatives. Now, in

2020, we could imagine algorithms or robots that do everything, and there's some artistic role for architects to play. If that's the only way in which we are seen to provide value, then architecture as a field is going to come to an end. That's the dystopic future.

In addition, if architects and designers are not involved in the process of building, you get structures that might have beautiful skins, but the way that they work together to create environments becomes limited because there's nothing in the building code or the owner's motivations that requires them to work with others. Societal disparities that come from built environments would get worse - and being born in the wrong zip codes could doom a person to poor health and social outcomes.

In the utopian future, we know more about the ways we design, build and operate buildings and environments.

ARCHITECTS, ENGINEERS & DESIGN PROFESSIONALS WILL BE?

DYSTOPIA

"EXTERIOR DECORATORS"

"FACADISTS"

BROUGHT IN LATE

LIMITED, CONTAINED WORK SCOPE

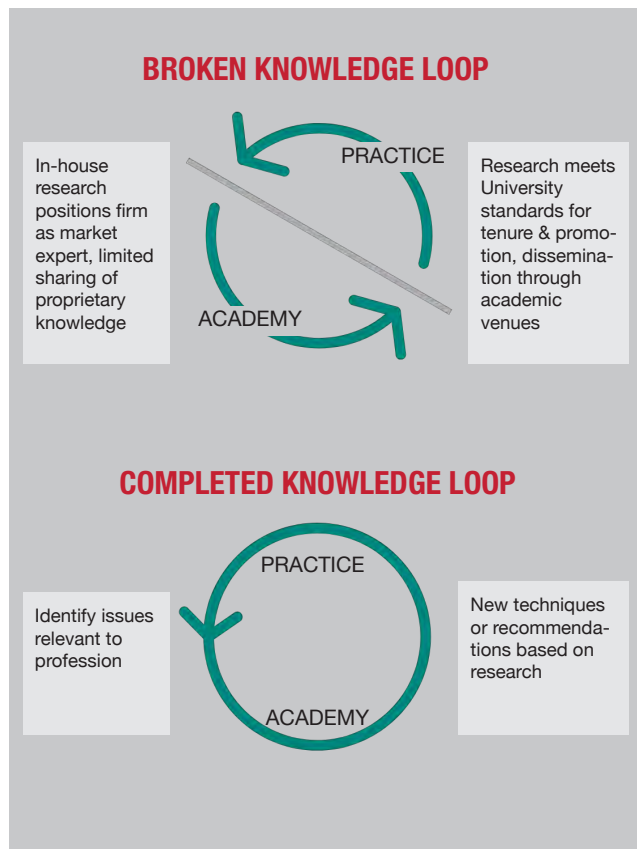
UTOPIA

SERVE COMPREHENSIVE OVER FACILITY
LIFE-CYCLE

DEFINE & SOLVE HOLISTIC, SYNERGISTIC
PROBLEMS

AT THE TABLE FOR EARLIEST DISCUSSIONS

COLLABORATORS BRIDGING MULTIPLE
DISCIPLINES



We know more about how they affect people, how they can benefit people and we invest. Architects become part of a broader set of decisions, such as how building materials are developed, how those building materials get specified, used and installed, and how they get disassembled. Designers imagine multiple potential futures simultaneously, even ones that seem contradictory, and they can resolve things synergistically. They are seen as valuable at every stage of consideration in the built environment. That's the utopic future.

DI: Where is the academy leading? Where is it behind? How can the academic world better connect to the rest of the industry and vice versa?

RC: Tom Fisher, Director of the Minnesota Design Center, talks often about the knowledge loop. It's a bit like the utopic vision of the future, in which

you have a problem or a solution that could originate from or be solved by either academia or practice - they work together. In medicine, which is an example Fisher often uses, a clinician might see a series of patients having similar issues and ask their academic counterparts to study the trend. Or, on the other hand, someone in academia might develop a novel treatment and say, "I think this will probably work based on our trials, but we need to look at it in the field." Either academia or practice could start the query, and the other serves a key complementary role. It's a virtuous cycle.

Currently we have a broken knowledge loop for AEC. Academia has its own motivations for doing the work we do, and it's largely based on promotion and tenure standards, which usually have to do with publication. Publications are usually easier, faster and more predictable to do without balancing an agenda



It's hard for firms to do rigorous applied research without academia. Yet academia can't do it on its own.

from a firm or doing applied field work.

From the firm side, firms doing research are completely motivated to market it as proprietary knowledge. They're not needing to publish in such a way that someone else can replicate the findings. Firms don't need to testing results in a way that uses rigorous research methods.

Its hard for firms to do rigorous applied research without academia. Yet aca-

demia can't do it on its own. There is value in academics that write books that have nothing to do with firms. There is value in firms that are doing work that has no relation to academia. Yet some of the most difficult problems lie at this critical intersection, these are the ones that can change the value proposition. These are important. They may not even represent most of the work we need to be doing but will catalyze change.

DI: Maybe all this converges to usher us into a new era of cooperation?

RC: *That's what we're hoping.*

Renée Cheng serves as the dean of the College of Built Environments at the University of Washington. Prior to UW, Dean Cheng was a professor, associate dean of research, head of the school of architecture, and directed an innovative graduate program linking research with practice and licensure at the University of Minnesota. She is a graduate of Harvard's Graduate School of Design and Harvard College.

A licensed architect, Dean Cheng's professional experience includes work for Pei, Cobb, Freed and Partners and Richard Meier and Partners before founding Cheng-Olson Design. She has received numerous honors and awards including Designintelligence's top 25 most admired design educators in the United States, the 2017 Lean Construction Institute Faculty Award, and was named to the American Institute of Architecture's College of Fellows in 2017.

Cheng is a leader in the American Institute of Architects (AIA) and advocates for equity in the field of architecture and in the practices related to the built environment. She has pioneered research surrounding the intersection of design and emerging technologies, including work on industry adoption of Integrated Project Delivery, Building Information Modeling and Lean.

Research

A Culture of Inquiry



DesignIntelligence[®]
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BILLIE FAIRCLOTH

Partner at KieranTimberlake

As a partner at KieranTimberlake, Billie Faircloth leads a transdisciplinary research team to better understand questions around the built environment. She spoke with DesignIntelligence about the integral role a culture of research and the power of inquiry play in design process.

DesignIntelligence (DI):
Your website tells us that you “conspire to pursue an answer to the question, ‘Why do we build the way that we do?’” What is the answer?

Billie Faircloth (BF):

This question comes from an essay called “Architecture and Construction” written in the early 1980s by structural engineer/architect Eladio Dieste. He was reflecting on several decades of work from his practice in Uruguay and trying to understand the differences between his approach and the dominant pressure of a market-driven construction practice.

This question resonated with me because I grew up in the industry. My father started out very young working on construction sites and in the middle of his career opened his own construction firm. I was employee number two, behind my sister. At age 14, I had already listened to many years of conversation about building and construction.

In hindsight, this question — which I believe is the question in our industry — points to the larger, broader work we have to do to understand building culture, by which I mean the culture that exists around the things we build. The question points to two things: the

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*Why do we build
the way that we do?*



agency we have to shape the outcomes of the things we create, and simultaneously, the agency we feel we lack to control the outcomes of the things we have created.

The question can only be tackled through collective intelligence — consciously, through talking about the outcomes of our design and building activities. The outcomes can only be understood if we're willing to see and learn from the things we have created. KieranTimberlake was founded to ask these kinds of questions, both about the things we're creating and their outcomes.

DI: Research is so integral to the culture of your firm. How is doing on-project integral research changing your process?

BF: It can be incredibly powerful to allow architects to pause and ask a targeted question associated with

specific systematic inquiry, allowing them to have a high degree of certainty about their intuition. Over the last 35 years of this firm, we have committed to building a research culture and to evolving in such a way that we continue to realize — we hope — better and better versions of that culture. The first step is to provide the resources to answer questions and to allow questions to be the basis for design invention and innovation.

There are a lot of assumptions around what a program of research is. Many believe research will be a kind of panacea to address, solve, or cure something. As we have engaged this process of culture-building, we have never approached research as a cure-all. That's not the point.

Rather, we have approached research as a way of helping us expand what's possible; to identify the goals and

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no shortage of questions

aspirations we should be aiming for and to put in place rigorous systematic inquiry so we can meet those goals and achieve our aspirations. For our practice, research is not a program — it's not a division or a studio. It's a position we have taken philosophically; as a firm of more than 100 individuals, we should be able to ask questions, plan ways of answering them and use those answers to elevate the profession.

We have never suffered from a shortage of questions. We have always defined projects, their objectives and the methods to interrogate them with clarity, whether it's a modular vanity, a multifunctional wall or the vegetative dynamics of seven installed green roofs. All those projects can be defined in terms of the questions we're asking, the anticipated outcomes, and how those outcomes might produce knowledge and enliven our practice.

DI: As you wrote in your 2019 article for Architecture Australia, “Searching and Searching Again: Research in Practice,” your firm shares an impressive list of developmental milestones in your research evolution: a “commitment to return profit to [the] practice to support proactive research (2003); the declaration of an ISO-certified design research process that is audited annually (2005); the decision to hire a dedicated, transdisciplinary research group (2008); codification of a research query process for data collection, analysis, modelling and simulation, physical prototyping and original experiments (2011); the strategic growth of the research group to 10 percent of our overall staff (2012); the first successful public release of an internally developed architectural tool for use by the profession (2013); the further articulation of a design computation platform as a companion to our more

established research platform (2015); and, most recently, the formalizing of a collective intelligence model in which every architectural project begins with a complementary team of architecture, research and communications staff (2016).” Were these milestones part of a plan or recognized reflectively?

BF: We have built infrastructure here to support research. Some of that infrastructure includes decision points — what do we want to do next? What we want to do next can be guided by our own strategic plan for research. It’s a three- to five-year plan in which we have identified a range of subject areas we would like to prioritize for proactive research.

But we also prioritize collective intelligence and want research to originate from every place in our firm. We want everyone to have access to what they

think might be done or a question they might want to ask — this too is proactive research. We have a history of it in our firm — projects like SmartWrap™, Cellophane House™, Ideal Choice Homes, the Green Roof Vegetative Survey, and more recently the work we did with UNICEF, Designing the 21st Century Ger project in Mongolia.

Not only do we have a filter given by our strategic plan, but we also have a process for stating the question we want to ask, the importance of that question and the expected outcomes. We have the ability to dedicate resources, staff, time and money to these questions.

DI: But did the decision to commit to this culture evolve over time, or was there a plan from the onset?

BF: It absolutely evolved. It began as a declaration: “We are going to grow our research culture and we are going to return profit to grow that research culture.” Yet this has grown into a process that is integral to our firm’s work and to our design philosophy.

When I started in 2008, the firm was in the third or fourth generation of research. Then, the decision was made to take the next step, to grow a dedicated research group and make it transdisciplinary, one where members in the group have backgrounds in subject areas like materials engineering, environmental management, urban ecology and physics. The premise of such a research group was part of a strategic plan, but we recognized that we needed other people’s knowledge and methods to sufficiently see the gaps in our own industry. At every milestone reached, we have continued to look forward and ask: Now what? What’s next?

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We want everyone to have access to what they think might be done or a question they might want to ask — this too is proactive research.

DI: In this world of accelerating pace, how does adding inquiry to your process impact scheduling? Given never enough time, how are you able to do more — ask and answer questions — within the same deadlines?

BF: We have certainly been in the position where a question we are attempting to answer for a project could benefit from more time. What we began to do early on was to test the questions we could answer over the course of a project.

