



Reducing the Impact of Fire in Buildings and Communities

Anthony Hamins
Fire Research Division
National Institute of Standards and Technology
Gaithersburg, MD

Reducing the Impact of Fire in Buildings and Communities

Fire Research Division

National Institute of Standards and Technology (NIST)

Morgan Bruns
Nelson Bryner
Matthew Bundy
Rodney Bryant
Kathy Butler
Lisa Choe
Artur Chernovsky
Tom Cleary
Rick Davis
Michelle Donnelly
Glenn Forney

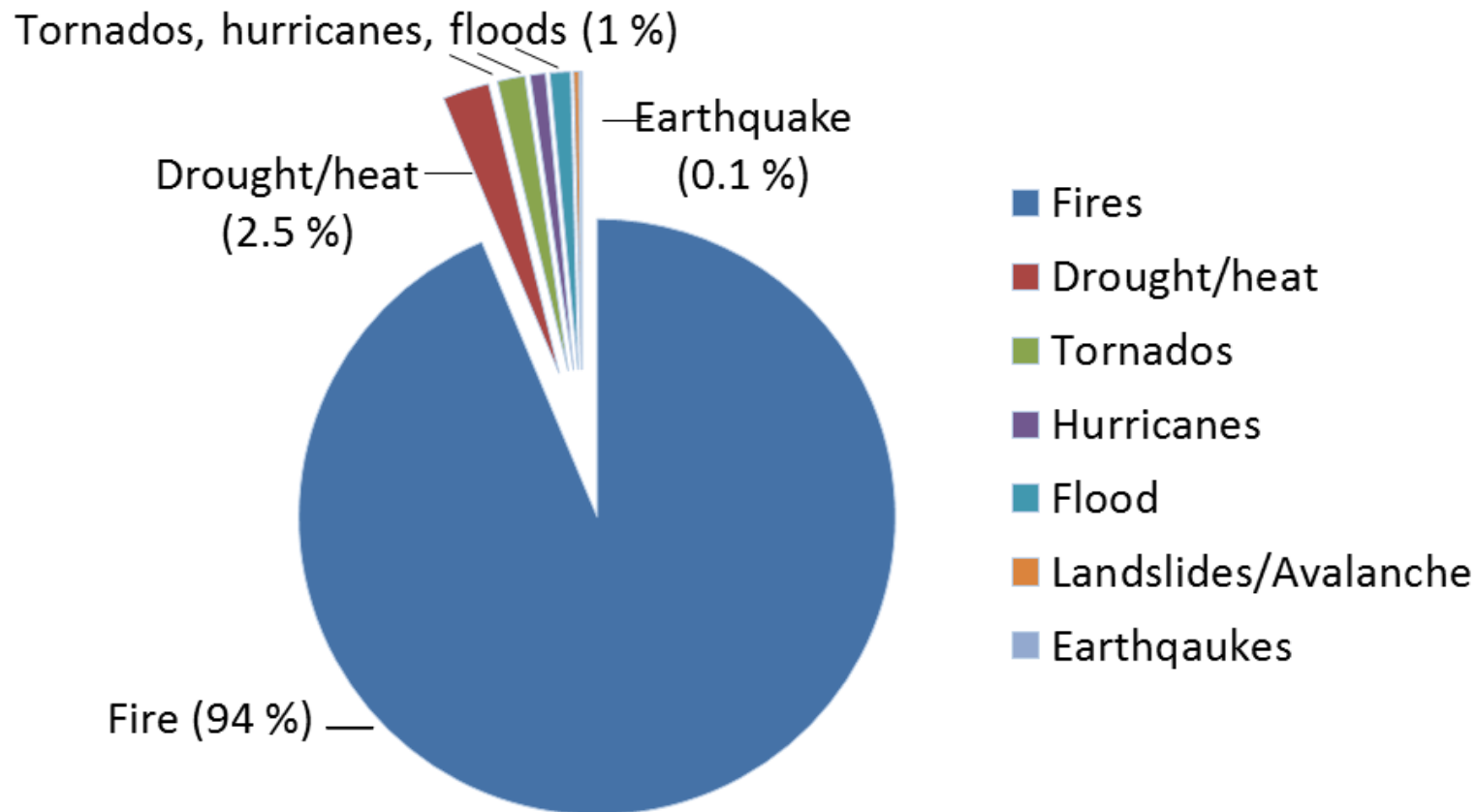
Richard Gann
John Gross
Rik Johnsson
Albert Jones
Greg Linteris
Nathan Marsh
Daniel Madrzykowski
Alexander Maranghides
Samuel Manzello
Randy McDermott
Kevin McGrattan

