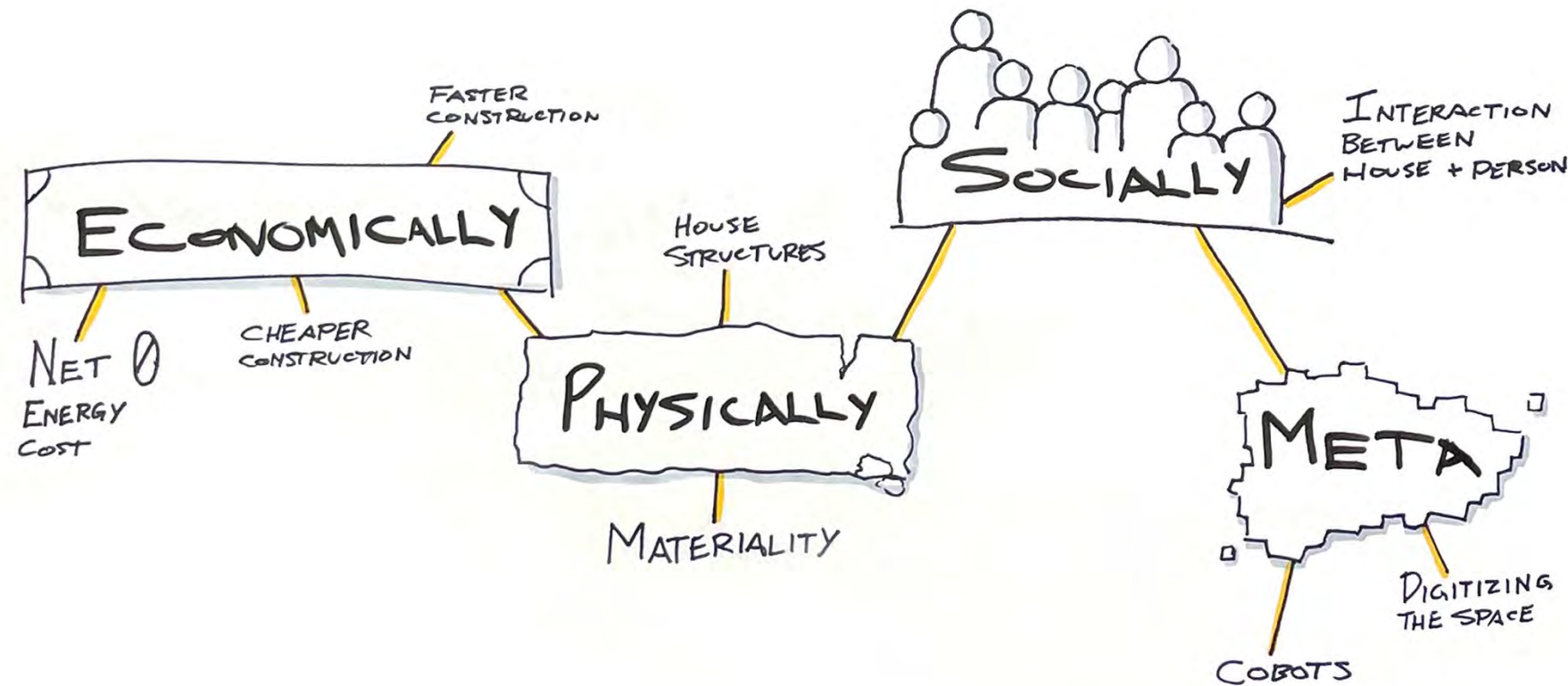


3D Affordable Innovative Technologies Housing



Iowa Area Development Group Partners Forum

3D Affordable Innovative Technologies Housing





2020

Riverhead, New York

First 3D printed house for sale.

Bedrooms	Bathrooms	Area
3	2	1,407 ²

Start-to-finished homes in 30 days.

5x faster than traditional home construction today. **9x faster** tomorrow.

3x

Faster than traditional

40%

Reduction in total

6k+

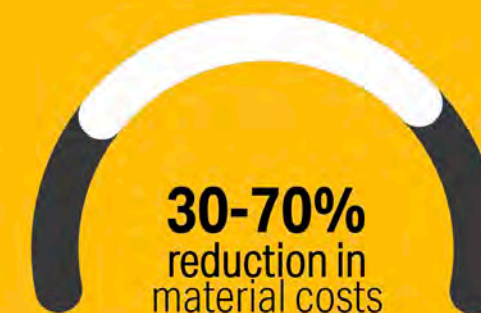
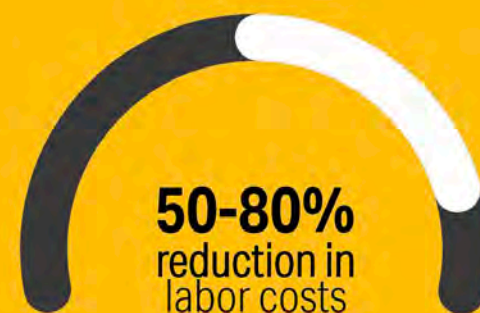
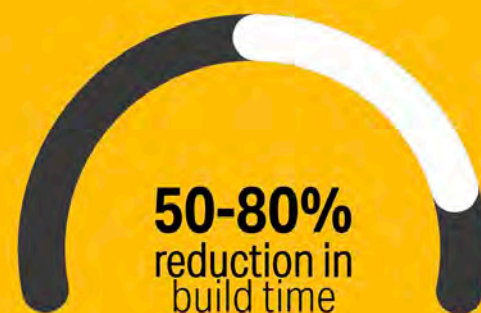
PSI results of compressive

3

Total laborers required for

Why 3D Printing

3D printing is revolutionizing the world in many ways. We focus upon construction of single to four story buildings and structures to save time, resources, labor, and overall cost.



Start-to-finished homes in 30 days.

5x faster than traditional home construction today. **9x faster** tomorrow.

Create a collaborative in-state ecosystem for high performing affordable housing through innovative and emerging 21st century technologies and strategies.

Other specific goals:

Zero energy

Housing affordability

Resiliency and sustainability and longevity

Ability to respond to disaster

Streamlined processes for quicker to market affordable homes

Workforce development (capacity building in formal and informal environments)

Retain Iowa talent to supply future communities in need

Local community policy (codes/ordinance/acceptability of 3D technology)

Collaboration with local parties and partners

Advanced technology educational opportunities in academic setting

3D Affordable Innovative Technologies Housing

Key Elements	Activities	Award
Strategic Infrastructure (SIP)	3D Construction Printers and other technologies to support design, testing, training and construction Materials	\$1,404,000
Design & Research (ARRA)	Housing Design & Affordability Modeling and Printer Configuration Materials Testing & Demonstration Print Energy Performance	\$222,459
Site and Community Planning	Zoning and Building Codes Site Design and Environmental Analysis	\$100,000
Project Management Curriculum Development Affordability Survey (CDBG)	Train future workforce with Iowa Central Community College + workshops across state Survey existing affordable housing projects across state & <u>compare</u> to 3DAIT housing project(s)	\$420,256
Total Award Amount		\$2,146,715