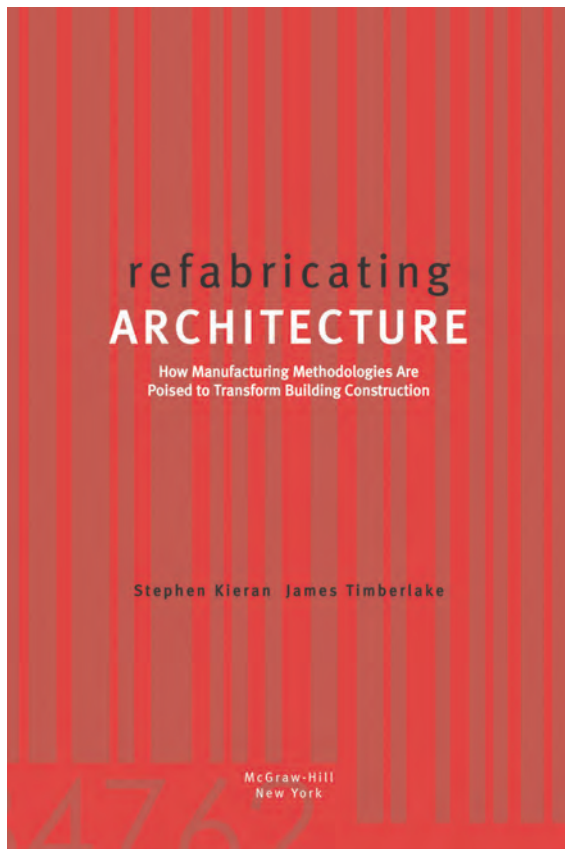
Much of the work we engage falls under normative categories. In some instances, we're asking questions that require us to map an observation or to diagram a certain condition. In other instances, we are measuring, collecting data, analyzing it and interpreting it to help guide a decision. Sometimes, we are actively building a model to interrogate a certain condition.

For a given project, we might engage anywhere from three to 10 different questions depending on project scale, scope and duration. But the work we are doing is connected to a decision to be made. We want the results of the work to be actionable and either tell us to do something or not to do something, to engage something or not to engage something, to support and amplify the design process.

DI: In 2016, Metropolis magazine published the article, “How Architects KieranTimberlake Turned Their Office Into an ‘Incubator,’” which talks about the HVAC experiment and some of the lessons learned from the work you did within your own office space. This included people sweating and complaining. What were your takeaways from the challenges of experimenting on yourself? Did it enhance your empathy for your clients and partners to whom you're doing this on many occasions?

BF: That's exactly why we did it. In the past, when we have challenged a client to consider minimizing resource consumption, we have thought, “There might come a time when we could test this out ourselves.” In the experiment, we integrated over 300 sensors in our building to understand the relationship between different spaces, conference rooms, desks, et cetera. Ultimately, we failed to eliminate HVAC, but we succeeded in learning quite a bit about ourselves, our building, our culture and what it takes to know a place.





DI: Since the publishing of “Refabricating Architecture” in 2003 and projects like the Cellophane House, there has been a rising interest in prefabrication. Yet, many people are not ready for it because it can also eliminate options. What has been your experience in this realm? I find many clients and partners aren’t ready for it because it shifts decision-making flexibility forward — the late changing of minds we’ve conditioned them to enjoy.

BF: We can look across the industry and see the continued interest in, and promise of, offsite fabrication. And we can continue to see companies emerge that are attempting to vertically integrate all aspects of design fabrication and delivery into their offerings. We continue to persist in applying principles of offsite fabrication when and where it makes sense. But infrastructure for offsite fabrication is

sometimes unavailable, and there is not a distributed network to deliver projects using offsite fabrication. We have been fortunate to work with clients who also want to persist in that mode.

It’s an interesting manifestation of an answer to the original question: Why do we build the way that we do? People are trying — and have tried for many decades — to change the nature, process and relationships in building and designing building construction simply through the delivery.

DI: Looking ahead five or 10 years down the road, what is your vision for the future of research at KieranTimberlake?

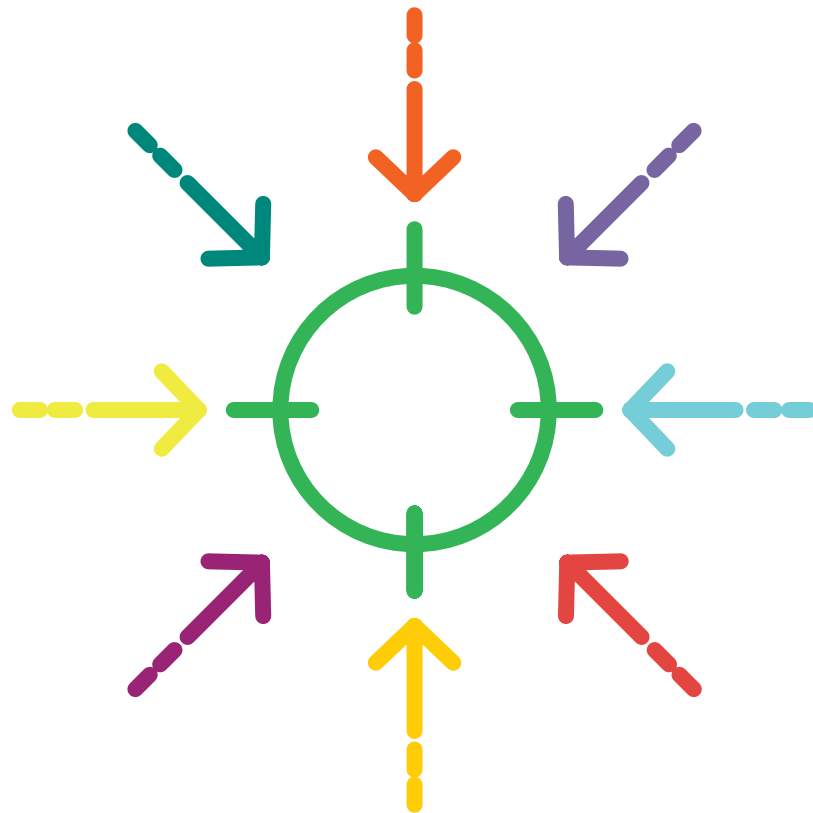
BF: Research hasn’t changed — it’s a way of thinking, a design philosophy. It can be informal, and it can be formal. We will continue to do it because it’s integral to the way that we think.

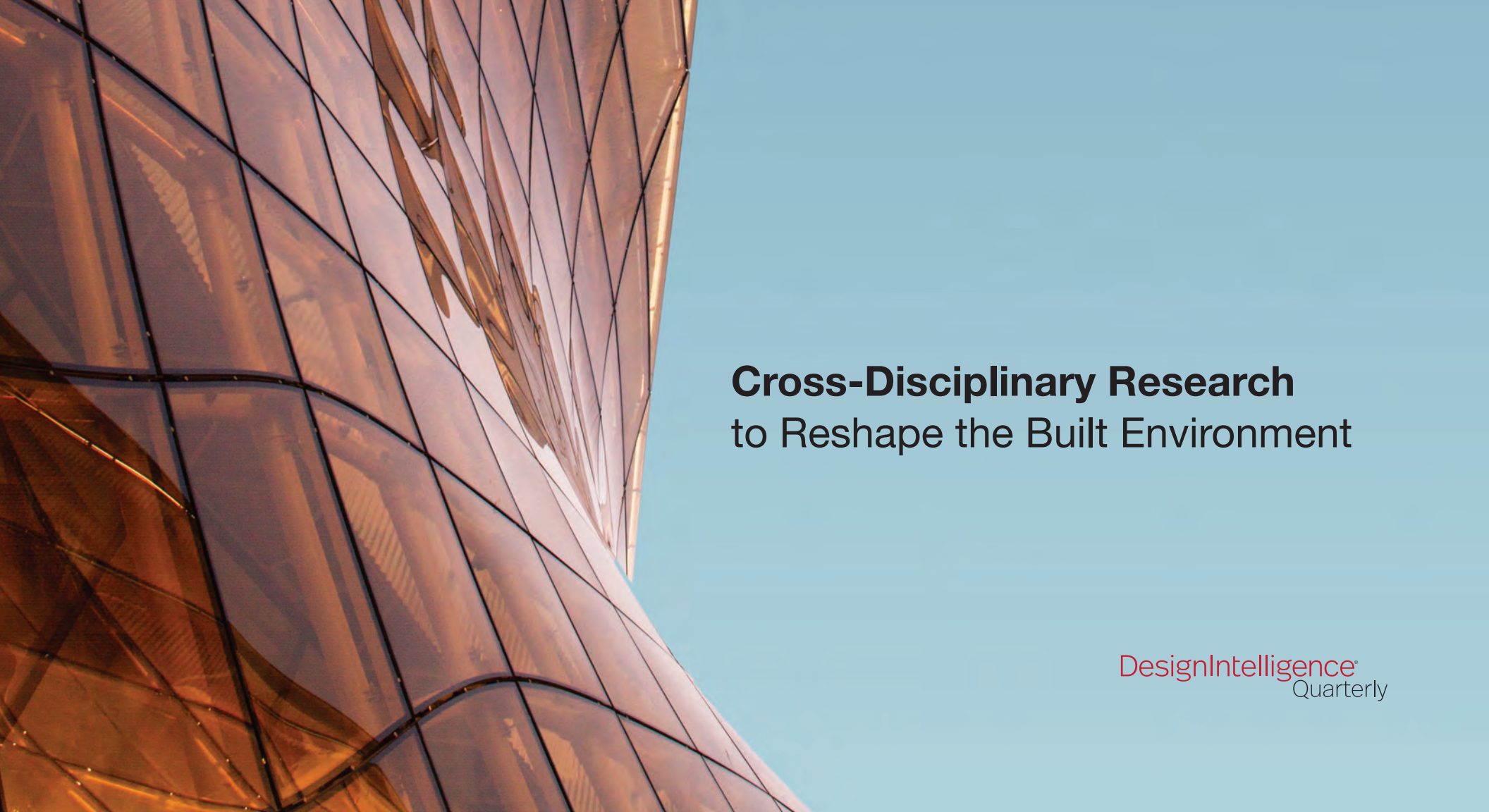
What has changed, as we have matured our own internal practices, is that now we desperately need to focus. The industry needs to focus on engaging projects day in and day out to reduce embodied and operational carbon. This goes beyond research. It requires us to approach our projects from the outset with a mind to tackling the whole carbon picture. My focus over the past six months has been to tackle this question with a group here at KieranTimberlake.

Billie Faircloth is a Partner at KieranTimberlake and leads a transdisciplinary group of professionals leveraging research, design, and problem-solving from fields as diverse as environmental management, chemical physics, materials science, and architecture. She fosters collaboration between disciplines, trades, academies, and industries to define a relevant problem-solving boundary for the built environment. Overseeing investigations via empirical experiments, prototypes, and analysis, she leads technology development that informs high-performance design, including Pointelist™, a wireless sensor network, Tally™, a life-cycle assessment application, and Roast, a post-occupancy survey tool.

She has taught at the University of Pennsylvania School of Design and Harvard University, and served as Portman Visiting Critic at Georgia Institute of Technology and VELUX Visiting Professor at the Royal Danish Academy of Fine Arts. Prior to KieranTimberlake, she was an assistant professor at the University of Texas at Austin School of Architecture. Her articles have been published by the Journal of Architectural Education, Princeton Architectural Press, Royal Danish Academy of Fine Arts, and ACADIA. She is the author of *Plastics Now: On Architecture's Relationship to a Continuously Emerging Material* published by Routledge in 2015, and the recipient of Architectural Record's Women in Architecture Innovator Award in 2017.

Now, we need action. How do we tackle some of the big challenges we face as a society, like climate change, injustice, human health and helping communities thrive? After a decade of building research infrastructure, proving that a transdisciplinary group can thrive and extend agency in practice, I'm committed to focusing on projects that demonstrate how important it is to have both research and design thriving equally and side-by-side.





Cross-Disciplinary Research to Reshape the Built Environment

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BARBARA BRYSON

Associate Dean for Research,
College of Architecture, Planning
and Landscape Architecture at
the University of Arizona



Barbara Bryson has spent years examining the importance of research in the built environment. She recently spearheaded a university-wide multi-disciplinary strategic initiative and symposium on research in the built environment at the university called “RESTRUCT.” She spoke to DesignIntelligence about this initiative, and how the design, construction and ownership communities can use research to build for the future.

DesignIntelligence (DI):
Your passion and advocacy for the emergence of research in the design, construction and ownership professions seem to be at a peak level as we begin the year. What forces are driving that? Why now?

Barbara Bryson (BB):
There are many reasons for believing research in the built environment is extraordinarily important right now. Almost nothing impacts our health, our economy, our culture, our well-being, our resources, or our climate quite

as much as our built environment does. Yet, the amount of research that has been done, in a holistic fashion, to solve the challenges of the built environment is almost minuscule compared to other areas of research.

According to the U.S. Green Building Council, in 2005, 70% of the electricity in the United States was consumed by our built environment. Edmondson and Reynolds wrote in “Building the Future” that 40% of raw materials and 12% of fresh water go into our built environment. Many sources tell us 30%

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It's time to look at how research can be addressed in buildings, so we solve these problems in a way that is fully informed, impacts decisions, and shapes policy.

