PERKINS+WILL

Research Journal

2014 / VOL 06.02

www.perkinswill.com

Editors: **Ajla Aksamija, Ph.D., LEED AP BD+C, CDT** and **Kalpana Kuttaiah, Associate AIA, LEED AP BD+C**

Journal Design & Layout: **Kalpana Kuttaiah, Associate AIA, LEED AP BD+C**

Acknowledgements: *We would like to extend* ***our APPRECIATION*** *to everyone who contributed to the research work and articles published within this journal.*

We would like to extend our ***VERY SPECIAL THANKS*** *to:*
Thomas Brown, Tim Pettigrew and Emily Gartland.

Perkins+Will is an interdisciplinary design practice offering services in the areas of Architecture, Interior Design, Branded Environments, Planning + Strategies and Urban Design.

PERKINS+WILL

Research Journal

2014 / VOL 06.02

TABLE OF CONTENTS

JOURNAL OVERVIEW

The Perkins+Will Research Journal documents research relating to the architectural and design practice. Architectural design requires immense amounts of information for inspiration, creation and construction of buildings. Considerations for sustainability, innovation and high-performance designs lead the way of our practice where research is an integral part of the process. The themes included in this journal illustrate types of projects and inquiries undertaken at Perkins+Will and capture research questions, methodologies and results of these inquiries.

The Perkins+Will Research Journal is a peer-reviewed research journal dedicated to documenting and presenting practice-related research associated with buildings and their environments. Original research articles, case studies and guidelines have been incorporated into this publication. The unique aspect of this journal is that it conveys practice-oriented research aimed at supporting our teams.

This is the twelfth issue of the Perkins+Will Research Journal. We welcome contributions for future issues.

RESEARCH AT PERKINS+WILL

Research is systematic investigation into existing knowledge in order to discover or revise facts or add to knowledge about a certain topic. In architectural design, we take an existing condition and improve upon it with our design solutions. During the design process we constantly gather and evaluate information from different sources and apply it to solve our design problems, thus creating new information and knowledge.

An important part of the research process is documentation and communication. We are sharing combined efforts and findings of Perkins+Will researchers and project teams within this journal.

Perkins+Will engages in the following areas of research:

- Market-sector related research
- Sustainable design
- Strategies for operational efficiency
- Advanced building technology and performance
- Design process benchmarking
- Carbon and energy analysis
- Organizational behavior

EDITORIAL

This issue of the Perkins+Will Research Journal includes five articles that focus on different research topics, such as using wood for tall buildings, the impact of lean principles on construction, sound masking in office environments, the design of therapeutic gardens for children with autism spectrum disorders, and the design of health districts.

“Lessons From Tall Wood Buildings: What We Learned from Ten International Examples” discusses a qualitative study that focused on the use of wood structural systems for tall buildings. The study used a survey to collect information about recently constructed tall wood buildings, and this article reviews the findings of the survey. The results indicate that one of the driving factors for using wood as a structural system is the potential for wood to reduce the carbon emissions impact from buildings (embodied and operational). The results also emphasize that the motivation and rationale for considering wood in tall building construction is often reinforced by supportive policy context.

“Impact of Lean Principles on Timely Project Completion” focuses on the impacts of lean strategies on timely completion of construction projects. The study used a survey to compare projects that applied lean principles versus non-lean projects. Results indicate that the application of lean principles assisted contractors to complete projects ahead of schedule, or helped them to adjust schedule to finish on time when delays were encountered.

“Sound Masking Systems and Their Effectiveness: Does Sound Masking Really Work?” reviews results of an experimental study that was conducted to understand the effects of sound masking systems on acoustic qualities of open office spaces. The findings of the study indicate that speech recognition is consistently lowered in open office spaces that have an active sound masking system, providing an elevated level of speech privacy.

“Analysis of Therapeutic Gardens for Children with Autism Spectrum Disorders” discusses how outdoor design elements and landscape design can benefit children with ASD. The study used a literature review and review of established design criteria, observation and analysis of built projects to evaluate design criteria, and an application of design guidelines to a specific project. The results of the study included a refined set of design guidelines.

“A Vision and Planning Framework for Health Districts of the Future” proposes a new planning framework for health districts, which are aimed to improve population health outcomes and to inspire healthy behaviors. The framework consist of four parts including population health, place, partnerships and performance.

Ajla Aksamija, PhD, LEED AP BD+C, CDT
Kalpana Kuttaiah, Associate AIA, LEED AP BD+C

01.
LESSONS FROM TALL WOOD BUILDINGS:
What We Learned from Ten International Examples

Rebecca Holt, M. Urb, LEED AP BD+C, ND, *rebecca.holt@perkinswill.com*
Kathy Wardle, M.E.S, LEED AP BD+C, *kathy.wardle@perkinswill.com*

ABSTRACT
The growing pressure to reduce the carbon footprint of buildings requires designers to balance functionality and cost objectives with environmental impact. With a significantly lower carbon footprint than concrete or steel structures and many other environmental and human health benefits, wood has reemerged as a desirable and viable structural material for taller buildings.

Forestry Innovation Investment and the Binational Softwood Lumber Council commissioned Perkins+Will to undertake an international survey of ten, completed tall wood projects. The goal was to compile experiences from project stakeholders who have designed and built successful tall wood buildings. The survey methodology included a short online questionnaire and individual in-person or telephone interviews. More than 50 individuals participated in the survey and site visits were conducted for nine of the ten project sites during the month of November 2013.

The work aims to learn from individual experiences, solutions and challenges, but also from aggregated information, trends and common lessons. The intent of this article is to distill the research into a concise summary that presents the market context and rationale for using wood in tall building applications, share the most important lessons learned from project stakeholders, and summarize the key design and construction solutions.

KEYWORDS: sustainable design, mass timber, low-carbon material, energy efficiency, quality of space, human health and well-being

1.0 INTRODUCTION

A tree is produced by energy from the sun, it provides valuable functions within ecosystems, it produces oxygen and sequesters carbon during its lifetime and it can be harvested for a durable, beautiful construction material, through responsible forest management. As such, wood offers a compelling opportunity to reduce the environmental impact of materials that are non-renewable, and require more intensive use of resources to extract, manufacture and install. While wood used as structure in taller buildings is not a new concept, century-old examples exist in North America[i], we have largely abandoned wood as a solution for tall structures since the early 20th century in favour of concrete and steel. The negative environmental and social impacts of natural resource extraction and processing of intensive, non-renewable materials present a significant challenge to professionals engaged in sustainable design. The relatively recent advent of engineered, mass timber products now affords the opportunity to consider timber for taller structures significantly lowering the carbon footprint of the built environment, and offering many other environmental and human health benefits.

[i] The Butler Brothers Building, Minneapolis, Minnesota is a nine storey heavy timber building constructed in 1906. http://www.mnpreservation.org/successful-preservation-profiles/. In Vancouver, BC, the Leckie Building is a 7 storey building constructed in 1910, and The Landing is 9 storeys built in 1905. Both are heavy timber clad in brick. http://www.woodfirstbc.ca/sites/default/files/FPI%20study%20on%20Historical%20Tall%20Wood%20Buildings%20in%20Canada_First%20Edition.pdf.

In the context of this work, a tall wood building is defined as a structure consisting primarily of mass timber, with five or more storeys[ii]. An increasing number is emerging around the globe, and 14 completed projects demonstrate mass timber as a successful construction material and method for tall buildings. To advance tall wood building, learning from the experiences of these early adopters in the industry is essential for building capacity, credibility and market acceptance. In 2013, Forestry Innovation Investment (FII) and the Binational Softwood Lumber Council (BSLC) engaged Perkins+Will to conduct a Survey of International Tall Wood Buildings (the Survey), with the goal of collecting lessons and experiences from built projects. The complete publication that outlines the results is publicly available[1]. The aim is to share this information with potential North American project stakeholders to help simplify processes, increase comfort and potentially lower the risk of designing tall wood structures, ultimately broadening the uptake of wood systems used in tall construction. This article is intended to distill the research into a concise summary, highlighting relevant results for design practitioners.

1.1 Market Context

Light frame timber construction is ubiquitous in North American residential construction, a very common building material used in single family and multi-unit housing construction under five storeys and some low-rise commercial buildings. Most building codes prohibit timber construction exceeding five storeys due to fire risk, and the structural limitations of light timber elements. The recent development of what is referred to as heavy timber, mass timber or solid wood products, such as Laminated Veneer Lumber (LVL), Glulams and Cross Laminated Timber (CLT), opens the doors to new structural opportunities for wood. These products are engineered for strength and dimensional stability and are being applied as alternatives to concrete, masonry and steel in many building types including those exceeding five storeys.

Built examples of tall wood projects to date range widely, and only a few exist in North America[iii]. These limited examples have been realized largely through industry leadership, where designers, engineers and timber industry professionals have come together in various ways to put innovation to the test. This momentum has generated support from industry organizations[iv], and a number of important resources have recently been published that have become integral to the discourse on the opportunity to advance mass timber and tall wood projects. These include MGB/Michael Green's The Case for Tall Wood[v], FP Innovations CLT Handbook[vi], which is being used around the world, and SOM's Timber Tower Research Project[vii] proposing that towers at a height of 30 storeys are possible with a timber structure. FP Innovations has also published the Technical Guide for Design and Construction of Tall Wood Buildings in Canada-[viii], which presents the unique and technical issues that should be considered when designing and constructing a tall wood building.

While these resources are essential and are certainly advancing education and dialogue about tall wood, they speak to the technical application and theoretical possibilities of constructing tall buildings with mass timber. Missing from this literature is a way to communicate applied experience from completed work, to fill the space between the technical application and the finished product. With 14 completed tall wood buildings around the world, the survey attempts to fill this gap by gathering and aggregating lessons and insights, an exceptionally valuable part of building knowledge and capacity. While many case studies have been published about the projects included in the survey, no other document

[ii] Typically, mass timber buildings are not recognized explicitly by most local building codes, and light frame wood construction is limited to between 4 and 6 storeys depending on the jurisdiction.
[iii] There are three completed examples of tall wood construction in North America including: Fondaction, in Quebec City, http://www.woodworks.org/wp-content/uploads/CS-Fondaction.pdf, the UBC Earth Sciences Building in Vancouver, http://www.cwc.ca/documents/case_studies/Four%20demonstration%20Case%20Study_May_30.pdf and the Wood Innovation Design Centre in Prince George, BC http://mg-architecture.ca/portfolio/widc/.
[iv] Binational Softwood Lumber Council http://www.softwoodlumber.org/, Canadian and American Wood Council http://awc.org/ and http://cwc.ca/, Softwood Lumber Board http://www.softwoodlumberboard.org/, Forestry Innovation Investment http://www.bcfii.ca/, FP Innovations https://fpinnovations.ca/Pages/home.aspx and Wood Works! http://www.woodworks.org/.
[v] The case for tall wood http://wecbc.smallboxcms.com/database/rte/files/Tall%20Wood.pdf.
[vi] FP Innovations CLT Handbook https://fpinnovations.ca/Pages/CltForm.aspx#.UVTCGRm1VVA.
[vii] SOM Timber Tower Research Project http://www.som.com/ideas/research/timber_tower_research_project.
[viii] FP Innovations Technical Guide for the Design and Construction of Tall Wood Buildings in Canada https://fpinnovations.ca/ResearchProgram/advanced-building-systems/Pages/promo-tall-wood-buildings.aspx#.VDM_j_ldWBY.

or project has cross referenced experiences, solutions and challenges to identify trends and common lessons, making this work significant for all jurisdictions around the world.

1.2 Scope and Methodology

The survey was focused on gathering qualitative information from four specific stakeholder groups: owner/developers, design teams, construction teams and authorities having jurisdiction. The emphasis was on discovering the drivers or rationale for pursuing a structural wood solution, lessons about design processes, construction process, approvals, and unique aspects associated with delivering a tall wood project. In addition, it addressed project insurance, financing and building performance.

The data collection was broken down by stakeholder group in order to gather lessons specific to each, thereby addressing the ultimate goal of reducing risk and increasing comfort among key players. Six to eight stakeholders per project were identified that could potentially contribute to the survey, representing one to two people per stakeholder group. Some individuals were able to represent more than one stakeholder group and some projects included several individuals within one group.
The survey methodology was designed to capture a range of information across stakeholder groups, limit redundancies for participants and ensure that not only project specific information was gathered, but that results could be effectively aggregated to identify trends. The approach was a mix of methods that could take best advantage of a short timeline including an online questionnaire followed by in-person or telephone interviews. First, a long list of built projects and associated contacts was created and a formal letter of invitation to participate in the survey was sent by email. Stakeholders who agreed to participate were asked to complete a short, online questionnaire to establish the basis for a more detailed one hour in-person or telephone interview with two researchers. Subject matter and questions posed in the online questionnaires and interviews were based on known knowledge gaps and perceived challenges and risks of constructing tall wood buildings in the North American market place. Stakeholders from 13 built projects were invited to join the survey, with the goal of including ten. At least one stakeholder from all 13 agreed to participate.

Site visits were conducted for nine of the ten projects (researchers did not visit Forté in Melbourne, Australia), and in-person interviews were arranged with the majority of project participants. Where stakeholders were unavailable or not within the practical limits of the travel itinerary, researchers conducted interviews by phone. In addition to the project site visits, researchers also visited timber fabricators and fabrication plants, interviewed building owners and developers, architects, structural engineers, construction managers, timber erectors and authorities having jurisdiction. All interviews were conducted by at least two researchers and audio recordings were made to ensure the quality of participant responses. Site visits were conducted during the month of November 2013.

Upon completion of the data collection, the results were analyzed to determine which of the 13 participant projects included the most robust results. The ten participant projects were chosen based on a variety of criteria including building typology, timber structure type, date of completion, willingness and availability of the stakeholders to participate and the extent of information already published. The projects included in the survey are listed in Table 1 below and images follow in Figure 1.

Table 1: Survey of international tall wood buildings - participant projects.

Project Name	Location	Building Type	Storeys	Wood Construction Type	Completion Date
E3	Berlin, Germany	Commercial/ Residential	7	Post and Beam	2008
Limnologen	Växjö, Sweden	Residential	8	Panelized	2009
Bridport House	London, England	Residential	8	Panelized	2010
3XGRÜN	Berlin, Germany	Residential	5	Combination Panels/ Post and Beam	2011
Holz8 (H8)	Bad Aibling, Germany	Commercial/ Residential	8	Panelized	2011
Forté	Melbourne, Australia	Residential	10	Panelized	2012
University of British Columbia Earth Sciences Building (ESB)	Vancouver, Canada	Institutional	5	Combination Panels/ Post and Beam	2012
Life Cycle Tower One (LCT ONE)	Dornbirn, Austria	Commercial	8	Combination Panels/ Post and Beam	2012
Tamedia	Zurich, Switzerland	Commercial	6	Post and Beam	2013
Cenni di Cambiamento	Milan, Italy	Residential	9	Panelized	2013

Figure 1: Survey of International Tall Wood Buildings - participant projects
From top, left to right: UBC Earth Sciences Building; 3XGRÜN; Bridport House; Cenni di Cambiamento, LCT ONE; Forté; E3; Holz8; Tamedia; Limnologen.

UBC Earth Sciences Building / Architecture by Perkins+Will (Photo credit: Martin Tessler)
3XGRÜN / Architecture by Atelier PK, Roedig Schop Architekten and Rozynski Sturm (Photo credit: Stefan Mueller)
Bridport House / Architecture by Karakusevic Carson Architects (Photo credit: Wilmott Dixon Group)
Cenni di Cambiamento / Architecture by ROSSIPRODI ASSOCIATI srl. (Photo credit: Riccardo Ronchi)
LifeCycle Tower ONE (LCT ONE) / Architecture by Hermann Kaufmann ZT GmbH (Photo credit: www.creebuildings.com)
Forté / Architecture by Lend Lease (Photo credit: Lend Lease)
E3 / Architecture by Kaden Klingbeil (Photo credit: Bernd Borachrt)
Holz8 (H8) / Architecture by SHANKULA Architekten (Photo credit: Huber&Sohn)
Tamedia / Architecture by Shigeru Ban Architects (Photo credit: Didier Boy de la Tour)
Limnologen / Architecture by Arkitektbolaget Kronoberg (Photo credit: Midroc Property Development)

2.0 LESSONS LEARNED

This section presents the highlights of the lessons learned and strongest trends conveyed by the survey participants relevant to development, design, construction and performance of tall wood buildings.

2.1 Rationale and Motivation

In an attempt to discover the major industry drivers to pursue wood solutions for tall buildings, the survey included a question set for each stakeholder group focused on motivations. The following sections describe the strongest motivators for pursuing a tall wood project emphasized by all stakeholder groups.

Market Leadership and Innovation

The opportunity to lead the market and innovate with techniques, products and ideas was identified as a strong driver for pursuing a tall wood project by all participants. Developers, designers and fabricators recognize the potential of wood to contribute to many goals the industry is trying to address in the built environment, and they have invested their expertise and capital to demonstrate that potential – they are dedicated to leading the market and they see developing expertise in mass timber as an investment in business and innovation for the future.

Environmental Benefit of Wood

All stakeholders identified and emphasized that using wood complements multiple goals as part of the industry's efforts to reduce the impact of carbon emissions from the built environment – both in embodied energy and as a material to support a high performing envelope.

Construction Schedule Savings

Every participant and stakeholder group identified that they were motivated by the potential of construction schedule savings afforded by the opportunity for extensive prefabrication of wood elements.

Cost

Cost was identified as a strong motivator in the sense that owners and developers perceived wood as a cost competitive option to alternatives. It was clear that participants applied a holistic, lifecycle approach to this evaluation accounting for quality, longevity and durability of the building systems over the life of the structure.

Figure 2 presents the online questionnaire results from the owner/developer participants indicating market leadership and carbon footprint as the strongest rationale for pursuing tall wood projects.

In addition to the results below, while not explicit within the questionnaire or interview question sets, the majority of participants emphasized that the motivation and rationale for considering wood in tall building construction was reinforced in almost all cases by a very supportive policy context. This is one of the most important outcomes of the study. It appears that in jurisdictions where governing policies exist in support of low carbon construction, energy efficiency or renewable resources, the market for mass timber construction is developing more rapidly. In such cases the governing framework was key to motivating all stakeholders to innovate with wood solutions, and teams in some cases were able to access incentive funding. A good example is the Limnologen project in Växjö, Sweden (Figure 3). It is sup-

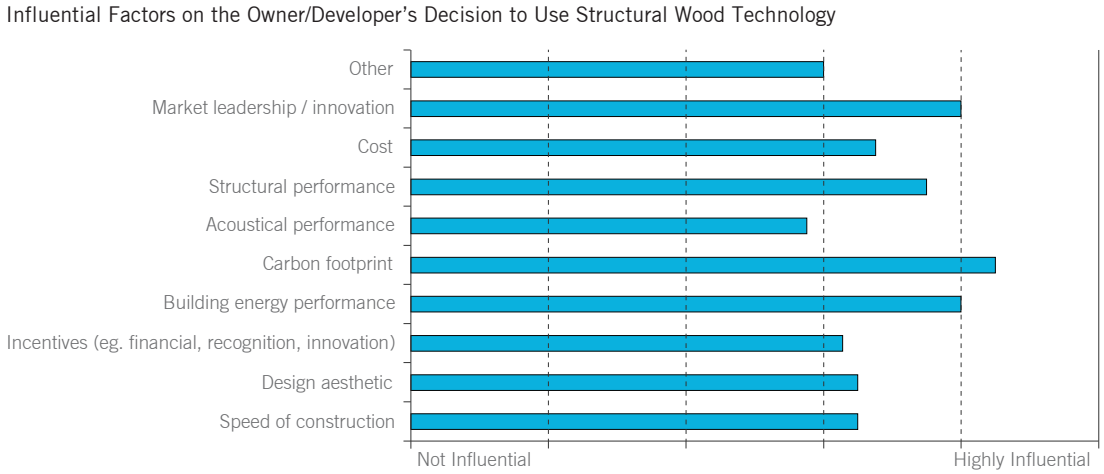

Figure 2: Online questionnaire results for owner/developer participant stakeholders indicating influential factors on the decision to use structural wood technology.

Figure 3: Limnologen (Växjö, Sweden) is supported by local and national programs to expand the timber industry in Sweden. (Photo credit: Midroc Property Development)

ported by local and national programs to expand the timber industry. Also, stringent energy efficiency and carbon regulations make wood an attractive choice to address multiple performance requirements.

2.2 Best Practices - Process

Stakeholders were asked to describe how the project development process, design process or construction process for a tall wood building was different or special from other projects. The following section summarizes the strongest responses.

Commit

Every participant emphasized that the project team must be committed to a wood solution from the start – resolving design, code and market dilemmas require effort and all participants must be committed to moving the project forward with a wood solution.

Conduct Market Research

Most teams identified that understanding the market for the project is imperative. Owners and developers spent additional time to conduct detailed research on how the potential market would react to a timber structure in order to respond accordingly with design decisions, and understand what barriers might need to be overcome. This is the reason many timber buildings do not appear from the exterior to be wood – the perception in the market place is often that a building similar in appearance to a conventional building would be more acceptable by the market.

Create Research Partnerships

Research partnerships were identified as exceptionally important to every project in the survey. Each team collaborated with either an academic research institution or industry organizations in support of advancing timber buildings to help resolve and test design solutions, work on overcoming code issues, market perception issues, and creating long term research projects to monitor performance and publish results to build the body of knowledge.

Collaborate/Integrate

In the field of design, an integrated design process is considered the most successful approach to generate high performance buildings. The survey participants of these tall wood projects described a collaborative process that reached beyond what is typically understood as integrated. Not only did project teams take advantage of research partnerships, but participants stated that contributions from all disciplines at the very earliest stages, especially timber fabricators, was important to success. In the European participant projects, it was clear that a greater blending of professional roles across disciplines and sectors resulted in a strong culture of collaboration – project teams were inclined to access expertise early to help eliminate construction issues with a design solution or collaborate on design drawings. Teams included highly trained fabricators who had a broad range of experience from engineering structure and 3D design modeling software to construction logistics and planning.

Innovate Holistically

Another strong outcome from all projects was the message that tall wood projects should be approached as wholly innovative, rather than with a focus on innovating with wood elements only. This was a very strong message from the Cenni di Cambiamento developer (Figure 4 on following page), who expressed that very

Figure 4: Cenni di Cambiamento, Milan, Italy (Architecture by ROSSIPRODI ARSSOCIATI srl. Photo credit: Ricardo Ronchi).

little about the process reflected a traditional approach, emphasizing that the timber structure opened a new set of opportunities that may never have been considered otherwise.

Pre-plan, Plan, Plan again

The importance of planning was stressed in every conversation and was the answer to almost every participant's response when asked to identify lessons or advice for future project teams. All participants noted planning and pre-planning and then planning some more was key to success and indicated that additional effort early in the project timeline was where the majority of time was spent. This effort was essential to detail design drawings, incorporate construction logistics considerations into drawings, accommodate testing and approvals processes, and ensure experienced subcontractors and trades can be accessed to assemble the building. Online questionnaire results also reflect this, indicating the majority of projects required additional time and resources to support their tall wood projects (Figure 5).

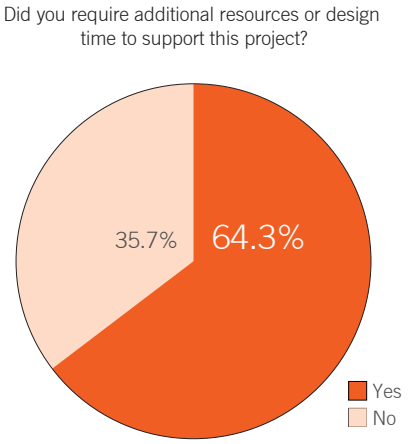

Figure 5: Online questionnaire results for the design team participant stakeholders indicating more than 60% required additional resources or design time to support their tall wood project.