Kris Overholt
Rick Peacock
Bill Pitts
Kuldeep Prasad
Tony Putorti
Paul Reneke
Randy Shields
Keith Stakes
Craig Weinschenk
Giann Yang
Mauro Zammarano



Hazard Types and Life Safety

6200 Average Annual U.S. Fatalities due to Hazards
(1960 – 2012)

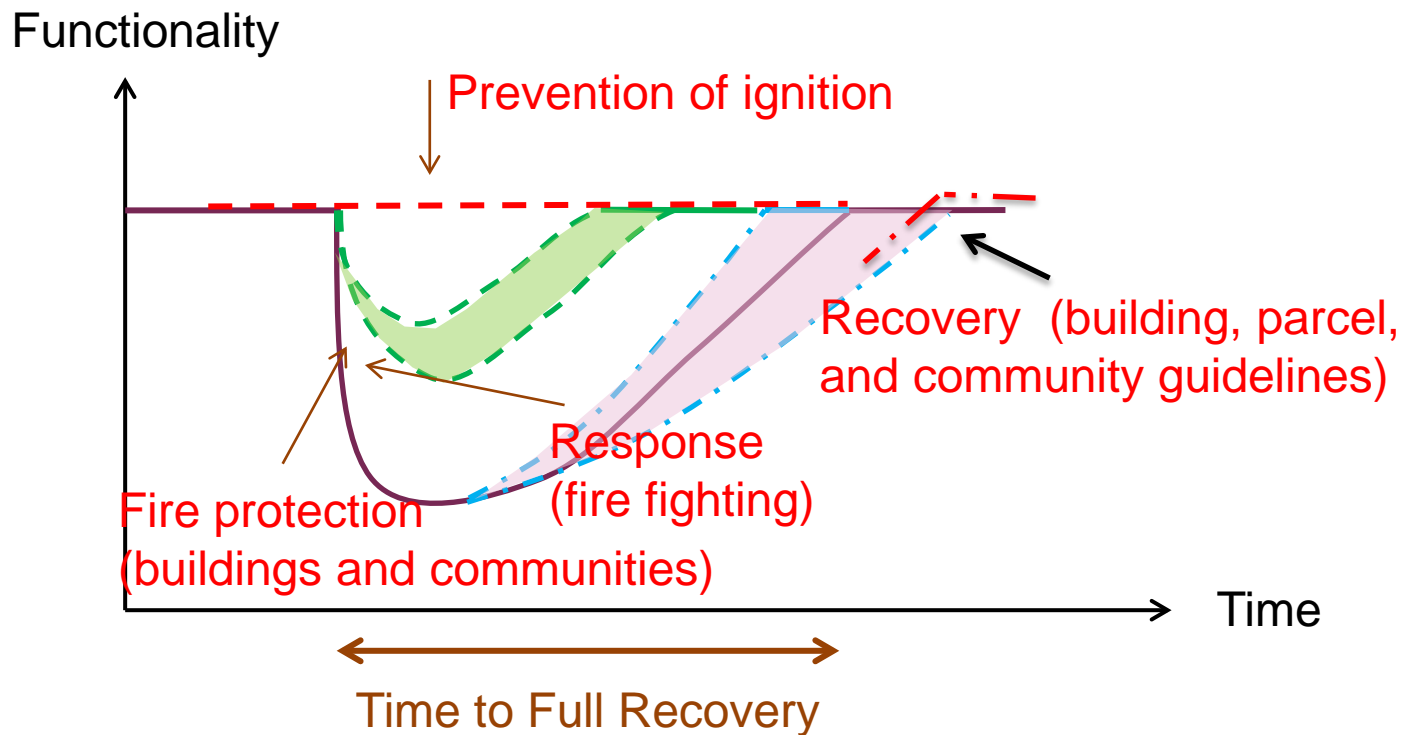


Data sources: NOAA, USGS, Census, NFPA, Met. Life Statistical Bulletin



Resilience

PPD 21 (March 2013): the ability to prepare for and adapt to changing conditions and withstand and recover rapidly from disruptions. Resilience includes the ability to withstand and recover from deliberate attacks, accidents, or naturally occurring threats or incidents.



