

PDMB VARIATIONS

(PDMB) Parametric Designed Metal Building

PDMB Variations researches the potential innovation of the typical (PEMB) pre-engineered metal building using parametric modeling, tapping into the inherent intelligence of this highly optimized system and ultimately delivering a new level of customization. We believe that pre-engineered metal buildings have not lived up to the potential of their promise and that PDMB Variations offers new possibilities for this banal typology.

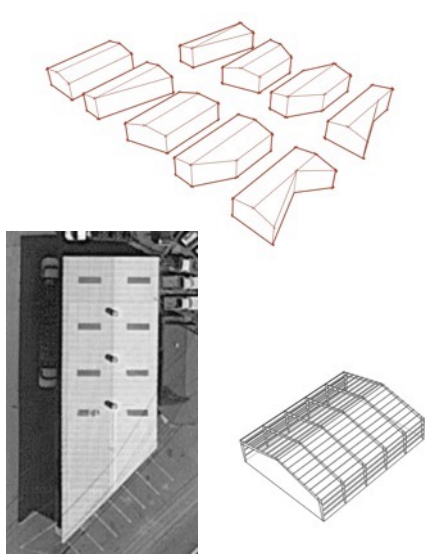


“Metal Buildings are the dream that modern architects had at the beginning of the century come true, but they themselves don’t realize it. If they followed their own theories to the letter-form follows function, using mass production techniques to make cheap things with no frills-what you end up with is a metal building!”

-True Stories, David Byrne

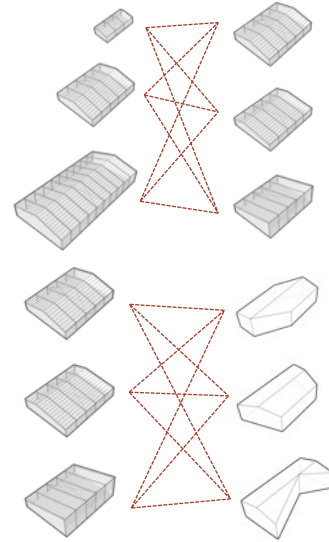
METHODOLOGY

Research Process



1-DEFINING PROBLEM

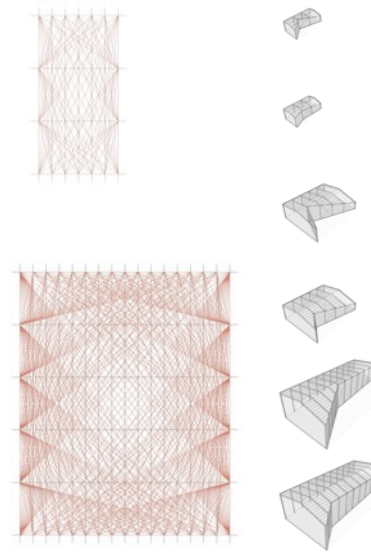
- Observations
- Education
- Ideation



2-RESEARCH DESIGN

Parametric Modeling

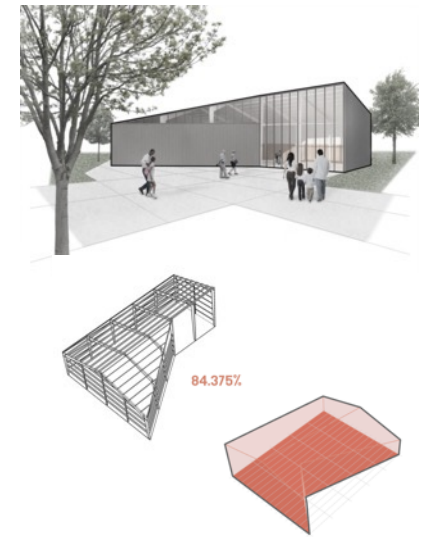
- Formal Operation
- Building Profile
- Building Size



3-DATA COLLECTION

Catalog of Variations

- Chamfer + Symmetrical
- Chamfer + Asymmetrical
- Chamfer + Shed
- Cross-Cut + Symmetrical
- Cross-Cut + Asymmetrical
- Cross-Cut + Shed
- Compress + Symmetrical
- Compress + Asymmetrical
- Compress + Shed



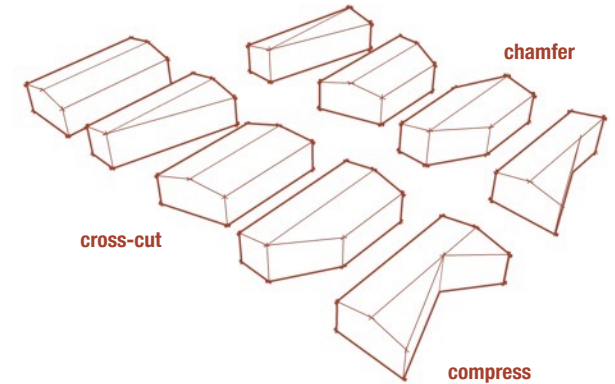
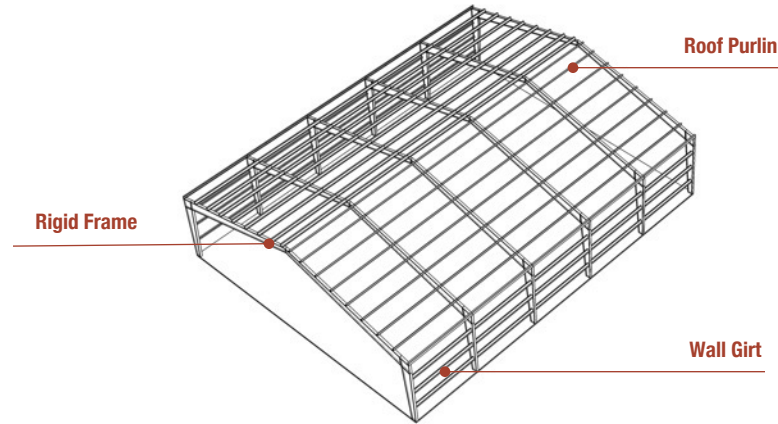
4-INTERPRETATION OF DATA