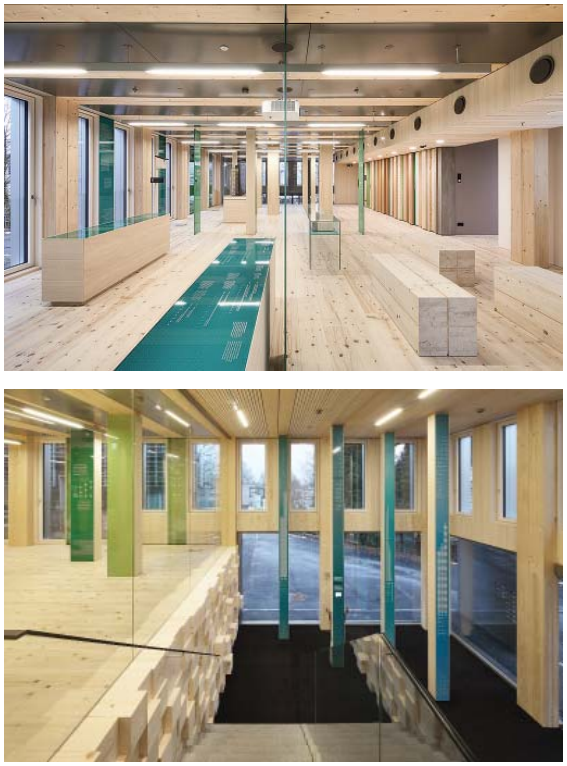

Figure 6: LCT ONE includes the Lifecycle Hub on the main floor of the building, an open education facility dedicated to advancing wood solutions. (Architecture by: Hermann Kaufmann ZT GhmH, Photo credit: www.creebuidlings.com)

Share

Finally, a very important message emphasized by participants was to share experiences, ideas, performance data and research to build the body of knowledge around tall wood construction and advance the industry. This philosophy was clearly practiced by all participant projects demonstrated by their willingness to share their time and thoughts for this survey. In addition, most have published research through various academic partnerships[ix], and are open sourcing performance data and sharing the experience of wood buildings with the public (Figure 6).

2.3 Design Solutions

Participants were asked to describe design and construction solutions across a variety of topics that had been identified as either challenging, were associated with perceived risk, or were thought to have knowledge gaps. These included: structure, lateral stability, fire protection, acoustics and vibration, systems Integration, and moisture protection and durability. The responses in all categories were generally wide ranging, indicating that there is a range of design and construction solutions as well as philosophies about addressing each of these issues. While there were certainly some common solutions, it is clear that no one technique or technology has emerged as the "best" in any category. Highlights of the results are listed below.

Structure

Panels are generally favoured for residential construction, while post and beam is favoured for institutional and commercial space, likely because post/beam offers a more open floor plan that can be reconfigured easily. Panels provide a more compartmentalized layout that are well suited for residential construction.

Fire Protection

In all cases, timber elements were oversized to include a char layer as part of the fire protection strategy, in addition to encapsulating timber elements with gypsum to some degree. Sprinkler systems and intumescent paint applied to exposed timber were also common fire protection strategies. Most projects chose not to install wood cladding on the exterior, and opt for non-combustible façades. Where wood façades are installed (Holz8, Limnologen), fire protection strategies were more challenging and complex.

Acoustics and Vibration

Acoustic and vibration strategies were generally complex and centered on strategies to separate or decouple floors and ceilings to eliminate noise and vibration transmission throughout spaces. Meeting local building code requirements, which varied widely across participant jurisdictions, was identified by most teams as a major design challenge. Almost all participants indicated that acoustic solutions were researched and tested through research partnerships.

Systems Integration

Design solutions for systems integration were varied across projects. In projects where structural elements are covered or concealed, participants indicated that resolving systems is relatively easy. In cases where

[ix] Serrano, E. Växjö University (2009). Documentation of the Limnologen Project: Overview and Summaries of Sub Projects Results, Retrieved on 10/16/2013 from http://www.cbbt.se/website3/1.0.3.0/31/FULLTEXT01.pdf

Figure 7: Ceiling panels between timber beams conceal systems at LCT ONE (Photo Credit: www.creebuidlings.com).

structure was exposed, integrating systems was identified as more challenging. In commercial applications, raised floors and dropped ceilings accommodated the majority of systems (Figure 7).

Moisture Protection and Durability
In general, moisture protection was not perceived as a major risk by design teams. In all cases, any exposed structural wood elements were either inside the building envelope, protected by an overhang or in the case of cantilevered panels, exposed only on the underside. In two cases, moisture sensors were installed to monitor envelope performance as part of ongoing operational research projects.

2.4 Construction Solutions

Participants were asked to comment on the same issues with respect to construction process. In general, the results were similar to the design solutions, a range of solutions and approaches were identified with a few strong common themes listed below.

Structure
In all cases, projects that used concrete cores emphasized that precast concrete panels accelerates the construction schedule and maintains a dry site. Of the projects that used cast-in-place concrete for the core, almost all of the schedule savings afforded by other prefabricated components were lost due to long curing time. Figure 8 shows the assembly of precast concrete panels for the core at the Holz8 project. The core was assembled first followed by the rest of the building, yielding a very fast construction time of about 16 days for the timber erection.

Figure 8: Holz8 building employed pre-cast concrete for the cores, contributing to a very quick construction time of 16 days (Architecture by: Schankula Architekten, Photo credit: Huber & Sohn).

In addition, every team identified challenges with tolerances at material interfaces (where concrete meets wood, or wood penetrates glass). Construction team participants emphasized that solid planning and detailing are critical to mitigating on-site delays and frustrations with variations in tolerances during construction.

Fire Protection
Participants indicated that accommodating frequent inspections from the fire authority during various stages of construction was key to increasing authority comfort with various fire protection strategies, and in some cases projects were able to eliminate redundant strategies once authorities had visually inspected assemblies and materials.

Weather Protection

Survey results concerning weather protection during construction varied from none at all, to temporary protection, to a fully tented structure. Different opinions on the need for weather protection appear to be related to the type of timber elements being installed and how they are treated before they are moved to the site. The Limnologen project employed a rising tent to cover the structure until enclosed (Figure 9), and all the project stakeholders emphasized the beneficial worksite conditions realized from the tent, as equally important as protecting the structure from weather. It created a clean, dry and warm site for the construction team.

Figure 9: Limnologen's rising tent structure for weather protection during construction (Photo credit: Midroc Property Development).

2.5 Approvals Process

Given that the majority of building codes do not explicitly recognize mass timber systems, obtaining approvals is identified as a significant challenge associated with pursuing tall wood buildings. While every participant project had a different set of experiences with respect to approvals based on existing codes, degree of market acceptance for mass timber as material for taller buildings, and varying regulatory policy, they all emphasized the importance of collaborating early to establish methods of compliance and methods of testing.

Survey participants were careful to emphasize that accounting for the effort to engage the authority having jurisdiction and the effort associated with alternative solutions and innovation is essential. Figure 10 shows results from the online questionnaire indicating that the majority of jurisdictions required additional documentation to satisfy the approvals for the wood solution.

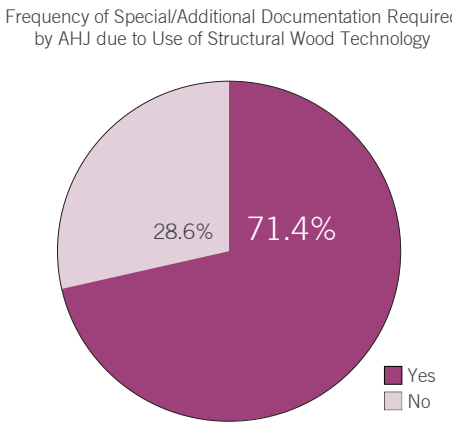

Figure 10: Online questionnaire results for design team participant stakeholders indicating frequency of special or additional documentation required by authorities having jurisdiction due to the use of structural wood technology.

Of the ten participant projects, only one approvals pathway was already established (3XGRÜN), owing to the E3 project completed a few years earlier in the same jurisdiction. All other projects were the first to successfully overcome code barriers and challenges. Participants identified two important strategies:

- "Start educating the authority when you start educating yourself". The Forté developer indicated that they collaborated with the local authority very early, provided them with credible industry resources, and engaged them in research.
- Establish an acceptable method of compliance as early as possible with the authority to allow the team to plan for testing and account for extra time associated with creating a new path to approvals.
- Plan to have the authority conduct regular on-site inspections during construction. Participants reported that where authorities were able to visually inspect assemblies and observe construction process and quality, their level of comfort increased and sense of risk decreased. In some cases, authorities deemed multiple fire protection strategies redundant and allowed a revised, less onerous approach.

2.6 Building Performance

The survey gathered information from project participants about building performance and operations in order to identify any unique issues, benefits or challenges associated with the performance of a tall wood

building. In all cases, participants indicated that mass timber was perceived as a beneficial material to support a combination of complementary building performance objectives.

- *Wood supports an efficient envelope*
  As a poor conductor of heat, wood minimizes thermal bridging, improving the effectiveness of the insulation compared to many conventional envelope assemblies.
- *Aligns well with Passive House standard*[x]
  In several instances participants identified the complementary advantage of achieving good airtightness owing to the precise cut and fit of prefabricated elements. These advantages were emphasized most by participants of buildings with panelized timber structures, where there are fewer joints, gaps and penetrations that require sealing as compared to other systems. This aligns very well with the air tightness requirement of Passive House, a European building performance standard applied around the world. The 3XGRÜN project, although not a certified passive house, meets the performance requirements for energy and air tightness. It was able to eliminate many systems and equipment by maximizing the efficiency of the envelope and other passive systems, simplifying operation/maintenance and thereby reducing capital and operational costs.
- *Occupant education is important*
  In all cases, participants emphasized occupant education as an essential part of a robust maintenance plan that supports the best building performance. In several residential projects, training sessions for tenants and new owners were provided.
  A very strong theme among every project was the benefit associated with occupant well-being and quality of space, listed below.
- *Exposed wood creates warm spaces*
  Almost all participants indicated that the quality of space achieved by exposing wood on building interiors was integral to the rationale for pursing the project.
- *Wood is a healthy material*
  Respondents emphasized that wood is widely understood as a material that contributes to our sense of well-being in spaces and can be a very healthy alternative to other finishes as an exposed surface on the interior.

Finally, every participant agreed that sharing lessons, ideas and performance data about tall wood building examples is key to advancing the industry. Areas of emphasis include moisture monitoring, energy performance and embodied carbon savings accounting, and occupant comfort. Several participant projects are engaged in ongoing performance monitoring in partnership with research and academic institutions.

3.0 CONCLUSION

The value of learning from applied experience cannot be overstated. The survey offers a range of lessons and knowledge from those most deeply involved in all aspects of tall wood buildings, from almost all jurisdictions in which they currently exist. The intent of this survey was to solidify the effort to advance the market for tall wood buildings.

The strongest message from all survey participants was that wood structure for taller buildings is a valid construction method with the potential to contribute substantially in reducing the negative impacts of buildings on the environmental and human condition. Of particular significance for practitioners engaged in sustainable design is the ability of wood to contribute to complementary goals of reducing the impact of carbon associated with buildings (embodied and operational), as well as improving occupants' sense of well-being and high quality indoor environments. Participants also revealed that supportive policy frameworks create an important regulatory grounding for tall wood construction, indicating that advocating for aligned policies at all levels of jurisdiction that serve to move beyond single benefit will be most valuable.

While it is clear from the survey results that the range in design and construction techniques are still evolving to respond to the varied code requirements, market demands and expectations, climates and regulatory conditions, time and innovation will continue to allow refinement and efficiencies are likely to emerge as more examples are realized. To build more momentum and support more built examples in North America and around the world, participants confirmed that more testing data is needed, especially for fire resistance. In order to reduce the perceived risk, the pool of testing data must grow. The survey also indicates that performance monitoring data is essential to demonstrate the benefit of operational efficiencies and human comfort.

[x] Passive House is a rigorous, voluntary energy performance standard for buildings, which aims to reduce the requirement for space heating and cooling, whilst also creating excellent indoor air quality and comfort levels.

Finally, survey respondents confirmed that there is still a gap in the market perception of mass timber construction, particularly regarding fire safety and durability. In general, the market perceives all timber construction equally and is ignorant to the difference between light frame wood construction and mass timber elements. Market research and education to increase familiarity with the qualities of mass timber and the quality of space that can be achieved with wood will be essential to furthering the application of tall wood construction.

While the participants of the survey of International Tall Wood Buildings are considered early adopters and innovators, it is clear from their success that momentum and capacity is growing, making wood a valid structural option for tall buildings with important benefits to consider.

Acknowledgements

The authors wish to acknowledge Forestry Innovation Investment and the Binational Softwood Lumber Council, our client group for the survey of International Tall Wood Buildings. We also wish to recognize Equilibrium Consulting, WSP Environment Sweden, and UK-based Sentinel-RPI, our Technical Advisors and collaborators for the Survey.

In addition, we wish to thank more than 50 survey participants who generously contributed their time and thoughtful responses to our queries. Finally, we would like to acknowledge our research colleague at Perkins+Will, Joanna Peacock, who worked along-side us to keep all the details in place; her effort was instrumental to the success of this work.

REFERENCES

[1] Forestry Innovation Investment and Binational Softwood Lumber Council, (2014). Survey of International Tall Wood Buildings, Retrieved on 05/2014 from www.rethinkwood.com/tall-wood-survey.

02.
IMPACT OF LEAN PRINCIPLES ON TIMELY PROJECT COMPLETION

Helena O'Connor, CAU-RJ, LEEP AP, *helena.oconnor@perkinswill.com*
Khalid Siddiqi, PhD, *ksiddiqi@spsu.edu*

ABSTRACT
Lean ideas have been used in the business world for some time. Lean advocates have been adapting these principles to different industries, including construction. The main principles of lean processes include value added to the customer and elimination of waste. It is very important for the owner to get the project completed on time, but that is a contractual requirement. Minimizing time waste and delivering projects "ahead of schedule" would be an added value to the customer. Some construction companies have successfully adopted Lean principles to manage their projects while others have not. The objective of this study was to determine the impact of Lean principles on timely completion of construction projects. In this study, projects with Lean strategies versus non-Lean strategies were compared to analyze the impact on their completion schedule. A survey was conducted with project managers of construction companies to collect data on project completion and Lean tools that are typically used. Results indicated that application of Lean principles assisted contractors to complete projects ahead of schedule, or helped them catch up to finish on time when delays were encountered. This study is intended for those general contractors who are skeptical of Lean practices and would like to see examples that Lean can help them deliver projects faster and more efficiently.

KEYWORDS: Lean principles, lean construction, lean tools, lean project delivery, project completion

1.0 INTRODUCTION
Lean principles have been used in the business world and manufacturing for some time. They originated in Japan, in the manufacturing floors of Toyota. Since then, professionals from different industries, including construction, have turned to Lean strategies hoping that these ideas can make their business processes and outcomes better. Since not all industries are the same, these Lean principles had to be adapted to each industry's peculiarities. The five principles of Lean production are: 1) specify value; 2) identify value stream; 3) make value flow; 4) let customer pull value; and 5) perfection pursue[1]. From these five principles we can infer that the main points are maximizing value and minimizing waste.

In construction, the critical starting point for lean thinking is value[2]. Lean construction is a "way to design production systems to minimize waste of materials, time, and effort in order to generate the maximum possible amount of value.[3]" Construction waste related activities are the ones that mostly waste time. "One type of it is response latency, the lag time from a participant asking a question to receiving an answer that is good enough to enable further work.[4]"Adding value is of the essence of Lean construction. In order to create added value, the project should be completed ahead of time, since finishing on-time is a contractual obligation.

Our motivation for this research was to investigate if construction projects can be delivered more efficiently with greater profit. Studies suggest that the application of Lean principles to manage construction projects might be the answer to accomplish this goal. "The theory and principles drawn from Lean production seem to be best suited for project management. Promising results in this regard have been reached already in one project management area, namely in Lean construction.[5]"

The objective of this study was to determine the impact of Lean principles on timely completion of construction projects. A survey requesting the same information on Lean and non-Lean projects was sent via email to project managers employed by various construction companies in the United States in order to answer the hypothesis that application of Lean principles does help contractors to deliver projects ahead of schedule.

2.0 METHODOLOGY

This study is founded in the following hypothesis: application of Lean principles does help contractors to deliver projects ahead of schedule. Delivering a project earlier means that less time was wasted during the construction process and earlier use of facility can be an added value to the owner. Lean construction adopters are using Lean tools in their project management to achieve this goal.

In order to answer our hypothesis, a survey was sent via email to project managers employed by various construction companies in the United States. We chose to contact project managers because they typically oversee project delivery and decide which management techniques to use for specific projects.

We administered 64 surveys and received 13 responses, yielding information on 34 projects total. The same data for Lean and non-Lean projects were collected, compared and analyzed. Information was collected on project type, square footage and location; if projects were Lean or non-Lean; if project completion was delayed, on time or ahead of schedule; what kind of Lean tools were used; if Lean tools were used alone or simultaneously; and if project managers' experience with Lean was positive or negative.

3.0 RESULTS

For the purposes of this research, we consider Lean every project that used at least one Lean tool, even if not using a Lean contract, or if Lean practices were not adhered company-wide. Information on 34 projects has been collected, with a total of 13 Lean projects and 21 non-Lean projects.

3.1 Lean and Non-Lean Projects Schedule

Out of the 13 Lean projects, eight have been completed ahead of schedule (62 percent), five have been completed on time (38 percent), and no project has been delayed (0 percent). Project managers stated that three out of five projects completed on time because Lean practices were in place and helped project teams to absorb delays (weather and unforeseen hazardous material abatement). A summary of results is shown in Table 1.

Out of the 21 non-Lean projects, five were completed ahead of schedule (24 percent), 14 were completed on time (67 percent), and two were delayed (9 percent). Project managers stated that two out of 14 on-time projects required significant overtime hours to finish on time, and owners were not satisfied with this aspect.

Table 1: Summary of Lean and non-Lean project totals and schedule.

	Total	Ahead	On Time	Delayed
Lean	13	8 (62%)	5 (38%)	0 (0%)
Non-Lean	21	5 (24%)	14 (67%)	2 (9%)

3.2 Lean Tools

Lean construction emerged since projects have become more complex, uncertain, and dynamic, and Lean tools have been developed in response to these challenges. The Last Planner System was created to address workflow unpredictability. Pull Planning was developed to address rarely accurate CPM schedule. Integrated Project Delivery began to try to overcome contract boundaries. Target Value Design increases collaboration among project participants[6]. Integrated Concurrent Engineering can reduce response time significantly[7]. BIM allows for better project coordination, clash detections and future use by maintenance teams. Lean Project Scheduling promotes better team communication and empowerment. Choosing by Advantages standardize the decision making process[8]. Table 2 shows survey results for the Lean tools used by project managers.

Table 2: Lean tools used by project managers.

Lean Tools	Number of PM's that Used these Tools
The Last Planner System	8
Pull Planning	5
Weekly Work Plans	5
Daily Stand Up Meetings	5
Constraint Log	2
Percent Progress Complete	2
IPD Contract	2
Project Website	2
Hyperlinked Drawings	1
BIM	1
Digital documents	1
Digital plan kiosk / tablets	1
Profit Sharing with Subcontractors	1
Design Assist	1
Direct Communication with Designers	1
Choosing by Advantages	1
Big Room	1
Visual Control	1
5S	1

3.3 Lean Tools Utilization

Previous research indicates that applying Lean principles simultaneously improved performance, particularly for a simulation of a structural steel erection project[9]. Findings of this research and survey responses indicate that projects that finished ahead of schedule used several Lean tools simultaneously. Although two respondents indicated that they noticed performance increase even by just using one Lean tool, these projects were on time, not ahead. The three Lean projects that finished on time after hitting delays also used several Lean tools simultaneously.

3.4 Project Types

Data collected shows that Lean principles can be successfully applied to multiple project types. Lean project types collected in this survey included: 6 Healthcare, 2 Government, 1 Correctional Facility, 1 Multifamily, 2 K-12, and 1 Higher Education type (Table 3). Non-Lean project types included: 9 Healthcare, 6 Higher Education, 2 Multifamily, 2 Office, 1 K-12, and 1 Mixed Use.

Table 3: Lean project types and completion.

Lean Project Tyoes	Completion
Healthcare	Ahead
Healthcare	Ahead
Healthcare	Ahead
Healthcare	On Time
Healthcare	On Time
Healthcare	On Time
Government	Ahead
Government	Ahead
Correctional Facility	Ahead
Multifamily	Ahead
K-12	On Time
K-12	On Time
Higher Education	Ahead

3.5 Lean Project Sizes

Project size was not a factor in terms of completion schedule for Lean projects. Lean assisted early completion of projects of a variety of sizes, ranging from 10,000 to 530,000 square feet (Table 4). Non-Lean project sizes ranged from 13,000 to 2,100,000 square feet. Further studies should be done on larger Lean projects to assess their timely completion.

Table 4: Lean project square footages and completion.

Lean Projects Sq. Ft.	Completion
10,000	Ahead
10,000	Ahead
10,000	Ahead
34,000	On Time
56,000	Ahead
56,000	Ahead
67,000	On Time
75,000	On Time
200,000	Ahead
205,000	On Time
400,000	On Time
450,000	Ahead
530,000	Ahead

3.6 Project Locations

All projects analyzed were located in the United States including the following states: Arizona, Florida, Georgia, North Carolina, South Carolina, Virginia, and Wyoming. Further studies should be done comparing completion schedule data of Lean and non-Lean projects for specific locations to account for different regional peculiarities. Other countries are also encouraged to pursue similar studies.

3.7 Project Managers' Lean Experience

In the survey responses, we also found valuable input on project managers' experiences with Lean. All project managers described their experience with Lean as positive, except one person who described as neutral because "despite the tools, Lean culture and behaviors never fully developed" for a specific project.

After analyzing responses, we offer a list of what composes a positive experience and relate that with current theory (Table 5). All experience elements fall within the "four elements that can be used to fill in the cultural framework and affect culture change in an organization: leadership, communication, empowerment, and teamwork.[8]" Also, they relate to the "Five Big Ideas" developed by Lean Project Consulting: "collaborate, really collaborate; increase relatedness among all project participants; projects are networks of commitments; optimize the project, not the pieces; tightly couple action with learning.[10]" It is important to note that the observation of these principles facilitates the deployment of Lean design and construction.

Table 5: Summary of responses relating to positive project managers' experience.

Experience aspect	Survey responses	Theoretical background
Leadership, Trust, and Collaboration	"The most powerful lean technique is the ability to create a culture of trust and collaboration on a project. The success of the tools hinge on the project's culture. If the project leaders can successfully build trust between all team members, then the positive impact of lean will be multiplied. Conversely, if trust does not exist, the team members will revert back to old habits."	"First, managers need to be committed to learning and understanding what it means to become lean and to changing their own behavior accordingly. They have to set an example and ensure a buy-in among people. Secondly, management needs to provide adequate resources to support a cultural transformation.[11]"
Easier Management	"Once everyone was committed to the process it seemed to make the job easier to manage."	
Enhanced Team Work	"Team members were pulling for each other rather than fighting each other." "I appreciated the subcontractor interaction and cooperation."	"Projects are a collaborative enterprise.[10]"
Enhanced Team Accountability	"Subcontractors worked well together and took accountability for their commitments during pull plan sessions. Allowing them (subcontractors) to have input (in the schedule) made them more accountable."	"Lean drives down the authority, responsibility and accountability to the lowest levels in the organization.[8]"
Early Identification of Issues	"It brings issues to the surface way before they start affecting schedule." "You proactively find the problems earlier, so you can help manage the design team and owner to come to resolution on these items."	
Better Coordination and Workflow	"It also helps plan work more effectively and efficiently by allowing trades to look ahead so they can ask the right questions in advance."	"Measuring and improving planning system performance is the key to improving work flow reliability.[12]"
Ability to Catch Up	"Lean allowed us to absorb these delays and finish on time."	"Managing the interaction between activities, the combined effects of dependence and variation, is essential if we are to deliver projects in the shortest time.[12]"
Proven Satisfaction	"I was very skeptical when I first learned about it, now that I have experienced it, I am sold. It changed my way of managing a project permanently." "I will not do any project the traditional way again." "It was my first experience, but I won't do another job without using the lean tools we implemented on the project."	