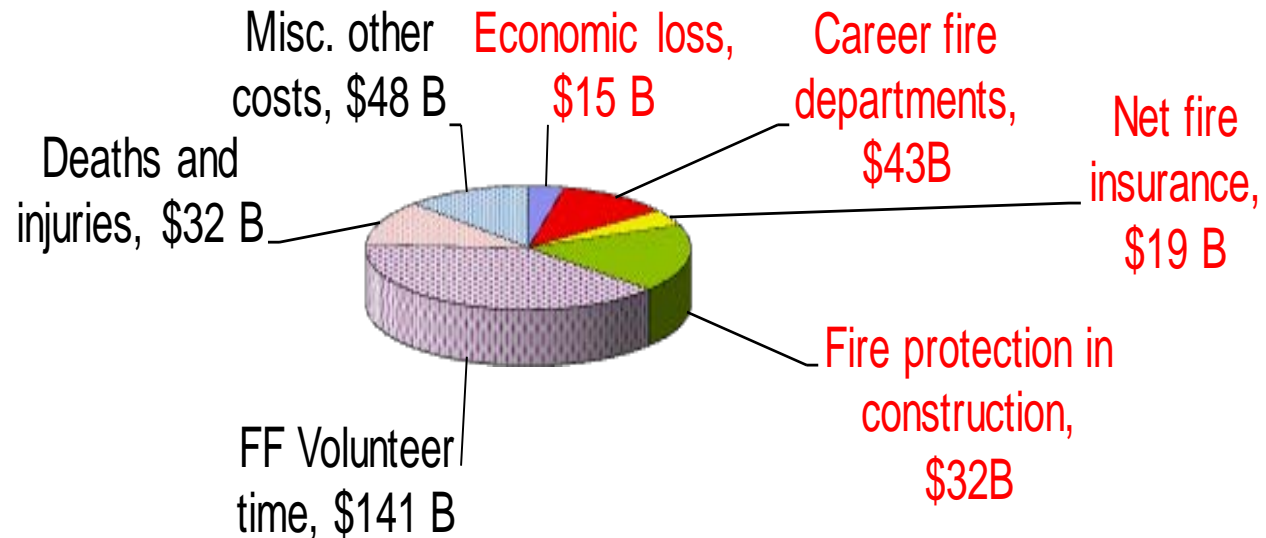
Adapted from McDaniels, 2008 and Bruneau, 2003

What is the U.S. Fire Problem?

3,100 fatalities & 18,000 injuries (2010 civilian losses)

72 fatalities & 72,000 injuries (2010 firefighter line of duty)

