Consortium for Research Practices

Renée Cheng, AIA,
Professor and Head, School of Architecture, University of Minnesota
did you know?
The AIA’S GOAL is to reach net zero carbon emissions by **2030**
The AIA’S GOAL is to reach net zero carbon emissions by **2030**

...the means to achieve this are not currently understood.
The AIA’S GOAL is to reach net zero carbon emissions by **2030**

...the means to achieve this are not currently understood.

We have 17 years to discover, *and implement*, what it takes to reach this goal.
did you know?
The globe has warmed $1.2^\circ F$ from pre-industrial levels.
“we will be producing a different planet.”

-NASA scientist James Hansen, forefront leader of American climate researchers

The globe has warmed $1.2^\circ F$ from pre-industrial levels.

2012 was the warmest year and 2nd most extreme on record in the US.

NASA scientists predict further warming of $3.6$ to $7.2^\circ F$, creating an entirely new planet.

“I think we have a very brief window of opportunity to deal with climate change... no longer than a decade, at the most”

-NASA scientist James Hansen

The globe has warmed 1.2°F from pre-industrial levels.

NASA scientists predict further warming of 3.6 to 7.2°F, creating an entirely new planet.

To avoid this, we have less than 5 years to enact change.

Source: “Warming expert: Only decade left to act in time” MSNBC.com
did you know?
Energy consumption is measured in “Quads” (Quadrillion Btus)

One Quad = 40 large nuclear power plants
The world uses approximately **400 Quads** of energy annually.

400 Quads = 16,000 large nuclear power plants
The world uses approximately 400 Quads of energy annually.

The United States alone uses approximately 100 Quads of energy annually.
The world uses approximately 400 Quads of energy annually.

The United States alone uses approximately 100 Quads of energy annually.

Of that 100 quads, 48% is from buildings.
did you know?
The United States construction industry spends $650 billion annually.

Source: New Wiring, The Economist, January 13, 2000
The United States construction industry spends $650 billion annually.

Inefficiencies, mistakes and delays account for $200 billion annually.

Source: New Wiring, The Economist, January 13, 2000
did you know?

The United States construction industry spends $650 billion annually.

Inefficiencies, mistakes and delays account for $200 billion annually.

$15.8 billion annually is lost due to lack of interoperability.

Source: New Wiring, The Economist, January 13, 2000
did you know?
The construction industry lost productivity between 1964 and 2004.
The construction industry lost productivity between 1964 and 2004...

...while all other non-farm industries more than doubled

Did you know?
did you know?
If you draw a curve showing where the majority of design activities occur...
If you draw a curve showing where the majority of design activities occur...

...they are too late to optimize cost savings

Source: Patrick MacLeamy, HOK, 2004
did you know?
did you know?

the design and construction cost of a building...
did you know?

the design and construction cost of a building...

....account for only 25% of its total life cycle cost

*reducing the remaining 75% could yield the largest untapped savings in the AEC industry*
did you know?
most disaster-related, fracture-critical failures could have been avoided with better design?
most disaster-related, fracture-critical failures could have been avoided with better design?

... and the cost of Super Storm Sandy exceeds $42 billion
did you know?
it takes an average of 8.5 years after graduation to become a licensed architect?
it takes an average of 8.5 years after graduation to become a licensed architect?

which means, in real time, its a 14.5 year path... which is longer than law or medicine

Sources: “Seven is Enough”, Architect Magazine, Jan 2013
NCARB by the Numbers, June 2012
do you think...

the value proposition in the AEC industry needs to change?
do you think...

the value proposition in the AEC industry needs to change?
architects need to show the value of design?
do you think...

the value proposition in the AEC industry needs to change?
architects need to show the value of design?
arhitectural education is at a cross road?
do you think...

the value proposition in the AEC industry needs to change? architects need to show the value of design? architectural education is at a cross road? the next generation of architect leaders can thrive?
Is my education equipping me to play a role in the future of the built environment?
students, ask yourselves...

Is my education equipping me to play a role in the future of the built environment?

