

UNIVERSITY OF SOUTHERN CALIFORNIA

Observations of the Resilience Architecture of the Firefighting and Emergency Response Infrastructure

Jennifer Maxwell
2/9/2009

Note: This paper captures my observations and conclusions from the February 3, 2009 INCOSE Resilience Working Group, and the information contained in Appendix A of Scott Jackson's "Architecting Resilient Systems: Accident Avoidance and Survival and Recovery from Disruptions". The contents of this paper are not based on research beyond these sources.

On February 3, 2009, the INCOSE Resilience Working Group met with members of the San Francisco Fire Department (SFFD) to discuss the policies and procedures of rescue and relief efforts. Members of INCOSE's Anti-Terrorism Working Group and Infrastructure Working Group also participated in this discussion. Many common themes among the principles of resilience and the emergency operations of the SFFD were highlighted during the meeting. This essay will draw conclusions about the application of resilience principles in the firefighting infrastructure.

As background for this discussion, the material in Appendix A of *Architecting Resilient Systems: Accident Avoidance and Survival and Recovery from Disruptions*³ was reviewed with the group. This summary captured the resilience heuristics that could be applied to fire protection infrastructure. Systems resilience is characterized by four main elements:

- Capacity to handle a disruption in the system
- Flexibility to adapt to a disruption and still perform the primary function
- Tolerance to handle a disruption without total breakdown of the system
- Inter-element collaboration to work with other organizations or internal systems to recover the primary function

This meeting concluded that the SFFD practices heuristics in all of these elements.

Capacity

While there are a number of heuristics in this area that could be applied to the fire protection infrastructure, the February discussions centered on applications of the margin heuristic and the context spanning heuristic. The margin heuristic is supported by the SFFD's policy to perform inspections of structures in their jurisdiction to ensure that they meet the fire code. The code is updated often based on new standards and lessons learned from previous events. By maintaining this code, structures have a better chance of surviving or "gracefully degrading" in the event of a fire.

The training curriculum was also explored. Large-scale emergencies are not as common as they once were. While this is a good thing for the overall system, new challenges have arisen in providing new firefighters with the experience they need to perform their job. A paradigm shift has occurred within the fire department in which scenario training modules have had to replace hands-on training as the primary method of education for new firefighters. In order to make these scenario training modules more robust, the SFFD has to practice the "context spanning" heuristic by exercising the most likely worst case scenario of a fire in the Bay Area Rapid Transit (BART) in San Francisco. The SFFD asked for additional help in developing these scenarios from organizations that could do a more thorough analysis of disaster possibilities.

Flexibility

During the February meeting, all heuristics applicable to the flexibility of the fire protection infrastructure were discussed. The SFFD is particularly strong in its ability to reorganize itself because it can quickly adapt its command structure based on the circumstances surrounding an emergency. A common example given was the change of incident commander when a higher ranking officer arrives on the scene to take over the rescue effort. A story from the Oakland fires also demonstrated one squad's ability to merge with an ongoing rescue effort without having to maintain its internal structure.

Diversity is an area that has been strengthened due to lessons learned from 9/11 and Katrina. During those events, it became clear that in order to work together, the ability to communicate was critical. Improvements were made to ensure radios were compatible. Other improvements included ensuring hose connections, etc have a common interface amongst nearby districts. Another contribution to increasing the diversity of the SFFD was the standardization of processes and reporting methods across agencies. All of these support the SFFD's ability to work with a wide variety of teams to recover from a disaster.

Tolerance

The most common themes of tolerance discussed in the INCOSE WG proceedings involved the drift correction heuristic, the neutral state heuristic and the organized decision-making heuristic. Drift correction is implemented during the planning and prevention of fires through fire code updates and inspections. In this way, the fire department is examining its codes and procedures for indications of "brittleness." The SFFD performs drift correction by implementing changes in fire codes, to ensure their command is robust in preventing and recovering from fires.

In real-time emergency situations, the heuristics of neutral state and organized decision made are critical. The SFFD representatives spoke about a very strict use of authority present in their organizational culture. Their culture is such that the firemen are trained to be aggressive, the mid-level officers aggressive but logical in decision making, and the incident commanders very conservative when leading a rescue effort. They rely on this three-tiered response to control and correct back to a neutral state when emotions, ego, or aggression may interfere on the job. One critical key to their success is that all decisions are made by one incident commander to avoid conflict or confusion during a rescue. This shows their demonstration of the organized decision-making heuristic. Another key to their success in this area is that they empower decisions at a low level. The first crew on the scene can begin a rescue effort to the "best advantage," the best method they see fit when they arrive on the scene, without explicit permission from another crew.