2010 U.S. Total Social Cost of Fire : ~ \$330 B ± 100B^{*} (~2 % GDP)^{**}



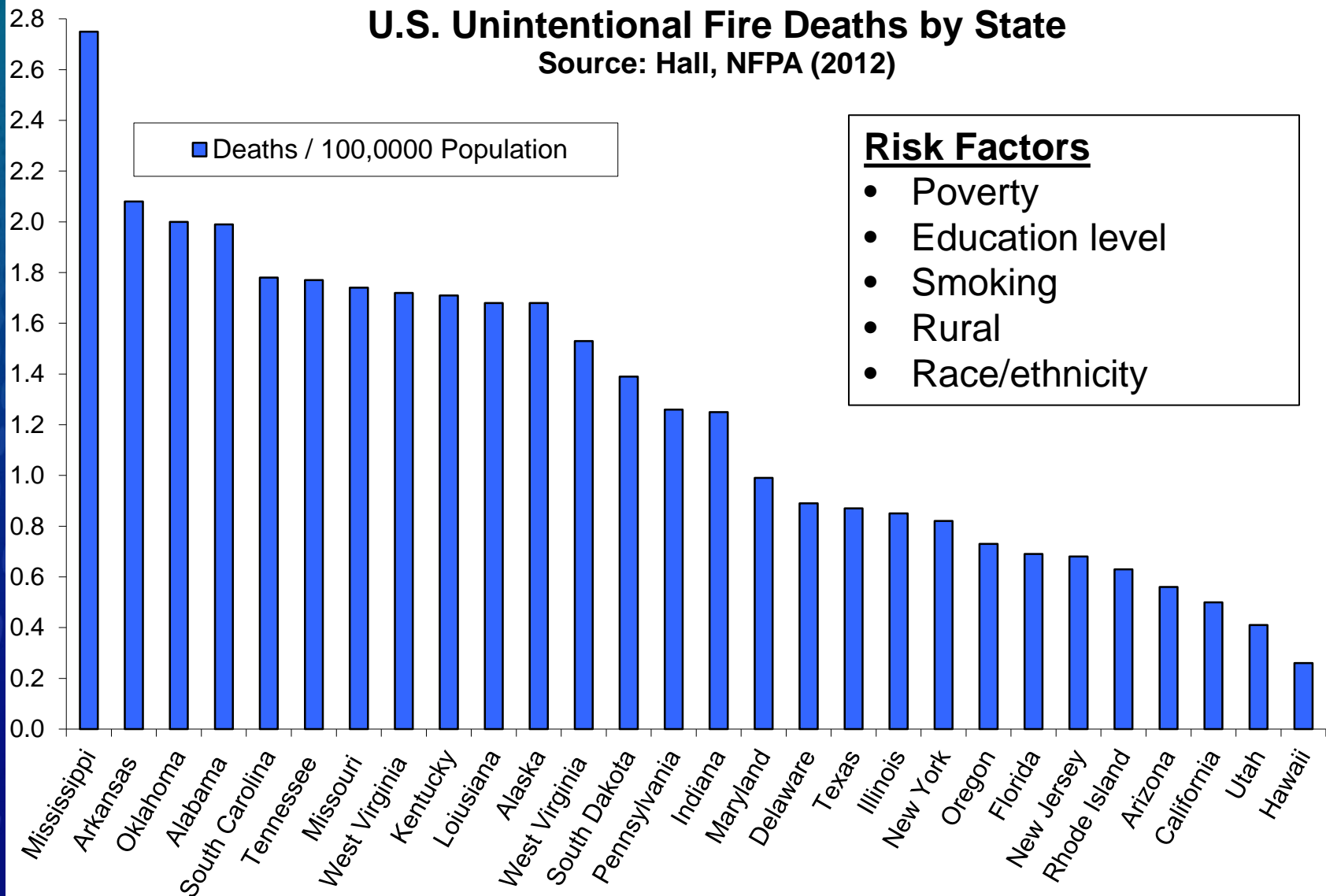
* Hall, J.R., *The Total Cost of Fire in the United States*, NFPA

** NIST Fire Protection Roadmap, 2012

What is the U.S. Fire Problem?

U.S. Unintentional Fire Deaths by State

Source: Hall, NFPA (2012)



Urban Fires - A Long-Standing Global Problem

San Francisco, 1906



Kobe, 1995



- London, 1666
- Kyoto, 1788
- New York, 1835
- Hamburg, 1842
- Newcastle, 1854
- Chicago, 1871
- Boston, 1872
- Baltimore, 1904
- San Francisco, 1906
- Kobe, 1995



2012 Super Storm Sandy: Breezy Point Fires



What is the Problem?

Top 15 U.S. Fire Loss Incidents (source: NFPA)

| <u>Incident</u> | <u>Date</u> | <u>Adjusted loss (2012 dollars)</u> |
|---|-------------|---|
| 1. World Trade Center, New York | 2001 | \$43 billion |
| 2. Earthquake and Fire, San Francisco | 1906 | \$8.9 billion |
| 3. Great Chicago Fire | 1871 | \$3.2 billion |
| 4. Oakland Hills Fire, CA | 1991 | \$2.5 billion |
| 5. So. California Firestorm, San Diego County | 2007 | \$2.0 billion |
| 6. Great Boston Fire, Boston | 1872 | \$1.4 billion |
| 7. Polyolefin Plant, Pasadena, TX | 1989 | \$1.4 billion |
| 8. Cerro Grande Wildland Fire, Los Alamos | 2000 | \$1.3 billion |
| 9. Wildland fire Cedar, Julian, CA | 2003 | \$1.3 billion |
| 10. Baltimore conflagration, Baltimore, MD | 1989 | \$1.3 billion |
| 11. "Old" Wildland Fire, San Bernardino, CA | 2003 | \$1.2 billion |
| 12. Los Angeles Civil Disturbance | 1992 | \$0.9 billion |
| 13. Power Plant, Dearborn, MI | 2000 | \$0.9 billion |
| 14. Southern California Wildfires | 2008 | \$0.9 billion |
| 15. Laguna Beach Wildland Fire, CA | 1993 | \$0.8 billion |

