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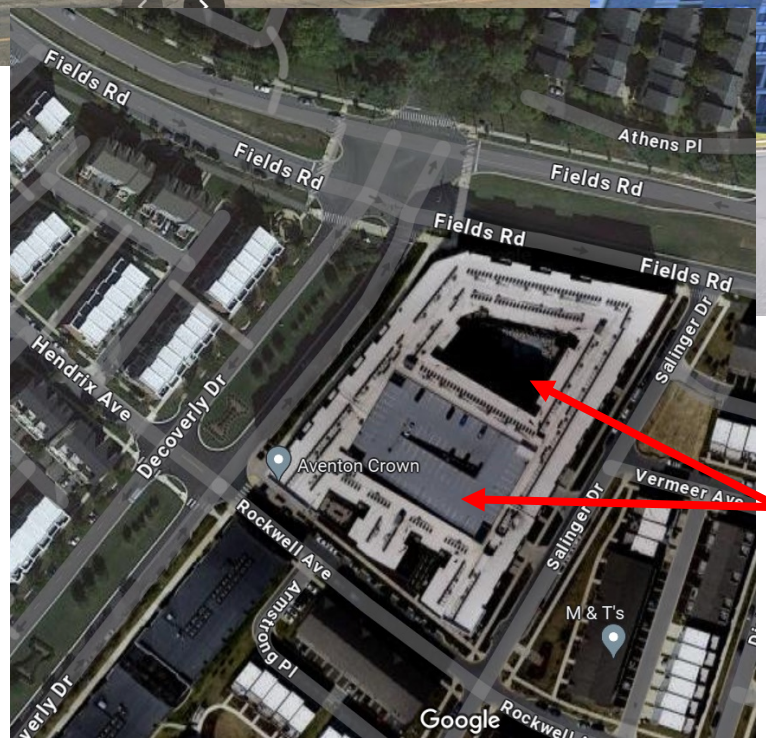
Structure Fire & Response: Fire Dynamics

Daniel Madrzykowski, Ph.D., PE

“Change is the only constant in life”

Heraclitus, 535 – 475bce



No access for Fire Ladder Truck

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New Materials and Construction Methods = Faster Fire Growth


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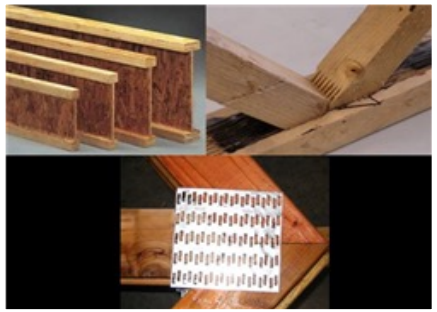
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- Faster fire propagation
- Shorter time to flashover
- Rapid changes in fire dynamics
- Shorter escape times
- Shorter time to collapse
- Increased exposure problems
- Emerging hazards

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Lightweight engineered wood I-joist supported floors can collapse after less than 5 minutes of burning.

Floor Support Type	Ventilation Description	Time from ignition of the fuel load to collapse	Time from ignition of floor assembly due to fire spread to collapse
Nominal Dimension 2 x 12	On-plane vent open at ignition	11:09	7:11
Nominal Dimension 2 x 12	On-plane vent open at 8:30 after ignition	12:45	10:45
Lightweight Engineered Wood I-Joist	On-plane vent open at ignition	6:00	2:45
Lightweight Engineered Wood I-Joist	No vent	6:49	4:06
Lightweight Engineered Wood I-Joist	No Vent	8:27	4:42
Lightweight Engineered Wood I-Joist	On-plane vent open at ignition	6:49	2:29