BUILT ENVIRONMENT IMPACT



70%

ELECTRICITY



40%

RAW
MATERIALS



12%

FRESH
WATER



30%

GREENHOUSE
GAS EMISSIONS



37%

CONSTRUCTION
WASTE



*Why research?
Why now?*

or more of greenhouse gas emissions are generated by the built environment. A McKinsey report told us we have the opportunity to save \$700 billion a year by addressing energy efficiency in the built environment. According to the Technology Strategy Board in the United Kingdom, 45% of the U.K.'s total carbon emissions are generated by buildings. The Movement

for Innovation Industry Report, published by The Economist in 2002, stated that 37% of construction materials are wasted. In Hong Kong, they estimated 38% of the total waste from their region comes from construction sites. Nearly every article on our cities and environment contain data related to impact and opportunities of the built environment.

Not all the data is environmentally driven. According to economists in 2017, 60% of the buildings in the U.K. failed to meet schedule goals, and 90% of the world's infrastructure problems do not meet budget or schedule goals. Edmondson and Reynolds also wrote in "Building the Future" that 75% of the activities in construction add no value, and, if we in the design and construction



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**ESTIMATED
INFRASTRUCTURE
REMEDATION
COST**

industry were as efficient as the manufacturing industry, we would add \$1.6 trillion to the world economy. The ASCE estimates the U.S. needs to spend \$4.5 trillion by 2025 to fix the country's roads, bridges, dams and other infrastructure, and that we have around 25,000 structurally deficient bridges.

Those aren't just environmental concerns, those are also economic, quality of life and efficiency concerns. For years, research into the built environment has been either neglected entirely or has been the purview of only the usual suspects. It's time to look at how research can be addressed in buildings, so we solve these problems in a way that is fully informed, impacts decisions, and shapes policy.

DI: What was your intent in convening the **RESTRUCT** (RESTRUCT.arizona.edu) symposium around research? Who was invited? What were your goals?

BB: First, it wasn't just me. Almost two years ago, the new dean of the University of Arizona College of Architecture, Planning, and Landscape Architecture, Dean Nancy Pollock-Ellwand, initiated a strategic planning process for the college. During that process, we had several focus areas, and one was research. The research working group, which I was a part of, looked at how we could improve and enhance research efforts at the college. We identified the problems I mentioned and realized they were larger than just our three disciplines, architecture, landscape architecture, and urban planning.

We decided to further the discussion and talk to the university as a whole. The new president, Dr. Robert Robins, was going through his own strategic planning process. We approached the strategic planning team with the idea that the University of Arizona could be the first to develop

a robust university-wide ecosystem supporting research, teaching and service for the built environment, defining new, fully integrated discipline-leveraging knowledge and research from all the university colleges. We imagined — through a process of workshops and symposiums — we would be able to focus on discussions that might include livable cities, the trillion-sensor future, crisis response, technology, changing design processes, decision policies, and built environment life cycles.

The university's strategic planning team embraced the idea and funded steps to begin these conversations. The symposium we held on December 12, 2019, was the culmination of a yearlong set of conversations, planning activities, and faculty workshops defining the grand challenges that the university would be taking on. The following day, we held an industry workshop, in

which we had 30 industry participants from all over the country tell us what they thought about the work we were doing and how they might like to be engaged in that work. The goal was to create an understanding of how industry and the university could align on building knowledge.

We named the event **RESTRUCT**, but that is not just the name of the event, it's the name of the entire initiative. After all, as our team has stated, "We are living the consequences of our standard practice. It is time to rethink, redefine, redesign, and restructure our human environment." We are doing just that through transdisciplinary research.

We invited the community, faculty, students, and industry members to the **RESTRUCT** symposium. It was great to have industry members come to what are essentially academic presentations. What I wanted our civic and

industry partners to understand above all was what rigorous research really is and how difficult it is. It's challenging to develop knowledge in a way that is credible, peer-reviewed, and replicable. In short, knowledge built in a manner that builds confidence. I hope the industry community will understand how the convergence of researchers with differing perspectives can change the questions, change how we think about decision-making, change how we think about processes of designing, change policy, and change how we deliver the built environment.

DI: You mentioned the university developed grand challenges to take on in addition to creating the symposium. What are they?

BB: The University of Arizona is focusing on four grand challenges of the built environment. These aren't the only grand challenges out there, and

we're hoping other universities follow our model. The **four grand challenges** the university has selected are:

- First, “redress inequality/injustice in re-envisioning the built environment.” That means re-addressing inequality and injustice through thinking about access to infrastructure such as utilities and internet and providing equitable interior urban spaces to meet basic human conditions. This is the area in which you would address accessibility and connectedness.
- The second grand challenge is “creating resilient and efficient urban and rural systems.” This goes to our strengths in environmental studies and in climate studies, but we also need to redesign systems for a more resilient future, designing the built environment to adapt and mitigate climate change, creating efficient urban food systems, and address crisis response. We also
- need to look at systems that achieve net-zero resource consumption in the built environment, decarbonization, and dematerialization.
- The third grand challenge, “design for optimal health”, also builds on the strength of our Health Sciences program; in fact, the Health Sciences program has also adopted the built environment as one of their grand challenges. “Design for optimal health” means we’re linking health, wellness and social interactions to the built environment. How do we design operations to address major health needs across age, disability and occupation? How do we design human-machine interfacing to optimize work efficiency and human health, aging with human dignity, and designing for health in an increasingly extreme environment?
- Finally, the fourth grand challenge is “enabling innovation through better

decision-making and data analysis.”

For us, this means creating decision support that effectively integrates public values and scientific information. This challenge addresses interdisciplinary mixed-method, data-driven evaluation to foster innovation in the built environment. It also promotes evidence-based governance and leveraging big data analytics for decision-making.

At the university-level, research is built on individuals and then on teams with common interests. For example, we have a team interested in crisis response in disadvantaged areas, that includes people from health sciences and people from our data sciences or atmospheric sciences, engineering, law, social and behavioral sciences — the work goes across the disciplinary boundaries to answer these big questions. We have construction management in our engineering



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college. They will be using some of these big-data analytics for decision-making to support work they may be doing in delivery processes.

DI: The symposium name, “**RESTRUCT**,” suggests there was discussion on project delivery methods, structures, and new ways to form teams and execute projects in research-based ways. Is this true?

BB: I’m writing a book called “Creating a Culture of Predictable Outcomes.” In it, I discuss that we’ve been asking the wrong questions related to project delivery for a long time. As an example, I am often asked: What is the right delivery process? My response is: That’s not the right question.

Process and delivery methods impact what you do, how you do it, and how well you do it. But the impactful questions are much higher level

than that. How do we work together? Successful projects with predictable outcomes are products of three things: leadership, collaboration and decision-making. Leadership empowers teams, motivates teams and places the right people on the teams, because high-performance collaboration works in the right way, values diversity and makes sure the best idea wins. This creates an environment where people can speak their mind and get the right information out there. Decision-making discipline gathers the right knowledge and make sure decisions are informed. Once all these elements are in place you can move into an innovative environment where real disruption — real innovation — can occur.

DI: What do you see as the first steps or leverage points in turning this into action — for the industry, for the government and for the design community as a whole?

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Get ready, because the freight trains of disruption are already here.

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BB: For those of us who've been long involved in the process of building buildings, how many times have we pushed away people who have tried to give us input about what we're building and how we're building because we thought of them as outsiders to the process?

Yet they are absolutely part of the stakeholder group. Deeply involved — and deeply impacted — by decisions we have made. I think about it as a person who formerly led the building program on a university campus. Everything we put on the edge of our campus changed the neighborhood dynamic just outside the edge of campus. We, as builders, planners, owners and implementers of the built environment must recognize there are many people who should have a voice in what we're doing. We also get frustrated when we want something done but don't know how to get it done because we don't know how to implement

policy in city government. Yet we don't pull in the behavioral scientists, business scholars or legal scholars to help us understand how all these systems work. That's why this strategic initiative in built environment research by the University of Arizona — so inclusive of other disciplines — is so important.

DI: What's your advice for firms around the country who want to take action? Firms looking to join or build on what you are discussing here?

BB: They should start by asking questions about what they're doing. What about their work would be better if they had credible knowledge that informed some aspect of their work? How would their work be improved? It might be a practice they are regularly incorporating into their work, but they are not confident it's the right decision because they don't have credible evidence it is the right thing to do.

As an example, Stephanie Carlisle at KieranTimberlake, just published a wonderful article in Fast Company. She writes, “I’ve been polluting the planet for years. I’m not an oil exec, I’m an architect.” You can tell Carlisle is asking herself some hard questions about her ordinary practices as an architect.

Once you have a list of questions, then go to your local university and have a conversation with the chair of the architecture department or someone in engineering and see if resources are available, or if there is somebody there also interested in those questions. Through an initial conversation, you might be able to work together to find those answers.

DI: What question am I not asking that needs to be asked? That you want me to ask? The question nobody’s asking that will have the greatest impact in advancing a smarter built environment industry?

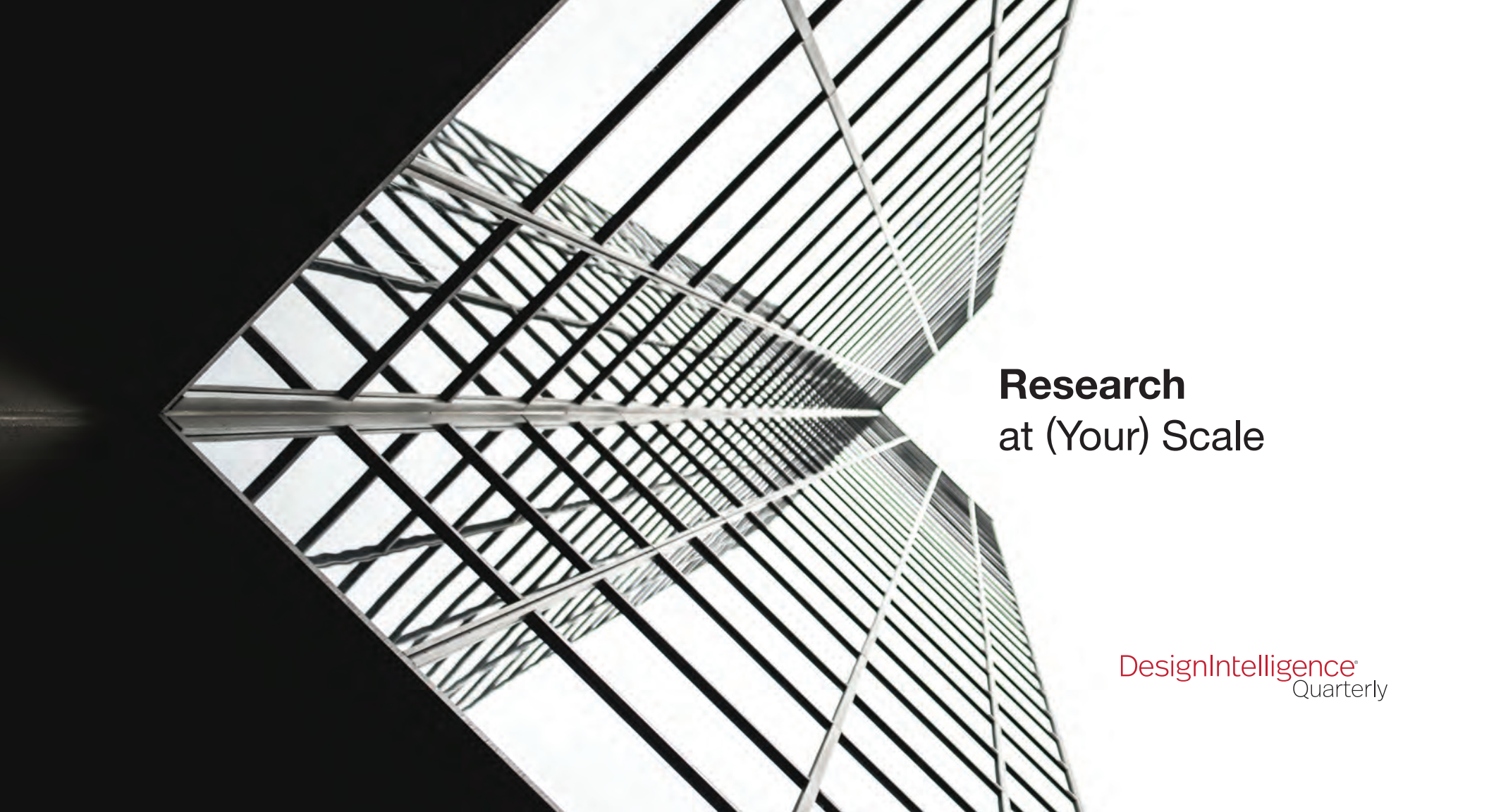
BB: The question not being asked is this: How would 20 freight trains of disruption change all this? I think the 20 freight trains of disruption — AI, machine learning, robotic construction, prefabrication, property technology, trillion-sensor future, all the different trends that aren’t even just trends anymore — are going to drive the need for more knowledge-building and knowledge-creation. They are going to drive your need as an architect, engineer, construction manager or project manager to have resources for knowledge. So, thinking about it proactively, how you want to build or define those resources in the future is going to be incredibly important. Get ready, because the disruption is already here.

