Adaptive design in the age of global weirding

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What's "beyond green building?"
Resilience.

- The ability to bounce back from external stressors
- Functional under a wider range of operating scenarios
- Supported by many green building precepts
- Requires a systems-based analytical lens
Resilient design

• Conventional design: sees code as maximum performance level; uses historical data as baseline ("dis-integrated design")

• Green building: context-responsive in that it examines existing site resources and challenges and creates designs in response ("integrated design")

• Resilient design: accounts for existing resources/challenges, but also examines future scenarios and designs for these as well; considers the social aspect and scalar implications more than green building ("integrative design")
Climate disruption: Illinois forecast

- Dangerously hot summers (heat and humidity)
- Heavier rains; flooding
- Wetter fall, winter + spring
- Drier summers; more frequent short-term droughts
- Increased air pollution

Source: Union of Concerned Scientists "Confronting Climate Change in the US Midwest"
Hot summers

Source: Union of Concerned Scientists
"Confronting Climate Change in the US Midwest"
Green building: integrated systems

- Heat transfer
- Air infiltration + ventilation
- Moisture/vapor
- Bulk water

How are these affected by a hotter, wetter, more extreme future? What design approaches and construction details can address this?
Thermal envelope

- 5-10-20-40-60 "rule"
- R5 windows
- R10 under slab
- R20 foundation walls
- R40 above-grade walls
- R60 attic/roof

Image: Green Building Advisor
Airtightness

- Passive House standard? (0.6 ACH @ 50Pa)
- GBA: 1-2ACH50
Proper ventilation

- Ventilation with energy recovery
- Spot ventilation in kitchen, bath, laundry
- Balanced systems
- Direct-vent or no combustion appliances
- No unvented fireplaces!

Image: www.builditsolar.com
Moisture management

- Water vapor and bulk water
- Proper flashing
- Ample overhangs
- Clear, layered drainage paths (down and away from building)
- Sufficiently pitched roofs
- Rain screen siding / cladding drainage gaps

Image: Green Building Advisor
Adaptable design

If up-front costs are a barrier, design and construct to allow future modifications

- "Solar ready" strategies
- Pre-plumb for rainwater harvest and graywater reuse
- Design for disassembly
- Service cavities inboard of air barrier layer; open-web truss floors, etc.

Image: Bensonwood Homes
Synergies

- Design shading components to also protect doors and windows from water exposure

- Well-insulated buildings will stay habitable longer during power disruptions and reduce strain on the grid

Oak Park home
Image: fourthickwalls.wordpress.com
Tradeoffs

• Enhanced overhangs protect structure from bulk water, but expose roof to wind uplift

• Thicker wall assemblies more prone to moisture damage

• Reinforced structures may require more building materials intensity and reduce thermal efficiency (e.g., precluding advanced framing techniques)

• Dry floodproofing methods can cause structural damage from hydrostatic pressure
Scenario: grid failure

- Super-insulation
- Passive solar design
- Natural ventilation; operable windows
- Daylighting (especially in common hallways and stairs)
- Photovoltaic system
- Backup energy / energy storage
- Microgrid
Scenario: flooding

- Site selection: build outside flood plain, PLUS a margin of safety
- Raise furnaces, water heaters, heat pumps (out of the basement!)
- Select materials that are quick to dry and resistant to mold

Image: Alex Wilson
Scenario: tornado

- Structural reinforcement
- Safe rooms: residential and community
- Storm shutters
- Efficiency features keep home habitable during power outages
Community-scale resilience

- Access to services (e.g., food deserts)
- Walkable neighborhoods
- Distributed utilities
- Community tornado shelters
- Community cooling centers
- Local food production
Transportation matters

Source: Union of Concerned Scientists
"Confronting Climate Change in the US Midwest"
Distributed utilities

Decentralized systems are less prone to catastrophic failure

- Energy production + storage (individual household; microgrid)
- Water harvest + treatment
- Wastewater treatment
- Stormwater management

Image: Prairie Rivers Network
Resilience at multiple scales

- Building
- Neighborhood
- Community
- Region
Resilience across multiple systems

- Economic
- Social
- Energy grid
- Transportation
- Food system
- etc.
In summary:

- Survey project’s existing context: site resources, challenges, and relationship to larger/nested systems
- Consider future scenarios and their probabilities; use them to inform design
- Build flexibility into designs, or, more importantly, avoid building inflexibility into them
Resources

- Resilient Design Institute
- Enterprise Green Communities
- FEMA
- Green Building Advisor
- Energy Star solar ready design
- Building Science Corporation
- Miami-Dade County Hurricane Code
Thank you!

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