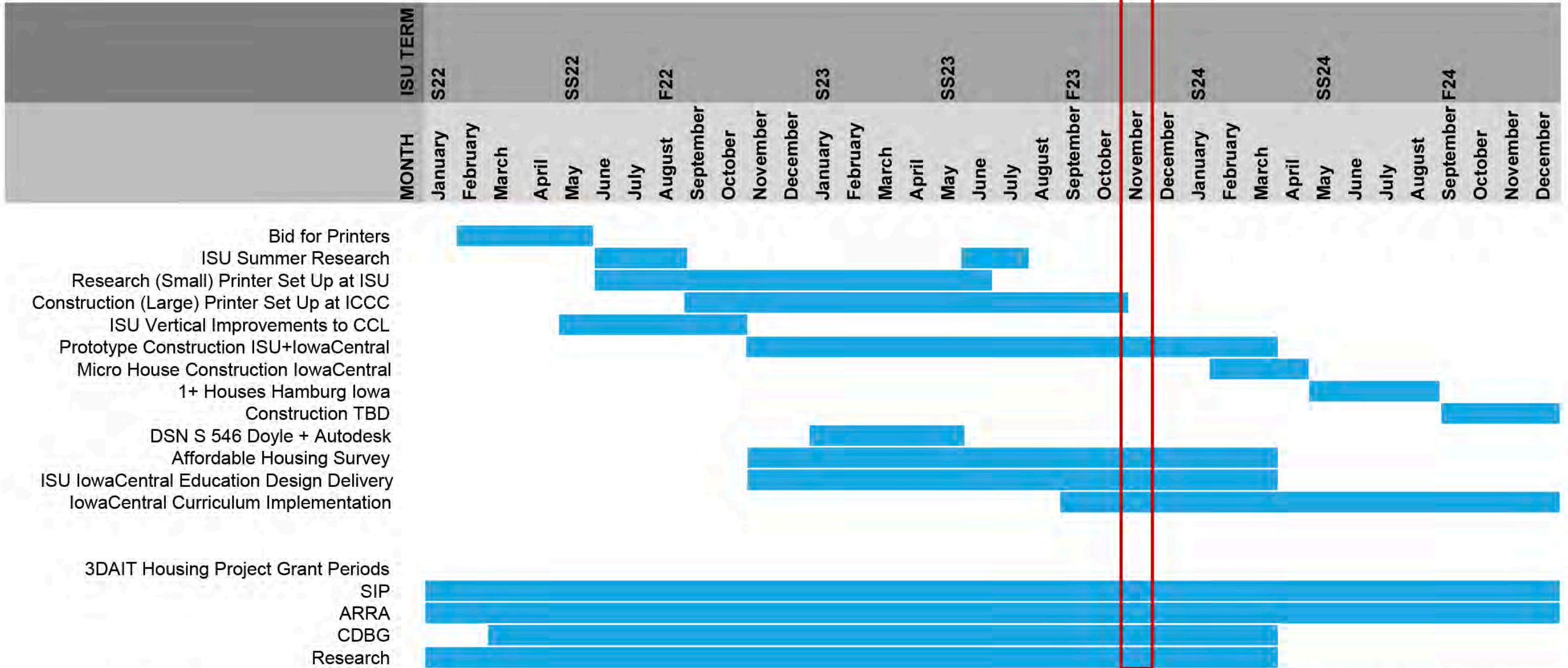
Schedule

Core Partners

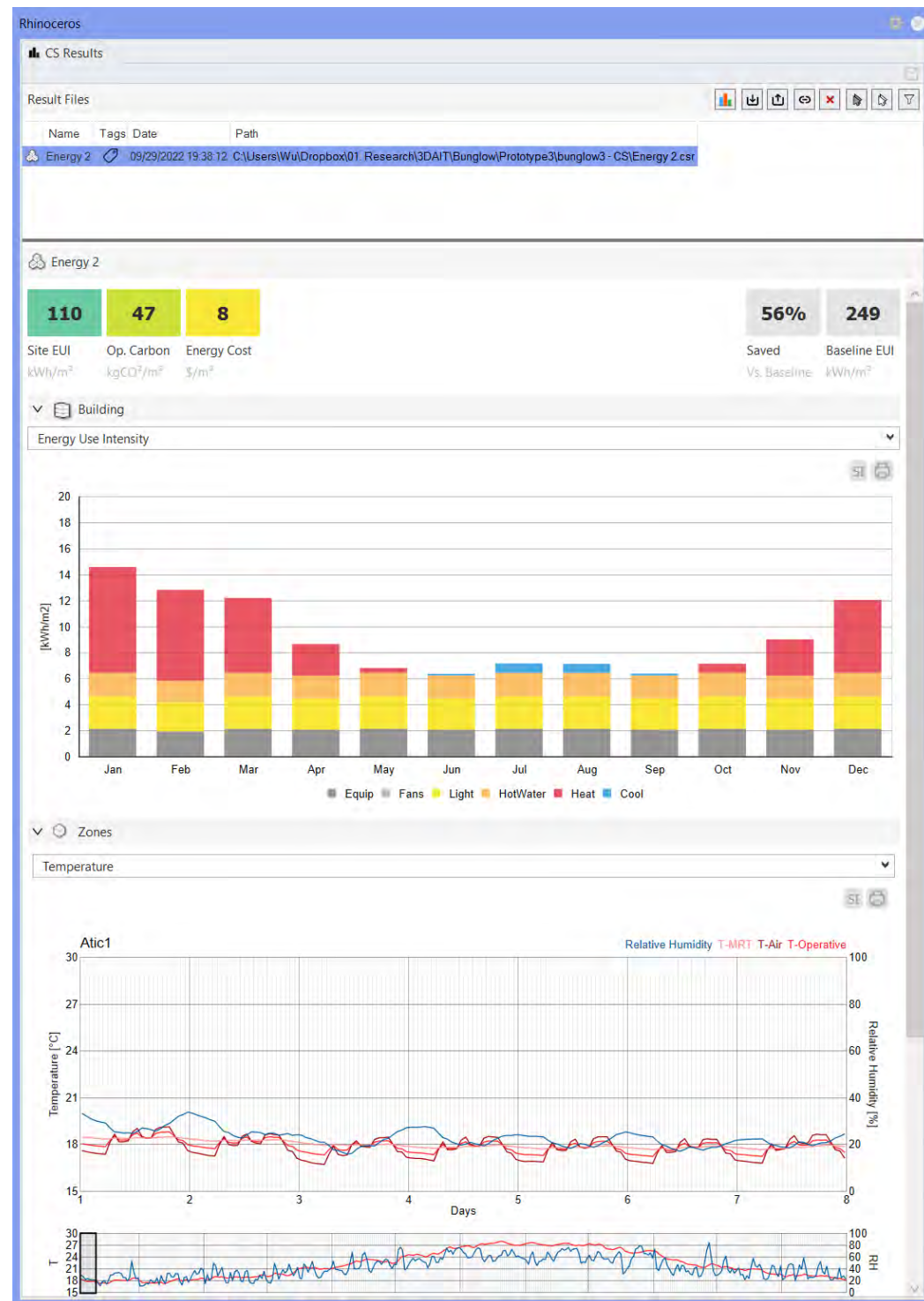
- Iowa Economic Development Authority
- Iowa State University
- Iowa Central Community College
- Brunow Contracting
- BNIM
- McAnally Consulting

Additional Partners

- Alquist 3D
- CT Creek
- Pella Corporation
- Hubbell Realty
- Iowa Association of Realtors
- Iowa Dept of Public Safety
- Iowa Habitat for Humanity
- Iowa Housing Partnership
- Iowa League of Cities
- Matthew 25
- Muscatine, Community Foundation & Community College
- The Element Group
- Vermeer Corporation
- Vaproshield
- (and more interest)



ARCC 2023 International Conference, Dallas. April 12 – 15, 2023 (research publication) Energy Simulation Comparison: Wood Frame VS 3DCP



