

## Cultivating a reluctance to simplify: exploring the radio communication context in wildland firefighting

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**Abstract.** Although communication is often cited as a contributor to organisational accidents, complexities of the communication context are still understudied. In training materials and some investigative reports, communication is often presented as an equipment issue or as a simple skill that can be picked up on the job. However, interviews with operational and managerial professionals in wildland firefighting reveal 10 simplifications in guidance about radio communication that do not match the complexities experienced by firefighters in the fire environment. Borrowing language from high-reliability organising theory, this study encourages the fire community to cultivate a ‘reluctance to simplify’ how communication is understood and taught, starting with introductory training. The study recommends a move away from the old information transfer model for communication and towards an ecology of meanings model for communication.

**Additional keywords:** training, high-reliability organising.

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### Introduction

Communication is foundational to wildland firefighting, as evident in coverage in the National Wildfire Coordinating Group (NWCG) S130 (Firefighting Training) and S190 (Introduction to Wildland Fire Behaviour) courses and a dedicated section in the Incident Response Pocket Guide (IRPG). Firefighters are advised to send complete messages, to provide clear instructions and to close the feedback loop by incorporating checkbacks. Such communication advice is echoed in lessons learned analyses, such as in ‘Is your communication adequate?’ produced by the [USDA Forest Service Pacific Southwest Region \(2014\)](#), where one finding reads ‘Critical information, thought to have been relayed, was not being received by the dispatchers’ ([USDA Forest Service Pacific Southwest Region 2014](#), p. 1). Lessons learned include:

- Assure pertinent incident information is both asked for and communicated up.
- Good two-way communication allows for proper planning, resource assignments and upward reporting.
- Command structure of incidents should be communicated to on-scene and incoming resources, by Dispatch and IC [Incident Command].

- When updates and resource ordering are communicated in a clear manner, it instils confidence in those responding to and monitoring the incident.
- Resource ordering should be done by ICS [Incident Command System] type, kind and number needed. ([Anon. 2014](#), p. 1)

These characterisations of communication, particularly for radio, adhere to a classic ‘information transfer’ model for communication ([Shannon and Weaver 1948](#)). Likely suitable for experienced firefighters, it may be difficult for beginning firefighters to know what it looks like in practice to be ‘clear’ and to ‘ensure information is “communicated up”.’ In fact, without such additional context, and because communication is already a cultural commonplace ([Craig 1999](#)), these prescriptions may sound obvious, and may oversimplify (at least for beginners) the actual complexities of communication in the fire environment.

Similarly, for years, serious accident investigations attributed communication problems to problems with equipment and with individual messages sent and received. The South Canyon Accident Investigation Report ([Wildland Fire Lessons Learned Center 1994](#)), for example, lists ‘Dispatching procedures and communications with the Incident Commander did not give a

clear understanding of what resources (crews and air support) would be provided to the fire in response to requests and orders' (Wildland Fire Lessons Learned Center 1994, p. 4), and 'radio communication was inadequate for the fire load and was recognised as a potential problem ...' (Wildland Fire Lessons Learned Center 1994, p. 7). (See also Wildland Fire Lessons Learned Center 2003; Wildland Fire Lessons Learned Center 2006; Wildland Fire Lessons Learned Center 2014.)

In recent years, accident investigations have begun to grapple with more complex communication issues. For example, in June 2013, 19 firefighters died on the Yarnell Hill Fire in central Arizona. The Yarnell Hill Fire Serious Accident Investigation Report (YHFI Report 2013) specifically addressed communication, twice. As with past reviews, the report first focused on difficulties with equipment:

Radio communications were challenging throughout the incident. Some radios were not programmed with appropriate tone guards. Crews identified the problem, engaged in troubleshooting, and developed workarounds so they could communicate using their radios. Radio traffic was heavy during critical times on the fire. (YHFI Report 2013, p. 2)

However, the second mention captures a more complex understanding of communication:

Although much communication occurred among crews throughout the day, few people understood Granite Mountain's intentions, movements, and location, once they left the black. The Team believes this is due to brief, informal, and vague radio transmissions and talkarounds that can occur during wildland fire communications.

