France-USA High Reliability Organizing in Incident Management Teams Project

The French Connection

Just like NYPD detective "Popeye" Doyle, who traveled to Marseilles in the 1970s hit movie “the French Connection” so too, did a Forest Service NIMO team this past December. Only it wasn’t for crime busting this time. It was a landmark match-up between two French and American Incident Management Teams to capture what makes these teams so successful in complex, rapidly changing, stressful situations. It is hypothesized that they exhibit many of the behaviors that directly align with high reliability organizing (HRO) concepts and principles.

Background

David Christenson, Assistant Center Manager of the U.S. Wildland Fire Lessons Learned Center (LLC), met Fulbright Scholar Renaud Vidal in 2006 at an international, inter-industry HRO convention in Ontario California. Vidal and famed HRO researcher and Graduate Professor Karlene Roberts, Co-Director, Center for Catastrophic Risk Management, located at the University of California at Berkeley, were exploring research avenues to improve incident management during catastrophic events. They recognized this special opportunity to examine how experienced incident management teams from two different cultures would likely serve as the perfect living laboratory to discover their HRO traits and possibly improve upon them.

The following spring, U.S. Forest Service Fire and Aviation Director Tom Harbour, and Merrie Johnson, Director of the National Advanced Fire and Resources Institute further examined the opportunity and likelihood of a joint HRO research effort with Roberts, Vidal and Christenson. After their attendance at the 2007 IAWF Conference in Seville, Spain, they all formalized the France-US HRO in IMTs Project at the Valabre Fire Training Center in Aix-en-Provence. A May 2007 kick-off meeting with the French firefighting representatives cemented the initial arrangements. It was agreed to exchange IMT for the research at their training centers as well as individuals for fire assignmements between the two countries.

The France-USA HRO in IMTs Project focuses on improving Incident Management Teams' performance in complex settings, and has attracted international interest and the support of a number of public and private agencies and organizations. The project has the on-going support from: French Ministry of Environment and Sustainable Development, Department of State, Min. Affaires Etrangères (Fulbright Program), France-Berkeley Funds program, Pôle Risqué, Ecole d'Application de Sécurité Civile, SDIS13, Université Aix-Marseille III, UC Berkeley Center for Catastrophic Risk Management, U.S. Forest Service Fire & Aviation Management, the Wildland Fire Lessons Learned Center (LLC), and the National Advanced Fire and Resource Institute (NAFRI).

During the 2007 fire season Renaud's researchers observed several U.S. incident management teams on fire assignments and followed the National Incident Management Organization - Atlanta Team (NIMO) during their deployment to the East Zone fire in McCall Idaho. These observations helped establish a base line of data and ensure research continuity. The previous two years, Vidal had tracked the workings of one of France's top firefighting IMT.

For more then twelve hours every day for thirty four days most members of the Atlanta NIMO team were fitted with small audio recorders to capture data for the researchers to analyze. In addition, the researchers attended most of the operational briefings, command and general staff, tactics, and planning meetings as well as holding interviews with the team and making numerous field observation trips throughout the incident.

Later that year as a precursor for the simulation, NIMO IC George Custer, NIMO Planning Section Chief Darrel Schwilling, and Cleveland National Forest's ADFMO John Truett, were invited to France during the winter of 2007 to work out preliminary details and view the proto-type simulators. A result of this trip was the decision to augment the NIMO team with several additional operational positions to satisfy the research requirements and simulation model.

The Simulations

November 2008, HRO project leader, Renaud Vidal in concert with his associates at the Université Paul Cézanne, his HRO research team from the University of California at Berkeley, and his Graduate Professor Philippe Beaumard at the University of Aix-Marseilles, crafted three simulations that placed the US and French teams in high tech virtual wildfires; each with different and growing challenges and complexities. To help ensure integrity of the US approach in wildland firefighting methodologies, NIMO Safety Officer Gene Madden was made part of the HRO simulation team.