3.8 Obstacles to Lean Implementation

Results indicated that 62 percent of Lean projects were completed ahead of schedule, as opposed to 24 percent non-Lean projects. However, one obstacle identified by the survey respondents was getting architects and owners on board with Lean and timely decisions. This needs to happen since there is a need for improvement within the design and construction industry. "Industry participants can no longer afford to sit idle wondering whether Lean is a good idea. They must ask 'What happens if Lean is not adopted?[13]". Further studies are necessary to specifically address barriers to implementation.

4.0 CONSTRAINTS AND LIMITATIONS

Our data was collected using a self-administered survey. This communication approach has inherent limitations. First, response bias could occur when participants, either intentionally or unintentionally, provide inaccurate data. In addition, respondents could potentially represent population extremes relative to those who receive such surveys, but do not respond.

Another limitation of this study is the fact that, given time and cost constraints, it was conducted using nonprobability sampling. Recipients of surveys were selected based upon researcher access and survey respondents were self-selected. Therefore, the findings cannot be generalized to represent the entire population of construction projects.

Finally, given the relatively small sample size, this research can only be considered to be exploratory. As such, it reinforces the notion that the application of Lean principles to construction benefits both owners and contractors. It, thereby, serves to strengthen the foundation for further research on this paper's hypothesis.

5.0 CONCLUSION

Since Lean ideas have emerged, professionals from different industries including construction have been studying and seeking how to apply this concept to their industries. Several construction companies have embraced the Lean culture and have been using Lean principles and tools in their project delivery.

The objective of this study was to determine the impact of Lean principles on timely completion of construction projects. After analyzing survey results, we concluded that managing construction projects by applying Lean principles helps contractors to deliver projects ahead of schedule. A few contractors also mentioned that Lean strategies already in place helped their team to catch up and finish on time after suffering delays. In addition, we found that almost all project managers of Lean projects categorized their experience with Lean as positive, with successfully implementation of Lean principles as suggested by current theory.

This study is relevant because it adds rigor to existing research that Lean principles can provide added value to the owner, and its applicability in construction is advantageous to contractors. Many professionals are still skeptical about Lean thinking and Lean tools, but results indicate that Lean projects are more likely to finish ahead of schedule than non-Lean projects, helping contractors to be more efficient and profitable.

We recommend investments in further studies using significantly large sample sizes. Data on project completion of Lean and non-Lean projects should be collected and compared for different states and countries. Since findings indicate that positive experience can be achieved, we also recommend that construction companies consider embracing Lean principles based on current established guidelines for Lean implementation. Further studies on owner and team satisfaction are also encouraged.

Acknowledgments

We would like to thank all the contractors that contributed to this study. Without their participation, this study could have not been possible.

References

[1] Womack, J., and Jones, D., (1996). *Lean Thinking: Banish Waste and Create Wealth in Your Corporation*. New York, NY: Simon & Schuster.

[2] Herrala, M., Pekuri, A., and Aapaoja, A., (2012). "How Do You Understand Lean?", *Proceedings of the 20th Annual Conference of the International Group for Lean Construction*, San Diego, CA, July 18-20.

[3] Koskela, L., Howell, G., Ballard, G., and Tommelein, I. (2002). "The Foundations of Lean Construction", in *Design and Construction: Building in Value*, R. Best and G. de Valence, eds., Oxford, UK: Butterworth-Heinemann, Elsevier.

[4] Koskela, L., Bolviken, T., and Rooke, J., (2013). "Which are the Wastes of Construction?", *Proceedings of the 21th Annual Conference of the International Group for Lean Construction*, Fortaleza, Brazil, July 29-August 2.

[5] Howell, G., and Koskela, L., (2000). "Reforming Project Management: The Role of Lean Construction", *Proceedings of the 8th Annual Conference of the International Group for Lean Construction*, Brighton, UK, July 17-19.

[6] Alarcon, L.F., Harrison, M., and Howell G., (2013). "Characterization of Lean Project Delivery", *Proceedings of the 21th Annual Conference of the International Group for Lean Construction*, Fortaleza, Brazil, July 29-August 2.

[7] Chachere, J., Kunz, J., and Levitt, R., (2009). "The Role of Reduced Latency in Integrated Concurrent Engineering", CIFE Working Paper #WP116, Stanford University.

[8] Rubrich, L., (2012). *An Introduction to Lean Construction – Applying Lean to Construction Organizations and Processes*, Fort Wayne, IN: WCM Associates LLC.

[9] Al-Sudairi, A.A., Diekmann, J., Songer, A.D., and Brown, H.M., (1999). "Simulation of Construction Processes: Traditional Practices versus Lean Principles", *Proceedings of the 7h Annual Conference of the International Group for Lean Construction*, Berkeley, CA, July 26-August 28.

[10] Forbes, L.H., and Ahmed, S.M., (2011). *Modern Construction: Lean Project Delivery and Integrated Practices*, Boca Raton, FL: CRC Press.

[11] Pekuri, A., Herrala, M., Aapaoja, A., and Haapasalo, H., (2012). "Applying Lean in Construction – Cornerstones for Implementation", *Proceedings of the 20th Annual Conference of the International Group for Lean Construction*, San Diego, CA, July 18-20.

[12] Howell, G., (1999). "What is Lean Construction", *Proceedings of the 7h Annual Conference of the International Group for Lean Construction*, Berkeley, CA, July 26-August 28.

[13] Naney, D., Goser, C., and Azambuja, M., (2012). "Accelerating the Adoption of Lean Thinking in the Construction Industry", *Proceedings of the 20th Annual Conference of the International Group for Lean Construction*, San Diego, CA, July 18-20.

03.
SOUND MASKING SYSTEMS AND THEIR EFFECTIVENESS:
Does Sound Masking Really Work?

Ivan E. Desroches, MRAIC, OAAAS, A.Sc.T., *ivan.desroches@perkinswill.com*

ABSTRACT

As we move toward designing more open offices, clients are faced with having to adapt to unfamiliar types of aural environments. Along with the advantages of open offices also comes the issues of noise disturbance and speech privacy from adjacent workstations, which are often addressed by the introduction of a sound masking system. The question remains, how well do these systems truly work at masking speech? Perkins+Will investigated the effectiveness of the technology by analyzing the user's ability to properly hear spoken conversation after the system vendor validated the system. This unconventional study demanded a different approach than that found in the ASTM E1130 standard method of measuring speech privacy in order to evaluate the subjective nature of the occupants' response to sound.

The method adopted for this study was to conduct a series of Speech Articulation (SA) tests. The results generated a matrix that was used to identify a correct Percentage of Articulation (PA) for each respective environment. The lesser the volunteer's ability to properly discern sounds, the more it can be demonstrated that the system functions as intended.

With the system running, the sound masking consistently lowered the PA values. SA tests also demonstrated that the system had little effect on speech intelligibility in some smaller open areas and had a greater effect in large open office environments. The results also provided a better understanding of the size of the privacy zones and limitations of a sound masking system. Sound masking systems should be selected in conjunction with the layout, scale, materiality and the type of architectural space. Gaining a better understanding of the efficiencies and inefficiencies will help designers yield maximum results.

KEYWORDS: open office, open plan, speech privacy, architectural acoustics, noise disturbance, perceived sound, field test

1.0 INTRODUCTION

The design industry is seeing more initiatives that promote collaboration and engagement between employees. In Canada, an example of this trend is the Federal Government's Workplace 2.0 standards[1]. This results in more open environments with reduced walls and reduced height of workstation screens to maximize natural light. One of the challenges in this transition is to achieve effective speech privacy, which is known to diminish in an open plan. For example, it is not uncommon to have speech understood up to 50 feet away in an open office. Sound masking systems are recognized in the industry as a way to assist in obtaining a higher level of speech privacy in open environments[2]. Organizations such as the USGBC are offering online continuing education courses recognized by architectural associations to raise an awareness of this issue[3]. The sound masking system introduces a specialized ambient sound tuned to interfere with the human voice into the space, as seen in Figure 1. This ambient sound makes it possible for people to converse within a zone, but makes it difficult to understand conversation out-

side of a privacy zone. Although adjacent conversations are still audible, sound masking is meant to diminish the intelligibility of these discussions.

In a temporary relocation space, a confidential client has adopted an office design that predominately uses open workstations. Although the pre-existing office space also included open workstations, the workforce was accustomed to a much larger ratio of enclosed offices to open workstations. The client, who was unfamiliar with sound masking systems, made a strategic decision to procure sound masking and allow the occupant to test the environment before committing to this solution in the final end state project. Throughout the temporary swing space areas, the sound masking system had been installed both in open workstation environments and adjacent to enclosed offices. Perkins+Will was retained to undertake an independent review of the supplier's installation at the temporary swing space to verify the effectiveness of the system.

The onsite investigation took place over two days with the spaces fully occupied. The goal of the testing was to observe the speech hindering effects sound masking had on the occupants. The data collected was then used to determine to what degree the system actively contributes to hindering the intelligibility of speech. The approach used to test the effectiveness of the system was to perform Speech Articulation tests. This consists of studying the amount of properly understood sounds from volunteers at various distances from source to establish a Percentage Articulation (PA) correctly heard. This unconventional approach uses the sensibility of the human factor of real occupants in the field to establish results. This is quite different than the method used in the ASTM E1130 standard, which uses a noise generator as a sound source and then proceeds to sample large amounts of data of certain frequencies at various locations in order to mathematically formulate a value assigned for Articulation and Privacy[4]. Although the ASTM method is accurate, being able to evaluate the impact actually heard by volunteers brings the advantage of demystifying the realm of acoustics, which is usually associated with complex acoustic measurements and formulas[5,6]. Furthermore, this approach carries a high level of simplicity that helps clients understand the results of the sampled areas and brings with it a sense of individual sincerity.

Figure 1: Conventional sound masking system in suspended acoustical ceiling (Courtesy of Environmental Acoustics Inc. © 2014 K.R. Moeller Associates Ltd).

The perceived speech heard by a receiver is also known to vary depending on user's gender, age, native language as well as his or her position from the speaker (real or artificial)[7]. To attain maximum faithfulness in the accuracy of the data gathered, volunteers from the client's workforce were obtained to fill the position of three males and three females representing various age groups. The volunteers were also screened to exclude acute hearing disorders as to avoid any significant bias in this relatively small sample group.

Volunteers were arranged in a standing position to the right and to the left of the recorded sound source to a maximum of 25 degrees from axis and to three predetermined distances: 15, 25 and 35 feet away (Figure 2).

There were four tests conducted in each area. The first series of word tests was performed with the sound masking off in efforts to collect data that could establish a benchmark comparison with the system functioning. The other three tests were performed with the sound masking on and the volunteers would then rotate their positioning from source for each test. This process would allow the volunteer to be in various distances from source and help determine the extent of the privacy zone. Three series of tests (position B, C and D) with the system on also provided more data to be collected and allow a higher degree of accuracy when averaging the results.

The method was followed with the sound source positioned in an open office area as well as with the sound source positioned in an enclosed office area (with the test subjects outside the office) for each of the three sample floors selected. When the tests were performed from an enclosed space, the sound source was pointed to the door to capture the weakest portion in the sound barrier.

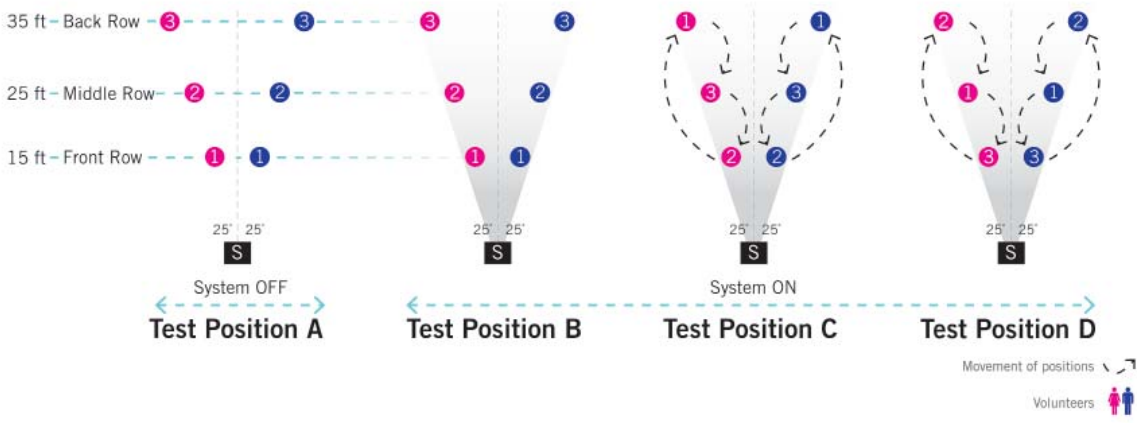

Figure 2: Positioning patterns of volunteers for each test.

The recordings were played back using a male voice to expose the volunteers to a series of 25 simple partial sentences for each test position. The format of the sentences were led with a starting statement, which would help the volunteers follow on their page as well as prepare them for what they needed to attentively listen. The sentence would then end with a nonsensical single syllable word pronounced normally.

Playback Recording	Volunteer Listener's Sheets
1. The first is BAIT [4 second pause]	1. The first is _____
2. Now try SET [4 second pause]	2. Now try _____
3. Next comes RIB [4 second pause]	3. Next comes _____
4. Group 4 is TEN [4 second pause]	4. Group 4 is _____
5. The next is WING etc…	5. The next is _____

As the recording was being played, a four second pause between each sentence was introduced to allow time for the volunteers to interpret and write down the last word of the sentence they heard. The data was then collected, analyzed with the actual recording and the average of correctly heard words was determined for each row. Given that four positioning pattern (A, B, C and D) were used, this resulted in four series of 25 word tests per area for two areas per floor (open office and closed office), and three sample floors for a total of 600 spoken words used as the basis of collecting data for this analysis.

The original recording of the word tests was done using a microphone, an external USB soundcard by M-Audio for analog to digital conversion, computer and Audacity software to produce an accurate 96/24 high resolution audio recording (Figure 3). At the time of testing, the sound masking system had been installed and calibrated by the vendor and the spaces were fully occupied by the tenant. Before performing any on-site SA testing, some basic training was given to the volunteers to brief them on the objective of the tests and to their responsibilities of recording what they hear. The digital playback system consisted of the same computer with an external USB soundcard by M-Audio to conduct the digital to analog conversion. This sound card was connected directly into an amplifier, which acted as the speaker by use of patch cord to maintain high resolution reproduction of the recording. Given that the degree of absorption varies in each sampling area, which would affect the playback amplitude, it was preferred to calibrate on site at each test area. Prior to starting each series of 25 word test, the source sound coming from the recording was individually calibrated on site (with the sound masking system turned off) by using the sound pressure level meter measured at three feet from source. Because of the normal variance in the human voice when pronouncing spoken words and to take into account the possibility of impulsive raised voice efforts, the recording play back could not be an exact consistent amplitude. Therefore, the sound source playback produced an A-weighted sound level that fell within the following parameters measured with the sound masking system turned off:

- 60dB (brief peaks up to 70dB) amplitude at 3 ft used for SA testing in open area
- 65dB (brief peaks up to 75dB) amplitude at 3 ft used for SA testing from small enclosed offices
- 70dB (brief peaks up to 80dB) amplitude at 3 ft used for SA testing from large enclosed room

Figure 3: Playback equipment used during the onsite Speech Articulation testing.

The amplifier acting as the speaker used to reproduce the recording was carefully positioned on top of pre-existing desks and tables is the sample areas. The position of the speaker located the sound source approximately 36 inches above finish floor and to a maximum of nine degrees off of vertical axis with the volunteer's first row and to a maximum of 25 degrees on each side of the horizontal axis.

According to the Noise Criteria Curve, office environments should be designed to NC-45, but it is not unusual that these types of occupied spaces reach up to an amplitude of 50dB depending on the circumstances of the building systems. The sound masking system's uniformity phasing, zoning, sound spectrum and sound levels of these sample areas were fully commissioned by the manufacturer. The actual ambient sound measured in the six spaces of levels 14, 16 and 18 averaged at 47dB with the sound masking system functioning as validated by system installer. Given that the volume of the tested spaces was smaller than 10,000 cubic feet, the level of reverberation was presumed negligible and therefore not considered as a factor in formulating the PA.

To help evaluate the relationships of the results gathered from the volunteers, a general guideline needed to be developed. The ASTM 1130 standard for speech privacy uses pink or white noise and then the results of the sound level measurements are used to calculate a value assigned in an Articulation Index (AI)[4]. Theoretically, the lower the AI, the less words can be properly articulated in that given environment and the higher values would be indicative of better articulation of spoken words. Therefore, an AI lower than 0.20 would require concentrated effort to follow a conversation and yield a quasi-private area whereas an AI above 0.30, speech would be well understood and provide an unacceptable privacy. This standard also identifies how these values can be directly translated into speech Privacy Index (PI) values as the inverse of AI. PI values range from 0 to 100, in which a PI of 80 and higher would generally achieve speech privacy. The standard also acknowledges the need for further research to establish the relationship of articulation index to speech privacy. In contrast to the ASTM E1130 standard test method, this case study records the subjective response of the human condition and their actual ability to properly hear spoken words from a recording in a field environment. This fundamental difference in the testing necessitated the need to develop a unique classification that could be used as a guideline for the percentage of correctly heard sounds. This newly developed approach yields speed and simplicity with tangible real life results. With the standards presented used as reference and with the help of the theories obtained from the book Acoustical Designing in Architecture[8], we developed a simple classification chart that was used to evaluate the data gathered from volunteers (Table 1).

Table 1: Syllable articulation classification chart.

SYLLABLE ARTICULATION CLASSIFICATION	
PA Correctly Heard	**Likelihood of intelligibility**
95 to 100	Extremely easily understood
85 to 94	Very good
75 to 84	Satisfactory but attentive listening is required
65 to 74	Barely discernable and fatiguing to the listener
0 to 64	Speech not heard suitably

The ASTM E1130 defines confidential speech when speech cannot be understood[4]. Therefore, the worse the speech intelligibility PA observed, the more it will demonstrate that the sound masking system is working effectively. Considering that most spoken words have multiple syllables and that if 25 percent of those sounds are not recognized correctly, full words not correctly understood would be in excess of 25 percent. The missing elements of a sentence would make it difficult to understand and follow in an ongoing conversation. For the purpose of this case study, a PA 74 and lower was considered as the threshold where an environment hinders speech intelligibility.

2.0 FINDINGS

Many factors may contribute in the variation of the final results, such as the limitation of participants' normal hearing range, the level of focus volunteers are able to devote, possible momentary distraction during tests conducted, the participants' native language, the clarity of the recording, articulation of the word test and the location of obstructions that would block or diffract sound.

Results were all scored by one individual to ensure consistency. Judgment made on the observations sheet would allocate a correct score for pronunciation of the sounded word and not on spelling. The data collected was then used to populate a matrix of values for each type of the tested area. This matrix identified the participants' responses for three open offices and the adjacencies to three enclosed offices. The results of a 25 word test from each row were averaged out between the six volunteers to generate PA value to an accuracy of two decimal places for the respective sample area.

2.1 Review of Open Office Areas

On the 14th floor, we tested an open office area occupied by two executive assistants, as seen in Figure 4. The area is designed as a formal reception point and is finished with hard walls and ceiling surfaces, along with a commercial carpet. The results of the 14th floor, with the system off, averaged PA 90 for the front row, 85 for middle row and 92.50 for the back row resulting in speech being very well understood in this space. With the sound masking system on, the average PA was recorded as 87.50 for the front row, 75.83 for the middle row and 84.17 for the back row. This results in speech intelligibility being very good along the front row, satisfactory along the middle and very good again along the back row. Given the size and layout of this space and the hard surfaces, it is understood that the sound was reflecting off of the wall and ceiling hard surfaces to the back row of this space. It was concluded that sound masking has a marginal effect and hinders very little of the speech intelligibility within this space.

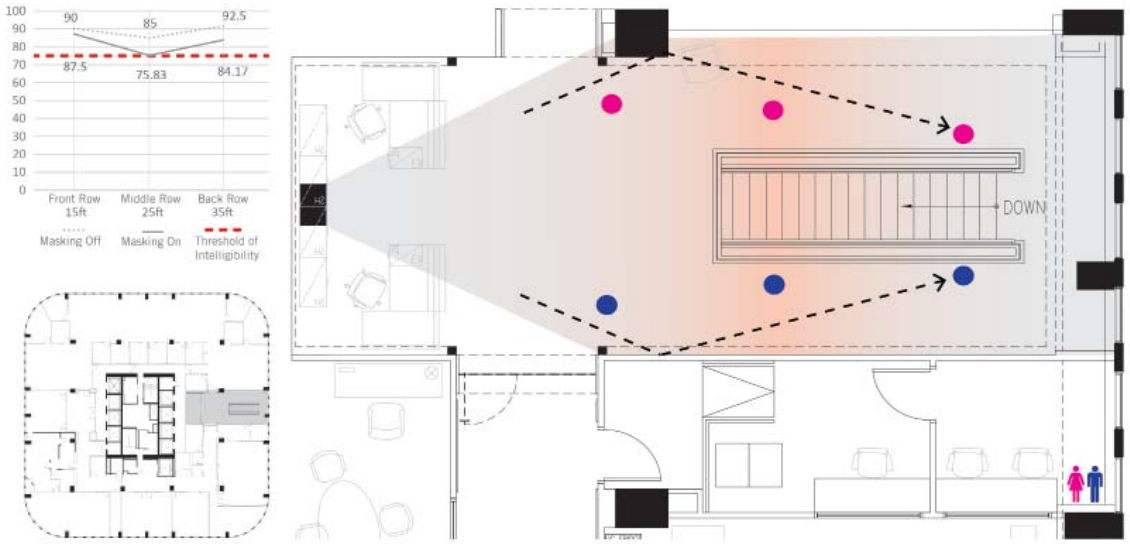

Figure 4: 14th floor plan of SA tests with PA results for the sample open plan environment.

Perkins+Will then sampled an area of the 16th floor, which is characterized by open, fabric-clad workstations, gypsum board walls, and mineral fiber lay-in ceiling tiles (Figure 5). The workstation panel height was set at 54 inches. The results of the 16th floor with the system off averaged PA 97.5 for the front row, 92.5 for middle row and 85 for the back row, resulting in speech being extremely easily understood to very good. With the sound masking system on, the average PA was recorded as 87.94 for the front row, 71.27 for the middle row and 53.25 for the back row. This results in speech intelligibility being very good along the front row, barely discernable along the middle row and not heard suitably along the back row. It is understood that the sound masking is helping in this environment and has contributed to further hindering speech intelligibility within the range of 24 feet away from source.

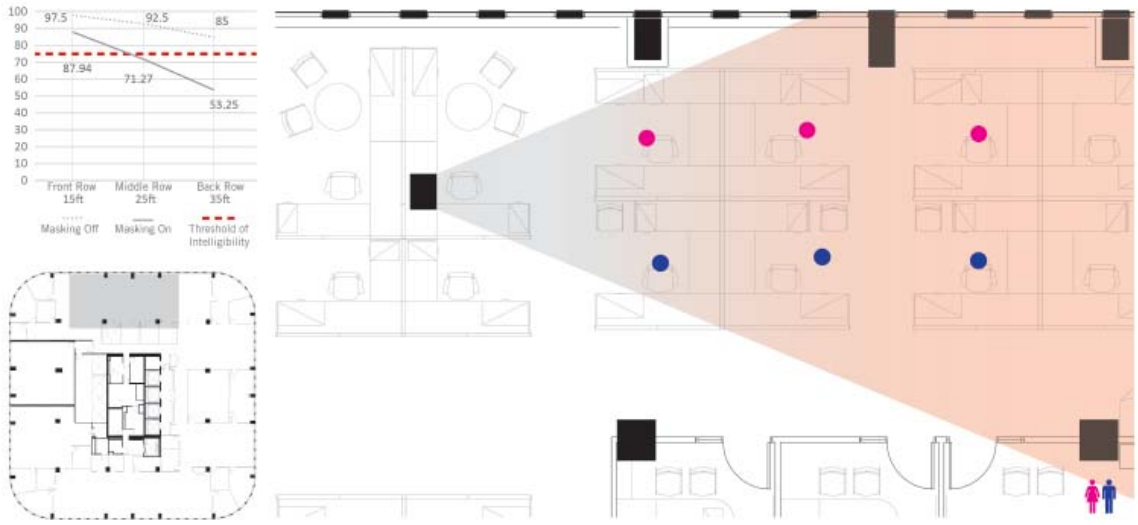

Figure 5: 16th floor plan of SA tests with PA results for the sample open plan environment.

