

Improving Wildland Fire Safety: A Challenge for Forest Fire Researchers

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Around our world, the hundreds of thousands of men and women who fight wildland fires are in a high-risk environment as they battle to protect our natural resources. Whether in Russia, China, Australia, Europe, Indonesia or North America, these firefighters are subjected to similar threats to their safety from the forces of terrain, weather and the fire. Several of the more recent fatal wildfire events in Spain, Australia and the United States were discussed in great detail during the Fire Safety Short course that was held last Saturday.

Illnesses and injuries are a daily event in the wildfire world. The long hours of hard physical work fatigues the firefighters, making them more susceptible to respiratory infections from the smoke. The adverse effects of the high temperatures from both the ambient air and the fire combine to drain the firefighter's energy, making them more likely to take a wrong step, or miss a subtle warning of a hidden danger. The longer the duration of the fire, the more likely that illnesses and injuries will occur because of the cumulative effects of exposure to the hazards described. Physical injuries tend to occur most frequently to the ankles, knees and backs, although detailed studies on firefighter injuries are sorely lacking.

Fatalities on wildland fires occur much too frequently around the world: reports over the last 5 years have documented deaths on fires in Russia, Spain, Portugal, Australia, China, Indonesia and the United States. While media reports of burnover fatalities gain most of the attention, a study in the US showed that heart attacks, aircraft and vehicle accidents were also significant causes of firefighter deaths.

The 20th Century saw massive changes in the tools and techniques to battle wildland fires: the introduction of air tankers and helicopters have been the most visible changes, but there are numerous other improvements that have resulted in a safer firefighting environment around the world. Such improvements as fire resistant clothing, protection systems for engines and tankers, and remote systems for igniting backfires have all contributed to safer workplace. In addition, more subtle changes like

remote automatic weather stations, fire behavior models and satellite technologies have also made it possible to deploy firefighters in dangerous situations with a greater knowledge of the expected activity of the fire.

The ever present risk of wildland fires around the world, and the need to help and protect the firefighters that battle them, has seen surprisingly few facilities evolve that specialize in the research and development of processes and procedures for wildfire suppression. Aside from research that is occurring at the university level, there are limited organizations and private firms looking at new concepts and technologies. In Australia, CSIRO and the Victoria Natural Resources and Environment Department are actively involved in studying fire behavior, developing new and/or better equipment, and transferring the information to on-the-ground firefighters. Some private firms (such as Iturri in Sevilla, Spain) have test and development facilities that look at new technologies as well as improving their existing product line of fire equipment. The Canadian Forest Service, the Russian Fire Service and the United States Forest Service all have dedicated research scientists and facilities to look at a wide range of forest fire topics. In addition, the U.S. Forest Service sponsors two Technology and Development Centers where wildland fire is a major focus of their efforts. While their numbers are few, the work of these fire researchers is truly worldwide in scope, and their efforts have been applied in all corners of the globe.

I believe that our challenge, as Forest Fire Researchers, is to coordinate integrated efforts among physical, biological and social scientists to develop meaningful products, with appropriate technology transfer, for field firefighters.

The key components of a successful forest fire safety research effort includes:

- It must address needed information or equipment;
- It must provide a cost efficient solution;
- It must be timely;
- It must be user-friendly.

The first step in improving fire safety through research is to identify your market. Although we speak different languages and work in different geographic areas of the world, there is a marked similarity in the fire safety problems that each of us seeks to remedy. With only minor modifications, the answers found in Siberia or Australia can be applied to fighting fires more safely in France or Italy or Canada. For that reason, I believe that our research efforts to improve fire safety are truly world-wide, helping

firefighters in the Old World of Europe, the New World of North America, and the 3rd World of newly developing countries of Asia and Africa.

And while the solutions that we may find are universal in scope, so too are the obstacles to improving wildland fire safety;

- Tradition, while often viewed as a strength in the fire services, can also be an insurmountable obstacle to improving safety;
- Ownership of new ideas or solutions is another barrier. In the U.S. there is an old saying that "if it ain't my wheel, it won't roll". Resistance to accepting change introduced by others is widespread around the world, and the fire world has the same problem.
- Physical limitations imposed by the terrain and fuels are continuous factors that prevent us from making significant improvement through our research efforts;
- And lastly, costs can be a serious impediment to improving fire safety, especially among the emerging countries of the 3rd world.

So now that we have identified our challenge and the obstacles, where are the opportunities for you, the forest fire researchers of the world, to make a positive impact of the safety of the firefighters? It is my opinion that there are six (6) key areas where our research has the opportunity to affect change that will save lives, and reduce illnesses and injuries:

1. Knowledge-based;
2. Equipment-based;
3. Behavior-based;
4. Health and Fitness;
5. Decision Support Systems;
6. Urban Interface.