Scenario Overview

	Scenario S1 *4 hours*	Scenario S2 *4 hours*	Scenario S3 *6 hours*

HRO related objectives	Performance will depend on the effectiveness/speed of collective action	Performance will depend on the accuracy of the situation assessment.	Performance will depend on the accuracy of the situation assessment and effectiveness of implementation.
Dynamics Uncertainty/ Equivocally/ Complexity	High tempo *Tight coupling with the environment (errors will be catastrophic)* *Linear, classical, stable situational trend*	Moderate tempo *Loose coupling during the exercise* *(errors are possible during the exercise, but errors of assessment are catastrophic for the next operational period)* *Changing, complex situation*	Moderate to high tempo *Tight coupling* *Complex int.*
Type of incident	Initial/Extended attack in WUI	Large Fire in WUI	Catastrophic fire in WUI
Type of inputs/sim team framework	No surprise	Inputs are equivocal, partial, enhancing complexity	Enhance complexity and require immediate resolution
Evaluation by outside experienced FF: main criteria	Are the objectives given by the Agency Administrator during the in briefing met?	The plan for the next operational periods	Management of current operations and plan for the next operational periods

Project Methodology

Prior to the start of the Sims basic ground rules were provided to each team. These instructions included that the goal of the simulation exercises was to compare High Reliability Organizations (HRO) and related organizational behaviors during incident operations. Comparisons of national strategies, such as doctrines for resource pre-positioning, resource ordering effectiveness were not examined. Further, to ensure a level playing field, the simulations were set up so that the similitude was not impacted. Both teams were asked to work as close as possible to their normal operating modes.

There were four research modules of particular interested:

- HRO Module 1: managing the tension between control and mindfulness
- HRO Module 2: operationalizing HRO concepts

- Stress Module 3: mitigating organizations' vulnerability to stressful situations

- Emerging emergency network Module 4: studying the interfaces between emergency responders, media and threatened communities

HRO Module 1: Managing the Tension between Control and Mindfulness

Research question

Organizations need to:
- Stabilize meaning/organization's interactions to make the world more predictable, save resources, and act collectively and timely on situations
- Update their representation/come up with novel responses to a changing environment

Processes that enable both demands to be met interact in a complex manner: sometimes complementarily but most often conflictingly.
Ex: - Ignore noise versus pick up on weak signal
- Buffer from stress versus develop the ability to improvise

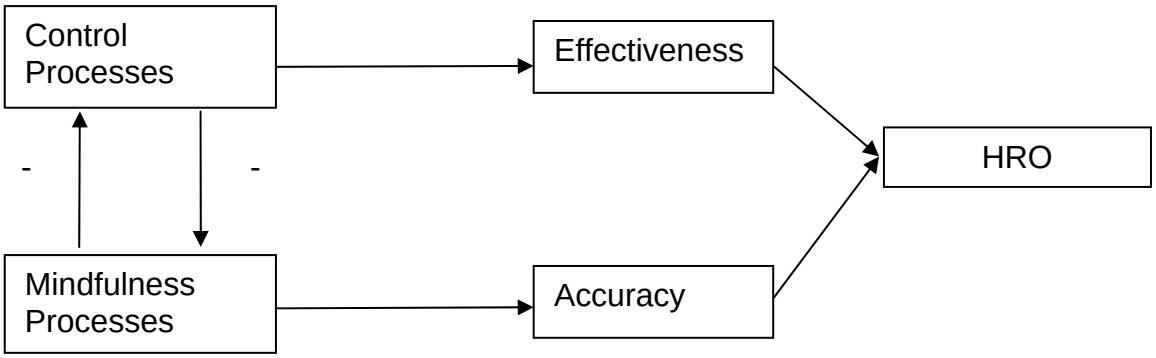
For the research *control processes* and *mindfulness processes* were defined as follows:

Control processes: enforce the norms, ignore noise, develop shared language, labels, expectations and interpretative frameworks, buffer from stress . . . and enable to act effectively and collectively.

Mindfulness processes: pick up on weak signals, develop conceptual/behavioral slack, sensitivity to operations … and enable to detect and act upon (small) changes in environment or small errors within the organization.

The Project proposed that High Reliability comes:
- less from the development of sophisticated "mindfulness" processes (Weick et al., 1999)
- and more from the ability to manage successfully the tension between "mindfulness" processes and "control" processes.

High Reliability was expected to be found in organizations that change and adapt while remaining coherent, through their ability to manage the dynamic tension between effectiveness and accuracy/plausibility, robustness and vulnerability, resistance and fragility, adaptation and adaptability.



The HRO Project hypothesis was:
Management of tensions →Expression of control processes as well as mindfulness processes →coherence and adaptability→High Reliability Organizing

Vidal and his team reviewed the HRO literature in the light of this tension, and re-interpreted the findings in terms of tension management strategies. They found useful to classify these findings according to the four ways of resolving paradoxes proposed by Van de Ven & Pool ("paradoxical requirements for a theory of organizational change", 1984).

