



REINVENTING THE BALANCE FOR SCHOOL SAFETY WITH OTHER REQUIREMENTS IN TODAY'S SCHOOL DESIGNS

FSB Education Design Studio
University of Oklahoma / College of Architecture

October 28, 2015

HEALTH / SAFETY / WELFARE

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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

COURSE DESCRIPTION

This session will explore trade-offs encountered when design professionals structurally harden schools to ensure student safety that include discussions lead by the research team as well as information gathering from design professionals about their experiences designing schools for safety.

LEARNING OBJECTIVES

Learning Objective 1

- ◉ Learn how decision makers would benefit from research and design tools that illustrate and support modeling of healthy school environments.

Learning Objective 2

- ◉ Gain an understanding of trade-offs, between structural hardening, sustainability, and environmental quality.

Learning Objective 3

- ◉ Understand how these tools are critical in times when decision makers are influenced by tragic events and lose perspective on ways in which reactive decisions might affect student and teacher performance.

Learning Objective 4

- ◉ Learn how the focus on one factor of school design often leads to a trade-off without the awareness of the possible implications to other areas in school environments.

SESSION DESCRIPTION

- Introduction
- Research Grant - An Overview
- Building Features List
- Structural Hardening & Safety
- What's Next?

PRESENTERS



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RESEARCH GRANT

HOW IT WORKS



How the grant works

- Grant is funded by the EPA
- Peer review for the EPA determines which projects to fund.
- University of Oklahoma College of Architecture is the primary lead for the research team

RESEARCH GRANT

EPA REQUIREMENTS

Structural Hardening

Increase the strength of materials by adding, building or replacing structural components; Structural safety

- ✓ *Building Inspection*
- ✓ *Floor Plan Review*

Sustainability

Reduce environmental impact of buildings; Reduce energy consumption; Efficient use of low carbon materials; Protects, preserves and improves water and air quality.

- ✓ *LEED Criteria - Rating system for Building Design and Construction*

Healthy Interiors

Interior spatial conditions that affect: Thermal Comfort, Lighting, Acoustics, Ventilation, Aesthetics, and Visual Harmony

- ✓ *In-situ testing + case modeling*
- ✓ *Building Inspections*

Air Quality

The degree to which the ambient air is pollution-free. Indoor air quality (IAQ) can be affected by a number of contaminants including mold, gases, particulates and any stressor that can be considered harmful to health conditions.

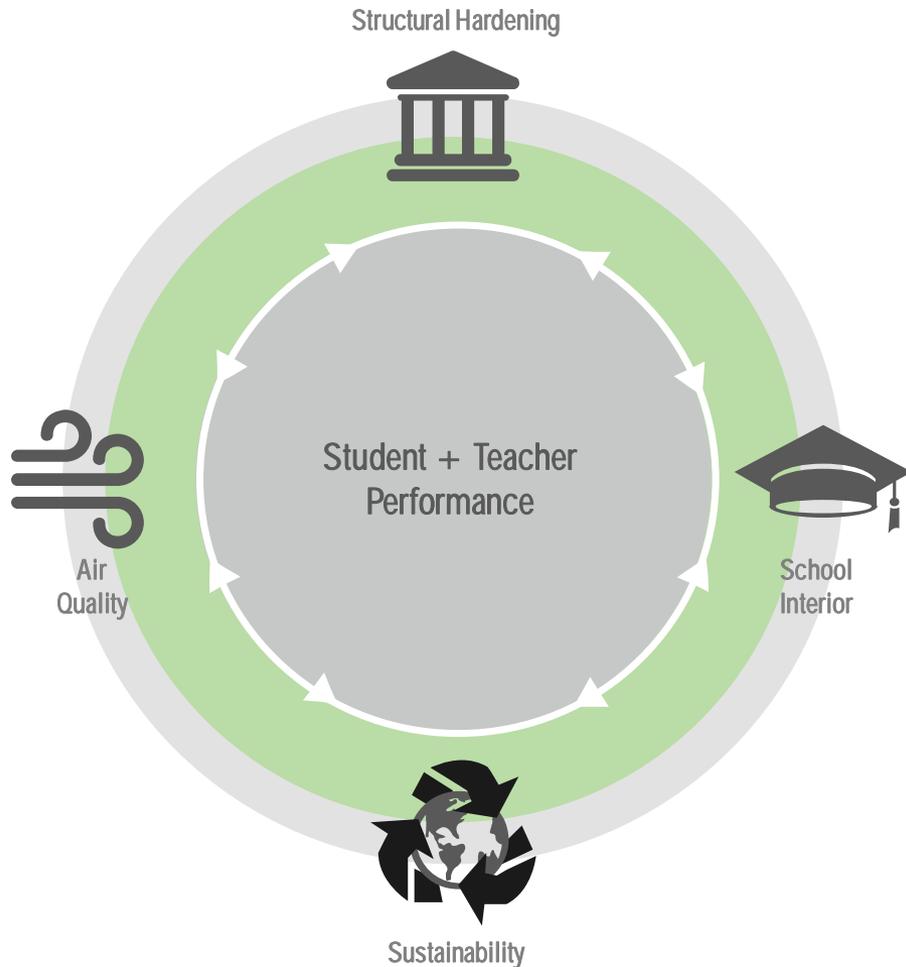
- ✓ *Air Quality Test*

RESEARCH GRANT PARTNERSHIPS



RESEARCH GRANT

RESEARCH GRANT OBJECTIVE



Determine the extent to which factors related to school building design affect:

- Student achievement
- Teacher achievement
- Occupant health
- Impact one has on another

RESEARCH GRANT

THE RESEARCH TEAM



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Frankfurt Short Bruza
Dennis Glover, Architect

RESEARCH GRANT COMMUNITY ADVISORY BOARD

What is input/insight does the CAB provide the research team?

- ⦿ “Keep us real”
- ⦿ To translate the results into real world information people can and want to use.
- ⦿ Ensure the final product is usable and applicable



RESEARCH GRANT

COMMUNITY ADVISORY BOARD

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BUILDING FEATURES LIST

THE VALUE OF RESEARCH

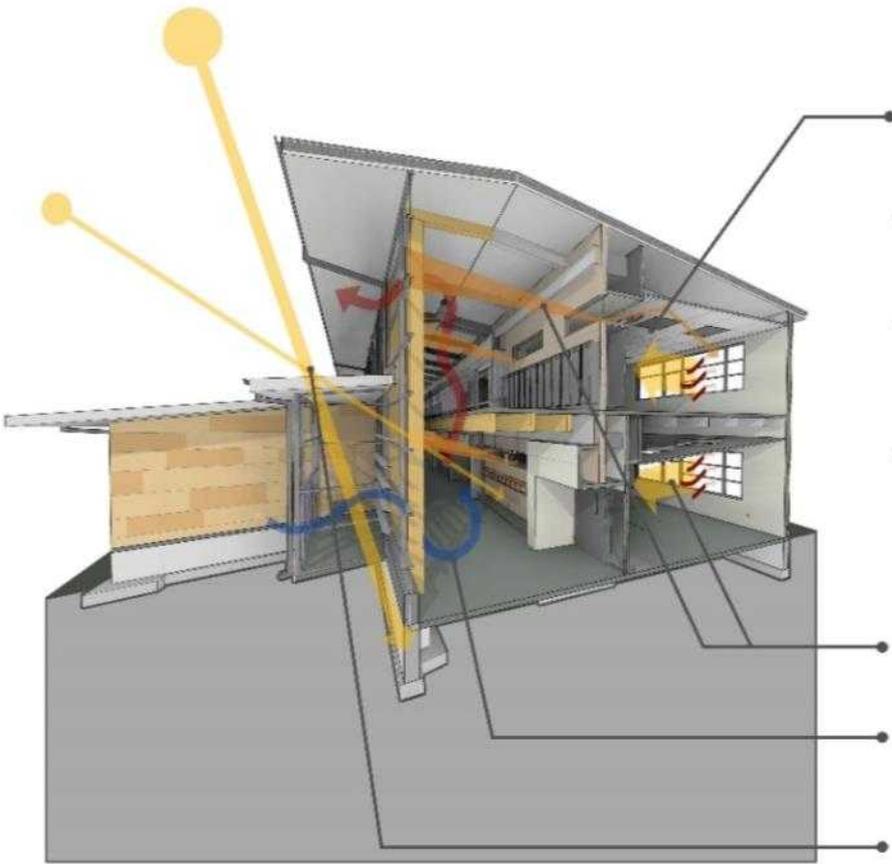


The purpose of this research is to:

- Give decision makers tools.
- Prioritize building features that affect student and teacher performance.

