AIA Architectural Research Agenda

2019 & 2020

In a period of profound social, technological, and environmental shifts, the built environment must respond to the changing conditions facing communities, organizations, and individuals in ways that enhance human experience and well-being, minimize costs, maximize efficiency, optimize resources, and enhance quality of life. This, in turn, requires new knowledge and innovative ideas gained through extensive experience and reliable research on the part of architects, researchers, and industry specialists.

This Architectural Research Agenda identifies areas of research needs and is itself a call for action. It serves as a call for expanding investment in architectural research, its prioritization within the architect culture, and the continued dissemination and exchange of findings.

Introduction

Buildings in the United States are tremendously impactful. They are not only strong economic drivers—representing 7% of the US GDP in 2018,[1] they also are where Americans spend 90% of their time working, playing, learning, and living.[2] Of the key players involved in creating our built environment, architects are at its origin, as well as being stewards across the lifecycle of its existence. As such, they play a critical role in the outcome of these buildings, which affect all levels of scale—from the singular individual to the global environment.

Yet the research available for study of architecture and buildings is disproportionate to its impact. According to various sources, approximately $13.5 billion, or 3% of all US research dollars expended annually, is spent on annual research on buildings and engineering. It is comprised of 4% of private research expenditures and less than 1% of federal research dollars.[3] In contrast, the healthcare industry is worth 18%

of GDP[4] and receives 46% of federal research dollars and 21% of private research money.[5] To be proportionate with its economic impact, federal research spending on buildings would not only need to be 10 times what it is today, it would also need to encourage nearly twice as much private spending. Such an investment would have tremendous benefit and payback.

Similarly, despite the architect's importance in the formation, preservation, and stewardship of our built environment, practice-relevant architectural research receives minimal investment compared with research in engineering, materials science, and new product development. Although that research is important, studies weaving architectural research into the multidisciplinary research within public health, environmental science, medicine, and other disciplines is equally important. Work across all these areas needs to be expanded, and the architect needs to be included in that work.

This Research Agenda serves as a call for action, with three primary goals to advance architectural research:

- Increase investment through new and expanded funding, both private and public.

- Prioritize research within the architect core competencies and firm culture, starting in school and continuing within practice.

- Continue and expand dissemination of research and promote exchange of findings, as well as methodologies and failures.

As such, the audiences for this agenda include funding sources (e.g., federal and state governments, foundations, industry, professional/trade associations), researchers within public and private institutions, think tanks, academics (e.g., design instructors, professors, deans), practitioners (architects and design teams but also related owner organizations, builders, planners), and policy makers.

Research Needs

Overview

Architectural research needs are multidisciplinary. The needs expressed in this Research Agenda bridge different professions and span diverse topics proportionate to architecture's far-reaching impacts. We recognize that not all valid or valuable areas of study are specifically mentioned in this Research Agenda. The intent is to highlight research needs that address the questions currently deemed critical by a cross-section of practicing architects and those within academia.[6]

We are in a time of rapid change, and research needs must also be adjusted as changes occur. A statement of needs is required for us to amplify, draw together, and encourage individual studies in order to advance research in a holistic fashion. We intend this Research Agenda to foster and encourage research, not to restrict or limit it. Descriptions of research needs are broad, outlining why that area needs investigation.

AIA supports both basic research, that is, research that creates or expands knowledge, as well as applied research, research that is targeted for a specific application. Basic research is critical in order to form new or expanded knowledge and is often most suited to take place within academia and research laboratories (e.g., NIST, Sandia National Laboratory, Oak Ridge National Laboratory, Construction Engineering Research Laboratory). In contrast, applied research is well suited to the professional architect's aptitude or to collaborations between professionals and academics. Trained problem solvers and systems thinkers, architects in practice and academia are suited to conducting applied research themselves, developing new tools and invention from applied research, or being part of the transfer of new discoveries into practice.

This Research Agenda follows AIA's past definitions of research.[7] While we support inquiry and literature reviews as well as project-based understanding, this Research Agenda calls for research that meets the following guidelines:

- has clearly identified goals at the outset of the research, whether basic or applied research

- contributes new knowledge around the research area, whether that is augmenting or reinterpreting current knowledge or offering a new line of inquiry, or builds on and extends existing knowledge in other fields into architecture/built environment

- follows a credible, systematic method or mode of inquiry that is objective, reliable, and repeatable in order to be scalable and generalizable

- is moral, following AIA's standards of ethics and standards for ethical research practice, which state that "members should strive to

improve their professional knowledge and skill" and "uphold human rights in all their professional endeavors."

Impacts

We believe that a primary motivation for architectural research studies is to understand better the impact of architecture and the architectural profession at large and beyond buildings. For example, researchers might form questions to understand daylighting's impact on promoting health, increasing productivity, or nurturing the environment. Alternatively, they might work with the research and development arm of industry to develop building envelopes that are more resilient and carbon neutral.

Five impact areas provide a motivation for developing research questions, a starting point.
(1) community
(2) health
(3) environment
(4) technology
(5) firm/practice

These areas are not in isolation with one another—studies that seek to enhance technology may also help to make design more accessible and equitable. Similarly, these impacts span across topic and scale. Decisions related to human performance and productivity, materials, and urbanism each impact community and quality of life, but at different, unique scales.