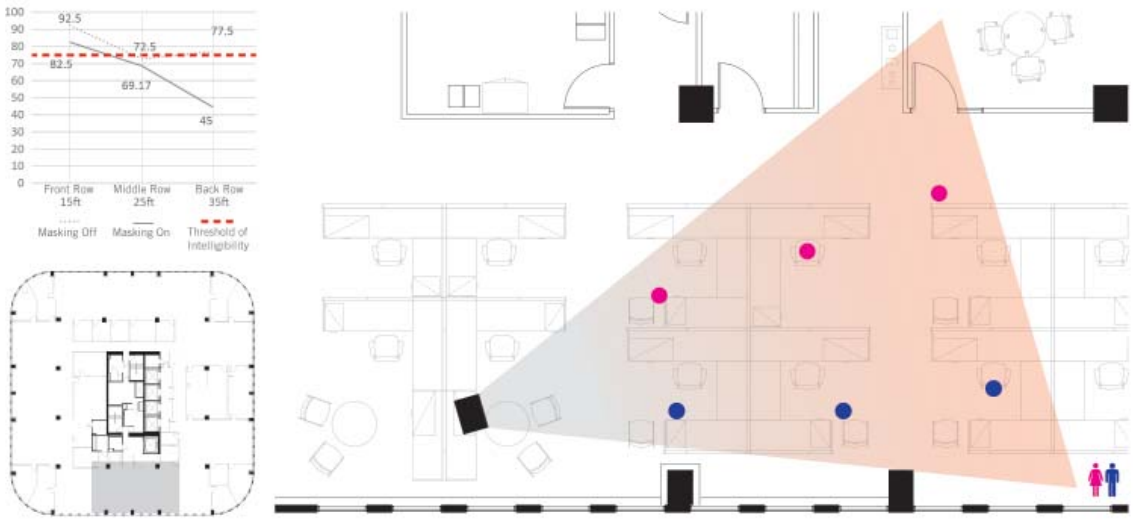

Figure 6: 18th floor plan of SA tests with PA results for the sample open plan environment.

Perkins+Will sampled an area of the 18th floor (Figure 6). The material and spatial characteristics of this floor were similar to the 16th floor. The results of the 18th floor with the system off averaged PA 92.5 for the front row, 72.5 for middle row and 77.5 for the back row resulting in speech being very good to satisfactorily heard. With the sound masking system on, the average PA was recorded as 82.50 for the front row, 69.17 for the middle row and 45 for the back row. This results in speech intelligibility being satisfactory along the front row, barely discernable along the middle and back row. It can be concluded that the sound masking is helping in this environment and has contributed to further hindering speech intelligibility within the range of 22 feet away from the source.

2.2 Review of Enclosed Office Areas

The 14th floor sample area was finished with commercial carpeted floor, hard wood panel walls and gypsum ceiling, as seen in Figure 7. The partition between the office and the adjacent corridor extended up to structure above. The results with the system off averaged PA 35.00 for the front row, 37.50 for middle row and 0 for the back row resulting in speech that is not heard suitably. With the sound masking system on, the average PA lowered even further to 30 for the front row, 23.33 for the middle row and 0 for the back row. The additional lowering of PA results in diminished speech intelligibility. However, the wall assembly alone is observed to adequately reduce PA below the threshold of intelligibility.

The 16th floor finishes included commercial carpeted floor, gypsum wall assemblies in the office and suspended acoustical tiles in the office (Figure 8). The adjacent open office area was finished with commercial carpet, acoustical tile ceiling and with system furniture of 54 inches high. The partition between the office and the adjacent corridor stop short of the structural slab and only extend up to the underside of the suspended ceiling system. Samples taken in this area, with the sound masking system functioning, showed a substantial drop in PA levels when compared with the sound masking system off. A drop of 54.17 in PA levels for the front row, a drop of 30 for second row and a drop of 5 in PA levels for the back row. The additional lowering of PA results in diminished speech intelligibility. However, the wall assembly alone seems adequate to reduce PA below the threshold of intelligibility.

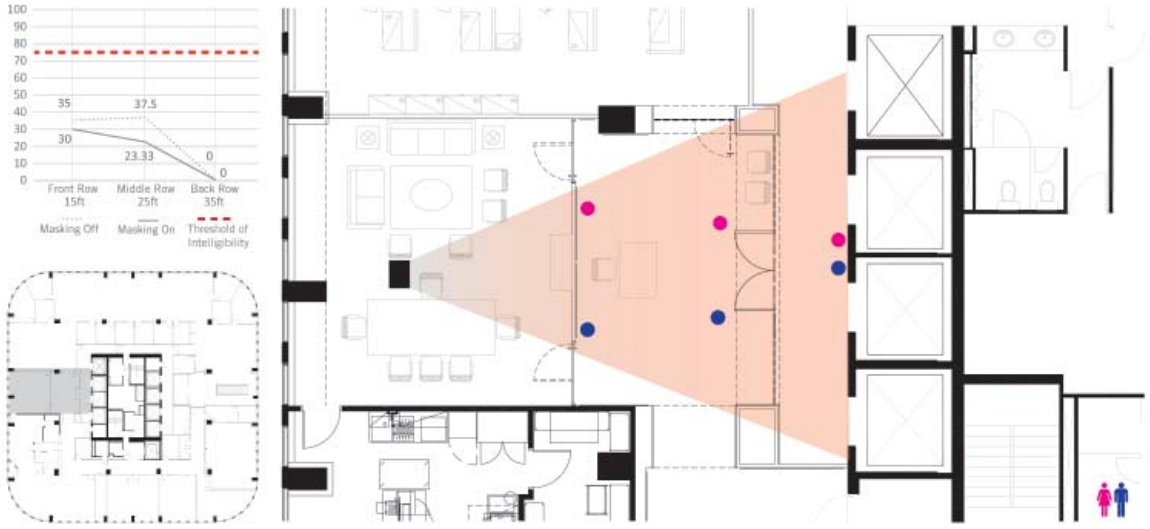

Figure 7: 14th floor plan of SA tests with PA results from the sample enclosed office environment.

The 18th floor was similar in finishes with partitions extending up to underside of ceiling system, as seen in Figure 9. Results were generally similar to that of the 16th floor, since it showed a consistent lowering of the PA level with the system running. In this sample we noticed that people within 20 feet of the source sound will properly hear conversations even with the presence of a wall. Although additional diminished speech intelligibility was observed, the wall assembly alone seemed adequate to reduce PA below the threshold of intelligibility when further than 20 feet away from source. Volunteers positioned within 20 feet from source would have intelligibility affected only when the sound masking system is on.

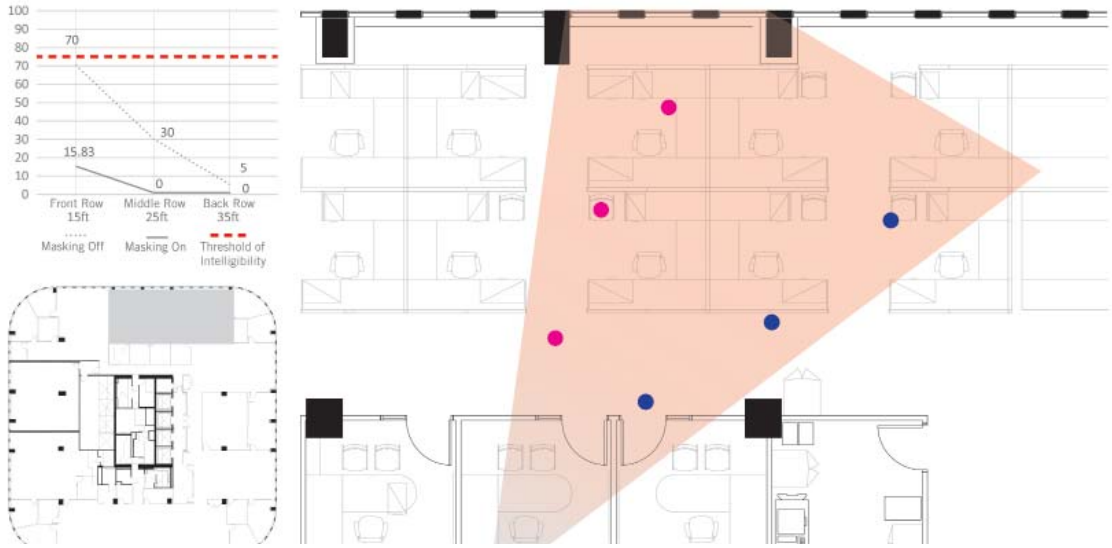

Figure 8: 16th floor plan of SA tests with PA results from the sample enclosed office environment.

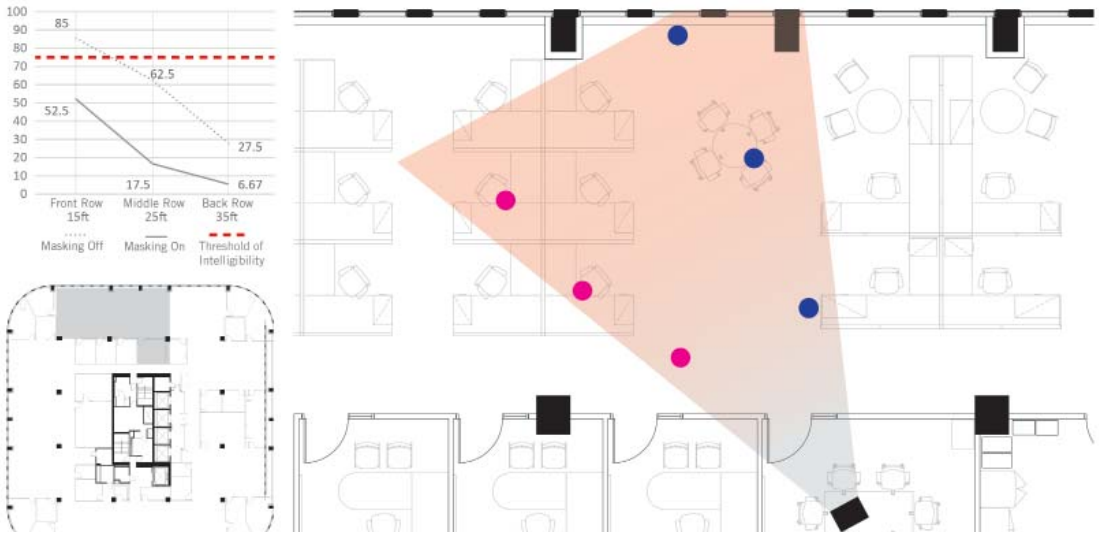

Figure 9: 18th floor plan of SA tests with PA results from the sample enclosed office environment.

3.0 GENERAL SUMMARY OF FINDINGS

3.1 Average Performance Results When Used in Open Office Environments

Figure 10 shows the arrangement of volunteers and distances from sound source that was used in an open office. Figure 11 shows the average PA results for the sample areas of open office enviroments. When we review the results of the three floors, with system off along the front row, the average PA is 93.33 percent, which yields that speech is very well understood. When we compare these results with the same front row position with the sound masking system running, the average PA is reduced to 85.98 percent, though lower, is still within the very good intelligibility range. Although the sound masking system has resulted in diminished intelligibility, speech privacy has not been achieved at a distance of 15 feet away from source.

Reviewing the results of the three floors, with system off along the middle row, the PA average is 83.33 percent, which yields that speech intelligibility is satisfactory, but attentive listening is required. When we compare these results with the same middle row position with the sound masking system running, the PA average is reduced to 72.09 percent, which is barely discernable to the listener. It is understood that sound masking is contributing to reducing speech intelligibility when standing 25 feet away from source.

Studying the results of the three floors, with system off along the back row, the PA average is 85 percent, which yields that speech intelligibility is very good. When we compare these results with the same back row position with the sound masking system running, the PA average is reduced to 60.80 percent to speech not heard suitably. It is understood that sound masking makes speech incomprehensible standing 35 feet away from source.

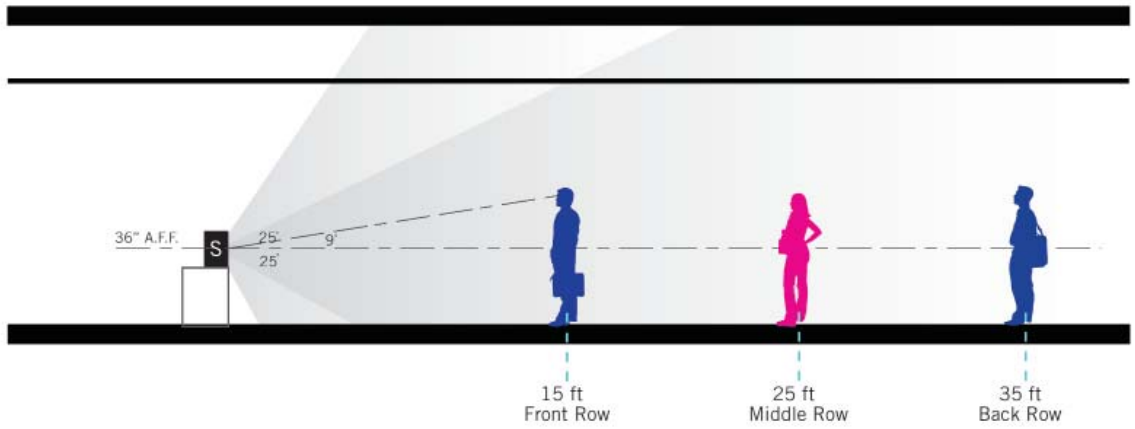

Figure 10: Arrangement of volunteers from sound source in typical open office environments.

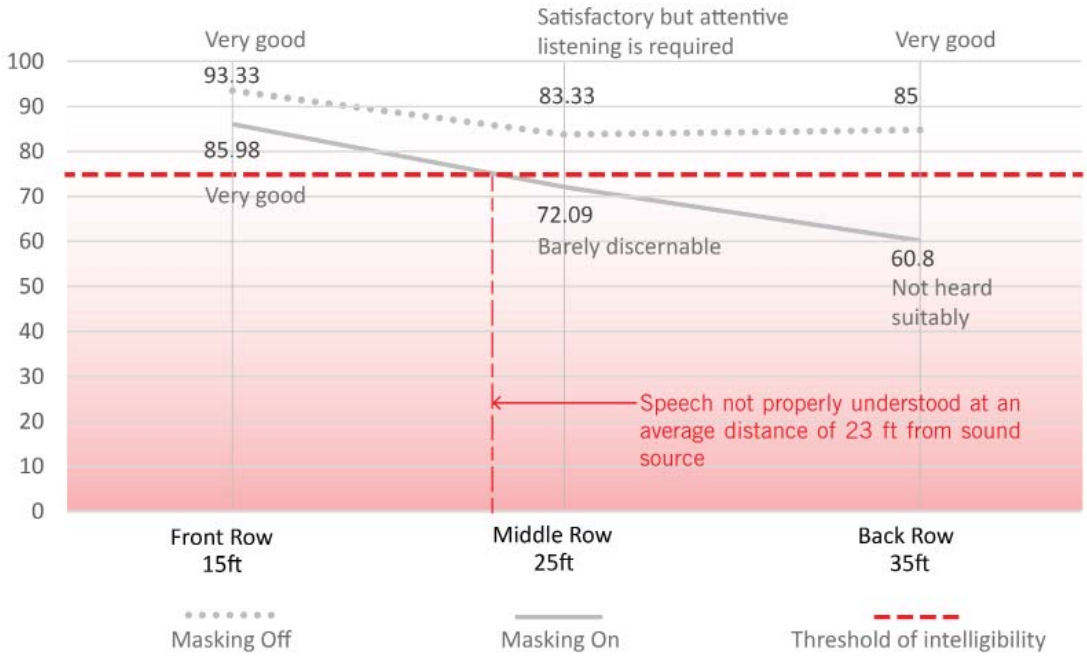

Figure 11: Average PA results from open office environments.

3.2 Average Performance Results When Used Adjacent to Enclosed Office Environments

Figure 12 shows the arrangement of volunteers in relation to sound source adjacent to enclosed office environments, and Figure 13 summarizes average PA results for the sample areas adjacent to enclosed office enviroments. When we review the results of the three floors, with system off along the front row, the PA average is 63.33 percent, which yields that speech is not heard suitably. When we compare these results with the same front row position with the sound masking system running, the PA average is reduced to 31.77 percent and speech is still not heard satisfactorily. It is understood that the average partition alone seems able to reduce speech articulation below the threshold of intelligibility. However, the sound masking system further diminishes the PA. A higher PA was observed at floor 16 and 18, where the partition did not extend up to structure above. It is understood that when devising corridor walls stop at the ceiling system, the average PA was 77.5. People standing at 15 feet from source would be able to hear satisfactorily.

Reviewing the results of the three floors, with system off along the middle row, the PA average is 43.33 percent, which yields that speech is not heard suitably. When we compare these results with the same middle row position with the sound masking system running, the PA average is reduced to 13.61 percent and speech is still not heard satisfactorily. It is understood that the partition alone seems able to reduce speech articulation below the threshold of intelligibility. However, the sound masking system further diminishes the PA.

Studying the results of the three floors, with system off along the back row, the PA average is 10.83 percent yielding that speech is not heard suitably. When we compare these results with the same back row position with the sound masking system running, the PA average is reduced to 2.22 percent and speech is still not heard satisfactorily. It is understood that the partition alone seems able to reduce speech articulation below the threshold of intelligibility. However, the sound masking system further diminishes the PA.

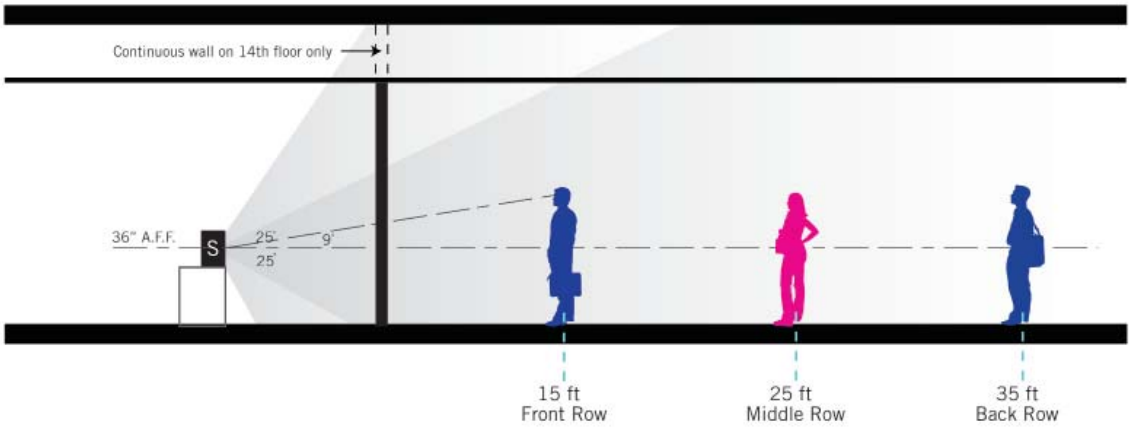

Figure 12: Arrangement of volunteers from sound source adjacent to enclosed office environments.

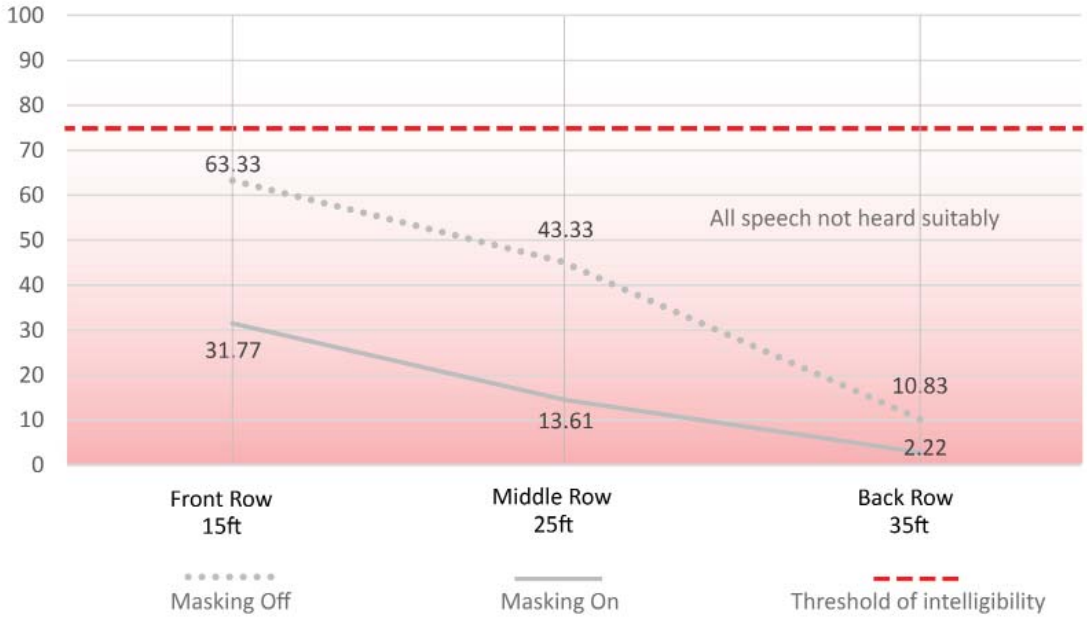

Figure 13: Average PA results for enclosed office environment.

3.3 Privacy Zone

The inherent characteristics of a sound masking system will also impact the size of speech privacy zones. A speech privacy zone is defined as the aural arena in which people can clearly converse and understand conversational speech. Given that the findings endorse that enclosed offices are generally private, a closer look at the impact sound masking has on open areas is warranted.

In an open office environment with the sound masking system off, the volunteers' position in the back row achieved an average PA of 85, which is classified as very good intelligibility. No tests were performed with volunteers beyond 35 feet from sound source and it is presumed that adequate speech intelligibility heard in this environment would exceed this distance. When the same open environment is compared with the system functioning, we observe that the threshold of intelligibility at a PA of 74 reduces the privacy zone. This identifies that on average, in an open office environment, speech can be properly heard within a 23 feet radius of the speaker and that people positioned outside of this zone would not properly understand or be able to suitably follow ongoing conversations, as seen in Figure 14. This finding suggests that in the presence of an active sound masking system, there is a tangible improvement in the size of the privacy zone that should also contribute to reducing adjacent disturbances.

4.0 CONCLUSION

The recorded and calculated PA given in this report are a function of the specific environment and may not directly apply to other project environments. Although this data raises an awareness on how the sound masking system behaves in difference spaces, the following conclusions are offered.

The Speech Articulation testing conducted along with the results gathered from the volunteers demonstrate that in the presence of an active sound masking system, speech recognition is consistently lowered, which provides an elevated level of speech privacy. It is generally understood that the further away the listeners are positioned from a sound source, the PA is also reduced due to the reduced level of sound energy. When comparing the results from the sound masking system turned off and with the system turned on, similar effects in the reduction of PA have been observed. This would indicate that having a sound masking system in place would have similar effects on the occupants as distancing the listener from source, which in turn helps to hinder intelligibility of speech.

