### TABLE OF CONTENTS

01  ABOUT CANNON DESIGN  
  • Healthcare Practice

02  HEALTHCARE RESEARCH  
  • Overview  
  • Perspectives and Approaches  
  • Selected Research Projects  
  • Recent Presentations and Articles

03  LEADERSHIP  
  • Deborah Sheehan, ACHE, EDAC, LEED  
  • Manuel Hernandez, MD, MBA, FACEP  
  • Jocelyn Stroupe, IIDA, AAHID, EDAC  
  • Peter M. Hourihan, LEED AP  
  • Zhe Wang, PhD, RA, LEED AP, EDAC

▲ Advocate Lutheran General Hospital Patient Care Tower and Advocate Lutheran General Children’s Hospital, Patient Care Tower front and back covers, University Hospitals, Seidman Cancer Center
WE ARE CANNONDESIGNERS – A HIGHLY INTEGRATED TEAM FOCUSED ON UNDERSTANDING AND ADVANCING SOLUTIONS TO THE GREATEST CHALLENGES FACED BY OUR CLIENTS AND SOCIETY.

THE DELIVERY OF HEALTHCARE IS ONE OF THOSE CHALLENGES.
01 ABOUT CANNON DESIGN
Cannon Design is an international architecture, engineering and interior design firm recognized for design excellence and technological innovation. Founded more than 60 years ago, Cannon Design has a staff of more than 1,000 dedicated people, operating 15 offices throughout North America and Asia.

Long recognized as one of the top ten architecture / engineering firms in the U.S., Cannon Design has planned, programmed and designed over one billion square feet of healthcare facilities in twelve countries around the world. However, we are far more than a healthcare design firm. Because we understand that facility, care delivery and operations are inextricably linked, we have evolved into a full-service healthcare consultancy that assists our clients with a complete continuum of issues.

Building upon our commitment to improve the performance of facilities and to create a positive experience for patients, families and caregivers, we look to forge long-lived collaborations with our clients.
CANNON DESIGN HEALTHCARE

performance focus
Our facility solutions focus on performance outcomes. From capital resource allocation, space management, operations, maintenance, technology, sustainability, staffing and throughput, we look at how your facilities can perform to their highest potential to help you meet your strategic, financial, operational and clinical goals.

thought leadership
Cannon Design is a member of many forward-thinking organizations including the Healthcare Advisory Board and Center for Health Design. As one of only a few architectural firms that are members of the Healthcare Advisory Board, Cannon Design understands healthcare business objectives and how technology will impact the future delivery of care.

clinical emphasis
We possess in-house clinical expertise with registered nurses and hospital administrators on staff. This allows us to challenge our clients to pursue progressive care models and measure the outcomes to demonstrate the achievement of efficient delivery processes and user-centered design.

in-house programming and planning
Our multi-disciplinary team focuses on all levels of healthcare planning, including campus master planning, detailed pre-design functional/operational programming, departmental volume workload analysis, bed capacity analysis and various research activities. As one of the five original Center for Health Design EDAC Champion Firms, we have demonstrated a clear understanding of the components of the evidence-based design process and base our design decisions on available, credible evidence.

healthcare interior designers
Our interiors studio, dedicated exclusively to designing healthcare environments, understands the complexities of healthcare spaces. We appreciate that it is necessary for products and designs to perform efficiently, adhere to regulatory guidelines and provide long-term value. Evidence-based research has demonstrated that positive healthcare spaces can influence patient outcomes, reduce medication usage and influence consumer preference. Calming, daylight-filled spaces with positive distractions improve the experience for both patients and staff.

client service
We achieve the best solutions by effectively engaging all stakeholders - administration, medical staff, facilities teams and clinical caregivers - throughout the process. This approach, combined with process leadership, enables us to assist our clients in improving operations, outcomes, and cost effectiveness through high-quality, well coordinated planning and design.
02 HEALTHCARE RESEARCH
While innovation will always be an intrinsic part of design, we find that the discipline necessary for commissioned work typically does not support the full depth of exploration and experimentation required to expand the traditional boundaries of the design process. For that reason, we self-fund a robust and multi-dimensional research program that reflects our firm-wide emphasis on not only research but also on turning that research into reality.

Our healthcare research platform aims to compel the development and application of new knowledge and creative invention in our work. This process will provide increasing distinction and competitive differentiation for our client partners and our firm. We view our design research as both the foundation and the fuel of our Ideas Based Practice culture.

Mindful that research must be applied in order to make a difference, Cannon Design’s healthcare design and planning teams infuse research into all aspects and phases of work, from programming and master planning through post-occupancy evaluation. We do this to provide the team and client partners with credible information - evidence - to shape strategic, operational, and facility decisions.