We need to have a general understanding in the industry that building knowledge is not only welcome, it’s critical. We need to be working together to share data and information, then

build and share that knowledge. We are so far behind in our industry, if we don’t get better at what we’re doing by sharing knowledge, somebody else is going to do it for us.

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It’s challenging to develop knowledge in a way that is credible, that will be able to be peer-reviewed, replicated, and build confidence in that knowledge in the future.



Research at (Your) Scale

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**BOB FISHER**

Editor-at-Large,
DesignIntelligence; Managing
Principal, Strategic Identity
Practice, DesignIntelligence
Strategic Advisors

Research holds great promise to transform practice for firms of all sizes. While exemplars throughout AEC have been building research-driven practices for years, many firms are still grappling with how they must change.

Meetings like these follow the script with tragicomic consistency. I am taking the senior leadership team of a 275-person professional services firm through a vision development exercise. The energy is high. A dozen or so owners and executives are participating. They begin to construct an ambitious picture of their future. The room is alive with potential. Everyone is excited by the clarity that is emerging.

One of the senior partners steers the conversation toward research, and the room follows enthusiastically. In their imagined future, every project begins with funded research to support design exploration. The firm also conducts research outside the context of projects,

going where their intellectual curiosity takes them. Research transforms practice, evidence substantiates design decisions, and outcomes for clients improve. The firm develops a powerful new tool for marketing. They become known for not only the elegance of their design, but also for the intelligence that drives it. Their imagined future is full of new capabilities and discoveries.

“This is great!” I say, taken with their enthusiasm. “Research is extraordinarily powerful. Clearly you’ve been thinking about how it will transform your practice.” And then: “Just so I understand—how does your firm define research?”

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The myth among many firms is that they are too small to do research. The larger firms have the same constraints regarding staff utilization, financial return, et cetera.

— Nicholas Holt



**I can hear the big needle
scratch sound now.**

The room's energy, surging just moments ago, abruptly deflates. Eyes turn down or dart around the conference table, looking for the next person to speak. As two of the partners wade into their responses, a few things become clear. The passion, curiosity, and intent are there, but they believe their future as a research-driven practice is still far away.

Adhering to the script, the leadership team falls prey to complexity, barriers, and doubt. They have invested in research here and there, with mixed results. Their ideas outstrip their resources. They're a mid-sized regional firm—how can they compete with the resources of the multinationals? They can't imagine their current clients, who want to value engineer every screw and

light fixture, would be willing to pay more for research. So many possible topics and directions to pursue—how do they focus? Their staff is stretched way too thin as it is, and besides, they don't have the type of expertise in research to be taken seriously.

And on it goes. The tragic part of the script—for this firm and others like them—is that those who follow it place unnecessary limits on themselves. They impede their own growth in an area that is essential for the future of practice.

In such situations, I am reminded of two recent discussions I had with veteran research leader Nicholas Holt. While a director at SOM, Nick spent

seven years as a principal at the Center for Architecture, Science, and Ecology (CASE). He was also the head of research in North America for Woods Bagot. “The myth among many firms is that they are too small to do research,” he said. “The larger firms have the same constraints regarding staff utilization, financial return, et cetera. They may be at a different scale, but they are in the same boat.”



Knowing your purpose and underpinning it with some sort of definable rigor is important to establishing credibility.

— Nicholas Holt

The question is not whether our example firm can achieve its ambitions. After all, KieranTimberlake is smaller than they are, yet a recognized leader in extraordinary, research-driven design. The path for small- to mid-sized firms may look different from their larger cousins, but the way is still open, and the destination is still paramount.

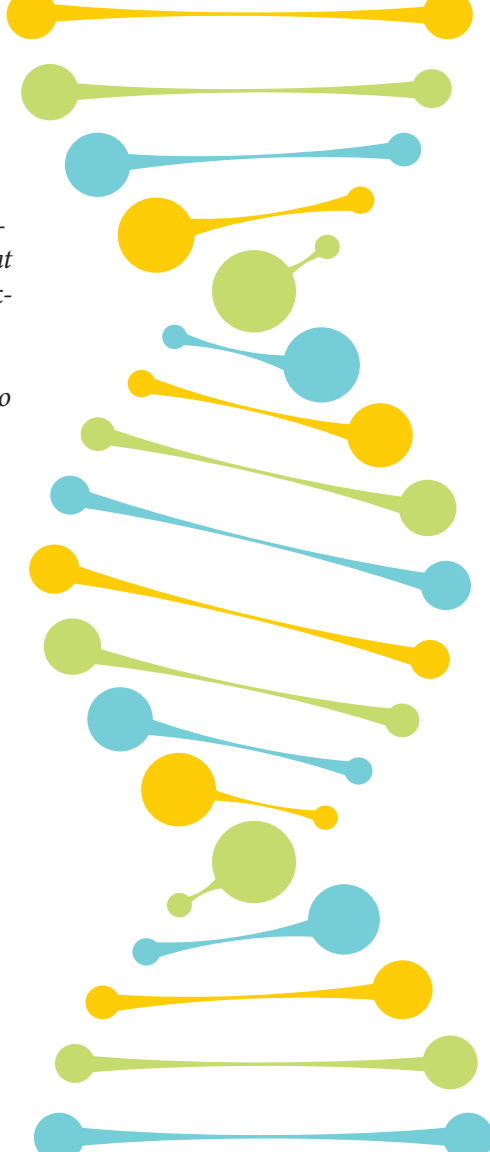
In Nick’s view, there are three tiers of research. Each has its purpose, characteristics, advantages, disadvantages, and level of effort. Some can be adopted in the near term, and others can only be attempted with the right in-house talent and structures. He described the tiers this way:

The first is ‘blue sky,’ or pure applied research in which firms, sometimes in partnership with other organizations, develop research simply to grow the base of knowledge in academia and

industry. This was the model for the Center for Architecture, Science, and Ecology, a partnership between Rensselaer Polytechnic Institute and SOM that ran from 2008 to 2017. CASE was looking at five to 10 years applied research with the goal to develop products for practical application, but they were also aiming for ancillary benefits along the way, which is similar to NASA’s model. It worked, and a lot of value was generated by the journey.

The second is what I call practical research, which can fit in a 12 to 36-month timeframe and focuses on invention, adapting or applying existing technologies to new purposes, and testing theories on a series of projects until they become viable.

The third is solely project-based and is really about technical design innovation supported by empirical data, good knowledge management,





Secondary research can be original and impactful in application. It is an attractive option for firms whose programs are in the early stages of development.

and collaboration with one or more industry partners. This option tends to be the one that is most accessible for firms and project timelines and can generate very meaningful results.

How do firms, regardless of size or stage of development, find the most effective way to integrate research in their work? To begin, the firm needs to answer a series of both philosophical and practical questions:

- What is the purpose of research for our firm?
- What type of research will we focus on?
- How will we organize ourselves to conduct research?
- How will we adapt our design methodology?
- How can we best leverage research for market advantage?
- What must we change to be successful?
- Where do we begin?

Purpose

“The first step to getting started is to have leadership buy in. Next is to establish a funding model, including a clear value proposition to the firm supported with metrics that inform staff advancement. Is the investment about innovation, invention, or giving yourself a marketable edge in knowledge?” Nick advised. “Knowing your purpose and underpinning it with some sort of definable rigor is important to establishing credibility.”

Values and fundamental motivations matter. Some are better than others. Nick favors an open approach that benefits the professions as well as individual firms: “It comes down to what your firm believes; whether the purpose of their research is for internal competitive edge, or if they believe there is greater value in being positioned as an industry leader. Perkins and Will’s work on healthy building

products is a good example. They have opened up much of their research and are now widely seen as an industry leader. You’ve got to get teams to think about leading via sharing.”

Research Types and Organizational Models

Firms are engaged in research on topics as varied as healthy and sustainable building materials, new technologies, novel construction methods, and the neurological effects of space on building occupants. The type of research a firm chooses stems from a combination of the firm’s philosophy, values, passions, and capabilities, as well as what is most relevant to the firm’s clientele.

The types of research the firm engages in determines the mix of talent they will need, which in turn drives the organizational model they will use. There are a variety to choose from.

Each has advantages and disadvantages. The choice of organizational model relates to the firm's underlying purpose, desired benefits, and practical constraints. It is not uncommon for firms to use a blend or mix of approaches that tend to include one or more of the following:

- **Dedicated specialists** - models can vary between lab-like groups that conduct highly specialized research, to individuals from research disciplines who become part of design teams as needed
- **Partnerships with academia** - examples run the gamut from long-standing partnerships like CASE, to NBBJ's sponsorships at the University of Washington, to collaborations between smaller firms and individual professors
- **Practitioner-driven** - a common approach is for practitioners to develop and conduct their own research; some firms believe this model is not only the best way to incorporate research into their work, but also it can be a compelling strategy to attract and retain talent

There is a grey line between research and innovation in professional service firms. Consequently, many firms conduct their research within the context of broader innovation programs. One such model includes competitive internal grants. In this approach, employees are encouraged to generate and design their own studies, which are usually supported by a combination of paid time and cash toward expenses. Once they complete their research projects, participants are generally required to communicate their findings throughout the firm in writing and presentations.

Regardless of the type of research, the degree of rigor determines its legitimacy. Criteria may vary based on the discipline—experimental studies in materials science versus observational methods from anthropology, for example. Rigorous research that professional service firms conduct

usually includes the following:

- **Repeatability** - the method and conditions can be duplicated by others who seek to replicate the research
- **Peer review** - in order to control for biases and ensure quality, research is subjected to and withstands the scrutiny of outside experts
- **Objectivity** - facts are taken on their own merits and research is conducted without the assumption of a given outcome

Discussions tend to focus on primary research, which firms seem to believe is the key to originality and greater impact. In Nick Holt's experience, even well-done literature review can have a tremendous positive effect on a firm's design work and culture. During his time at SOM, Nick's team created a number of white papers based on secondary research that had significant effects on them: "Beyond having

REPEATABILITY

PEER REVIEW

OBJECTIVITY

knowledge to share at beginning of the design process, thorough literature reviews changed the culture of the teams because every decision needed to be backed up by data. It inspired even our junior staff to rethink the way they looked at their day to day work.”

Secondary research can be original and impactful in application. It is an attractive option for firms whose programs are in the early stages of development.

Adapting Design Methodology

Simply because a firm conducts research—even if it has ample resources and a sophisticated program—does not mean its design is research-based. It is not always easy for all parts of a larger organization to remain connected. Knowledge does not always work its way from researchers to those who are practicing day to day.

Firms that are research-driven have internalized the practice. They have consciously shaped their design methodology to incorporate research.

Crucially, these firms are committed. If the data indicate a solution that contradicts their intuitive aesthetic judgement, they follow the direction indicated by the research.

Even with earnest, deeply held intentions, the path to a research-driven practice is neither easy nor fast. “It’s a big challenge to ask design teams to change what they do. It takes time. If they don’t see immediate results, teams can lose motivation even if the firm’s partners are enthusiastic,” Nick said. It requires not only a change in approach, but also in culture.

However, in Nick’s experience, part of the solution is the research activity itself. “In ‘real’ research, rigor underscores everything,” he said. “Would your work stand up to a peer review? Teams are much more serious when they know their work will be subject to external review. I’ve seen the effect in practice. It’s profound.”