BUILDING FEATURES LIST

HOW IT WAS DEVELOPED



These 150 items were grouped into six categories:

- Lighting
- Acoustics
- Thermal Comfort
- Interior Design
- Aesthetics
- School Campus

BUILDING FEATURES LIST

LEARNING RELATIVITY

1

Natural light

2

Window orientation

3

Depth of light penetration

Hierarchy of Building Feature Items:

- ◉ Items evaluated by Community Advisory Board and research team
- ◉ Categorized by direct impact on student learning
- ◉ Learning Relativity Categories
 1. Highest impact
 2. Some impact
 3. Less impact

(1.1) Orientation of the building
Direction windows face in a room

(1.2a) Natural light
Amount of natural light in the room

(1.2b) Lighting fixtures
Any source other than natural light

(1.2c) Task lighting
Amount of light over selected reading area in the classroom

(1.2d) Glare
Areas of concentrated light that are uncomfortable for the occupant

(1.2e) Distribution of light
How light is distributed within the room

(4.1)
Configuration of room in elevation and floor plan

(4.2)
Occupant installed objects which block lighting fixtures, not including intentional shading devices (lamp-shade)

(4.3) Exterior wall depth
Depth of the exterior walls of the building

(4.4) Interior partitions or large objects
All objects and movable partitions that divide the space temporarily and affect lighting (when you change the configuration of the room, how it affects lighting)

(4.5)
Plants and trees that blocks sunlight

(4.6)
Exterior site features which may cover, protect or block penetration of natural lighting into the space



(5.1) Light reflectance value
Reflection of floors, ceilings and walls

(3.1) Adjustable lighting
Occupants are able to control the systems to increase or reduce amount of artificial light in the room

(2.1) Amount of walls with windows
Number of walls which have windows in the room

(2.2) Dimension of windows
Ratio of total window area to total floor area.

(2.2a) Windows blocked
Elements which block natural lighting in the room not including louvers, baffles and shades

(2.2b) Depth of light penetration
Distance of light penetration to the opposite walls from the windows

(2.3) Glass and window system
Type of window glass and layers. Ex: Double glazed window with low e-glass

(2.4) Skylights
Natural lighting originating from the roof

(2.5) Louvers, baffles and shades
All window adjustable elements designed to control penetration of direct sunlight

General definition

Systems, spaces and/or functional elements that produce background noise in the room

(1.1) HVAC Systems

(1.2) Computers, projectors, others

(1.3) Noises adjacent to classroom

- ✓ Walkway, hallway, others
- ✓ Parking, streets
- ✓ Service Rooms
- ✓ Playground
- ✓ Gym, cafeteria and Recreational spaces

(1.4) Bell system

(4.1) Flooring materials

Top flooring material in the room

(4.2) Ceiling materials

Bottom ceiling material in the room

(4.3) Wall materials

Wall materials in the room

(4.4) Furniture

Soft and hard materials

(2.1) Form/shape variation

Irregular configuration that affects acoustics

(2.2) Glass and Windows system

(2.2a) Windows blocked

Ratio of total windows area to total wall area

(2.2b) Depth of light penetration

Configuration of the glass as part of the windows in the rooms

(2.3) Interior partitions or large objects

All objects and movable partitions that divide the space temporarily and affect acoustics

(2.4) Vegetation

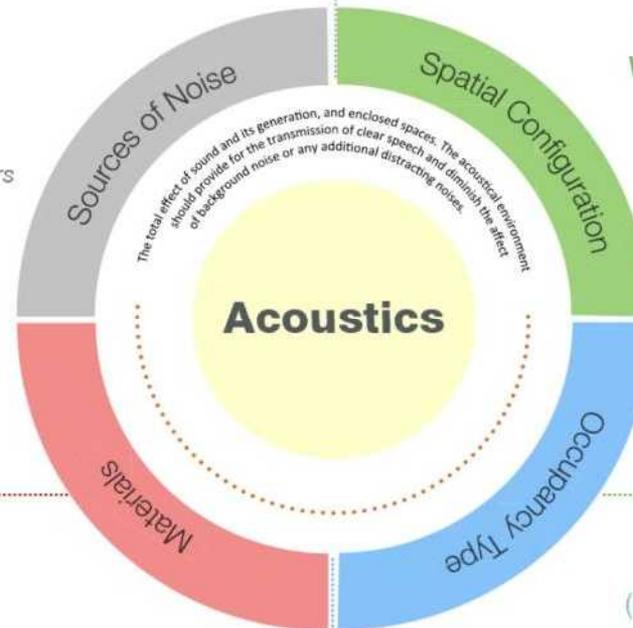
Plants and trees that block noise

(3.1) Room activity

Use of the space based on activities

(3.2) Population-density

Average number of people using the space



(1.1) Passive systems

(1.1a) Crossed ventilation

The desired circulation or flow of air through openings, such as doors, windows or vents, that are on opposite sides of the room

(1.1b) Stack effect

Vertical movement of air in and out the building. E.g:
Warm air rises and produces a chimney effect

(1.2) Form/shape variation

Shape of the room in elevation and floor plan

(1.2a) Height of spaces

Distance from floor to ceiling in the room

(1.3) Vegetation

Plants and trees that serve to reduce heat and block wind and natural light

(1.4) Topography and landscape structures

Sunken or burned structures

(3.1) Orientation of windows

Direction windows face in a room

(3.2) Windows

Ratio between total window area and total wall area

(3.2a) Operable windows

Occupant can open windows

(2.1) HVAC Systems

Type of heating, ventilation and air conditioning in the room

(2.1a) Thermostat Control

Users have the ability to control the thermostat in the room

(2.2) Lighting Fixtures

Any lighting source other than natural light that releases heat

(2.3) Appliances and equipment

Equipment that releases heat

(4.1) Interior color and material

Color and materials of floors, walls and ceilings and any other elements with relevant area that could absorb and/or reflect light

(3.3a) Glass and window system

Type of window glass

(3.3b) Shading devices

Physical elements (interior or exterior) that control direct sunlight affecting room temperature

(3.3c) Skylights

Natural lighting originating from the roof

(3.3d) Blocking elements

Elements which block direct sunlight in the room not including shading devices (louvers, baffles and shades)



(3.3) Lighting control systems

- (1.2) **Interior materials**
 - (1.2b) **Long-term usability**
Lifecycle and usability of materials
 - (1.2c) **Texture or surface of materials**
The texture or surface of the material effectively supports the intended activity

(1.3) **Interior Color**
Color of interior surfaces

(1.4) **Ergonomics of furniture and equipment**
Fit of occupants to furnishings and equipment

(1.5) **Size of classroomms**
Total area of the room

(1.6) **Personal and Social Space**
Distance between seated students

(1.7) **Communal spaces**
Area available for group activities in the classroom

(1.8) **Interior Color**
Secured space for media, tools, supplies, teacher and student belongings.

