Course Learning Outcomes for Unit VIII

Upon completion of this unit, students should be able to:

4. Describe and apply the process of burning.
   4.1. Analyze the value in using computational modeling of fires.
   4.2. Compare and contrast deterministic and a probabilistic fire models.
   4.3. Define the limitations of computer fire models.

Reading Assignment

Chapter 14:
Computational Modeling of Fires

Unit Lesson

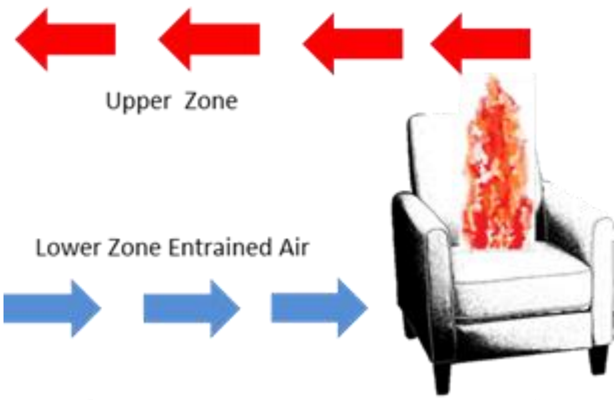
According to Firetactics (2014) the, "transition in replacing hard earned fire-ground experience with advanced training [has] failed to take place" (Firefighter life losses on the increase, para. 2). The authors surmised that with the number of building fires decreasing, "we now have a situation where the death rate amongst firefighters (traumatic life losses versus the number of building fires) is spiraling to the highest levels for thirty years" (Firefighter life losses on the increase, para. 2). Why is this occurring? Is it the lack of experience as suggested? Is it the lack of training? Is it the lack of knowledge of fire behavior and combustion? Is it false nostalgia for fire-ground experience? For decades in the fire service we have used experience as a guide on how to fight fires. Decades ago Crosby, Fiske, Forster Handbook of Fire Protection (1936) states:

> Experience has shown that heavy streams in large numbers are essential to controlling a conflagration. Ordinary streams from hand lines are not only ineffective on a large body of fire, but it is frequently impossible for men to get near enough to use them effectively due to the great heat. (pp. 991-992)

Fire ground experience is important and decades ago that was the only way to learn fire behavior and combustion. Today, computational modeling of fires can be used for the, "assessment of fire hazards and risks…using a series of calculations or a computational model of a fire in a building" (Gann & Friedman, 2015, p. 208) to teach firefighters fire behavior and combustion. In fact, computational modeling of fire could be used to understand why ordinary streams from hand lines are ineffective as seen in 1936. Computational modeling of fire is used today to understand and see what went wrong in fatal fires. The modeling "begins with the local movement within the fire plume and progresses to movement throughout a building" (Gann & Friedman, 2015, p. 213).

Computational modeling of a fatal training fire was used by NIST (2002) to determine the cause of flashover. The incident was a live fire training exercise in an acquired structure that was conducted partially in compliance with the requirements of NFPA 1403. As a result, two firefighters lost their lives because officers and firefighters on the scene did not sufficiently assess fire behavior and combustion of the burning characteristics and the quantities of material used (NIOSH, 2003). The incident occurred on July 30, 2002 where a lieutenant and firefighter died while participating in live fire training. "Fuel for the fire consisted of pallets and straw placed in and outside of a closet in the bedroom. The fuel was ignited with a road flare" (USFA, 2014, para. 4). Due to weather conditions the fire was decaying and a "foam mattress was placed on top of the burning pallets and straw" (USFA, 2014, para. 4). The firefighters made entry into the fire compartment performing primary search and rescue in front of two attack lines. Horizontal ventilation was called for and many believed it induced a flashover while the search team was in the fire compartment. As a result NIST (2002) conducted retrospective computer modeling to reconstruct the actual fire. The results indicated the foam rubber mattress used on the fire emitted large amounts of carbons and fire gases that lead to the flashover because the fuel load was more than the amount required to create the desired fire effects.

Gann and Friedman (2015) supposed there are two types of computational modeling of fire: prospective and retrospective. “Prospective users are interested in products with reduced flammability, better design guidelines for fire-safe structures or vehicles, or approval of an architectural plan. Retrospective users are concerned with reconstruction of the details of actual fires” (p. 258). Gorbett and Pharr (2011) suggest the main purpose of retrospective is for post-fire analysis or fire investigations. In addition, Gann and Friedman (2015) stated, “Retrospective users usually consist of litigants, arson investigators, code officials, and instructors. They focus on a fire that has already occurred, and for which many specific pieces of information are available” (p.258). Of the computer fire models Gorbett and Pharr (2011) suggests, “Zone fire models are the most common type of modeling utilized for evaluating enclosure fire dynamics” (p. 270). The authors continue by stating, “This type of modeling typically separates the compartment into two zones, commonly referred to as the upper (hot) zone and lower (cool) zone” (p. 270).