Do I have the willingness to take on large, messy, complex problems?
faculty, ask yourselves...
Am I instilling the passion for lateral, creative thinking—
in other words, design?
faculty, ask yourselves...

Am I instilling the passion for lateral, creative thinking— in other words, design?

Am I inspiring my students to ask questions that I could never imagine?
AEC firms, ask yourselves...

Is my firm going to be part of the solution?
AEC firms, ask yourselves...

Is my firm going to be part of the solution?

Do we have the willingness to be a collaborative partner in this consortium?
What if...
What if...

...there was a way for recent graduates to have a focused, structured path to licensure which for some qualified students may lead to licensure upon graduation?
What if...

...there was a way for recent graduates to have a focused, structured path to licensure which for some qualified students may lead to licensure upon graduation?

...and that path included substantive leadership in areas of research linking faculty expertise with firm needs?

...and a consortium of firms collaborated with a school to create...
Consortium for Research Practices
Consortium for Research Practices and Master of Science in Architecture, Research Practices
Consortium for Research Practices and Master of Science in Architecture, Research Practices at the School of Architecture University of Minnesota

http://rp.design.umn.edu
In-house research positions firm as market expert, limited sharing of proprietary knowledge.

Research meets University standards for tenure and promotion, dissemination through academic venues.

**Broken Knowledge Loop**

**Completed Knowledge Loop**

Identify issues relevant to profession.

New techniques or recommendations based on research.
INDIVIDUALS AND ORGANIZATIONS

SCHOOL

CONSORTIUM

STUDENT

FACULTY

FIRM

NON-PROFIT
FEE STRUCTURE

- STUDENT
- CREDIT
- FEE
- STRUC
- TUR
- SCHOOL
- STUDENT
- CREDIT
- FEE
- STUDENT
- STIPEND
- STUDENT
- CREDIT
- STUDENT
- STIPEND
- STUDENT
- CREDIT
- FIRM
- FIRM
- NON-PROFIT
- FIRM
- NON-PROFIT
- FACULTY
RELATIONSHIPS

- Faculty
  - Student
  - Firm
- Student
- Firm
- School
- Consortium
- Non-profit
RESEARCH GOALS

Student → Faculty → Consortium Goal 1 → Consortium Goal 2 → Non-Profit → Firm → Student → School
RESEARCH GOALS

STUDENT → FACULTY → CONSORTIUM GOAL 1 → CONSORTIUM → NON-PROFIT
STUDENT → FACULTY → CONSORTIUM GOAL 2 → CONSORTIUM → FIRM
STUDENT → SCHOOL → CONSORTIUM → FIRM
STUDENT → SCHOOL → CONSORTIUM → NON-PROFIT
STUDENT → FIRM
STUDENT → NON-PROFIT
RESEARCH GOALS

FACULTY

CONSORTIUM GOAL 1

CONSORTIUM GOAL 2

SCHOOL

STUDENT

STUDENT

STUDENT

STUDENT

FIRM

FIRM

NON-PROFIT

NON-PROFIT

STUDENT
EXAMPLE 1
IES energy modeling

SCHOOL
Blaine

FIRM: MSR
Tom

15 weeks x 15 hrs
3 credits
directed research

15 weeks x 15 hrs
internship

Chris
EXAMPLE 1
IES energy modeling

SCHOOL

Blaine

FIRM: MSR

Tom

Chris
EXAMPLE 2
Virtual Reality

SCHOOL

Renee

15 weeks x 15 hrs
3 credits
directed research

FIRM: HGA

Amy

15 weeks x 15 hrs
internship

Jenna
EXAMPLE 2
Virtual Reality

- SCHOOL
- Renee
- Jenna
- FIRM: HGA
- Amy

Connections:
- Renee to Amy
- Renee to Jenna
- Jenna to Amy

EXAMPLE 3
Virtual Reality

VR COURSE:
12 students

SCHOOL

FIRM:
HGA

Katy
Lee
Renee
Amy
Dan
Jenna
EXAMPLE 3
Virtual Reality

- Katy
- Lee
- Renee
- Amy
- Dan
- Maya
- Jenna

VR COURSE: 12 students

FIRM: HGA

SCHOOL
How to integrate energy modeling into current design process
FIRM A \rightarrow \text{QUESTION} \quad \text{How to integrate energy modeling into current design process} \quad \text{RESEARCH PROJECT} \quad \text{IES training and workflow study}
FIRM A

