What Research Tells Us About the Modern Fireground

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Since the inception of the American fire service, firefighters throughout the country have relied on personal experience and the experience of their predecessors to guide their strategy and tactics. To the credit of many, these tactics have proven successful in controlling and mitigating the hazards of fire for more than 250 years. Yet today, firefighters from all areas of the country are being challenged by different fireground hazards—and as a result, many of these "proven" tactics are now in question.

Over the last three years, the research team at UL (guided by fire service professionals throughout the country) has conducted a series of full-scale tests to "demystify" the modern fireground. In short, they've designed tests to replicate modern fire conditions and evaluate the success or failures of our chosen tactics.

To the surprise of many, much of what we thought we knew has been proven wrong. In fact, many of the tactics that we've passed on from generation to generation are in desperate need of change. As one might imagine, the quest to change some of these longstanding tactics and personal beliefs has not come easy.

In this article, we take a look at several scenarios that illustrate changing fireground conditions, and discuss possible related changes in tactics.

Soften the Target

You're the first-arriving company officer at a working fire in a single-story residence. A quick 360-degree size-up confirms heavy fire involvement in the front portion of the house with visible flames showing from the front door and two windows on the A side. It's unknown whether there are occupants still inside. What would you do?

The tactical priorities that most firefighters have been taught are: rescue, exposure, confinement, extinguishment, overhaul—ventilation, salvage, known to most as Lloyd Layman's Tactical Priorities, or "RECEO-VS." We're also taught that the most effective way to control a fire is to attack it from the unburned side—always attempting to get a line between the victim and the fire—and drive it or "push" it out of the structure.

Research shows that a much different approach is likely in order.

Applying water to the fire as quickly as possible—regardless of where it is emitting from—can make conditions in the entire structure better. During the UL experiments, water was applied for approximately 15 seconds into a door or window with fire coming from it or with access to the fire from the exterior. This small amount of water had a positive impact on conditions within the structure, increasing the potential for victim survivability and firefighter safety. This included stopping water flow for 60 seconds while conditions were monitored. If a firefighter crew moved in and continued to suppress fire, the conditions would have improved even faster.

What does this mean for us at actual fire incidents? During size-up, firefighter crews should assess the fastest and safest way to apply water to the fire. This could be by applying through a window, through a door, from the exterior or from the interior. Using a ranch house as an example, the first line can be placed in many locations based on the location of the fire, information determined during the size-up, staffing and many other considerations.

If getting water on the fire is a top priority, the discussion about tactics is narrowed. Let's look at four examples. In each one, we'll assume that the hoseline approaches from side A or the bottom of each figure; this is a one-story structure.

- *Example 1:* Fire showing from the front door. In this scenario we could apply water through the front door. Although this isn't fighting the fire from the unburned to the burned sides, it will make conditions better faster for victims and firefighters alike.
- *Example 2:* Fire showing from the living room window. In this scenario, we could apply water through the front window before entering the doorway. Although the front door and living room are attached in this floor plan, we likely wouldn't know that upon arrival. The front door may not necessarily access this room or there could be an entranceway that would require the crew to make it down a hallway to get to the fire, placing the crew in the flow path once they open the door.
- *Example 3*: Fire showing from a bedroom on side A. In this scenario, we could apply water through the bedroom window. This can be done faster and have a faster impact on the fire than would navigating the interior of the home, regardless of interior layout or conditions.
- *Example 4:* Smoke showing from the front door and fire showing from a kitchen window on side C. In this scenario, if water can be applied faster from the front door or interior, that may be the better choice than stretching the hoseline to the back of the house. If the fire cannot be seen through the open front door and the path to the fire is unknown, then the better choice may be to stretch to the back and put water on the fire through the window, where we know it will reach the seat of the fire.