SOUTHERN CALIFORNIA WILDFIRES

as of 10/31/07 - 0600 Hours PDT
with Start Dates - Chronologically



Created by OES - GIS/J. Higgs
 October 31, 2007 Source: FANWEB 2009
 Active_incidet/fires/2007/Statewide/October/
 projects/Statewide_Fires_103107*.pmx



Response to the 2007 Witch Creek Fire, San Diego, CA

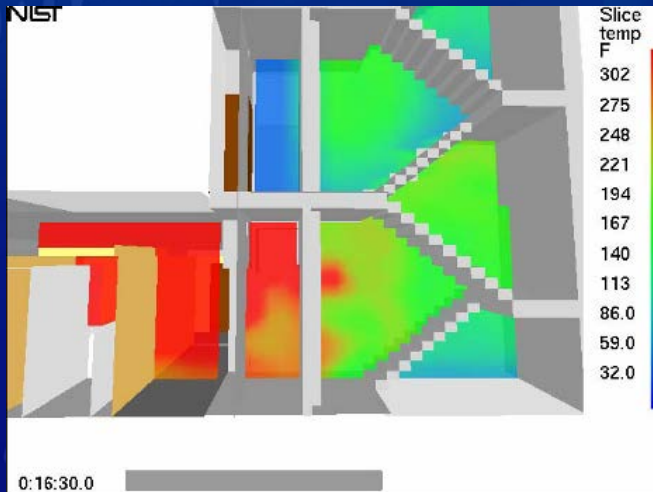
Courtesy of the San Diego Fire Department



Research to Enhance Resilience



Fire Prevention

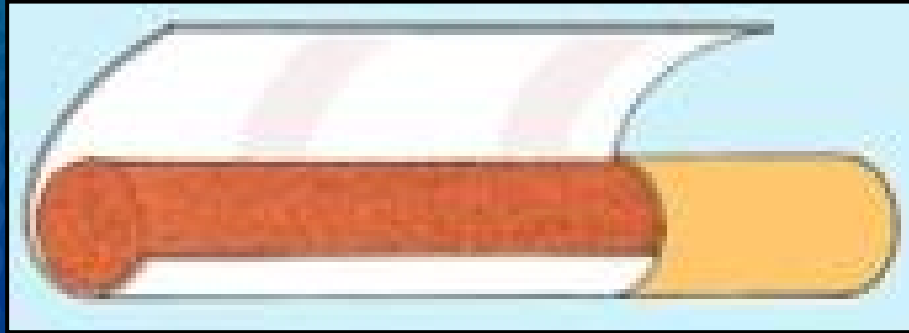


Fire Protection



Fire Response

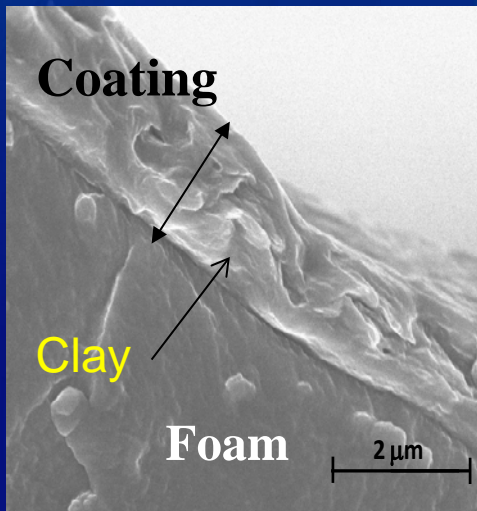
Research to Enhance Resilience: Prevention