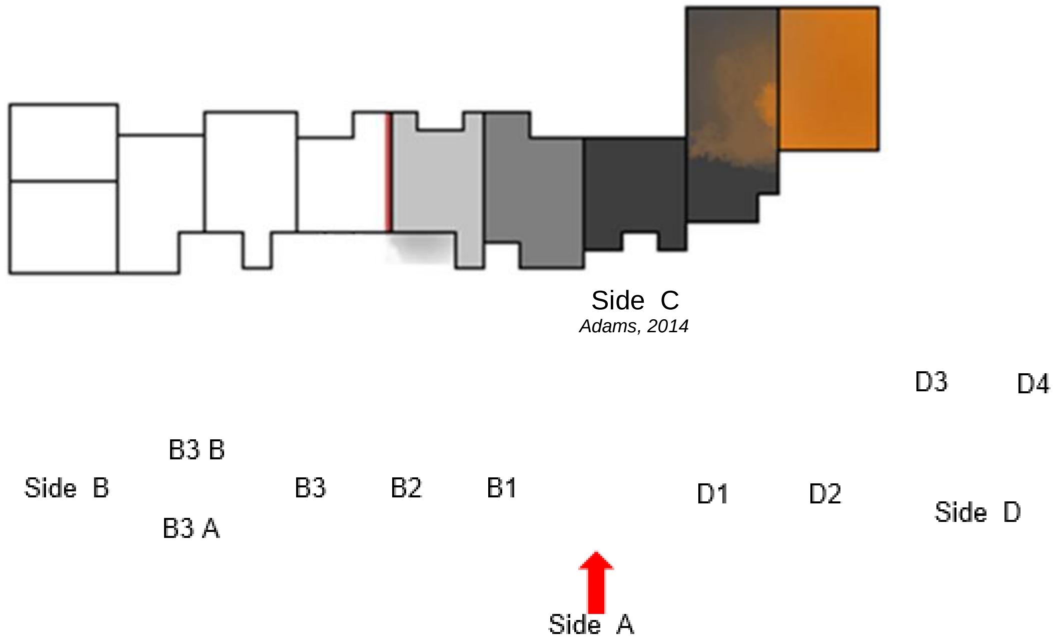
Adams, 2014

According to Gann and Friedman (2015):

> Zone models divide each compartment in a structure into a small number of zones. Within each zone, each predicted property has a single value. Field models, also known as computational fluid dynamics (CFD) models, predict three-dimensional distributions of the fire and its products. (p. 269)

Points to Ponder

Units respond to smoke in a mattress store in a non-sprinklered strip mall. The mattress store occupies five of the store fronts or compartments in the strip mall with openings cut in the walls allowing access to each store. Foam mattresses lined the show room floors in the first three store fronts and were stacked to the ceiling in the last two compartments. The exterior windows of the last two compartments were blocked in for security reasons. There was a concrete block fire wall on side “Bravo” of the main store. Earlier that day units responded for a slight odor of smoke and nothing was found. Upon arrival later that night smoke was showing from Side “Alpha” in the middle of the strip mall. As firefighters entered they reported light smoke conditions in the main store with no sign of fire. Two firefighters broke off from the attack line and started searching exposure “Delta 1.” They reported heavier smoke conditions as they entered exposure “Delta 2” and after entering exposure “Delta 3” conditions were untenable and radio contact was lost. At the same time outside crews noticed flames breaking through *the roof in “Charlie Delta.”*



Adams, 2014

Should computational modeling of fire be used to develop an understanding of the fire growth? Should computational modeling be used to determine the effect sprinklers would have if they were installed? Should realistic a Fire Dynamics Simulator (FDS) be used?

In this unit you will analyze the three zones of the plume of a fire burning in the open and calculate the air entrainment into the flame and the height of the luminous flame. You will define three reasons why the nature of the ceiling jet is important and calculate the mass out-flow from a room in which a steady-state fire is burning.

References

Gann, R., & Friedman, R. (2015). *Principles of fire behavior and combustion* (4th ed.). Burlington, MA: Jones & Bartlett.

Corbett, G., & Pharr, J. (2011). *Fire dynamics*. Upper Saddle River, NJ: Pearson Education.

Death in the line of duty: Career lieutenant and fire fighter die in a flashover during a live-fire training evolution–Florida. (2003, June). *NIOSH.* Retrieved from http://www.cdc.gov/niosh/fire/reports/face200234.html

Tactical Deployment & Command. (2014). Retrieved from http://www.firetactics.com/

The National Institute for Science and Technology. (2002). NIST computer simulations and live fire experiments to be used to discover causes of rapid fire progress in Florida training burn. Retrieved from http://www.firetactics.com/OSCEOLA.htm

United State Fire Administration. (2014). Firefighter fatality details. Retrieved from http://apps.usfa.fema.gov/firefighter-fatalities/fatalityData/search

Suggested Reading

Fire Behavior and Tactical Considerations
https://www.youtube.com/watch?v=v2JcNonr4us

New vs. Old Room Fire Final UL
https://www.youtube.com/watch?v=aDNPhq5ggoE

Learning Activities (Non-Graded)

Review What You Have Learned

The Challenging Questions at the end of Chapter 14, on page 271, will help you evaluate computational models used in fire safety analyses.

This is a non-graded activity, so you do not have to submit it. However, if you have difficulty or questions with the concepts involved, contact your instructor for additional discussion and/or explanation.