(1.10) **Water fountains**
Ability to vary the configuration of the room through movable walls



(4.1) **Visibility**
Visibility of safe areas and the interior of classrooms from main hallways

(4.2) **Adjancency with emergency spaces**
Paths to emergency space is efficient

(4.3) **Secured entry**
Secure and operable entry process

(4.4) **Security systems**
Existing and operable security system

(3.1) **Circulations**

(3.1a) **Walkways and Pathways**
A path or route that connects the main exterior areas of the building with the interior areas

(3.1b) **Interior corridors**
A narrow hallway or corridor that opens to different rooms in the interior the building

(3.2) **Hierarchy of spaces**

Obvious entrance areas and gathering spaces to which paths in the building connect

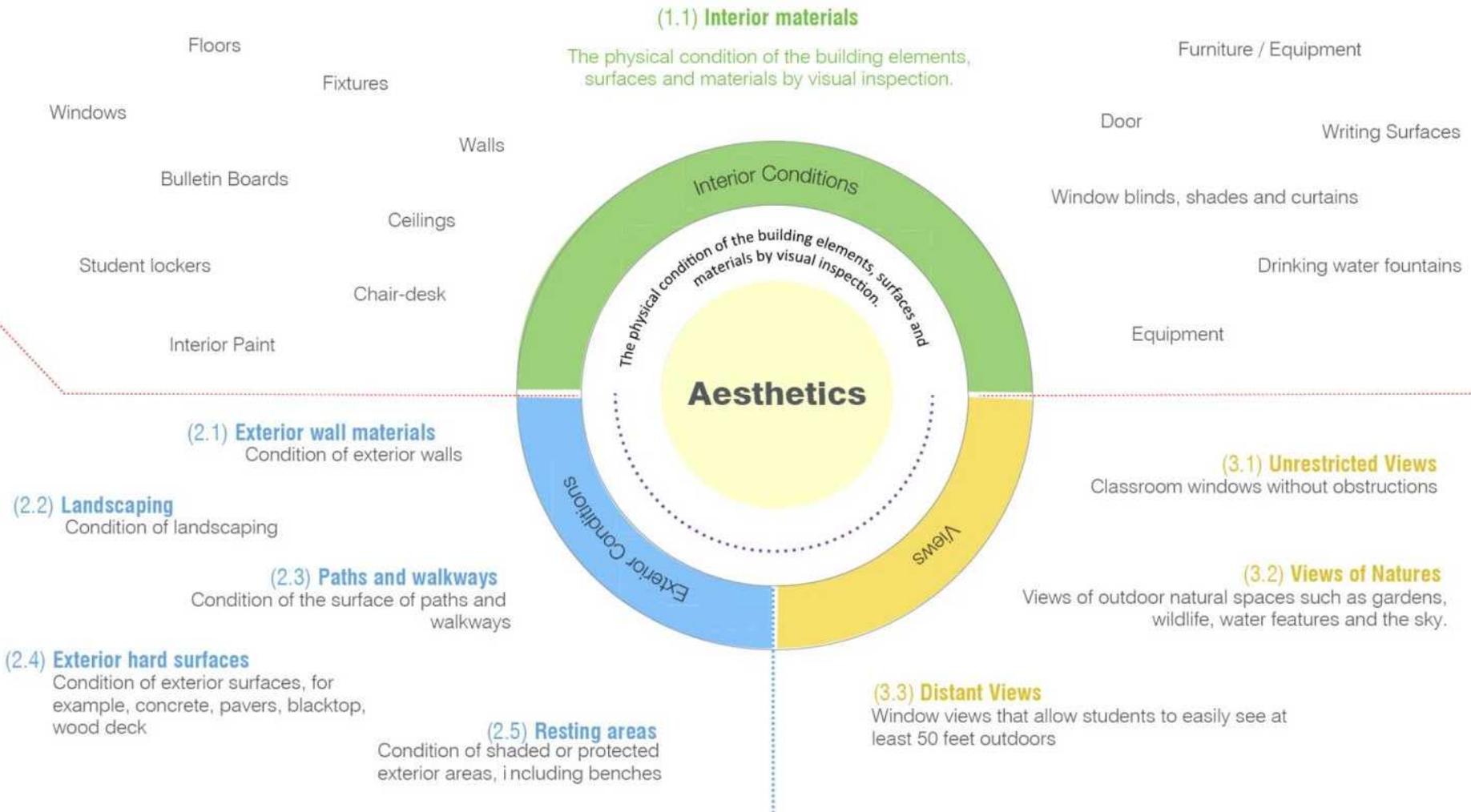
Gathering spaces as a result of architectural and spatial conditions

(3.3) **Adjacency with spaces**

(2.1) **Interior Flexibility**
(2.1a) **Moveable Partitions & Furniture**
Ability to vary the configuration of the room through movable walls

(2.2) **Space Adaptability**
(2.2a) **Display surfaces**
The room provides designated areas for displaying student work

(2.2a) **Display surfaces**
Any interior element and/or structural element which interferes with line of sight for instruction



(2.1) Playground and outdoor activity areas

Outdoor area provided for students to play on and exercise

(2.2) Outdoor learning spaces

Active designated outdoor space designed for formal learning

(2.3) Common spaces

Gathering areas controlled by school staff and used by students and staff

(2.4) Courtyard

Areas between buildings and enclosed by at least 3 exterior walls with sufficient space to accommodate a group of students