Leveraging Research

The surest way to win more research-based work is to attract enlightened clients. Showcasing the firm's research insights is an obvious place to start. But simply making research findings available in their original form usually falls short. Research needs to be framed appropriately for the audience, including the information and medium of delivery. Often it needs to be integrated into a story that makes it accessible. Handled appropriately, research provides powerful fuel for positioning a firm to win the right type of work.

Clearly, research and marketing have a relationship that is both symbiotic and potentially synergistic. But to ensure integrity it must have boundaries. Making completed research understandable and relevant to the audience, and letting them know it exists, is the responsibility of good marketers.

Directing, influencing, or reshaping research results is not. Worse yet are firms who conduct research, often of dubious quality, solely to create promotional fodder.

As Nick said during one of our conversations: "Clients can and will see through fluff, or perhaps worse, thin research will be exposed during the project process and damage your credibility."



Clients can and will see through fluff, or perhaps worse, thin research will be exposed during the project process and damage your credibility.

Advanced firms successfully define the relationship between research and marketing. Leslie Taylor, global director of marketing at Gensler, explained in a recent conversation how her firm avoids pitfalls and achieves the right balance:

Our leaders have structured the firm organizationally so that research and marketing sit right next to one another, meaning on a regular basis we're partnering to look at initiatives strategically. Marketing has an opportunity to be a part of the earliest conversations with the Gensler Research Institute and its projects. There are times we've been able to provide feedback on the insights that will resonate most with our clients and audience. We serve as their in-house agency, communicating the research to the marketplace. I would say it all is very fluid and organic in a really beautiful way. The result has been extraordinary positioning for both our research and the firm.

External communication is only half of the equation. More important is the free flow of information inside the firm. Too many professional practices conduct good research, only to have it stuck within organizational silos. Insights and potential innovations never make it to design teams, like tools that stay on the ground while workers who need them high above them on the scaffolding. The key, according to Nick, is how a firm chooses to handle the information it generates: "Without an adequate knowledge management infrastructure, be it culture or technology driven, to spread innovation within the firm, research efforts are often wasted."

Back in the conference room, one of three recently elevated partners lets out a sigh. "Are we the most backwards firm you've ever seen?" she asks. Her ironic tone is poor camouflage.

"Not by a long shot," I reply. "You may be a few years behind the known leaders, but so are a lot of firms. The good news is that you are open to change, and you are creating a bold vision for your future. The path ahead will take some time and require investment and commitment, but you won't need to wait to the end to see benefits—and neither will your clients."

Most of the leaders smile. A few mutter jokes of relief to their neighbors.

"We have a lot to figure out," says the CEO. "But it sounds doable. Looks like it's time to get down to work."



What We Don't Know About Buildings

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**SCOTT SIMPSON**

Senior Fellow, DesignIntelligence

The design, construction and ownership communities are overdue for adoption of data-informed processes. When will we join the rest of the business and scientific fields?

People spend the vast majority of their time in buildings, and since every aspect of the built environment is designed, manufactured, installed and operated by human beings, you'd think we know pretty much everything there is to know about how architecture affects our daily lives. But that's far from true. We're just beginning to understand how little we know.

A case in point is the emerging interest in "evidence-based design" increasingly used in healthcare facilities. It seems self-evident that brighter colors and more natural light will make for a cheerier environment, and perhaps may be therapeutic in some way. The healthcare industry is awash in all kinds of data (statutory requirements for extensive record keeping

are often cited as a significant source of frustration—and medical error—by physicians), but we have yet to turn that data into a deep understanding that underpins safer and more cost-effective outcomes for patients across the board. How do we know this? Because despite the best intentions and huge amounts of money spent annually on healthcare in the US (the most expensive in the world on a cost per capita basis), the system does not yet deliver some basic results we should be able to take for granted. (As one example, the infant mortality rate in the US is 5.9 per 1000 births, compared with 3.9 in other OECD countries.) Clearly, something is amiss. How much does this have to do with the way medical facilities are designed and operated? We just don't know.

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We do know designing with data in mind can lead us in new directions. The advent of autonomous vehicles has created a bumper crop of data analytics, and even conventional vehicles are now equipped with a broad array of data collection devices. Information about speed, fuel consumption, and battery life are just the basics—our cars are now talking to us about traffic conditions and road hazards, plotting the most efficient travel routes, telling us when we need an oil change or a new set of tires. Real-time data collection can even track individual driving habits and lower insurance rates for careful operators. Our cars can pay our tolls for us, and data driven services like Uber or Lyft hold the potential to radically reduce traffic congestion and the need to build parking garages. Autonomous driving, once considered to be in the realm of science fiction, is likely to have a profound impact on how cities are designed and built in the future.

Why not apply this same approach to architecture as well as cars? That would be a game-changer. Too often architects think about buildings primarily as “place making”—static containers that enclose habitable space. However, what’s important is what happens inside buildings—that’s literally where the action is. Thinking about the places and their processes together will open new doors and lead to a deeper understanding of how architects can create significant additional value for owners and users alike. That’s when design thinking becomes strategic rather than transactional.

A good example of how architecture can impact outcomes is the recent spate of STEM buildings constructed at college campuses across the country. There’s more focus on cross-pollination among the basic scientific disciplines (physics, chemistry, and biology); more open labs with bench space and



equipment arranged to accommodate team-based project work; more experiential, hands-on learning rather than focusing just on texts or memorizing the periodic table. As a result, new STEM labs are more open, more interactive, and more geared to multi-media teaching and learning. Not surprisingly, the number of STEM majors has increased substantially, grade point averages are rising, and new graduates are securing well-paid employment in a wide variety of related industries, from engineering to healthcare to biotechnology. All this is rooted in a deeper understanding of how architecture can enhance success in STEM curricula. It's a marriage of place and process.

Design thinking is not limited to healthcare projects or STEM labs. "Process design" can be applied anywhere at any scale. For example, in a typical office building, where do people

spend their time? How much (and what kind of) activity takes place at an individual's desk, and how much on the phone, in a conference room, or at the coffee machine? Which kind of activity is the most productive, and are there ways to design office space that will measurably enhance communication, collaboration, and teamwork? Over the past few years, there has been a clear trend toward more open office environments, but what do the data tell us? What is the ideal ratio of spaces for privacy and community? Why do so many conference rooms sit empty most of the time? What are the ideal seating arrangements for mixing executives and general staff? Are companies with open offices more profitable. If so, why?

The answers to questions like these will lead designers in interesting directions. For example, what role does design play in public health? How can civic spaces be designed to enhance safety and

reduce crime rates? How can correctional facilities be designed to reduce recidivism rates? Why is the risk of acquiring an infection so much higher in a hospital than an airport, and what can be done about it? Could schools be designed so that student safety can be taken for granted? The questions—and the opportunities—are endless.



"Process design" can be applied anywhere at any scale.

In thinking about issues like these, it should be obvious that “design” is not limited to plans, sections, and elevations. It invites (and requires) broad expertise in sociology, science, business, logistics, manufacturing, information technology, transportation, and other fields. Because buildings are the source of 46% of carbon emissions annually, knowledge of materials science is also a

critical factor. This opens new territory for designers to have a positive impact, since everything we make, consume, and discard is designed in some way.

The implications are clear. Architects need to care as much about how things work as how things look. And they need to know more. When that happens, the sky is the limit.

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The questions—and the opportunities—are endless.





Why Should Architects Be Any Different?

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PAUL HYETT

Past President of the RIBA,
Architect and Principal
HKS Architects

In this personal retrospective of applied research in United Kingdom design firms, Paul Hyett cites ground-breaking work resulting from research — and challenges current practitioners.

Unlike the AIA which ‘accredits’, the RIBA validates architecture schools. Both are worthy systems, but the former focuses heavily on inputs, the latter on outputs. The RIBA is therefore more concerned with product than resource, measured almost exclusively through the student portfolio.

Research as an output has caused many a vexed conversation among RIBA Visiting Boards. As in the USA, British universities place great emphasis on the value of research. A complex scoring system has emerged through which validated architecture courses receive points based on the number of words they publish within refereed journals. This inevitably leads to

ever-lower staff student contact time as faculty locks itself away to write more and more about what cynics might claim is less and less of either relevance or interest. All in pursuit of those coveted research points so critical to sponsorship and grants.

Despite what cynics might say, much research of great value is carried out in our universities, some of it in partnership with architectural practices. But many practices still prefer to ‘go it alone’, seeing research as an essential part of their DNA, but opting to carry out that research in isolation. They occasionally test their propositions through lecturing, but ultimately use them to inform their own built work

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Where an architectural practice has developed high levels of expertise, and it intends to expand and develop such expertise, how can it not seek to inform its work through constant, planned, and focused research?

for commercial advantage. This often results in a series of experimental buildings realised across several decades — even a lifetime. With that output inevitably come the parallel publications — usually books as opposed to formal research papers, but nevertheless good, hard, ‘research-informed’ material.

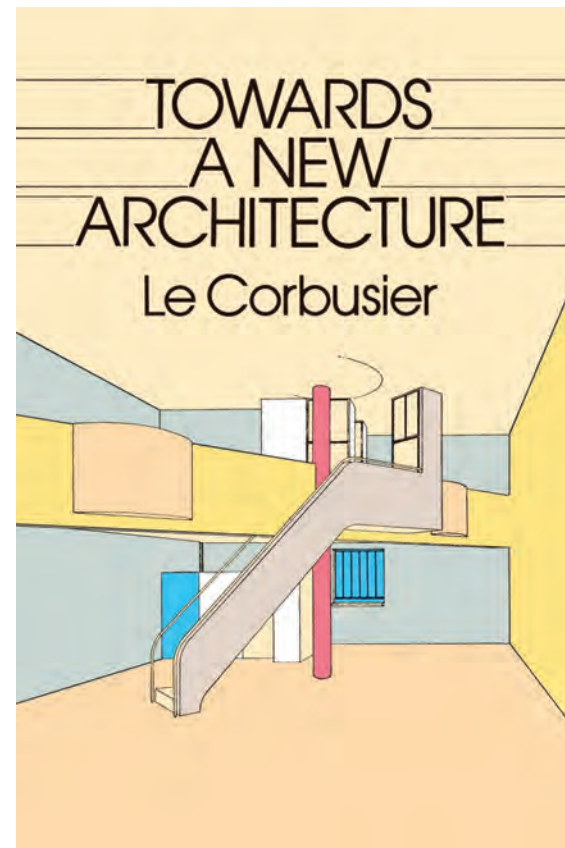
I am not referring here to glossy, often lightweight, monographs — you know, those glitzy, tiresome assemblies of projects with perhaps an up-front essay penned all too often by some friendly hack journalist. Neither am I referring to manifestos. The most famous of which must be Charles-Edouard Jeannerette-Gris’: ‘Towards A New Architecture’, published in 1926, but still on my first-year mandatory student reading list back in 1971. Le Corbusier’s opening sentence remains as one of our profession’s greatest-ever ‘call to arms’:

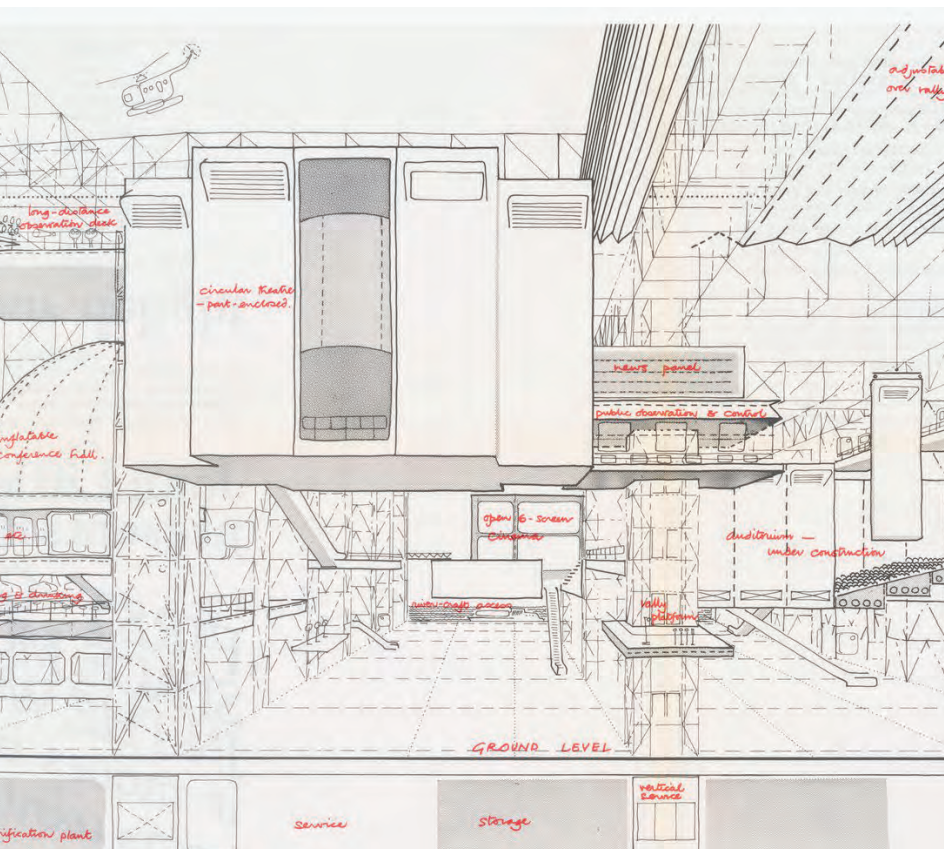
‘The Engineer’s Aesthetic and Architecture are two things that march together and follow one from the other: the one now being at its full height, the other in an unhappy state of retrogression.’