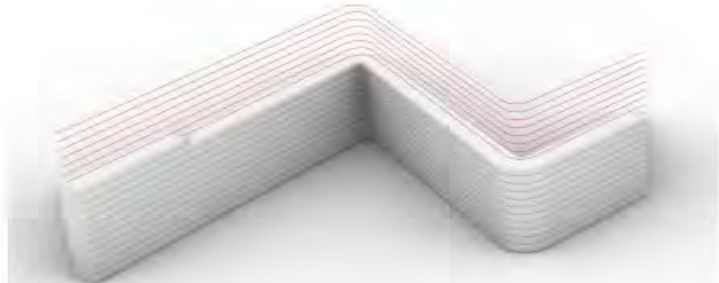
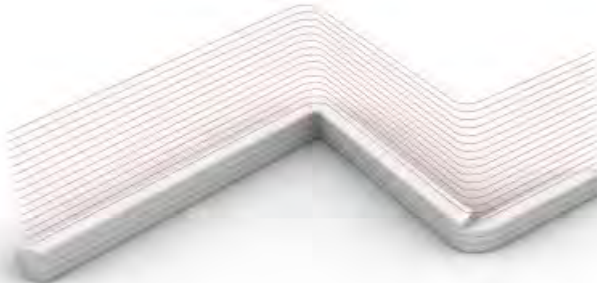
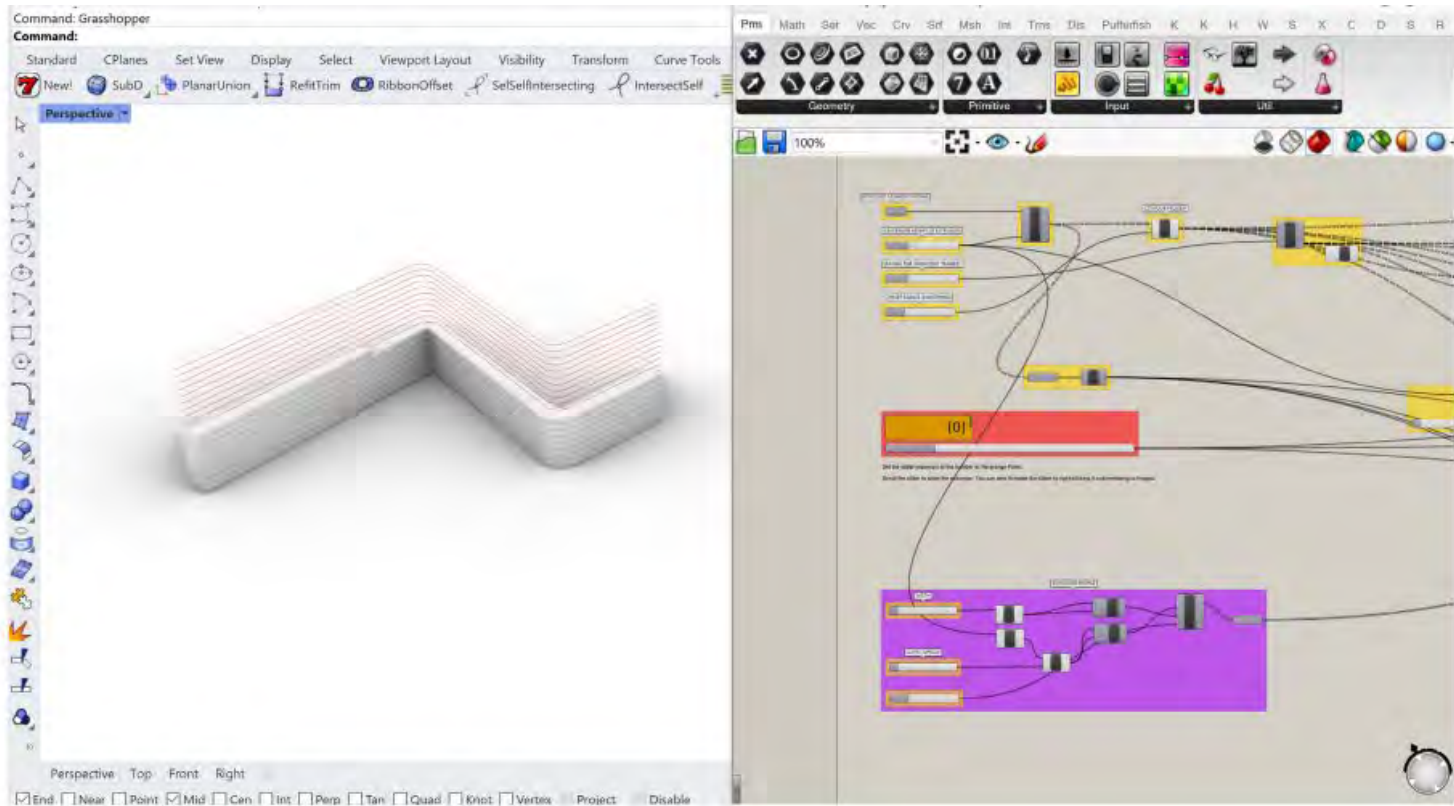
2 X 6 wood stud EUI: 115 kWh/m²
3DCP EUI (6" insulation): 110 kWh/m²

* Energy saving came from difference in R-value

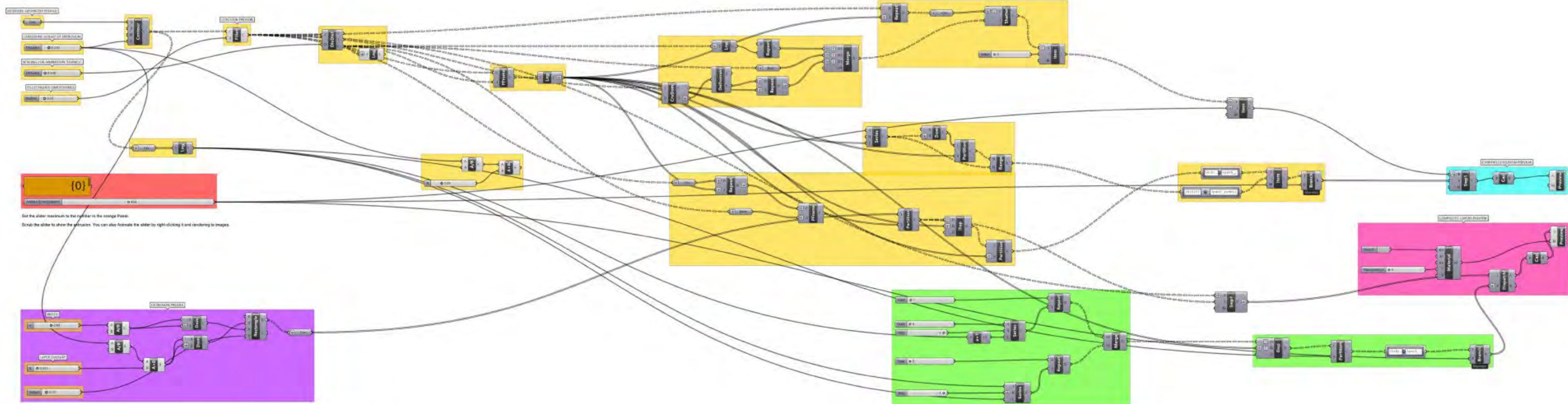
Conclusion

- Removing thermal bridges through design and material choice.
- Without thermal bridges, the R-value of 3DCP walls is primary determined by the thickness and insulation.
- 3DCP can achieve the same or better energy performance compared to conventional wood frame.