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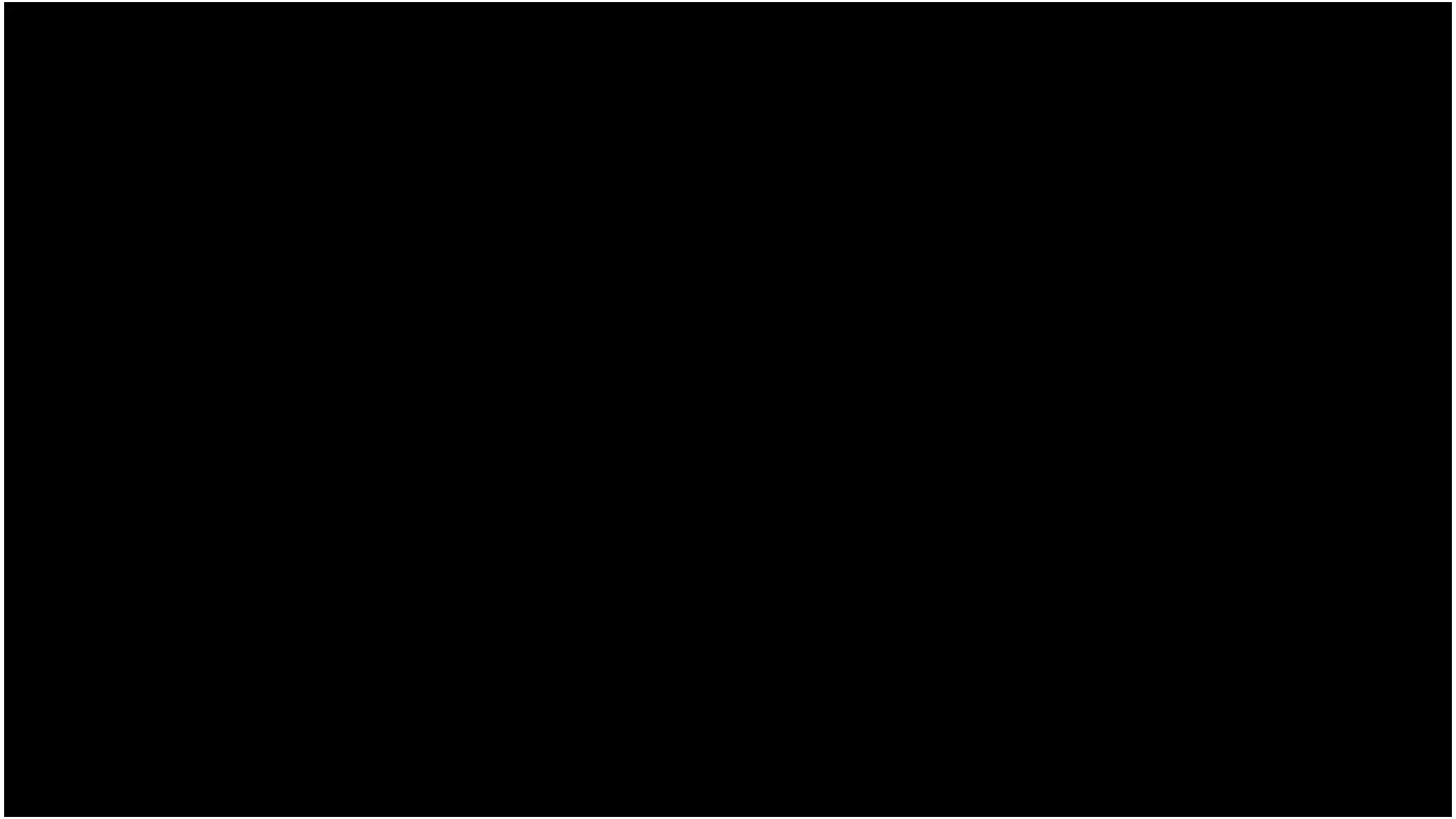