(2.5) Green spaces

Open space with undeveloped landscaping within the site

(2.6) Landscaping

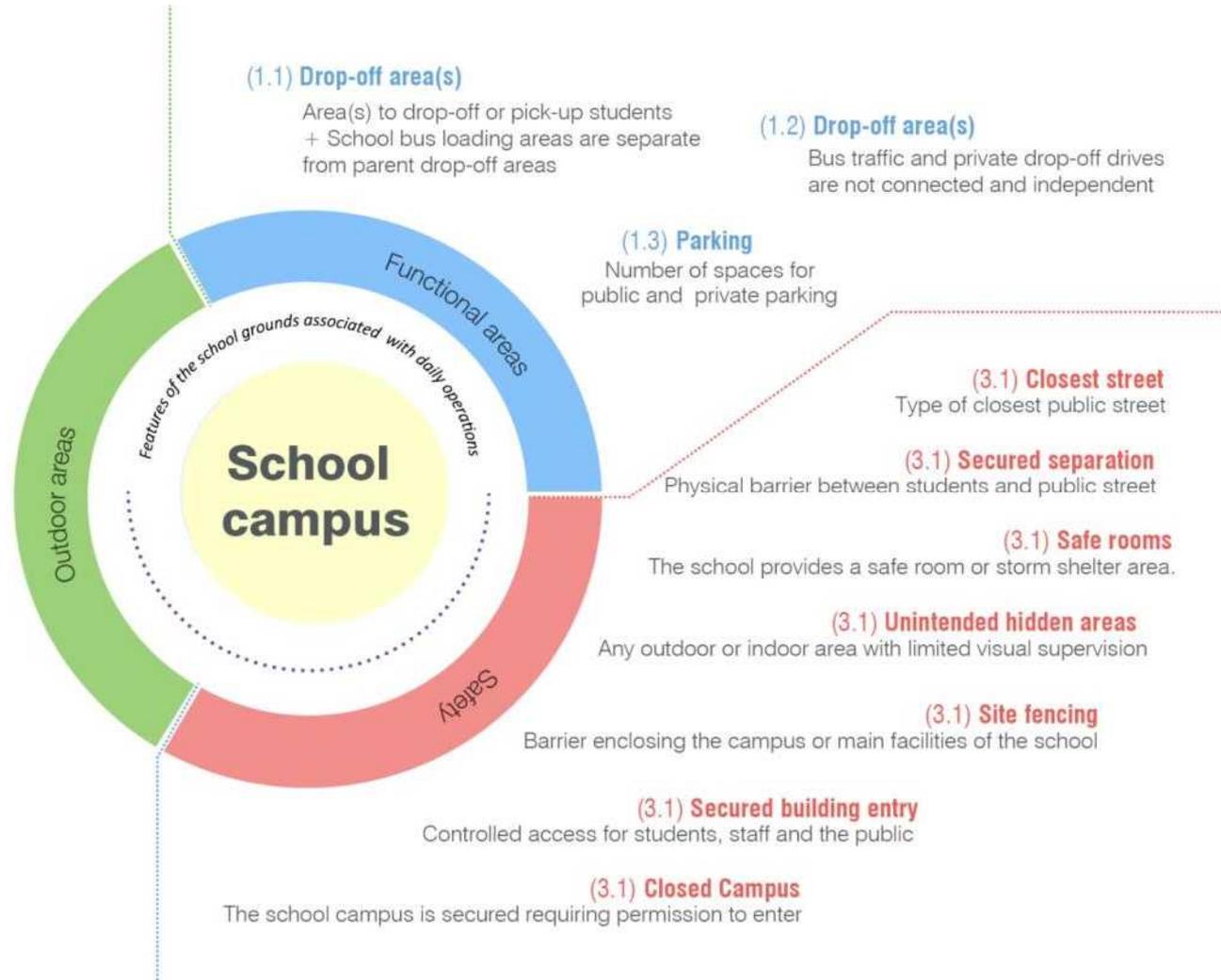
Open space with intended plants within the site

(2.7) Unprotected resting areas

Outdoor areas for students with furniture to sit that are not sheltered from weather

(2.8) Protected resting areas

Outdoor areas for students with furniture to sit that are sheltered from weather



STRUCTURAL HARDENING & SAFETY

THE BIG PICTURE



What is safety & security?

- Safety - "condition of being protected from danger"
 - By a device
 - Fire alarms, fire rated walls/exits, fire extinguishers, bunkers, safe rooms...
- Security - "the quality or state of being free from danger"
 - Means to prevent an event
 - CCTV, access controls, secured entries, security guards...



STRUCTURAL HARDENING & SAFETY

FOCUS ON SAFETY

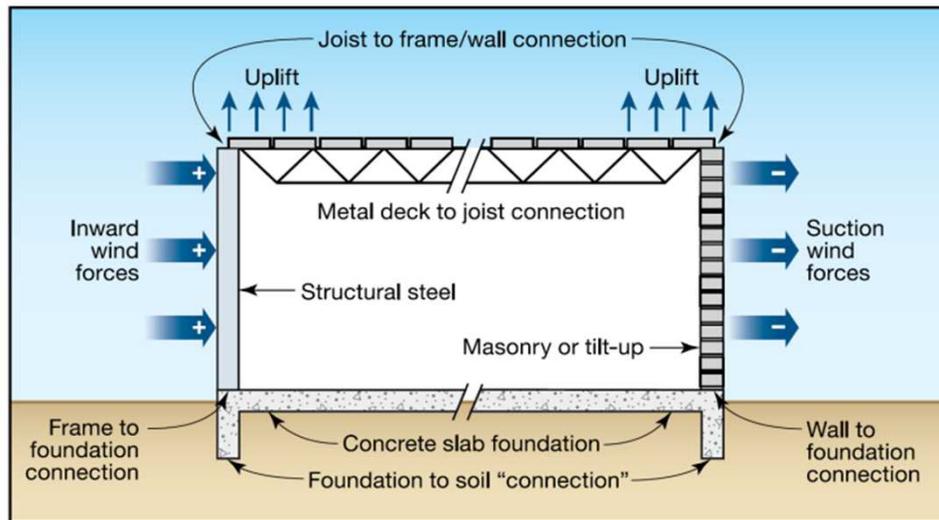
Transparency is the visual connection and control:

- Of building entries
- Into and out of classrooms
- Provides the ability to identify threats at a distance.
- Pod lockdown



STRUCTURAL HARDENING & SAFETY

HARDENING - REGULATORY GUIDELINES



How is a hardened room defined?

- Hardened Structure
 - Structures designed to resist a specified wind event
- Storm Shelter
 - Meets ICC 500
 - Provides "life-safety protection" from wind events
- Safe Room
 - Meets FEMA 361
 - Meets/exceeds ICC 500
 - Provides "near-absolute protection" from wind events