Custom Printing Definitions & Simulation



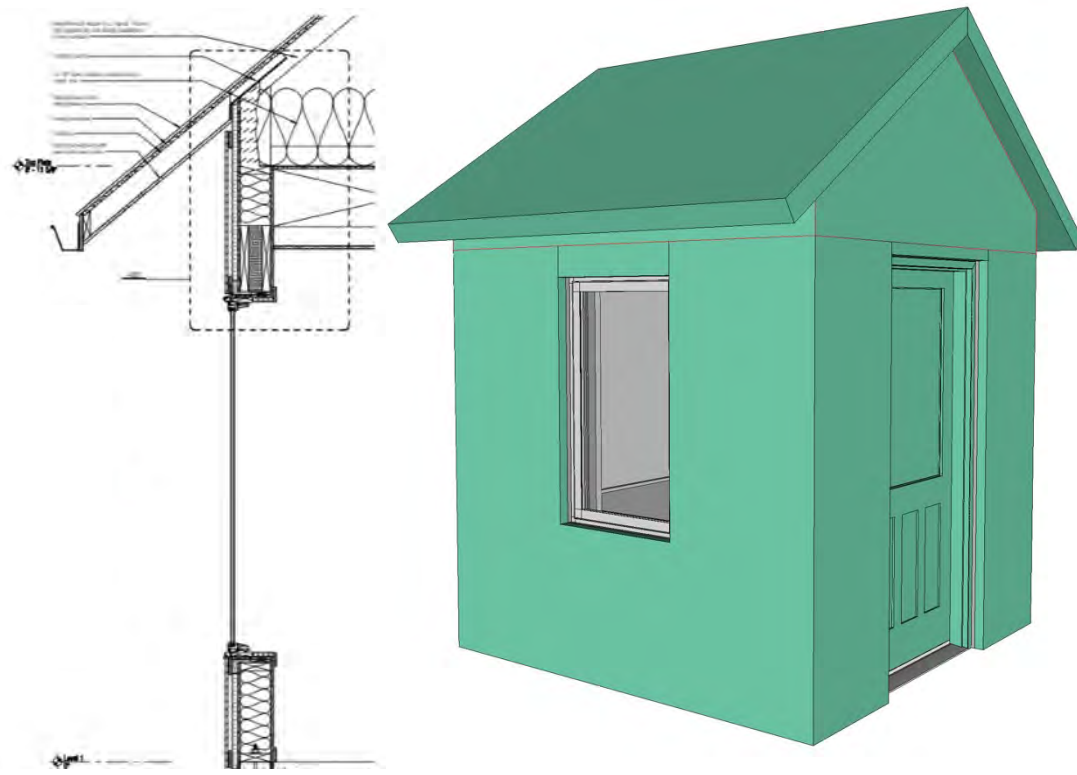
Simulated 3D printed wall based on input geometry.



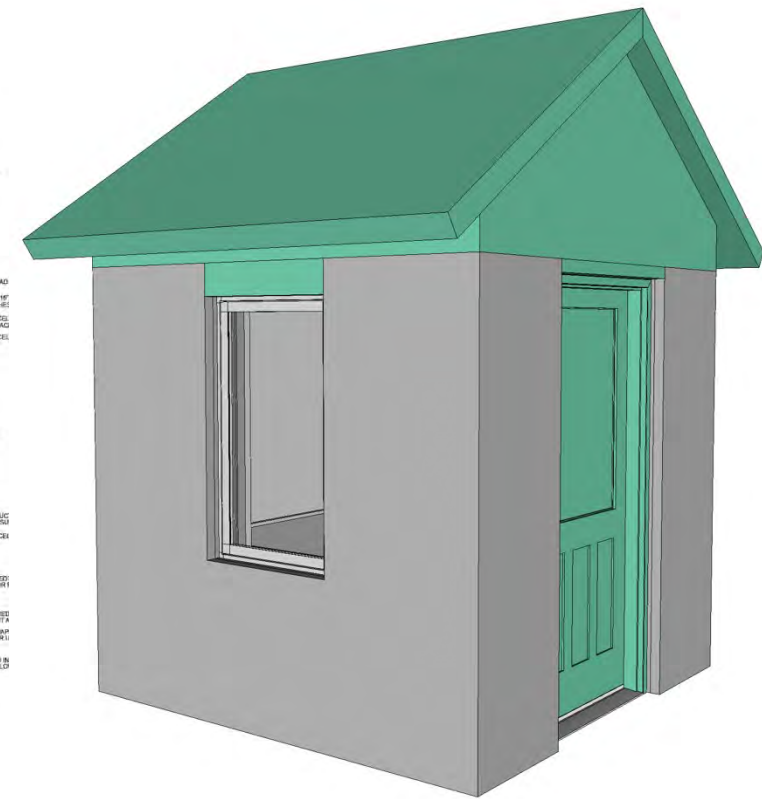
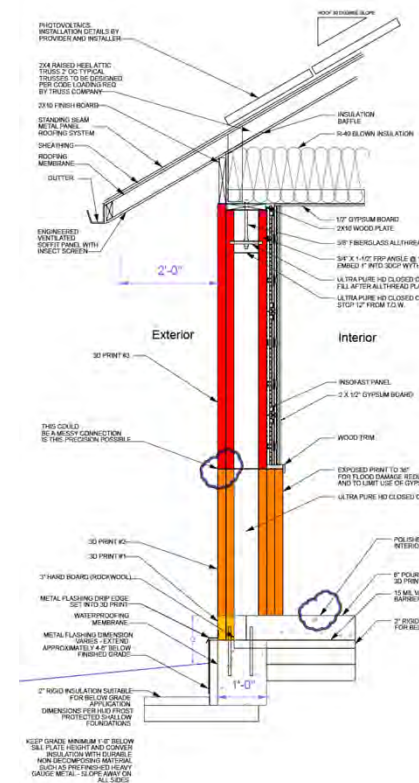
Using Grasshopper, a built-in plugin for Rhino3d, we are able to simulate the print path before any material is introduced.



test shed prototypes at Iowa Central Community College



BNIM IEDA Prototype
wood frame – high performance

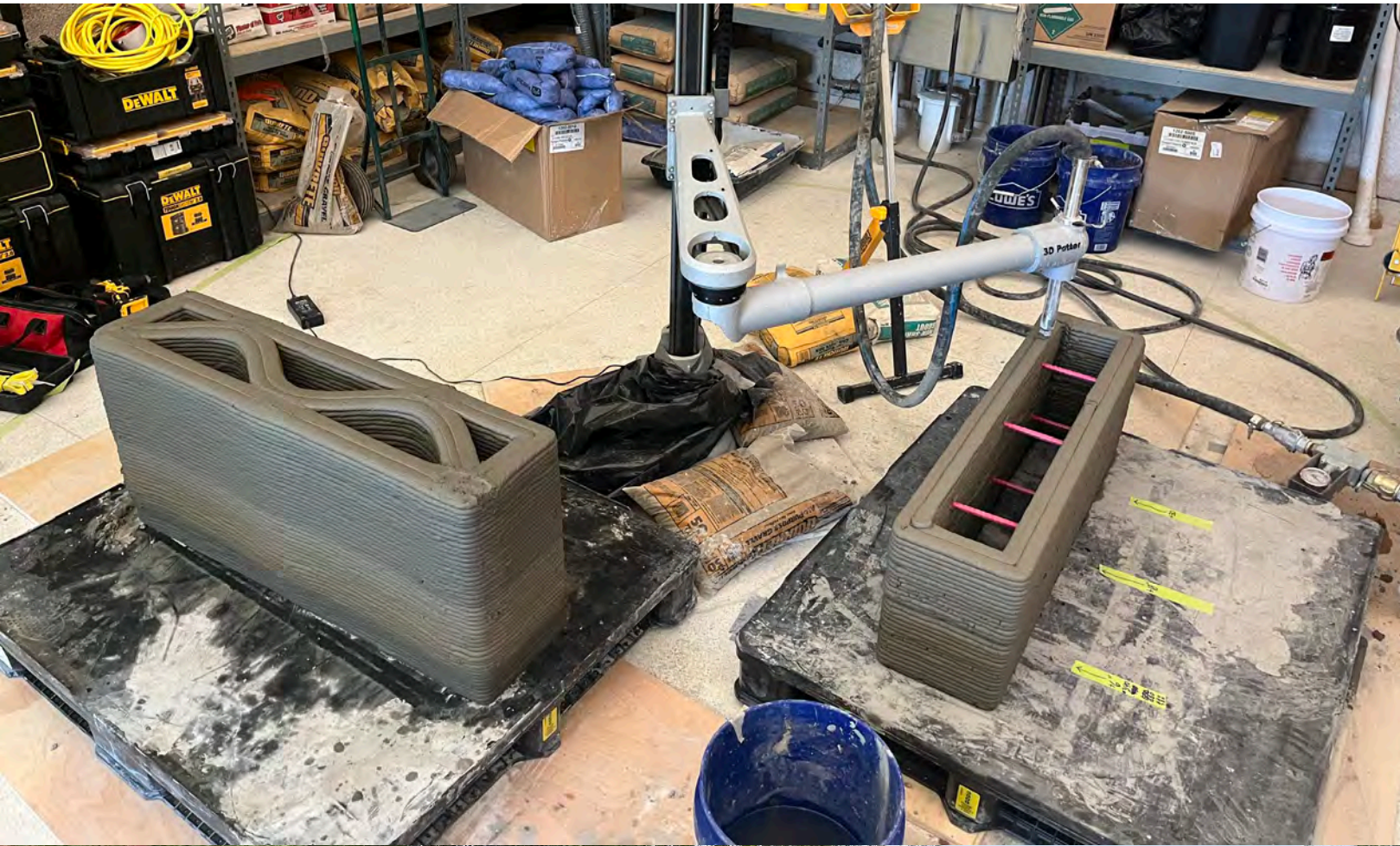


3DAIT
3DCP Quikrete

... DEMO !?