This second instance goes beyond problems with equipment and with messages sent and received. It defines communication in terms of problems of coordination between and among individual groups, including over the radio. It also acknowledges radio communication practices that may be well known but not necessarily functional.

Of late, the fire community is acknowledging communication problems that are more complex than can be accounted by the dated information transfer model. Additionally, newer organisational learning tools are emerging that can address problems of communication and coordination, such as Facilitated Learning Analyses (FLAs – an often in-depth process used to capture lessons learned after unintended outcomes including interviews, facilitated dialogue and site visits), Rapid Lessons Shared (RLS – brief reports written quickly after incidents to capture and circulate lessons), and After Action Reviews (AARs – a process used by a team to enable sense-making and capture lessons learned). Ultimately, what is needed is a model for communication that can account for the complexity of communication in interagency coordination and in scalable Incident Command on complex incidents on the one hand, and one that members of the fire community can adapt as they become more experienced and face more complexity in their roles on the other.

### Cultivating a reluctance to simplify communication

Embracing an appropriate communication model is not just a theoretical concern. It is a practical one. The effective management of risk is a primary concern in wildland firefighting and relies on effective communication. Although scholarship and practice in risk management continue to search for the essence of what helps an organisation to manage risk, the work of Weick and Sutcliffe (2001, 2007) on high-reliability organising (HRO) provides a language for the complexity that is being managed and discursive tools for organisational members to reflect on their own risks.

Indeed, HRO has been used to explore risk management in fire operations with the goal of understanding mindfulness and sense-making (Weick 1993; Putnam 1995), for example. Illustrating the connection between language use and mindfulness, Thomas *et al.* (2015) argue, 'We are better thinkers and more informed managers when we remember that language is powerful and structures our thinking in particular ways' (Thomas *et al.* 2015, p. 11). Their work falls into a growing body of research aimed at operationalising the principles of HRO mindfulness and bridging theory and practice (e.g. Weick and Sutcliffe 2001, 2007; Bearman *et al.* 2010; Black and Baldauf McBride 2013; Vidal and Roberts 2014).

We know from existing research that highly reliable organisations in other industries, such as aircraft carrier operations (Rochlin *et al.* 1987) and hospital administration (Berwick 2007), exhibit certain hallmarks that represent habits and practices cultivated by professionals in everyday operations. One such hallmark is a 'reluctance to simplify interpretations', or resisting oversimplification and assumptions.<sup>a</sup> Because communication is cited repeatedly as a factor in unintended consequences, then it is important to explore where the fire community may be oversimplifying and find ways to complicate old ways of thinking. Therefore, in the present paper, we extend the notion to 'reluctance to simplify communication'.

The present paper is part of a larger project by a team of researchers and practitioners to develop a set of tools that can help members of the fire community understand and manage the complexity of communication in an increasingly complex fire and operating environment. In this particular paper, we focus on radio communication because radio is a major communication modality and because members of the fire community already associate the radio with communication in reflective practice. The paper proceeds as follows.

First, the literature review shows how existing communication research covered in the International Journal of Wildland Fire (IJWF) tends to focus on community and public relations (e.g. Shindler *et al.* 2009). In other outlets, advances in human factors, risk management, leadership and HRO represent attempts to grapple with increased complexity in the fire environment, but only indirectly focus on communication, with a few notable exceptions (e.g. Ziegler and DeGrosky 2008; Lewis *et al.* 2011; Gabor 2015). The literature review concludes

<sup>a</sup>Additional hallmarks include preoccupation with failure (a perpetual suspicion that something has been overlooked), sensitivity to operations (paying close attention to how all aspects of the organisation are functioning together), deference to expertise (a willingness to allow those with the skill, experience and knowledge to make decisions regardless of rank or title), and a commitment to resilience (learning from unintended outcomes and developing plans to manage unexpected events).

with the observation that, to date, the fire community lacks a systematic, comprehensive, communication model (and related vocabulary) for understanding, diagnosing and solving complex communication problems in fire operations, and for conveying lessons learned that can be incorporated into training and development going forward. We briefly introduce communication as the ecology of meanings (Campos 2007) as an alternative model.