The sound masking system does not considerably affect speech privacy when conversational speech is broadcast from enclosed offices. This is attributed to the physical partition, which generally acts as a sufficient sound barrier. There were variances noticed

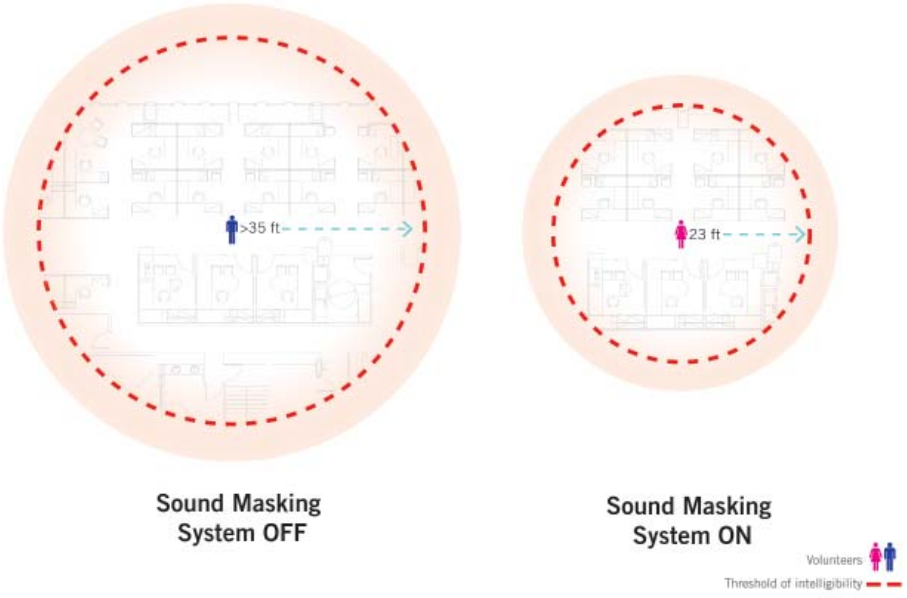

Figure 14: Extent of Privacy Zone diagram.

on the impact to occupants in the near vicinity to an enclosed office. These PA values varied from speech not heard suitably when adjacent partition extend to structure above to speech heard very well when adjacent partitions stop at the suspended ceiling system. Where the speech was being heard very well along the front row, the sound masking did hinder speech intelligibility in the range of 20 feet from sound source of the enclosed room. From a practical sense, this means that in the absence of a sound masking system, people walking through the nearby corridor would hear confidential discussions that would occur from the office. This stresses the importance of proper construction of partitions and their respective doors to act as virtuous sound barriers. Given that site workmanship of said barriers may vary depending on contractors or trades, there is an inherent benefit to have sound masking systems in order to ensure speech privacy is maintained immediately adjacent to enclosed offices, especially when partitions do not extend to structure above.

The sound masking system hinders speech intelligibility, enhancing speech privacy in a privacy zone in the range of 23 feet away from source when used in open office environments. The efficiency of the sound masking system seems to be reduced when used in smaller open office environments where nearby walls and ceilings are made of elevated amounts of hard surfaces. This implies that first order reflections would reinforce the sound energy further in the back row. This stresses the importance of designing spaces with materials that have a good absorption to reduce intelligibility to speech and to help reduce the size of the privacy zone.

Acknowledgments

The author acknowledges the significant contributions of the Head Office Renewal relocation design team. In Chicago: Joe Connell, Jennifer Carzoli, Lara Leskaj, Courtney Ruhl and Rebecca Hinss. In Ontario: Matt Johnston and Robert van Lin, with key support from Linda McDonald. Special thanks to Tony Barr of Environmental Acoustics, who acted cooperatively with the design team during and after the testing. The client team was highly supportive throughout the process.

REFERENCES

[1] Public Works and Government Services Canada (2012). Guideline for the Government of Canada Workplace 2.0 Fit-Ups Standards, Ottawa, CA, Retrieved from www.raic.org/resources_archives.

[2] Egan, D., (2007). *Architectural Acoustics*, Plantation, FL: J. Ross Publishing.

[3] U.S Green Building Council. “Speech Privacy & Sound Masking in Modern Architecture”, Retrieved from: http://www.usgbc.org/education/sessions/speech-privacy-sound-masking-modern-architecture-4751677.

[4] ASTM (2008). Guideline E1130-08 Standard Test Method for Objective Measurement of Speech Privacy in Open Plan Spaces Using Articulation Index, West Conshohocken, PA: ASTM International.

[5] ASTM (2013). Guideline C634-13 Standard Terminology Relating to Building and Environmental Acoustics, West Conshohocken, PA: ASTM International.

[6] ASTM (2013). Guideline E1179-13 Standard for Sound Sources Used for Testing Office Components and Systems, West Conshohocken, PA: ASTM International.

[7] National Academy on an Aging Society. “Hearing Loss: A Growing Problem that Affects Quality of Life”, Report, Retrieved from: http://www.agingsociety.org/agingsociety/pdf/hearing.pdf.

[8] Knudsen, V., and Harris, C., (1978). *Acoustical Designing in Architecture*, Melville, NY: The American Institute of Physics for the Acoustical Society of America.

04.
ANALYSIS OF THERAPEUTIC GARDENS FOR CHILDREN WITH AUTISM SPECTRUM DISORDERS

Micah Lipscomb, ASLA, LEED AP BD+C, *micah.lipscomb@perkinswill.com*
Alexander Stewart, ASLA, LEED AP BD+C, *alexander.stewart@perkinswill.com*

ABSTRACT
Current research on the impacts of landscape architecture on children with Autism Spectrum Disorder (ASD) are surprisingly lacking, considering the believed benefits of the natural environment on individuals with special needs. This study examines how outdoor design elements benefit children with ASD and specifically, how these design criteria can be implemented to inform the design of a camp that serves children with ASD. In the study, the team used the following research methodology: a review and critique of established design criteria, an observation and analysis of built projects to evaluate experiential design criteria, and an application of design guidelines to a specific project. The results of the study were a refined set of design guidelines that creates a hierarchy of importance for the criteria. This design criteria enriched the conceptual design of a camp called Camp Southern Ground, by focusing the design on elements that appear to provide therapeutic benefits to children with ASD. While the complexity of ASD does not allow for simple answers, the article provides a framework to both inform better design for outdoor spaces for this unique population and expand the conversation beyond the limited research that exists today.

KEYWORDS: landscape design guidelines, sensory environments, sensory processing disorder, special needs therapeutic landscapes, evidence-based approach, restorative outdoor spaces, healing gardens

1.0 INTRODUCTION
The percentage of individuals diagnosed with Autism Spectrum Disorders (ASD) is rising in our society. A 2010 CDC report estimated that one in every 68 children are affected by autism, which marks a dramatic increase from the rates in previous studies (a 123% increase from a 2002 study)[1].

ASD affects the way individuals understand and process their environment. It is a complex neurological disorder that affects three primary areas: sensory integration, social interaction and communication, and repetitive patterns of behavior[2]. The word spectrum suggests the wide range of symptoms for individuals with ASD; some individuals have good language skills and high cognitive skills while others are nonverbal and have significant social, cognitive, and motor skill challenges. A well-known phrase is “if you’ve met one person with autism, then you’ve met one person with autism” because characteristics vary greatly from individual to individual[2].

Engagement with nature provides an important experience for children with autism. This theory is supported by numerous scientific studies that have documented improved health outcomes from views of and engagement with nature[3]. Richard Louv has pointed out that children are happier, smarter and better adjusted with more time spent in the outdoors[4]. Kaplan and Kaplan have noted that the outdoors can provide restorative benefits as well as sharper mental focus[5]. The benefits

are slowly being documented, but autistic children who are exposed to nature benefit from these experiences. Landscape architecture design for children with ASD has had limited exposure.

Autism characteristics are often discussed in partnership with Sensory Processing Disorder (SPD). SPD is a neurological disorder that causes difficulties with taking in, processing, and responding to sensory information about the environment and from within the own body. Individuals with ASD often have this disorder, but not all, and individuals with SPD are not all autistic. Individuals with SPD live in a spectrum of sensory experiences ranging from hypersensitive (oversensitive to stimuli) to hyposensitive (under-sensitive to stimuli). In addition to the traditional five senses, two other senses have been determined to be valuable in understanding autism: proprioceptive and vestibular senses[6]. Designing public or inclusive spaces requires accommodation of as many characteristics as possible, whereas designs for individuals can be customized, focused and honed to the individual's needs. Below is a brief description of how the role of senses impacts individuals with SPD, and Figures 1 to 7 illustrate how landscape design can be utilized to address these specific sensory factors.

A. Visual: Creating ordered, calm, and consistent language in spaces is critical for children with ASD[7]. Seeing too many elements at once can overstimulate an individual with ASD. Clear sight lines should be provided so that the individuals can take in their surroundings. Visual clues such as a clear definition of space, patterns in pavement or signage, can help put special needs children at ease. Some children with ASD are photosensitive, therefore it is important to provide shade in garden areas[8].

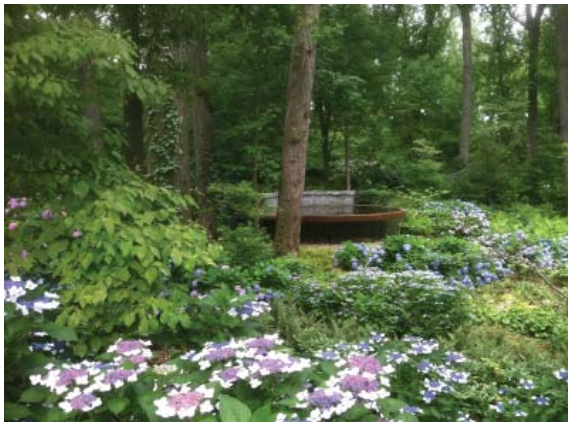

Figure 1: Visual senses and design elements.

B. Auditory: Children with ASD can be overly sensitive to noise while others can be hyposensitive. Cocooning spaces should be created for hypersensitive children so that they can retreat when they get overwhelmed. In building design, careful attention should be paid to how sounds bounce off walls[9]. Hyposensitive children need safety precautions to protect them from danger that mainstream individuals recognize, such as traffic.

Figure 2: Auditory senses and design elements.

C. Tactile: Spaces should be designed with the understanding that texture may be important for some children; a pebble path, a sand box, even grass. Hyposensitive children might need spaces that downplay these textures. Public spaces must then be developed with an array of surfaces that are well separated for a range of experiences.

Figure 3: Tactile senses and design elements.

D. Smell: Strong fragrances can be an issue with some ASD children[6]. Therefore, if fragrant plants with temporal blooms are used in the landscape they should be localized so that sections of the landscape do not have strong aromas. Plants with leaves that are fragrant when crushed can be used throughout a landscape since the aroma is more controlled.

Figure 4: Smell and landscape design elements.

E. Taste: Similarly to smell, flavors can impact children with autism in different ways. While this has a low impact in the design of spaces, it is yet another important factor in the complex understanding process of children with ASD.

Figure 5: Taste and landscape design elements.

F. Vestibular: Balance, movement, and the sense of spatial orientation is largely regulated by the vestibular system. One of the reasons some children with ASD like spinning, rocking, pacing or running is because their vestibular system is under stimulated. On the contrary, children with hypersensitivity to movement may have their energy levels drained by activity. Providing a variety of activities from swinging to cocooning will help accommodate different users.

Figure 6: Vestibular aspects and design elements.

G. Proprioceptive: Proprioceptive systems give individuals sense of awareness and movement of one's body in space. If children with ASD have a proprioceptive system that does not function normally, it may cause them to be clumsy and unable to evaluate distances between them and others. Providing spaces that are designed for safety is important because of this factor. Vibration therapy in the form of drumming decks is one method that could be integrated into a landscape to assist with ASD symptoms.

Figure 7: Proprioceptive aspects and design elements.

Understanding the wide variety of sensory inputs that affect autistic individuals gives clues to the complexity of the problem. The spectrum of characteristics suggests that there are no simple solutions or quick answers.

2.0 RESEARCH METHODOLOGY

The team used the following research methodology: a literature review and critique of established design criteria, an observation and analysis of built projects to evaluate experiential design criteria, and an application of design guidelines to a specific project. The project, Camp Southern Ground, is a summer camp designed to serve children of diverse abilities and backgrounds (including special needs and neuro-typical children) to come together and learn life skills, and encourage personal growth in a positive environment. In short, the goal of the camp is to have children with special needs and other children not only be comfortable with one another, but to build a deep trust between two groups that are often isolated from one another.

2.1 Precedent Projects

To broaden our perspective on what makes an ideal site for children with ASD, we visited six cities and numerous projects. As there are very few sites that are specifically designed for children with special needs, we expanded our visits to include children's gardens, public playgrounds, and camps for special needs children. The following is a brief description of the places we visited and the lessons learned from each of these visits.

2.1.1 Camp Glisson (Dahlonega, GA)

Camp Glisson (Figure 8) is a rustic camp located north of Atlanta successful in mingling mainstream campers with special needs children. A couple of key components make Camp Glisson a valued resource. First, it offers a clear separation of mainstream campers and special needs children in their living quarters. Through our research, it was clear that allowing special needs children their own space and place to get away is critical. At the same time, the lodging is close enough that they are still very much a part of the camp. The second component that should be noted is the lack of special activities just for the special needs campers. The activities were always integrated and universal even if it meant that there were special lifts or systems to accommodate all children. The camp appears to be comfortable pushing the boundaries of all children and letting them grow to their own needs.

Figure 8: Camp Glisson.

2.1.2 Coastal Maine Botanical Garden (Boothbay, ME)

The Coastal Maine Botanical Garden demonstrates three items of significance for the notion of a therapeutic garden for children with special needs (Figure 9). First, the Garden of the Five Senses incorporates opportunities for children to explore using different senses (taste, smell, hearing, touch and vision). The garden is well built, beautiful and based on a strong concept, however, our impression was that the specific senses could have been better explored. Second, the Children's Garden allows for activities such as pumping of water, playing in the sand, a ropes tree house, or pulling up lobster buoys. All activities work on different strengths of the children and engage them in a variety of opportunities. The last item is the integration of the natural landscape with manmade objects. There are plenty of opportunities for children to walk in the woods and engage with natural materials (such as building play houses with sticks or climbing on a giant rock outcropping). A wide variety of fountains fully engage the children and allows them to touch, watch or jump over water. Using natural materials allows them to learn the complexities and simplicities of nature. While the garden is not designed for

Figure 9: Coastal Maine Botanical Garden Garden of the Five Senses.

Figure 10: Huntington Botanical Garden Children's Garden.

special needs children, it offers significant opportunities for enjoyment and learning.

2.1.3 Huntington Botanical Garden and Library (Los Angeles, CA)

Huntington Botanical Garden is an amazing complex with many resources. What is special about Huntington is how it mixes play with learning. The Children's Garden is surrounded on three sides by a conservatory and greenhouse, which is more like a small children's museum. Here kids can understand root growth or how seeds travel in the wind by cranking fans. It is a very creative way to teach the children in a safe environment. The Children's Garden itself provided a few items of significance. The scale was appropriate where the kids could easily find their way around, but also not quite see what is around the corner. Devices, where children drop rocks onto metal pegs for sound, were inventive and engaging. Misting rooms cooled children while creating a safe sense of mystery. Along with opportunities to get their hands dirty, to climb, and to explore, the garden had elements that engaged both parents and children (Figure 10).

2.1.4 Morton Arboretum Children's Garden (Garden Lisle, IL)

This four-acre garden engages children in learning about nature through outdoor play. The garden develops in complexity with an initial quiet entry sequence, which builds into an "Adventure Woods" with multiple destinations that appeal to a wide variety of abilities. Interactive water features are some of the most popular elements in this garden. Children seemed to delight in manipulating their environment through hand powered water pumps, moveable stones to create dams in a stream, or stone globes that spin in water. Colored concrete pavement patterns and leaves imprinted in the pavement provide repetition and a sense of continuity in the garden. Meandering paths provide a sense of mystery. Vine tunnels and artificial caves provide places for escape while providing clear sight lines for parents. An elevated lookout nestled in the trees provides a place for children and parents to take in the full range of play options. Parents indicated that the most popular element for their children was the Wonder Pond, an artificial shallow pond that comes to life once a year with tadpoles (Figure 11). This reminds us that the interaction with plants and animals is an essential experience in these designed landscapes.

Figure 11: Morton Arboretum Children's Garden Wonder Pond.

2.1.5 Center for Discovery (Monticello, NY)

This vast facility serves around 450 patients with a range of special needs including ASD (Figure 12). The experience at the center is more about a holistic experience that encompasses the entire landscape, rather than a discrete contained garden. Fields of crops, greenhouses, fruit orchards, mobile chicken tractors, and sinuous paths are all integrated into the patient experience. For example, organic produce and eggs from the farms are gathered by patients, cooked by patients, and then feed the patients and staff. This reflects the center's "whole systems-whole person" approach to the disorder, which looks beyond just behavioral and neurological problems to include nutrition, exercise, music, and other areas. The challenge of maintaining such a large facility was clear and we were reminded of the need to craft durable, low-maintenance landscapes. Dry stack stone walls provided a sorely needed sense of continuity throughout the landscape. The broad scale of the center expanded our notions of what role landscape can have in the lives of children with ASD.

Figure 12: Center for Discovery.

2.1.6 Julius Kahn Playground (San Francisco, CA)

At first glance, Julius Kahn Playground is a typical neighborhood playground (beyond the view to the Golden Gate Bridge and wonderful setting in the Presidio); intimate and comfortable with swings, a sand box and a jungle gym (Figure 13). Upon closer look, it is clear that there were significant decisions made to serve an autistic audience. As described by Vince Lattanzio, ASLA, President of Carducci and Associates in San Francisco, the park provides "flexibility and opportunities for adaptation of use, visual clues and clear lines of sight, clear definition of space, predictability and non-threatening elements, clearly defined boundaries and signage"[9]. There is plenty of room in this park even though it is intimate. The key elements are well spaced, leaving plenty of running room within the confines of the small boundary fence.

Figure 13: Julius Kahn Playground.

2.1.7 Mission Delores Park (San Francisco, CA)

Mission Delores Park has been transformed with the addition of the new playground. While not focused on special needs specifically, it has many of the elements that have been outlined as suitable design elements including challenge opportunities, swings, open space for children to roam, multiple slides to reduce congestion and the incorporation of planting as an integral part of the design (Figure 14). Adults seem to be enjoying the park as much their younger counterparts, because the opportunities are creative and vast. The park offers a wide range of options that appeal to a spectrum of people.

Figure 14: Mission Delores Park.

2.2 Design Guideline Review

We identified two resources that outline the guidelines for landscape architecture design for children with ASD[2,6]. Hebert and Vincenta developed these guidelines through examination of current available research, personal interviews and observations. Our approach was to compare and contrast these documents and to create a hierarchy of importance. Many of the guidelines overlapped or seemed to be less critical than others, yet were treated with equal importance. In categorizing essential guidelines, we focused on elements that provide safety, accessibility, and help children overcome sensory issues. These guidelines should be viewed as a preliminary framework that needs to be evaluated in a built work with post-occupancy evaluations to determine if the strategies are effective. In addition, as Vincenta observed "these should be considered for their appropriateness within the context of a given project and should not be considered guaranteed solutions"[2].

One of the most important principles outlined by Claire Cooper-Marcus and Marni Barnes in their book Healing Gardens: Therapeutic Benefits and Design Recommendations is to design for the needs of the users[10]. This principle is challenging to apply to a garden for ASD children, given the spectrum of symptoms for ASD. The complexity of ASD dictates that each project would need to apply the guidelines to meet the needs of the users, as every child with ASD has different needs. We have outlined a refined set of guidelines for the design of gardens for ASD children in Table 1.

Table 1: Guidelines for the design of gardens for ASD children.

Essential Guidelines	Other Guidelines
1. Design for safety, security, and supervision a. 5' minimum height for a perimeter fence b. Avoid toxic materials and plants c. Clear sight lines to garden 2. Universal Design (Beyond ADA) a. Clear edge along paths (for vision impaired)- such as texture differention b. Plenty of visual aids and signage (orientation maps) c. Smooth, wide surfaces (avoid overcrowding) 3. Provide opportunities to overcome sensory issues 4. Quiet location-mask or screen unwanted noise 5. Provide places for retreat from sensory overload a. Cocooning places-willow tunnels, hammocks 6. Provide opportunities for exercise a. Increase motor skills, coordination, and balance 7. Design for maximum nature interaction 8. Provide shade 9. Design for emotional and human comfort 10. Design for the needs of the users	1. Provide elements of consistency – in the form of materials or plants 2. Provide transition between spaces 3. Sequence activities 4. Provide fixed and non-fixed activities 5. Flexible design that accommodates a variety of uses and individuals 6. Provide opportunities for increased socialization-social seating spaces, moveable seating 7. Build in challenges 8. Provide observation points 9. Provide storage (for play equipment used in therapies)

3.0 CAMP SOUTHERN GROUND

The inspiration for this research was Camp Southern Ground, a summer camp/conference center nestled in the rolling hills of Fayette County, Georgia. Perkins+Will was engaged in the master planning of the project. The design and planning was informed by the needs of its driving force, special needs children (Figure 15). Through the research, we examined factors that would provide the clearest landscape goals in the design of the camp. The following is a description of the core elements we integrated into the design of the camp as a result of this research. As this was a master plan level effort, there is an opportunity for future design efforts to better address the site-specific design considerations. As the design is advanced, careful consideration must be made to integrate positive natural distractions into the camp experience. For example, the nearby wetlands, lake, and surrounding forest are being designed to be engaged through boardwalks, docks and treehouses and the existing large clay borrow pit is being transformed into an activity adventure center. However, these elements also do not address the important operational considerations that will enrich the camp experience, such as horticulture therapy within the healing gardens, input from occupational and physical therapists, and other programming considerations. The site design only addresses part of the camp experience, for it is in the human interactions that transformative personal growth will occur for campers.

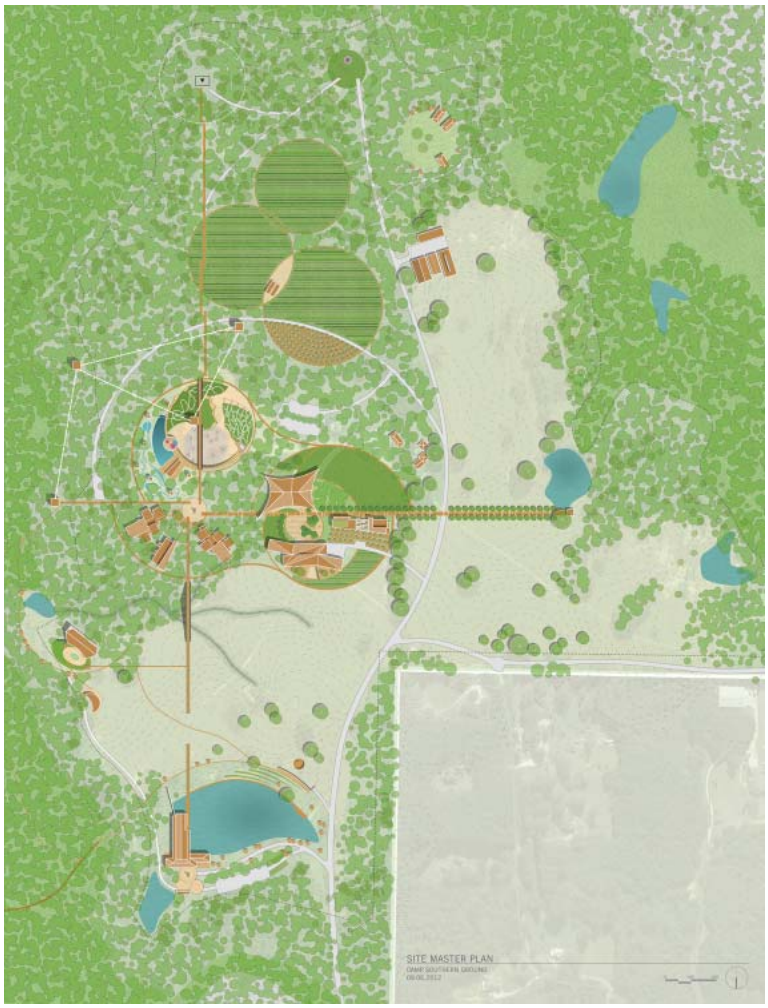

Figure 15: Camp Southern Ground site master plan.

3.1. Sequencing of Site

Vincenta describes sequencing as a critical element for special needs children as they move from space to space[2]. This theory is supported by research on architectural design for autistic children by Mostafa[8]. In the design of the camp, we expanded the concept from a garden scale to a community scale, where each camp district has distinct characteristics that elevate in intensity as one moves through the site (Figure 16). The sequence begins from the point of arrival at the welcome center (#1). Here the design of the space is simple, warm and inviting, providing families and campers an opportunity to settle into the space. Traveling through a tunnel along the north-south spine, the transformation into more challenging spaces begin. After this tunnel, the lodges (#2) expose campers to a bit more wild nature while maintaining a comfortable environment. Once campers are ready, they can challenge themselves with a visit to the adventure center (#5), where they learn to trust each other and their own abilities.