In my definition of research opportunity areas, Decision-based fire research is that which focuses on learning more, and better, information about those factors that we cannot control, but which significantly impact our fires, and consequently, our firefighter's safety. In spite of all the work that has been done in the area, Fire Weather is an area ripe for additional research as it impacts our overall fire danger level, and more importantly, how it affects on-going fires. I also believe that there are excellent opportunities to increase our Fire Behavior knowledge, especially in the areas of spotting, crowning and extreme fire behavior. Lastly, decision-based fire research needs are virtually unlimited in the area of Smoke Management. Why Smoke

Management, you ask? How does that impact firefighter safety? Well, aside from the obvious answer of less smoke in the firefighter's face, there is also another important concern: better knowledge about smoke management, and more specifically smoke dispersion, will allow us more opportunities to conduct prescribed burning without adversely impacting population centers. More acres burned under prescription should reduce those acres burned by wildfires, and therefore put fewer firefighters at risk, both from the smoke and from the wildfire itself.

There are already some excellent recent examples of success stories in conducting fire behavior-related research: the "Project Vesta" burns in Australia, and the International Crown Fire Modeling Experiments in Canada's Northwest Territories show the rest of the world the scope and commitment that is needed to make significant contributions to the body of knowledge in a complex field of study.

Equipment-based fire research is another field that constantly requires work, as the technology changes and improves for areas of application outside of wildland fire. A few of the areas that I believe can help fire safety in the very near future:

1. Protective clothing: lightweight and breathable, offering protection from both heat stress and radiant heat from the fire.
2. Personal shelters: the Aussie fire blanket and the US fire shelter have both proven their value in saving firefighter's lives. What is the next step, both in protection, and that meets the cost restrictions of our poorer nations?
3. Much continues to be said about the effects of wildland fire smoke on a firefighters respiratory health, but little has been done to develop an wildfire respiratory protection system that is effective, yet allows firefighters to work for prolonged periods of 10-12 hours per day for multiple days, without suffering adverse impacts from the respirator;
4. Many countries in the world use engines/tankers as important tools in wildfire suppression, and too often these engines/tankers are burned over with firefighters trapped inside. While some work on protective curtains is being studied by CSIRO in Australia, much additional work is needed to safeguard firefighters in their vehicles.

Behavior-based fire research is perhaps the area with the highest potential payoff in Fire Research: by working with the firefighter's minds, we can help them become both more successful, efficient and safer without the need of expensive technology that

may not be available to them. A few of the areas in this field that need work by Social science researchers include:

1. Human Factors;
2. Crew Cohesion;
3. Fireline Leadership;
4. Decision-making under Stress.

This is truly an area of fire safety that has been largely ignored until just recently, yet shows large promise to modify behavior in the future that will result in improved safety awareness and performance. There have been some early successes in addressing some of these areas of study, but extensive research, and follow-up training for the field firefighters, remains to be done.

As I mentioned in my opening, burnovers are only a small piece of the firefighter fatalities that occur: by addressing the complex health and fitness requirements of wildland firefighters, we can keep the healthy, while reducing their illnesses, injuries and even fatalities.

While the firefighters on the ground are most directly at risk from the fire, there are also opportunities in the Decision Support Systems arena to improve their safety. The integration of GPS/GIS/IR technology will not only let fire managers know where a fire is located and the firefighter's location relative to it, and will also allow them to evaluate terrain and fuels information that can be factored into Fire Behavior forecasts. The fields of Risk Analysis and Dispatch Coordination also offer prime new ground for researchers to assist the effort to improve safety.

The last area where I believe that research can make significant improvements in firefighter safety is in Urban Interface fire scenarios. Work to develop or improve firesafe building materials; give better definition to vegetation management needs; develop meaningful public information programs; and improved structure protection systems: all of these will not only make the firefighter safer and more efficient in the Interface, but will also make valuable contributions to the safety of the homeowners in the area.

We have discussed the areas needing new or additional research effort, but what are the mechanisms to coordinate such an effort, especially give the world-wide scope of the wildland fire problem, and the need to provide timely and meaningful help to the world's firefighters? I believe that the structures are in place that will facilitate the

successful implementation of such an ambitious program of research. It will take close cooperation and information sharing among a diverse group of individuals and organizations:

- Universities
- Professional Societies
- Fire Conferences
- UN/E.U.
- IUFFRO
- Government Agencies

Our record of making these complex coordination efforts work is getting better: the two previous World Fire Conferences in Boston and Vancouver, and the upcoming Conference in 2003 in Sydney; the movement of the International Standards Organization (ISO) towards an international standard for wildland fire protective clothing; the United Nations 1996 Conference in Siberia; the Crown Fire Modeling experiment in Canada that included researchers from around the world; and, of course, this and the previous International Conferences on Forest Fire Research (ICFFR): all are excellent examples of the great work that we can accomplish as a group of individuals and independent nations when we agree to work together.

My friend Domingos asked me to present this keynote address because he knows of my commitment to the area of firefighter safety. My commitment has been strengthened over the years because of my work of investigating the fire fatalities that have occurred in my country when fire safety policies, procedures, equipment or people failed. The monument that you see for the fourteen (14) firefighters that died on Storm King Mountain in Colorado in 1994 bears testimony to their sacrifices and deaths. Through your research efforts towards improving firefighter safety, we will hopefully never have to build another such memorial.

Thank you!