

NEW TOOLS FOR EMERGENCY RESPONSE AND MANAGEMENT: ADVANCED R&D THROUGH TECHNOLOGY TRANSFER FROM OUR FEDERAL LABORATORIES.

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ABSTRACT

Present-day emergency management continues to try to advance the state-of-the-art in using new tools and methods to plan for and control emergencies. Yet, to this day, most of the work of locating, extricating, and treating victims of these emergencies is "pick and shovel" technology. This nation needs to take the lead in developing the new technologies and systems needed to enhance the survivability of victims of disasters.

The federal laboratories (especially the national laboratories involved in weapons R&D) and federal agencies in general are presently undergoing major changes in their missions, funding, and in their ways of doing business. One issue that is emerging as a common denominator in the survival equation for each of the federal laboratories is that of technology transfer. Technology transfer is seen as a major need for bringing technology out of the laboratories to the civilian sector for development into either civilian use or dual-use (civilian and military) products.

THE "HOPEFUL" SCENARIO

It's midmorning in greater Megalopolis, and the downtown area is "normal," with people living, working, or just trying to survive in the big city. The sidewalks are small rivers of humanity, all of which seem to be fighting their way upstream to their destinations. Vehicles clog the streets and the homeless line the sidewalks. These are the everyday

obstructions to "living the good life" in the big city that its denizens have come to cope with.

It's also the not-so-distant future that we've all predicted, feared, and avoided all those years. However, the present and enlightened administration elected by a country demanding change and responsibility has responded with a comprehensive disaster mitigation plan that has provided a nationwide emergency management organization based on preparedness, advanced technology, local responsibility, and governmental agency support. Although not yet perfect, the new system has developed a new awareness in our country so that citizens are preparing themselves to survive in a disaster.

Deep in the earth on a major fault, rock slips past rock after building up huge stresses over the years. P and S waves radiate from the huge section of fault, aiming directly at Megalopolis. The new, statewide network of seismic monitors detects the movements and transmits the signals to the State Center for Disaster Mitigation (CDM) by satellite. The CDM's massively parallel computer system quickly analyzes the data, using a worldwide network to access other data, expert systems, artificial intelligence, neural networks, and calculations from other computers in various government, university, and private organizations. The CDM's computers quickly analyze the signals, deduce the magnitude and location of the seismic activity, and predict the possible results to populated areas in the area. Within seconds, the computers have

been able to tell the scientists in the CDM that a major earthquake is beginning to happen, and that the seismic waves will soon start propagating their destructive powers. Megalopolis is threatened!

Seeing the warning and remembering the predictions of major seismic activity from the previous days, the CDM Director activates the state's Disaster Early Warning System. All media immediately begin to broadcast a warning, and the small, lipstick-sized Personal Disaster Notifier/Locator (PDN/L) that all residents of Megalopolis carry emits a shrill siren sound. Because residents were already aware that a major earthquake was imminent (thanks to the CDM's new earthquake predictive capabilities), they are now able to seek preplanned shelters. As workers exit their office building, their PDN/L is interrogated by the building management system, keeping track of who is still in the building. The building management system's database is queried to determine where each person is most likely to be located in the building.

Only a couple of minutes elapse from the initial jolt at the epicenter to the arrival of the quake at Megalopolis, but those couple of minutes have allowed thousands of people to seek shelter, emergency units to be dispatched to their primary staging areas, and all emergency services to alert their staffs to report to their disaster duty stations to prepare for the first victims or to take shelter themselves.

Although new, enlightened, tougher, and better enforced building codes have made buildings and homes more resistant to the forces of the earthquake, this major quake inflicts heavy damage and many victims are killed, injured, trapped, or made homeless. Now, all the city is delayed on its "way to the good life!"

Within minutes after the quake has subsided, the first emergency responders are dispatched from their staging areas to begin the work of locating, extricating, and

treating the victims. Overhead, the satellite starts mapping the disaster area, sending it down to the CDM where the visual and infrared data starts putting together a picture of the situation. At airports outside the disaster area, the Air Force dispatches reconnaissance planes to fly over the area to use the latest remote sensing technology to provide more detailed disaster assessment information. In minutes, new maps are generated and then compared with existing area maps, and the extent and magnitude of the damage become shockingly apparent. The new maps are immediately digitized and transmitted on the new Disaster Communications Network, accessible by all disaster agencies, and completely compatible with all communication systems in the country. Copies of the maps and an initial damage assessment is transmitted to the state's Emergency Operations Center (EOC), as well as to the Federal Emergency Management Agency (FEMA). The State Incident Commander contacts the governor of the state and suggests that the governor request a declaration of disaster from the President.