- Both processes operate alternatively in time
- Both processes operate at different organizational levels
- Live with the conflict
- transcend the paradox (and usually find a new one …)

Researchers compared this review with their field observation of IMTs on large and complex fires during the past 2 years both in France and the U.S. Several strategies identified in the literature were found to be used, new ones were discovered. The result of this study is available on another document. The goal of the simulations was to observe the strategies used by the two teams in a controlled environment.

Data collection
- IMT members' video taped interactions
- Debriefings
- Any documents produced by the team detailing the plan for the next operational periods
- Objectives given by the agency administrator

Data analysis
- Simulation scenarios

S1 is linear with high tempo. It is designed to create the conditions for the team to express control processes only.
S2 is complex with moderate tempo. It is designed to create the conditions for the team to express mindfulness processes only.

S3 is complex with high tempo. It is designed to create tensions that HROs are supposed to manage successfully.

- Coding:
  - Identification of critical events (by researchers, experienced firefighter, debriefings questions)
  - The analysis will be focused on time periods prior to critical events
  - Coding of types of interactions will be performed to identify control processes and mindful processes
    - S1 will be used to confirm/adjust our coding of control processes
    - S2 will be used to confirm/adjust our coding of mindful processes
    - After ad-hoc adjustments will be applied for S3 to code processes
- Analysis:
  - Identification of tension management strategies in S3
  - Relating strategies to performance conducted by combining:
    - The evaluation referential (are objectives met? what is the quality of the plan for the next operational periods?)
    - Evaluation of expert FF
    - Comparison between US and FR IMT
      - Case n°1: a team does better than the other
        The reason why will be analyzed through differences in tension management
      - Case n°2: the teams' performance is identical
        Similar tension management strategies will have greater external validity

- Expected outcome: re-conceptualization of HROs as successful at tension management

HRO Module 2: Operationalizing HRO Concepts

Research question

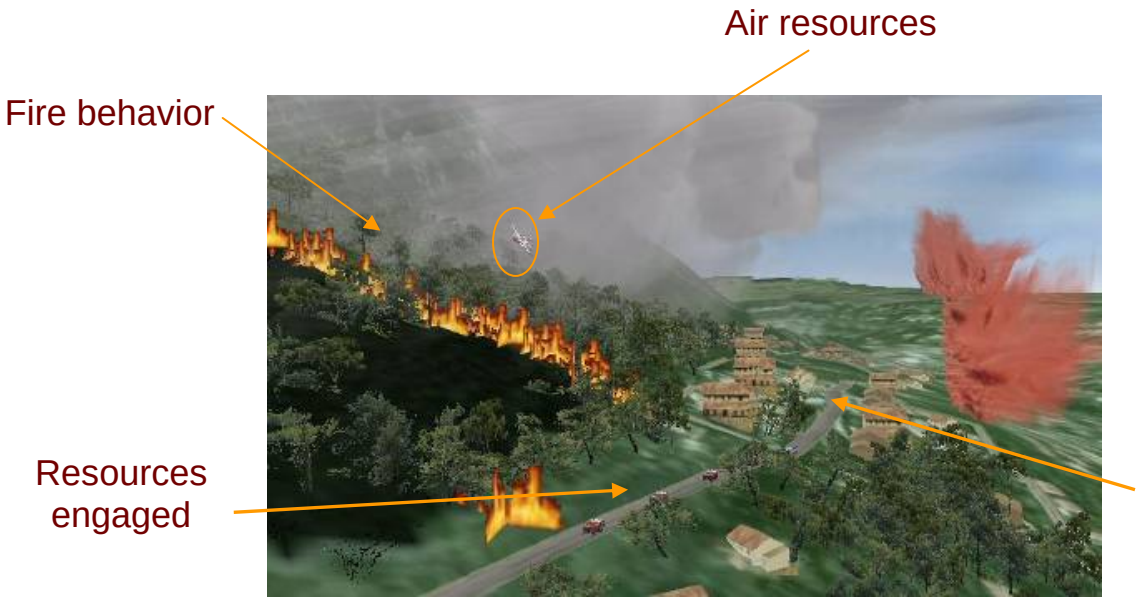
This module seeks to operationalize key HRO concepts