Second, we review official guidance about radio communication, and note how materials produced tend to be *ad hoc* and not centrally located, and present radio communication as easy to learn and largely a matter of equipment handling. In search of an appropriate method, we take a cue from ‘deep smarts’ research on HRO, e.g. Thomas *et al.* 2015, who claim that these habits and practices are evident in the expanded vocabulary of professionals when they talk about complexities of the environment and their adapted skill sets. In other words, expert practitioners cultivate a ‘reluctance to simplify’, and it is possible to hear this in their talk about actual practice.

Third, as part of our methods, we asked mid-level operational and managerial fire practitioners to talk about their experiences with radio communication and to reflect on factors that contribute to communication effectiveness in operations. Our goal was to mine the articulated experiences of expert communicators to map the complex communication landscape as they perceive it and to begin to capture their advice about best practices.

In the results, we distil 10 simplifications (e.g. ‘communication is easy’ and ‘you’ll pick it up’) and we juxtapose these with interviews that reveal the more complex lived experiences and practices of operational firefighters. Finally, in the discussion, we posit that to improve system reliability, a similar reluctance to simplify communication should be cultivated within the broader fire community, starting with initial training. To this end, we offer recommendations for how to teach communication to beginning firefighters. Finally, we call for further exploration of the ecology of communication in future research.

## Literature review

As the flagship journal for the wildland fire community, the *IJWF* has traditionally focused on technical topics like fire behaviour and fuels management research. As attention to human factors has grown, *IJWF* has included studies about communication. To date, communication has been discussed primarily from a public relations or community relations perspective (e.g. Shindler *et al.* 2009; Olsen and Sharp 2013), public participation in fuel loading assessment (Ferster and Coops 2014) and training for land-management practitioners (Mickler *et al.* 2013). As one recent exception, Gabor (2015) reviewed the cultural and technical barriers to effective communication by radio in wildland firefighting, drawing attention to incidents where ambiguous, assumptive or incomplete wording was a contributing factor to accidents and fatalities. The study drew attention to the role of vocal tonality in radio communication, as well as the need for more training on the crafting of radio messages.

Elsewhere, advances in research and practice in human factors, risk management, leadership and HRO attempt to grapple with the human complexities of the fire environment.

Studies of mindfulness and self-compassion, and insights about high-reliability practices can be found in the work of Black *et al.* (2013), Lewis *et al.* (2011), Waldron and Ebbeck (2015) and Waldron *et al.* (2015). These studies address communication, but only indirectly. Communication has been studied directly in models for practical leadership development. For example, in tracing how ‘leader’s intent’ was imported from the military, Ziegler and DeGrosky (2008) tracked how leadership as a cultural process of cultivating shared mind was flattened into a model of leadership that was about transmitting forceful messages. To date, few studies have focused on communication in fire operations and its potential interplay with training. One specific study to focus on communication in operations was offered by Lewis *et al.* (2011), who examined self-silencing in upward voice among novice firefighters. They found that firefighters early in their careers are more likely to silence themselves when they perceive risk and rely on experienced colleagues to maintain safety. Although the authors discussed self-censorship in relation to career stage and experience level, there was no specific focus on a communication medium (e.g. radio, cell phone or face to face).

## Practical literature

In the practical literature, radio communication has been discussed by several communication coordinators, experienced trainers and firefighters in newsletters and professional magazines such as *Fire Management Today* (e.g. Varone 2003; Whiting 2006; Ferranti 2008; Frederick and Tuominen 2009; Shouldis 2013) and *Two More Chains* (e.g. Rosenthal 2014). For example, Frederick and Tuominen (2009) highlighted the importance of radio etiquette, including the need to censor negative emotions such as anger or panic on the radio and avoiding pointless radio traffic. From a training perspective, Whiting (2006) wrote about the importance of radio drills and of developing a strong familiarity with the radio.

