Agenda

- High-performance homes effort to date
- Model home prototype
- Innovations in home construction
- 3D printed home project is born
- Help us design the project
- Questions

IOWA economic development

Funding Matters

- Funding for housing is critical
  - But…
- What about…
  - Design of the home
  - Size of the home
  - Location of the home
  - Home livability/accessibility
  - Materials used
  - Techniques applied
  - Operations and maintenance

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High-Performance Homes Effort to Date

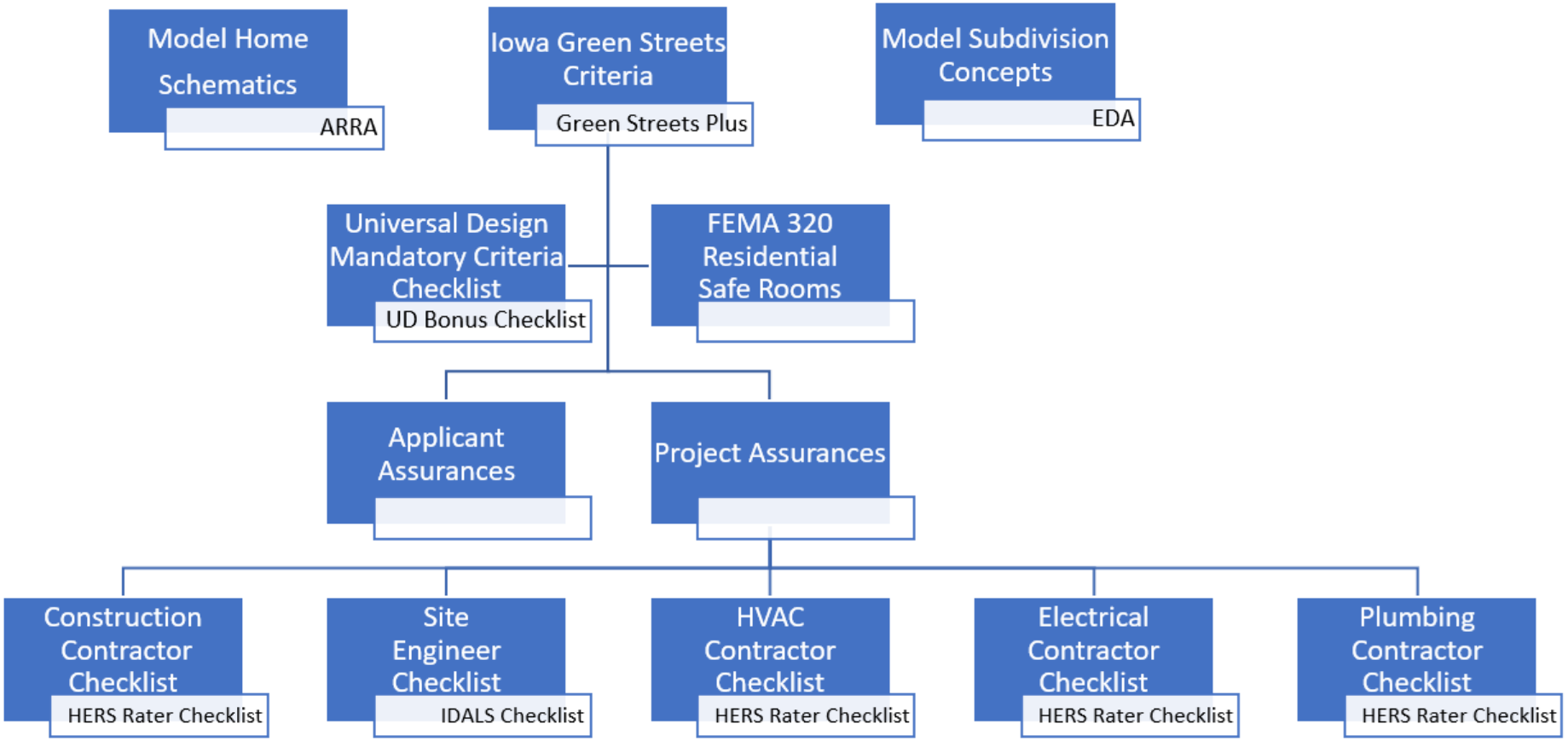
- Iowa Green Streets Criteria
  - Integrated Design
  - Location & Neighborhood Fabric
  - Site Improvement
  - Water
  - Operating Energy
  - Materials
  - Healthy Living Environment
  - Operations & Maintenance

High-Performance Homes Effort to Date

ZERO ENERGY READY HOME
U.S. DEPARTMENT OF ENERGY

				Solar Ready	Solar Ready
				Eff. Comps.& H_2O	Eff. Comps.& H_2O
				EPA Indoor Air Package	EPA Indoor Air Package
				Optimized Duct Location	Optimized Duct Location
		HVAC QI with WHV	HVAC QI with WHV	HVAC QI with WHV	HVAC QI plus HRV
		Water Management	Water Management	Water Management	Water Management
	Independent HERS Verif.	Independent HERS Verif.	Independent HERS Verif.	Independent HERS Verif.	Independent PHIUS Verif.
IECC 2009 Enclosure	IECC 2012 Enclosure	IECC 2009 Enclosure	IECC 2012 Enclosure	IECC 2015 Encl./ES Win.	Ultra-Efficient Enclosure
HERS **85-90**	HERS **70-80**	HERS **65-75**	HERS **55-65**	HERS **48-55**	HERS **35-45**
IECC 2009	IECC 2012	ENERGY STAR v3	ENERGY STAR v3.1	ZERH	PHIUS+

High-Performance Homes Effort to Date



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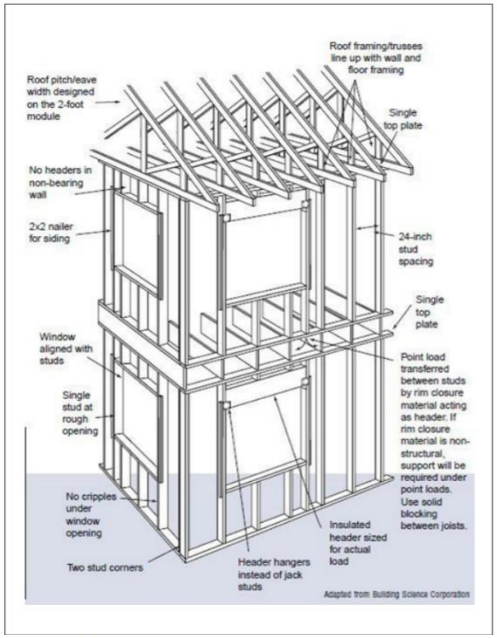
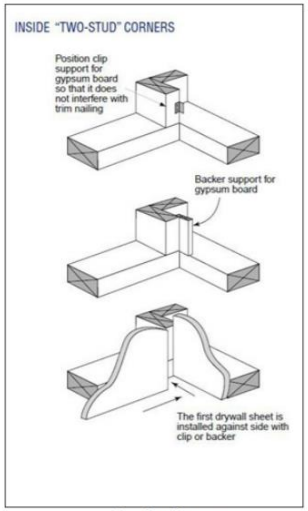
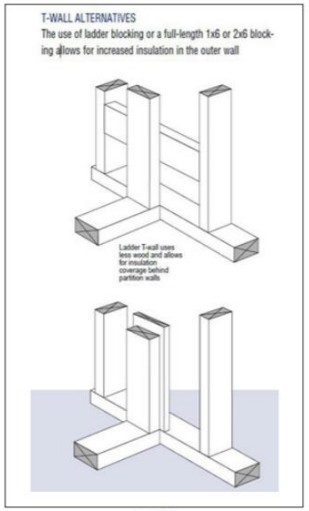
High-Performance Homes Effort to Date

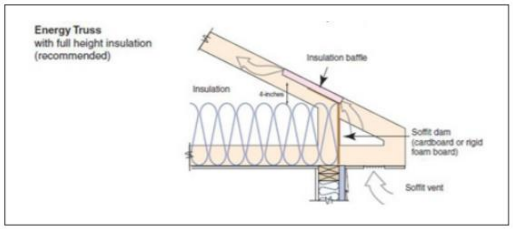




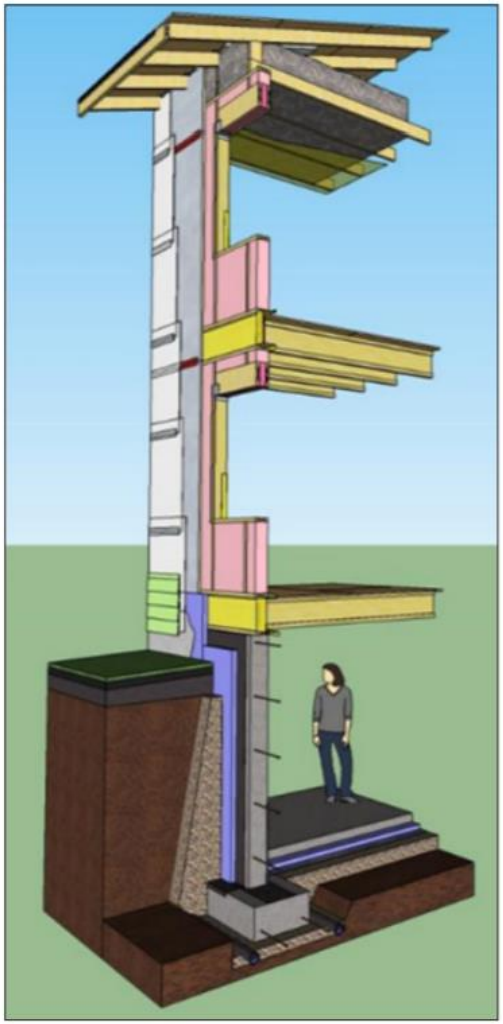
Two-Stud Corner



T-Wall



(Image: Building America Solution Center)
Raised-Heel Truss
www.apawood.org/raised-heel-trusses