... test, monitor, measure, compare, control throughout an Iowa year

Scara Elite – CAD to CAM & Hybrid Pavilion plus Erectorbots (2)



Geospatial, Autonomous Drones and Photogrammetry

Zoom Level 0



512 px

Ground Control Points

6-17-22 92° Rio #2 McALPIN 21227
 CLEAR 55°#2 TENOPIR

	NORTHING	EASTING	ELEVATION	
97	229021.668	1041745.11	924.047	CPT
98	228805.674	1041883.759	917.458	CPT
99	228908.045	1041670.926	924.347	CPT

Zoom level	Meters/pixel	Meters/tile side
0	156543	40075017
1	78271.5	20037508
2	39135.8	10018754
22	0.037323	9.55463
23	0.0186615	4.777315
24	0.00933075	2.3886575

3/8"-1/2" per pixel imaging detail

<https://learn.microsoft.com/en-us/azure/azure-maps/zoom-levels-and-tile-grid?tabs=csharp>



Ground Sample Distance (GSD) for various fixed Heights

HEIGHT (FT)	HEIGHT (M)	SKYDIO 2 GSD (MM)
5	1.5	0.632
8	2.4	1.011

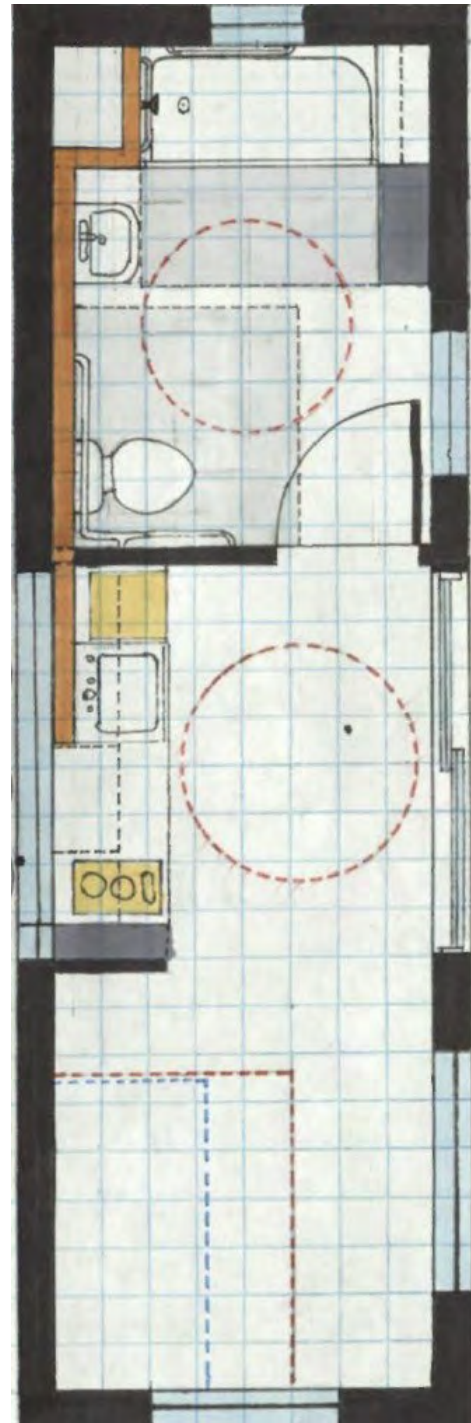


1/16" per pixel imaging detail
 (Construction tolerances!, Geospatial location and building)
 ... and automated scheduling onsite ... DEMO !?