→ Requisite Variety
→ Situational Awareness
→ Structural fluidity
→ Resilience

Data collection

- Communication network (all communication are taped)

- Simulation objects appearing on the screens (all screens are video taped)



Screen of the branch director

- Existing simulations objects (a specific view of all sim object is recorded)

<u>Data analysis</u>

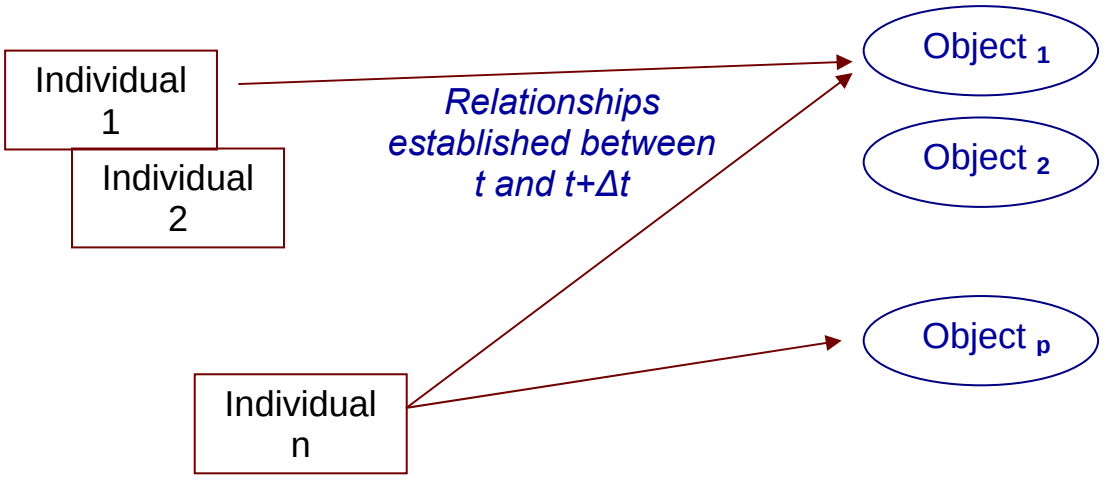
STEP 1: the following three are constructed to be analyzed:

- **Communication network**

As a reminder, the typical communication network measures are:
→ Individual measure
- in/out degrees, diversity, closeness, betweenness, centrality, prestige
- individual profile: star, liaison, bridge, gatekeeper, isolate
→ Team's profile
- reachability, connectedness, redundancy, centralization, symmetry
→ Sub-systems and type of couplings
- Long and infrequent interactions = loose, short and frequent=tight

- **Bimodal network**

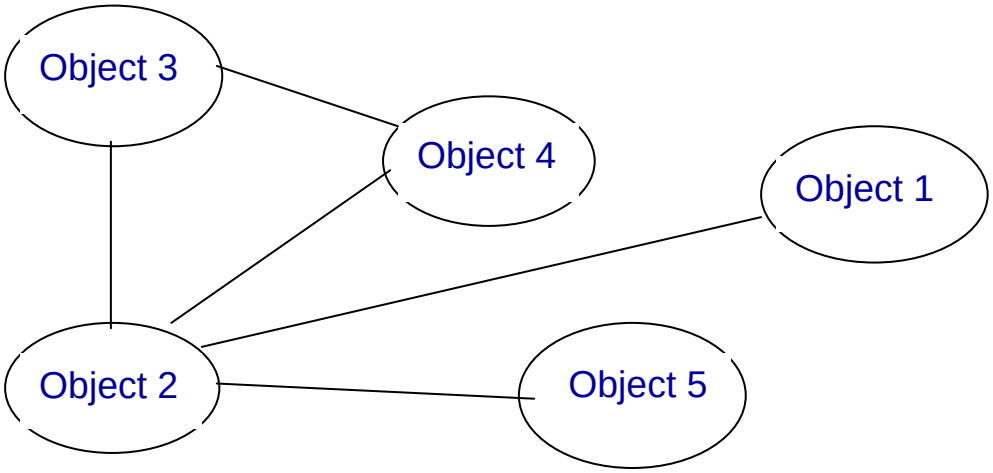
This network is constructed on the basis of: who sees what object?