The five impact areas also provide a framework for assessing the

progress of practice-relevant architectural research, particularly research encouraged, supported, or conducted by or for AIA. In the aggregate, they are a lens through which we can encourage ties between studies, identify gaps or areas lacking investigation, and demonstrate holistic impact. Because these impacts align with AIA's strategic plan, reflect our values, and support our vision, AIA will track the success of the research aligned with this agenda according to these five areas.

Figure 1: Research impact areas

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(3) environment
(4) technology
(5) firm/practice

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Research Topics

There are three scales of influence architectural research can affect. [Figure 2] This Research Agenda calls for and supports research across all of these scales: individual/human, industry sector and building function, and community and societal. While we have organized work into these scales, we do recognize and appreciate how much more expansive some areas of inquiry are, as well as the crossover and intersections among the different scales. For example, systems in a building might also be part of an investigation of a community issue, or a human interaction study might produce results applicable to assess functions of a building and environmental impact.

Figure 2

Scales of influence

Occupant scale

Individual/
human

Building scale

Industry sector and
building function

Societal scale

Economy, equity,
environment
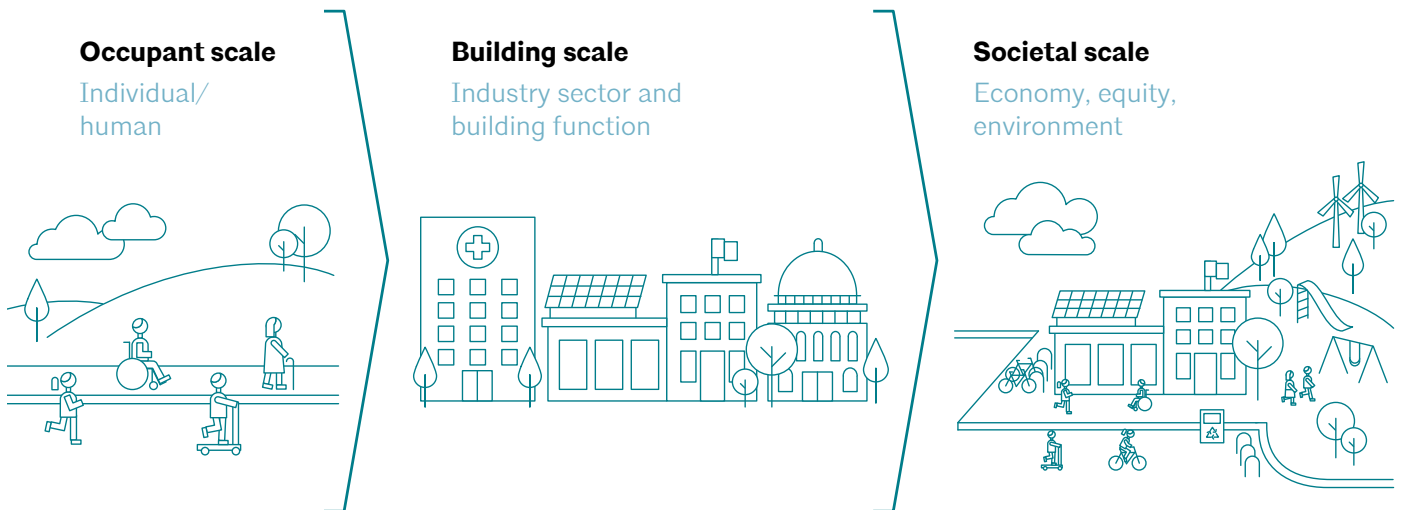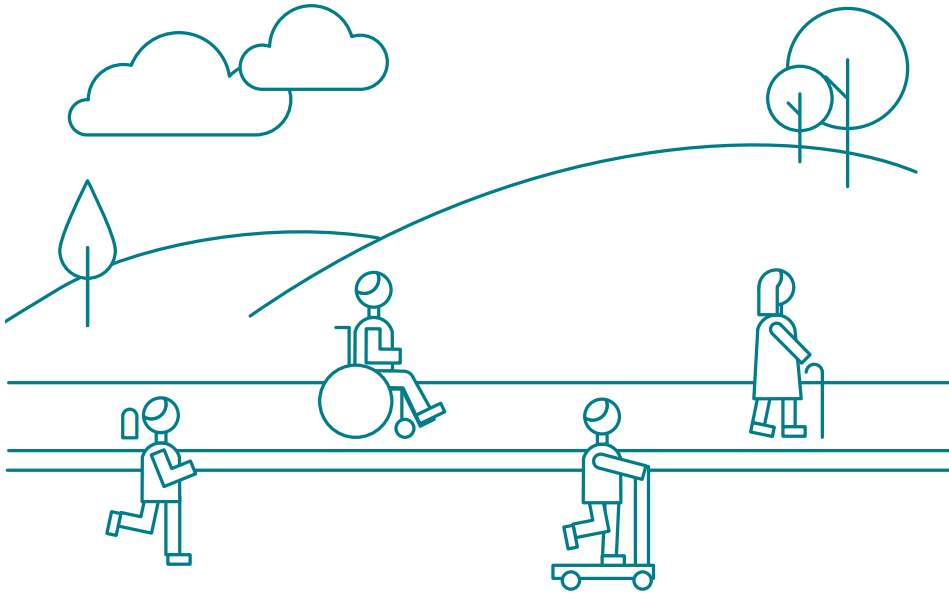
Occupant scale: Individual/human

At the heart of our built environment are the occupants of buildings, whether they be homes or offices, or schools or other building types. According to the US Environmental Protection Agency (EPA), Americans spend 87% of their time inside buildings, making the built environment they inhabit critical. Because of that, research that focuses on the impact on the occupant of the design and construction decisions made by architects are important to understand in the context of scientific evidence rather than simply what has historically been an aesthetic choice of the architect.