Inter-element Collaboration

Inter-element collaboration has been an area of considerable focus in recent years. The National Incident Management System (NIMS),⁴ a system put in place by the Department of Homeland Security in cooperation with Federal, State, Local, tribal, and regional emergency rescue organizations, has

significantly improved the fire protection infrastructure's ability to maintain knowledge between nodes. This system allows for standardized reporting of status information and record-keeping across agencies before, during, and after an emergency. By creating a common interface, agencies can more readily access information provided by another unit. In addition, the establishment of the Incident Command Centers² also brought together city planning, infrastructure, and protection agencies so that each organization is informed and aware of what is happening or what may be needed in an emergency event. This also strongly supports the intent awareness heuristic by establishing a standard protocol in discussion and response amongst agencies. Another way this heuristic is supported by the SFFD is through training and knowledge of what is important to other agencies' investigations. For example, the police force is interested in preserving evidence in a crime scene. The SFFD is trained to look for and protect potential objects of evidence during their rescue efforts.

Lastly, removing all inter-element impediments is an ongoing area of improvement by the fire protection services and the Department of Homeland Security. The effort to train awareness of other agency's needs supports this, as does the standardization of reporting processes, procedures, and interface equipment across agencies. There was some sign that impediments still exist. During the February meeting, the discussion indicated that federal response agencies may unnecessarily block the efforts of the local rescue agency rather than work collaboratively with them and rely on their knowledge and expertise. The SFFD inter-element training efforts may also be lacking because the SFFD is a large organization, self-sufficient entity with adequate resources to handle most emergencies. In smaller districts where fewer resources are available, cross-organization collaboration is essential to their preparedness since that rely heavily on outside aid. The SFFD representatives suggested that talks were in place amongst senior officers for cross-training efforts with federal and police agencies, but the financial support was not there to back them yet.

Overall, the fire protection infrastructure is a good demonstration of resilient practices. They exercise resilience in all three phases: avoidance, survival, and recovery. In avoidance, they practice fire code enforcement as a prevention method to avoid a disruption. They have a very organized decision making structure to help survive emergency situations. And they are able to recover from disruptions or deficiencies in their nominal resources or response efforts by working across agencies to provide additional support. Another interesting principle of resilience can be observed through the reporting of near-miss incidents. Fire protection organizations capture this information on *firefighternearmiss.com*¹, an online public record of events and lessons learned that can be shared with fire protection units nationwide. This suggests the "iceberg theory" is indirectly supported by this infrastructure in their intent to use near-miss situations to indicate breakdowns in the resilience of their infrastructure. Further study of this infrastructure and the improvements that have been made since 9/11 and Katrina could help uncover additional characteristics of resilience.

Works Cited

1. *Home Page*. (n.d.). Retrieved from National Fire Fighter Near-Miss Reporting System:
<http://www.firefighternearmiss.com/>
2. *Incident Command System*. (n.d.). Retrieved from FEMA NIMS Resource Center:
<http://www.fema.gov/emergency/nims/IncidentCommandSystem.shtm>
3. Jackson, S. (2008). *Architecting Resilient Systems: Accident Avoidance and Survival and Recovery from Disruptions*. John Wiley & Sons, Inc.
4. *NIMS Document: Chapter 1*. (n.d.). Retrieved from Nims Online:
http://www.nimsonline.com/nims_3_04/introduction_and_overview.htm

LFB is one of the largest firefighting and rescue organisations in the world and we are here to make London a safer city. Decisions are made either by the London Fire Commissioner (the statutory fire and rescue authority for Greater London), the Mayor of London or the Deputy Mayor for Fire and Resilience. A Fire, Resilience and Emergency Planning Committee of the London Assembly holds the Commissioner, Mayor and Deputy Mayor to account. Executive summary. LFB is the enforcing authority for fire safety legislation applying to railway infrastructure in Greater London.Â Observations on the draft for public consultation. Resilience The ability of a Building to resist and recover from the effects of fire. SSC The Standards Setting Committee (SSC) appointed by the IFSSC to develop global standards for fire safety. Stakeholder An individual, or representative of same, having an interest in the Building and its operation.Â This has led to the proliferation of insulation products with higher thermal properties and the use of materials to accomplish these additional Building performance characteristics. Climate change and the push for more sustainable construction also bring challenges to our built environment, and societies need to become more resilient to change and disruption. In response to all of these challenging factors, construction products, processes and technologies continue to evolve. As part of the study, the authors also look at the possibility of using the principles of resilient systems design and the fundamental principles for agile systems engineering when managing critical infrastructure facilities. Keywords: agility, critical infrastructure, CURVE factors, organizational and technical system, resilience, systems engineering. 1 INTRODUCTION The authors define an organizational-technical system (OTS) as a network of groups of professionals from various domains that interact between each other and, despite possibly being part of different business structures, work fo... Observations of the resilience architecture of the firefighting and emergency response infrastructure. Insight, 45-46. Ministry of Civil Defence.Â The study of resilience encompasses the processes, disciplines, and infrastructure that need to be in place to anticipate and prevent major accidents, survive unprecedented disruptions, and maintain systems operation. Architecting Resilient Systems presents a framework for implementation that both public and private organizations can use as a guide to establishing procedures for anticipating, surviving, and recovering from disruptions. The U.S. Department of Homeland Security, in collaboration with the U.S. Department of State, has prepared this guide to serve as an overview of the approach to critical infrastructure security and resilience adopted in the United States. As attacks on soft targets and crowded places continue across the globe, the need to address current and emerging challenges increases.