I am instead referring to research of real quality, developed through live projects within the studio environment of commercially independent practicing architects.

Early Exemplars

I first experienced this very special world of non-academic investigation during my early career with Cedric Price. He likened his office to an experimental laboratory and ran it with attendant secrecy. Paid commissions supported unpaid research — informed by and tested through lecturing (mainly





Fun Palace, Cedric Price

at the Architectural Association). Also through in-office ‘conversation’ with scholars such as the distinguished architectural critic and author Reyner Banham; with journalists like Paul Finch, later editor of *Architectural Review* and founder of World Architecture Festival, and Paul Barker, who edited *New Society* for some 20 years of dramatic social and political change; and with academics such as Roy Landau and the great planner Peter Hall.

These exchanges informed research through which an architecture of highly original form and language emerged, based on extraordinarily innovative programming (the catalyst). Accordingly, this work was as fresh as it was shocking in concept. This architecture found expression through projects such as ‘Fun Palace’ (1961), a cultural arts and performance centre for Joan Littlewood in the then run down and abandoned dockyards of east London.

Sadly, it was not built, although a lesser version in the form of the Inter-Action Centre was. If you want to see Fun Palace in all its glory you need look no further than the Pompidou Centre in Paris, the first germs of which, many would argue, can be traced directly back to Cedric’s ‘White Room’.

And so it was that a series of research projects flowed from that small office, including the ‘Potteries Thinkbelt’ proposal (1966), which unceremoniously ‘rejected all previous and contemporaneous ideas about appropriate university

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He likened his office to an experimental laboratory and ran it with attendant secrecy.



These exchanges informed research through which an architecture of highly original form and language emerged, based on extraordinarily innovative programming.

architecture'; and 'McAppy' (1973) commissioned by construction giant Robert McAlpine. The latter project reset agendas for site safety, comfort and efficiency for UK construction workers in anticipation of the impending 1976 Health and Safety legislation.

Such inventive thinking led to new concepts of space and space definition. Walls and floors were freed from primary structure as prefabricated assembly dominated construction. Concepts such as 'aiming to miss' (significant tolerances that enabled loose fit of pre-manufactured and finished cabins) informed a philosophy that found expression in a rich new architectural 'language'.

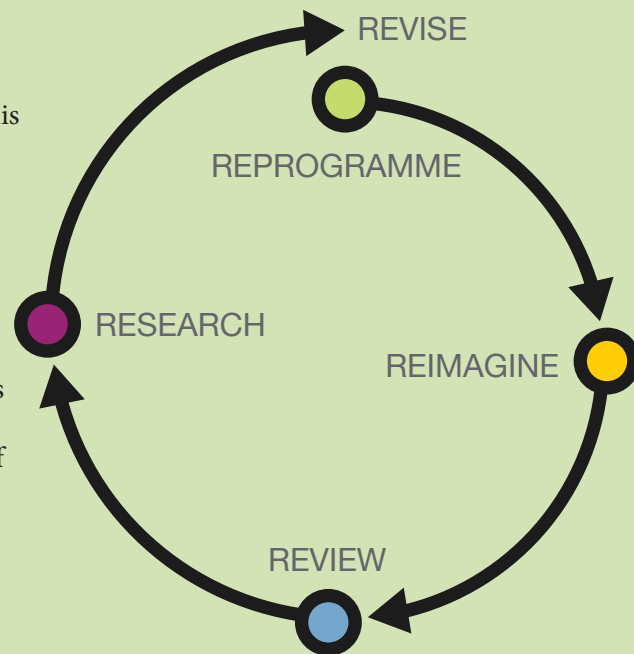
Programming as core stimulant to informing more sophisticated user demand — 'the virtuous cycle': Research, Reprogramme, Reimagine, Review, Revise. Diagram courtesy Paul Hyett

As would be expected, these ideas were further developed by disciples like Will Alsop, who worked with me at the Price office, going on to deliver a series of redoubtable buildings including the Grand Bleu in Marseilles (1994), the Peckham Library in London (2000) and the Sharp Centre in Toronto (2004). Price's influence through research was all the more remarkable because, despite its huge influence and legacy, his office was never more than six strong.

Much architectural activity involves research. This was the argument of those who resented the RIBA's necessary enquiries about the research activities of faculty during validation visits. Many of the better design tutors have routinely developed their own architectural theory across a variety of teaching programmes spanning multiple cohorts of students: Zaha Hadid is one such figure, giving enormously to, but also taking richly

from her experience as a teacher at the AA, then Yale, Harvard, and through her masterclass sessions, at the University of Applied Arts in Vienna.

THE VIRTUOUS CYCLE



Radical Thinkers

More evident is the role of the design studio in using theoretical projects and the 'crit' process to test and hone ideas through generations of radical thinkers: Rem Koolhaas and Elia Zenghelis taught Zaha. Her greatest prodigy is perhaps the celebrated Chinese architect Ma Yansong, who she taught at Yale and who later worked in her office. Again, research through teacher-student collaboration leading to an amazing progression of ideas and ambition, first in Zaha's projects and later evident in the curvilinear, free-formed projects for which Yansong has gained much-deserved international acclaim in his own right.

Projects such as the Treatment Centre for Victims of Torture, and the Fire Research Testing Station (both Paul-Hyett built projects of the 1990's) required serious research. The former involving research with and through

the therapists to explore conditions and environments conducive to successful therapy in circumstances where intense emotion required calm as harrowing experiences were shared. In the latter case, the task was more technical. The research was less challenging: a study of precedent — what had worked? What had failed? What conditions are required for hosting intense fire?

Programme

But rather than focus on the kind of research that addresses the problems of a single project brief, best described as 'problem solving research', I want to look again at the architect's office as a place of more progressive and wider-based research. Particularly, the kind of research that influences programme; and which through programme achieves a significant level of social engineering. That is, the process of shifting and manipulating space (the essential work of the architect) to

create new possibilities and invoke new and heightened expectations among those who use buildings. My own bookshelf at home has abundant examples. I will cite just a few.

First, at the grand scale is the work of the likes of Frederick Gibberd, Terry Farrell and Richard Rogers. As architect for Harlow New Town back in the 1960's, Gibberd developed a rich experience which he shared through his book 'Town Design'; a major text that would influence a generation of architects and town planners in the UK and internationally. Here, the methodology was recorded as the process unfolded — a living research project in which Gibberd addressed the discipline of town planning as an art.

Farrell was more committed to the richness of an urban design that took 'grain', scale and history as its starting

points. More a practitioner than the likes of David Gosling and Gordan Cullen who also contributed richly to the evolution of a new urban design within the UK, but whose contexts were respectively academia and journalism, Farrell's writing, based on the research of his practice, has been prolific. With his theories revealed through multiple publications and through lecturing, Farrell's work has been highly influential, albeit more as an urban designer than as an architect.

In similar vein the work and research of the Richard Rogers office addressed a wide agenda through his Task Force Report (1999), as commissioned by the Blair government. Its mission was to identify the causes of urban decline and to posit alternative practical solutions that would bring people back into our towns and cities within well designed, economically, and ecologically sustainable urban planning.

Above all, the research work as expressed in print and through the lecturing of these three giants of the architectural scene are neither monographs nor manifestos — they represent pure and radical research originating directly out of practice: that is the point.

On the eco agenda, no single architectural practitioner has done more than Ken Yeang to fuse research and practice in the pursuit of a new, better-informed architecture. With his prolific research and writing output Yeang has, throughout his long career, continued to test his ideas through built work. In doing so, he has further informed his theory through research and parallel audit and measure of his buildings in use. Out of all this has emerged an architectural language as rich as it is innovative.



Above all, the research work of these three giants are neither monographs nor manifestos – they represent pure and radical research originating directly out of practice: that is the point.



Guthrie Pavilion, Ken Yeang
photo credit: T. R. Hamzah & Yeang Sdn. Bhd.

Heavy duty, prolonged research, undertaken discretely within practice has routinely informed a continuing series of Yeang designed, experimental buildings. Despite being produced under all the normal commercial pressures, these buildings are an extension of the very research that informed their design.

Plenty of other architects' research has underpinned a philosophy that has informed experimental social programming of buildings through an ongoing series of projects. Swedish architect Ralph Erskin is one such figure: his interest in human relationships led to a phenomenal research programme which resulted in projects like the Byker Wall housing in Newcastle and his Ark project in West London. Here, commercial offices were arranged around an open atrium that was traversed with bridges that linked a series of social spaces. More recently, the celebrated

Danish architect Kim Nielsen of 3XN has conducted a similar exploration. Described in his book 'Investigate, ask, tell, draw, build', it offers a telling account of his firm's philosophical approach to social interaction based on research. No mere monograph or poor grade advertisement, it is a valuable sharing of intelligence.

The Most Obvious of Questions

Which brings me to my own experience at HKS. Research, in the form of evidence-based design, has been at the heart of our health work for five decades. This suggests the most obvious of questions: where an architectural practice has developed high levels of expertise in a particular building genre, as HKS has across a variety of sectors, and it intends to expand and develop such expertise, how can it not seek to inform its work through constant, planned, and focused research?

Any major manufacturer, such as Boeing, or Toyota does.

Why should architects be any different?

Research Directions For the Built Environment

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BLAINE WISHART

Software Architect
based in Berkeley, Ca.
and Hainan, China



TAYLOR HAHN

Full-Stack Developer
based in Berkeley, Ca.

In this menu of strategic responses to IT-related challenges, two global experts offer opportunities for action by data-enabled firms.

**Rapid Technical Change
Offers Opportunity**

The AEC industry is ready for technical change but has been slow to seize technical, legal, and contractual opportunities for reasons such as inadequate staffing and limited resources. Like most industries, AEC has had opportunities to use technology developed over the past few years to address a variety of problems. But if the pace of innovation is led by current AEC players, some fear that change will be driven from the outside, and current players will be bypassed. Firms that focus on innovating new and creative technology rather than leveraging existing technology may miss the opportunity to

act in the most efficient, effective way with fewer resources. To avoid being bypassed, we must focus on measuring outcomes, the intersection of IoT and 5G, and machine learning, while weighing the opportunities and dangers of these technologies.



If the pace of innovation is led by current AEC players, some fear that change will be driven from the outside, and current players will be bypassed.



Challenges

Industry challenges abound. Among them are:

1. How can companies find enough resources to develop software/hardware products and take them to market to move the industry forward?
2. Can we use custom hardware/software to make 5G and IoT more secure or do we have to live with what AT&T, Verizon, Microsoft, Cisco, et al. give us? For example:
 - Can we use software/routers to make it harder to hack companies I.T. infrastructure?
 - Can we make it harder for a hacker to hack an apartment dweller's Nest or Alexa's IoT devices?
3. Can we design buildings and civic structures that are secure from malicious attacks?
4. Can AEC firms develop and market design software which improves sustainability?
5. How can the built environment help with disease prevention and epidemics?
6. The current pace of change seems already too much for designers, builders, and owners. Can we collaborate to identify better methods of responding to exponentially rapid change?
7. Unlike other industries, designers, engineers, building trades, building managers and owners lack good feedback on the performance of buildings and structures.
 - Can we develop hardware/software tools that measure the performance of new and existing structures and buildings?
 - Can we develop better ways of standardizing, sharing, validating, and organizing data?
 - Can Machine Learning (ML) and other forms of AI be useful?
 - Do we need to look past the limitations of today's common design tools?