Cannon Design’s healthcare leaders translate our research to inform best practices globally. Our team has presented on healthcare operations and design topics to organizations such as Joint Commission International, World Health Congress, Sg2, Healthcare Design, American Society of Healthcare Engineers, Environmental Design Research Association (EDRA), American College of Emergency Physicians and The Strategic Research Institute. We have published in journals and magazines including Health Facilities Management, Healthcare Design, World Health Design, Medical Construction & Design, Oncology Issues, Laboratory Design, Emergency Department Leadership and Management, Sg2 EDGE Publication.

Our participation in advancing the health industry dialogue with leaders throughout the world directly informs our work and stimulates our research with continual best practice benchmark analysis.
perspectives and approaches
Cannon Design takes a multi-layered approach to healthcare research, drawing on the expertise not only of architects, engineers and planners but also of healthcare administrators, clinical operations specialists including MDs and RNs, public health professionals, statisticians, and librarians. Each of these team members contributes his or her own knowledge, skills, abilities and perspectives to the development, collection and application of research. We have developed a number of divisions and working groups that contribute to the richness of our research platform and project innovation.

Research Core Team
Cannon Design’s research core team, trained in both qualitative and quantitative research methods, works with our project teams to define research hypotheses and develop appropriate and rigorous tests. This group’s responsibilities include supporting global healthcare practice research activities, building the secondary research data and knowledge base, developing research education/training programs, translating research into design practice applications, and publishing and presenting the firm’s research findings.

Confluence by Cannon Design emerges from the idea that the services we provide to clients need to be integrated—embracing “ideas” rather than the conventional thinking of what a design firm has traditionally encompassed.

Through Confluence by Cannon Design, we advocate for a new manner of working that integrates healthcare professionals and design professionals to examine how transforming healthcare delivery can alter and be impacted by changes in the physical environment of healthcare facilities. Our team of clinical, operational, financial, Lean/Process design and simulation modeling experts utilize some of the most inventive approaches available. In place of a model that allows data without context to drive critical decisions, is a process rooted in an understanding of where you are and where you want to be. From here, solutions are tested against the backdrop of the mission, vision and principles that speak to the core of who your organization is and will be in the future.

Knowledge Management
The Knowledge Management team works within the Healthcare practice to assure the latest, most relevant research and information is available to support Cannon Design’s consulting and design activities. The team supports Cannon Design’s secondary research initiatives by performing literature reviews, managing subscriptions, and strategizing how to effectively disseminate this information both internally and externally. In addition, the team administers the firm’s internal communication platform to optimize sharing of knowledge and expertise across the company.

Lean Thinking & Process Design:
Over the past several years, Cannon Design has focused on developing a solid base of knowledge in process design, specifically Lean, approaches. Team members have received training in Lean and Virginia Mason Production System. Our commitment to research and innovation extends to the work we do with our clients everyday. We utilize a variety of tools and methodologies to explore and optimize the processes that make up daily care delivery. Our team of trained experts utilizes Lean tools to engage providers in collaborative value stream mapping exercises that highlight inefficiencies and challenge the staff to brainstorm innovative ways to address the current state.
CANNON DESIGN HAS NURTURED A CULTURE WHERE IMAGINATION, INVENTION AND CREATIVE TALENT FLOURISH.

OUR CONTINUED SUCCESS RELIES ON MORE THAN JUST WHAT WE HAVE DONE BEFORE; IT RELIES ON WHAT WE DO NEXT.
Primary and Secondary Research

Development and documentation of new knowledge through proven qualitative and quantitative methods

Cancer Infusion Design Research

Between 1999 and 2010, Cannon Design studied the design of the infusion bays in which patients receive chemotherapy. We interviewed patients at six cancer centers in a phase one pilot study and distributed survey questionnaires at three cancer centers in phase two. More than 400 cancer patients and families were engaged in the study.

Pre-design research revealed that the most prominent needs of infusion patients can be classified into three categories: 1) choice and control; 2) privacy and social support; and 3) positive distractions.

Cannon Design then worked with focus groups of patients and family members during the design phase of new projects to develop specific design strategies to address these needs and improve patient satisfaction. We followed up with post occupancy evaluations comprising patient/family surveys and on-site observations at three completed projects to determine the designs’ efficacy in addressing patient needs.

Our research results were not only widely published but were Highly Commended by the International Academy for Design & Health.