RESOURCES

- Advanced Energy: Comprehensive design and installation guidelines. ww
- Building Science Corporation: Features articles on conditioned crawl spa foundations and slabs, or high R-value walls topics at buildingscience.cc
- U.S. Department of Energy, Office of Energy Efficiency & Renewable Ener downloads on best building practices.
  energy.gov/eere/buildings/building-america-bringing-building-innovations-market

Slab Insulation

Capillary Break

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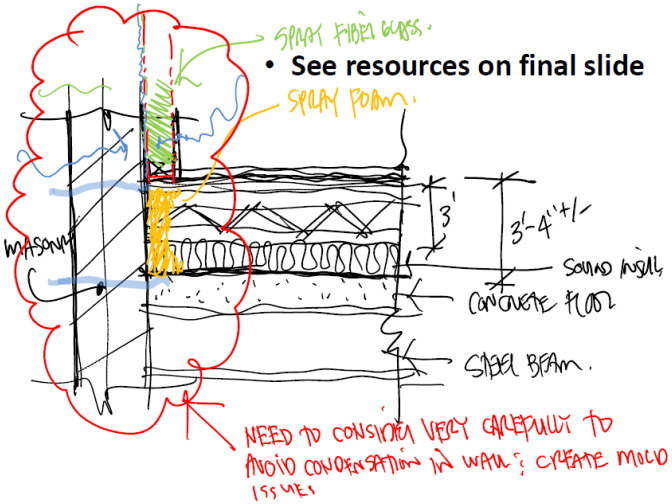
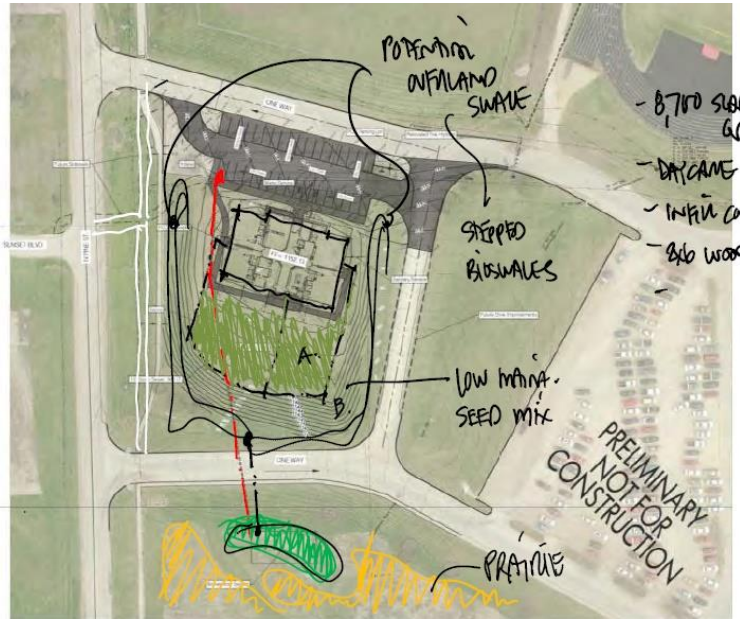
High-Performance Homes Effort to Date

- Design Consultations
  - Architecture
  - Planning
  - Living Infrastructure
  - Landscape Architecture
  - Mechanical/Electrical Engineering
  - High-Performance Construction
  - Building Science



- See resources on final slide



IOWA economic development

Prototype Home

- Prototype Home Project
  - Goals
    - Affordability - Study the drivers of the cost of the home and respond with appropriate design strategies to balance the overall cost of the home.
    - Adaptability – Considering the need for housing in Iowa for independent seniors and young families, investigate a design that is adaptable.
    - Energy Efficiency – Evaluate through energy modeling various strategies to increase energy efficiency beyond current code compliance and look to the DOE Zero Energy Ready Home (ZERH) program for applicability to the design.

Prototype Home

Lead Design Team:

Kevin Nordmeyer, AIA	BNIM
Aaron Hauptmann, Assoc. AIA	BNIM

Design Collaborators:

Dan McGuire	The Element Group HERS Rater
Michael Boerst	The Element Group Energy Consultant
David Yocca, FASLA	Landscape Architect
Matt Faber, PE	KCL Engineering
Bill McAnally	McAnally Consulting Construction Specialist

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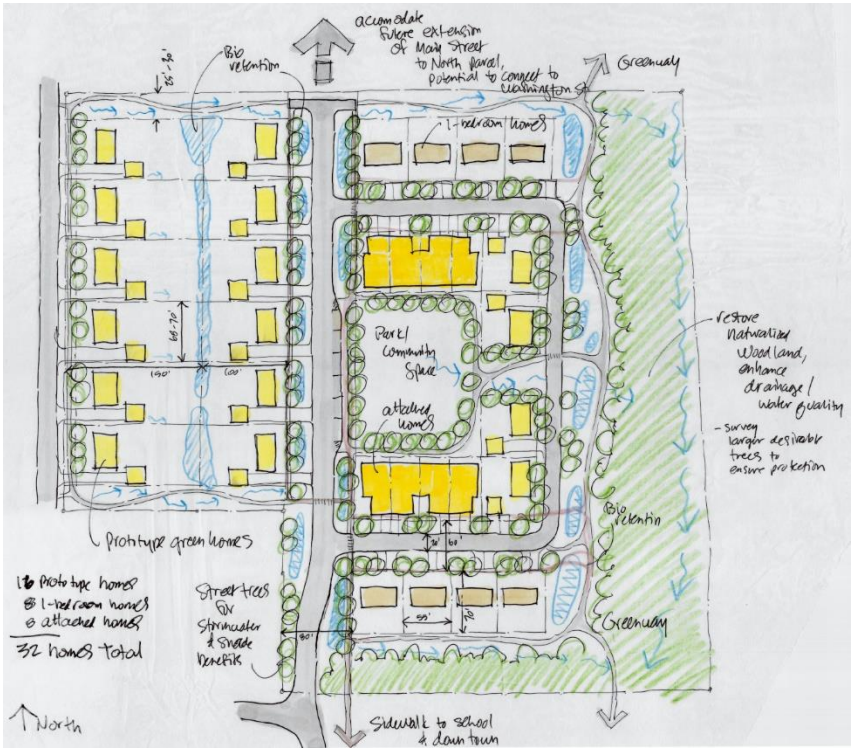
Prototype Home

- Prototype Process
  - Banker / Lender
  - Residential Contractors
  - Realtor
  - Hamburg Mayor and City Clerk



IOWA economic development

Prototype Home

- Prototype Concepts
  - Option 1:Base Home: 1196 sf – 2 Bedroom, 1 Bathroom, Slab-on-Grade
  - Option 2:1 ½ Story Home: 1841 sf – 4 Bedroom, 2 Bathroom, Slab-on-Grade
  - C. Option 3:1 ½ Story Home: 1841 sf – potential 5 Bedroom, 3 Bathroom, Slab-on Grade - With Basement

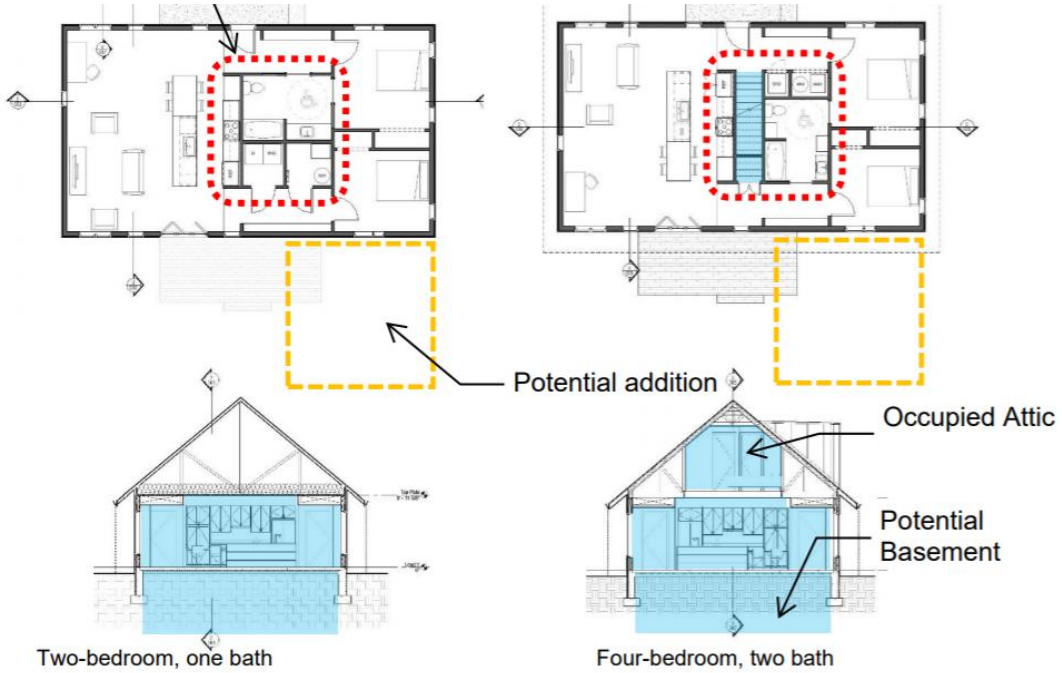


Figure 3: Prototype Plans and Sections

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Prototype Home

- Prototype Performance
  - Modeled home performance to:
    - Baseline Iowa energy code (IECC 2012)
    - 2018 IECC
    - DOE Zero Energy Ready Home
      - 2 ACH 50
      - All-electric home
      - Air Source Heat Pump (9 HSPF, 16 Seer)
      - Balanced ventilation w/recovery
      - 2.0 EF Heat pump water heater
      - Energy Star Appliances - all electric
      - 2x4 advanced framing, no cavity insulation, 4” of rigid insulation outboard
  - Results
    - All 3 home concepts with energy modifications above met DOE ZERH home energy rating system requirement of HERS Index 48-55.