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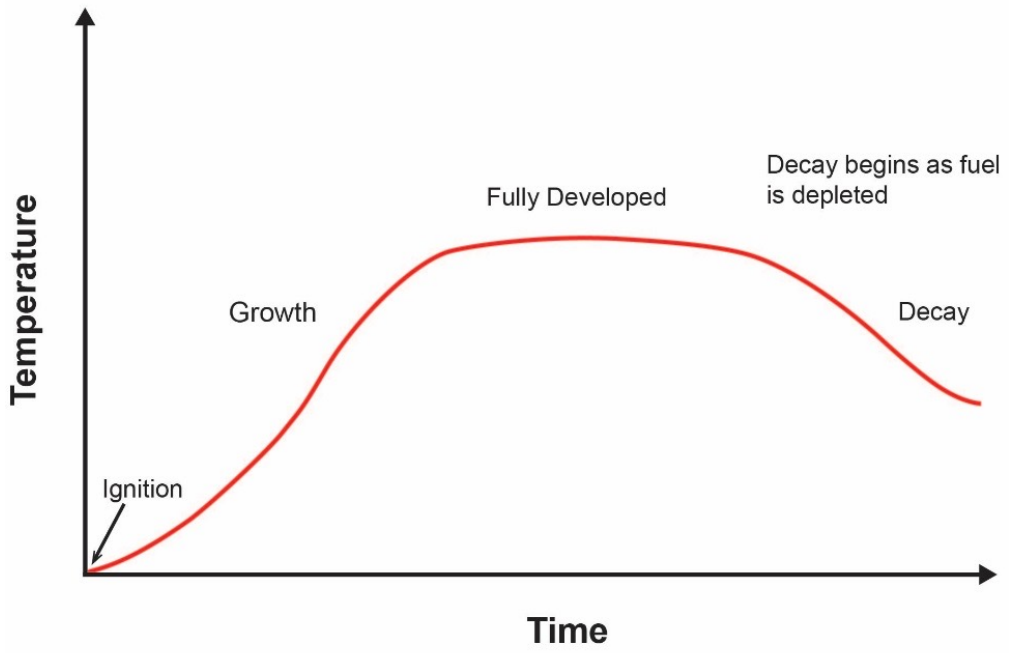
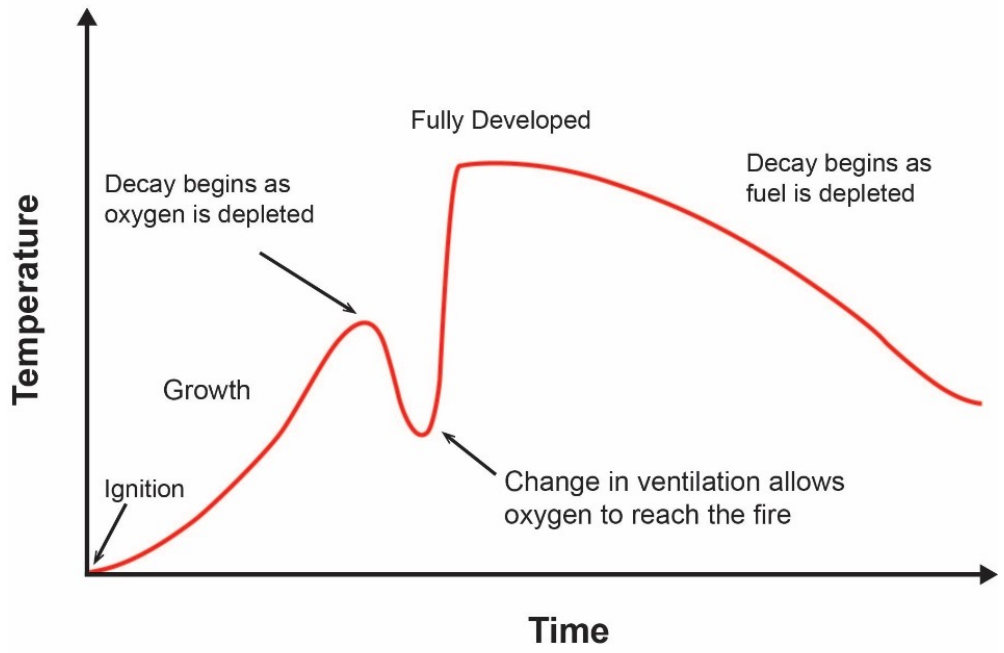
Recognition of ventilation limited fires