Cigarettes



Barrier Materials



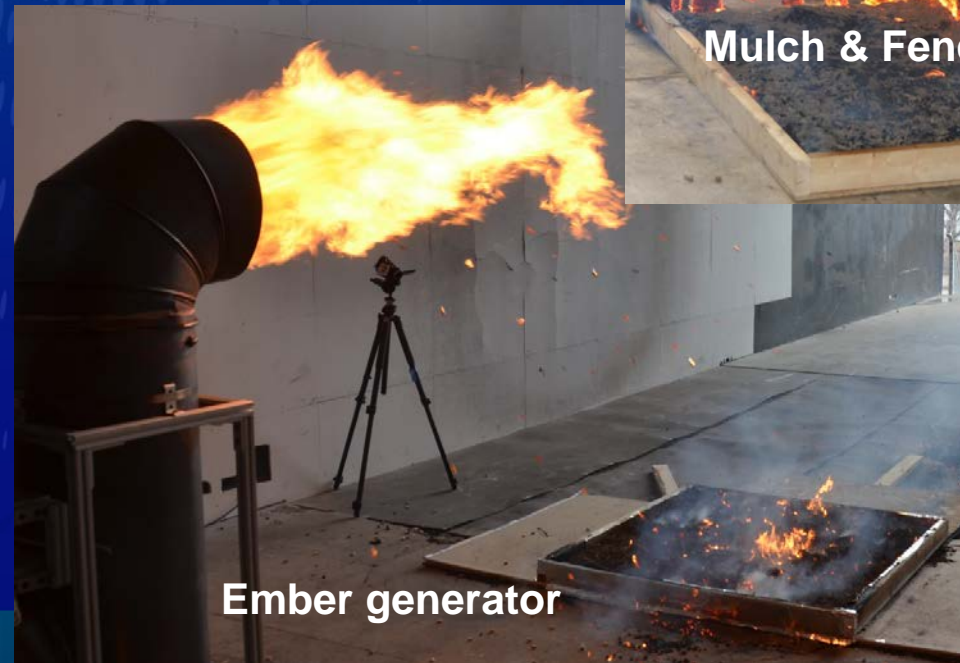
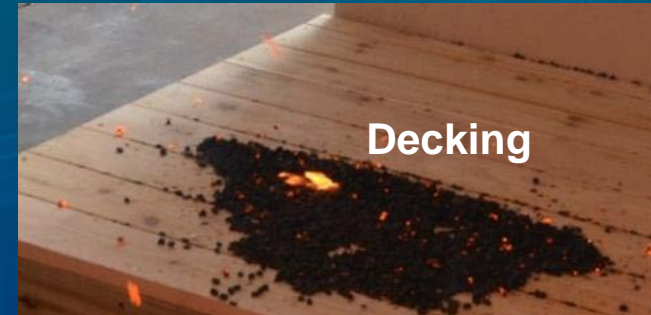
Fire Resistant Coatings



**Fire Resistance
of Building Elements**

Wildland-Urban Interface Fires: Hardening Buildings against Ember Showers

Test methods to evaluate the ignition resistance of building materials, components and assemblies, providing a technical basis for improved WUI building codes & standards



Fire Resistant Coatings to Prevent Furniture Foam Ignition

Untreated Polyurethane Foam

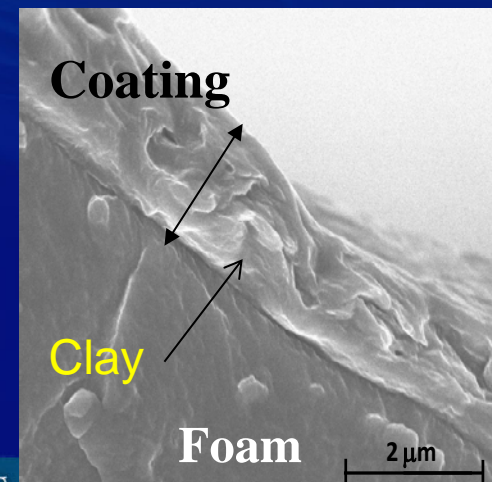


Treated Polyurethane Foam
sodium polyborate - clay additive



Playing at 4X speed

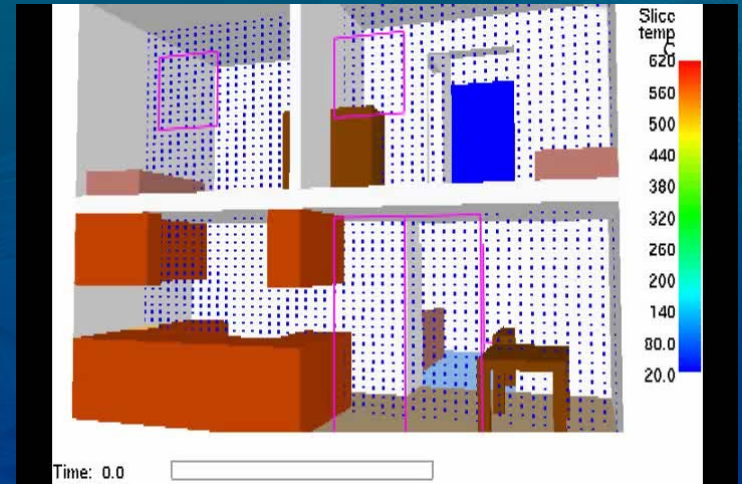
Reducing product flammability using novel processes, technologies, and material additives (Layer by layer coatings, nano-clays, -tubes and -fibers, bio-inspired materials, etc...).