- **Objects network**:

This network can be constructed by application of the following rule:

Two simulation objects are linked together if they are seen:
- by the same individual (bimodal network), or
- by two different individuals who communicate (bimodal + communication networks)



STEP 2: the construction of these 3 networks allows us to build the 4 following measures:

→ M1 - what is known/what is to be known?
= nb of objects seen/nb of objects to be seen
→ M2 - how much is situational knowledge overlapping?
= redundancy of the bimodal network
→ M3 - how much is knowledge about objects interconnected?
=density/connectedness of the object network

→ M4 – characterization of communication patterns (distributed, centralized . . . .)

STEP 3: Operationalization of key HRO concepts

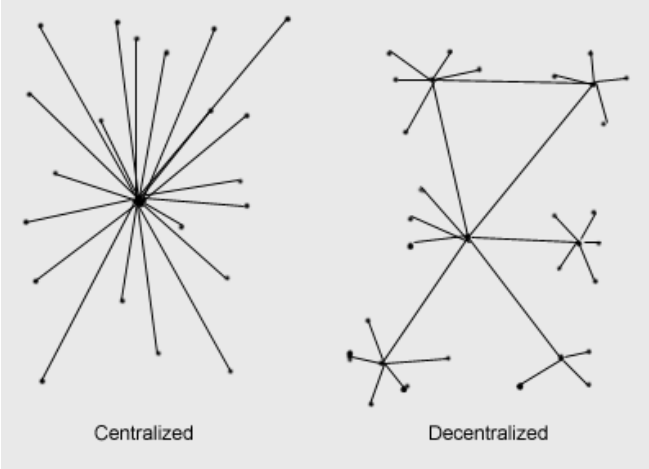
Operationalization of Requisite Variety:

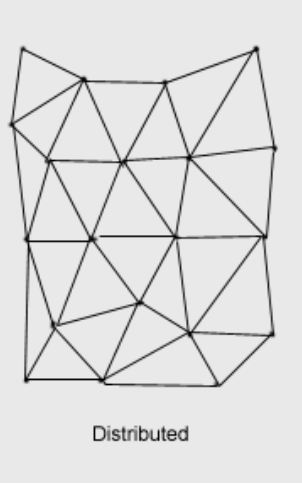
→ M1: what is known/what is to be known?
→ M2: how much is situational knowledge overlapping?
This measure defines the degree of "variable disjunction of information" (Turner, 1978), that can be harmful.
→ M4: communication patterns – i.e., how much situational knowledge is shared among the team?

Operationalization of Situational Awareness:

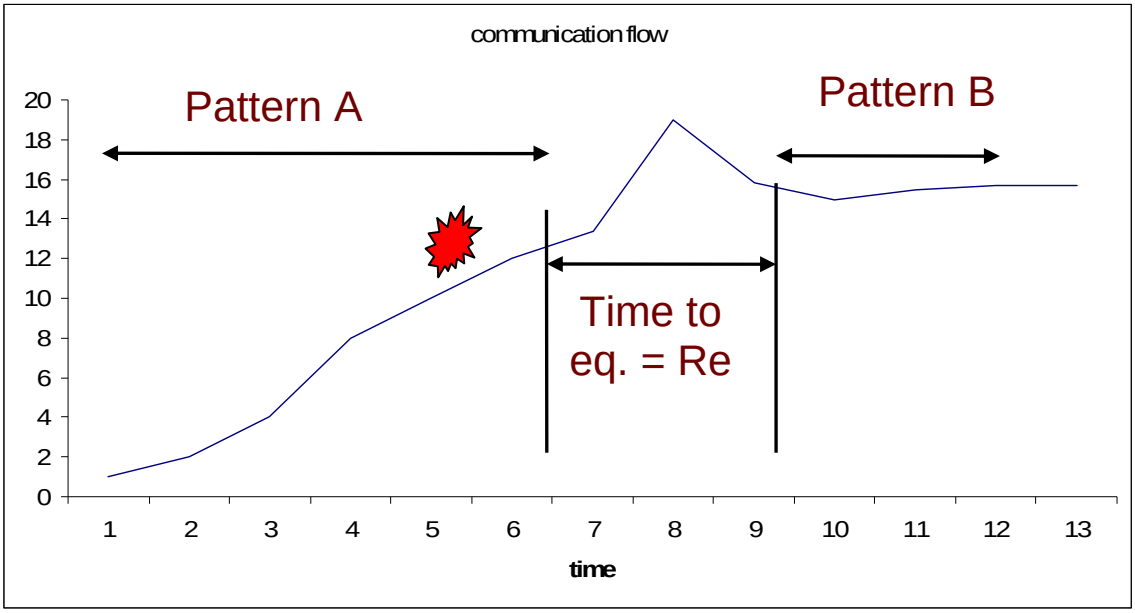
→ M1 - what is known/what is to be known?
→ M3 - how much is knowledge about objects interconnected?
as a predictor of how objects interrelate for short term projections.