As preparations are made to bring in outside help, the local emergency response units are already at work. Fully equipped disaster vehicles bring in specialized equipment. More equipment is issued from strategically located caches, both within and around the disaster area.

First responders are in shock themselves, but they rally to begin locating and treating those who are trapped under collapsed structures or in vehicles. First responders and citizen volunteers, some of whom are walking wounded themselves, begin the heartbreaking chore of digging out.

The initial mass confusion is lessened as volunteers remember the training received at their workplaces, and they form into rescue and first aid teams, using both their personal survival equipment and the equipment they can salvage from the caches their companies

have stored for this very purpose. In the next few hours, many victims owe their very lives to these initial volunteers and first responder units.

Meanwhile, the state government has responded to this major disaster. Most Megalopolis resources are already committed, so mutual aid has been requested, and is already pouring into the EOC-assigned staging areas. Modular, easily transportable units arrive by ground and air to provide heavy rescue equipment, field trauma treatment centers, and command, communications, control, and information (C³I) capabilities. Logistics units set up portable power generators, initial communications lines, portable shelters, and sanitary facilities. Fast-moving recon/rescue teams go to work triaging buildings and victims, followed by heavy rescue and medical units. Small, all-terrain vehicles allow personnel and equipment to move into areas congested with debris. Computer-based, completely interoperable communication systems talk to all on-scene resources and surrounding jurisdictions. The National Guard is mobilized, providing personnel and equipment. The Guard units have received training in Urban Search and Rescue (US&R) and are assigned immediately to augment the local rescue efforts.

Local, state, and federal agencies have responded with specially equipped US&R units. Now, field units are operating victim locator devices that are based on seismic, acoustic, infrared, visual, and ground-penetrating radar technologies that can both locate the victim and determine whether the victim is still alive. Rescuers use high speed tools with special coatings to cut through concrete and rebar quickly. Foams and expandable grouts provide shoring and help move pieces of debris. Small hand-held sensors quickly determine the presence or absence of dangerous gases, hazardous materials, or live electrical circuits. Dust is sucked away by portable ventilation systems and clean air is directed into the work area.

Large concrete pieces such as highway structures are quickly penetrated, cut, and moved, allowing fiber optic viewing devices with infrared capability to be inserted to help locate victims and assess damage.

As victims are found, a portable diagnostics unit uses near-infrared spectroscopy to determine the patient's condition. Quick setting foam is used to provide form-fitting immobilization and splinting, and dressings based on artificial skin technology are applied. If necessary, a laser scalpel can provide quick field amputations, and a computer controlled fluid infusion device provides fluid replacement and monitors the victim's condition as extrication and transportation is accomplished. A hypothermia vest is used on patients whose bodily functions have been affected by exposure to cold, and burn victims are treated with the new artificial skin dressings. As each victim is removed, a 3-D bar code tag is generated on a portable computer that carries complete information on the status and treatment of the victim. This tag follows the patient completely through the rescue and medical system, and is updated at each stage of treatment. This information can be read at the treatment center and transmitted to the operations center to be part of the incident records.

Within a few hours, FEMA US&R Task Force Teams and the National Disaster Medical Assistance Teams (DMAT) begin to arrive, and volunteer support agencies begin to set up to help the victims. Mobile advanced life support units are deployed in the area, and field hospitals are set up by the DMAT units. The military is now providing a continuous supply effort, bringing in rescue, medical, and logistic supplies from nearby supply caches managed by FEMA. The disaster operations now begin to convert from rescue and treatment to shelter and feeding of the survivors and the ultimate rebuilding of the disaster area.

The road to the "good life" is now lined by thousands of caring people providing helping hands to the survivors—in the best American tradition! Many people owe their lives to those who risked all to help, and to the new equipment and methods that allowed quick rescue and effective treatment of the victims.

THE "REAL WORLD"

The "hopeful scenario" of the preceding section is not now possible. In fact, present abilities to respond to and mitigate the effects of the "Big One" are very reactive, not proactive, and—in some cases—do not exist. Local response capabilities will be immediately overwhelmed in most cases in any moderate-to-large disaster, and the tools and methods available to rescue and treat the victims is both fairly low-technology and in short supply. Above all, there does not now exist a community or personal awareness, concern, or state of preparation that allows individuals and communities to both prepare and respond adequately to a major disaster.