Paths Forward

The AEC industry can respond to these challenges in three ways:

1. Respond to technical challenges and opportunities on a company-by-company basis. That is necessary, but more is possible.
2. Limit initiatives to those sponsored by Google, Microsoft, Amazon, IBM, and other leaders. Those and similar companies will offer some opportunities but may find it difficult to hold on to traditional values among designers, architects, and engineers unless more independent paths are developed.
3. Form collaborative projects between design, architectural, engineering, building trade, building management, and building ownership firms. These collaborations may take financial, skills, problem/opportunity identification, and other forms.

Opportunities

Based on the paths above, we offer the below menu of considered choices for firms to consider.

Beyond Generic

Problem: Generic hardware is not always appropriate.

Google made a major leap in adoption 20 years ago largely because they standardized commodity hardware. Most computer companies followed this path. Pressure from the gaming community led to an arms race in specialized chips (GPUs), for 3D graphics processing. Later, against the advice of most programmers, Google engineers harnessed GPUs for Machine Learning (ML) — a task for which they were not designed. The success was so great that Google then developed its own type of processing unit called a Tensor Processing Unit (TPU). Tensor is the name of a data structure valuable

for ML. Today, Google depends on their own chips, as Apple and other market leaders depend on theirs. Can a consortium of small players (compared to Google et al.) follow a similar path in a search of more secure IoT and 5G?

We are not proposing to have hardware ‘hackathons’ at Design Futures Council meetings. Rather, firms may find a way to collaborate in a search for innovation with an aim for security in IoT, especially in combination with 5G. For many problems, environmental sensors, or custom chip security as a key design goal are examples of reasonable undertakings for companies smaller than Apple, Google, Microsoft, Facebook, or Amazon. Specialized software to enhance router security and off the shelf products from Cisco and their competitors are other possible innovation paths.

Built Environment Reloaded

Problem: The character of the built environment is changing radically.

1. Considered broadly, the FitBits and Apple watches people wear are part of the built environment. They represent the heart of our concerns: the built environment of 2020 is the work product of diverse players, not just architects, engineers, contractors and manufacturers.
2. The introduction of smart devices and rich data acquisition devices such as Alexa, smart phones, watches, HVAC controls, and local routers — devices which can collaborate over Bluetooth, WiFi, and (potentially) other channels -- offers potential diagnostic and active care services.
3. Smart devices, wired and wireless, can engage in new levels of environmental monitoring. Are all the new

plants really improving air quality? The hall temperature is 72 °F. But how hot is the living room getting? There is a construction across the street, but how much of that dust are we breathing?

On-Site, Automated and Modular Construction

Problem: onsite construction is less efficient than offsite

WikiHouse is an open source construction system aiming to use digital manufacturing to simplify the building process. It allows anyone to affordably design, download, 3D print, and assemble structures without the need for traditional construction skills and tools. WikiHouse harnesses three main ideas: digital design, local fabrication, and rapid assembly. Can these any of these ideas be extended to more mainstream AEC aspects?

Retrofitting

Problem: We need to reuse/adapt our buildings rather than build anew to conserve resources.

We need to make an engineering science out of retrofitting existing buildings for energy efficiency, environmental quality, and energy production. California made a quantum leap in earthquake safety by rethinking building codes and retrofitting everything from single car garages to bridges. Similar things can be done from energy efficiency, sustainability, residential and office security concerns.

For example: Changing municipal codes e.g. you are not allowed to cover an entire roof of a house with solar panels in San Francisco because neighbors think it looks 'ugly'. This does not involve any technical progress but requires changes to building codes and zoning. Many problems fit this pattern.

Data Integrity

Problem: Data should be shared across projects and companies, but current data management practices make that difficult technically.

There may be valuable technical progress which can facilitate this, but the starting point should be to make use of existing computer science by reverting to basic principles. Many, probably most, AEC firms will benefit by evaluating current practice without the time pressure of a specific project. Possible topics for review include rigorous use of relational algebra, strongly typed languages, data encoding designed to cross hardware and software boundaries, encryption, possible read-only shared ledgers, and data pipelines to ensure integrity and usability of data as it flows across diverse systems.

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California made a quantum leap in earthquake safety by rethinking building codes and retrofitting everything from single car garages to bridges.



Construction Data and Market

Problem: Many current construction cost estimates are based on phone surveys. Their data sources are limited.

Use blockchain and/or more conventional cryptography to share construction and maintenance costs between trades and BPMs and create a market for construction data based on real world events, not surveys. Can this information be used to lower the cost of building materials for the building trades and owners? Can it be used by BPMs to optimize their R&D spending?

Rather than a pure technical approach, we recommend that creating new markets for data be considered.

Data Organization

Problem: As it stands, the industry does not have the right tools or skill sets to organize data in a scalable manner.

We need to organize data in a way that can be compared across projects. The poster child for dealing with unstructured data may be the Panama papers. A few terabytes of unstructured stolen data were essentially useless until graph algorithms were applied. In addition to widely used deep learning, probabilistic reasoning and strongly typed functional languages may play a role. The problem is far too deep to simply have everyone try to adopt the same standards. If that could have worked, it would have been done last century.



We can do more by exploring the combining technology and health care institutions while considering the goals and objectives of those who occupy the built environment.

Data and Models as IP

Problem: Generate income from data and models of data.

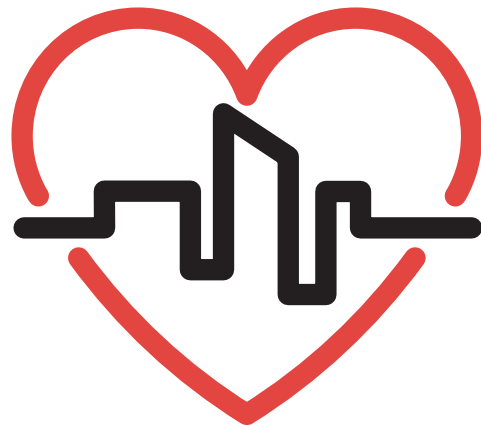
Aggregated data and stats on data are products in themselves (e.g. being able to rent out data and machine learning models built from the data to other firms to maximize efficiency).

AEC firms consider data and associated models to be their IP. Do we want to share the data or sell the Machine Learning systems based on the data? Would something stemming from the cryptography be appropriate? Oasis Labs treats data as private property — this approach is based on custom hardware coupled with a design that starts with scalability and security, contrasting widely adopted approaches to blockchain.

Healthy Offices and Buildings

Problem: The design of buildings and the materials used in their construction often leads to unhealthy living and working conditions.

As we rethink the built environment as suggested in the section named Built Environment Reloaded, it's possible to rethink the relationship between homes, offices, and the health care system. 5g and IoT offer amazing possibilities to facilitate collaboration between medical providers, public health organization, and the structures themselves. Some companies have already developed sensor networks which can be easily installed and monitored for measurements of well-being such as temperature and humidity. [One such effort inspired this article.] We can do more by exploring the combining technology and health care institutions while considering the goals and objectives of those who occupy the built environment.





Covid-19 Looms Large (and Other Directions?)

These opportunities and responses offer a host of strategies and actions in forms interested in developing responses to research opportunities for practice. The challenge will be to find those best suited to your values and capabilities.

As we finish this article, global pandemic Covid-19 is running out of control in Italy and much of Europe. The San Francisco Bay Area, where we live, is under 'shelter in place' orders. The world is concerned that as China

returns to work, they may experience a Covid-19 resurgence. This sharpens but does not change the basic value of collaboration across firms, civic, and professional organizations to improve the sustainability, safety, and utility of the built environment. Because technology is changing so rapidly, the opportunities and dangers are increasing exponentially. If any of these research directions interest you, please write to us at DesignIntelligence Quarterly. If you have other, possibly much better ideas, please tell us about those as well.

A Conversation with Jacobs

DesignIntelligence®
Quarterly



NANCY SIEFERT

Vice President and Global
Director for Interiors and
Strategies Solutions



ELLEN SISLE

Principal, Global Director
Science & Research



NATASHA LUTHRA

Global Innovation
Director

*Where does the push for data-driven projects come from?
How does a global firm collaborate, innovate and use data??
In this discussion, three leaders of Jacobs' global initiatives
share their experience.*

DesignIntelligence (DI):

**Our focus for this interview is how
Jacobs is using research and innova-
tion to make a difference in projects.
Can you briefly introduce yourselves?**

Natasha Luthra (NL):

I've been with Jacobs for over 10 years. I am an architect by training and practice, and over the last 10 years I've entered the technology space. I started as a BIM manager and then became interested in emerging technologies and what that means to us as an industry. I also run our global innovation program — a grant program that funds innovation across the company.

Ellen Sisle (ES):

I head up our Global Practice in Science and Research. I am also an architect by training and by practice. I've been working now for 35 years, 25 of those with Jacobs, and the client focus is primarily pharmaceutical, biotech, science-and-research-related facilities for government and academic institutions.

Nancy Siefert (NS):

I'm the Global Solution Leader for Interiors and Strategy for Jacobs as part of our built environments team. I've been a part of Jacobs for 20-plus years.



DI: How did you evolve into your current roles?

NL: Even though I've been here 10 years, I haven't had the same job two years in a row. The pace of technology changes so rapidly. It's been interesting to follow that as we grow as an industry and as a company.

ES: At the beginning of my career, being exposed to this type of work was circumstantial. But it was something I gravitated toward. I've always had a science and math head but have been fascinated with how individuals work and how the environment they work in supports that work — particularly around R&D labs where a lot is required of the space to enable the work.

NS: I'm a designer by training — a fine arts major in college and then to graduate school for a more focused look at people and work. Natasha, Ellen

and I share an interest in how people work and how physical environment and technology support people working. The industry has focused on this over the last few years.

DI: In your roles as change agents is there a plan, or is it reactive?

NL: There is a plan, and you never make the plan! Our biggest challenge is our sheer size, serving 30,000 people in the organization. How do you get to that many people and get from them the kind of work they're doing? Innovation and research happen every single day across the organization. Communication is a massive task internally. Scale is where we struggle most, but we also delight in hearing about amazing things happening around the world every day.

ES: In addition to our size, the client has to be ready to engage in exploring

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Scale is where we struggle most, but we also delight in hearing about amazing things happening around the world every day

the ways in which innovations and technologies can impact project content or delivery. The project pace and approval levels inside a client's organization can present a challenge. It's most successful when a client comes to us with the specific aim of looking to do something in a different way, has created a project out of that, and is looking within his or her organization for a test project to apply that learning to.

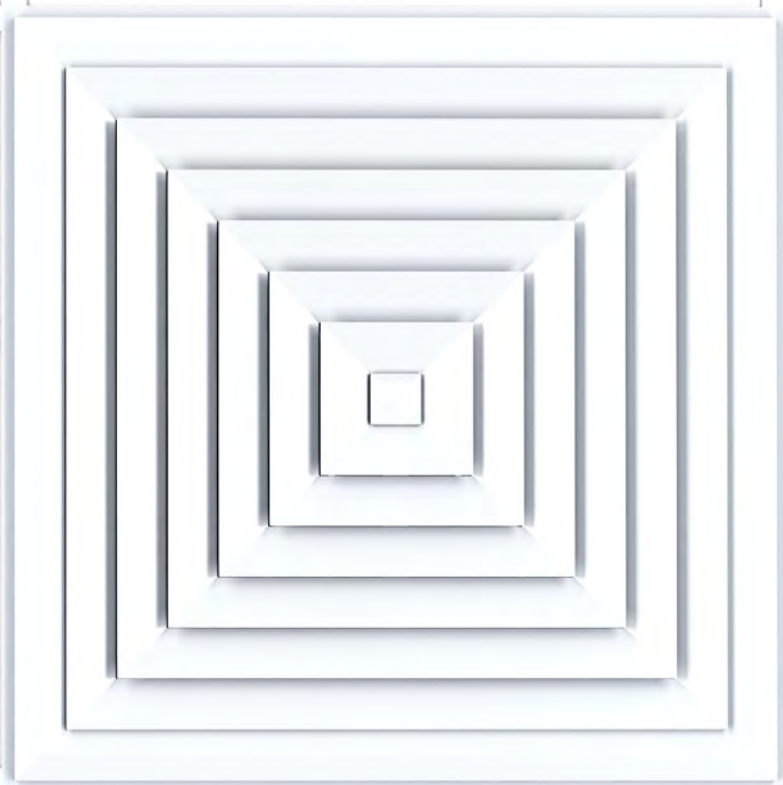
DI: Ellen, as the person whose job it is to lead design process for science-and-research-based facilities, can you share any examples of when you've had one of those good clients — availing yourself and the project team of shared knowledge that resulted in a better outcome?