Case Studies

- Performance
- Programmatic
- Aesthetics

PROBLEM

Opportunity



OBSERVATION

Inspired to ask the question, “what else can the building do?”, after an observation of this unusual site-specific response. The sharp angular “cut” to the metal building relates to the adjacent highway and railroad right of ways.

EDUCATION

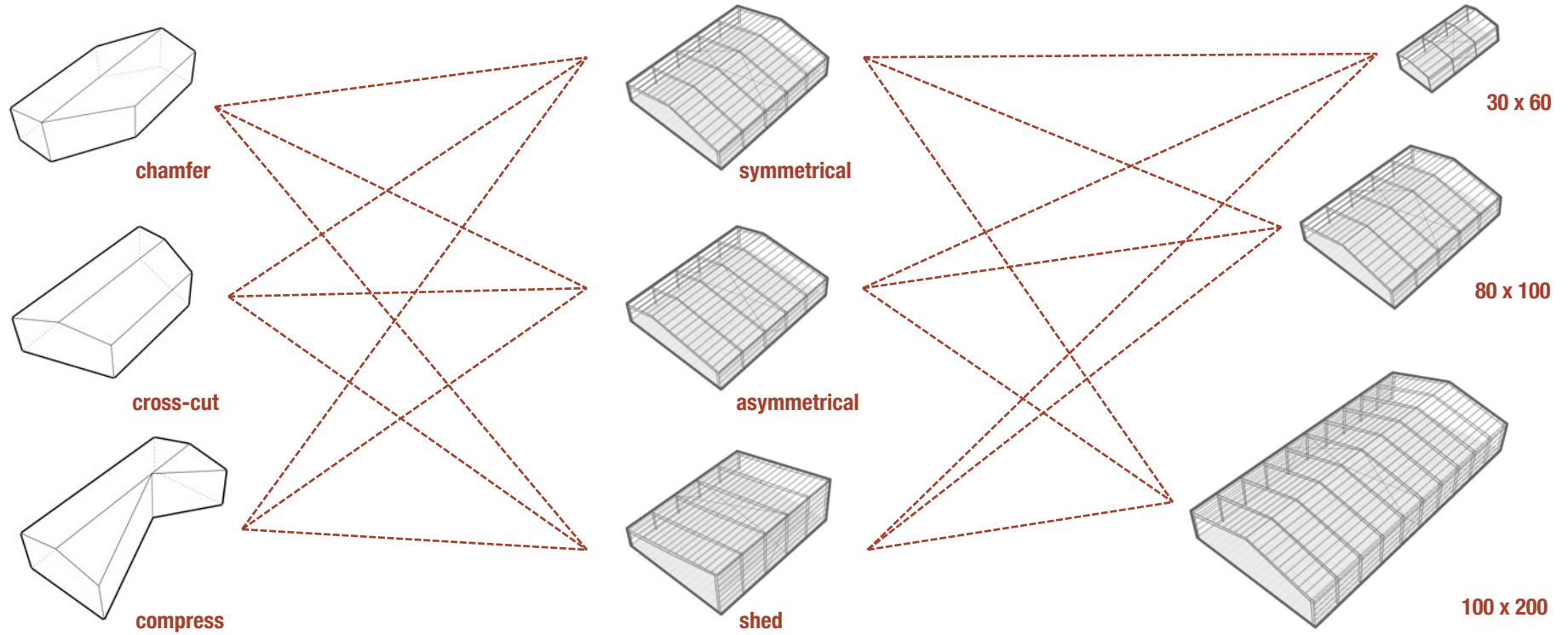
Metal building systems are highly optimized and use standard components like the rigid frame, wall girt and roof purlin. These components are fabricated in a manufacturing facility, delivered to the site and erected. Building construction time is significantly less than typical construction. The system is characterized by its long span structure offering flexible open floor plates. The steel used in the structure is almost 100% recycled content and the building can be demounted or recycled at the end of its useful life.

IDEATION

Using sketches of initial studies, formal strategies were explored. Many of these strategies had similarities. For the purpose of this research project, we selected three strategies or operations, chamfer, cross-cut and compress.

RESEARCH DESIGN

Parametric Modeling



OPERATION

Three formal strategies or operations; chamfer, cross-cut and compress were compiled from sketchbook studies and building observations.