Additional training documents and articles were published online by particular forest organisations (Nelson 2012), the National Wildfire Coordinating Group (2012, <http://www.nwccg.gov>, accessed 4 July 2017) or Wildfire Magazine (e.g. Peltz-Lewis and Godson 2013, <http://wildfiremagazine.org/article/it-part-1-tablets-smart-phones-and-%E2%80%A8common-operating-picture-intelligence/>, accessed 4 July 2017). Because these resources are dispersed and challenging to locate when trying to research radio communication practices in wildland firefighting, we assume they are similarly challenging for those attempting to learn and practise.

In the next section, we explain the information transfer model and contrast it with the ecology of meanings model.

## Information transfer model

The dominant communication model used and taught in firefighting is the oldest in the communication field: the sender–receiver communication model by Shannon and Weaver (1948), also known as the information transfer model. This model regards communication as occurring between a speaker and a receiver who are transmitting messages to one another by a particular medium (e.g. telephone, radio, face to face). Because the sender–receiver model is transactional rather than interactional, it focuses

our attention on the sender's role while the receiver is simply a person waiting to become a sender. This model invites us to equate communication with *transmission* and assumes that the meaning of the message resides primarily with the sender.

This model may help to understand the mechanics of communication but it does not recognise, for example, the complexity of communication environments where multiple speakers with potentially different goals interact with various degrees of power and authority. When applied to firefighting, the transmission model may help explain the surface transaction of messages that happens in the moment over the radio, but does not account for the formative, cultural influence that past interactions (both on- and off-duty) may have had on a firefighter's emotions, attitude and expectations regarding future interactions. Arguing generally, communication theorist Robert Craig (1999) described the transmission model as 'philosophically flawed, fraught with paradox, and ideologically backward' (Craig 1999, p. 7) and argued for its replacement with a model that conceptualises communication as a 'constitutive process that produces and reproduces shared meaning' (Craig 1999, p. 7).

#### *Ecology of meanings model*

A more helpful perspective on communication is a constitutive one that recognises how communication creates our social reality. One such model is the ecology of meanings model (Campos 2007), which takes a critical constructivist approach. In this model, communication is both interactive and historic, 'dialectically dependent on the historical evolution of social constraints derived from the concrete economic conditions of life and from the way public and private administration molds the insertion of individuals in society' (Campos 2007, p. 395). Campos suggests that communicators have both an inner response (e.g. emotions) and outer response (e.g. will to act) to an interaction, as they form configurations of meanings (constructed and co-constructed images of the world). These configurations of meanings may or may not be assimilated or accommodated, but humans have the ability to process numerous such configurations and language possibilities, which allows the creation of knowledge in dyads, small groups or larger communities, organisations and societies. This dynamic interplay is what forms a social environment (Campos 2007). Given the complex realities of firefighting, where individuals negotiate physical, social, cultural and political constraints, this approach to communication may have more explanatory power. Campos' model has been used to analyse communication in networked communities and organisations (Yang and Taylor 2015), and to understand how different attitudes develop across cultures (Grabovschi and Campos 2014).

When applied to firefighting, Campos' model can help understand how communication interactions prior to organisational entry, while on and off duty, and one's physical and psychological experiences combine to create configurations of meaning that communicators negotiate moment by moment and that powerfully shape work processes. For example, one experienced firefighter observed that organisational members enter the organisation with different conflict management styles that affect their radio interactions and relationships. Additionally, Campos's model invites us to consider physical stressors,

current sociopolitical organisational events and emotional reactions as integral parts of any situation. For example, in a size-up, the initial attack crew communicates their understanding regarding fire activity. That report is influenced by the experience, emotions, past interactions and linguistic ability of the people giving the size-up messages as well as the physical environment (e.g. weather, fire behaviour) and technical considerations (e.g. repeaters, radios). Further, meaning is negotiated and co-constructed with other individuals and crews as they engage in interaction (e.g. air, ground, IC).