The occupant also influences the performance and function of the building, often in ways that are not anticipated. Studies clarifying the factors behind occupant preferences can help to create buildings that are more responsive to changing behaviors and needs. There has been a tremendous amount of research conducted on these issues.[8] However, we believe research in these areas should build on that work, and also help to link that research to each other and the practice of architecture.

We highlight three research themes at this scale. While these themes overlap, we believe they constitute different applications and therefore are worth separate delineation.

- **Human behavior:** The understanding of how a building design can improve human performance, including the metrics, measures, and methods necessary in order to evaluate the impact of buildings on the human experience

- **Health and well-being:** The ways a building influences the occupants' health. This includes the occupants' safety, as well as their physical and mental health status.

- **Neuroscience:** The understanding of how the human brain reacts to stimulus and its impact on behavior and cognitive function

Human behavior

No one individual experiences space in the same way. Therefore, it is important to define which factors influence those interactions. This could include designing for different ages, personality types, etc. Consistent metrics help produce results that can be repeated and tested over time. Clear performance metrics, appropriate measures, and applicable methods for measure are important across all studies, but particularly those evaluating the impact of space on people. This work is substantial and would take significant investment but is important for AIA to encourage.

Many behaviors are worthy of investigation. Productivity benefits of building design decisions have long been sought after by building

owners. Office building owners have been particularly interested in improved productivity since poor employee performance, absenteeism, and rising employee health benefits can cost 10 times what they pay to operate their buildings. Similarly, healthcare providers are looking to improve patient outcomes and provide a safe, less stressful work environment for physicians, nurses, and staff. The education sector desires improved student performance and academic outcomes in an environment that fosters critical thinking while emphasizing diverse and equitable learning. These are just three building sector examples. Studies testing correlations between the built environment and human performance and productivity would advance our understanding of how design interventions connect to occupant outcomes—whether they be universal metrics and performance studies, materials innovation, or sector specific.

Health and well-being

Design choices made in buildings have major effects on health.[9] The World Health Organization constitution from 1946 defined health as "a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity." Not only should health research focus on the impact of design to mitigate or prevent physical or mental disease, but also help to create supportive, health-promoting environments.

There are several efforts underway that aim to translate current theory and evidence to design practice via a set of design recommendations. Most well-known among those are the evaluation criteria of the WELL Building Standard from the International WELL Building Institute

and the criteria behind Fitwel, a joint initiative led by the US Centers for Disease Control and Prevention (CDC) and General Services Administration (GSA). These design guidelines and checklists are valuable and easy tools to assist the industry transferring research toward implementation within the architectural practice. Research is needed to evaluate the metrics and methods, their success in implementation, and improved monitoring.

McKinsey & Company predicted that "wellness" is the next trillion-dollar industry, and cross-disciplinary research ties the architectural discipline together with engineering, science, medical and public health researchers. To ensure these studies are comprehensive in nature, AIA encourages collaborative partnerships with these and other disciplines in order to learn from existing knowledge in other disciplines and build on or extend that knowledge into architecture and the built environment.

We also encourage partnerships between architectural researchers and those in other fields in order to build into the findings results at a level of detail architects and designers require to make use of that research. Architects and their work can be assets to researchers looking for opportunities to apply research.

Neuroscience

Neuroscience research has shed much light on the influences of building design on human mental health. Given the import and breadth of this type of investigation, we believe it should be noted independently. As Fred "Rusty" Gage, PhD, The Salk Institute president, noted at the 2003 AIA National Convention,

"architectural design changes our brain and behavior." The Academy of Neuroscience for Architecture (ANFA) is a leader in this field. Established by the AIA San Diego Chapter with an AIA College of Fellows Latrobe Prize, ANFA's work is adding research into this body of knowledge around the intersection of the brain and design. Neuroscience is of interest to architects, often providing content for some of the more popular education sessions at AIA's annual Conference on Architecture, demonstrating how important architects consider the human condition in their work.

We believe the engagement of architectural firms in this field of research has significant room for advancement, providing tremendous opportunity to learn from other disciplines and apply learning to the built environment. Learning from social science research, particularly the field of psychology, can help to bridge gaps in communication between neuroscience/physiological tools and the design community. An example of one study where architects may want to look for collaboration opportunities may be the National Institutes of Health (NIH) Adolescent Brain Cognitive Development (ABCD) study, a long-term study following 10,000 healthy children from age 9–10 through early adulthood. This study focuses on understanding factors affecting the brain and cognitive development, including environmental factors. Applications for the results of this study include education and healthcare facility design, among others, where architects could translate these biomedical findings into architectural decision-making.
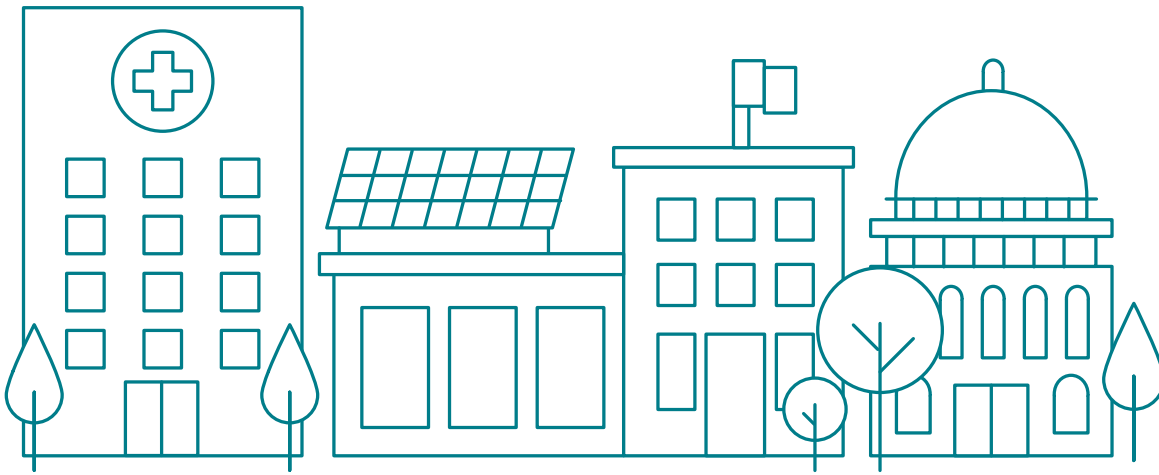
Building scale: Building type, performance, delivery