ES: A great example is a recent project we did for Merck in San Francisco. We were teamed with the construction management firm DPR. The client was

motivated to incorporate the target value design and delivery approach with aspects of IPD and lean delivery. They were open to working with the CM, Jacobs and their own staff to embark on the project in a different, nontraditional way.

The outcome was successful — I know it sounds like a cliché, but we delivered on budget, on time, with a high level of trust and collaboration between all team members. It was almost 300,000 square feet. That's a large-scale innovation in project delivery.

At a small scale, innovations in engineering often impact projects. Then, that moves the client to accept technology in a wider way. A few years ago, we were doing a renovation converting biology labs to chemistry labs. There were new fume hoods on the market that used considerably less air, but the clients were reluctant to incorporate the technology because, at the time,



only one vendor made them. There wasn't time to vet the product with a safety group, an HVAC group, a procurement group and anybody else who might have to give this their blessing.

But, because it was the only choice to facilitate the renovation, we incorporated these innovations. That allowed the client to see how they worked on this smaller project and then feel comfortable incorporating this technology in other projects. We are often faced with the same dilemma: in the pace of the project, it's too late to have all parties agree to incorporating something that would involve a change in their standards.

DI: Nancy, as the firm's workplace strategy leader, you've been collecting data to move from: "I'm the expert, I have the experience, I'm just going to intuit this design," to: "Let's avail ourselves of data that can improve outcomes." How is that working?

NS: At Jacobs, we've been actively collecting data for 30-plus years. But we use data differently now than we did in the past. Technology advancements and globalization are having a huge impact on how we work. If anything, the pace of change is increasing daily. Clients are realizing they have to do more with their workspaces to support their businesses.

Real estate is typically the second largest cost, behind people, so what can they do to better optimize the space? That doesn't mean driving to less space but driving to space that supports the work and is able to adapt.

Where does the drive for research and innovation come from? Are clients asking for it? Is it a top-down firm mandate? Or, do you see yourselves as grassroots, bottom-up folks driving change?

NL: It's both top-down and bottom-up. This desire for change and innovation

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“... we've been actively collecting data for 30-plus years. But we use data differently now than we did in the past.”

is completely coming from top-down. But we also see research opportunities and innovation at office, regional, national and market levels. We're trying to capture that information in a cohesive way. That top-down approach combined with bottom-up enthusiasm brings it together.

NS: Natasha and I were part of a presentation on the future of work delivered to our senior leaders last year. This conversation was not imaginable a few years ago. The executives knew the importance of changing how we work together. The push for talent is becoming the holy grail everyone is after — that and how you create an environment to attract those best thinkers.

The way we work is not just physical space. It's also work-processes, the tools to bring it together and the culture of how you work within it. It's a topic we're exploring within Jacobs, and our

more sophisticated clients are having the conversations with us.

DI: Is there a story where these initiatives are making a difference? Or, on the dark side — what's keeping you up at night?

NS: We have a global financial service client we've been working with for 20-plus years. They realized they needed to change how their teams worked. Together, in a tight timeframe, we created a work environment to be used as a pilot. Interestingly, the senior executive team was willing to completely put themselves out there about how they worked. They set the example for the entire organization.

It was a wild success. The organization recognizes now that they need to change how much of their physical space works based on the outcomes from that pilot. And to capture the data

from that success, we're continuously monitoring that space now.

More and more organizations realize nothing is stagnant. They might create a fabulous space today, but if a year from now, they are working in a different way, the space might not support it. So, it's critical to continue to monitor and adapt the space to support people.

Still, we're not doing this fast enough.

NL: Many of my success stories are confidential, but there are cases where clients have pushed us outside of our comfort zone. They made us think about things differently or asked us to reimagine how we work. We've had both the most success and the most difficult work with those kinds of clients.

DI: Nancy, you said you were monitoring. You're talking about metrics, sensors, data, right? Hard data?

NS: Yes, hard data. Observation is still a piece of it, but now it's also based on user surveys and feedback. Sensors and metrics track how space is used and adopted. It starts with designing and delivering the space and then moves to ongoing monitoring: how we're going to help them continuously adapt their space.

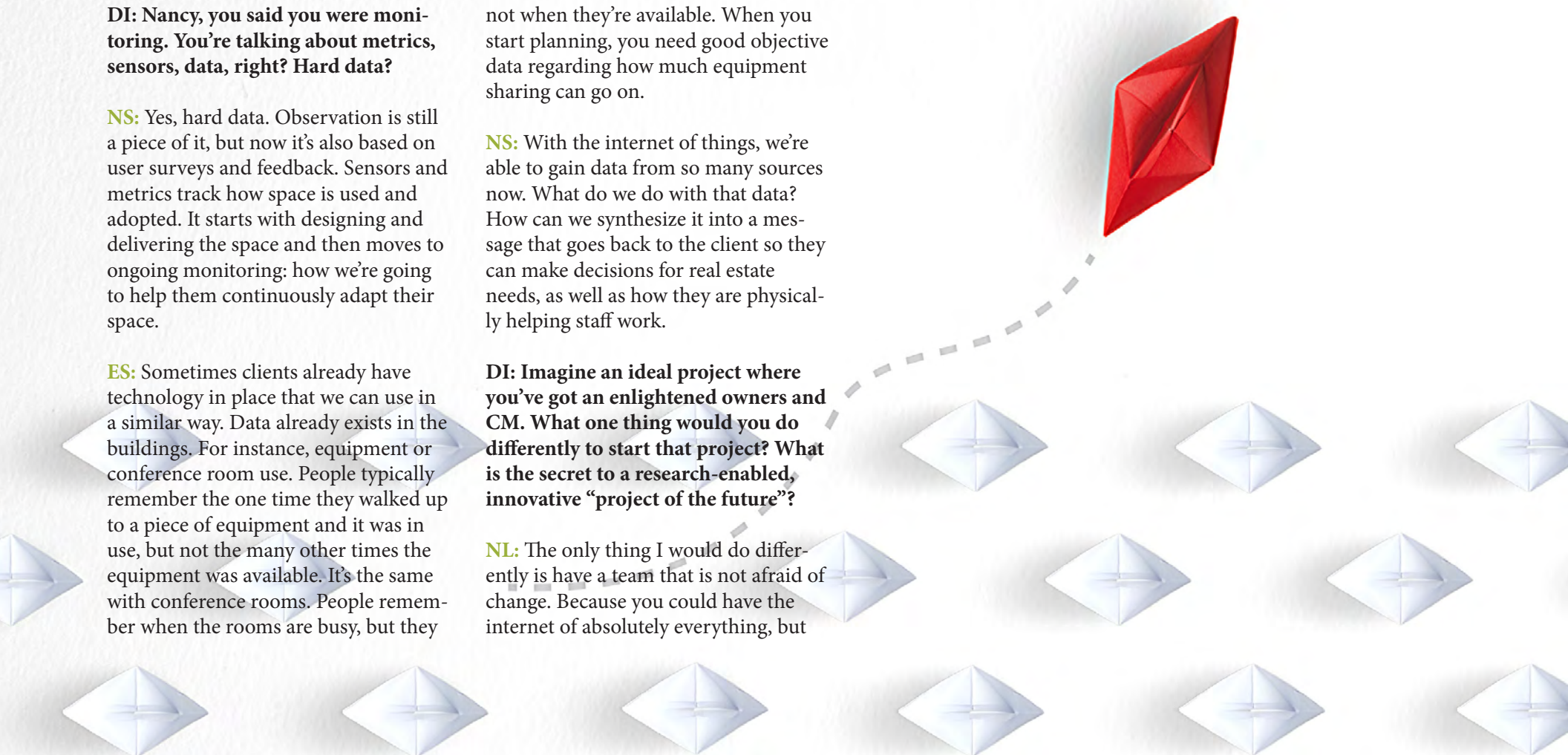
ES: Sometimes clients already have technology in place that we can use in a similar way. Data already exists in the buildings. For instance, equipment or conference room use. People typically remember the one time they walked up to a piece of equipment and it was in use, but not the many other times the equipment was available. It's the same with conference rooms. People remember when the rooms are busy, but they

not when they're available. When you start planning, you need good objective data regarding how much equipment sharing can go on.

NS: With the internet of things, we're able to gain data from so many sources now. What do we do with that data? How can we synthesize it into a message that goes back to the client so they can make decisions for real estate needs, as well as how they are physically helping staff work.

DI: Imagine an ideal project where you've got an enlightened owners and CM. What one thing would you do differently to start that project? What is the secret to a research-enabled, innovative "project of the future"?

NL: The only thing I would do differently is have a team that is not afraid of change. Because you could have the internet of absolutely everything, but





The only thing I would do differently is have a team that is not afraid of change. Because you could have the internet of absolutely everything ... but if we are still afraid of change, I don't think we'll be successful.

Natasha Luthra is the Director of Emerging Technologies at Jacobs. She runs an Emerging Ideas Innovation program focused on incubating transformational ideas, technologies, and tools - cultivating and validating emerging ideas based on client needs. She facilitates the Jacobs strategic mission to advance the practice through innovative processes and client workshops to co-create and co-develop solutions for envisioning and preparing for the future. She has spoken about technology, innovation and architecture at conferences such as Autodesk University, BILT NA, BILT Asia, BIMForum and the AIA National Convention and has been featured in and written articles for the Architect Magazine, YAF Connection and AUGI World. As the 2018 Chair for Technology in Architectural Practice, the AIA knowledge community, she hosted the

— and this is true of every single one of us — if we are still afraid of change, I don't think we'll be successful. To be able to build that sort of culture means not being afraid of failure and having the ability to deal with change.

NS: It's no longer just about work or office or lab space, it's about how we can support people. In my ideal future, we will have the ability to seamlessly bring together the expertise needed for a project. I want to be able to tap into expertise around the globe. If we can break down the barriers among ourselves, we can be a game changer as

2018 Building Connections Congress in Washington DC, on the future of design in the age of AI and Machine Learning. While trained as an architect, her impetus is to be the tip of the spear related to technology in design.

Ellen Sisle is Principal, Global Director Science & Research with more than 30 years of science and research experience, including programming, planning, project management and operation-based sales. Her clients include government, higher education, academic, medical and pharmaceutical organizations. She is a frequent presenter at industry conferences and co-author of a book on the sustainable design of laboratories, published by Wiley. An active member of the architectural

we move into the future.

ES: We emphasize that a lab is just another workplace. It has a lot of technical requirements, but it's still a workplace. For people.

NS: The future is exciting but scary. I'm hoping people see it more as exciting than anything else.

community, Ellen has served on numerous juries and is a board member of her community's historic preservation association.

Nancy Siefert is Vice President and Global Director for Interiors and Strategies Solutions. She leads Jacobs Building Interiors Solutions after serving as Division Vice President and Market Sector Leader for interiors and workplace performance. Her strong leadership skills and passion for clients built national teams for clients such as Shell, Abbvie, J&J and JP Morgan over her 35 years of experience in interior architecture for corporate professional and high-tech multi-use facilities. Nancy joined Jacobs in 2012 through the acquisition of KlingStubbins.

“Cutting off fundamental, curiosity-driven science is like eating the seed corn. We may have a little more to eat next winter but what will we plant so we and our children will have enough to get through the winters to come?”

Carl Sagan

“The measure of greatness in a scientific idea is the extent to which it stimulates thought and opens up new lines of research.”

Paul Dirac

“What we find changes who we become.”

Peter Morville

”

“Research is the highest form of adoration.”

Pierre Teilhard
de Chardin

“Instead, he would make death his final project, the center point of his days. Since everyone was going to die, he could be of great value, right? He could be research. A human textbook. Study me in my slow and patient demise. Watch what happens to me. Learn with me.”

Mitch Albom

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