PROFILE

PEMB, pre-engineered metal buildings have a variety of shapes depending on the manufacturer. For this project, the three most common profiles were used; symmetrical, asymmetrical and shed.

SIZE

PEMB, pre-engineered metal buildings come in standard and custom sizes. For research purposes a small, medium and large scale were selected.

DATA COLLECTION

Parametric Generated Variations

symmetrical

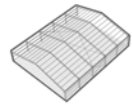


30x60

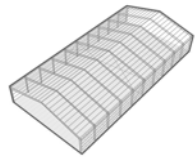
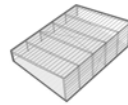
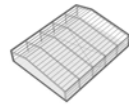
asymmetrical



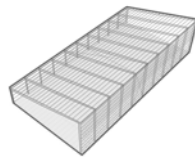
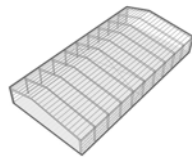
shed



80x100



100x200



chamfer + cross-cut + compress

COMBINED OPERATOIONS

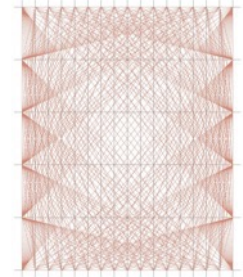
112 variations

30x60



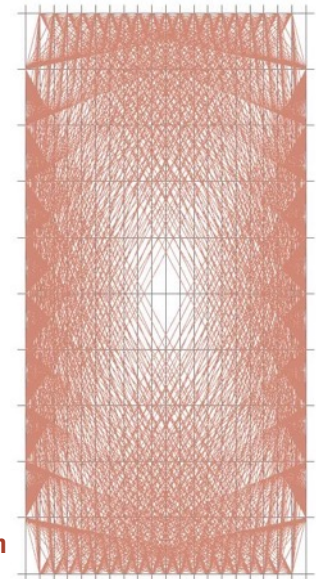
408 variations

80x100



924 variations

100x200

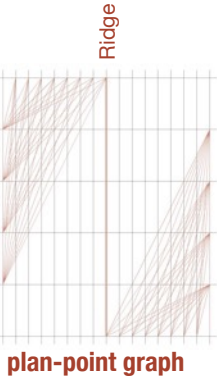


plan-point graph

The primary and secondary structural spacing for PEMB, pre-engineered metal buildings vary. To standardize the research process, rigid frames were determined to be 20'-0" on center and that secondary structural components like wall girts and roof purlins were 5'-0" on center. A plan grid with point coordinates was established for each building size. Grasshopper was used in the parametric process to create 3D forms based on size, profile and operation. The lines on the plan-point graph show the number of possible variations per building size.

CHAMFER+SYMMETRICAL

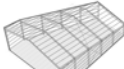
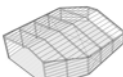
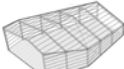
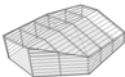
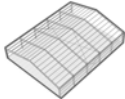
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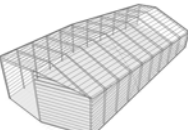
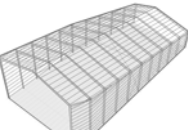
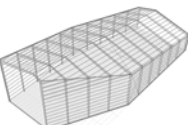
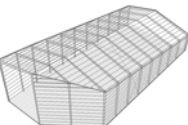
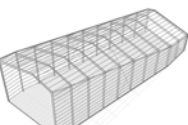
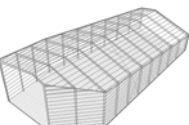
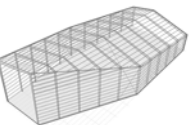
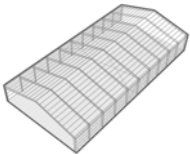
30 x 60



80 x 100

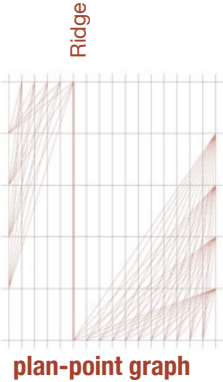


100 x 200



CHAMFER+ASYMMETRICAL

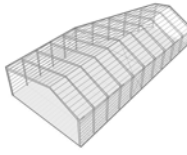
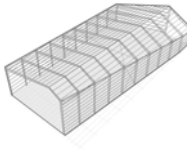
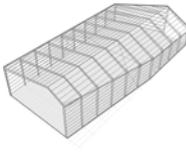
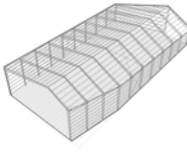
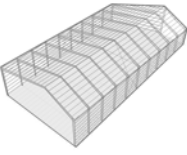
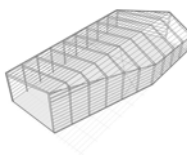
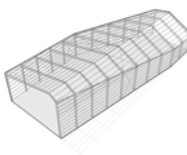
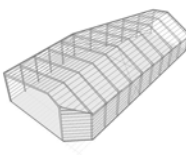
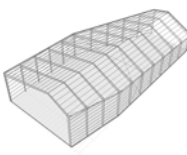
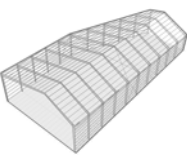
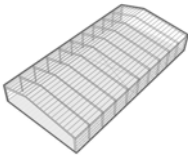
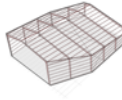
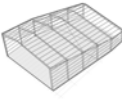
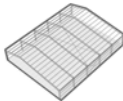
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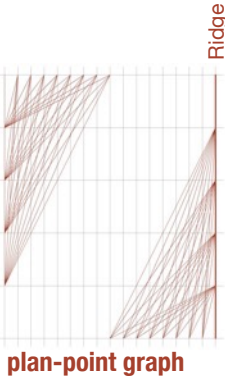
80 x 100