Operationalization of Structural Fluidity
→ Variance in M4 (patterns of communication)





Operationalization of Resilience



- Time between two measures of M4, statistically significant (when the interaction pattern is stabilized).
- M3 - how much is knowledge about objects interconnected?

as a predictor of the ability to recombine objects for the sake of improvisation.

STEP 4: Tests on Sims Data

At this stage, the researcher sought to find the best function characterizing each concept's measure. Each exercise had on average 6 major inputs. Since there are 6 exercises, the total number of inputs was 36. The study considered each input in terms of requisite variety, situational awareness, fluidity or resilience on theoretical grounds. For example, there are 9 inputs that need high situational awareness at the team level to be dealt with successfully.

For each of these 9 inputs, it was asked of the SMEs whether the input was successfully dealt with. With 9 observations of the dependant variable (degree of success) and the independent variables M1 and M3, Vidal and his team were looking to find the best statistic based on M1 and M3 predicting success.

Stress Module 3: Mitigating Organizations' Vulnerability to Stressful Situations

Several members of both teams voluntarily consented to have heart-rate monitors attached so that their cardiac stress levels could be monitored during the scenarios for additional scientific research purposes.

Heart coherence is an indicator of the degree of arousal of the autonomic nervous system. The bridge between the High Reliability Organizations theory and arousal of the autonomic nervous system is Mandler's theory.

High Reliability Organization theory is interested in how organizations anticipate and/or contain errors/crisis before they enlarge into catastrophic failures. Crises are associated with interruption of plans or cognitive structures or unfolding actions. Stress is an example of such interruption and informs such mechanisms.

Stress is known to cause the following behaviors in organizations (Weick, 1990):

1- Regression to first learned responses
2- Narrowing of perception (tunnel vision), due the arousal of the autonomous nervous system absorbing information processing capacities
3- Breakdown in coordination: the team stops being synergic (Hackman, 1987)
4- Salience of hierarchy and formal authorities, inducing distortion in communication (to please the receiver) through behaviors such as gate keeping, summarization, changing emphasis, withholding, …

The general HRO related research issues in the study addressed the question of how to mitigate the organization's vulnerability to stressful situations.

For example, over-learning is at first sight an effective strategy to buffer individuals from stress. However, over-learning heightens the ANS arousal when the interrupted routine is no longer working, increasing the chances of perceptual narrowing, and consequently decreasing the ability to cope with the disruption. There seems to be a tension between processes that contribute to buffer from stress and those that enhance the organization's ability to improvise. How is this tension to be managed successfully?

Further, the following exploratory questions were asked:

- What are the impacts of stressful situations at the individual/team level? Do we find the same expected effects: regression, narrowing of perception, breakdown in coordination, salience of formal authority? If there are other effects, what are they? If there are less effects, why?
- If there is a significant difference between the US and FR team, how is this variability to be explained?

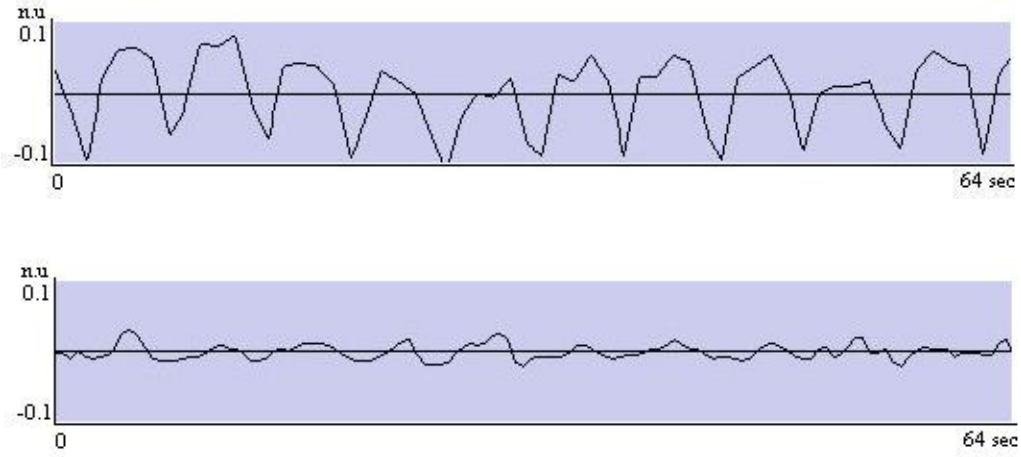
Data collection

Measures of heart coherence were performed by Symbiofi/CHRU (a medical research center in France). The same four IMT members were equipped for each exercise.