Post-Occupancy Study

BJC Healthcare Institute of Health at Washington University School of Medicine

In early 2010, we initiated a before-after study of the new BJC Institute of Health research building to evaluate the improved work efficiency and quality of work environment. The study tested the hypothesis that the implementation of selected design features improve research collaboration and productivity as well as work space comfort, health and satisfaction. Research methods included two survey questionnaires, interviews and focus groups, historical and future data on research publications and evaluation of physical space.

We found that principal investigators mentored more people, planned and submitted more manuscripts and had more accepted manuscripts after moving into the new building. These increases, however, were not observed among more junior researchers; more study will be needed to determine the reasons for the discrepancy.

Perhaps one of the most interesting findings is that researchers reported that more collaborative discussions were held in non-traditional spaces and meeting areas such as break rooms and even open staircases with step-aside areas than in more formal and traditional work spaces.

Occupants of all levels reported significantly higher energy levels and greater satisfaction in the new building. Findings related this increased energy to five specific design strategies: ample daylight, use of stairs, convenient lab support shared with other groups, window views, and interesting things to see in corridors.
Medical Distribution and Nursing Efficiency

In 2008, in partnership with Northwest Community Hospital we developed a study of how changes in medication administration affect the efficiency of nursing staff. The study focused on the travel paths, or number of “runs”, by nurses during standard medication administration on an inpatient unit. The findings resulted in changes to the bed floors’ physical plans. A post-occupancy survey was conducted in late 2010 to determine the facility’s performance.

Post-Occupancy Study - Third Patient Circulation Corridor

In 2010, we initiated a before-after investigation to compare the patient care and operational efficiency of a new third corridor adult cardiac ICU unit with the prior ICU patient unit. The mixed research methods include staff environmental perception survey questionnaire, analysis of nursing and support staff operational data, acoustic measurement, observation, and physical measurement. Acoustical measures of noise within the new ICU and a control environment of the previous unit were collected during four workdays, along with on-site observations of corridor traffic.

Rethinking Daylight in Patient Rooms

A design-phase study was undertaken in 2009 with South Shore Hospital to assess the impact of daylight, view, energy use, and glare avoidance in the design of a vertical bed floor expansion. Data were collected through both physical measurement and survey questionnaires.
Specific design investigations related to both the processes and the products of our work

**Future Proofing: Universal Grid Theory**

For the past eight years we have hypothesized, designed, and built healthcare facilities utilizing a universal grid planning module under the premise that these buildings would be more transformable, flexible, and adaptable to unknown future conditions. The use of the universal grid planning module has shown positive results in design and delivery speed as well as "future-proofing."

Cannon Design’s proprietary Universal Grid concept is a key element in providing the flexibility that will make the building work through unforeseeable technical, procedural and service line changes in the decades ahead.

The Universal Grid consists of the optimum set of vertical and horizontal dimensions for a building’s structural bay. From this fundamental building block - vetted for engineering soundness and construction efficiency - prototype health science facilities accommodate a wide range of potential uses, including multi-acuity inpatient nursing care, ambulatory care, offices, surgery, and interventional radiology as well as clinical research and even wet-bench research.

**Prototyping for the World**

Cannon Design worked with the International Organization for Migration and USAID to design a scalable prototype for freestanding hospitals to be built in rural Afghanistan and other developing nations. The prototype, which is designed to operate on a fully self-contained site in response to the absence or unreliability of utility service infrastructure, proposes a permanent, site-specific building that encourages the participation and investment of local residents. It does not import Western solutions, but instead uses universal techniques to adapt to the cultural and medical needs of the visitors.

The prototype’s 15-meter-wide universal module provides flexibility for a range of uses, allows the building be scaled easily from 20 to 150 beds, and can be built with any material that is common to its locale. The modules can provide all the basic services needed for community health and education, including an emergency department, radiology, surgery, obstetrics, lab, pharmacy, physical therapy, outpatient services, an education center and support services, with enough space to house a few key specialties. For instance, in Afghanistan, the need for training midwives and female caregivers is essential to reducing infant mortality rates. Orthopedic services are also in high demand due to landmine injuries. Depending on care model, service line, staff level and cultural preference, the units can be managed in many configurations without renovation.

*Cannon design provided A/E services for this 100-bed hospital in rural Afghanistan based on our prototype concept.*
Simulation Modeling

Making an operational decision that could cost millions without all the information is like betting your organization’s future at the roulette wheel. Arming yourself with the right information turns decision making from a gamble to a sound business decision.

Computer-based simulation modeling is a forward-thinking approach to test and prioritize potential processes, workforce and technology innovations. Using advanced simulation software and our proprietary operational optimization methodologies, Confluence by Cannon Design works with clients to model future innovations with the goal of understanding the impact before costly time and resources are dedicated. We utilize the data and outcomes to inform future designs.