100 x 200



CHAMFER+SHED

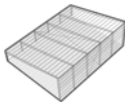
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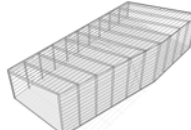
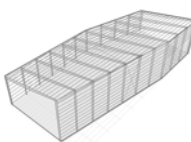
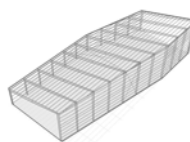
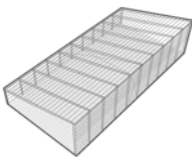
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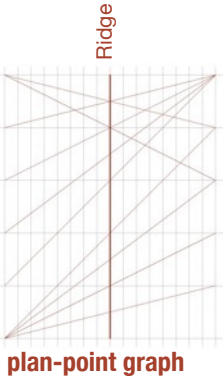


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CROSS-CUT+SYMMETRICAL

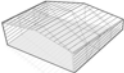
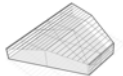
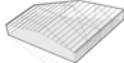
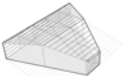
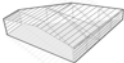
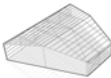
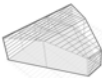
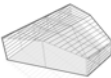
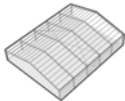
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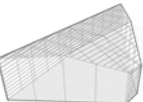
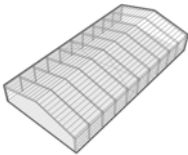
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80 x 100