Data analysis

- Stressful sequences were identified through low measures of heart coherence and expected to take place after the main Sim team inputs (example “dispatch signals that children have been seen near the head of the fire”).
- The impact of stress were analyzed through:
  - The viewing of video taped stressed individuals by an expert FF (to spot regression, narrowing of perception or other impacts)
  - Analysis of communication network pattern changes enabled researchers to identify breakdown in coordination and salience of hierarchy
- For the same team variance in impacts for different scenarios were identified.
- For the same scenario (stressful inputs), variance in impacts were identified.

For these last two items, the dependant variable was the variance. The independent variables expected to be found by this exploratory analysis, were mainly in relation with the nature of team interactions (Weick, 1990; Hackman, 1987).



tachograms

Emerging Emergency Network Module 4: Studying Interfaces between Emergency Responders, Media and Threatened Communities

The idea was to analyze the emerging interaction network between emergency responders, the residents threatened by the fire and the

media. The ultimate goal was to create the conditions for a synergic cooperation. This round was exploratory.

Scenario Specifications

Both teams were asked to stretch a little in their normal processes/standards due to language and some fundamental organizational and firefighting differences. (See box below) However, the overarching goal of each simulation was developed to see how the individual team made sense of the situation as well as act decisively during operations in each more complex situation given to them.

Actual Scenarios

The Silverwood Lake fire was first test for the teams. The scenario was located in an area with the type of terrain, fuel model and weather often found in southern California. However, the teams were cautioned not to assume similarities such as weather patterns or evacuation preparations with the actual San Bernardino National Forest area despite the obvious use of it as a model for the simulation.

French FF "approaching the fire" from one of the simulation booths. Note the black column of "smoke" above the road.

HRO research designers with input from representatives from both the Forest Service's National Incident Management Organization - Atlanta team and the Bouches-du-Rhone's SDIS13 IMT selected this geographical location due to its'

similarity to the terrain found in much of the Mediterranean. On the Silverwood Lake fire, both IMTs were confronted with red flag conditions that pushed a fast growing fire to evacuate a restaurant and threaten the community of Silverwood Lake.

OPS Bob Houseman (left) and PSC Darrel Schwilling (right) confer over the 215 during a Sim

On the next day for the second simulation, both teams found themselves contending with red flag conditions again; this time with a growing wildfire north of the fictitious Lake Arrowhead Country Club in the San Bernardino National Forest. Rough, steep, rocky, rugged terrain was par for the course.

Researchers monitored the behavior and communication of the teams as they were challenged with subtle input signals such as wind shifts and previously unrecognized smoke sensitive centers (hospital). Tossed in for good measure were: lost hikers, false spotting reports, rumors, traffic congestion and visiting VIPs.

US team IC George Custer is "interviewed" by the media during Sim 2

The third and final challenge for the teams was the Devils' Hole fire. Again, the backdrop was the Mediterranean-like San Bernardino plateau country. Long term drought, high temperatures, strong winds, extreme fire conditions and an escaped 5000 acre wildfire greeted the teams when they took over command in this scenario from a type 3 IMO.

Colonel Luc Jorda (wearing the yellow vest) the French team IC discusses tactics with his C&G

	General Observations
1	• The hospitality of the French to the US IMT in assisting with the logistics and translation to ensure a well rounded experience was commendable.
2	• The French firefighters are well trained in multiple disciplines and respond to more than wildland fire. This expertise helps when running into other situations during wildland fire operations.
3	• The US IMT was comprised of firefighters from across the Nation – some of which never had worked together. This tested the concept of the ICS and HRO process which is standardized for this purpose. It proved to work very well and allowed individuals who had never worked together to perform soundly.