IOWA economic development

Prototype Home

- Cost Analysis

NAHB Survey Data *NAHB data from Figure 7 data and appendix report*	2019 data		2020	2021	2021 Lumber adjustment
Average Finished Floor Area	2594				
Construction Cost	$ 296,652		$ 307,034.82	$317,781.04	$364,210.24
$/sf calculated on finished area	$ 114.36		$ 118.36	$ 122.51	**$ 140.40**
Total Sale Price of Home	$ 485,127		$ 502,106	$ 519,680	$566,109.37
Includes total costs including land and other overhead, profit, etc.					
$/sf calculated on finished area	$ 187.02				**$ 218.24**

Comparable Iowa Home - planned build 2021 - Western Iowa		
Finished Floor Area	1100	
	w/bsmt	
Estimated Construction Cost	$ 185,000	
$/sf calculated on finished area	**$ 168.18**	Construction only
Total Sale Price Estimate	$ 251,250	
Includes total costs including land assumptions, overhead, etc.	w/bsmt	
$/sf calculated on finished area	**$ 228.41**	Sale Price

Comparable Home - Waukee, Iowa	2019	2020	2021
Finished Floor Area	1643	3.50%	3.50%
Sale Price	$ 338,000	$349,830.000	$362,074.05
$/sf finsished area (has basement)	**$ 205.72**	**$ 212.92**	**$ 220.37**

Range used to estimate probable costs for IEDA Prototype Home Concepts		
Construction Cost Range	$ 142.25	$ 172.25
Sale Price Range	$ 220.25	$ 232.25
Includes Incremental ZERH Costs noted below		

Cost Ranges for Prototype Homes		**Option 1B**	**Option 2B**	**Option 3B**
Area		1196	1841	1841
Construction cost range	$ 142.25	**$ 170,131**	**$ 261,882**	**$ 261,882**
	$ 172.25	**$ 206,011**	**$ 317,112**	**$ 317,112**
Sale Price Range	$ 220.25	$ 263,419	$ 405,480	$ 405,480
	$ 232.25	$ 277,771	$ 427,572	$ 427,572
Sale Price Accounting for no basement (1B,2B)	$ (8,000)	**$ 255,419**	**$ 397,480**	**$ 405,480**
	$ (12,000)	**$ 265,771**	**$ 415,572**	**$ 427,572**

ZERH Incremental Costs					
		2015	2019	2020	**2021**
Incremental Costs					
2012 IECC to ZERH		$ 4,403	$ 4,557	$ 4,717	**$ 4,882**
finishe area	2200			$/sf	**$ 2.22**

Figure 5: Cost Calculations – green areas have been added – not from NAHB

IOWA economic development

Prototype Home

» Cost Analysis

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Figure 5: Cost Calculations – green areas have been added – not from NAHB

IOWA economic development

Prototype Home

Energy Information									PV system Energy Production					
Climate Zone 5			Des Moines, Iowa							6kw	7kw	8kw	9kw	10kw
Model	HERS	Heating (kwh/yr)	Cooling (kwh/yr)	Water Heating (kwh/yr)	Lights and Appliances (kwh/yr)	Total (kwh/yr)	Monthly Average (kwh/yr)	% Energy Savings Over Baseline	kwh/yr	8636	10075	11514	12953	14392
Baseline 1	96	9525	1260	4132	6787	21704	1809		kwh/mo -avg	720	840	960	1079	1199
Option 1B	49	3839	615	879	3733	9066	756	58.2%						

Energy Modeling Information									PV system Energy Production					
Climate Zone 6			Waterloo, Iowa							6kw	7kw	8kw	9kw	10kw
Model	HERS	Heating (kwh/yr)	Cooling (kwh/yr)	Water Heating (kwh/yr)	Lights and Appliances (kwh/yr)	Total (kwh/yr)	Monthly Average (kwh/yr)	% Energy Savings Over Baseline	kwh/yr	8420	9823	11226	12629	14033
Baseline 1	93	12485	967	4396	6759	24607	2051		kwh/mo -avg	702	819	936	1052	1169
Option 1B	50	5363	381	938	4073	10755	896	56.3%						

Cost Ranges for Prototype Homes		Option 1B
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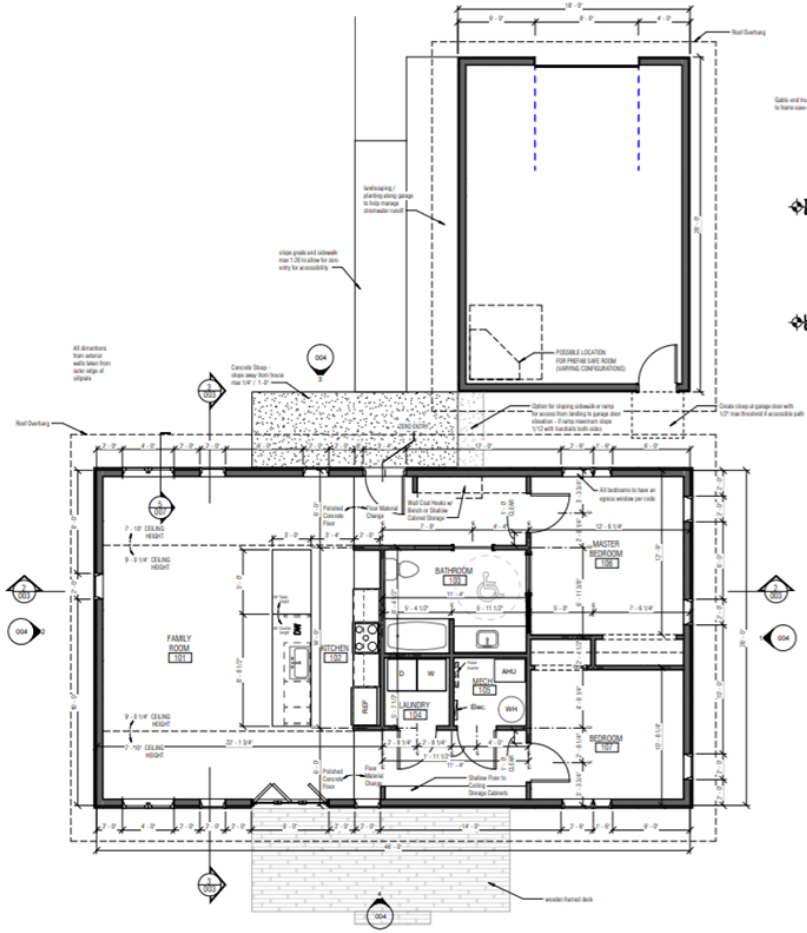
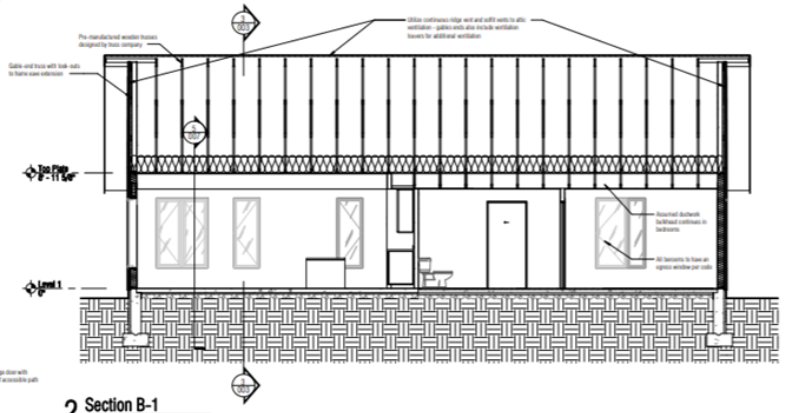
Prototype Home



