DESIGN FOR RESILIENCE
DESIGN FOR LONG TERM SURVIVAL

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LEARNING OBJECTIVES

ATTENDEES AT THIS SESSION WILL:

• UNDERSTAND WHY RESILIENCY STRATEGIES ARE NEEDED TO ADAPT TO THE “NEW CLIMACTIC NORMAL”
• UNDERSTAND VARIOUS STRATEGIES TO MAKE OUR BUILDINGS MORE RESILIENT
• UNDERSTAND THE RELATIONSHIP OF SUSTAINABILITY AND RESILIENCY
• LEARN ABOUT PROJECTS INCORPORATING STRATEGIES TO IMPROVE THE BUILDING’S RESILIENCY.

AGENDA

1. ARGUMENT FOR RESILIENCY
2. DEFINE RESILIENT ARCHITECTURE
3. CASE STUDIES
4. FUTURE THINKING
We know that we can’t design for all such unpredictable events, but we could make sure our buildings and cities are better able to weather these disruptions and bounce back afterwards.

Toward Resilient Architectures

Michael Mehaffy & Nikos Salingaros
EXTREME HEAT
EARTHQUAKE
EVACUATIONS
HOW!
ADAPTABILITY AND FLEXIBILITY OF THE DESIGN IS ESPECIALLY IMPORTANT DURING A NATURAL OR MAN-MADE DISASTER
CRITICAL CONCEPTS

1. Learn from Biologically Resilient Systems
2. Hierarchical, Interconnected network structure
3. Develop diversity and redundancy
4. Scalability
5. Passive Survivability
6. Disaster Planning

images from MoMA Rising Tides
# Intersection of Sustainability & Resilience

## Sustainability
- Material Disclosure
- Indoor Air Quality
- LEED Certification

## Sustainability & Resilience
- Daylighting
- Natural Ventilation
- Stormwater Management/Rainwater Capture
- Shading
- On-site Renewable Energy
- Walkability

## Resilience
- Flood Barriers
- Raised Elevation
- Backup Generators
MEMORIAL SLOAN-KETTERING CANCER CENTER
New York, New York
Architect: Perkins & Eastman
MEMORIAL SLOAN-KETTERING CANCER CENTER
74th Street Complex

• Location: New York City
• Lot Size: 66,111 square feet
• Building Size: 1,100,000 gross square feet
  • 750,000 for Memorial Sloan-Kettering
  • 336,000 for CUNY
• Floors: 23 stories
  • Includes 5 mechanical floors
• Height: 453 feet
MEMORIAL SLOAN-KETTERING CANCER CENTER
74th Street Complex

Key Design Revisions for Resilience

• Lobby Floor Level set at 500 year flood level
• Utility Vaults raised to Level 2
• Fuel Oil Tanks in watertight elements on lower level
• Stackable flood barriers
• ROI Chart dictated all decision making
• Material Choices at Flood Prone Locations
  • Moisture Tolerant Materials

ROI CHOICE MATRIX

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Prioritize by $$ and Space Constraints
Evaluate by Value Added
KIOWA COUNTY MEMORIAL HOSPITAL

Facts

• 50,000 SF Critical Access Hospital
• 15 Acute-care beds
• Rural Health Clinics
• Replacement for original hospital destroyed by EF5 Tornado in 2007
KIOWA COUNTY MEMORIAL HOSPITAL

Key Design Revisions for Resilience

- Partners with U.S. Department of Energy & National Renewable Energy Laboratory
- 100% Renewable Energy
  - Greensburg Wind Farm - (10) 1.25 MW supplies 12.5 MW - enough for entire town
- Long-term Cost Savings critical to decision making
- On-site Bioswale for gray water filtration
  - Utilized for laundry, showers, & lavatories
VA MEDICAL CENTER
Defend in Place

THE NEXT GENERATION OF SMARTER AND SAFER HEALTH CARE

This 7-day “defend in place” capability allows the campus perimeter to be secured and the facility to remain fully-operable during severe natural disasters, providing accommodations and provisions for up to 1,000 staff and patients. Read about the features that make it possible below.

FULLY STOCKED WAREHOUSE
A 60,000-SF warehouse located on-site stores emergency supplies, including food and water.

SELF-SUFFICIENT POWER
The central energy plant stores 320,000 gallons of fuel, enough to provide full power for one week, and the refueling pump is located in a waterproof enclosure above the 500-year flood line.

FLOOD OPERATIONAL
Mission-critical components, including the emergency department, are located at least 21 feet above base flood elevation.

HURRICANE READY
The building envelope is constructed of glass, metal and concrete that can withstand Category 3 storms.

ROOM TO GROW
All single-occupancy rooms can be temporarily converted to double-occupancy in order to accommodate a potential increase in patients due to an emergency.

ENERGY EFFICIENT, EVEN IN CRISIS
Roof tops connected to a 1 million-gallon rainwater storage tank maintain operation of cooling systems and reduce use of city water.

HELIicopter ACCESSIBILITY
A helicopter landing area on top of the parking garage accommodates Blackhawk-class helicopters to transport patients.

BOAT ACCESSIBILITY
The ramp to the emergency department extends up to the facility’s second floor, doubling as a boat dock in the event of flooding.