FEMA

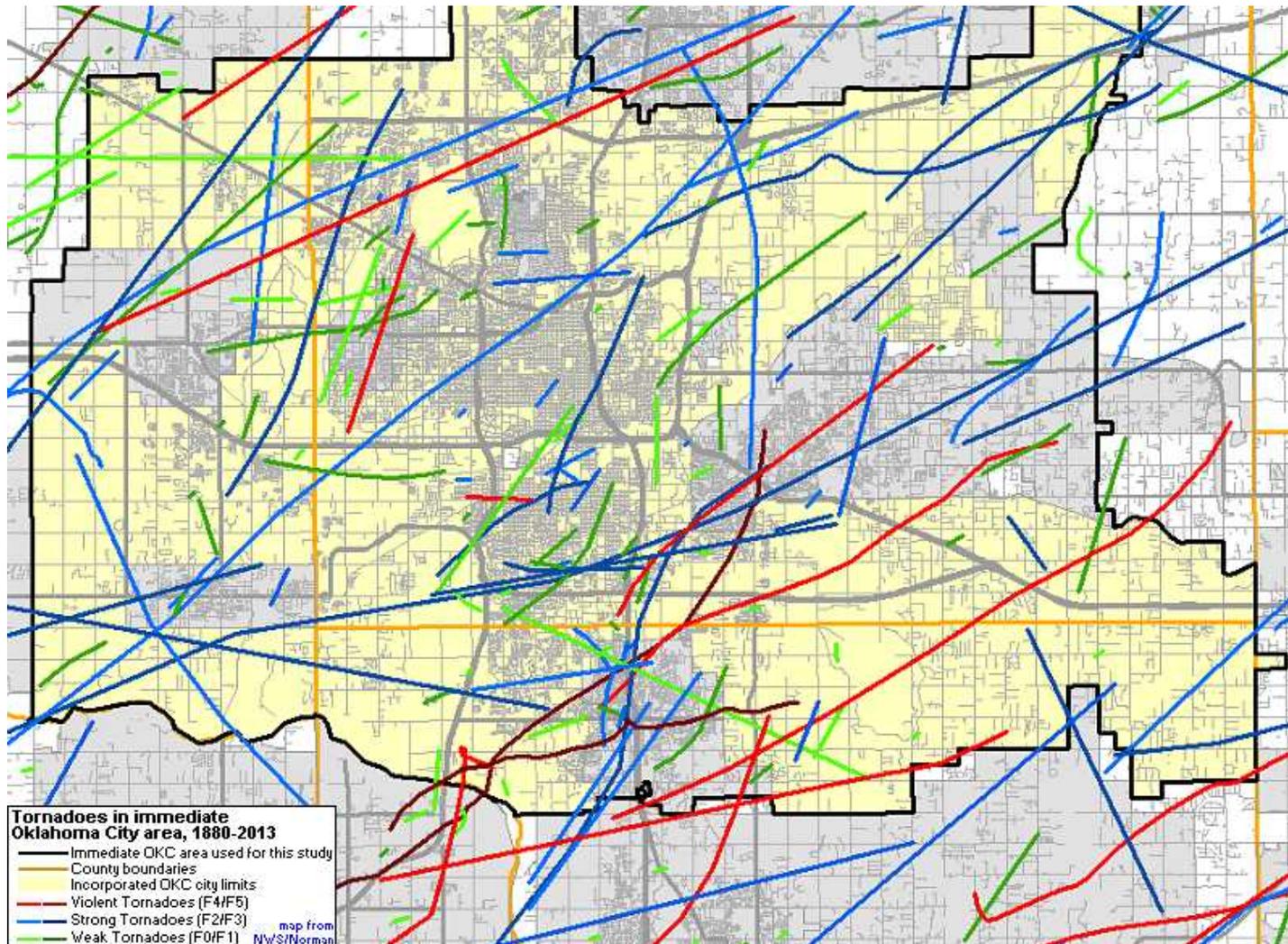
STRUCTURAL HARDENING & SAFETY

HARDENING - REGULATORY GUIDELINES

	Tornado Refuge Area	Best Available Refuge Area	Hardened Area or Room	Storm Shelter	Safe Room
Designed to minimum building code requirements	<input checked="" type="checkbox"/>				
Evaluated by a design professional and identified as least vulnerable area / room in building		<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Designed to consider wind speeds or wind-borne debris impacts at some level between code and ICC 500 / FEMA criteria			<input checked="" type="checkbox"/>		
Designed specifically to provide life-safety protection per ICC 500 or FEMA criteria				<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Designed specifically to provide near-absolute protection per FEMA criteria (including operational and emergency planning criteria)					<input checked="" type="checkbox"/>

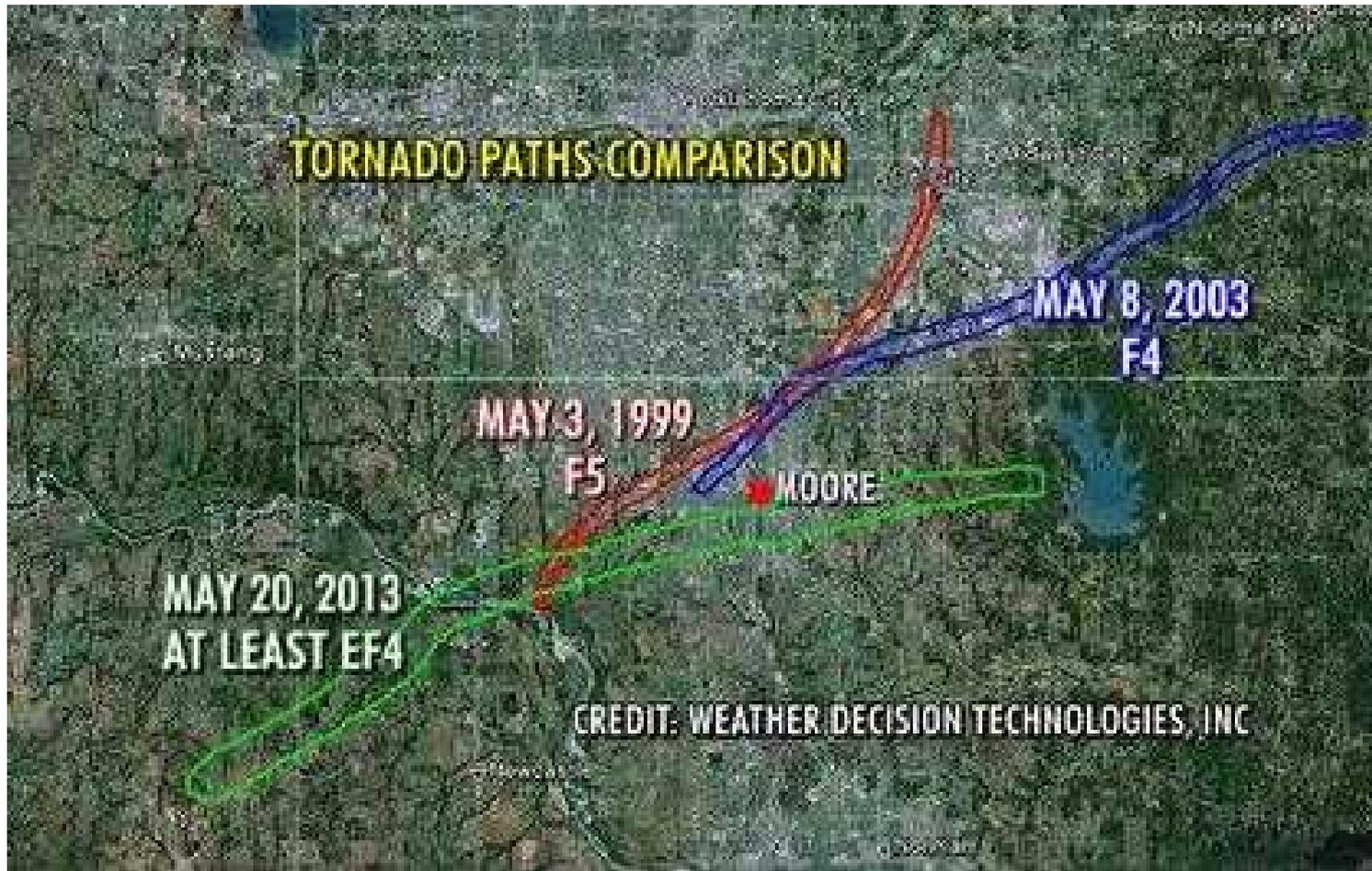
STRUCTURAL HARDENING & SAFETY

THE OKLAHOMA EXPERIENCE



STRUCTURAL HARDENING & SAFETY

THE OKLAHOMA EXPERIENCE



















16. Love and a Dead Rat	90
17. "What?"	96
18. The Substitute	100
19. A Bad Case of the Sneeze	106
19. A Wonderful Teacher	112
19. Forever Is Never	117
20. 21. & 22. Eric, Eric & Eric	124
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26. The Mean Mrs. Jewls	147
27. Lost and Found	155
28. Yuhoooh	161
29. The Lost Ear	168
30. Wayside School Is Falling Down	174

WAYSIDE SCHOOL IS
FALLING
DOWN

STRUCTURAL HARDENING & SAFETY

INITIAL REACTION



Initial reaction:

- Save and protect the children
- Build highly reinforced enclosed rooms

Initial outcome:

- Reduce functional efficiency
- Reduced aesthetics
- Hardened structures designed to resist wind events
- Bunkers instead of learning spaces

STRUCTURAL HARDENING & SAFETY

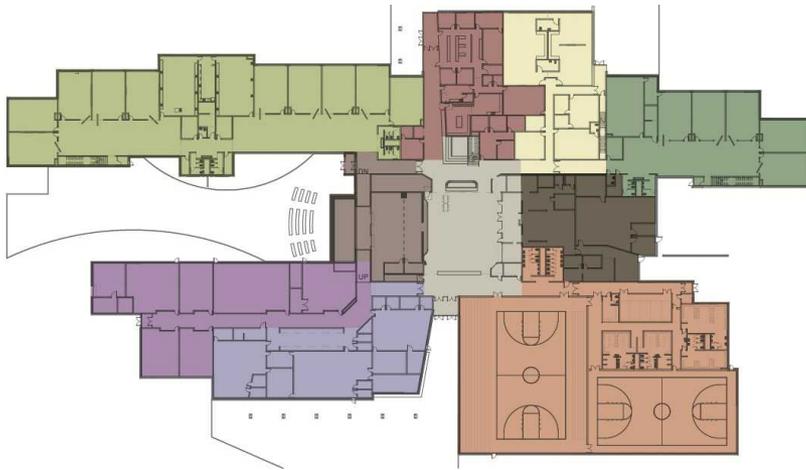
POTENTIAL TRADE-OFFS



What are the potential trade-offs a school or designer will come across?