Buildings are significant contributors to GDP, yet the buildings' design, systems, materials, products, and physical construction also have tremendous impact on the environment and our natural resources. Buildings are the heart of many communities, and these structures act as incubators for new technologies and innovations.

Although buildings are frequently referred to as a collective unit, as if all the same, the industry is actually comprised of various building sector types—residential—both single family and multifamily homes, commercial offices, education—K–12 and higher education, healthcare, retail, and hospitality, among others. These building sectors have both similarities and equally unique elements. Research can focus narrowly on a particular building but can also be integrated into design and construction at large.

The building construction is at the nexus of design and engineering. Design and construction support the market for building materials, products, and technology. Research is critical in order to create the most efficient, adaptable, and long-lasting structures as possible, and architects are at the forefront of this investigation.

There are four research themes at this scale. They often overlap but have research that is distinct enough to be noted independently.

- **Building performance:** Buildings consume large amounts of resources and themselves have tremendous impact. This study area covers the science of buildings, including efficiency, high performance outcomes, resilience, and impact on the environment.

- **Technology:** Understanding use, adoption, advantages, etc., to using new technology to create

and operate a building as well as technologies used in design, practice, and construction.

- **Materials:** Improving buildings function and form, new materials, materials impact, and transparency, sustainability, etc.

- **Project delivery and processes:** Examination of the way a project is delivered, includes formal project delivery systems as well as construction methodologies, risk allocation, relationships between clients and partners, building codes and permitting, etc.

Building performance

The building sector is one of the leading contributors to the US's greenhouse gas emissions. Building operations, including occupant activity, generate a fifth of all US greenhouse gas emissions, including 11% of direct emissions and a third of all emissions from electricity.[10] Similarly, buildings (residential

and commercial) use 38% of all energy consumed in the US, larger than industrial uses (32%) and transportation (29%). They also use more than 70% of the electrical energy. This costs the US more than $430 billion each year.[11] The largest share of energy used in commercial buildings goes to space heating (25%), followed by lighting, refrigeration, and ventilation (all using 10% of energy respectively).[12] For homes, the climate location heavily influences how energy is consumed. When looking at the country in aggregate, most homes use energy for space heating (42%), followed by electronics, lighting, and appliances (30%), water heating (18%), and air conditioning (6%).[13] Obviously, in very warm climates, energy on air conditioning is significantly higher and space heating is lower.

Water use in commercial buildings is responsible for nearly 10% of all water used in the US.[14] With an increasing prevalence of droughts (40 states told the US Government Accountability Office that they expect to have water shortages over the next 10 years[15]), water efficiency, conservation, and reduction of use will become more critical. Natural disasters, such as flooding, are also critical issues that buildings need to address. Design strategies and interventions in building structures can lead to more resilient structures.

The goal of research in this area is to help advance the use of high-performance design criteria, codes, and standards in the programming, design, and management of building performance. This area includes issues such as building envelope and enclosures, windows and doors, and products such as building controls and lighting that contribute to improved building performance, etc. Complimentary to the improvement of building performance is evaluation of the modeled predictions as compared with actual building performance. This study could feed back into the knowledge base around how and when a building's performance is evaluated.

Technology

Technology in buildings takes on two facets—building technologies, that is the technologies that comprise the building and its operations, and technology used in the creation of a building. Both are important areas of investigation. Technology research in architecture and the built environment is inherently tied to building performance, but not exclusively so. Therefore, we separately note this as a research need.

Much of the research in this area is done to improve building products and therefore, investment by the private sector for proprietary purposes. Architects can bring a strong voice to this research, and we encourage public-private partnerships between architects in academia and practice with manufacturers, national labs and testing facilities, and others doing work to improve building technologies and products. Technologies, such as heating and cooling systems, lighting, sensors and controls, are key areas for investigation, as well as systems that connect, such as the Internet of things (IoT).

Technologies that are dedicated to improving the safety of buildings continue to be a core tenet of the architect's responsibility. New technologies and systems that can help improve safety, both those that are used in all buildings, as well as those specific to the safety concerns of different building types—such as the need to mitigate risk to students in schools or those used in corrections facilities.