1 Floor Plan - Slab-on-grade



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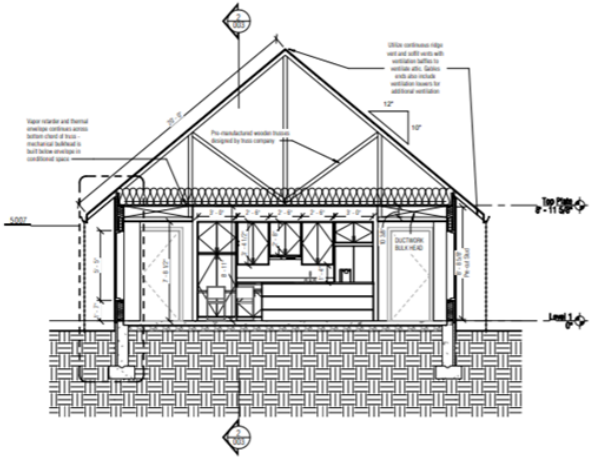

3 Section A-1

bnim

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317 Sixth Avenue, Suite 100, Des Moines IA 50309
www.bnim.com

Schematic Design Documents

Iowa - High Performance Prototype Home

Iowa Energy Office

Iowa Economic Development Authority

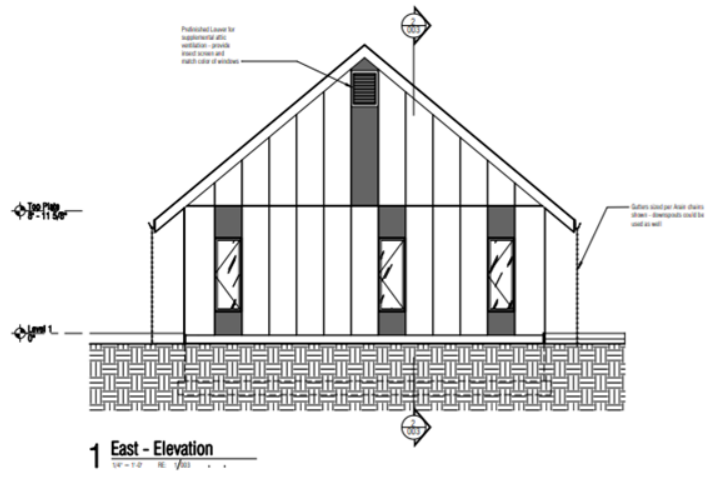
Project No: 20023.00

May 1, 2021

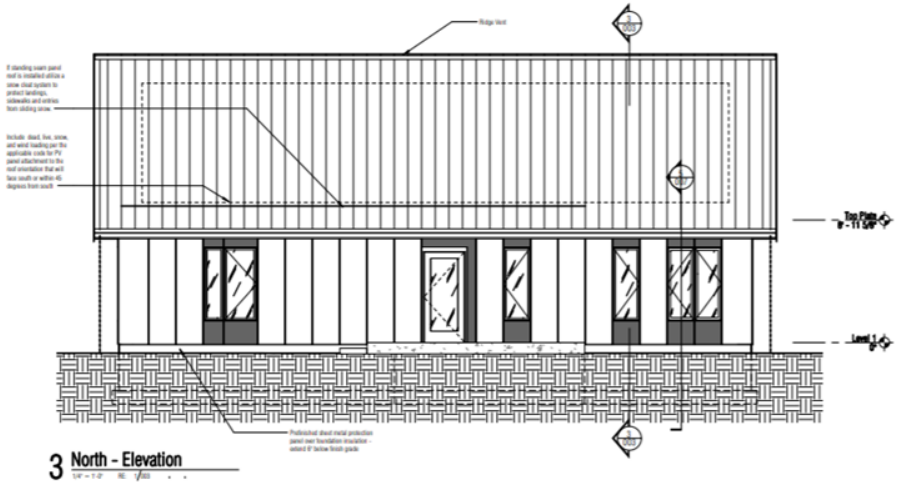
1 Story Option Plans

003

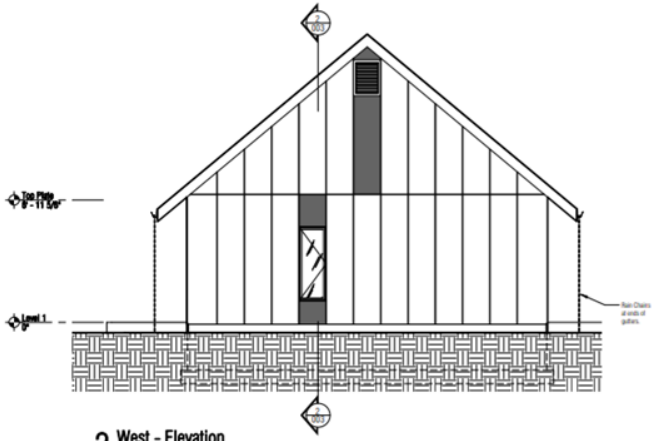
Prototype Home



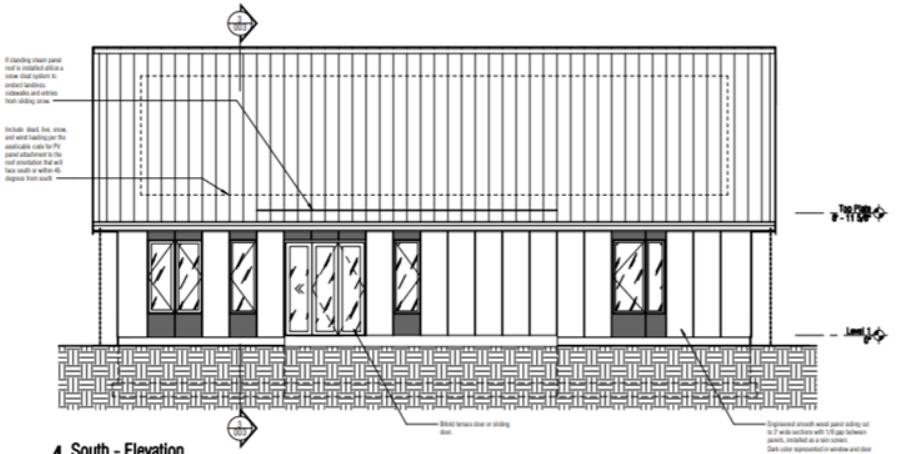
1 East - Elevation



3 North - Elevation



2 West - Elevation



4 South - Elevation

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Schematic Design Documents

Iowa - High Performance Prototype Home

Iowa Energy Office

Iowa Economic Development Authority

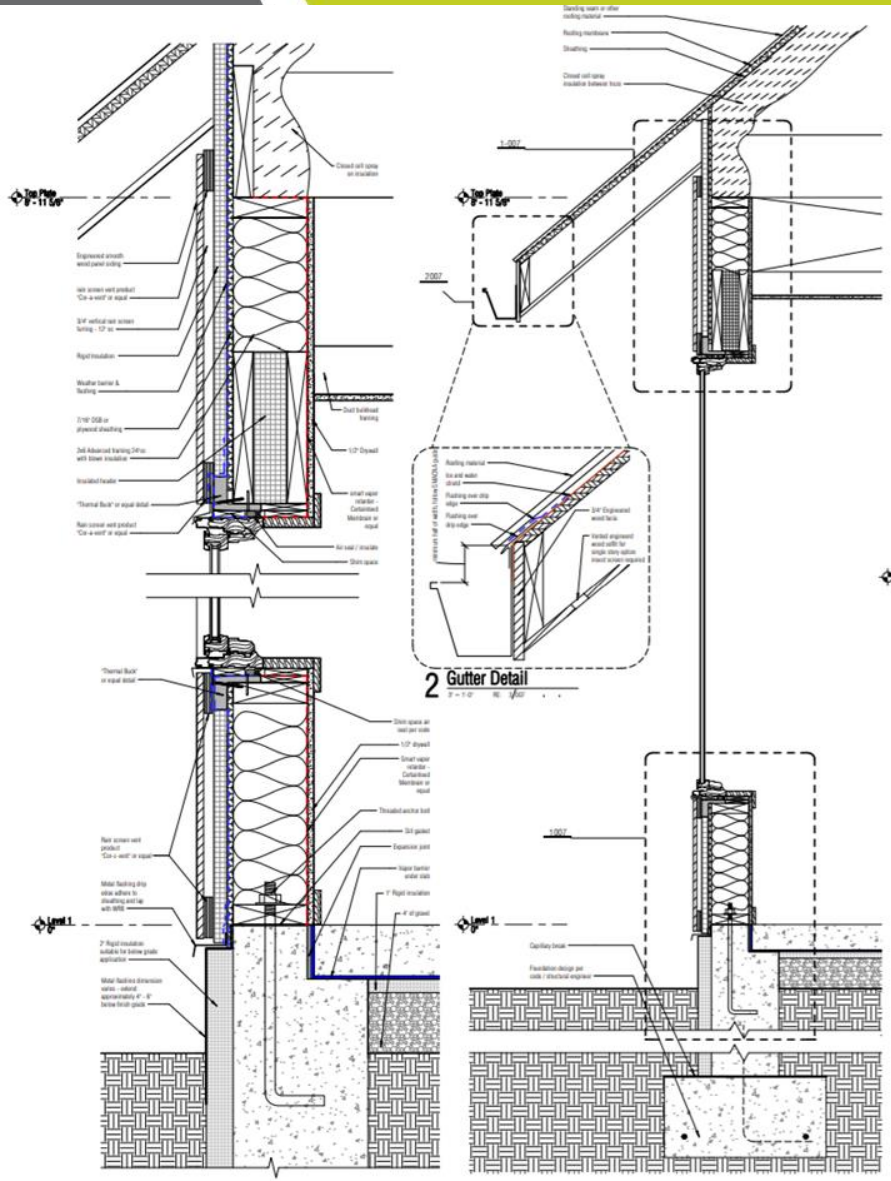
Project No: 20023.00

May 1, 2021

1 Story Option Elevations

004

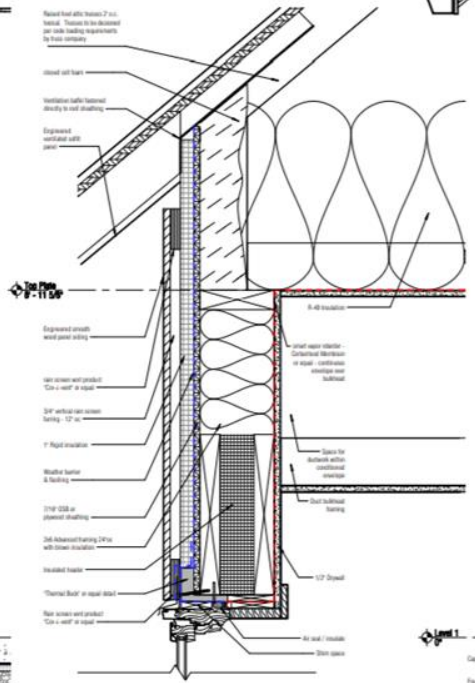
Prototype Home



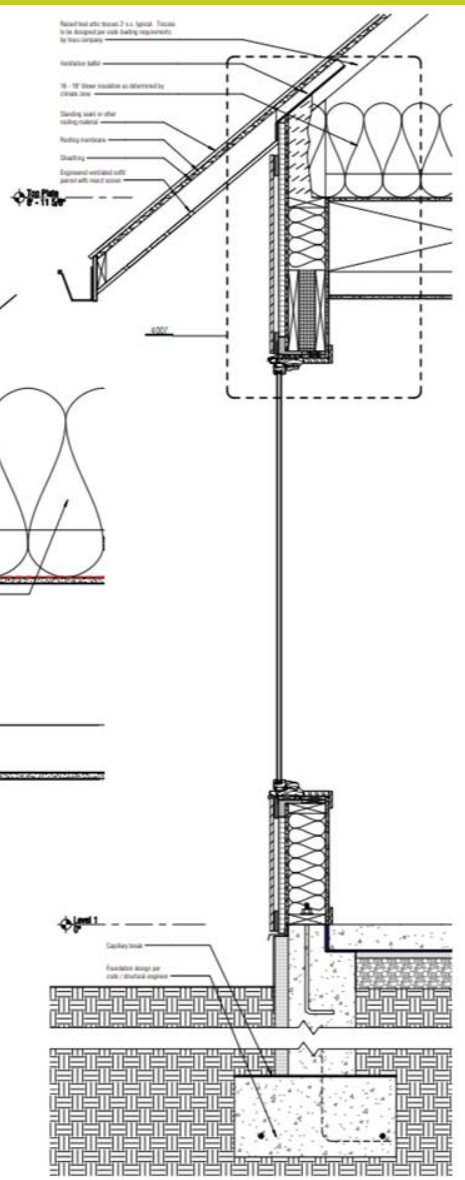
1 Detail Section - Foundation and Sill

2 Gutter Detail

3 Exterior Wall - 2 Story Option



4 Vented Attic Detail



5 Exterior Wall - 1 Story Option

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Schematic Design Documents

Iowa - High Performance Prototype Home

Iowa Energy Office

Iowa Economic Development Authority

Project No: 20023.00

May 1, 2021

Details

007

Innovations in Home Design & Construction

- Cost still too high