All of the above examples illustrate the concept of "softening the target." And this concept applies in two-story structures as well. If you've spent any time at all watching fire videos, you've probably seen a first-arriving company pull up to a working fire in a two-story structure with fire showing from a window on the second floor. The fire appears to be a room-and-contents fire upon arrival, but grows exponentially as the crew prepares for their initial attack. Why? Because we've always been taught to never attack a fire from the outside when there are potential victims inside. An offensive attack must be initiated by deploying handlines inside directly to the seat of the fire—right?

UL experiments in a two-story house call that belief into question. Fire is showing from the second floor of side A (examples 5 and 6). Traditional tactics call for the hoseline to be charged in the front of the house prior to entry but water is usually not flowed onto the fire prior to entry. Even if the interior path to the fire is known, flowing water directly onto the fire is faster from the outside than it is from the inside. A common reason why this is not done is because the conditions beyond the fire would be made worse. In this experiment, temperatures were measured in the hallway just outside the room and in the other bedrooms on the second floor. Twenty-five gallons of water directed off of the ceiling of the fire room from the exterior decreased fire room temperatures from 1,792 degrees F to 632 degrees F in 10 seconds; the hallway temperature decreased from 273 degrees F to 104 degrees F in 10 seconds.

You Can't Push Fire

Talk to any firefighter/fire officer with a day or more of experience and they'll likely share with you a story about how someone (typically from the outside) pushed fire on them or at them. Truth be told, fire streams don't push fire, they simply change the flow paths (directional air flow), thus giving us the perception that the nozzle is "pushing the fire."

Another tactic that commonly surfaces when discussing pushing fire: hydraulic ventilation using a fire stream. If nozzles don't push fire, then how does hydraulic ventilation work? It's all about the flow path.

You cannot push fire with water. A previous UL study included the concept of pushing fire in the data analysis; it subsequently generated a lot of discussion. In many of the specific fires discussed in this and other studies, in the study, the firefighters were inside the structure and in the flow path opposite the hoseline. In most cases the event being described occurred while fire attack crews were advancing on the inside and not applying water from the outside into a fully developed fire.

All of the UL experiments were designed to examine the operations and the impact of the initial-arriving fire service units, so we did not, do not and will not suggest that firefighters should be positioned in a flow path opposite the hoseline. However, there are times when this may happen, so the experience of these firefighters should not be discounted. We also did not simulate water being applied from inside the structure by an advancing hoseline, even though we understand this happens on most fires.

So why do so many firefighters have an experience where it seems like the fire is "pushed" onto them or someone else? We identified four events that could have created the appearance of pushing fire.

1. Flow path is changed with ventilation, not water application.

When the firefighters are opposite the hoseline, in many cases they entered from a different point than the hoseline and left the door or window open behind them. This flow path is entraining air low, where the firefighters are crawling, and hot gases are exiting over their heads. As the fire reacts to the added air, the burning moving over their heads increases, and conditions could deteriorate quickly. If an attack crew is preparing to move in or is inside, it's easy to see how they might blame the effect on the hoseline. However, the fire was just responding to the air and the added flow path, not water flow. Often this occurs close to the time water is applied, and without coordination (Example 7).

2. A flow path is changed with water.
Opening a wide fog stream changes the flow path or plugs a flow path by entraining air; this can also be accomplished with a straight or smooth-bore stream when whipped in a circular pattern. This can disrupt the thermal layer and move steam ahead of the line—which is why firefighters do it during an interior attack with a ventilation point opposite the attack. If a firefighter is downstream for whatever reason, they're going to get the impression of pushing fire or of elevated heat, especially if they are in the cool inflow of another vent location.

It's important to understand that there's a right way (like most tactics) to apply an exterior stream if you want to minimize steam movement throughout the structure: Apply a straight or smooth-bore stream at an exaggerated angle off of the ceiling so that the outlet (window or door) can continue to be a low pressure for steam to flow out of. If you plug that low pressure with a fog stream or rapidly circulated straight stream, the steam will go somewhere and if there is a flow path, it will move into the structure, which should be avoided.