QUESTION
How to integrate energy modeling into current design process

RESEARCH PROJECT
IES training and workflow study

CSBR

Chris
Blaine
Mary
Ian
FIRM A

 QUESTION
How to integrate energy modeling into current design process

 RESEARCH PROJECT
IES training and workflow study

 KNOWLEDGE
Best practices for use of IES in design

CSBR

Chris  Blaine  Mary  Ian
KNOWLEDGE

Best practices for use of IES in design
FIRM B

QUESTION
How can VR contribute to the design of better health care spaces?

KNOWLEDGE
Best practices for use of IES in design
FIRM B → QUESTION
How can VR contribute to the design of better health care spaces?

RESEARCH PROJECT
Comparing virtual and physical mockups of hospital lobby
FIRM B

**QUESTION**
How can VR contribute to the design of better health care spaces?

**RESEARCH PROJECT**
Comparing virtual and physical mockups of hospital lobby

KOHNLEDGE
Best practices for use of IES in design

VRDL

UNIV. HEALTH CENTER

Katy

Renee

Lee
How can VR contribute to the design of better health care spaces?

Comparing virtual and physical mockups of hospital lobby

Understanding the role of VR in the design process

Best practices for use of IES in design

FIRM B → QUESTION

RESEARCH PROJECT

VRDL

UNIV. HEALTH CENTER

Katy

Renee

Lee
Best practices for use of IES in design

Understanding the role of VR in the design process
Best practices for use of IES in design

Understanding the role of VR in the design process

How to coordinate passive solar and daylighting strategies
KNOWLEDGE
Best practices for use of IES in design

KNOWLEDGE
Understanding the role of VR in the design process

QUESTION
How to coordinate passive solar and daylighting strategies

RESEARCH PROJECT
Integrating quantitative and qualitative daylighting software in VR
KNOWLEDGE
Best practices for use of IES in design

KNOWLEDGE
Understanding the role of VR in the design process

FIRM C

QUESTION
How to coordinate passive solar and daylighting strategies

RESEARCH PROJECT
Integrating quantitative and qualitative daylighting software in VR

VRDL

CSBR

Lee
Katy
Blaine
Mary
Ian
KNOWLEDGE
Best practices for use of IES in design

KNOWLEDGE
Understanding the role of VR in the design process

FIRM C

QUESTION
How to coordinate passive solar and daylighting strategies

RESEARCH PROJECT
Integrating quantitative and qualitative daylighting software in VR

KNOWLEDGE
Expansion of VR for use in passive solar design
## CURRENT RESEARCH PRIORITIES

<table>
<thead>
<tr>
<th>INDUSTRY IMPROVEMENT</th>
<th>EMERGING PRACTICES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Modeling</td>
<td>Climate Change/Water Issues</td>
</tr>
<tr>
<td>Integrated Design</td>
<td>Off-site Construction</td>
</tr>
<tr>
<td>Lean Processes</td>
<td>Robotics</td>
</tr>
<tr>
<td>Patient Safety</td>
<td>Virtual Reality</td>
</tr>
<tr>
<td>Productivity</td>
<td></td>
</tr>
<tr>
<td>Passenger Safety</td>
<td>Health and welfare in developing countries</td>
</tr>
<tr>
<td>Learning Environment</td>
<td></td>
</tr>
<tr>
<td>Post-occupancy Evaluation</td>
<td>Public Interest Design</td>
</tr>
<tr>
<td>Aging in Place</td>
<td></td>
</tr>
</tbody>
</table>