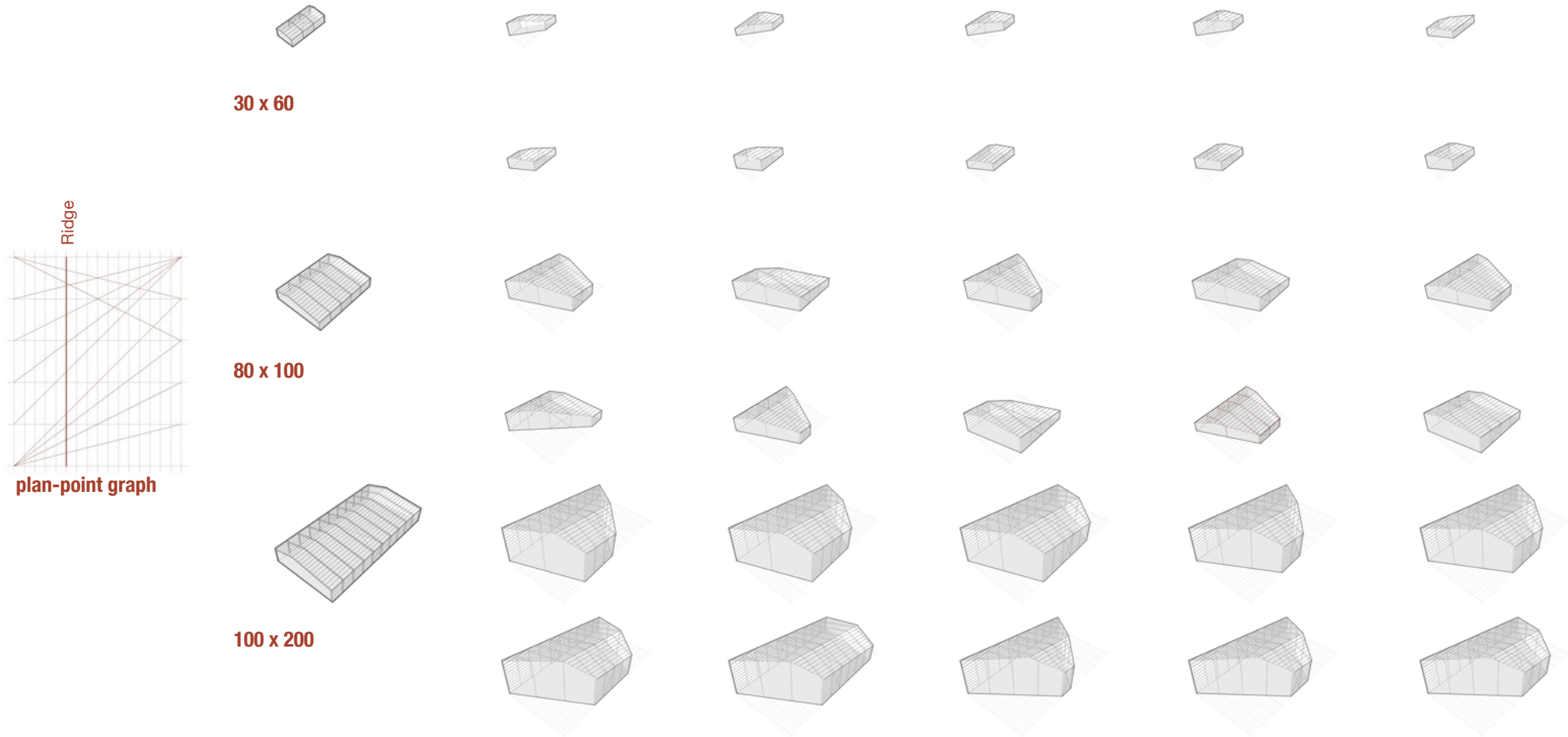


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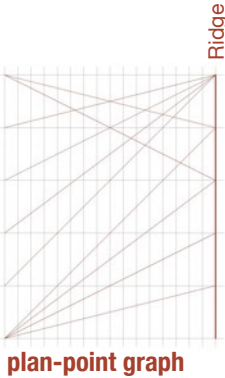
CROSS-CUT+ASYMMETRICAL

Data Catalog



CROSS-CUT+SHED

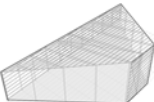
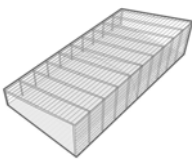
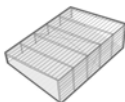
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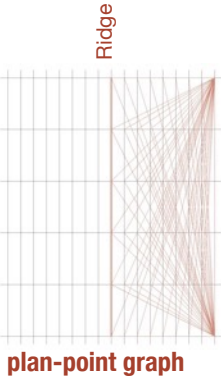
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100 x 200



COMPRESS+SYMMETRICAL

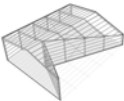
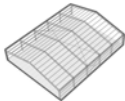
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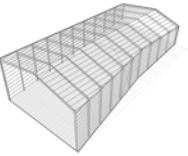
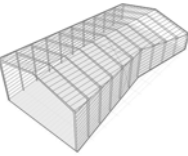
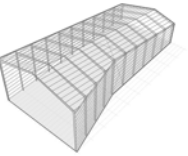
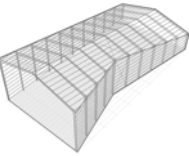
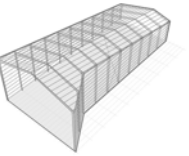
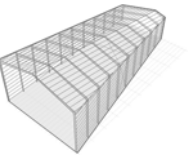
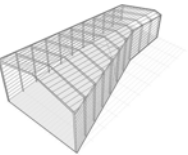
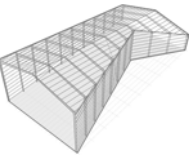
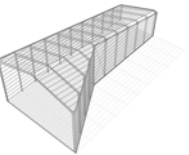
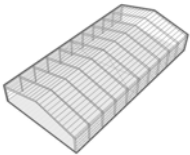
30 x 60