Key to Sequence Diagram
1. Welcome Center
2. Lodging
3. Dining
4. Education components
5. Adventure

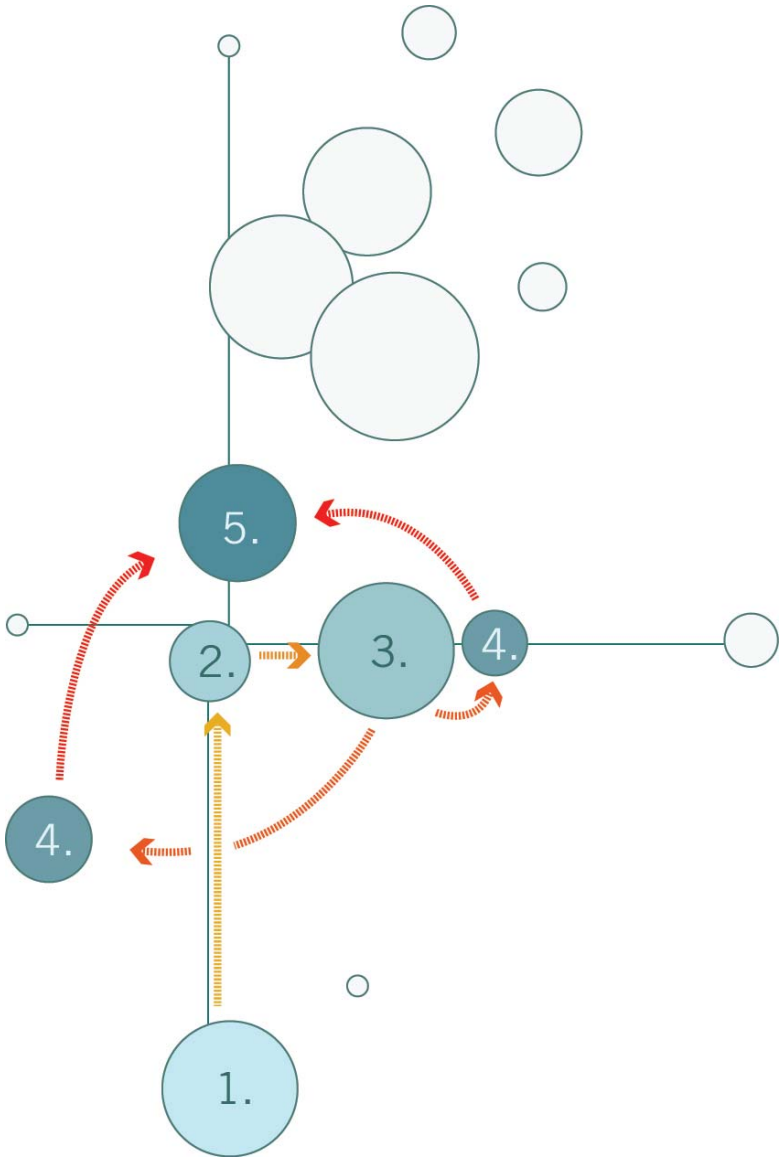

Figure 16: Camp Southern Ground sequencing diagram.

3.2 Decompression Zones

Spaces for re-centering and calming were implemented throughout the campus. These spaces integrate nature as a soothing element, especially at the health center where water and reflection are focus elements within small garden "rooms" (Figure 17), and at the respite lodge where cocooning swings are incorporated into the design.

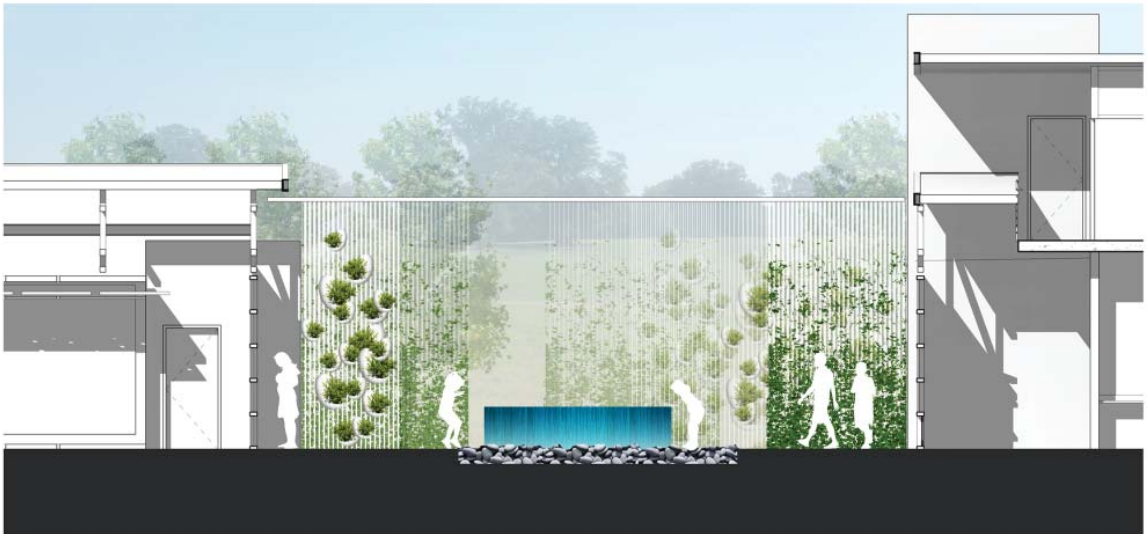

Figure 17: Health Center cross section.

3.3 Healing Gardens on a Broader Scale

Most districts have healing gardens associated with their key characteristics. While traditional camps, retreats or campuses are fortunate to have one healing garden, the design for the camp has been broadened and pushed to focus on simple senses in order not to overwhelm individuals. Within all of these gardens, there is a great opportunity to incorporate horticulture therapy into the camp experience. In her book on gardening with children with ASD, Etherington noted many benefits for ASD children in horticulture therapy, such as easing anxiety, promoting sensory integration and building social skills[11]. The taste garden is especially well-suited to horticulture therapy, since the children would be able to eat and share the fruits of their labor with others.

Key to Healing Garden Diagram
a. Visual garden with the arts complex
b. Sound garden with the music building
c. Aroma garden with the health and environment building
d. Tactile gardens as part of the respite lodge courtyard
e. Taste gardens as part of the dining hall and organic farm
f. Vestibular and proprioceptive gardens as part of the adventure zone
s. Staff decompression garden

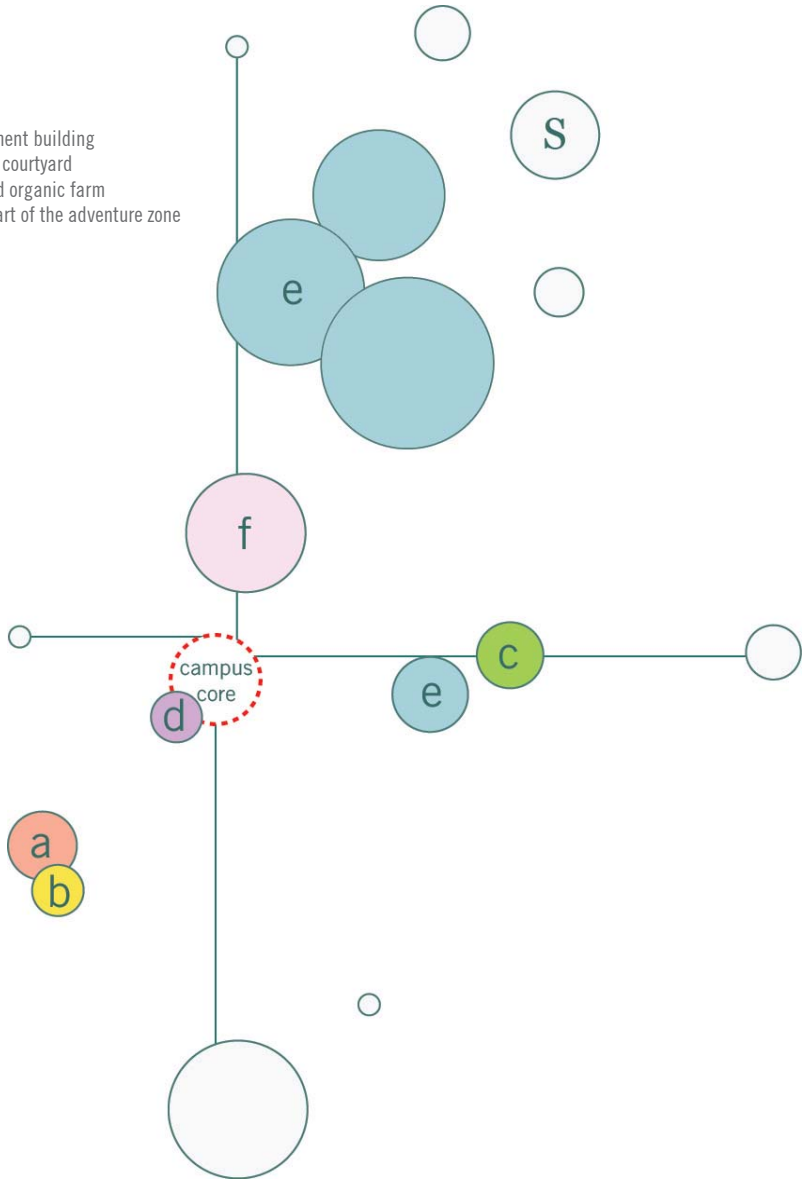

Figure 18: Healing Gardens diagram.

The following gardens were incorporated into the master plan (Figure 18):

a) Visual garden with the arts complex
b) Sound garden with the music building
c) Aroma garden with the health and environment building
d) Tactile garden as part of the respite lodge courtyard
e) Taste garden as part of the dining hall grounds and the organic farm as part of a hands on experience for the children.
f) Vestibular and proprioceptive gardens as part of the adventure zone
s) Staff decompression garden to allow for the staff to re-energize.

3.4 Spectrum of Experiences

The vision for this camp is to open the door for as many individuals as possible. The design follows this direction by creating opportunities for children to succeed in the ways that fit them best. This is carried out through the separate gardens as outlined above as well as an array of opportunities to learn through (but not limited to) natural play, music, art, cooking, digital arts, and environmental studies. Further, each of these can be explored in individual preferences. This model creates a wide spectrum of activities where each child can find their own path. Figure 19 shows the spectrum of experiences to be provided and how a child may find his or her own path.

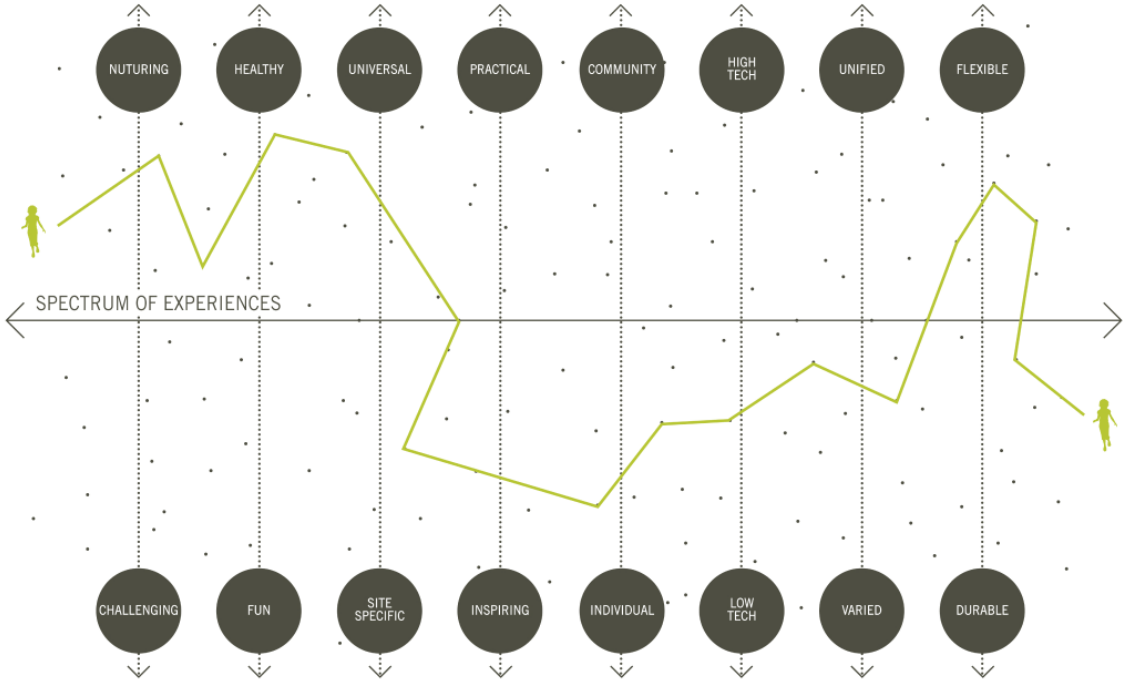

Figure 19: Spectrum of experiences diagram.

3.5 Respite Lodge

The respite lodge (Special Needs Housing) (Figure 20) includes many elements specially designed for those who will use the site, although on a much smaller scale than the rest of the camp. The looped circulation system is consistent with observations that some children with ASD enjoy following circuits. The design for the courtyard started with this concept for creating a series of closed loops for the children to exercise on and follow. As they follow the circuit, they will encounter zones for activity and a spectrum of natural material experiences on a local scale. These include the calming respite of water, the rich textures for tactile engagement of a stone garden, the challenge and climbing space of sculptural wood elements (Figure 21) and a sand garden to build and be creative in.

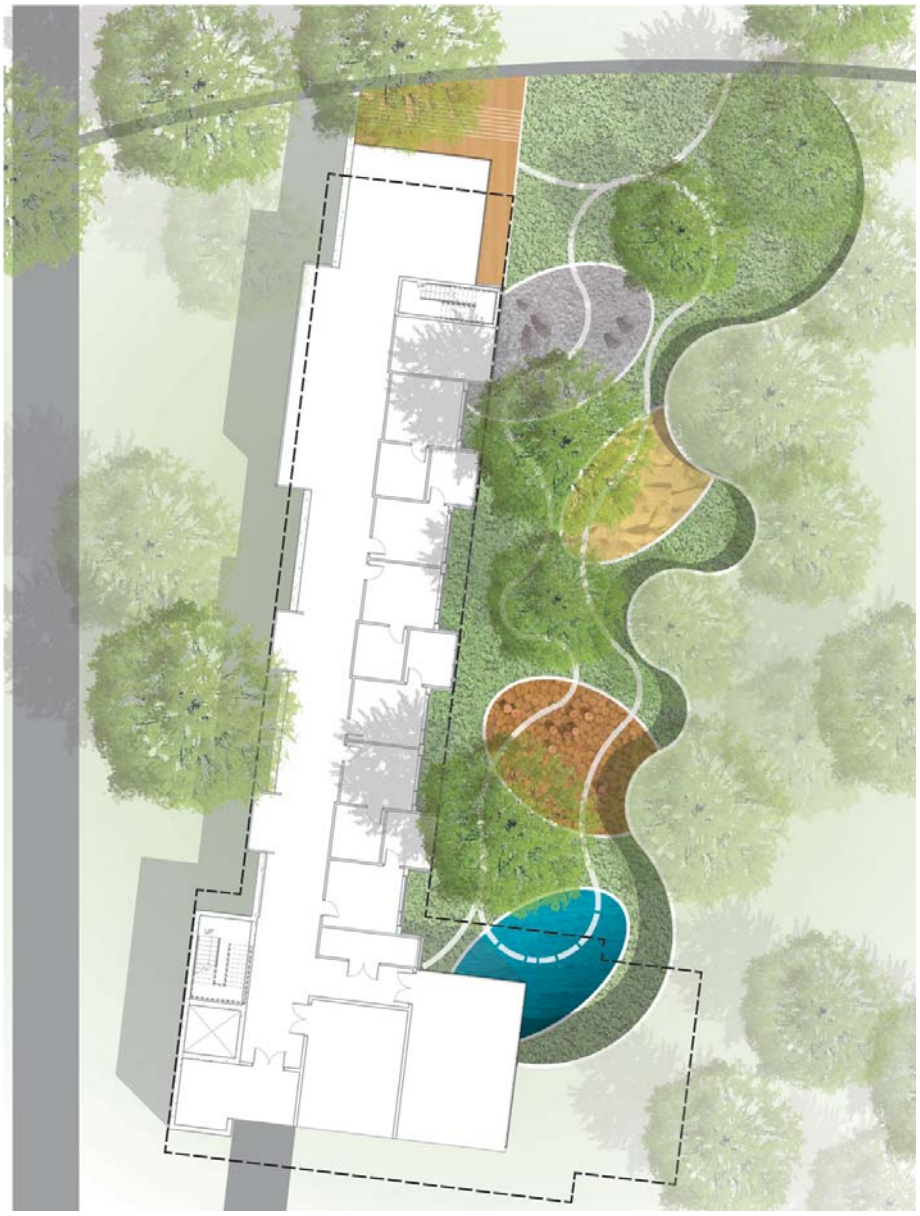

Figure 20: Respite lodge site plan.

Figure 21: Respite lodge east-west section – Wood Garden.

The site is uniquely tied to the architecture with spaces that flow inside and out to provide elements for comfort. Surface safety in the garden was considered through the use of a combination of planted surfaces and rubber mat surfacing that continues into the building. An organic shaped stone wall, combined with the architecture, creates a protective nest to shield the children from wind from all directions. Further, the space is entirely shaded as the site is nestled comfortably in existing woods, and the building is oriented to the west of the garden to add shade and protect from the setting sun. A roof overhang over the water garden and covered outdoor terraces provide additional sun protection. Cocooning swings hang within the porches facing the garden and green walls incorporating nature into the interior (Figure 22). The design team has also located utilities on the roof of the building to keep noise and venting away from the children.

Figure 22: Respite lodge north-south sections.

4.0 CONCLUSION

Design of therapeutic gardens for children with special needs must consider many different aspects, as we have illustrated in this article. During the literature review and observational study of built projects, we found that there is not a single, specific design method that should be used. After reviewing research articles, books and other sources, we felt that we had a good understanding of what children with ASD need. However, we discovered that the spectrum was so wide, that it was hard to have a short answer. Rather, different criteria must be considered, and we developed a list of essential factors, and guidelines. The first principle should be to create a universal and safe design that meets everyone's needs. We also implemented these guidelines into the design of Camp Southern Ground. Further research, analysis and post-occupancy evaluations are necessary to evaluate the effectiveness of different design strategies that were used during the design.

Acknowledgments

Special thanks to designers who shared information and discussed concepts with us including Regan Coover, Jean David Derreumax, Peter Dollard, Thomas Brown, Leo Alvarez, Basak Alkan, and Vincent P. Lattanzio.

The research for this article was conducted in a limited amount of hours through Perkins+Will's Innovation Incubator program, a micro-grant program to support the culture of innovation through small, focused, fast-paced investigative projects that are led by Perkins+Will employees. This represents a first step into research on this subject only, and there is a great opportunity for the subject to be further explored.

REFERENCES

[1] Baio, J., (2014). "Prevalence of Autism Spectrum Disorder Among Children Aged 8 Years — Autism and Developmental Disabilities Monitoring Network, 11 Sites, United States, 2010", *MMWR Surveillance Summaries*, Vol. 63, No. SS-2, pp. 1-21, Retrieved from http://www.cdc.gov/mmwr/preview/mmwrhtml/ss6302a1.htm?s_cid=ss6302a1_w.

[2] Sachs, N., and Vincenta, T., (2010). "Outdoor Environments for Children with Autism and Special Needs", *Implications*, Vol. 09, No. 1. Retrieved on 2/6/2012 from http://www.informedesign.org/_news/april_v09-p.pdf.

[3] Taylor, A., Kuo, F., and Sullivan, W., (2001)."Coping with ADD: The Surprising Connection to Green Play Settings", *Environment and Behavior*, Vol. 33, No. 1, pp. 54-77.

[4] Louv, R., (2005). *Last Child in the Woods: Saving Our Children from Nature-Deficit Disorder*, Chapel Hill, NC: Algonquin Books of Chapel Hill.

[5] Kaplan, R., and Kaplan, S., (1989). *The Experience of Nature: A Psychological Perspective*, Cambridge, NY: Cambridge University Press.

[6] Hebert, B., (2003). *Design Guidelines of a Therapeutic Garden for Autistic Children*, MLA Thesis, Louisiana State University.

[7] Reynolds, D., (2011). "Autistic Children with Epilepsy are Often Sensitive to Light", Retrieved on 10/20/14 from http://www.emaxhealth.com/1506/autistic-children-epilepsy-are-often-sensitive-light.

[8] Mostafa, M., (2008). "An Architecture for Autism: Concepts of Design Intervention for the Autistic User", *International Journal of Architectural Research*, Vol. 2, No. 1, pp. 189-211.

[9] Johnston, B., "Interview with Brian Johnston on the Landscape of Autism". Retrieved on October 2012 from ASLA blog the Dirt. http://www.asla.org/ContentDetail.aspx?id=37601

[10] Cooper-Marcus, C., and Barnes, M., (1999). *Healing Gardens: Therapeutic Benefits and Design Recommendations*. Hoboken, NJ: John Wiley & Sons.

[11] Etherington, N., (2012). *Gardening for Children with Autism Spectrum Disorders and Special Education Needs: Engaging with Nature to Combat Anxiety, Promote Sensory Integration and Build Social Skills*, London, UK: Jessica Kingsley Publication.

05.
A VISION AND PLANNING FRAMEWORK FOR HEALTH DISTRICTS OF THE FUTURE

Basak Alkan, AICP, LEED AP, *basak.alkan@perkinswill.com*

ABSTRACT

The U.S. healthcare industry is undergoing the transformation of a century. The move away from the fee-for-service payment model and the Affordable Care Act are driving a paradigm shift towards disease prevention and population health management with services increasingly delivered in lower-cost, community-based settings.

Redefining healthcare typologies and planning methods is an integral part of this transformation. An increasing number of hospitals and health systems are already joining forces and partnering with community organizations to invest in programs that are intended to keep citizens healthy and out of the hospital. Many of these initiatives, however, fall short of addressing the socio-economic and environmental root causes of unhealthy behaviors, which are impacted by the planning, design, and operations of health facilities.

This research paper proposes a new planning paradigm for healthcare called Health District Planning. A Health District is a place where investments are targeted to improve population health outcomes and to inspire healthy behaviors. Best practices from various case studies, and related evidence from public health and healthy community design research is synthesized into a four-part framework—the 4 P's of Health District Planning: (i) population health, (ii) place, (iii) partnerships, and (iv) performance. The goal is to offer a guideline for planning the Health Districts of the future.

KEYWORDS: health districts, planning, healthcare design, population health outcomes, healthcare reform, healthy community design, sustainable urbanism

1.0 INTRODUCTION

The U.S. healthcare industry is undergoing the transformation of a century to address the tremendous challenges brought on by demographic and economic changes. The "silver tsunami" of aging Baby Boomers and the growing population of chronic disease patients continues to raise demand for healthcare, while government reimbursements for those services continue to decline. Hospitals and health systems are being asked to do the seemingly impossible: to deliver better care with new technologies for more people and less money.

The 2010 Patient Protection and Affordable Care Act (ACA) has amplified these challenges by increasing the number of Americans covered by federal and state insurance programs, and expanding rights, benefits, and protections to insured Americans. The ACA has also brought forth regulatory mandates and incentives to address systemic shortcomings in quality, outcomes, cost and equity that continue to plague the U.S. health care system in spite of its global recognition as a leader in healthcare science and technology[1]. As a result, the business of healthcare is changing and more systemic changes are expected to follow suit in the following decades[2]. The National Commission on Physician Payment Reform, a bipartisan senate organization, has prepared a plan to phase out of the fee-for-service model by 2020. The very definitions of healthcare, medical education, and medical research are also being reformulated to align with changing priorities and new technologies. These structural shifts are creating new performance criteria that are impacting the way we plan for

and design our medical facilities and campuses. It is a time of tremendous change, but also an opportune time for healthcare institutions to plan for the future.