Even given a "new citizen mindset" that would provide a better preparedness, it is commonly acknowledged in the emergency management and disaster response community that new and improved tools and techniques are badly needed if we are to provide an adequate response to the large disasters of the future. Robert P. Fletcher, Jr., Chief of the Federal Response Division of the Federal Emergency Management Agency, states that "...much additional research into equipment design and considerable development of equipment capabilities for use in both urban and heavy rescue environments are badly needed."¹ New technology that can be applied to all types of search and rescue, field and hospital treatment of the victims, and command operations will greatly help to mitigate the effects of the disasters we are sure to face soon.

The bottom line of the "US&R problem" is that our nation needs to take the lead in researching the technologies needed to enhance the survivability of victims of disasters. This will require several courses of action, such as

- establishing a viable national system of US&R, supported by Congress and responsible federal agencies,
- maintaining trained heavy rescue US&R teams, available on short notice,
- educating the public, so that they will be better able to prepare and respond to a disaster affecting their area, and
- providing better equipment and methods to rescuers, based on new or advanced technologies to improve their performance and usefulness.

As discussed in a previous paper,² it is in this latter area that the federal laboratories can best contribute ideas and resources. The pool of talent at our federal laboratories represents a deep and as-yet untouched treasure of new technology that has great promise in improving the tools and methods required for US&R. There are a great number of technologies that have an application for US&R, either to improve equipment or methods.

Proposals have been presented to several federal agencies to try to interest them in promoting advanced technology for the US&R and disaster mitigation and response areas. The subject of these proposals, the Disaster Mitigation and Rescue Technologies Program (DM&RTP) provides many program development opportunities and new revenue potentials. The program is based on finding technology transfer opportunities for Los Alamos National Laboratory (LANL) and other federal laboratories. By working with LANL's Industrial Partnership Center and other laboratories' technical transfer offices, Cooperative Research and Development Agreements (CRADAs) will

be developed for new products based on one or more technologies available at each laboratory.

This program has been proposed and pursued since 1991, but has yet to be accepted by any federal agency willing to provide funding. One reason for this is that the majority of programs presently offered by the federal agencies to promote technology transfer require that the federal laboratory team up with an industrial partner as part of the initial agreement. The objective of the DM&RTP is to find those industrial partners, so there is an immediate problem presented by the lack of an industrial partner. Although the program is still being actively pursued in its original form, it is also being approached by trying to locate a company that would be interested in some more specific part of the project. The objective of this approach would be to match a specific new technology with a new system or product that could be developed for the emergency market.

The Disaster Mitigation & Rescue Technologies Program offers some very attractive benefits to both the federal laboratories and industry. Some of these are as follows:

- Develop stronger ties between the laboratories and the Department of Defense (DOD) to support defense conversion initiatives.
- Help meet a major national need to provide a better capability for DOD, FEMA, and other agencies tasked under the Federal Response Plan to meet their responsibilities to provide a national US&R Emergency Support Function.
- Develop laboratory-wide outreach activities that will focus on laboratory spin-off technologies.
- Establish start-up companies using the laboratory technologies.

- Help obtain funding for new industrial partnership programs.
- Increase applied civilian R&D.
- Enhance interactions with industry in civilian and dual-use technologies.
- Explore innovative ways to expedite the pickup of technology for commercial applications.
- Allow the Lab to empower its employees to help shape the directions of and strengthen the Lab through their actions and regain throughout the Lab a sense of citizenship, responsibility, and accomplishment.
- Help the Lab and other federal agencies convince the nation that its investment in people and facilities for defense is a major asset for finding solutions to other evolving, important problems facing the nation.

It is the author's most sincere hope that the new administrations in the Department of Energy, the Department of Defense, and the Federal Emergency Management Agency will be more interested in meeting this important national need for better systems and technology. It is also intended to bring the program to the attention of the Vice President with the help of the LANL management. Proposals are to be presented to try to bring the program to reality, along with a continual effort to try to find industrial partners to develop technologies into useful products.

SUMMARY

The Disaster Mitigation & Rescue Technologies Program provides the best possibilities of improving the equipment and methods required for US&R. Advanced equipment and methods are required to improve the chances of getting to victims and removing them faster, treating them better, and minimizing the

damage caused by catastrophic earthquakes. If we continue to rely on the "pick and shovel" technology we now use, the casualty and damage figures will continue to climb. The resources of our federal laboratories provide the maximum potential for improving the protection of the health and welfare of citizens vulnerable to catastrophic disaster.

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