We also believe there is a need to research and improve technologies used in the design of buildings. This includes research that expands information mobility beyond BIM into 4D and 5D modeling[16], as well as adoption and use of newer technologies, such as virtual and augmented reality (or XR more broadly), robotics, artificial intelligence, 3D printing, etc. These technologies, and other systems, are also important to help a firm integrate their own data—from models to specification data, building performance information, economic and financial data, and overall tracking of a firm's portfolio. New methods to integrate and mine these data are important in order to advance firm profitability and prosperity. Examples of work already underway in this arena of integrative computation design, a holistic approach, which accounts for materials properties and characteristics, and the potential of advanced manufacturing technologies while leveraging CAD/CAM processes to model and code. Leading the work in this area is Professor Achim Menges, registered architect, and professor at the University of Stuttgart.

Materials

The materials that architects source for the buildings they design impact the performance of buildings, occupant health and well-being, costs, and the environment. Therefore, knowing where materials come from, their content, how they were

made, and how long they will last are important questions for architectural research. This information would allow architects to identify areas of innovation and influence the new products needed to improve the performance and outcomes of design. The result is improved performance in all facets: environment, social, health, and economic.

This is also an area of innovation. Architects and architectural researchers can use materials science and development to help address larger social and environmental problems, such as air pollution or health improvements, or response to climate change. With more investment in research, newer materials and fabrication techniques can also help realize design visions that cannot be accomplished today.

Project delivery and processes

It is not only the building itself that is important, but also the methods by which a project is delivered. It is a time of innovation in project delivery with new strategies emerging. An example is progressive design–build, which combines traditional design–build with the advancement in digital technologies to deliver projects in ways that are transforming relationships among the architect, owner, engineers, and contractor—as well as the other players involved in bringing a project from concept to operations.

Understanding the changes in these relationships, advantages and pitfalls of different delivery methods, and risk allocation are important in order to ensure positive outcomes.

Aside from project delivery methods and contracting, the production of buildings is also changing, as well as the processes for doing so. Modularization and offsite production of buildings and components, or the production of building materials via 3D printing and robotics are also changing how projects come to creation from design. These trends are leading to new business formations and blurring lines of how architects, contractors, owners, technology providers, and others serve the industry. There are numerous nonprofit organizations, government labs, and research consortia working on these topics, which are prime opportunities for collaboration. One such example is the Green Building Research Center at the University of California Berkeley.
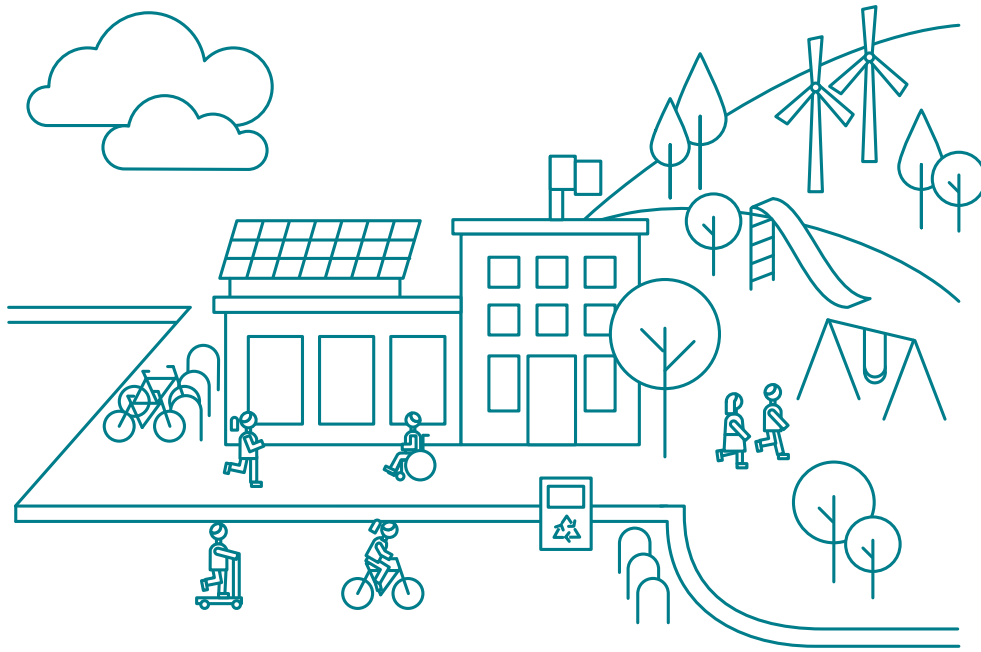
Societal scale: Economy, equity, environment

The architectural profession and the buildings they design are also part of the fabric of life, whether that be a rural community, small town, or urban landscape. The architect then is a part of the solution to problems that are larger than any individual building. This Research Agenda recognizes the importance of the architect's role and interventions that the architect can make to help be part of the solution to larger social and societal issues.

There are a number of social issues the architectural profession, through design, can influence, but we focus on four areas that we believe architects are uniquely positioned to lead.

- **Urbanism:** Influence of the built environment in shaping human potential in the context of rapidly accelerating urbanism

- **Resilience & adaptation:** Study of resilience, adaptation, reuse, urban and community planning, and other design interventions that can mitigate the effects of disasters

- **Climate change:** Design interventions that reduce the impact of the built environment on climate change, including mitigation, decarbonization, preservation, materials innovation, etc.

- **Community:** Understanding use of design, community engagement, and culture to improve equity and quality of life for all

Urbanism

In many parts of the world, there has been rapid urbanization. In 2007, the global population shifted, and for the first time more of the world's population was living in urban areas. That percentage has increased in the ensuing decade. In 2017, 55% of the world lived in urban areas. In the US, that number is significantly higher. In 2017, 82% of Americans lived in urban areas, compared with only 70% in 2006.[17] With so much population concentrated around urban centers, the urban condition becomes even more critical to understand in order to improve it.