This research paper proposes a new planning paradigm for healthcare called Health District Planning. A Health District is a place where investments are targeted to improve population health outcomes and to inspire healthy behaviors. The term "health" is used here instead of "medical" because a medical campus, by definition, is focused solely on the treatment of sick patients. A Health District, by contrast, is a hub that integrates and links services across the continuum of care. Similarly, the term "campus" is replaced with "district" because a campus, by its definition, is a separate entity from the surrounding community. A health district, by contrast, is integrated into the surrounding community with public infrastructure, distinguished from its context only by its specific uses and character. In Section 2.0, Health District Planning goals are identified by drawing on changes in the healthcare industry. An expanded concept of health is introduced to make a case for the alignment of medical facility and campus design with the health needs of the entire community. In Section 3.0, the vision for Health Districts is detailed by looking at best practices from various case studies, and related evidence from public health and healthy community design research. Lessons learned from best practices are synthesized into a four-part framework—the 4 P's of Health District Planning: (i) population health, (ii) place, (iii) partnerships, and (iv) performance. Finally, Section 4.0 evaluates the effectiveness of this working framework as applied to ongoing planning work in Baton Rouge, Louisiana, where a complete Health District is being planned from scratch. The potential of a Health District lies in any medical campus or facility.

2.0 THE LOST "HEALTH" IN HEALTHCARE

The U.S. is experiencing a "health crisis" with growing rates of obesity and related chronic diseases seen in adults and children. Americans rank towards the bottom of health indicators when compared to peer nations while spending, on average, two-and-a-half times more on healthcare[3,4]. Our healthcare spending, in other words, has not translated into better health for citizens.

This seeming paradox is explained simply by analyzing what makes one healthy. Public health research shows that individual behaviors such as smoking and lack of physical activity--and the socio-economic and environmental factors that influence those behaviors--are greater contributors of overall health than genetics or access to healthcare[5]. Clinical care (or healthcare) accounts for no more than twenty percent in health outcomes (Figure 1), yet consumes almost ninety percent of health spending in the U.S. Majority of this spending goes to treat preventable chronic diseases that are caused by unhealthy behaviors[6]. The U.S. health crisis, and the crisis of the U.S. healthcare economy, in other words, are both fundamentally linked to a failure to invest in services and places that help keep people healthy.

The way out of our health crisis is a significant shift of funds and resources from sick care to disease prevention and health promotion[7]. This includes addressing the socio-economic determinants of health, such as access to quality education. Investment in communities will also play a role: a child growing up in a neighborhood where it is not safe to walk or where there are no grocery stores will be less likely to get enough physical activity or eat well enough to maintain his or her health.

If the road to a healthy nation is outside of healthcare, where does that leave our hospitals and health systems in the near future? Until recently, healthcare providers have profited from treating a growing number of sick patients. The continued increase in the healthcare costs has reversed that trend: as government reimbursement for medical services continues to fall, hospitals and health systems are facing financial losses from treating a growing number of chronically ill and/or aging patients with government insurance[8,9]. Reducing demand for care is an imperative in today's healthcare business. Instead of waiting for sick patients to come through their doors, many hospitals and health systems are now partnering with community organizations to provide low-cost disease prevention and health promotion services, such as diabetes screening and education in local churches.

Community outreach is not a new concept for healthcare. There are many, well-documented cases of large hospitals and health systems using their economic engine for the good of the community, with initiatives ranging from local purchasing and job development programs to partnerships in neighborhood redevelopment and revitalization. A medical center is often the largest employer in any given city. The American Hospitals Association estimates that each hospital job supports about two more jobs, and every dollar spent by a hospital supports roughly $2.30 of additional business activity for the community[10]. In Minneapolis (MN), Phillips Partnership has helped mobilize $1.5 billion in resources to build housing and infrastructure and reduce crime in its seventeen years of existence. Phillips Partnership was established in 1997 by Abbott Northwestern Hospital, Children's Hospitals and Clinics, City of Minneapolis,

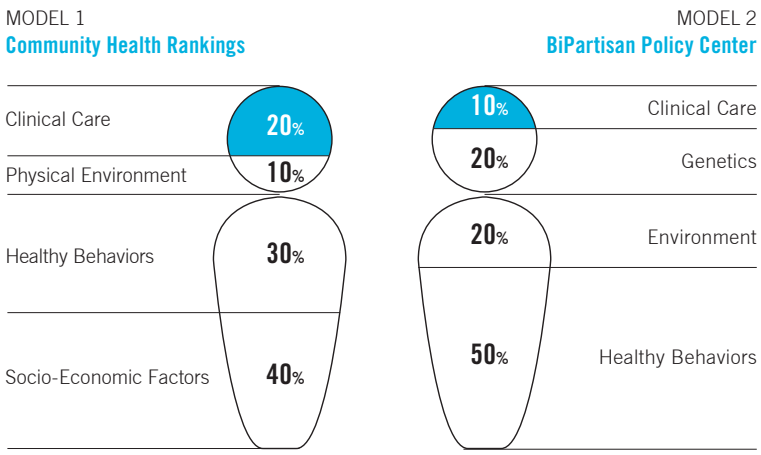

Figure 1: Two different models on health factors (i.e. what makes us healthy) illustrate the small role of healthcare in overall individual health.

Hennepin County, Metro Transit, and Wells Fargo Home Mortgage. In La Crosse (WI), Gundersen Health System has built a local renewable energy economy to serve the sustainability goals of its campus. Bon Secours Health System in Baltimore (MD) has built more than 650 units of affordable housing in surrounding neighborhoods[11]. In today's healthcare economy, initiatives such as these have new significance as potential pathways to improved community health that help secure the financial stability of hospitals and health systems.

2.1 The Paradigm Shift from Sick Care to Prevention

Economic, demographic and regulatory pressures are driving a paradigm shift that will fundamentally change the way healthcare is delivered in the future. At its core, the change has to do with how most insurers in the U.S. pay for healthcare. With the current "fee-for-service (F.F.S.), volume-based" payment model, a provider (such as a doctor) is reimbursed for each service delivered to each patient, even if the patient gets worse. Care is "fragmented," meaning that each provider keeps their own set of patient records and runs their own tests, with little incentive to coordinate with others who see the same patient. The terms "provider-centered" is also used to indicate that the patient is not empowered to take part in maintaining their health outside of the healthcare system. In fact, financial incentives are stacked against services such as primary or preventative care that keep people out of the hospital.

The F.F.S model was already well under scrutiny in 2010, when the Affordable Care Act was signed into law. In February 2009, physicians gathered at the Institute of Medicine (I.O.M.) summit called for a move away from the current fragmented system towards integrative medicine, a health care system that focuses on efficient, evidence-based prevention, wellness, and patient-centered care that is personalized, predictive, preventive and participatory. Integrative medicine, as defined, expands healthcare beyond sick care. Patients and community members are empowered to become stewards of their health through patient education, behavioral health support, policy changes, and community-based efforts[12]. Later that spring, the Robert Wood Johnson Foundation (RWJF)—the nation's largest philanthropy devoted solely to the public's health—published significant findings from a one-year study led by its non-partisan Commission to Build a Healthier America. The commissioners concluded that "building a healthier America will hinge largely on what we do beyond the healthcare system" and recommended targeted investments in early education, nutritional support and healthy community design in addition to reforms that may be conducted in healthcare[13]. Taken together, these two reports highlight the foundations of the paradigm shift towards public health and prevention in the U.S.

The Affordable Care Act has accelerated the pace of the paradigm shift. The law provides financial incentives for integrative-care models under Medicare with programs that offer financial rewards or penalties to

voluntary groups of providers who can demonstrate improved health outcomes for a defined "population" and not just individual patients who come through the door. Participants in each group share patient information in order to "coordinate" or "integrate" care across the "care continuum," collectively providing services ranging from flu shots to post-surgery rehabilitation (Figure 2). These "performance-based" or "value-based" models are expected to be adopted by private healthcare industry, pushing hospitals and health systems further into the territory of population health management.

The shift from volume to value in healthcare is not a simple adjustment. It is re-defining of aspects of our health infrastructure, from the way we educate doctors and dispense medical research dollars, to the way we design of facilities where care is delivered. Our standards for medical education have not changed for over a hundred years. A global independent commission called for comprehensive reform in the training of healthcare professionals with a focus on training "enlightened change agents", who are able to adapt global knowledge and resources to local health problems[14].

Resources previously spent in building hospital beds and imaging suites for individual patients will now be shifted towards health and wellness programs[15]. As a result, healthcare delivery will continue to shift away from the clinical settings, with a greater number of less costly services being delivered in the community—such as a healthy cooking demonstration at a local YWCA or a phone conversation with a care coordinator (Figure 2).

2.2 Envisioning the Future of Medical Facilities and Campuses

In a recently recorded conversation among four healthcare CEOs, John Bluford of Truman Medical Centers (Kansas, MO) stated that "the future of the hospital can't be the building on the corner or down the street. It's got to be immersed in the daily culture of the community that it serves"[17]. The last decade has seen a growing trend of hospitals sponsoring low-cost, high-impact prevention programs such as farmers' markets, and recreational trails to connect with their communities on health and wellness[18]. A more recent trend is the construction of new outpatient facilities with cafés or

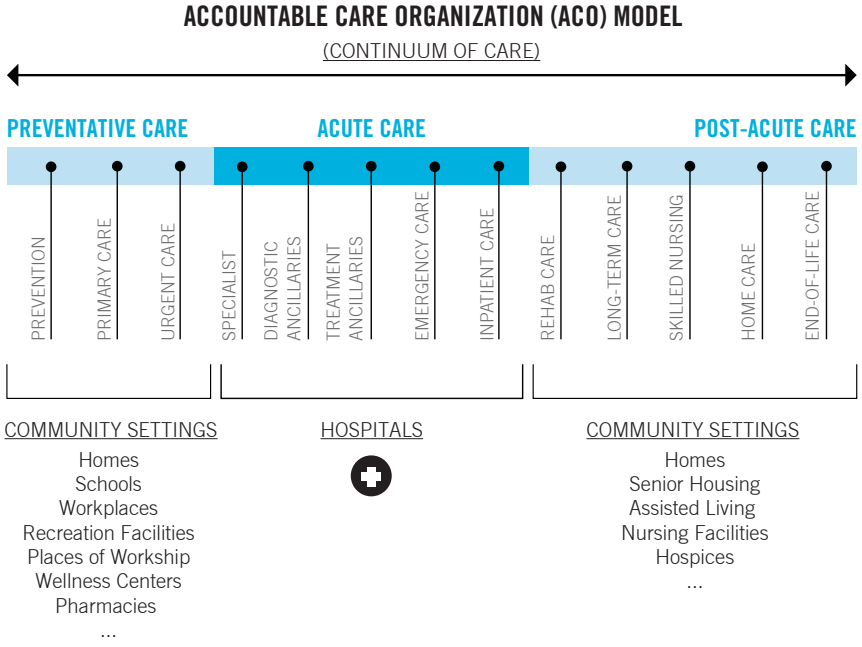

Figure 2: Hospitals and health systems have traditionally focused solely on acute care. The Medicare Accountable Care Organization (ACO) model incentivizes groups of providers to coordinate patient care across the entire care continuum. First year results from early adopters show promise: 32 pioneer groups who piloted the ACO model were, as a collective, able to hamper cost increases and generate $33m savings for Medicare[16].

stores to capture demand while also creating a new, retail-like healthcare interface for the community[19]. While headed in the right direction, these steps do not add up to comprehensive strategy for future campus design.

It is not clear what will become of medical facilities that become obsolete or redundant as healthcare delivery shifts into community settings. Discussions on this topic tend to be focused on the negative, citing impacts of the growing number of hospital consolidations and the subsequent closures of small community and rural hospitals[20]. It is clear that we need a compelling vision to shape places where health services will be delivered in the future. Targeted strategies will also need to be developed to address four potential scenarios: closed hospitals, shrinking campuses, growing campuses, and new campuses. Both the vision and strategies will need to align closely with the expanded role of the healthcare institution to keep populations healthy.

This highlights a particular problem: our healthcare campuses are not designed as health-promoting environments. They are typically designed with an inward-focus on the patient: the health needs of the community members—including medical staff and visitors as well as neighborhood residents—are of secondary importance. For most of the twentieth century, hospitals have focused their resources internally to give the patient the best chance for recovery. For early hospitals, this meant building a series of airy, daylit pavilions in pastoral settings outside the city. With air conditioning, the typology shifted towards a single tower that consolidates all patient services. As cars became the predominant mode of travel, many hospitals built drop-off plazas facing new parking lots at back, turning their front door away from the public street[21]. Today, healthcare planning is an inward-focused endeavor that is driven primarily by adjacency requirements of hospital components. In fact, the imperatives of healthy community design—small block sizes, walkable streetscapes, active ground floors, and open green spaces—are often at odds with conventional healthcare planning and design practices (Figure 3). When viewed from the community perspective, hospitals are akin to ocean liners in a sea of cars. Car-oriented culture intensifies the disconnect, forcing growing hospitals to expand into neighborhoods

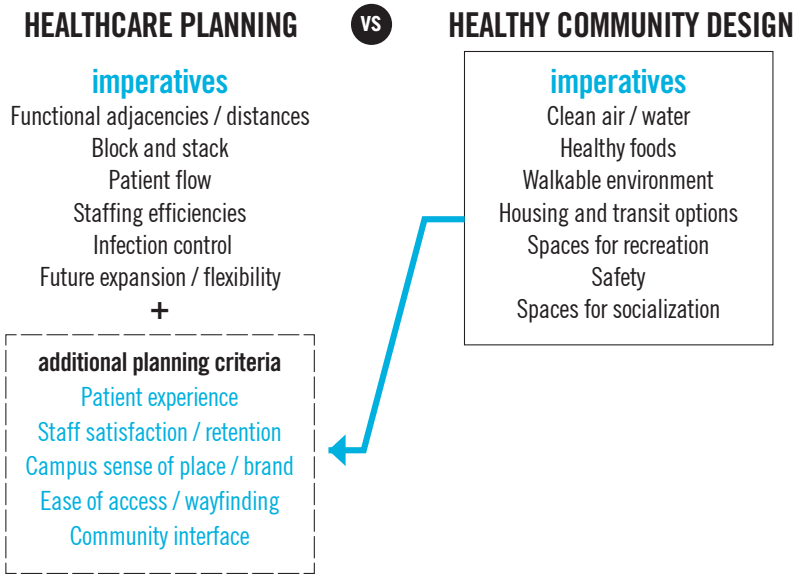

Figure 3: The planning and design of medical facilities prioritizes operational efficiency to ensure patient outcomes. The imperatives of healthy community design, which contribute to positive health outcomes for patients as well as those who work at and live near the medical facility or campus, is often not part of the equation. Additional planning criteria that have emerged over the last decade have the potential to bring healthcare planning into closer alignment with healthy community design.

Figure 4: The Health District planning approach draws inspiration from medical districts such as the Longwood Medical Area, that have achieved a healthy balance between the operational needs of the hospitals and the health needs of the community from the urban environment.

as parking needs grow. While examples of community-integrated, pedestrian-friendly campuses do exists in our older urban centers (Figure 4), it is difficult to find a healthcare campus that is a healthy place to heal, work, learn and live by design. This is why we need a new planning paradigm for the future of our medical facilities and campuses.

3.0 THE HEALTH DISTRICT VISION AND PLANNING FRAMEWORK

The future state of today's medical facility or campus is emerging to become what is referred to in this paper as a Health District: a place where investments are targeted to improve population health outcomes and to inspire healthy behaviors. Health Districts support collaborative efforts in the delivery of healthcare, integrating programs and services that help partners in the monitoring, management and improvement of population health. The focus on population health addresses the growing need for healthcare institutions and their partners to improve the diagnosis, maintenance and prevention of chronic disease among community members.

The analysis in Section 2.0 identified four key elements integral to the definition of a Health District, each of which affect the program and operations of a healthcare institution and campus to enable it to respond to the non-clinical factors impacting health (Figure 1):

1. A focus on population health
2. A focus on place
3. A focus on partnerships
4. A focus on performance.

3.1 A Focus on Population Health

3.1.1 Background

Population health is a scientific field of study and related practices focused on "the health outcomes of a group of individuals including the distribution of such outcomes within the group"[22]. It is based on the democratic ideal that all citizens should have the benefit of equal protection from disease and injury, and as such, is largely supported through government and non-profit

sector initiatives. Pioneers of epidemiology and public health worked to prevent the spread of infectious diseases in the late 19th century. Since the 1980s, however, the focus in population health has shifted towards the chronic disease epidemic. The 2011 launch of the National Prevention Strategy—a cross-sector and integrated plan to align government actions around chronic disease prevention—has crystallized this new focus. Led by the National Prevention Council comprising of 17 heads of departments, agencies, and offices across the Federal government, the National Prevention Strategy aims to "improve America's health by helping to create healthy and safe communities, expand clinical and community-based preventive services, empower people to make healthy choices, and eliminate health disparities"[23]. The strategy is a big part of the population health focus embedded in the Affordable Care Act.

Population health, in many ways, is antithetical to the traditional business of healthcare, which provides individual care to sick patients. Its emergence in healthcare circles is a recent phenomenon driven largely by the growing cost of treating chronic disease patients. A recent study of the Canadian case found, similarly, that hospitals view the population health approach as an effective method to reduce the use of costly emergency room and hospital services by chronic disease patients[24]. A growing number of hospitals and health systems are joining forces, and partnering with public health and community organizations to implement initiatives to prevent disease and promote health in community settings. A leading example comes from Dallas, where Baylor Health Care System Foundation partnered with the City of Dallas Parks and Recreation Department to renovate an aging recreation center to include a Diabetes Health and Wellness Institute (DHBI). The DHBI at the Juanita J. Craft Center takes diabetes care, diagnosis and prevention programs to the heart of the Frazier community in South Dallas, where high rates of diabetes and lack of access to diabetes care were manifest in the state's highest rates for diabetes-related hospitalization[25]. The outcome is not only improved health in a medically underserved population, but also long-term cost and capacity savings for the Baylor Health Care System where close to a third of hospital admissions are linked to diabetes. Beyond the compelling business case, many hospitals recognize the need to focus on prevention and primary care as a means to bring them closer to their health mission.

There are opportunities in each community for healthcare institutions to step beyond their walls to impact population health and to save costs in so-doing. The Affordable Care Act has required each charitable hospital to complete and implement actions to address a Community Health Needs Assessment (CHNA) every three years to maintain its non-profit and tax-free status. In many communities, CHNAs are being completed by a consortia of hospitals and local public health agencies, which is considered to be a best practice that can lead to greater success through shared goal-setting, visioning and project implementation. Section 501(r) IRS requirement (or the "CHNA" requirement, as it is widely known) currently lacks regulatory teeth, but is expected to become more onerous as the IRS strengthens its guidelines for approval in the coming years[26]. Free online resources such as Dignity Health's nationwide Community Needs Index have made it easy for communities to include information on socio-economic barriers to health, such as lack of access to housing, in their assessments.

3.1.2 Application in Health District Planning

CHNAs can be integrated directly into the Health District Planning process to define future space and program requirements for disease management, prevention and health-promotion services in addition to the typical healthcare market analysis that are used to estimate future clinical space demand. Health District Planning also takes into account estimated reduction in utilization that can be expected to occur through successful implementation of population health measures. A population-health focused market analysis can identify specific opportunities for the hospital or health system to expand services into community settings (as in the Baylor example) or build specifications for new spaces, such as a health food store, which can be incorporated into the district to advance employee and community health. Other opportunities for the institution to impact socio-economic barriers to health, such as local purchasing or jobs development programs, can also be identified.

Funding remains the biggest barrier to widespread adoption of the population health approach in healthcare. Payment models are simply not set up to reimburse non-healthcare spending. In New York, State Commissioner for Health has unsuccessfully bid for the use of federal Medicaid matching funds to build supportive housing even though each unit is expected to save the government over $30,000 a year in emergency room visits or stays in shelters or jails[27]. Similar challenges exist in the private market even when the return on investment is apparent. However, healthcare is changing. As healthcare reimbursements are increasingly tied to population health metrics in the future,

hospitals and their partners will have stronger financial incentives to invest in community health[28].

3.2 A Focus on Place

Each Health District is a unique place set in a specific context, with built environment supports for healing and healthy lifestyles for employees, visitors and residents. The focus on place brings the community perspective into Health District Planning with an emphasis on the projected health outcomes of facility planning decisions on surrounding communities. The goal here is not only to take actions that mitigate negative impacts associated with healthcare facility operations, but to re-curate the built environment of the facility or campus with uses and amenities that enable healing and healthy lifestyles.

3.2.1 Background

Public health research has identified two main pathways through which the built environment impacts health (Figure 5). The first path, exposures to toxic elements in the air and the water, is well accepted and regulated. The other path is less known: we have only recently come to appreciate the significant impact that the built environment can play in enabling as well as preventing healthy behaviors, such as walking and healthy eating. Some of the earliest work on this topic originated at U.S. Centers for Disease Control and Prevention (CDC) in the early 2000s, and has grown into a burgeoning research and practice field known as "healthy community design". At its core, "healthy community design" seeks to re-establish the links between urban planning and public health that date back to the shared origins of both professions in the late 19th and early 20th centuries. The CDC still provides some of the latest research in this field through its interdisciplinary Built Environment and Health Initiative. This research has been instrumental in establishing a link between the design of our suburban environments (i.e. disconnected street patterns and low density development) and our obesity epidemic[29]. In its application, healthy community design is an extension of smart growth and sustainable urbanism practices, with a greater focus on individual health outcomes.

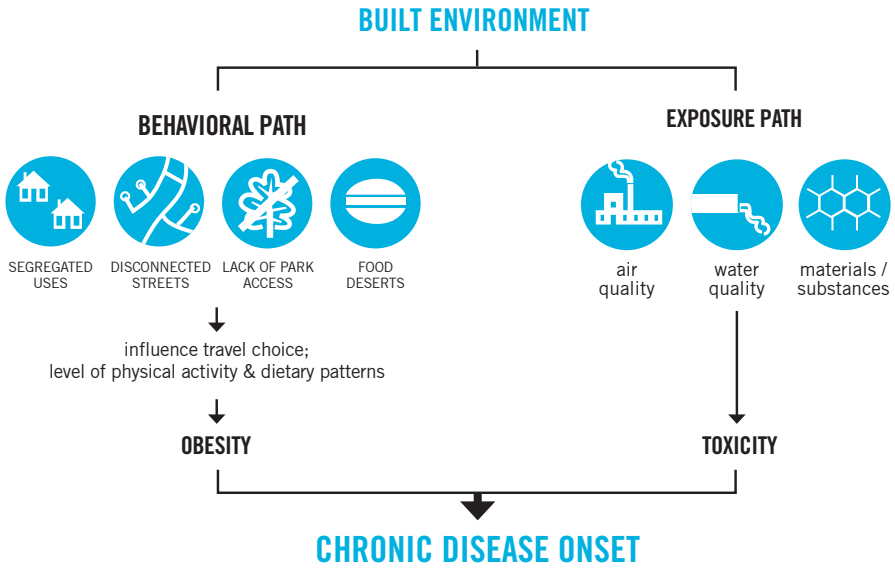

Figure 5: The built environment impacts individual health directly through exposures or indirectly by creating barriers to healthy choices. In many underserved communities, disinvestment in the built environment (such as lack of safe parks) compounds the impact of socio-economic barriers to health (such as lack of time for recreation).

A parallel field of inquiry—evidence-based design (or EBD)—has transformed healthcare facility design during the past decade by focusing on design elements such as natural daylight, which are demonstrated to promote healing among patients. Healthcare's focus on the patient, however, has prevented the expansion of this logic to the outside of the facility, where the large parking lots often abut the neighborhood edge, degrading walkability and safety. Urban communities with strong planning traditions and agencies such as Boston (MA), New York (NY) and Portland (OR), have used zoning regulations, design guidelines and review processes to create community-integrated medical facilities and campuses. With the paradigm shift in healthcare, a growing number of institutions are looking at these best practices to improve the health of their facility and campuses.