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Figure 5: Cost Calculations – green areas have been added – not from NAHB

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Innovations in Home Design & Construction

- How else can we lower costs?
  - Cost = Size + Quality + Materials/Methods + Time
    - We've attempted to address size
    - We've worked on improving quality with same or reduced costs
    - What could we address materials and time?

Innovations in Home Design & Construction

- How can we shorten the time to construct a home?
  - 3D printing
  - Pre-fabrication
    - (EPS) Structural insulated panels
    - Superior Walls
    - Modular construction
    - Manufactured homes
    - CNC technology
    - Digital design

Innovations in Home Design & Construction

SCJournal

Partnerships

- ISU proposal for 3D Affordable Innovative Technologies Housing
  - IEDA reviewing
- Partners:
  - Iowa State University
  - Iowa Central CC
  - Ames
  - BNIM
  - Brunow Construction
  - Hubbell Realty
  - Iowa Association of Realtors
  - Iowa DPS
  - Iowa Habitat for Humanity
  - Iowa Housing Partnership
  - Iowa League of Cities
  - Lincoln Savings Bank
  - Matthew 25
  - McAnally Consulting
  - McClure Engineering
  - Sukup Manufacturing
  - The Element Group
  - Vermeer
  - You ???

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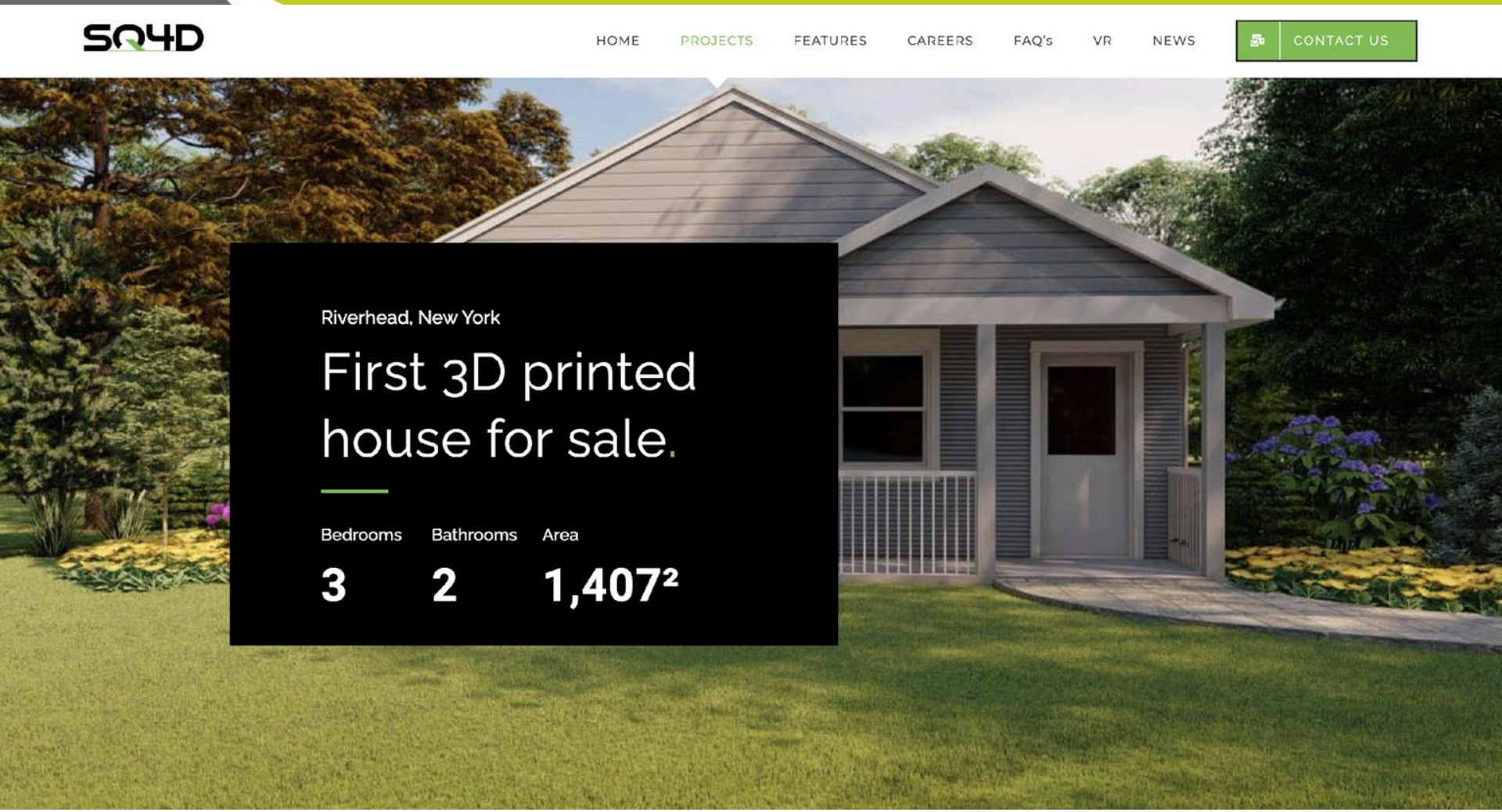
3D Affordable Innovative Technologies Home



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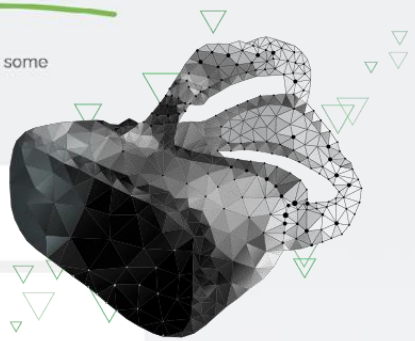
3D Affordable Innovative Technologies Home

SQ4D

HOME PROJECTS FEATURES CAREERS FAQ's VR NEWS CONTACT US

Frequently asked questions.