Product Development

Sustainable Technologies: eVap Product Series

The eVap product series (patent pending) utilizes the existing building’s chilled water or process water system to reject the heat from the laboratory experiments through a highly efficient magnetic bearing pump and stainless steel metal plate and frame heat exchanger. Developed by the Cannon Design Products Group, the eVaps are currently in use at research lab facilities as prominent as Oak Ridge National Laboratory and Cal Tech, and it has won awards from ASHRAE and Green Dot.
What is (Discrete Event) Simulation Modeling?

A simulation model is a custom-designed, data-driven model of a specific system comprising system processes with assumed data to approximate real situations.
healthcare research steering committee
We are committed to advancement of research in the healthcare environment and pursue this research through full-time dedicated principal-level research leadership, multiple PhD research architects, in-house clinical resource teams, and Lean workflow specialists. Our healthcare planning leaders are experts in applying research, publishing, speaking, and presenting nationally in client and peer settings. Our research efforts are led by our Research Steering Committee.

Our internal knowledge-building and sharing is also supported by the Healthcare Practice Fellowship Professional Development Program and The Cannon Design Academy, an educational program for all Cannon Design employees.

Deborah Sheehan, ACHE, EDAC, LEED AP
Principal / Healthcare Practice Research Director

Deb Sheehan is responsible for the design and construction of more than $1 billion in healthcare projects, ranging from replacement hospitals for USAID to community hospital expansions. Her groundbreaking work in the development of a prototype for community healthcare in developing nations has generated interest around the world. She will present it at the 8th World Congress on Design and Health, to be held in Kuala Lumpur, Malaysia this summer. Honored for her evidence-based design approach to planning in competitions sponsored by Modern Healthcare and the American Institute of Architects, Sheehan has been invited to speak at numerous industry forums, including ACHE, the American Society of Healthcare Engineering, and the Strategic Research Institute. Sheehan is past recipient of Building Design + Construction’s 40 Under 40 Award, and her work has been featured in Modern Healthcare, The Wall Street Journal, and Healthcare Design.

Manuel Hernandez, MD, MBA, FACEP
Principal / Clinical Advisory Service Director

Dr. Manuel Hernandez is the Principal who leads Confluence by Cannon Design, the firm’s Healthcare Performance Initiative. He is a dynamic physician executive with 20+ years of healthcare experience. Focusing his talents on visioning future clinical delivery models, innovation in healthcare and the intersection of clinical operations and facility design, Dr. Hernandez is an accomplished consultant, public speaker and professional facilitator. He has assisted over 100 health care organizations to achieve optimal outcomes in clinical strategy, operations and facility design.
Jocelyn Stroupe, IIDA, AAHD, EDAC
Principal / EDAC Director

Jocelyn Stroupe, Cannon Design’s EDAC Director, has more than 25 years of experience uniting the disciplines of planning, programming, branding, and facility management with cohesive, comforting interior design. Jocelyn is president of the American Academy of Healthcare Interior Designers and the Pebble Partner leader for the Froedtert & The Medical College of Wisconsin Clinical Cancer Center, in Milwaukee. Stroupe is a frequent speaker for Healthcare Design and the Center for Health Design. Her projects have been recognized by the American Institute of Architects, Modern Healthcare, and Contract.

Peter M. Hourihan, LEED AP
Principal / Research Director

With a career-long passion for learning and teaching and broad experience as a practitioner in all dimensions of architecture and engineering, Mr. Hourihan deeply understands the vital connection between research and design practice. Mr. Hourihan coordinates the firm’s leveraging of research and invention in healthcare, higher education, and sustainable design projects. He organizes primary and secondary research, prototyping and invention, and futures platforms, developing and promoting new ideas within the firm to increase the impact of research firmwide and deliver transformative projects to clients.

Zhe Wang, PhD, RA, LEED AP, EDAC
Senior Researcher

Zhe Wang is a Senior Researcher and Architect at Cannon Design. Supported by her nine years of experience in design practice in the US, Singapore and China, Dr. Wang’s research focuses on evidence-based design for health. She recently won the International Academy Awards in Research Project and has published a number of first-author and single-author papers in peer-reviewed journals and publications for World Health Design and the AIA; presented findings at the international Environmental Design Research Association conferences, national AIA conferences, Healthcare Design conferences, Gerontological Society of America and Active Living Research conferences; and has received awards and grants from the AIA, Nurture by Steelcase and TX Architectural Foundation.
Kaleida Health, Clinical and Medical Research Building: Gates Vascular Institute (GVI) and UB Clinical Translational Research Center/Incubator (CTRC)

University of Kansas Hospital, Physicians Medical Office Building