The Development of an Advanced Panelized Residential Roof System

John Carmody
Garrett Mosiman
Jane Davidson
Susan Mantell
Gur Mittelman
• Up to 3 day erection time requiring skilled labor
• Mechanical system and ducts often located in unconditioned attic
• Loose fill insulation has gaps and thermal bridges
• Construction waste

• Off-site manufacture and ½ day field installation
• Mechanical equipment in conditioned attic saves 30-35% of energy for space conditioning*
• Designed to minimize thermal bridging
• Open attic space
• Reduced on-site construction waste

*Dejarlais, Petrie and Stovall, 2004
Additional design criteria

- Clear span from soffit to ridge with no additional supports
- Span capacity of at least 24 feet
- 50 + year lifespan
- Minimal risk of moisture problems (corrosion, decay, mold, condensation)
- Applicable to a wide range of designs
- Lowest possible costs
- Potential to incorporate solar thermal and/or photovoltaics at the factory
Exterior insulation panels
(Originally designed for cold climates)
Interior insulation panels
(Originally designed for hot climates)
Truss core structural design

Analytic model:
Evaluate design constraints for range of geometries

Identify lowest weight options

Select design

Finite element analysis:
Check deflection, stresses, buckling

Prototype and test
Truss core hygrothermal analysis

- WUFI 2D-3.0
- Modeled in a variety of cities
- Exterior foam panel is limited by exterior humidity
- Interior foam panel is limited by exterior minimum temperature.
- Probability of metal corrosion in many climates necessitates coating of the steel structure
Exterior foam panel details
10/12 pitch, occupied second story
Interior foam panel details
6/12 pitch, cathedral ceiling
Conclusions

• A long-span roof panel has been developed that is adaptable to accommodate a variety of house designs and climates.
• Those panel designs that incorporate an integral metal roof can provide roof structure, insulation, and finish with a minimum of field labor, but are not appropriate for roof shapes with valleys or similar conditions.
• Greatest economic advantage is realized in house designs with a cathedralized roof, or with an occupied second floor.
• Factory integration of solar panels may improve the financial attributes of the system - analysis is ongoing.