We're developing new technology, so it's natural to have some questions. Here are a few that we hear often.



+ What is the lifetime of the printer?
+ Is SQ4D a publicly traded company?
+ Can you tell me more about SQ4D's ARCS 3D printer?

3x Faster than traditional

40% Reduction in total

6k+ PSI results of compressive

3 Total laborers required for

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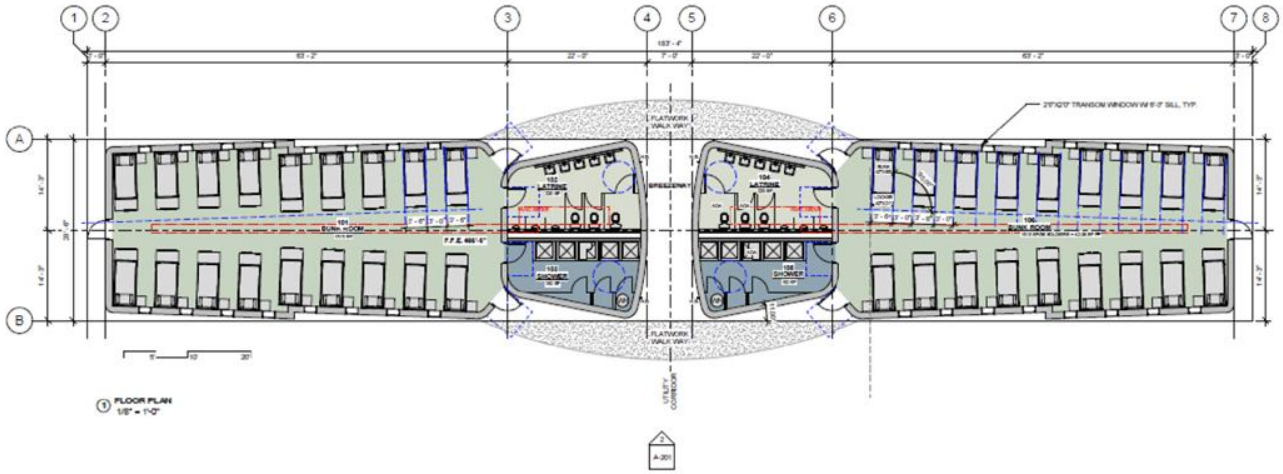
3D Affordable Innovative Technologies Home

UNCLASSIFIED//FOUO

ICON 3D Printed Barracks

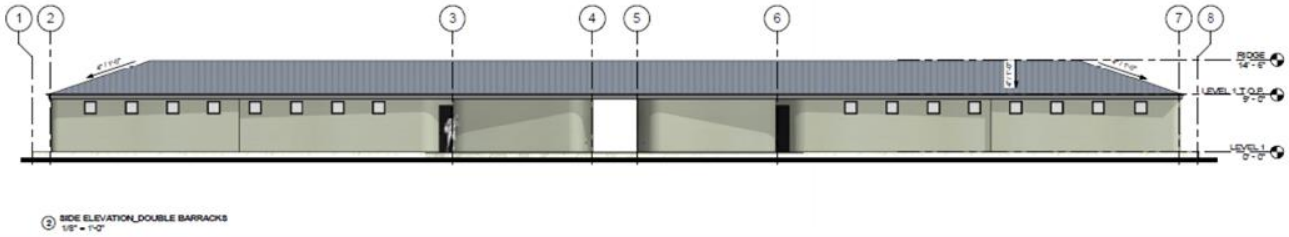
TXARNG Camp Swift Training Center:

- Largest TXARNG training site
- Centrally located to support TXARNG units
- Pre-deployment training for T10 missions
- RSOI and Training for DSCA missions
- 1600 beds, 2xDFAC, Ranges, Training Areas
- 25% Relocatable Transient Training Barracks
  - 13 "Swift Temporary Barracks" = STB
  - Beyond the end of lifecycle
  - Very inefficient to operate
  - Non-viable to maintain
- Opportunity to Replace STBs with permanent more efficient and improved soldier quality of life



Barracks of the Future:

- Approx. 5,000 SF TT Barracks
- Innovative Design and Construction
- Construction Scale 3D Printed Building
- Very High Efficiency and Long Life
- Reduced O&M Cost
- Will replace 2 Relocatable / Temp barracks
- Will house up to 72 soldiers (36 per bay)



3D Affordable Innovative Technologies Home

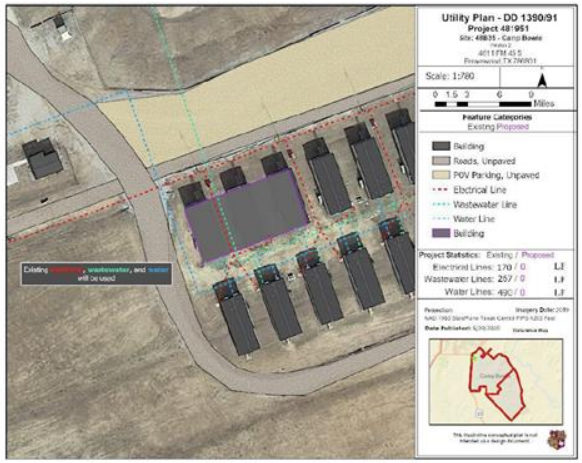
UNCLASSIFIED//FOUO

INNOVATIVE BARRACKS INITIATIVE

Engaging innovative technology and partnerships to help resolve our shortage of transient training barracks

Camp Bowie
UMMC TT BARRACKS

- Traditional D-B-B project $3M
- 7,261 SF TT Barracks
- Traditional Construction Methods



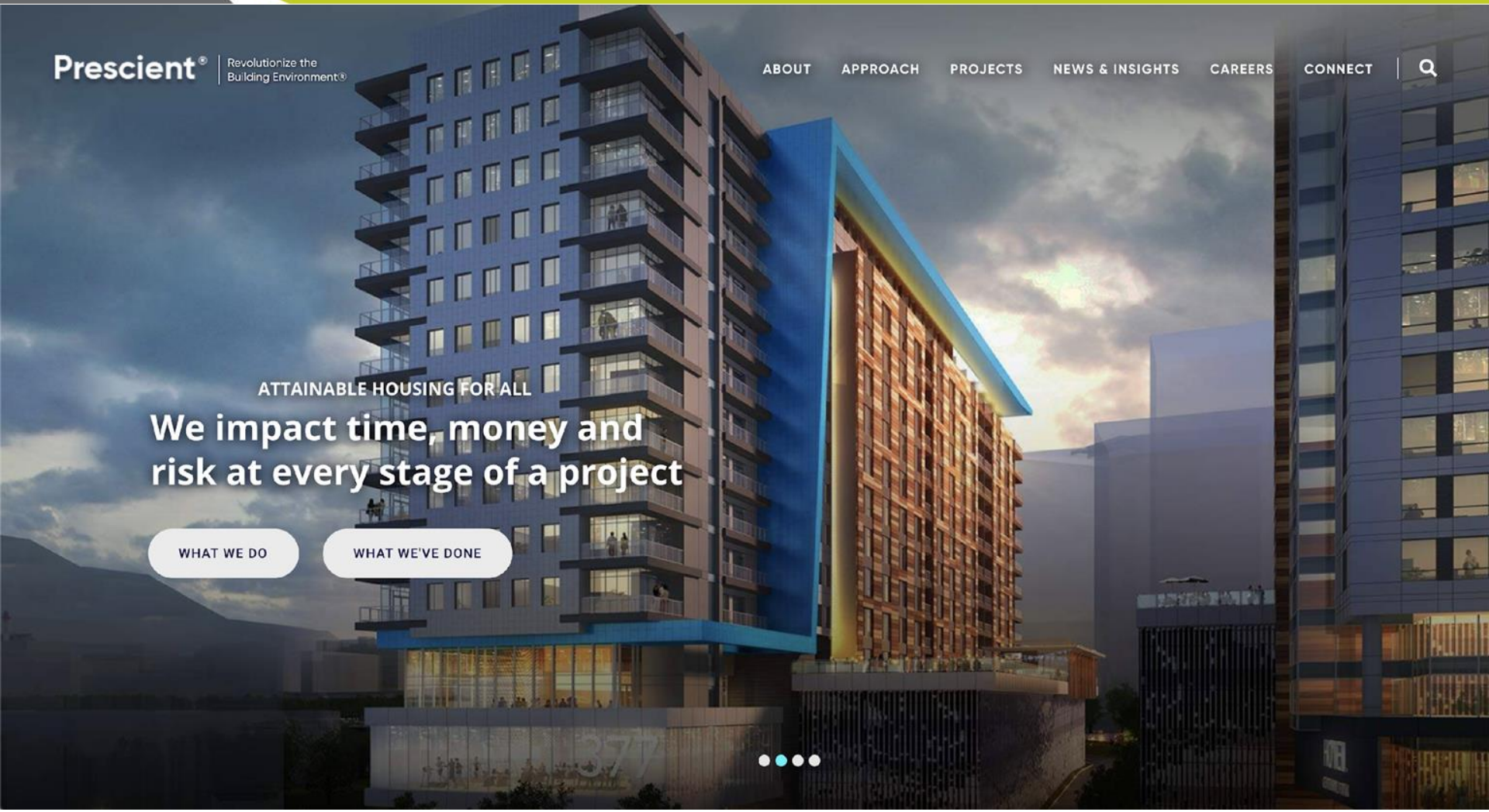
Camp Swift
ICON 3D

- AFWERX SBIR II ANG Project
- 5,000 SF TT Barracks
- Construction Scale 3D Printed Building
- Innovative Design
- High Efficiency / Reduced O&M