- ◉ Reduced access to natural daylight
- ◉ Reduced quality and amount of lighting
- ◉ Limitation of construction materials and methods
- ◉ Reduced aesthetics
- ◉ Reduced IAQ
- ◉ Increased cost

STRUCTURAL HARDENING & SAFETY OPPORTUNITIES



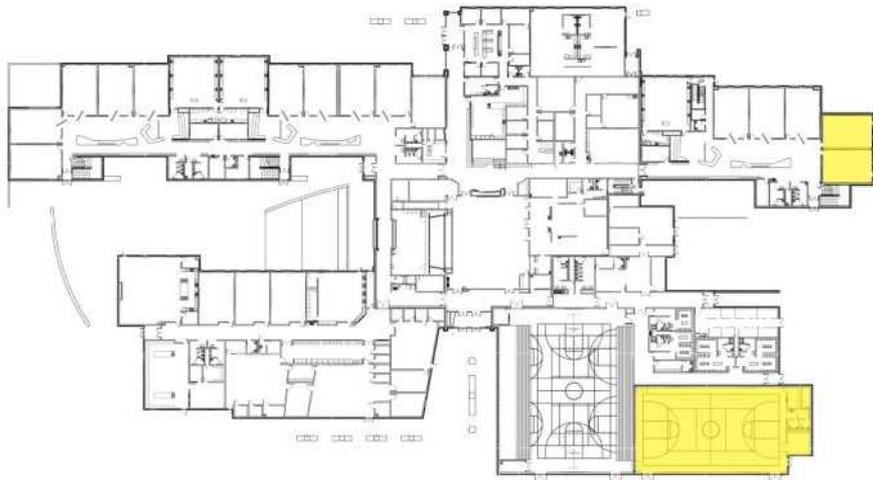
Where are the best opportunities for hardened structures?

- Restrooms
- Gymnasium
- Band Room
- Classroom
- Media Center
- Cafeteria



STRUCTURAL HARDENING & SAFETY

CREATIVE SOLUTIONS - CASE STUDIES



Edmond Heartland Middle School

- Practice Gymnasium
 - For entire school population
 - Natural Ventilation
 - No windows required by program
- Two adjoining classrooms
 - Reserved for special needs students
 - Incorporated into classroom wing = less travel distance
 - Has impact tested exterior windows
 - No obvious visual difference from other classrooms



STRUCTURAL HARDENING & SAFETY

CREATIVE SOLUTIONS - CASE STUDIES



Edmond Public Safety Center

- ◉ Basement in HQ building is an Area of Refuge
- ◉ Reinforced, cast in place concrete structure.

South Support Facility

- ◉ Conference room as Storm Shelter
- ◉ Programming complimented shelter design
- ◉ No exterior windows
- ◉ Smaller in size, not a community storm shelter.



STRUCTURAL HARDENING & SAFETY

CREATIVE SOLUTIONS - CASE STUDIES



ASTEAC Middle/High School

- Gymnasium as Safe Room
 - Tilt up concrete construction
 - Restrooms under bleachers
 - Natural ventilation in wind event
- Secured vestibules
 - Visual control of entries
 - Security film
 - Access control
 - Security office at secondary entrance



STRUCTURAL HARDENING & SAFETY

CREATIVE SOLUTIONS - CASE STUDIES



Northern Oklahoma College

- Recreational room doubles as Storm Shelter
- Public restroom access via shelter
- FEMA doors used as exterior shutters for windows to reduce cost



STRUCTURAL HARDENING & SAFETY

CREATIVE SOLUTIONS - OVERCOMING TRADE-OFFS



Wind & impact resistant coiling doors

- Tested to meet FEMA 361 impact requirements
- Allows natural light during normal occupancy
- Protects large openings
- Unlimited height
- Width limited to 16'-0"
- Only closes when space is used as a safe room



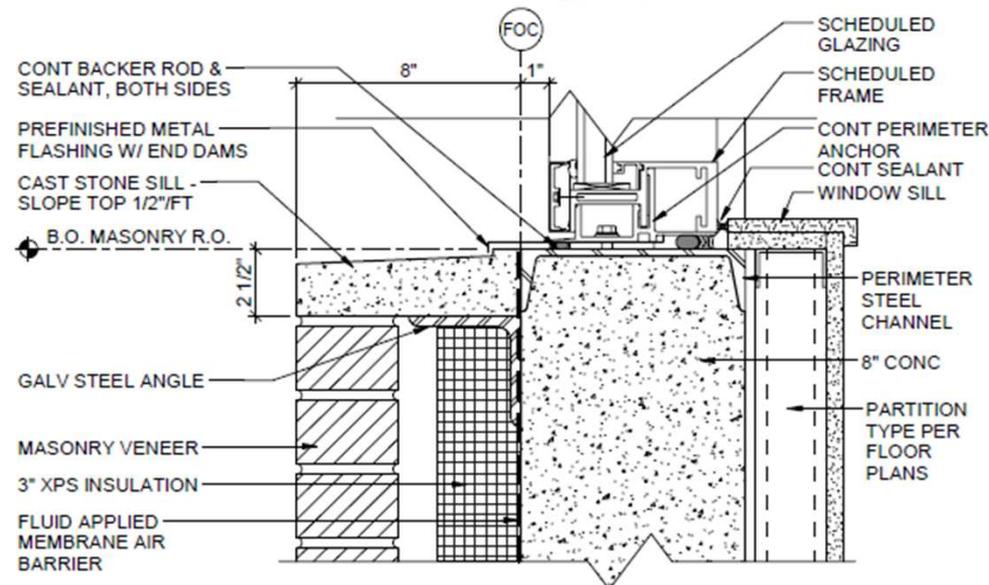
STRUCTURAL HARDENING & SAFETY

CREATIVE SOLUTIONS - OVERCOMING TRADE-OFFS



Wind & impact resistant windows

- Retrofit or new construction
- Conventional installation methods
- Potentially no additional protection required
- Some size restrictions



STRUCTURAL HARDENING & SAFETY

THE OKLAHOMA RESPONSE

How are schools addressing structural hardening in Oklahoma?