Fuel Limited Fire



Ventilation Limited Fire



Providing oxygen to a ventilation limited fire

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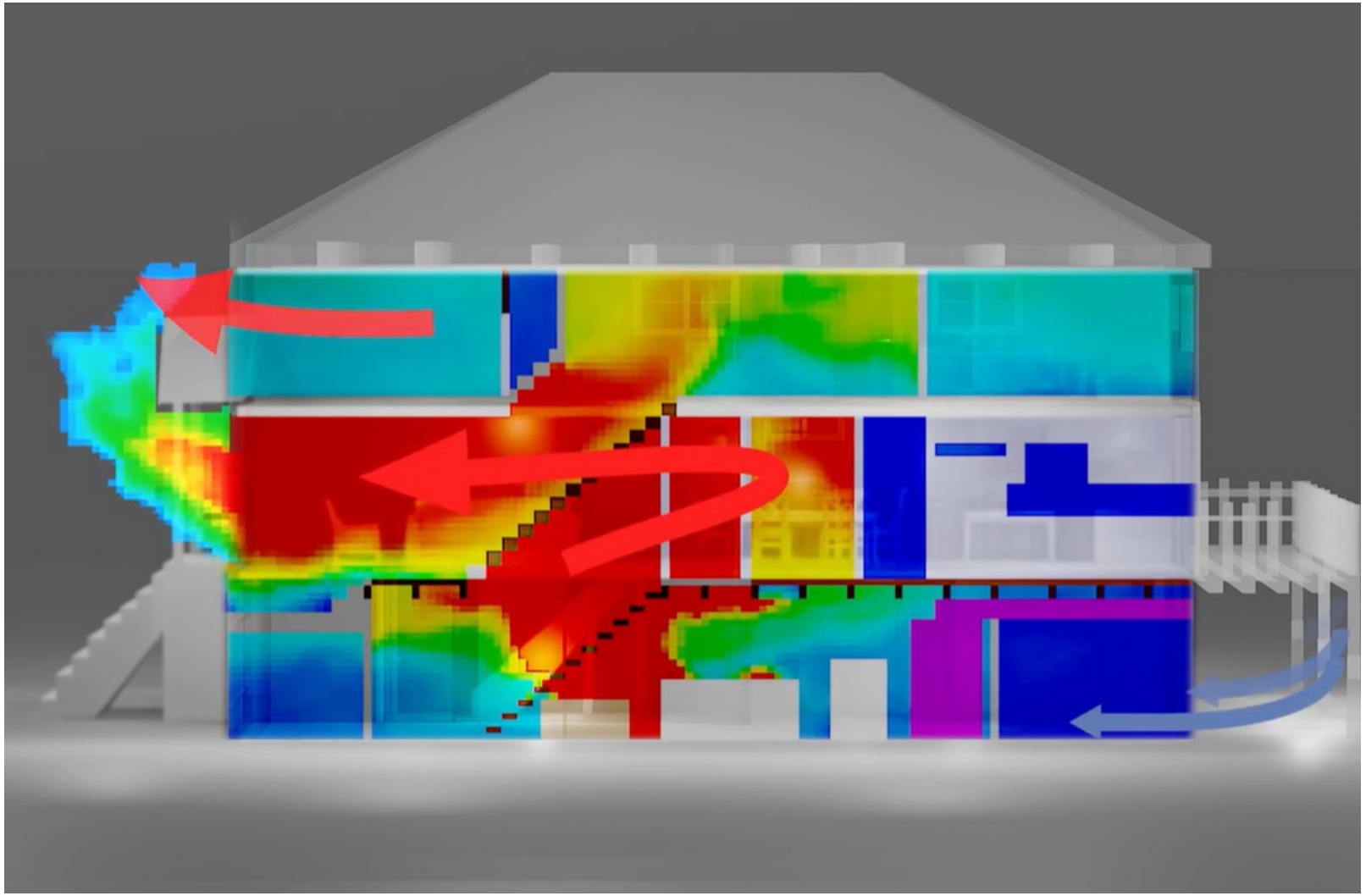
Understanding the flow path in a building is key to an effective fire attack.



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Improved understanding of suppression tactics: gas contraction due to cooling

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Hose Stream Mechanics

- Water distribution in compartments
- Air entrainment due to stream type & nozzle motion
- Water impact on fire flow & fuel surfaces

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Fire Dynamics Knowledge & Hose Stream Mechanics = Effective Suppression

