2009 BFRL Project Description

Project Title: Virtual Fire Fighter Trainer

September 15, 2008

Principal Investigator: Daniel Madrzykowski

Co-Investigator(s): Glenn Forney, Steve Kerber

BFRL Program: Advanced Fire Service Technologies

Objectives: To develop a computer based fire fighting training tool based on science, as implemented by the Fire Dynamic Simulator (FDS), to improve training opportunities while lowering the cost and risk of death and injury.

Problem:

What is the problem? The most effective method for learning how to fight fire is to fight fire. This however is expensive and particularly dangerous for the trainee. Further due to safety considerations "live fire" training can not provide the wide range of fire conditions that fire fighters must be prepared for in a real world fire, for example the effect of high wind conditions on a structure fire. Other fire situations that must be trained for are too large and dangerous to re-create in a training setting involving real fires, for example a large two story house with vaulted ceilings and real furnishings. In addition, environmental concerns are limiting the amount and kind of live fire training available in many areas of the country.

Why is it hard to solve? There is limited fire data available from training structures or structure fires. As a result there are no "validated" computed based fire training simulators. Even with data, modeling all relevant phenomena associated with fire is beyod the state-of-the-art.

How is it solved today, and by whom? The fire service currently relies on limited amounts of live fire training and "expert-based" simulations. The "expert-based" simulations typically focus on incident command issues. The fire simulations are not physics based and the changes to the fire are based on "expert" responses to student inputs to the fire scenario.

Why NIST? BFRL is an international leader in measurement science and predictive tools for the fire safety community. This project requires advanced fire measurement, analysis and modeling techniques which are central to one of BFRL's Core Competencies of fire protection and fire spread within buildings and aligns with the BFRL Strategic Priority on measurement science for innovative fire protection.

Approach

What is the new technical idea? BFRL has improved predictive and visualization capabilities in the form of FDS Version 5 and the Smokeview Demonstrator. FDS 5 has an improved combustion model and regional pressure zones that can be used to better represent a fire ground environment. Smokeview now has a prototype Demonstrator feature which will easily enable firefighters to interact with Smokeview in order to examine the impact of different fire fighting tactics on the structure fire being simulated. BFRL has improved measurement capabilities for use in field locations. These capabilities include temperature, pressure, heat flux, gas concentration, thermally protected interior video and thermal imaging. These measures will provide a characterization of what is occurring inside of a structure fire, providing a comparison to the FDS calculations as well as providing the fire fighters with interior and exterior views of the fire.

Why can we succeed now? BFRL currently has a unique mix of expertise, instrumentation, field measurement capabilities, computational facilities and OA funding to conduct the tasks to address this research need. In addition, BFRL has developed full scale training facility fire data and experiments are being planned under the Multiphase Study on Firefighter Safety and Deployment, which could prove very useful for real scale validation.

What is the research plan? The project broken is down by phases as follows:

- Phase I - Develop and validate trainer modules based on fire training facilities.
- Phase II – Develop an interactive trainer module for a stand alone residential structure.
- Phase III – Complete a suite of interactive training modules for three different types of residential structures

BFRL has developed sets of data from three different training facilities. These will be compared with simulations from FDS 5 and the Smokeview Demonstrator. Using the validated trainer modules, BFRL will create an interactive computerized trainer module illustrating various venting strategies and suppression effectiveness for a single family residential structure by inputting into FDS the data collected and research results of projects that have been conducted at NIST over the past couple of years and that are ongoing. These projects include the Fire Suppression Effectiveness of Hose Streams, Evaluating Structural Ventilation Techniques, Examining Fire Fighting Tactics under Wind-Driven Conditions, Heat Transfer for Firefighter's Personal Protective clothing and the Multiphase Study on Firefighter Safety and Deployment.

BFRL will document full scale fire experiments in training buildings and in structures constructed for the fire experiments. Each structure will be documented in terms of construction and fuel load. Each structure will be instrumented to monitor the thermal environment and fire development noting changes in the thermal environment due to changes in ventilation and suppression tactics. Using the validated trainer modules, BFRL will create an interactive computerized trainer module, based on FDS 5 and Smokeview Demonstrator, illustrating various venting strategies and suppression effectiveness for a single family residential structure.

Recent Results:

Output: Madrzykowski, D., Fatal Training Fires: Fire Analysis for the Fire Service.Interflam 2007. (Interflam '07). International Interflam Conference, 11th Proceedings. September 3-5, 2007, London, England, 1169-1180 pp, 2007.

Output: Forney, G.P., User's Guide for Smokeview Version 5: A Tool for Visualizing Fire Dynamics Simulation Data. NIST Special Publication 1017-1, August 2007.

Standards and Codes: Dissemination of results and technology transfer will occur through several means including: the NPFA Technical Committee on Fire Service Training, the National Fire Academy Technology Transfer Program, International Fire Service Training Association, and International Society of Fire Service Instructors.