80 x 100

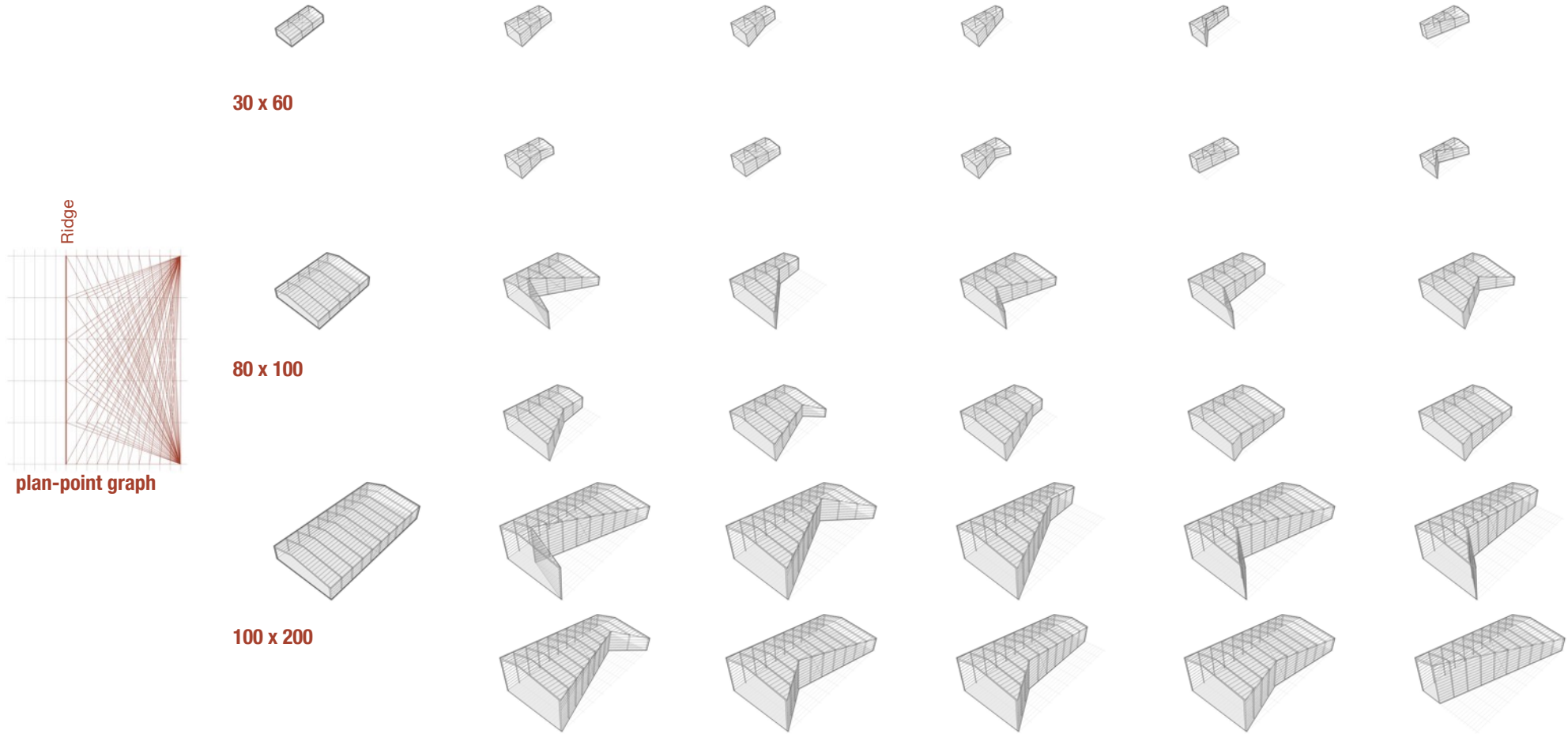


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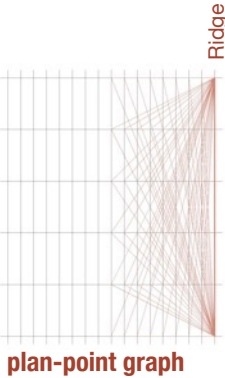
COMPRESS+ASYMMETRICAL

Data Catalog



COMPRESS+SHED

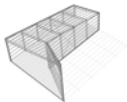
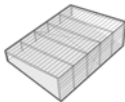
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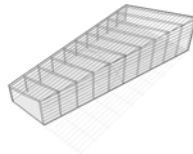
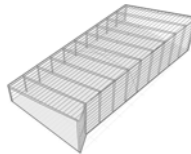
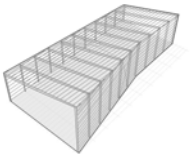
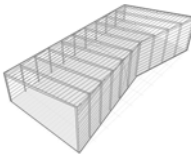
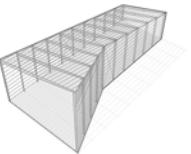
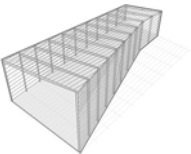
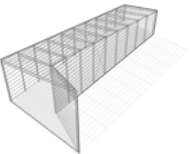
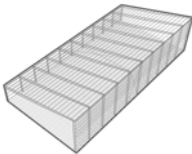
30 x 60



80 x 100



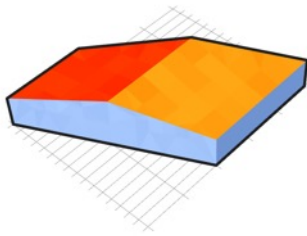
100 x 200



PERFORMANCE EVALUATION

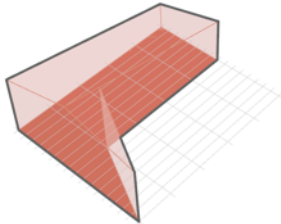
80X100 Case Study

Using Colibri plugins for Grasshopper 3D, data sets of the designs were uploaded to the cloud-based data visualization platform, Thread, by Thornton Tomasetti's Core Studio. This enabled the creation of dashboards and interactive charts of complex data to explore these designs.