Additional prototypes at Iowa Central Community College



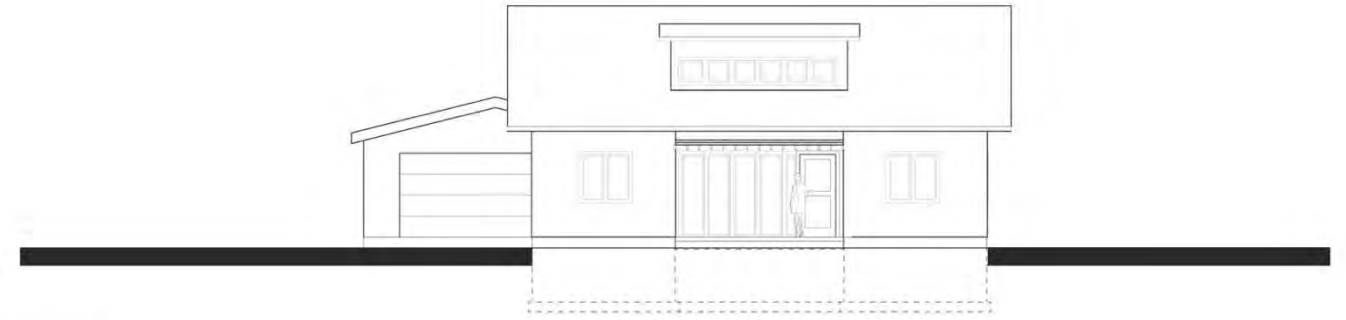
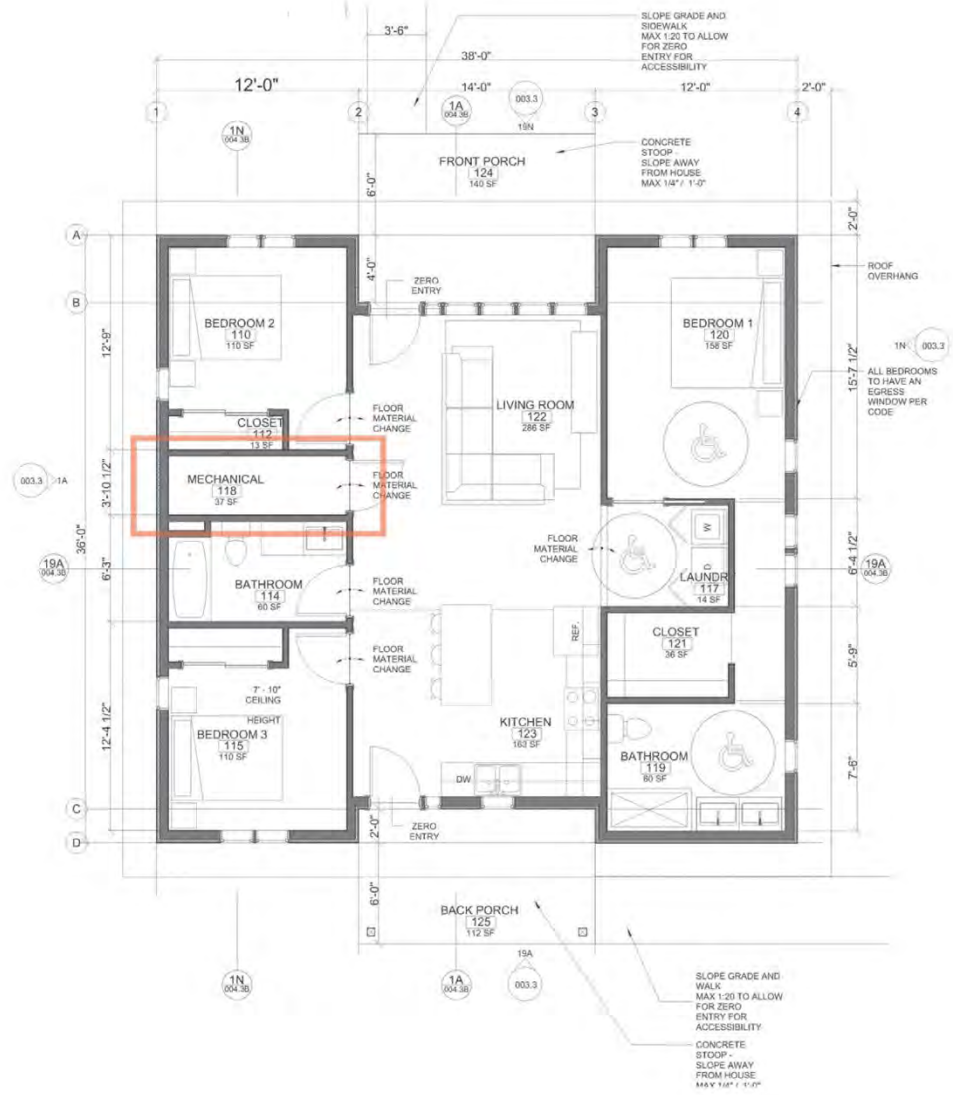
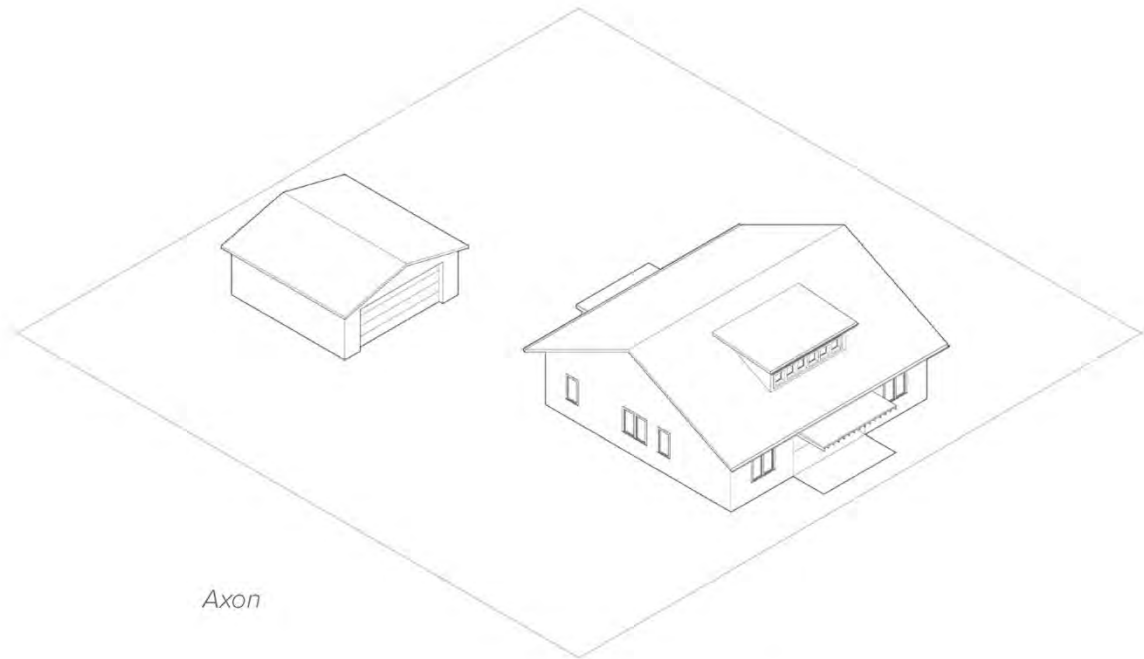
Affordable...



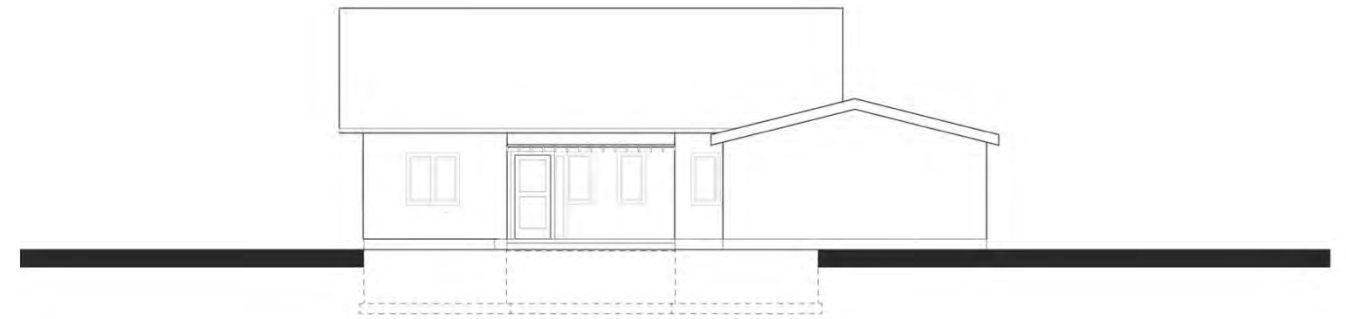
Accessible...



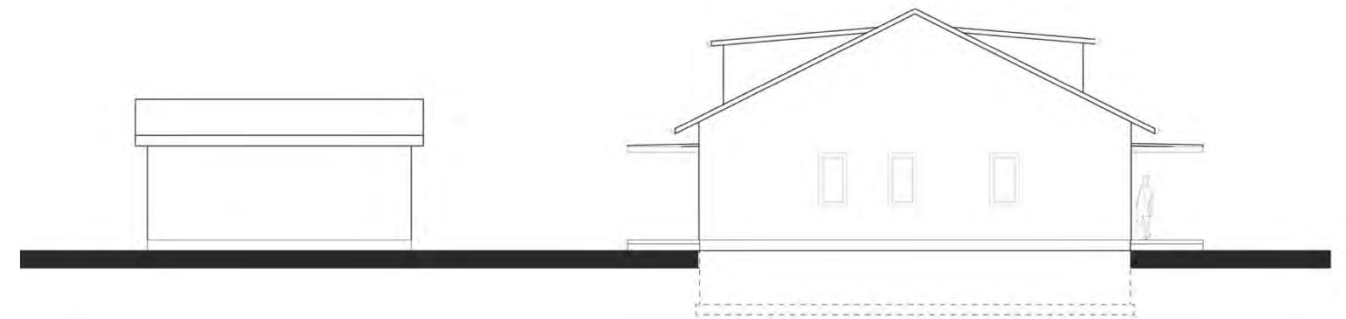
... potential microhouse at Gypsum City RV Park



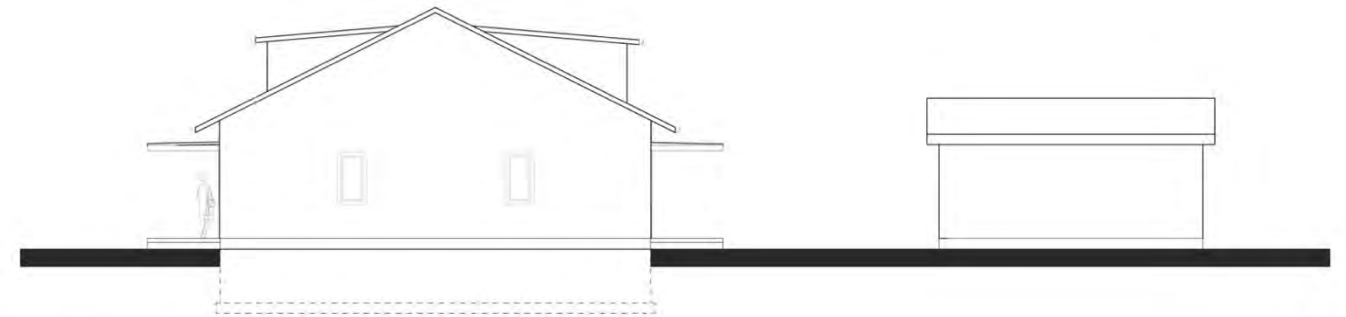
Elevation A



Elevation B



Elevation C



Elevation D



We're gearing up to support the future of urban infill development.
Sign up to get notified when we launch.