## **Methods**

### *Data collection*

Our team used three different methods of data collection: analysis of organisational texts; participant observation in classroom (June 2015), simulation (February 2015) and an active incident (August 2015); and qualitative interviews. Our team chose these particular methods because they produce data that provide deep understanding of meanings that individuals associate with certain organisational practices. These methods (analysis of texts, field observations and interviews) are typically employed for the study of organisational cultures in order to capture not only the visible norms and rituals of organisation but also the taken-for-granted assumptions that accompany them (Driskill and Brenton 2011; Keyton 2011; Alvesson 2012).

To enhance the validity of study results, our team engaged in both researcher triangulation (five researchers were involved in data collection and analysis) and methods triangulation. Triangulation involves the use of different methods and sources to check the integrity of or extend inferences drawn from the data (Denzin 1997; Ritchie and Lewis 2003).

In 2014, each research professor obtained approval from the Institutional Review Board at their respective university in order to ensure that our research protocol sufficiently protected the confidentiality of our participants. We developed and used a sampling procedure to maximise demographic, experiential and functional variety, such as air, ground and dispatch communicators, and we recruited novice, mid-career and highly experienced firefighters. We sought such participants through opportunistic sampling (see Appendix 1, Table A1).

### *Textual analysis*

Selecting what texts to analyse is as important as understanding how to read them. We chose to focus our textual analysis on three documents to which every firefighter is exposed: the IRPG, which is read and carried by most firefighters in the field, as well as the training manuals for the introductory firefighter training courses (S-130, S-190 and L-180), all taken by firefighters during their initial certification. We paid attention to instances where communication was mentioned, including recommendations for 'effective' communication, such as 'It's press and speak, not press and think'. We examined these for underlying assumptions grounding those recommendations.

### *Classroom and field data collection*

The first two authors completed S-130/S-190 and L-180 training courses, including passing the arduous physical fitness test to obtain red cards. Attending the S-130/S-190 and L-180

course allowed us to observe how radio use is taught to beginner (Type 2) firefighters, as well as how topics such as weather, fire behaviour and safety rules are conveyed. The other three researchers had completed S-130/S-190 and L-180 training in years past and contributed their recollections to the dataset.

### Interviews

Our research team conducted in-depth interviews with 27 firefighters of varying levels of experience (novice, mid-career, highly experienced), operational realm (air, ground, dispatch) and operational role (dispatchers, Assistant Forest Management Officers, Zone Forest Management Officers, fixed-wing pilots, trainers, radio operators, communications specialists, engine crew members, dozer operators) (Appendix 1, Table A1). Interviews ranged between 30 and 120 min, with an average length of just over 1 h. Interviews were transcribed and verified against the audio recording, resulting in over 900 pages of written transcripts.

The interview protocol included questions about individual and team practices, such as, 'What are the most important practices you personally try to follow when it comes to talking on the radio during an incident?' and 'What are the most common misconstructions or misinterpretations that happen over the radio?' (See Appendix 1, interview protocol.) Questions also addressed the training participants received in radio communication and prompted participants to recall and articulate critical incidents when radio communication was particularly important.

Thematic analysis and critical discourse analysis were used to identify and assess communication. We employed an iterative analysis process (as described by Tracy 2013, for example) grounded in the anthropological practice of comparing emergent (emic) readings of the data and a deductive (etic) use of existing models and theories. In the present study, the three communication researchers brought their expertise and pedagogical insights to the process. Three researchers examined the transcript data and individually assigned codes that captured their essence. These were synthesised in a second, collective cycle to produce a sound analytic frame for future analysis. In the remainder of this paper, we present our key findings organised around these analytic frames.

### Results

We found that on the one hand, training texts and materials encoded the information transfer model, whereas on the other hand, in interviews, mid-level operational and managerial fire practitioners articulated experience with a more complex communication environment. To them, communication is not only more complex than presented in training and other materials (and certainly about more than operating equipment), but they were also able to articulate how they cope with complexities in practice. Below, we contrast 10 oversimplifications with the lived complexities as articulated by our interviewees, within categories of *Communication training*, *The nature of communication* and *Communication technologies*.