- ◉ Tulsa area district - no hardening, reinvesting into technology
- ◉ OKC Public Schools - shelters for students in all new construction & additions
- ◉ OKC amendment to IBC requires schools to provide a safe room with an occupancy load equivalent to or greater than the number of students and faculty the building or structure is designed for.
- ◉ Rural community - build a community center, with a safe room, next to the school.
- ◉ Edmond Public Schools - hardened room for every student at every facility by 2020 (325mph wind event)

STRUCTURAL HARDENING & SAFETY

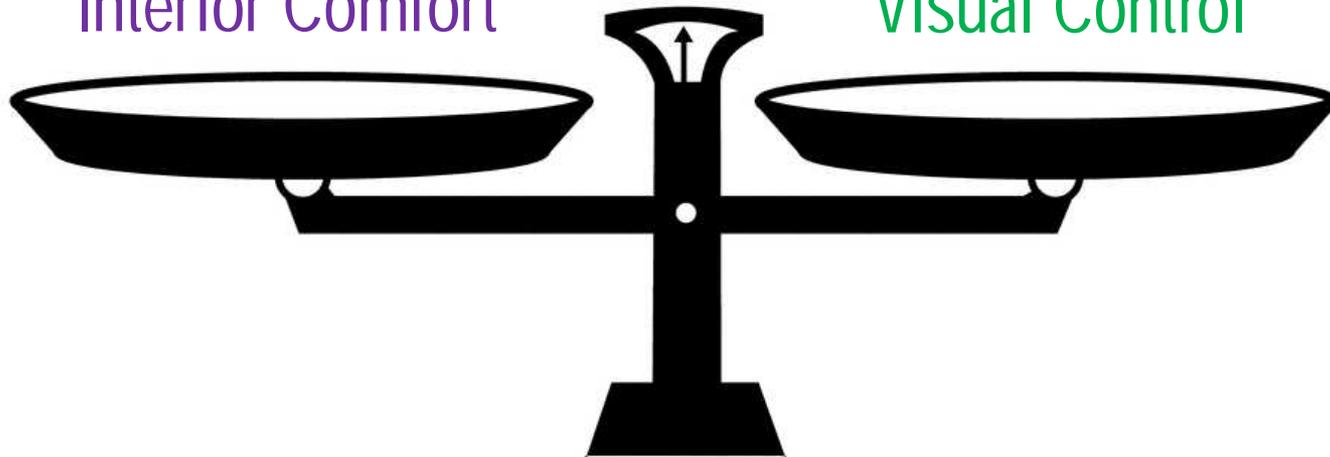
BALANCING PRIORITIES AND TRADE-OFFS

Student Learning

Natural Light
Aesthetics
Indoor Air Quality
Functionality
Interior Comfort

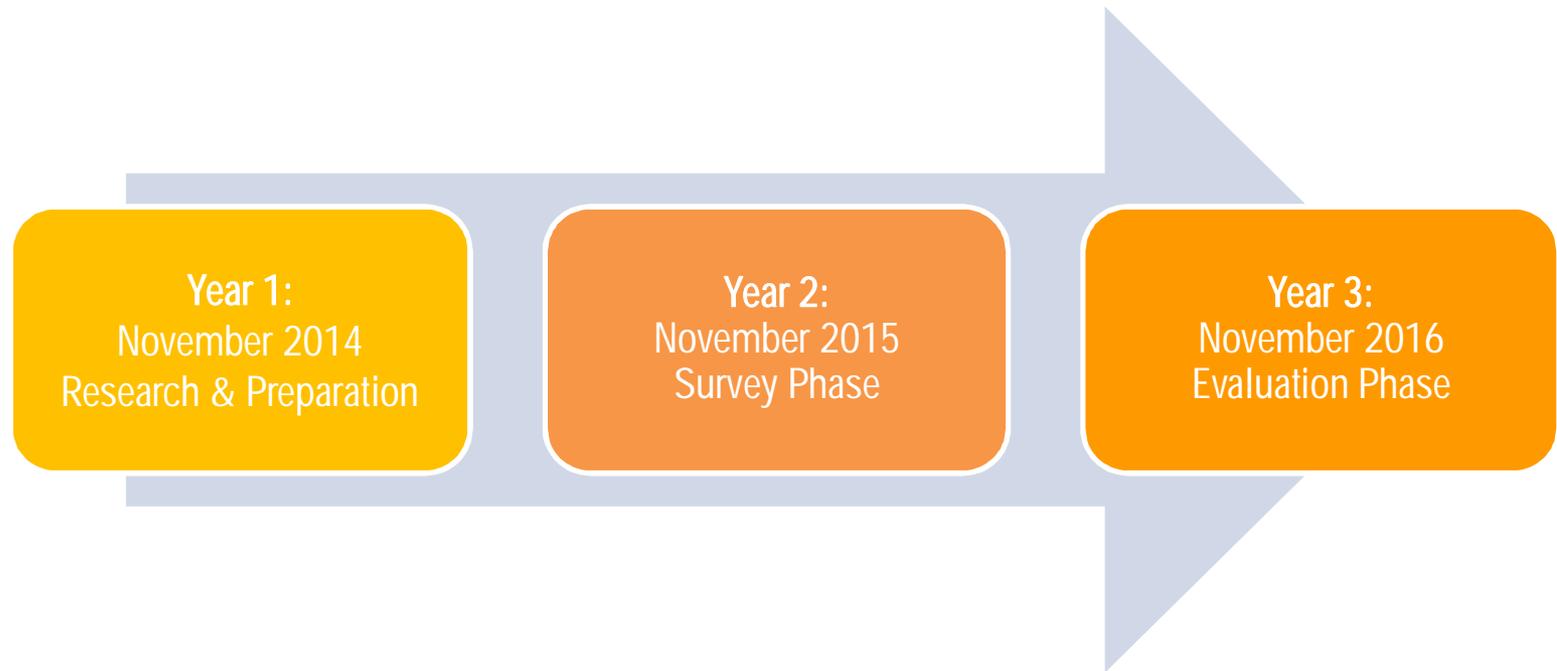
Student Safety

Safe Rooms /
Storm Shelters
Secured Entries
Visual Control



WHAT'S NEXT?

GRANT RESEARCH TIMELINE



WHAT'S NEXT?

FINISHING THE RESEARCH



Year 2 of the research:

- Continue to fine tune the Building Features List
- Define these features in everyday terms
- Assign a scale or metric to each item
- Start Beta testing of measurements and field survey



WHAT'S NEXT?

FINISHING THE RESEARCH



Year 3 of the research

- Field measurements estimated to be complete Summer 2016
- Field measurement data will be analyzed by the research team
- School testing data will be cross referenced with field data
- Relationships made between building features modifications and student/teacher performance
- A final report will be created to help stakeholders make better informed decisions



This concludes The American
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Education Systems Course

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THOUGHTS & QUESTIONS

Thank you

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For polling results, presentation executive summary and downloads:

education-design-studio.com

The University of Oklahoma

Welcome to the OK Healthy Schools Project

Please join us as we work with parents, teachers, school administrators and staff and other school design professionals in the OKC metropolitan area.

Our aim is to develop a tool that will aid decision makers in making school building design and renovation decisions that balance the need for structural safety, healthy environments, supportive learning interiors and overall student achievement.

To be successful we need your help. For more information about the project and how you can help improve schools, please click on either the English or Spanish button below to find out more!