Camp Maxey
MAX STEEL

- AFWERX SBIR II ANG Project
- 3,200 SF TT Barracks
- Modular Steel Barracks
- Long Life
- Very High Efficiency / Reduced O&M

3D Affordable Innovative Technologies Home



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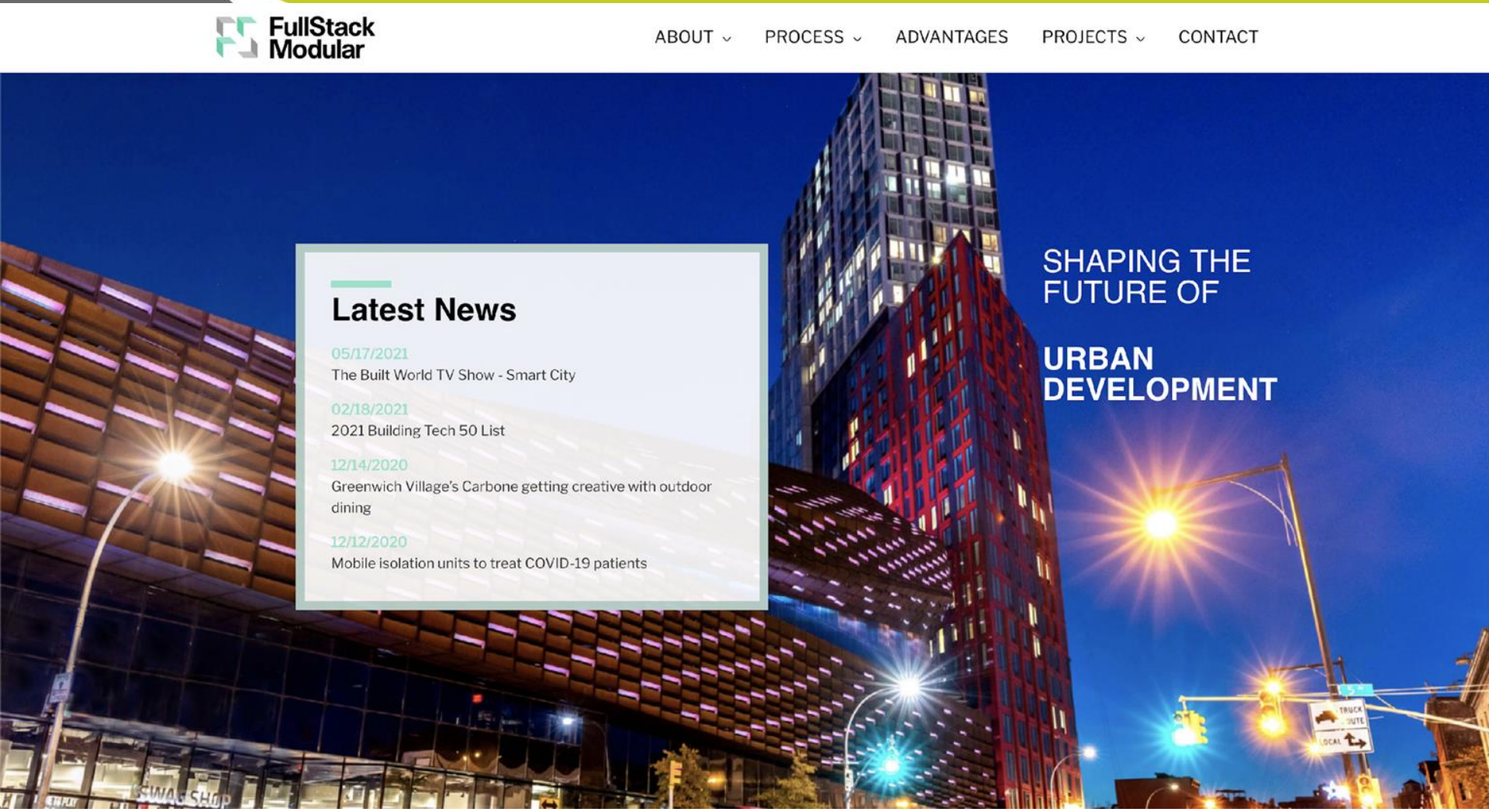

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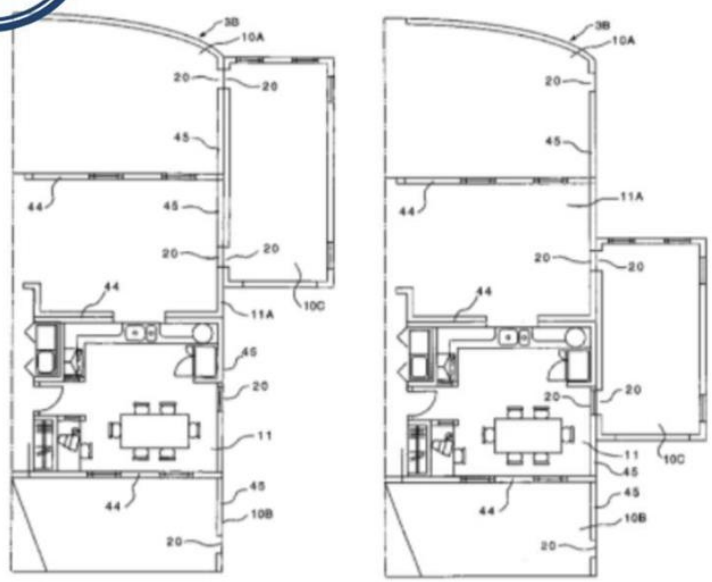
PATENT FILING BOXABL

Publication Number
US 8,733,029 B2

US008733029B2



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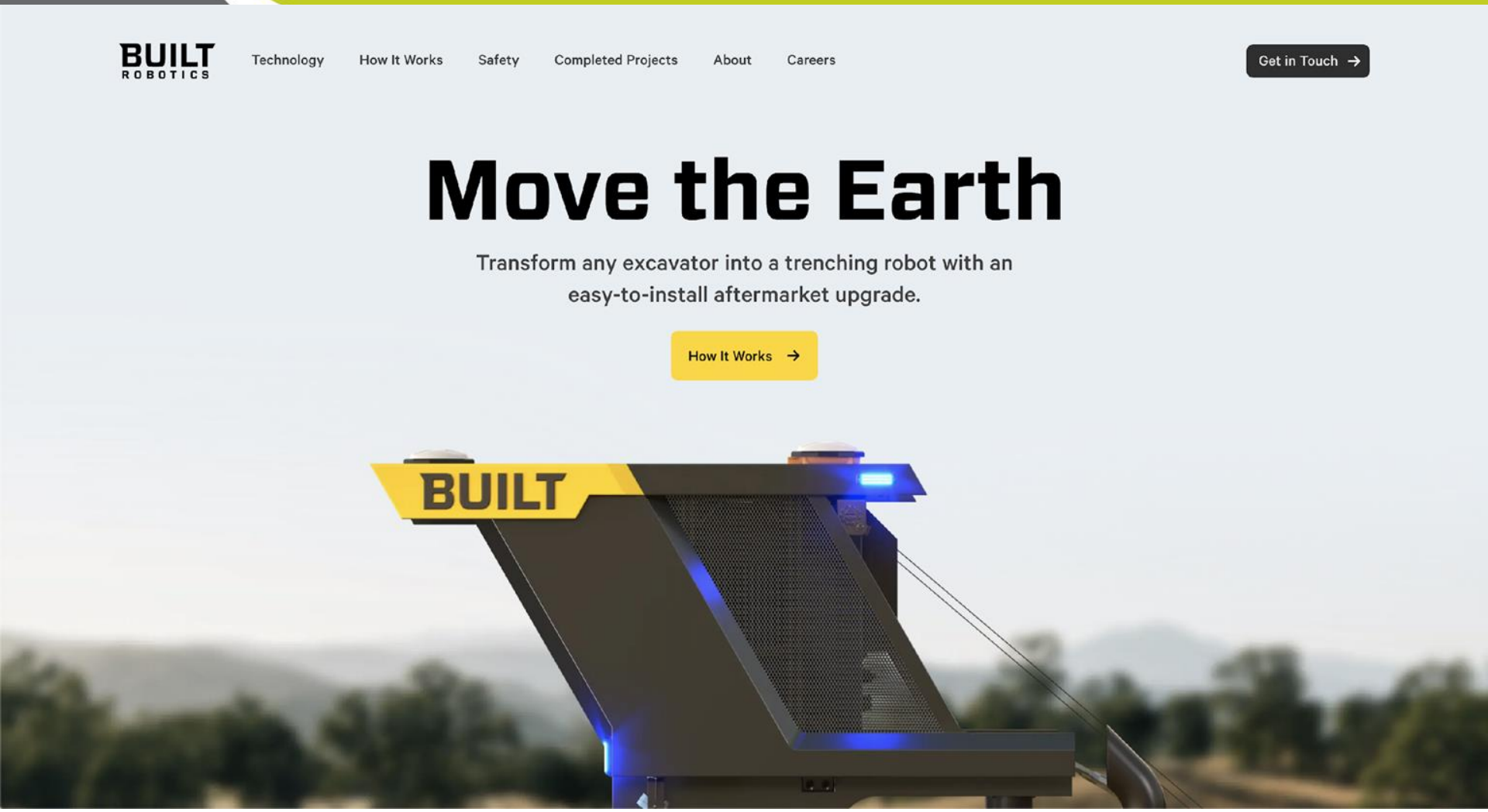

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Overview | The House | The Design Process | The Build | The Data | The Team | News & Events

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Kitchen planner

Thinking about a new kitchen but don't know where to start? Our kitchen planner is here to help. Find out how your new kitchen could look like in just a few steps.