Research in this area advances AIA's commitment to the New Urban Agenda, including support of the goals and principles of the UN New Urban Agenda, Paris Agreement on Climate Change, and AIA's sustainable development goals.[18] It covers a breadth of topics, including healthy communities, affordable housing, homelessness, adaptive design, sustainable planning, etc.

Resilience & adaptation

Hazardous weather events, including those exacerbated by climate change, are on the rise, continuing to be more frequent and erratic.[19] Architects play a major role in working with code officials, community leaders, and

planners to create mitigation and adaptation plans. They use design to address a particular building's vulnerability within the context of that community. Not only are people affected and displaced, but communities are changed forever by these events.

Additionally, abatement and recovery costs billions of dollars annually. The Natural Hazard Mitigation Saves: 2018 Interim Report Studies conducted by the National Institute of Building Science found a national benefit of $11 for every $1 invested in mitigation. The 2018 Interim Report highlighted the savings that resulted from implementing mitigation strategies in terms of safety, and the prevention of property loss and the disruption of day-to-day life. Additional research to determine the most cost-effective design solutions and to encourage advances in material science and technology could serve to enhance safety, improve resilience, and increase the cost savings to society.

We must continue to advance research in this area, including studies such as those by the universities that participated in the National Resilience Initiative, a joint program of AIA and the Association for Collegiate Schools of Architecture (ACSA) that united university-led architecture studios to develop new designs, research, and policies to improve resilience in the built environment.

Climate change

Climate change caused by human activity remains one of the most urgent challenges of the 21st century. Rising levels of carbon dioxide and other greenhouse gases already are causing rising sea levels, extreme weather events, and degradation of natural resources. These trends are projected to continue and possibly accelerate, posing significant risks to national security, human health, food and water supply, global economies, and natural ecosystems; many of these may result in refugee crises. The threat of climate change is understood by climate scientists[20], the US Department of Defense[21], the general public[22], and the financial and insurance industries.[23]

The built environment is one of the largest contributors to climate change due to the energy used in operating and constructing a building. Today, embodied carbon is one-quarter of annual building sector emissions and that share is growing. By researching materials, reuse, methods, and processes to reduce the embodied carbon in our buildings and communities, architects can make an impact on reducing the effects of climate change. Climate change research focused on the built environment can demonstrate the larger impact of design on community, economy, and urban design.

Community

While architects and the built environment affect the individual, the building, the environment, and the community, architects can also design in order to preserve community culture, identify, promote equity, and celebrate diversity. The need to preserve a cultural identity while also designing for diversity and allowing for personalization are potentially at odds with one another, yet both are important for successful advancement of equity. Architects, through their own hiring and professional development practices as well as through their design and community engagement, can be leaders and champions for social equity and stronger communities. Research can help support the architect's role in this work and the improved quality of life for everyone.

Action Plan

To achieve the goals of this Agenda and address the identified research needs, AIA poses the following call for action. As an ongoing activity, AIA will provide a biannual review of progress against this Agenda.

There are three primary needs to advance the work noted above:

- **Increased investment** through new and expanded funding for architectural research and demonstrated impact and benefit of that research

- **Prioritization of research** within the architect culture, starting in school and continuing within practice

- Continuation and expansion of the **dissemination of credible research** and exchange of findings, as well as expanding research literacy[24] in the profession.

Increased investment

We assert that research related to the built environment is underfunded considering its impact on the economy, human condition, and society at large. Architectural research is even more poorly funded.

For government funding, we propose the following actions:

- Expand eligibility for all government research grants related to the built environment to include architecture schools and research centers. Architectural research centers are as dedicated to scientific research as their engineering counterparts, but often architects are not considered relevant players in this research. This is a lost opportunity at making that research as successful as possible. The National Science Foundation should be encouraged to include architects on the multidisciplinary teams

they award grants to. Other federal government agencies, such as the Department of Defense, Department of Transportation, Department of Education, should consider funding projects that involve design, health, productivity, community, and the built environment's effects on these areas.

Architects are creative thinkers, paradigm shifters, and strategic planners. Research teams can gain more relevance and greater success with architects on their teams.

- Revise and extend the research tax credit. To date, this credit is typically only used by large firms with the infrastructure to support extensive research study. Yet, small and midsize firms are also on the cutting edge of new product, material, and design testing. Tax incentives could spur

innovation yet are limited by the current language. We recommend revising the provision to make it easier for small and midsize firms to take advantage of these tax benefits.

For private sector research institutes or product manufacturers, we propose the following:

- Consult architects in new product development. Not only do architects have a unique design thinking that would complement scientists, engineers, and technologists involved in new product and material development, but they also can provide insight into market demand and barriers to implementing new technologies into practice.

For architecture firms, we propose the following:

- Examine your projects as potential subjects for research. One approach: Quantify what you do, define a problem, develop hypotheses about outcomes, collect data, and appropriately analyze data. Another approach: Identify a question or problem; explore that through the stages of a project (pre-occupancy, design, construction, post-occupancy); collect and analyze data; and share findings with others.

  These approaches will start to build a body of data and exploration that may help inform different design decisions over time—both pre-occupancy and post-occupancy. In order to have a data set rigorous enough for study, firms need to plan,

prioritize, and build a data infrastructure. However, a firm of any size can explore problems through their work and engage in a culture of knowledge sharing.