[Go to the app](#) [Contact us](#)

© 2022 Cedar Build, Inc.

Fremont County, IA [Change](#)

1500 MAIN ST Hamburg, IA, 51640-1430

Save [Show Street View](#) [Analyze Property](#)

Property Details

Flood Zones
Zone X Minimal flood risk

Soil Types
Property intersects soil type: 12B

Zoning
Zoning Type: R - Residential
Height limit: 35 ft / 2.5 stories

Front yard setback: 30 ft
Side yard setback: Minimum lot width: 66 ft

Minimum lot area: 9,240 sq ft
Single family: 9,240 sq ft
Two family: 12,320 sq ft
Multi family: 12,320 sq ft

Lot Size: 14,706 sq ft
Zoning Type: R - Residential
Existing Structures: 2
Existing Structures Area: 2,192 sq ft
Use Description: Residential (Individual Dwelling Unit)

Feasibility Scenarios

Each site planning scenario is developed with various optimization strategies in mind to help you find the right yield, unit mix and development outcomes that works the best for you.

01 | "Fremont"

Structure count	2
Parking Count	3
Gross developed area	16,225 sq ft
Impervious area	16,225 sq ft

02 | "Sidney"

Structure count	2
Parking Count	3
Gross developed area	16,225 sq ft
Impervious area	16,225 sq ft

03 | "Shenandoah"

Structure count	1
Parking Count	2
Gross developed area	16,225 sq ft
Impervious area	16,225 sq ft

Options **01 "Fremont"** 02 "Sidney" 03 "Shenandoah"

Uses

- Covered Parking - Garage
- Covered Parking - Carport
- Basement

Development Totals

Dwelling unit count	1
Parking count	3
Bedroom	3
Bathroom	2
Gross area	2,311 sq ft
Floor-area-ratio	0.24
Building coverage	16,225 sq ft 21%
Impervious cover	13,490 sq ft 33%

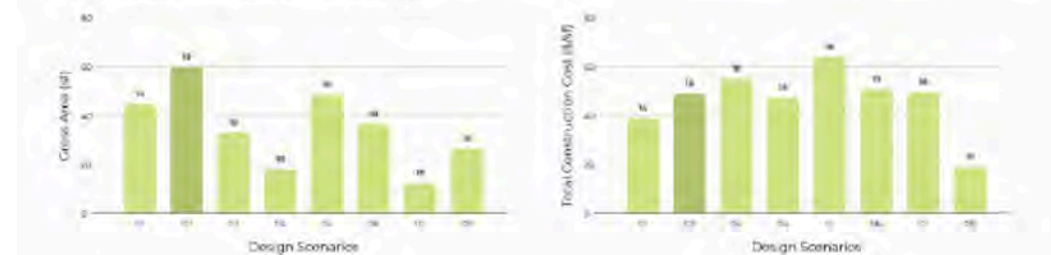
IRC Code Review

Construction Type	Type V
Assembly Type	Stick Frame vI
Performance Level	High
Accessibility	x
Occupancy	x

01 | Option Name [View 3D](#)

Feasibility Metrics

Cedar brings a data driven approach to the site optimization process and provides you with the metrics to help you better evaluate each site planning scenario.



Project Costs

Costs	% / Project	Cost / SF	Total Cost	% / Total
Property Acquisition			\$600,000	21.2%
Design / Engineering		\$55,000	5.9%	4.4%
Finished Construction	\$275	\$937,750	5.9%	9.1%
Unfinished Construction	\$125	\$43,888	5.9%	3.3%
Overhead (% of Construction)	10.0%	\$136,163	6.1%	8.9%

cedar Home About **My Portfolio** The Forest JD

1711 Main St, Hamburg, IA, 51640

Zoning & Permitting Step 4 of 5

- Baseline zoning requirements satisfied
- City Architect review potentially required
- Historic Preservation review potentially required
- Land Status Determination potentially required
- Wildland-Urban Interface adjacency
- Zoning variance potentially advantageous
- Powerline location verification potentially required
- Right-of-way verification potentially required
- Neighborhood plan requirements verified
- Alley location potentially requires review
- Deed restrictions
- Pending permits
- Address is not in historic district
- Site does not intersect with 100-year floodplain

Assets
If you have any supporting documents and would like to add them here for your records, you can upload them below. Your documents will never be shared with anyone unless we receive permission from you directly.

Support Documents ZIP, PDF, DOC, PSD [Upload](#)

[Property Risk Profile](#)

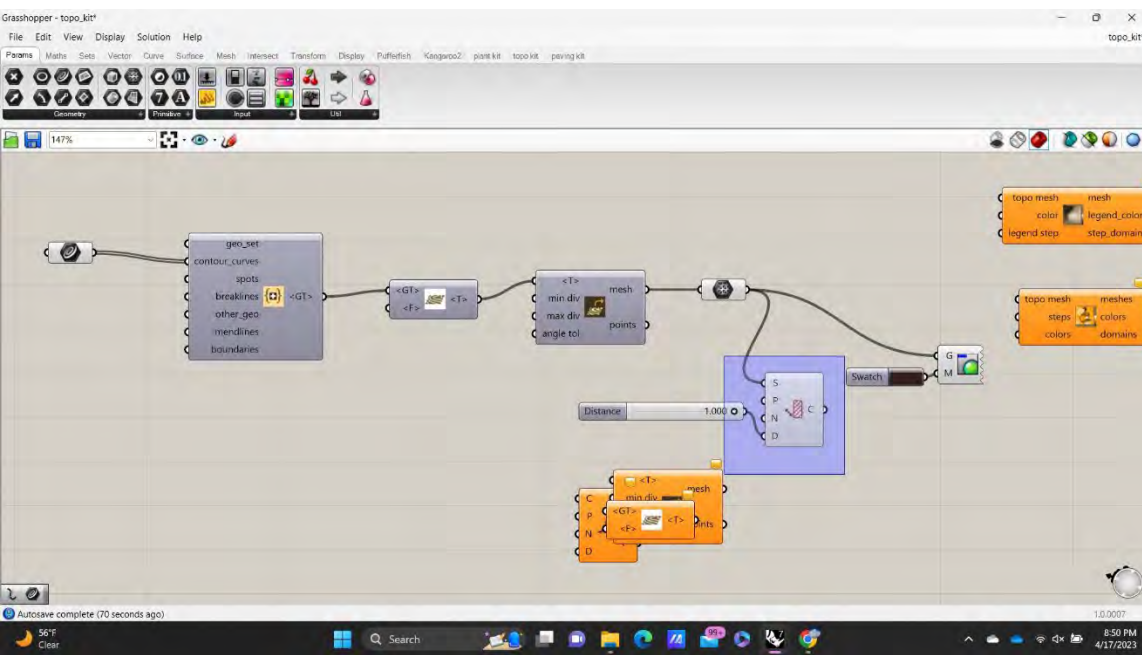
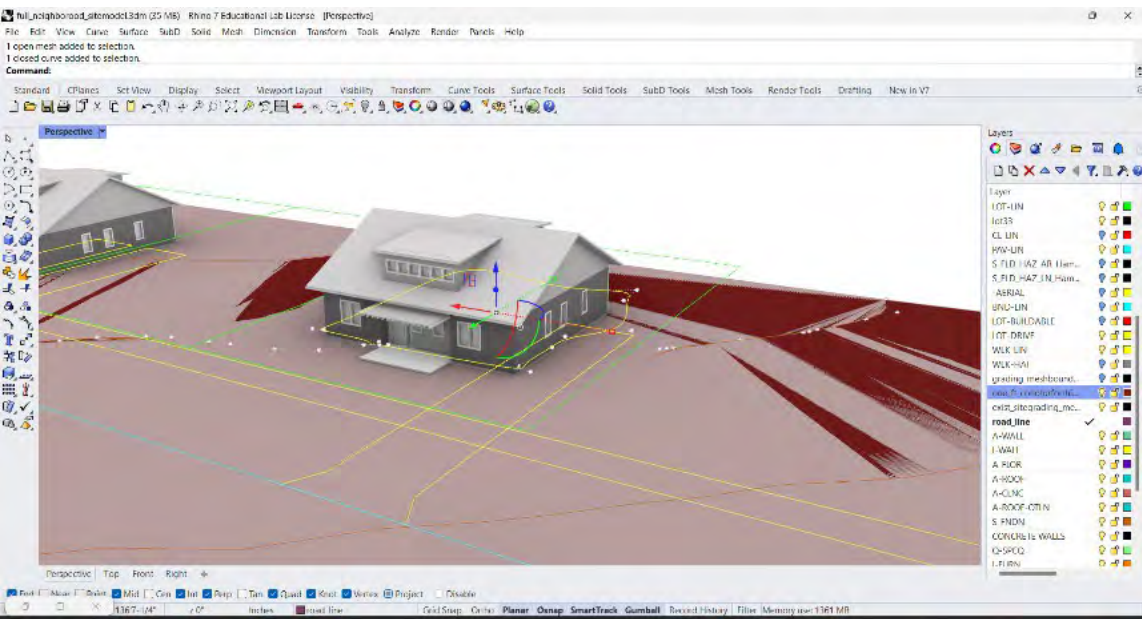
Zoning Analysis