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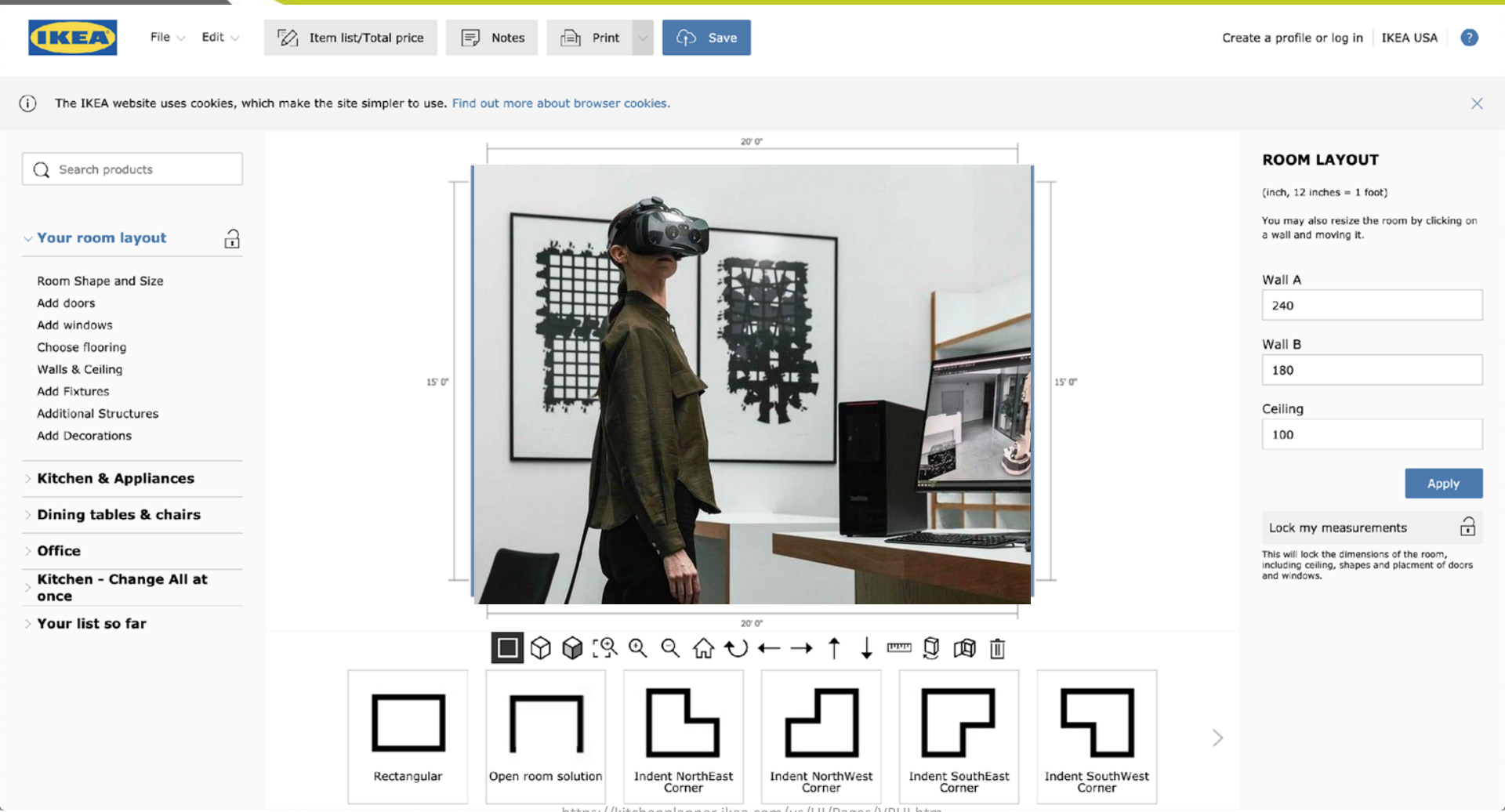

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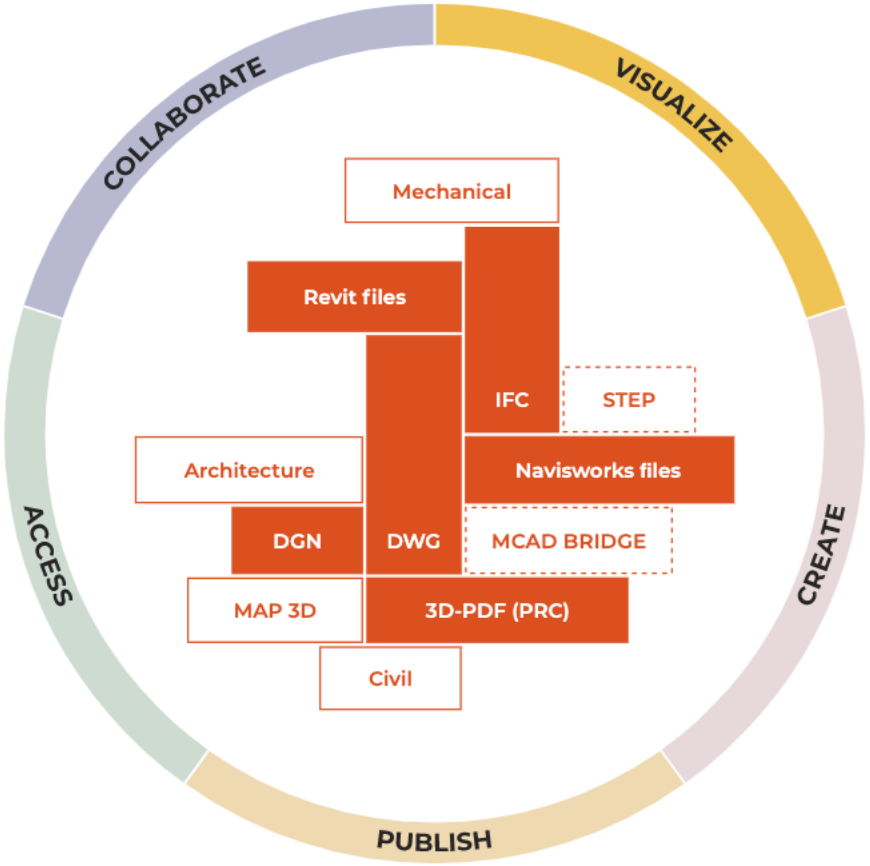

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The buildingSMART Data Dictionary is a service from buildingSMART International. The Data Dictionary actively delivers an open and neutral solution to drive digital transformation and automation in the built asset industry.

- ✓ You own your data
- ✓ Data Security
- ✓ Usage Analysis
- ✓ Extend IFC
- ✓ Vendor neutral
- ✓ Linked data
- ✓ Always open
- ✓ openAPI spec
- ✓ ISO 12006-3 (IFD)
- ✓ ISO 23386/7 (PDT)
- ✓ ISO 16739-1 (IFC)
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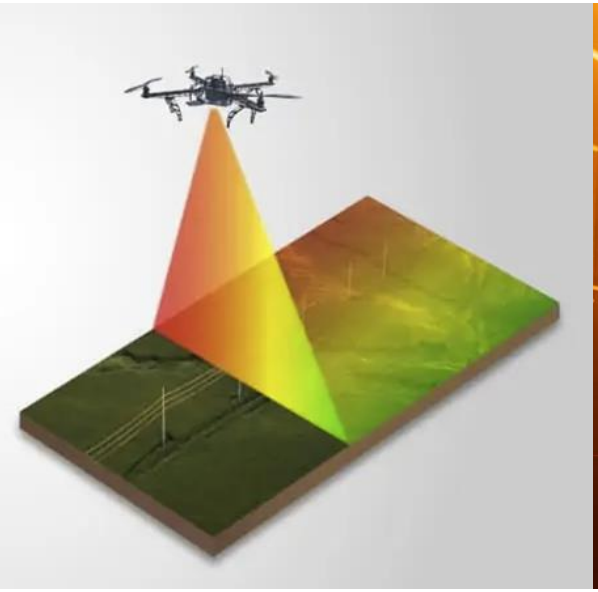

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Comments – Questions?

Contact Information

Jeff Geerts
Special Projects Manager
Iowa Economic Development Authority
1963 Bell Ave, Ste 200
Des Moines, Iowa 50315
515-348-6211
Jeff.geerts@iowaeda.com

Pete Evans AIA IDSA
Assistant Professor, Industrial Design Department
Coordinator, Forward Learning Experience
Iowa State University
pmevans@iastate.edu