- Become involved in local government and committees and work around code development and construction standards (e.g., ASTM, ASCE). Research that informs new codes needs to be informed by architects. Architects can also help to identify the unintended consequences of codes and standards.

- Connect with academia—take advantage of research expertise, students, studios, technology research consortia, etc. Faculty need research projects to gain tenure, and students want to learn through actual projects.

- Forge multidisciplinary relationships and collaborations, including with public health, medicine, education, planning, engineering, neuroscientists, biologists, material scientists, etc., so that the architect's influence on buildings may be considered a way to evolve the work.

- Expand your agency with clients by embedding concepts of architectural research within scopes of work and agreement. Many clients mistakenly believe architecture firms can absorb costs of research, yet traditionally, architecture fees do not. Architects are the bridge from the client vision to realization of that vision—and research can be a powerful partner in that. Include a

research component into your standard contracts as an add-on. Research into a project's performance often leads to savings for the client, akin to how post-surgical doctor visits lead to better health benefits for a patient.

- Expand your influence and relationship with product manufacturers. Become a partner with them in product development and materials and other research so that they see architects as partners, not solely as customers.

Prioritization of research

AIA is committed to advancing research literacy in the profession. In order to do that in an impactful way, the commitment to research must extend from school all the way through practice and academic research. It is imperative that architects embrace research—both as critical consumers and, as warranted by interest and additional training, as researchers themselves.

However, commitment to research is only one element, and it does not exist in isolation from the other areas. Therefore, AIA is committed to conducting an extensive study starting in 2019, to be published in 2020, that investigates current culture in academia and practice in order to benchmark the current state of architect culture throughout the architect's path from school through retirement. Included will be a gap analysis and recommendations around the path forward in creating a culture that will ensure a thriving, dynamic profession, including how to make one that is research-minded and directed. In a sense, this work builds on "The Boyer Report,"[25] a groundbreaking study that discussed the direction of architectural education and outlined seven principles for action. This proposed study would advance some of the understanding in that work but also extend through the culture in practice. Just as AIA did in 1996, we look forward to working with partners to make this work as impactful as possible.

Dissemination of research

AIA is committed to helping make research more broadly available or connect architects to where that research resides. Through the BRIK (brikbase.org) library and partnerships, AIA is working toward making links to credible research that has been vetted for validity. We encourage the same sharing and transparency throughout the profession.

AIA is also committed to helping create consistent and useful approaches for post-occupancy evaluations, case studies, and key metrics. Work of the AIA Knowledge Communities is already contributing to this work. This will be expanded in 2019 and 2020.

AIA will also continue its work to advance research literacy to help it be more consumed by architecture firms, including providing examples of how research is working in practice, offering continuing education courses focused on expanding use of research in practice, and expanding partnerships with our academic counterparts, ACSA and ARCC, in order to tie together architectural researchers with practitioners more closely. The end goal is to help research findings be translated and easily consumable by practicing architects.

Scope and Intent/ Background Information and References

This Architectural Research Agenda is intended to be both a guiding document, and a living one. AIA will be using this to prioritize research spending and initiatives, and also to benchmark and evaluate our work at encouraging research and knowledge sharing according to the identified need areas. However, in this time of profound change, we see this agenda as a document that should, and will, be reviewed regularly and updated if needed to ensure that we are being as impactful as possible in our call for expanded research, knowledge, and tools to elevate our built environment.

Member groups of AIA have established or are developing research agendas for their various programs (e.g., Knowledge Communities [Academy of Architecture for Health (AAH)], Committee on Architecture for Education (CAE), Academy of Architecture for Justice (AAJ)]); Intersections Symposium at the AIA Conference on Architecture (higher education), strategic initiatives

(materials, health). This overall AIA practice-relevant research agenda aims to help integrate those into an overarching agenda that enables easier assessment of aggregate impact.

Background

As far back as 1926, the American Institute of Architects has had an investment in research with the formation of its Scientific Research Department established to keep architects informed of new developments. In the 1940s, AIA contained the Department of Education and Research that included a clearinghouse of research in architecture, which also served manufacturers. In the 1950s, AIA established a Board Committee on Research, which in turn established a Department of Research. Its focus was applied research. In the early 1970s AIA fully invested in research and established the AIA Research Corporation, a $10 million enterprise

with 60 employees, conducting research, publishing papers, and producing a quarterly journal. Mostly funded by the U.S. Department of Energy, when government funds dissipated, the corporation ended.

In 2004, AIA issued a white paper on research, establishing the elements of a research agenda. An outgrowth of that document was the establishment of the AIA Upjohn Research Initiative, investing $100,000 annually through four to five research projects of as much as $30,000 for an 18-month study. The AIA Research Summits began in 2008, followed in 2011, 2012, 2015, and 2017—set up to help advance research in practice. As outcomes of the 2011 and 2012 Research Summits, AIA partnered with the National Institute of Buildings Sciences (NIBS) to create the Building Research Information Knowledgebase (BRIK) at brikbase. org. Following the 2015 Summit, AIA releases a Practice-Relevant Research Roadmap in order to establish AIA

goals around advancing research.

AIA's 2016–2020 Strategic Plan outlined research as a strategic objective, advancing the study of evidence-based practices in architecture that lead to improved building performance, elevating research back to a guiding force in the overarching objectives.

Since 2015, AIA has sponsored research projects through *Intersections Symposium* at the AIA Conference on Architecture, which enable academic research to be shared with a practitioner audience—helping to encourage connection between practice and academia.