Research to Enhance Resilience: Protection



Evacuation



Fire Models



Smoke Alarms



Structural Fire Resistance



Research to Enhance Resilience: Response



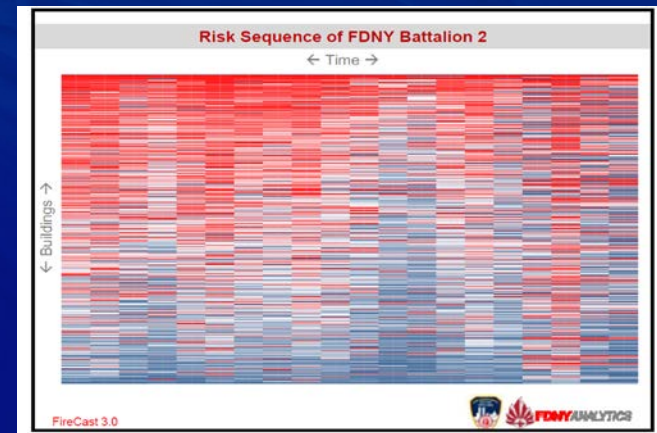
Personal Protective Equipment



Electronic Equipment



Tactics



“Smart” Firefighting



Future Directions: Cyber Physical Systems

Massive
integration of
wireless networks,
robotics, advanced
sensors, 3D
simulations, and
cloud services



Future Directions: Cyber Physical Systems

SMART Cyber-Physical Systems

Infrastructure



Fire
Fighting



War fighting



Production



Healthcare



Buildings
& Structures



Transportation



Future Directions: Cyber Physical Systems

This publication is available free of charge from <http://dx.doi.org/10.6028/NIST.SP.1174>

NIST Special Publication 1174

Smart Firefighting Workshop Summary Report March 24-25, 2014 Arlington, Virginia

Anthony Hamins
Nelson Bryner
Albert Jones
Galen Koepke
Casey Grant
Anand Raghunathan

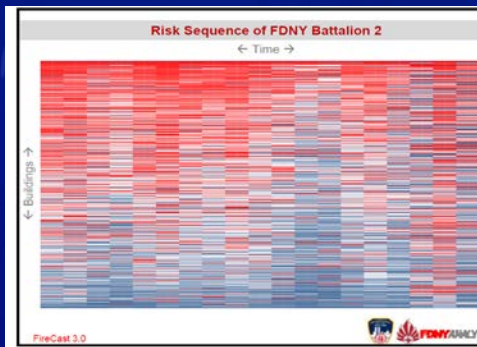
<http://dx.doi.org/10.6028/NIST.SP.1174>