### Communication training

#### *Simplification #1: Communication is easy and you'll pick it up*

Nowadays, firefighters carry radios and start using them much earlier in their careers than in the past, but classroom training has not kept pace with this organisational reality. The S-130/S-190 is an important course for every newcomer because it precedes earning a red card, lays the foundation for additional field training, and indirectly socialises newcomers to the organisational culture.

Current training in radio communication is guided by the perception that communication is easy and all one needs is a basic working knowledge of language to be a good communicator. Although specific training in radio communication may vary according to how S-130 is delivered, in general these modules are short (e.g. covered in 30–60 min) and focus on the mechanics of radio operation. The complexity surrounding radio communication is simplified by its presentation in training that is short, lecture-based and technologically focused, with little to no practical exercises. When the initial presentation of communication is so attenuated, it likely will not cover the complexities of lived communication contexts.

The classroom lectures in S-130 and L-180 that we observed mostly consisted of technical principles of communication and key technological terminology. In terms of human interactions, the lesson briefly covered the mechanics of how to transmit and receive a message, followed by a few troubleshooting principles and advice from personal experience. When asked about ways to communicate risk, instructors indicated that 'May-day!' or 'It's getting hot here' were common ways to report risk, but strategies to do so effectively or the complexity of communicating risk were not discussed in much detail. At the end of the lesson, students were left with the impression that radio communication would be simple, and mostly depended on their ability to use the equipment properly. Assessment of what students learned relied on short-term memorisation using a multiple-choice test.

#### *Simplification #2: Learning about communication means you'll be ready to communicate*

When asked to recall their classroom training in radio communication, interviewees reported the following issues:

- Not enough experiential learning in the classroom
- Lack of practice opportunities outside of a fire or crisis
- Not enough recognition by fire management and trainers about the anxiety beginner firefighters and other firefighters feel when communicating on the radio.<sup>b</sup>

In contrast with the limited attention paid to communication in the training of beginner firefighters, the experienced firefighters we interviewed reported that they paid considerable attention to their communication practices. To them, communication is not easy; you cannot just pick it up. It requires practice. They relayed that they practised speaking on the radio on their own and understood that radio communication is a perishable skill. In

<sup>b</sup>One interviewee suggested that the classroom training for communication was adequate for adult learners who are meant to continue learning on the job. By qualifying his statement, he also drew attention to the notion that the current training, by itself, is not enough.

the words of one interviewee: 'It's not something you can do once in your career and call it good'. Interviewees gave concrete examples of how they developed skills to become good communicators, techniques that Leonard *et al.* (2014) and others might label 'deep smarts' (see e.g. Leonard and Swap 2005; Thomas *et al.* 2015; Leonard *et al.* 2014).

Sometimes communication practices are integrated into basic and refresher firefighter trainings, but they are not consistently taught across the regions. During the annual refresher, one air attack boss asked attendees to imagine how they would communicate if one of their airplane engines were on fire. He recalled instructing,

'Think about what you would say to dispatch. Think about what you would say to the copter and what you would say to the pilot.' Walk[ed] them through the process. Okay, cool. Two volunteers. They raise their hand and I say, 'Say it out loud.' And it was amazing. Two really experienced air attacks sounded completely, completely flustered trying to get the words out.

The same participant emphasised the value of practicing communication over the radio even if only mentally, like a musician reading the score and imagining playing it without the instrument.

If you mentally rehearse these things and actually speak the words aloud repeatedly, when you get into that high-stress, high-tempo environment where your life may be in jeopardy or someone else's life may be in jeopardy, the last thing you would want to do is to fail them because of your inability to communicate.

In another interview, an air attack boss pointed out that communication skills are perishable and need to be maintained. He shared that his solutions included watching others, recording himself, playing out multiple scenarios while biking to work:

I used to record all of my dispatch assignments. I would make a note on my board of times. I would just look at the recorder or look at my watch and write the time down if there was something I wanted to revisit or I thought I could do better. I'd go to my hotel at night and I would play back. I fight a lot of fire in my head.