	Some Observed Notable *Similarities* in Organizational Concepts
1	• While some operational differences were noted, both the French and the US team developed remarkably similar tactical plans during the SIMs and completed the exercises largely with the same results.
2	• The French "Anticipation" unit is similar to what the US is attempting to do with the Wildland Fire Decision Support System (WFDSS). How they utilize anticipation should be evaluated to further develop the

	concepts of integrating decision support during the incident. The general concept of the French is similar to the way the US organizes to deal with an incident. The areas of responsibility differ slightly but the process of the team still ensures that the duties are accomplished. *(**Author's Note:** the teams differed by the degree of centralization. That is the French team displayed a centralized decision-making process (or, in other words, top-down), while the US team had a more decentralized or distributed decision-making capacity. To illustrate, in the US model, tactical decisions are decentralized from Operations to the fireline exhibiting a "doctrinal" approach to decision making. In contrast, the French process is more centralized routing tactical decisions through the IC before executing on the ground.*

	Some Observed Notable *Differences* in Organizational Concepts
1	• Having the Prefect (typically a "county or regional executive" level governmental position in France – but may also be at a National level too) as the "overall Agency Administrator" was an effective approach. This allowed the IC to have one individual to deal with when there are multiple jurisdictions and allows for a single point of contact for all the socio-political challenges that arise because of the incident.
2	• During the evaluation of the French team, the US team noticed that tactically the French used direct attack more frequently and indirect tactics used by the US are not as common in the French firefighting culture. *NOTE: France's fuels, geography, population density's are not conductive to indirect attack. Thus, the French fight fire from the road systems generally. They do not have hand crews or equipment that constructs fire line (as we do in the US). They have identified a number of locations where they have prepositioned permanent dip tanks and water reservoirs for engines to fill their tanks.*
3	• The French have excellent firefighting equipment. Their equipment reflects modern technology for fire safety. When the French places an order, they know exactly what type of equipment they are receiving, where the US has so many different types/kinds of equipment, it makes it difficult to gage the capability of equipment.
4	• The French use GPS locators on all of their equipment, so if a firefighter is trapped they can set off an alarm to notify dispatch which allows for aviation resources to be notified with a specific location so air drops can assist them immediately.
5	• The technology that the French use to track their resources through GPS is modern and allows for the accurate tracking and knowledge of what resources are being used and what is available to be reassigned.
6	• All fire vehicles have safety devices installed with drop down oxygen masks and external sprinkler systems to help prevent vehicle burnovers.

7	• French air tankers are able to drop in tandem which is an effective technique and should be revisited by the US.
8	• On high fire danger days, the French fly their air tankers in the vicinity of where there is high fire probability so they can readily respond.
9	• In France, laws require homes and buildings to be built to withstand fire. This aids the French firefighters in allowing more sheltering in place when dealing with wildland urban interface issues. Additionally, French insurance companies do not reimburse for loss of property for approximately two years after the loss and reimbursement is limited.

Some Other Differences between French & U.S. Wildland Firefighting	
French Firefighters	*US Wildland Firefighters*
IC is a "hands on" commander and directs both strategy and tactics	IC approves operations developed by the C&G. Ops does tactical decision making down to DIVS
Uses a ground-based air attack	Air attack is an aerial platform
Does not have "Hotshot" crews	There are approximately 100 Hotshot crews in the US that are used extensively
Wear standard European-style FF bunker gear	Wear PPE that complies with NWCG & NFPA standards
Most wildfires of short duration	Long term wildfires are common
Recently embraced the concept of safety officer - as a collateral duty	The dedicated safety officer position has been an integral part of U.S. wildland response for over a decade

Conclusions

Vidal and his research team continue to examine the results from the joint exercises at Valabre. He plans to carry on his HRO research between the French and American firefighters and hopes to return to the US to further observe fire management processes. Vidal believes that this research will strengthen international cooperation, serve as a platform for sharing new ideas, and improve operational training techniques and knowledge. In fact, this was evidenced in Colonel Jorda's close out remarks when he observed that the European countries lack a common system where all countries could function together and that he saw the usefulness of ICS, the approach that the US employs.

In the meanwhile, other countries and entities have expressed an interest in the Center for Catastrophic Risk Management and HRO, including the European Union and the United Nations.

One of the French pilots “flying” a CL 415 “over” the Devil’s Hole fire.

For more information on HRO and the French-American Project visit:

http://www.wildfirelessons.net/HRO.aspx

http://iber.berkeley.edu/ccrm/index.html

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