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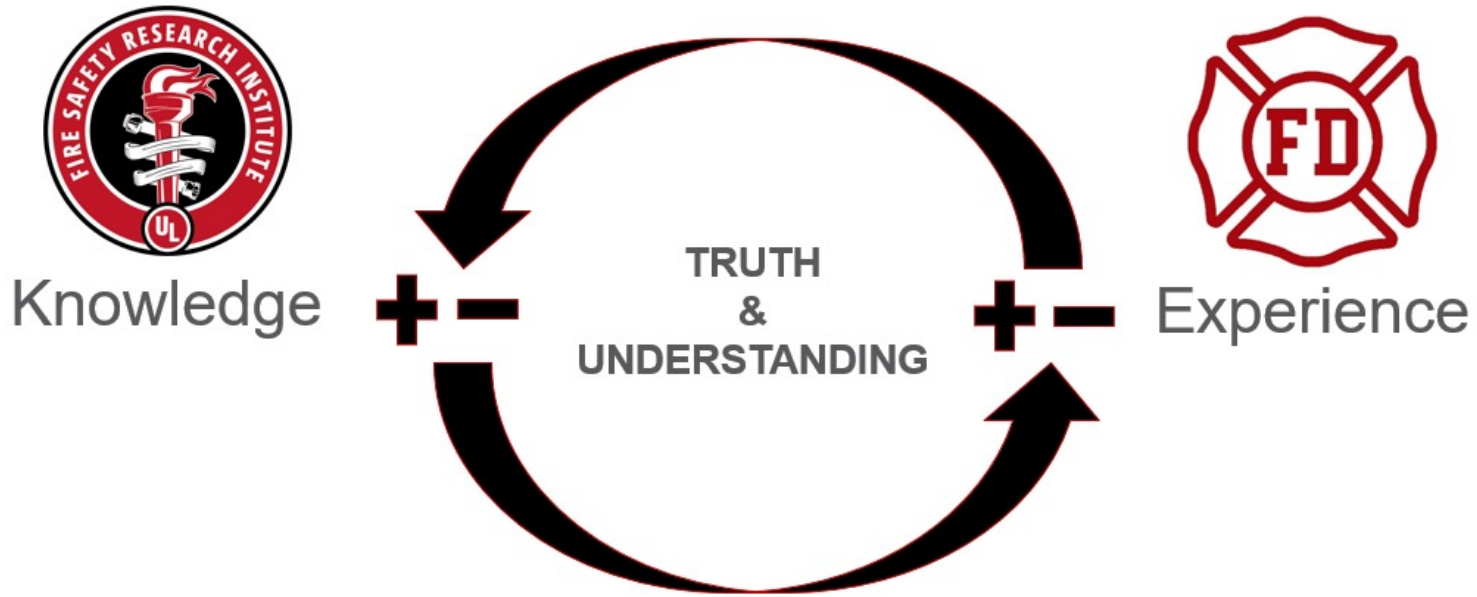
1 ¾” (45mm) Handline: 185 Gal (700 liters)

Good decisions require:

- Good information (data) from a trusted source
- Knowledge & Experience to interpret the data
- Knowledge & Experience to account for the context (the system)



Decisions on Firefighting Strategy and Tactics

- Size up is the basis of the Incident Action Plan (DATA)
- Impact of ventilation on a vent-limited fire = Increased Growth (HRR) (KNOWLEDGE & EXPERIENCE)
- Existing Flow Paths (DATA)
- Potential Flow Paths (KNOWLEDGE & EXPERIENCE)
- Fire dynamics (KNOWLEDGE) needed to understand observations (DATA)

High Energy Materials, New Construction Methods and Bigger Buildings mean that

- More fixed fire protection systems are needed
- More firefighting resources needed
- Less time to make decisions

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Fire as a Global Threat: Human Factors and Consequences

Dr. Sabrina Cohen-Hatton

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NFCC Improvement Lead
Hon Research Fellow, Cardiff University

Mark Hardingham QFSM

Chair, National Fire Chiefs Council

Fire as a global threat:

Human Error

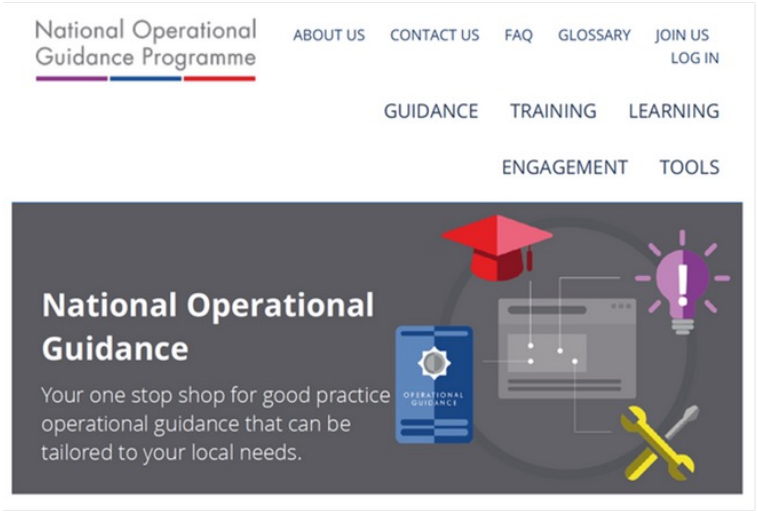
80% of firefighters are injured from human error.