We found little evidence in our research to suggest that current training is capturing the complexity that marks the communication environment; however, firefighters report creative ways they polish their communication skills. The experienced firefighters seem to depart from the information transfer model relayed in initial training and seem to embrace the complexities that contribute to their own and others' configurations of meaning.

#### *The nature of communication*

*Simplification #3: There is a standard way to communicate in all roles*

Interviewees also raised concerns that challenged simplifications related to the nature of communication. One such simplification was to assume that there was one best way to communicate in all situations. However, they noted

significant variations in what good communication sounds like depending on one's role in the ICS. An incident commander, dispatcher, or division supervisor each might need a different communication skill-set. People report that they are often unaware of the communication constraints of other positions – such as dozer operators not always being able to attend to radio traffic or air attack having to multitask to avoid air collisions – because they do not know the roles various ICS positions play to carry out their responsibilities, or how to work within the constraints inherent to each ICS position.

Radio dispatchers, firefighters on the line, air attack bosses and incident commanders all function in different physical, psychological and relational environments that require different communication skills. A dispatcher told us:

I wish more ground operations folks would come into dispatch to see what we do. They'd understand what we are up against and why we say what we say.

#### *Simplification #4: Messages are easily packaged*

There is widespread perception – supported by training and culture – that the characteristics of a 'good' message include being brief, direct and declarative. Unfortunately, these characteristics also result in conversations that focus on transmitting 'conclusions'. When coupled with a preference for brevity, this stymies the very types of conversations that enable collective sense-making, according to HRO; i.e. open, tentative and inquiring (see also Vidal and Roberts 2014). Declarative statements are often difficult to challenge, particularly without raising defensiveness. Such an atmosphere also tends to lead to misinterpretations of inquiry, acknowledgement of partial knowledge and sharing of tentative interpretations as evidence of lack of confidence or competence. It is not that such conversations do *not* exist in wildland fire; it is more that these are not apparent or encouraged over the radio. The conundrum for the wildland fire community, thus, is when, where and how do dispersed groups of firefighters successfully conduct necessary sense-making?

#### *Simplification #5: Good communication is emotion-free*

Another tension related to the nature of communication stemmed from the idea that 'good' radio communication is free of emotions. This view fails to acknowledge that significant non-verbal information is transmitted by emotional communication. Experienced radio users, particularly when they know each other, glean important information from tone of voice and emotional cues. One participant told us that he can 'see facial expressions' over the radio. In some cases, the inability to communicate an appropriate sense of urgency can lead to a lack of understanding the magnitude of a particular threat. Ironically, our interviews reflect that firefighters are trained to *speak without* emotion so as not to stir up emotions among those listening, but when they listen, they *listen for* emotion. One AFMO told us: 'We rely upon tone and inflection to give us "the rest of the story" when there is an emergency.'

*Simplification #6: Audience-centred messages are intuitively framed*

Interviewees reported the complexity associated with listening to messages or framing them so that they can be easily understood. Speakers often overlook the strategies for organising and delivering effective messages. A primary step in planning an 'audience-centred' or 'listener-centred' message is recognising the listener's communication context. What are the demands of that situation? Related to this type of adaptation is the need to prepare the listener to receive certain types of information, especially complex information including long lists and emotionally difficult content.

Even if content was communicated clearly, firefighters recognised that relational work is also being carried out on the radio, yet training does not address this type of complexity. Talk-interactions, seen within an 'ecology of meanings' framework mentioned earlier (Campos 2007), are always about more than just the topic being discussed. There is the topic of discussion and the language being used (e.g. my particular method of talking) but also identity issues (Who am I in the interaction?) and relational goals (What do we represent to each other in this interaction?).