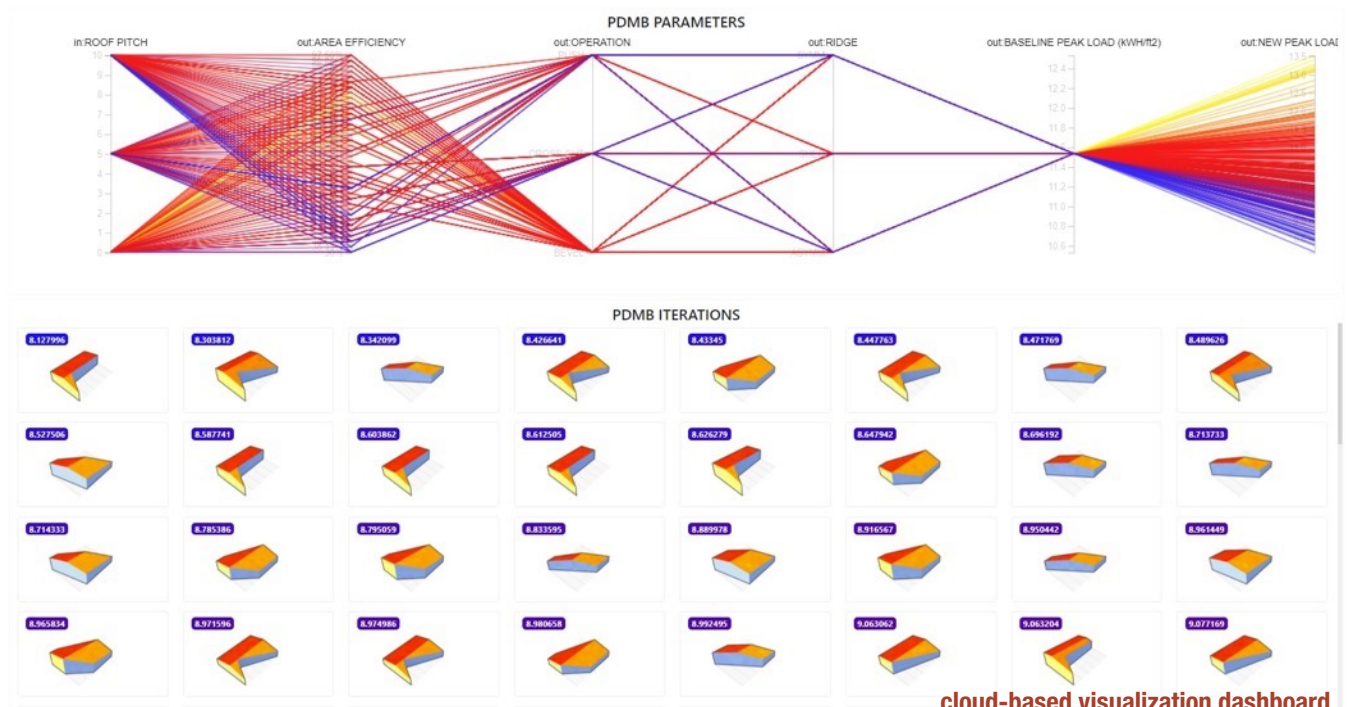


solar insolation

55%



floor area efficiency

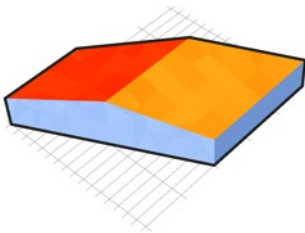


PERFORMANCE EVALUATION

80X100 Case Study

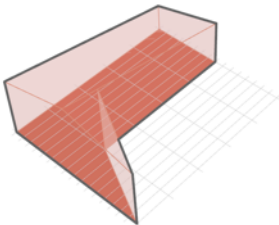
This workflow facilitated the evaluation of 312 designs to find a balanced solution between the relationship of floor area efficiency and solar insolation on the building envelope during the peak load hours. Once the data had been aggregated onto the Thread platform, a narrow range of the output metrics was determined along with a map of the parameter inputs of the selected design solutions.

This workflow differs from an optimization workflow. Instead of targeting individual objectives within the model it used the Colibri iterator to log and categorize the data within the model to explore in a data rich environment.