3.2.2 Application in Health District Planning

Health District Planning seeks to balance the space and operational needs of medical facilities and campuses with the quality of life needs of patients, families, employees and neighbors. This is best accomplished through a well-facilitated, multi-stakeholder planning process informed by clear goals and a comprehensive built environment analysis. While these methods are commonly used in urban planning, their use in the healthcare setting has been limited to regulatory approvals.

A 2013 Health District Plan prepared for Gundersen Lutheran Medical Center and the adjoining Powell-Poage-Hamilton neighborhood in La Crosse, Wisconsin illustrates the power of these facilitation tools in maximizing health outcomes for all users in the community. The neighborhood was named Powell-Hood-Hamilton at the time of the study. The 9-month long participatory planning process revealed shared health need of employees and neighbors around safety, affordable housing and healthy food options, making a case for greater collaboration between the city and the health system for implementation. The planning team used sustainable urbanism metrics from the LEED for Neighborhood Development Guidelines to create a long-term

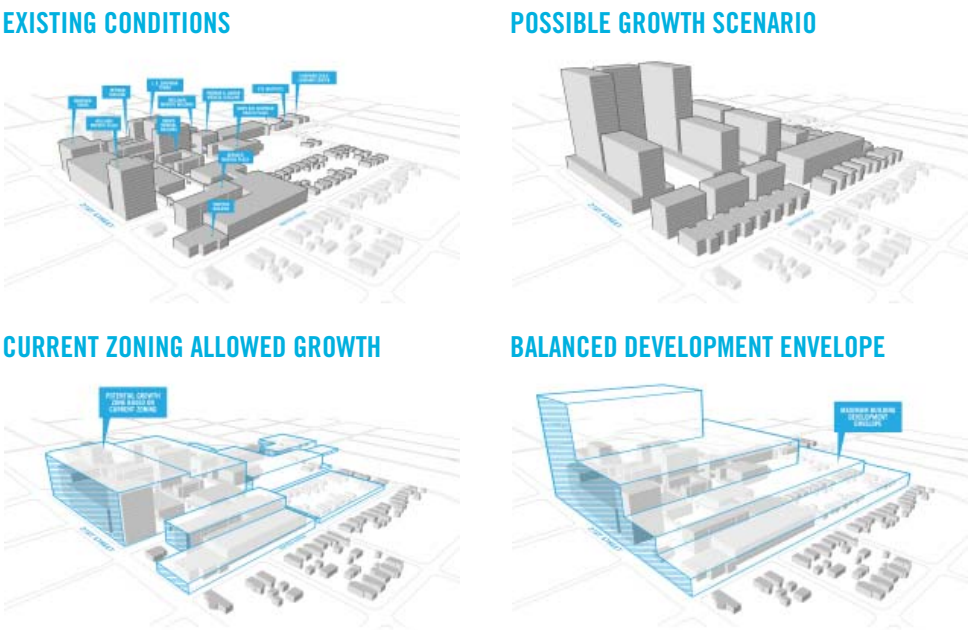

Figure 6: Conceptual diagram showing re-distribution of campus density to enable height and character transitions between St. John Medical Center and adjoining historic neighborhoods in Tulsa, Oklahoma.

Street Framework Plan that will provide improved connections between the neighborhood, campus and the Mississippi riverfront[30]. A Health Impact Assessments (HIAs) were not produced, but recommended for use as project-specific decision making tools are during the implementation process.

Zoning (build-out) analyses are also used in Health District Planning to identify regulatory barriers to healthy community design. In Tulsa, Oklahoma, a build-out analysis of the St. John Medical Center (SJMC) was used to establish the need for new zoning stipulations that enable to hospital to build taller to avoid encroachment of medical uses into historic and residential neighborhoods (Figure 5). The recently adopted Mixed-Use Institutional Zoning (MX-I) category enables Tulsa hospitals, such as SJMC, to get closer to the Health District ideal with each new development[31]. As with the La Crosse project, the success of the SJMC Health District Plan is a direct outcome of the planning team's engagement of government and neighborhood stakeholders.

3.3 A Focus on Partnerships

Health Districts are driven by diverse and multi-stakeholder partnerships to reach shared health goals. Partnerships are a necessity for a healthcare institution seeking to impact population health, or engage in place-based initiatives (or do both, at the same time). As previously mentioned, there are many precedents of hospitals partnering with local government or other non-profits to influence the socio-economic determinants of health. In Health District Planning, however, these partnerships are not only desired, but critical for the implementation of projects and programs that improve community health.

3.3.1 Background

The perception is that hospitals, due to the competitive nature of their business, are more likely to work with partners outside of healthcare than those within. A 2011 survey conducted by the American Hospital Association shows that is not the case: 98 percent of healthcare CEOs who responded were open to partnerships with other clinical providers and physicians to address health care issues that they cannot accomplish on their own. Only 67 percent, by contrast, said that they would pursue partnerships with community, public health and government agencies towards the same goal. These results may stem from a variety of reasons—including a healthcare entity's previous negative experience with government processes—that can be overcome through facilitated and focused dialogue.

3.3.2 Application in Health District Planning

Identifying and matching the network of implementation and funding partners is a key part of a Health District Plan. It requires cataloging of shared interests and complimentary capabilities. A regional medical center, for example, may be interested in improving transit access to its campus, but does not have a transit agency's ability to draw on federal funds. The solution here would be the build a partnership between the two, where the transit agency can show the hospital as a civic partner in its grant applications and strengthen its case by including a description of the employee transit incentives the hospital aims to offer if transit is brought to its campus. This "matchmaking" effort begins early on in the planning process and involves a large number of individual interviews and group discussions during the planning period.

Partnerships are also an excellent panacea to the problem of funding discussed under Population Health (see Section 3.1.). In La Crosse, the Health District Plan is currently being implemented through a reverse-TIF (tax-improvement financing) agreement that enables Gundersen Health System to fund projects that will revitalize its surrounding neighborhood in return for future reimbursements through increased tax revenue. The projects are being managed by a recently-formed Joint Development Corporation (JDC) that includes city, health system and neighborhood representatives as decision-makers. Formal partnerships like the JDC may become more common as more healthcare institutions look for ways to experiment with population health initiatives.

3.4 A Focus on Performance

Health Districts make investment decisions based on best available evidence, and monitor and evaluate results to ensure outcomes.

3.4.1 Background

Medical practice has well-established protocols for diagnosis and treatment of a patient[32]. After recording a patient's complaints, a doctor orders some tests – and if necessary – corroborates his ideas with scientific studies before finalizing a diagnosis and treatment plan. There is, in many cases, a follow-up that is scheduled to see how the patient is progressing, and adjustments are made to medications – if needed – at that appointment. In some cases, new and unexpected results are documented in medical journals to be used as "evidence" in the treatment of the next patient.

3.4.2 Application in Health District Planning

To ensure outcomes, a Health District Plan integrates the similar approach into its processes. Recommendations are backed up with evidence (from literature review, case studies or project-specific modeling) that the expected results will most likely be delivered. Innovative projects for which no precedents exist are implemented as pilots in order to build evidence around outcomes before expanding the scale of application. Tools and methods (such as randomized controlled trials, online surveys, anonymous and user-initiated mobile data gathering) are put in place to enable monitoring of outcomes, with touch points scheduled for evaluation of results and necessary corrections. Findings are documented and, where possible, publicized to add to the body of knowledge to guide and add credibility to future actions.

The growing availability of "user-generated big data" is expected to make this methodology much more commonplace and feasible. A partnership initiative between Boston Medical Center (BMC)—the largest safety net hospital in New England—and the City of Boston demonstrates how this may work. The initiative enables BMC doctors to "prescribe" patients with transportation and weight issues a $5 year-long membership to the city's $85-a-year bike-share program. By matching patient data collected at follow-ups with data on their bike usage, the partners can build evidence around the types of programs that do improve health outcomes among those who are most in need[33]. As solutions are developed to enable the collection, sharing and analysis of data without harm to groups or individuals, we will have additional ways to harness data to achieve the desired results.

4.0 THE FRAMEWORK IN APPLICATION: THE BATON ROUGE HEALTH DISTRICT

The Baton Rouge Health District Plan is one of the first projects where the Health District Planning Framework outlined in this paper is being applied to a multi-stakeholder planning process. The plan was initiated in 2013 by the Baton Rouge Area Foundation (BRAF) to identify ways to increase formal collaborations between competing hospitals, large physician groups, a regional insurance company, and academic institutions that are loosely clustered in a 1000+ acre area of South Baton Rouge. The planning team worked with BRAF to establish an advisory group of healthcare and academic leaders, along with a 60+ Task Force of experts who helped produce recommendations in four study areas: (1) Innovation in Healthcare (2) Health Education and Research (3) Healthy Places, and (4) Emergency Preparedness. A fifth group focused on implementation strategies, starting with the formation of a shared governance entity to manage funds and partnerships.

The four elements of the Health District Planning Framework were integrated to varying degrees to each one of the four study areas identified by the district leadership for the plan. The real power of the framework, however, can be seen in the potential health impact of shared initiatives that have come out of the planning process. These include:

- A data-driven Diabetes and Obesity Center that consolidates education, research, treatment and policy-making efforts under one roof to address a critical health need in the community
- A Clinical Trials Consortium (CRC) that facilitates research partnerships between the Pennington Biomedical Research Center, LSUHealth, local healthcare pillars and industry partners to bring cutting-edge treatments and new jobs to Baton Rouge
- District Health loop: multi-use trail installation along Ward Creek in partnership with BREC (Recreation and Parks Commission). The trail would connect the hospital and university anchors, neighborhoods, and existing park amenities including the currently inaccessible 440-acre Burden Center
- Public and institutional support for the addition of a new arterial to reduce congestion on the two regional arterials serving the hospital emergency rooms. The new arterial is the first project to come out of the District Street Framework Plan, which doubles the connectivity of streets serving the area
- Zoning updates to encourage the development of compact, pedestrian-friendly, mixed-use clusters around each of the three anchor healthcare campuses.

5.0 CONCLUSION

Healthcare is changing rapidly: new models of care are being tested, new partnerships are being formed, and new technologies are shifting the role of the patient. In this time of sea change, planning is of incredible value: hospitals and health systems that plan today will be well-positioned to implement transformative change as the industry transitions to performance-based models. Health District Planning is a nascent planning paradigm that can be expected to grow and get refined as more communities, hospitals, and health systems adapt its framework to plan for a healthier future.

Health District Planning is designed to highlight synergies and enable collaborations towards improved community health. Bringing voices to the table is a first necessary step. Many cities now have venues for ongoing discussions on health between hospitals, health systems, provider groups, insurers, employers, government entities, non-profits and citizen groups in each community. The opinions of patients and families, and healthcare professionals are also being included. These groups will be instrumental in the alignment of local health cultures with more global changes in healthcare. The ability to aggregate, organize and share digital information will be a critical for the future success of these collaborations.

Acknowledgments

The author would like to express appreciation for the leadership of the Baton Rouge Area Foundation, Gundersen Health System, City of La Crosse, WI, and the St. John Medical Center in completed and ongoing Health District Planning projects, and thanks project team members for their contributions. Special thanks goes to the Urban Design Group at the Perkins+Will Atlanta office, and to David Green, AIA, who provides tremendous support and guidance for ongoing research on health district planning and other innovative urban design initiatives.

REFERENCES

[1] Institute of Medicine, (2013). "Best Care at Lower Cost: The Path to Continuously Learning Health Care in America", Retrieved on 10/2014 from http://www.nap.edu/catalog.php?record_id=13444.

[2] Haberkon, J., (2013). "Commission Advocates Ending Fee-For-Service System", March 4, Retrieved on 7/2014 from http://www.politico.com/story/2013/03/commission-advocates-ending-fee-for-service-88348.html#ixzz39YPn79z2.

[3] Kane, J., (2012). "Health Costs: How the U.S. Compares With Other Countries", *Public Broadcasting Service*, October 22, Retrieved on 7/2014 from http://www.pbs.org/newshour/rundown/health-costs-how-the-us-compares-with-other-countries/.

[4] Institute of Health Metrics and Evaluation, (2013). "The State of US Health: Innovations, Insights and Recommendations from the Global Burden of Disease Study", Report, Retrieved on 7/2014 from http://www.healthdata.org/policy-report/state-us-health-innovations-insights-and-recommendations-global-burden-disease-study.

[5] Marks, J., (2009). "Why Your Zip Code May Be More Important to Your Health than Your Genetic Code", *Huffington Post*, April 23, Retrieved on 7/2014 from http://www.huffingtonpost.com/james-s-marks/why-your-zip-code-may-be_b_190650.html.

[6] Centers for Disease Control and Prevention, (2009). "Chronic Disease: The Power to Prevent, the Call to Control", Report, Retrieved on 7/2014 from http://www.cdc.gov/chronicdisease/resources/publications/aag/chronic.htm.

[7] Lavizzo-Mourey, R., (2012). "We Must Focus on Preventing Disease if We Want Our Nation to Thrive." *The Atlantic*, May 30, Retrieved on 7/2014 from http://www.theatlantic.com/health/archive/2012/05/we-must-focus-on-preventing-disease-if-we-want-our-nation-to-thrive/257759.

[8] Bipartisan Policy Center, (2012). "Lots to Lose: How America's Health and Obesity Crisis Threatens our Economic Future" Report, Retrieved on 7/2014 from http://bipartisanpolicy.org/sites/default/files/5023_BPC_NutritionReport_FNL_Web.pdf.

[9] Lowes, R., (2013). "Medicare Rates Continue to Fall behind Practice Expenses", *Medscape Medical News*, August 29, Retrieved on 7/2014 from http://www.medscape.com/viewarticle/810242.

[10] American Hospital Association, (2013). "The Economic Contribution of Hospitals Often Overlooked", Retrieved on 7/2014 from http://www.aha.org/content/13/13brief-econcontrib.pdf.

[11] Zuckerman, D., (2013). "Hospitals Building Healthier Communities", The Democracy Collaborative at the University of Maryland, Report, Retrieved on 7/2014 from http://community-wealth.org/content/hospitals-building-healthier-communities-embracing-anchor-mission.

[12] Institute of Medicine, 2009. "Integrative Medicine and the Health of the Public: A Summary of the February 2009 Summit", Report, February, Retrieved on 7/2014 from http://www.iom.edu/Reports/2009/Integrative-Medicine-Health-Public.aspx

[13] Robert Wood Johnson Foundation, (2009). "Beyond Health Care: New Directions to a Healthier America", Report, April, Retrieved on 7/2014 from http://www.rwjf.org/en/research-publications/find-rwjf-research/2009/04/beyond-health-care.html.

[14] Frenk, J., Chen L., et al., (2010). "Health Professionals for a New Century: Transforming Education to Strengthen Health Systems in An Interdependent World", *Lancet*, 376, December 4 , pp. 1923–58. Retrieved on 7/2014 from http://www.healthprofessionals21.org/docs/HealthProfNewCent.pdf.

[15] Davis, K., (2014). "The Hospital of Tomorrow: Redefining Hospitals under Affordable Care Act", *Forbes*, May 21, Retrieved on 10/2014 from http://www.forbes.com/sites/robertlenzner/2014/05/21/the-hospital-of-tomorrow-redefining-hospitals-under-the-affordable-care-act/.

[16] Bunis, D., (2013). "Pioneer Accountable Care Organization First-Year Results Include Savings and Losses", *CQ HealthBeat*, July 22, Retrieved on 8/1/2014 from http://www.commonwealthfund.org/publications/newsletters/washington-health-policy-in-review/2013/jul/july-22-2013/pioneer-aco-first-year-results.

[17] Butcher, L., (2014). "More than a Building: 4 CEOs Rethink Their Hospitals' Place in the New, Wide World of Health Care", *Hospitals and Health Networks*, April 8, Retrieved on 7/2014 from http://www.hhnmag.com/display/HHN-news-article.dhtml?dcrPath=/templatedata/HF_Common/NewsArticle/data/HHN/Magazine/2014/Apr/cover-story-redefining-hospital.

[18] Park, M., (2009). "Farmers Markets Bloom at Hospitals", June 3, Retrieved on 7/2014 from http://www.cnn.com/2009/HEALTH/06/03/farmers.markets.hospitals.

[19] Kutscher, B., (2012) "Outpatient Care Takes the Inside Track", *Modern Healthcare*, August 4, Retrieved on 7/2014 from http://www.modernhealthcare.com/article/20120804/MAGAZINE/308049929.

[20] Benson, B., (2014). "2014 Bodes Ill for Hospitals", *Crain's New York Business*, January 5, Retrieved on 7/2014 from http://www.crainsnewyork.com/article/20140105/HEALTH_CARE/301059978/2014-bodes-ill-for-hospitals#.

[21] Burpee, H., (2009). "History of Healthcare Architecture", *Mahlum Architects Healthcare Design Insights*, Autumn, Retrieved on 7/2014 from http://www.mahlum.com/pdf/MahlumHDIAutumn2009Issue01.pdf

[22] Kindig, D., and Stoddart, G., (2003). "What Is Population Health?", *American Journal of Public Health*. Vol. 93, No. 3, pp. 380-383.

[23] National Prevention Strategy. Retrieved on 7/2014 from: http://www.surgeongeneral.gov/initiatives/prevention/strategy/.

[24] Cohen, D. et al., (2014). "The Population Health Approach: A Qualitative Study of Conceptual and Operational Definitions for Leaders in Canadian Healthcare", *SAGE Open Medicine*, Retrieved on 7/2014 from http://smo.sagepub.com/content/2/2050312114522618.

[25] Baylor Healthcare System. "Diabetes Health and Wellness Institute", Retrieved on 10/2014 from http://www.baylorhealth.edu/CommunityOutreach/Pages/DiabetesHealthandWellnessInstitute.aspx

[26] Shaw, F. et al., (2014). "The Patient Protection and Affordable Care Act: Opportunities for Prevention and Public Health", *Lancet*, Vol. 384, pp. 75-82, Retrieved on 7/2014 from http://www.thelancet.com/journals/lancet/article/PIIS0140-6736%2814%2960259-2/abstract.

[27] Aronczyk, A., (2014). "New York Debates Whether Housing Counts as Health Care", July 28, Retrieved on 10/2014 from http://www.npr.org/blogs/health/2014/07/28/335324046/new-york-debates-whether-housing-counts-as-health-care.

[28] Larkin, H., (2014). "Population Health: The Risks & Rewards", *Hospitals & Health Networks Magazine*. February 11, Retrieved on 7/2014 from http://www.hhnmag.com/display/HHN-news-article.dhtml?dcrPath=/templatedata/HF_Common/NewsArticle/data/HHN/Magazine/2014/Feb/cover-story-population-health.

[29] Ewing, R. et al., (2014). "Relationship between Urban Sprawl and Physical Activity, Obesity, and Morbidity – Update and Refinement", Health and Place, Vol. 26, pp. 118-126, Retrieved on 7/2014 from http://www.sciencedirect.com/science/article/pii/S135382921300172X

[30] Perkins+Will, (2013). "Joint Neighborhood and Campus Plan for Powell-Hood-Hamilton and Gundersen Lutheran Medical Center", Report, Retrieved on 7/2014 from https://www.cityoflacrosse.org/DocumentCenter/View/7561.

[31] City of Tulsa Zoning Code, Chapter 7A – Mixed-use Institutional District Provisions, Retrieved on 10/2014 from http://www.incog.org/city%20of%20tulsa%20zoning%20code.html.

[32] Kinney, E., (2004). "The Origins and Promise of Medical Standards of Care", *Virtual Mentor: American Medical Association Journal of Ethics*, Vol. 6, No. 12, Retrieved on 7/2014 from http://virtualmentor.ama-assn.org/2004/12/mhst1-0412.html.

[33] Khazan, O., (2014). "How Being Poor Makes You Sick", *The Atlantic*, May 21, Retrieved on 7/2014 from http://www.theatlantic.com/health/archive/2014/05/poverty-makes-you-sick/371241/.

PEER REVIEWERS

Dr. Abbas Aminmansour
School of Architecture, University of Illinois at Urbana-Champaign

Boyd Black
Facilities Services, University of Chicago

Virginia Burt
Visionscapes Landscape Architects Inc.

Dr. George Elvin
College of Architecture and Planning, Ball State University

Robert Gerard
Arup

Dr. Kyoung Sun Moon
School of Architecture, Yale University

Dr. Ralph Muehleisen
Argonne National Laboratory

Matt Raimi
Raimi + Associates

Michael Robinson
College of Architecture, Design and Construction, Auburn University

Gregory Tocci
Cavanaugh Tocci Associates, Inc.

AUTHORS

01. 

REBECCA HOLT

Rebecca is a sustainable building advisor and senior researcher as part of Perkins+Will's research team. She consults on a variety of work related to sustainability concepts and high performance building design, contributing to community energy plans, sustainability plans, green building strategies, indicator and benchmarking programs, and sustainable land use planning. Rebecca was the lead researcher and primary author for the Survey of International Tall Wood Buildings.

01. 

KATHY WARDLE

As associate principal and director of research, Kathy plays an instrumental role in the development of high-performance green building projects. She directs Perkins+Will Vancouver office's research and sustainable design advisory team, where she manages the portfolio of sustainability advisory and design assistance services for the firm's projects. Kathy was the Principal-in-Charge for the Survey of International Tall Wood Buildings.

02. 

HELENA O'CONNOR

Helena is a licensed architect in Brazil, where she received a 5-year professional degree in architecture and urban planning from the Federal University of Rio de Janeiro. She is a LEED accredited professional, works in Perkins+Will Atlanta office and is currently pursuing a Masters of Science in Construction Management at Southern Polytechnic State University. Helena has more than 10 years of professional experience working on a variety of architectural and urban planning projects in Brazil and the United States.

02. 

KHALID SIDDIQI

Khalid is a professor and chair of the Construction Management Department at Southern Polytechnic State University. He continues to play a pivotal role in preparing construction managers to support the economic development in Georgia and the US. Prior to his teaching and university administration career at SPSU, Khalid worked in the construction industry for fifteen years. He has worked on US Army Environmental Policy Institute projects and also managed projects in Atlanta's empowerment zone. Khalid has also worked on World Bank financed infrastructure projects as project planning and monitoring consultant.

IVAN DESROCHES

03.

Ivan is part of Perkins+Will's Ottawa office. He brings a unique technical perspective to his work, having entered the profession as an architectural technologist, and later enrolling in the RAIC Syllabus. This gives Ivan a strong design sensibility that is firmly grounded in construction reality. He is able to leverage his problem solving skills to address client, consultant and contractor teams' requirements.

MICAH LIPSCOMB

04.

Micah is a landscape architect in Perkins+Will Atlanta office, with a specialty in therapeutic garden design, green infrastructure, and planting design. He broadened his knowledge of therapeutic garden design in two symposiums on the subject at the Chicago Botanic Garden. He has a Masters of Landscape Architecture from the University of Georgia and a B.A. from Eckerd College.

ALEXANDER STEWART

04.

Alexander is a landscape architect, urban designer and sustainability mediator. He is part of Perkins+Will's Atlanta office. His work is marked by simple, yet thought-provoking methods for drawing out the distinctive character of the landscape. Over the last decade, he has worked with the preeminent figures in the practice of landscape architecture and contributed to a wide range of transformational projects. Alexander has exhibited his work internationally and assisted in teaching at the nation's leading design institutions.

BASAK ALKAN

05.

Basak is an urban designer with more than 10 years of experience in the design and planning of walkable, mixed-use environments at all scales, and works closely with institutions and communities in design places that support healthy lifestyles. She is part of Perkins+Will's Atlanta office. She is a founding member of the Congress for the New Urbanism's Health Districts Initiative and has lectured on topics related to sustainability and healthy community building at regional and national conferences.

MOHAWK windpower

This piece is printed on Mohawk sustainable paper which is manufactured entirely with Green-e certificate wind-generated electricity.

Through its "Green Initiative" Program, Phase 3 Media offers recycled and windpowered paper stocks, recycles all of its own post-production waste, emails all client invoices, and uses environmentally friendly, non-toxic cleaning supplies, additionally Phase 3 Media donates 5% of all sales from its recycled product lines to Trees Atlanta.

PERKINS+WILL

For more information, please send an email to **pwresearch@perkinswill.com**

ISBN 978-0-9815436-7-3
90000>
9 780981 543673