EMERGING PRACTICES
25%

INDUSTRY IMPROVEMENT
75%

REGIONAL IMPACT

EMERGING PRACTICES
50%

INDUSTRY IMPROVEMENT
50%

NATIONAL IMPACT

EMERGING PRACTICES
75%

INDUSTRY IMPROVEMENT
25%

INTERNATIONAL IMPACT
This research internship will produce a field guide for Perkins + Will's Social Responsibility Initiative (SRI) which is intended to serve as the basis for the firm to understand the context of the Serengeti Plains. This guide will help simplify and expedite design decisions in preparation for building a rural health clinic in the Maasai Mara Region of Kenya. Areas of study will include human health factors, food production techniques, sanitation, innovative local building materials, and the status of ecological health in the region. The guide will help prioritize appropriate design tactics such as material assemblies, passive strategies, and siting as influenced by local architecture. It will also aggregate technologies for water filtration/treatment, sanitation, refrigeration, energy production/capture, agriculture, and data management. As Randy Hester poses in his book Design for Ecological Democracy, with every cultural challenge, there is most likely an ecological challenge that exists in parallel. This project will address both cultural and ecological challenges of the Serengeti Plains and present “no-tech”, “lo-tech”, and “high-tech” solutions which aim to treat both simultaneously.
Project delivery – the process by which a building is designed and constructed – needs to be redesigned. Many aspects of the traditional non-collaborative relationship between designer and builder have proven to lead to poor outcomes. We have long recognized that collaboration between the designer and the builder creates value for the client, raises the level of design excellence and produces innovation. The nature of collaboration in the building industry has been studied in a variety of ways but clear metrics and rigorously tested best practices have not been widely adopted. This research project will span over several years and begins with the establishment of base metrics that can be applied to conventional/traditional project delivery (with limited collaboration) and project delivery with a high degree of integration and collaboration.

Mortenson Construction, DLR Group and the University of Minnesota, School of Architecture in the College of Design will work together to define this research starting in Fall Semester, 2013. UMN researchers will begin this research by reviewing and organizing existing literature on the topic of metrics in the building industry and their relationship to project delivery methods including Lean Construction and integrated practice. After the literature review, the larger team will evaluate if new research is needed or if metrics can be developed from current knowledge. Testing and refining metrics will be done by applying them to case studies from DLR and/or Mortenson. This work will provide a baseline measurement of project delivery from which to build future research.
In contemporary architectural discourse, focus has expanded from “making form” to “finding form.” In form-finding, geometry grows out of a careful analysis of building program, user behavior and other “performative” standards such as light or sound. Typically, “parametric” software is used that can bind chosen parameters with geometric output. Resulting surfaces and material treatments are “tuned” to the nuances of program, light or sound, creating complex surfaces. These varied surfaces would be difficult or cost prohibitive to fabricate through traditional construction methods using standardized building units. To achieve the tuned surface in a cost effective way, architects must engage in the parametric design of fabrication methods, partnering with fabricators in a digital fabrication process, also known as “digifab”.

The outcomes of this proposal would include a report speculating how parametric processes might have been incorporated into a completed HGA project. The report would include physical and digital mock-ups of a hypothetical redesign for a surface in the completed project, speculating on how the project might have benefited from a variable “tuned” surface. This proposed option would conclude with a proposed framework for incorporating parametric processes in future projects.
SANFORD MEDICAL CENTER: IMPROVING DESIGN PHASE OUTCOMES THROUGH DIGITAL PROTOTYPING AND FULLY IMMERSIVE VIRTUAL REALITY

Student: William Adams
Faculty: Lee Anderson, Renee Cheng, and Andrea Johnson
Project Supervisors: Taylor Cupp and Ricardo Kahn

Digital prototyping, in which a detailed, three dimensional model is created virtually, is a developing technique in the building industry. It allows designers across trades to coordinate and collaborate on design issues before they become physical. The most advanced digital prototypes are being applied to the completion of a variety of tasks and products – design documents, construction documents, energy performance simulation, and fabrication, among others. This project seeks to leverage the detail of the digital prototype with advances in fully immersive virtual reality (VR) technology. Anticipated outcomes include, but are not limited to, better design decisions made faster based on direct visual feedback in VR, enhanced support for collaboration across various trades, and greater overall customer satisfaction and building quality.