“UP-SIDE-DOWN” HOSPITAL
Primary utility distribution, which connects the hospital to the city power grid, is located on the fourth level to avoid flood damage.
SPAULDING REHABILITATION HOSPITAL

Facts

• 378,300 SF Rehabilitation Hospital
  - 261,300 SF Above Grade
  - 117,000 SF Below Grade
• 9 Floors above grade, including Mechanical Penthouse
• 132 Acute rehab beds
• Outpatient Clinics & Therapy
• Research and Teaching Hospital
• Replacement for original hospital designed in early 1970s
SPAUDDLING REHABILITATION HOSPITAL

Key Issues for Resilience Planning

• Coastal Storms

• Rising Sea Levels
  Building was in Design Development when Partners Healthcare asked: What is the design team doing in response to anticipated Sea Level Rise?

• Shelter in Place/ Passive Survivability

Maps: The Boston Harbor Association, Rising Tide Report
RESILIENT FEATURES

1. Plantings & retaining walls act as protective reef against storm surge
2. Ground floor and top of parking set at 19’-0”, above high flood level
3. Critical patient programs located above ground floor
4. Passive Survivability: Operable windows keyed open in event of systems failure
5. Mechanical, electrical & emergency services located within enclosed penthouse out of harm’s way
DETERMINING GROUND LEVEL
Rethink Critical Determining Element
Water Level vs. Street Level

1. Finish Floor set at 19’ providing 3.35’ offset from current 100 year flood and 1.35’ offset from 75 year anticipated increase in flood elevation
2. Garage ramp lip, vents, & areaway sills set at 19’
3. Glazing raised from floor level to provide sill for waterproofing
4. Limited doors and openings at grade to be sandbagged in extreme events
SITE & LANDSCAPE
MITIGATES & DISSIPATES STORM SURGE
1. Additional SF required in Penthouse Mechanical
2. Requires cooperation with Utility Companies. Revises base code and design guidelines
3. Additional architectural and structural requirements for concrete encased conduits and water tight construction
FUEL OIL PUMPS BEHIND WATER TIGHT CONSTRUCTION

ELECTRICAL SUPPLY ENCASED IN CONCRETE
250 KW CO-GEN UNIT
PASSIVE SURVIVABILITY
Computation Fluid Dynamics to Study Patient Comfort

1. Daylight Harvesting & Illuminance Level Studies helped determine foot candle levels
2. Confirmed Light Shelves were not required
ENERGY EFFICIENCY
Computational Fluid Dynamics to Study Patient Comfort

1. Comfort studies between Triple Glaze Windows and Traditional Insulated Double Glazed Windows with Perimeter Radiation
2. Both systems performed equally and were cost neutral
3. Triple Glazed windows selected for long term ROI and increased usable SF
MISSED OPPORTUNITIES
We Can Always Improve Our Design

1. Gray water system was eliminated. Concerns over infection control and 11 year ROI due to inexpensive water/sewer rates
2. Fuel pumps are still vulnerable due to electrical feeds that are susceptible to flooding
3. Kitchen located on Level 1 due to Facilities of Public Accommodation
FUTURE THINKING
POST-DISASTER PUBLIC HEALTH
A COMMUNITY APPROACH

COMMUNITY

HEALTHCARE

GOVERNMENT
TEMPORARY HEALTH FACILITIES

SYSTEM TYPE SELECTION: ANALYZING ALTERNATIVES

DEPLOYABLE HEALTH UNIT

TENT
TEMPORARY HEALTH FACILITIES

RDoC ENERGY, WATER, WASTE

- Solar
- Shading
- Insulation
- Energy Generation/Storage
- Optimized Solar Orientation
- Water Storage/Treatment
- Waste/Recycling
- Daylighting
- Natural Ventilation
- Healthy Materials
TEMPORARY HEALTH FACILITIES
RDoC SPECIFICATIONS

- Cleanable/anti-bacterial surfaces
- (Modular) structural insulated panels
- Vision panels
- Universal connectors
- Lightweight materials
- Easily stored
- Flat pack
- Easily deployable

perkinswill.com
San Francisco hospitals and emergency response locations.
Other potential “hard” locations:
– New K-12 schools
– New community colleges
– New power plants

Expected seismic performance:
safe and operational by 2030
FLOATYARD MULTI-FAMILY HOUSING
Charlestown, Massachusetts
Architect: Perkins+Will
CELEBRATING THE MARITIME HERITAGE

Floatyard will be Boston’s first ship/multi-family housing hybrid. In addition to a construction team, the building will be constructed by ship builders and engineers. Merging maritime craftsmanship into the construction process will yield a sturdy, waterproof building with a ship-like nature.
01 Hollow concrete foundation acts like a ship’s hull to make the building float.

02 The courtyard floor is made up of a hollow metal float system covered in wood decking.

03 The mooring post pistons allow the building to rise and fall with the tide while anchoring it in place.

04 The compression chamber hosts the piston that rises during high tide and lowers during low tide to compress air in the pressure chamber.

05 Turbine Converter

06 Column

07 Plimsol Line/Water Line

08 Integrated Photo voltaic Roof Panel

09 Floating Wetland Island
HELPING A NEIGHBORING COMMUNITY

Floatyard will be constructed in the Fore River Shipyard, in Quincy Massachusetts about 10 miles from Pier 5 in Charlestown.

The shipyard, once a leader in the shipbuilding industry, is no longer active. The shipbuilding infrastructure remains and could support the construction of Floatyard, merging shipbuilding and building construction industries.
One can expect to see a sense of regional pride reignited by bringing back a new maritime trade as shipbuilding was once an essential ingredient in the community. One might also conclude that the construction of Floatyard has potential to spur more large-scale water-dwelling projects and that the Fore River Shipyard could perhaps become the place where these ocean vessel building hybrids are manufactured.