Meet the 11 member advisory board that ensures the project grounded in Oklahoma communities, schools and families

[In English](#) [En Español](#)

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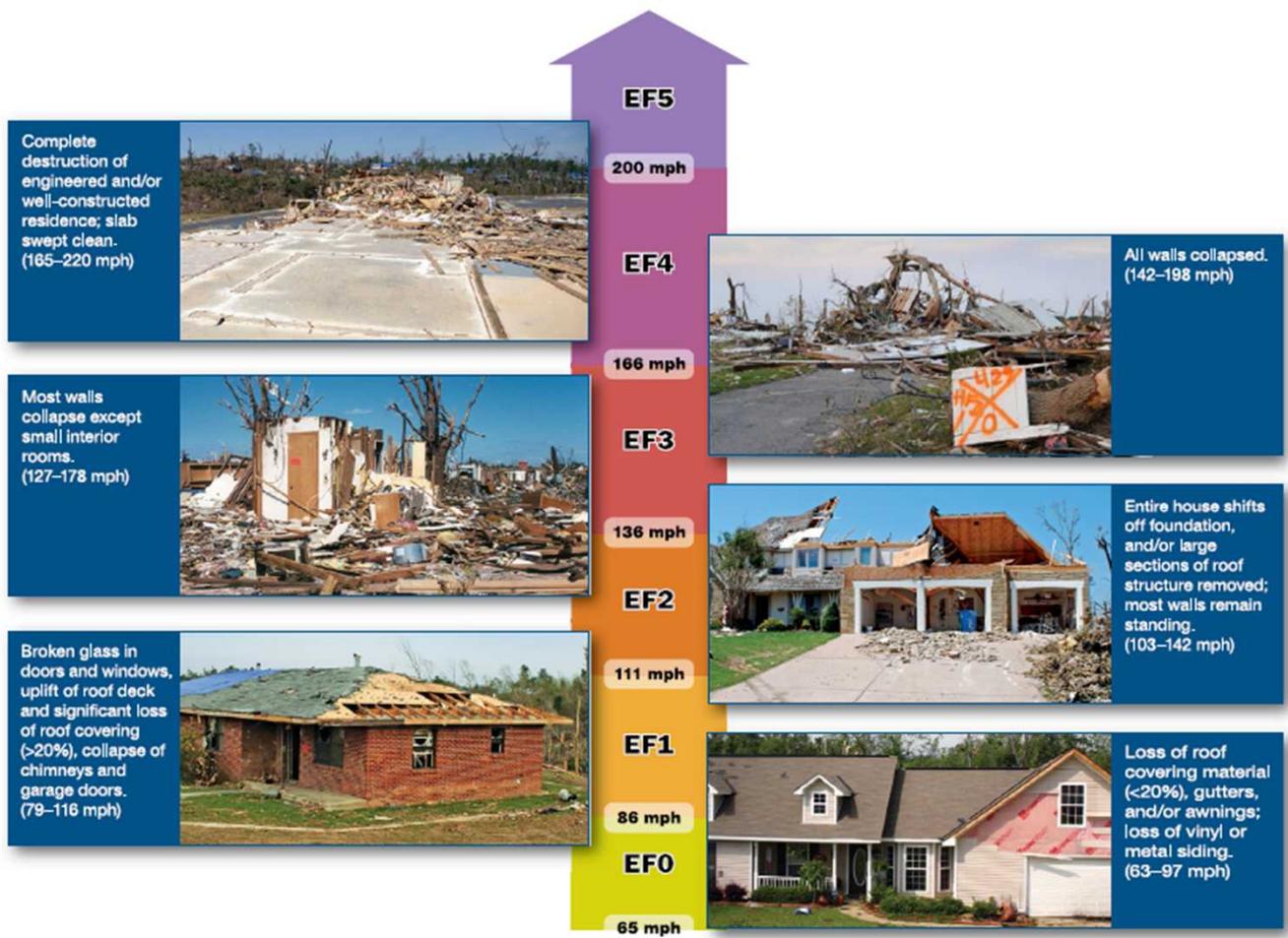


Figure A2-1. Typical tornado damage descriptions to one- and two-family dwellings and their corresponding intensity according to the EF Scale (wind speeds are estimated 3-second-gust wind speeds)

(SOURCE: NOAA NATIONAL WEATHER SERVICE, STORM PREDICTION CENTER, WWW.SPC.NOAA.GOV/EFSCALE/EF-SCALE.HTML)

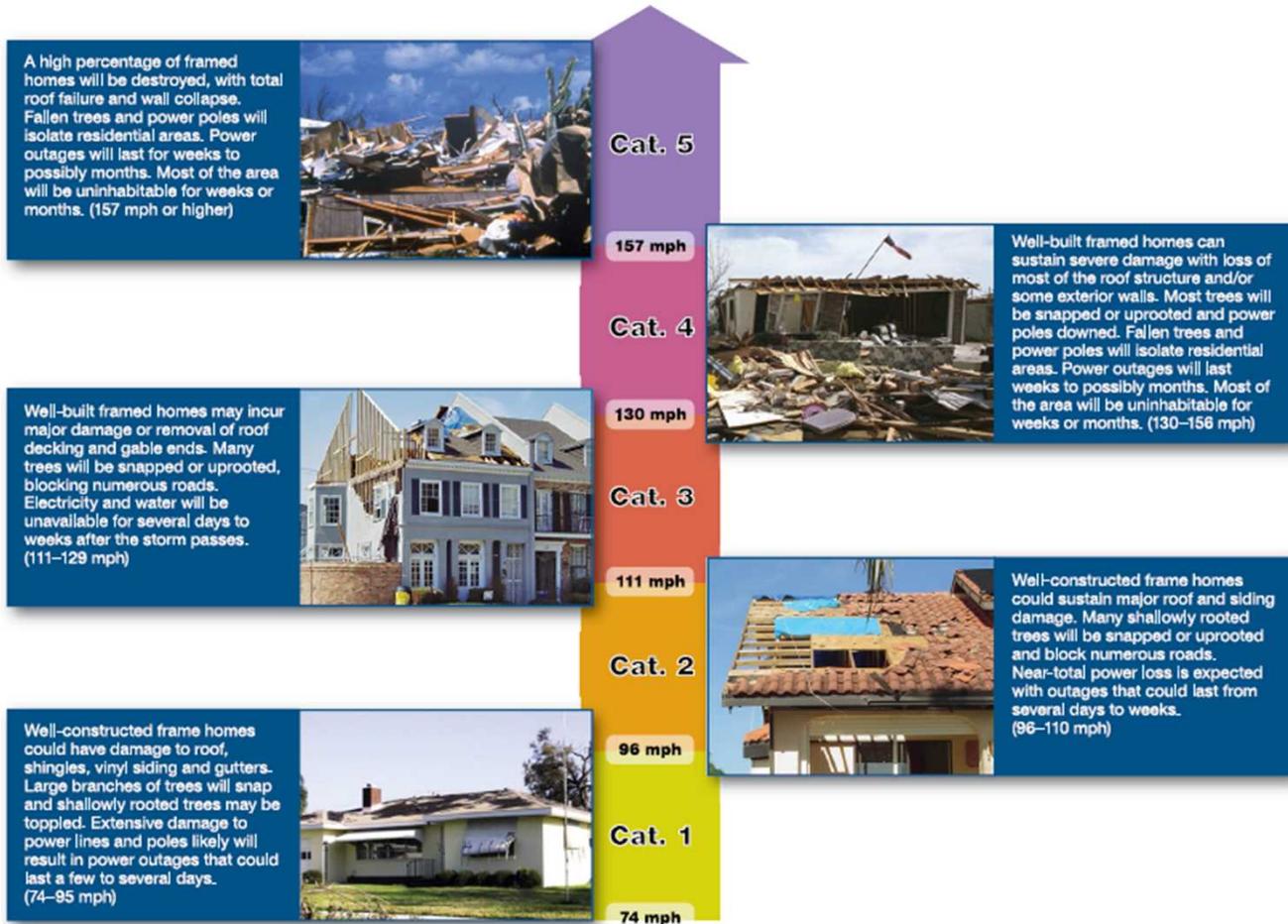


Figure A2-4. Typical hurricane damage descriptions to one- and two-family dwellings and their corresponding intensity according to the Saffir-Simpson Hurricane Wind Scale (SOURCE: NOAA NATIONAL WEATHER SERVICE, NATIONAL HURRICANE CENTER, WWW.NHC.NOAA.GOV/ABOUTSHWS.PHP)