How Decisions Were Made

80%
Intuitive

20%
Analytical

Decision Control Process



JESIP

Working Together – Saving Lives

bbsrc
biotechnology and biological sciences research council

AMERICAN PSYCHOLOGICAL ASSOCIATION

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Fire as a Global Threat: Multi-Agency Working

Assessment, Planning and Execution

Little consideration of powers, policies, options or contingencies

Explorers and Exploiters

Some repeatedly search for information, seeking optimal option. Others take a bet to make a decision quickly, not optimally.

Pivotal Role of Chair

More understanding about nuances of individual decision making and impact on the group to avoid decision traps.

Decision Controls for Group Decision Making

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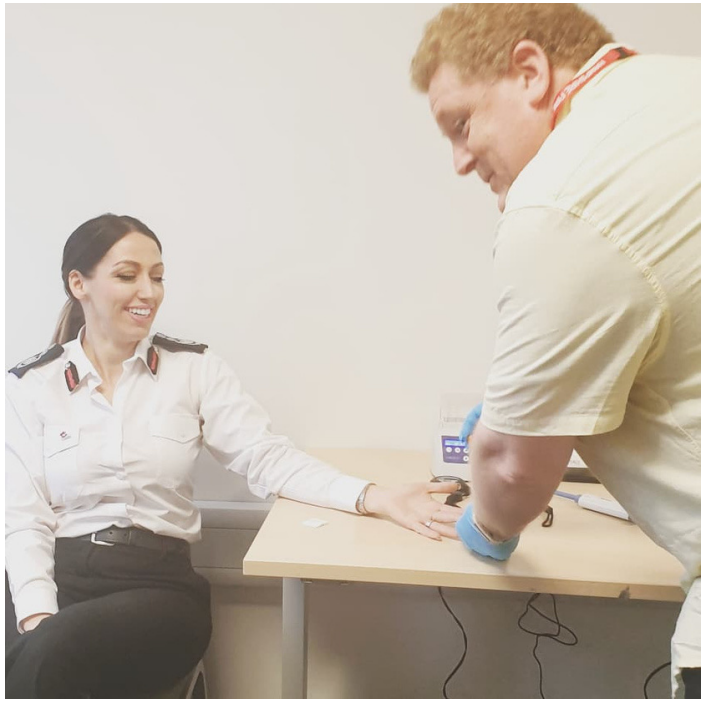
Decision Controls

A) WHY ARE WE DOING THIS?	What goals are linked to this decision? What is the rationale, and is that jointly agreed? Does it support working together, saving lives and reducing harm?
B) WHAT DO WE THINK WILL HAPPEN?	What is the likely outcome of the action; in particular what is the impact on the objective and other activities? How will the incident change as a result of these actions, what outcomes do we expect?
C) IN LIGHT OF THESE CONSIDERATIONS, IS THE BENEFIT PROPORTIONAL TO THE RISK?	Do the benefits of proposed actions justify the risks that would be accepted?
D) DO WE HAVE A COMMON UNDERSTANDING AND POSITION ON:	The situation, its likely consequences and potential outcomes? The available information, critical uncertainties and key assumptions? Terminology and measures being used by all those involved in the response? Individual agency working practices related to a joint response? Conclusions drawn and communications made?
E) AS AN INDIVIDUAL:	Is the collective decision in line with my professional judgement and experience? Have we (as individuals and as a team) reviewed the decision with critical rigour? Are we (as individuals and as a team) content that this decision is the best practicable solution?

Fire as a global threat: Paradoxical effects of decision making under uncertainty



Uncertainty

Emergencies are by their nature extreme. Information can be limited and uncertainty high.

Impact of stress

Stress reduces processing capacity and limits that available for processing information and making decisions.

The paradox

Uncertainty increased stress, which increased tendency to rely on rules. Even when no rules were appropriate because the situation was so novel.

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Decision Traps

Situational Awareness

Decision Inertia

Paralysis by analysis sees decisions either not made (decision omission) or deferred (choice deferral).

Wicked Problems

Problems exist that are incomplete, are in flux, and have no right answer. Some require you to find the least worst option.

Confirmation Bias

Seeing the truth that you want rather than finding the truth that is there.

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