In 2018, AIA joined together its research programs to hold the first AIA Collaborative Research Summit, bringing together practitioners, academics, AIA's Design and Health Research Consortium member schools, National Resilience Initiative members, Upjohn and Latrobe recipient research teams, AIA Knowledge Committee research leaders, and other AEC industry partners. The culmination of that work was the identification of research questions, which were expanded upon by discussions at the AIA Knowledge Leadership Assembly, which convenes the leaders of AIA's Knowledge Communities. These provide the basis of the sample research questions integrated throughout this Agenda.

AIA acknowledges the past and present contributions of dozens of architects and staff that led to this Architectural Research Agenda. We believe in the power of design and believe that investment in research will demonstrate the impact of that power and the import of the architect.

References

Publications/papers:

- 1986: Architectural Research Priorities

- 2004: Research: Challenges, Direction & Opportunity

- 2015: Architectural Research Roadmap

- 2017: Board Knowledge Committee Statement on Research

- 2018: The Bell Propelled: A Progress Report on the Sustainability Leadership Opportunity Scan

Events/groups:

- Research Summits: 2008, 2011, 2012, 2015, 2017

- 2018 Collaborative Research Summit

- Design and Health Research Consortium

- National Resilience Initiative

- Knowledge Communities

- Strategic Council study groups: Research (2016), Forecasting Knowledge (2018)

- Intersections Symposium: 2015, 2016, 2017, 2018, 2019

AIA Committees/member groups:

- Board Knowledge Committee (BoKnoCo)

- Government Advocacy Committee (GAC)

- Sustainability Leaders Group (SLG)

Program partners:

- ACSA: Association of Collegiate Schools of Architecture (acsa-arch.org)

- NIBS: National Institute of Building Sciences (nibs.org)

Endnotes

1 US Department of Commerce, put-in-place construction spending

2 US Environmental Protection Agency. Klepeis, Neil E. and others, "The National Human Activity Pattern Survey: A Resource for Assessing Exposure to Environmental Pollutants," Lawrence Berkeley National Laboratories, 2001

3 NSF Survey of Federal Funds for R&D; NSF Business Research and Development and Innovation Survey

4 US Center for Medicare & Medicaid Services, US Department of Health & Human Services

5 NSF Survey of Federal Funds for R&D; NSF Business Research and Development and Innovation Survey

6 Research topics and questions drawn from various sources, most notably from the 2018 AIA Collaborative Research Summit, which drew together over 90 architectural practitioners and academics, industry partners, and other academic disciplines. The Summit included a working session that identified key research questions, which were organized and presented within this Research Agenda. In 2017, the AIA Research Summit participants led by members of the AIA Board Knowledge Committee identified disruptive innovation areas, which are also covered within this research agenda. Additionally, research agendas and questions were also pulled from several AIA Knowledge Communities, including but not limited to the Academy of Architecture for Health (AAH), Academy of Architecture for Justice (AAJ), Committee on Architecture for Education (CAE), Committee on the Environment (COTE), and Technology in Practice (TAP).

7 The key topic and outcome of the 2012 AIA Research Summit was

around definitions of research. For more information, email AIA at research@aia.org.

8 www.informedesign.org

9 Frumkin, H. "Urban sprawl and public health," Public Health Rep. 2002; 117: 201–217

10 US Environmental Protection Agency, "Sources of Greeenhouse Gas Emissions in 2016," <https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions>

11 US Department of Energy, Energy Information Administration, Annual Energy Outlook 2015

12 US Department of Energy, Energy Information Administration, 2012 Commercial Buildings Energy Consumption Survey (CBECS): Energy Usage Summary, Table 5 (March 2016)

13 US Energy Information Administration, Residential Energy Consumption Survey (RECS) 2009

14 US Department of Energy, Energy Information Administration, 2012 CBECS (March 2016)

15 US Government Accountability Office, Highlights of GAO-14-430, report to Congress, 2014, <https://www.gao.gov/assets/670/663344.pdf>

16 In June 2016, McKinsey & Company, a consultancy, identified 5D BIM technology as one of five big ideas poised to disrupt construction. It defined 5D BIM as "a five-dimensional representation of the physical and functional characteristics of any project. It considers a project's cost and schedule in addition to the standard spatial design parameters in 3-D."

["Imagining construction's digital future," McKinsey & Company]

17 The World Bank Data, World Urbanization Prospects: 2018 Revision
<https://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS>

18 AIA Resolution 18-5, "Blueprint for Better Communities:
Implementation of the New Urban Agenda in the Architectural
Profession" (2018)

19 2017 AIA Disaster Assistance Handbook <https://www.aia.org/
resources/71636-disaster-assistance-handbook>

20 https://climate.nasa.gov/scientific-consensus/

21 https://dod.defense.gov/News/Article/Article/612710/

22 https://news.gallup.com/poll/190010/concern-global-warming-
eight-year-high.aspx

23 S&P Global

24 Research literacy refers to building the capacity to understand and
conduct research.

25 "The Boyer Report" is the common name for the study: Building
Community: A New Future for Education and Practice, published in 1996
and so named for its co-author Ernest L. Boyer. It was commissioned
as an independent study by AIA and its collateral organizations: The
American Institute of Architecture Students (AIAS), the National Council
of Architectural Registration Boards (NCARB), the National Architectural
Accrediting Board (NAAB), and the Association of Collegiate Schools of
Architecture (ACSA).