Zoning type	R-Residential	Front yard setback	30 ft
Use type	Individual Dwelling Unit	Side yard setback	
Special incentives	N/A	Height limit	8 ft Dwelling 20 ft Other
Height limit	35 ft 2 stories	Minimum lot width	66 ft
Minimum lot width	66 ft	Minimum lot area	9,240 sq ft
Minimum lot area	9,240 sq ft	Minimum developable area	640 sq ft
Minimum developable area	640 sq ft	Rear yard setback	35 ft Dwelling 45 ft Other

Baseline zoning requirements	<input checked="" type="checkbox"/>	Wildland-Urban Interface adjacency	<input checked="" type="checkbox"/>
Site grading excessive slope	<input type="checkbox"/>	Railroad right-of-way adjacency	<input checked="" type="checkbox"/>
Water available	<input checked="" type="checkbox"/>	100-year floodplain intersection	<input type="checkbox"/>
Sewer available	<input checked="" type="checkbox"/>	25-year floodplain intersection	<input type="checkbox"/>
M district adjacency	<input checked="" type="checkbox"/>	Soil suitability	<input checked="" type="checkbox"/>

Neighborhood Analysis

Site and Landscape (Landkit)...





The International Code Council is the leading global source of model codes and standards and building safety solutions that include product evaluation, accreditation, technology, training, and certification. The Code Council's codes, standards, and solutions are used to ensure safe, affordable, and sustainable communities and buildings worldwide.

The International Building Code (IBC) is a model building code developed by the International Code Council (ICC). It has been adopted for use as a base code standard by most jurisdictions in the United States.

Model building codes rely heavily on referenced standards as published and promulgated by other standards organizations such as ASTM (ASTM International), ANSI (American National Standards Institute), UL (Underwriters Laboratories), and NFPA (National Fire Protection Association).

General information Preview

Status: Under development. You can **comment** on this draft international standard by contacting your **national member**.

Edition: 1. Number of pages: 36.

Technical Committee: ISO/TC 261 Additive manufacturing.

ICS: 25.030 Additive manufacturing.

SUSTAINABLE DEVELOPMENT GOALS

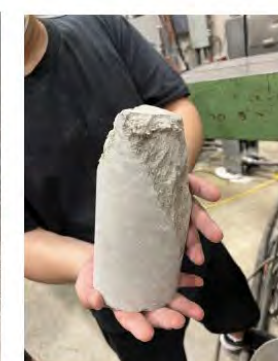
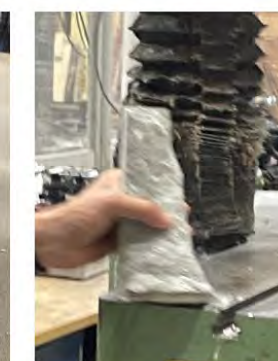
This standard contributes to the following Sustainable Development Goal:

Life cycle

Now

Under development
ISO/ASTM DIS 52939
Stage: 40.20 ~

00 | 10 | 20 | 30 | 40 Enquiry | 50 | 60 | 80 | 95



Consulting

01 Materials and Testing

02 International Standard Compliance (ISO/ASTM 52939)

03 Operational and Workforce Protocols

04 Education, Training, and Workforce Development

05 Traditional vs AC Comparable Analysis

... plus numerous network interactions and introductions

3DCP Material Tests	Standards
Flowability	ASTM C 1437
Slump	ASTM C 143
Compression	ASTM C 39
Flexure	ASTM C293 / C78 / 1609
Setting time	ASTM C 191
Absorption	ASTM C 642-21
Surface resistivity	AASHTO- T 358
Drying shrinkage	ASTM C 596



ENVISION

measures the sustainability of infrastructure projects across 64 criteria organized in 5 categories:

Quality of life (14 criteria)

Leadership (12 criteria)

Resource allocation (14 criteria)

Natural world (14 criteria)

Climate & risk (10 criteria)



WELL v2, Q1-Q2 2023

10 Concepts

24 Preconditions required

100 Optimizations available



Air



Water



Nourishment



Light



Movement



Thermal Comfort



Sound



Materials



Mind



Community



Innovation

Integrative Design

Location and Neighborhood Fabric

Site Improvements

Water Conservation

Operating Efficiency

Materials

Healthy Living Environment

Operations, Maintenance, Occupant Engagement

Training, Curriculum Development and Survey

Project Scope: Prepare the future workforce by introducing the technologies and equipment across wide spectrum

- Formal Component: Development of a community college curriculum that will support workforce being trained in building industry.
- Informal Component: Focus on existing suppliers in the construction industry and deliver community level workshops and demonstration activities
- Supporting activities: Introduce 3D technologies curriculum at the K-12 level to support the future interest development
- Survey and interview work



Certificate Program for Fall 2023 to be delivered at Iowa Central Community College, Fort Dodge in conjunction with the Diploma in Carpentry

Associates Degree Program for 2024

Program Titles: Year 1 Certificate Program - Additive Construction Management ACM 1 focused on Design/Planning and Year 2 Associates Degree ACM II Construction

Collaborative work with team comprised of ISU and ICCO faculty and staff

Iowa State University Extension & Outreach

Develop of a series of engaging activities that promote the core concepts and skills being used to design and fabricate affordable, innovative housing with upper elementary (3-5) and middle school (6-8) students.

1. Introduction to Engineering Design
2. Introduction to 3D Design
3. Introduction to 3D Printing
4. Affordable and Durable Design
5. Design, Robotics, and the Environment
6. Interaction of Physical and Digital Design Environments



3D Affordable Innovative Technologies Housing



Thank you!

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... more to be published at:
<https://iowainnovativehousing.design.iastate.edu/>