3. Turnout gear becomes saturated with energy and heat passes through to the firefighter.
It's important for firefighters to know how their gear protects them. Gear absorbs energy to keep it from getting to the firefighter inside. When the gear absorbs as much as it can, any additional energy can pass through to the low temperature firefighter inside the ensemble. In some cases firefighters inside a structure have been absorbing energy for some time and when a hoseline is opened at the same time, it may seem that the hoseline caused a rapid heat build-up, when in fact it could be that their gear was saturated and heat began to pass through.

4) One room is extinguished, which allows air to entrain into another room.
Certain types of buildings have a layout where rooms are attached to rooms in a linear fashion. These are commonly referred to as "railroad" or "shot gun" layouts. In these types of structures it is possible for multiple rooms to be on fire; one room gets suppressed and the ventilation-limited room behind it now has access to oxygen, causing it to ignite or increase in burning. Usually the hoseline cools several of these rooms but there may be a case where doorways are offset and water does not make it to the second room.

In Big Volume Spaces, Apply Water to What's Burning
The aggressive nature of firefighters, coupled with a fully encapsulating protective ensemble, oftentimes promotes the advancement into places and conditions where we should not be. The longstanding argument for our deep penetration into these environments has always been to support a "direct attack" on the seat of the fire. With highly compartmentalized structures of years past, this approach was often logical. But today, many modern homes are designed with large, open floor plans that allow for a much different form of direct attack.

In larger volume spaces, such as the family room/great room in the two-story house, it's important to put water on what is burning. In modern, open floor plans and great rooms, there's a very large volume, so water application is not the same as a legacy home with smaller rooms and eight-foot ceilings. Much of the water applied to a flashover condition in a small room will be applied to a burning surface and the gases will be cooled as the water is converted to steam. In modern floor plans, a stream of water can end up several rooms away from the room that has flashed over. To have the biggest impact, water should be directed onto burning objects if possible.

The same open floor plan that can allow water to flow beyond the fire room can allow for suppression of a fire that is several rooms away. In open floor plan houses, the reach of a hose stream can be beneficial in ways it can't be in an older, divided home. In the two-story floor plan, water can be applied into any room from more than 20 feet away with some open lines of sight longer than 35 feet. This allows the fire to be knocked down from a safer distance without needing to be in the room or right next to the room to begin suppression. In addition, every bedroom on the second floor could have water flowed into it from the first floor before proceeding up the stairs.

In another UL experiment, two rooms (kitchen and family room) were involved in fire when water was applied. As flames were venting from the family room window, water was intentionally directed toward the kitchen fire for 15 seconds. While this slightly cooled the kitchen area, the family room fire was still fully developed, maintaining high temperatures in the remainder of the house. Once the stream was directed into the family room, the temperatures in the whole house cooled significantly.

Needed: Open Minds

Today, we're armed and equipped with something previous generations were not—empirical research, facts and statistical data that validate the strategy and tactics we deploy. The question: Will we allow our longstanding traditions and beliefs (some of which have proven to be mythical in nature) overshadow the overwhelming evidence that demands that we change the way we approach the modern fireground?

As leaders of the American fire service, we're responsible for conducting safe and effective operations in an effort to save lives and protect property. To do this, we must remain open-minded and constantly evaluate the many factors that make up the environment we operate within, as well as the strategy and tactics we deploy. We can't get hung up on terminology. Regardless of what you call an attack that starts on the outside of a structure, (transitional attack, exterior offensive attack, softening the target, blitz attack, quick water, hitting it hard from the yard, etc.), what matters is the direction you're moving in—if you're moving forward, you're deploying an offensive fire attack.

Aggressive tactics cannot and should not be based on a one-dimensional approach to fire attack—deployment of handlines inside a structure. Nor should research be labeled as an "outsider's approach" to "pacifying" the American fire service. We work in a much different environment than those who have come before us and we've been provided an opportunity to do what we've always done in a safer, more effective way. Yet the question remains: Are we willing to support the facts and make the change?