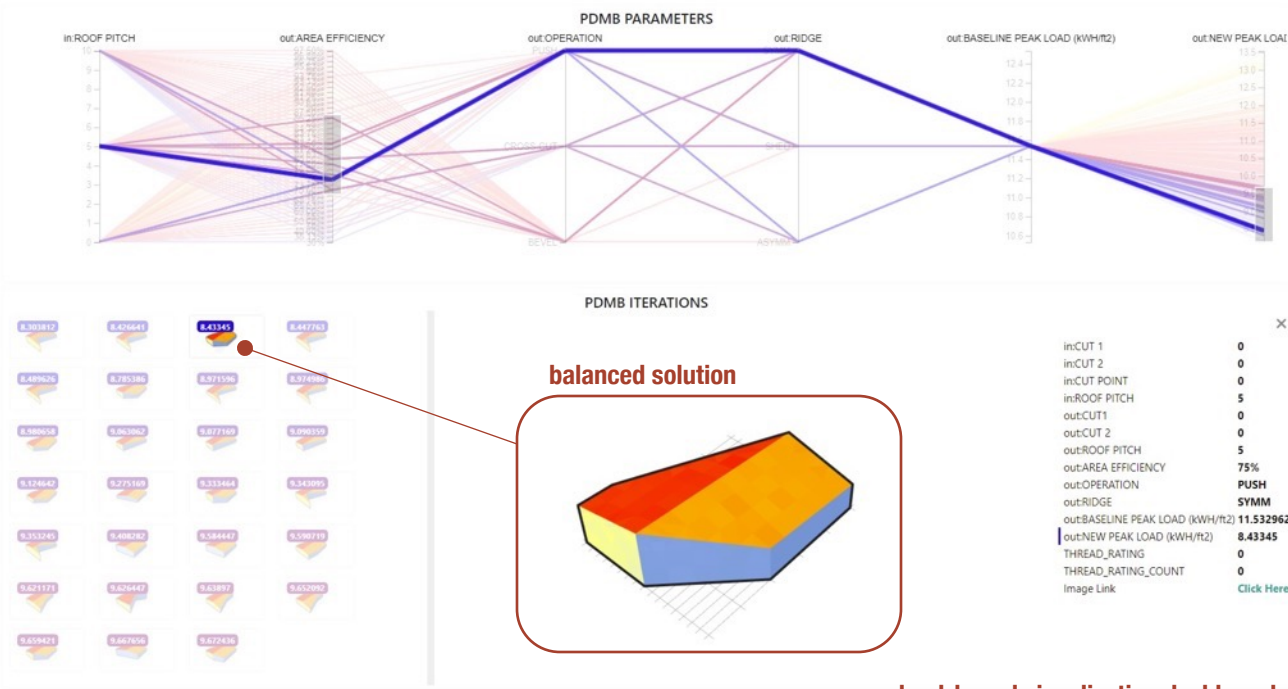


solar insolation

55%



floor area efficiency



cloud-based visualization dashboard

PROGRAMATIC EXPLORATION

Case studies of varying scales, profiles & operations



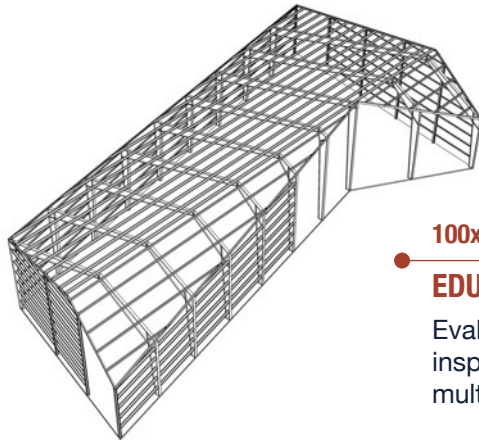
30x60+shed+chamfer

RESIDENTIAL



80x100+symmetrical+compress

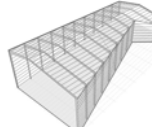
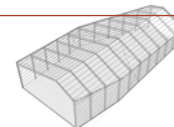
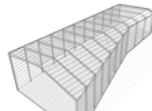
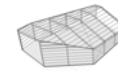
CONGREGATIONAL



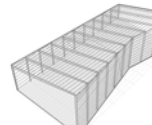
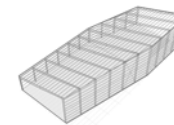
100x200+asymmetrical+cross-cut+compress

EDUCATIONAL

Evaluation of 3D generated forms
inspired designs that combined
multiple operations



+

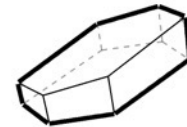
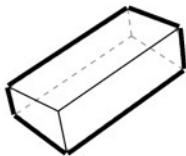


RESIDENTIAL CASESTUDY

30x60 + Shed + Chamfer



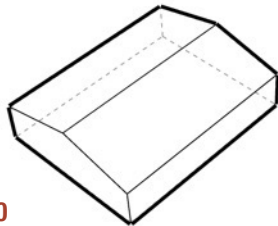
30 x 60



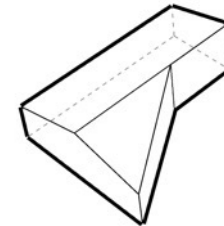
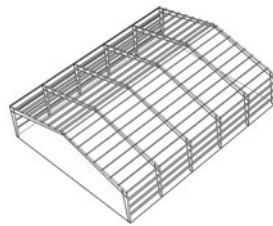
chamfer

CONGREGATIONAL CASE STUDY

80x100 + Symmetrical + Compress



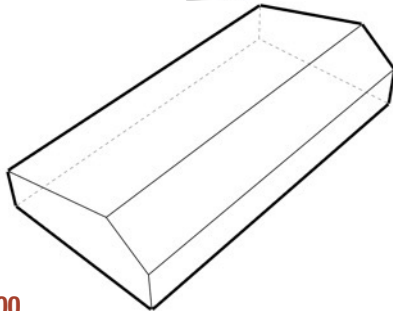
80 x 100



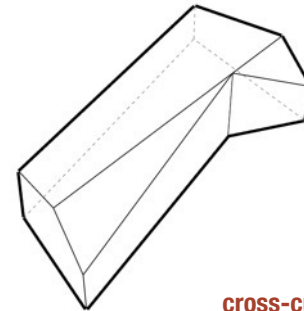
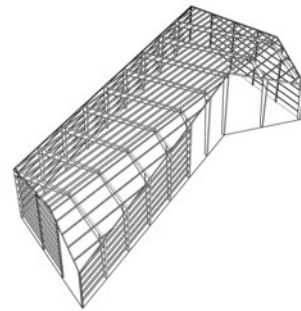
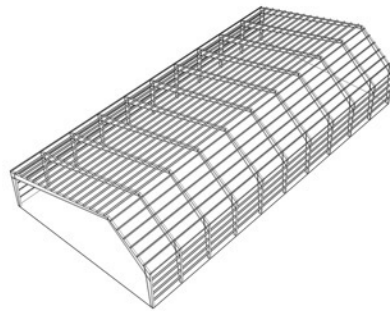
compress

EDUCATIONAL CASE STUDY

100x200 + Asymmetrical + Cross-Cut + Compress



100 x 200



cross-cut+ compress