Smartphone Apps



Fully interoperable
laboratory equipment





Big Data analytics

FDNY Building Inspections

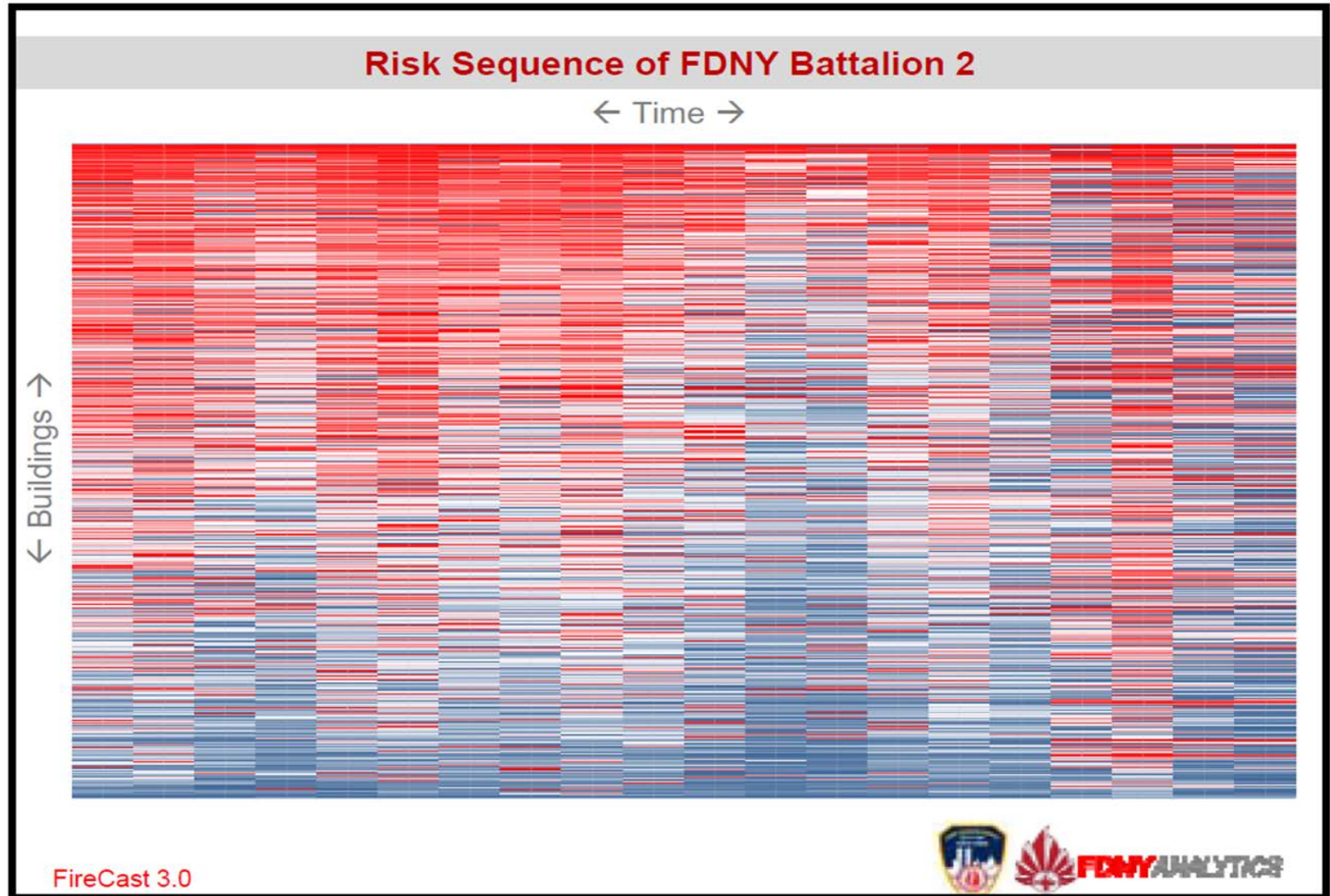
- 330,000 buildings in inspection portfolio
- 10% inspected per year
- 9 hours of inspections/week by each company

FDNY Tech
Pre-March 2013

Overview

  **FDNY ANALYTICS**

FireCast: a data driven predictive risk engine



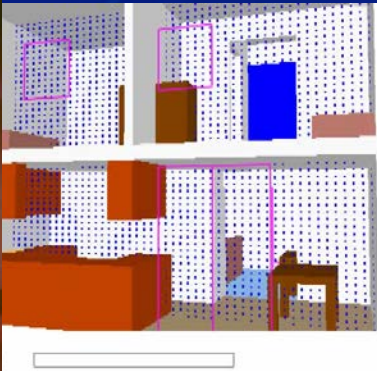
Jeff Chen & Jeff Roth, Analytics Unit, FDNYcv

Summary

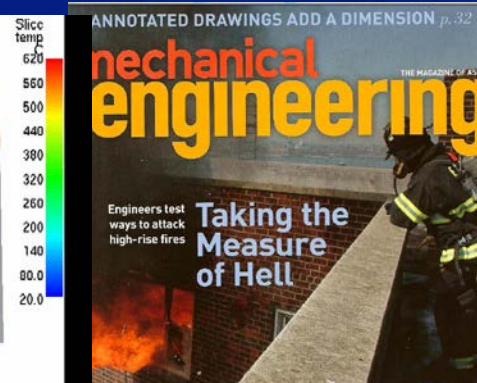
- Fire is a major cause of human & capital losses.
- Research can deliver knowledge and tools to enable fire prevention, protection, and response, enhancing resilience and reducing fire losses and costs.
- Future is linked to engineering innovation, including cyber physical systems, new materials, and technologies.



materials



models



measurements



investigations



standards