*Simplification #7: Words are transparent to all and carry the same meaning*

Ironically, in an effort to eliminate perceived complexity, 10-codes or numerical codes that represent commonly used radio verbal phrases, were discontinued as a way of standardising communication on the radio. However, this may have led to a false sense that language *could* easily be standardised. We may expect the use of jargon to present problems, but common words with multiple meanings may also lead to miscommunication. We heard of several instances in which specific words are used to mean different things in different agencies:

A prime example, you're getting flooded with radio traffic, and then somebody says, 'Hey, I need you to **deploy** your truck along this road', instead of saying, 'I need you to go **stage** along this road.' Just that one word 'deploy', that's one of those keywords that fire managers pick up on, and all you hear, with all this traffic, then all of a sudden you just hear the word 'deploy', the first thing that jumps in your mind is, 'Somebody's deploying their fire shelter.'

There are also several differences based on the geographical and regional differences. A firefighter from Hawaii told us about expressions they use locally that are unknown to firefighters from the mainland:

We were talking to the helicopter pilot and we were using terminology, we were using 'mauka' and 'makai' and so you'd be calling in the helicopter and you'd say something like, 'I'm mauka of you, keep coming', or 'We're just makai of the pool' or whatever [...]. 'Mauka' means uphill, 'makai' means downhill, literally towards the ocean. [...] if you grew up here, you know what it is, but when their guys come in, it's a new word and you hear it twice and you still can't say it because it's just new.

To mitigate such linguistic differences, the Hawaiian crews agreed to eliminate regionalisms and speak 'mainland English'

for the duration of the collaborative exercises. One other Forest Service Agency in the Mid-West created a list of local terms that would be important to know by an incoming fire organisation.

*Communication technologies*

*Simplification #8: Radios are reliable and work when needed*

One assumption we observed related to communication technologies was that radio communicators often assume that all radio equipment and all the supporting electronics needed to make a forest-wide radio system functional are reliable and will work when needed. However, radio coverage over any existing geography will never be complete. There will always be 'holes' in the radio or cell phone coverage, often induced by mountainous terrain, where communicators cannot send or receive messages. The repeaters infrastructure is not up to date everywhere in the country.

A Communications Coordinator gave the repeaters infrastructure an average grade of B-:

That can range anywhere from about an A in some areas to probably a C, maybe even a C minus in some areas. From my point of view, we don't spend as near as much money as we should on the C portion of LCES [Lookouts, Communication, Escape routes, Safety zones].

*Simplification #9: Programming a radio is easy*

In addition to location and functionality being assumed, a second assumption is that the proper use of channels, frequencies, and repeaters is understood and experienced similarly by all involved. However, programming a radio or changing a channel and frequency can be both physically difficult and anxiety-producing, especially for new firefighters. Gloves can get in the way. An insufficient knowledge of 'which channel does what' can lead to confusion. Each time a channel is changed, the audience changes in size and type, and with that, the stakes of the interaction change too. The appropriate use of different radio channels (e.g. command, crew, dispatch, air-to-ground) for the different functions of fire management are not clearly discussed in the basic training courses. We were told stories of firefighters who do not realise they are on the wrong channel, until they are told of their interference by others. Interviewees also reported that firefighters use different standards to judge what constitutes 'emergency' radio traffic. Although it is unlikely that any *a priori* standard can be established, a discussion of how prioritisation occurs would be useful. One bulldozer operator recalled a 'bad situation' when in the midst of a fire 'blowing up' another crew, which was working with local evacuations and thought they were operating on a local tac (tactical) channel, got on the command repeater to coordinate 'moving their llamas from the corrals'.

*Simplification #10: Frequencies are readily available and those with radios will be able to use them*

Another complexity is that radio frequencies and channels are finite and just because one has a radio in his or her hand does not mean there will be an open channel to use. An FMO recalled a specific situation during which time competition for radio

channels added to the difficulty associated with managing multiple fires. He said:

Division Alpha happened to get on the radio first, 'We got spot fires. I need additional resources; I need aircraft.' And then Division Bravo is waiting for him to quit, get done, and all of a sudden Division Charlie's quicker on the button than Bravo is, and he's doing the same thing. So, yeah, there's some competition for, you know, I hate to say there's just not enough frequencies out there.

Making student firefighters aware of these complexities would improve their learning and readiness level.

In the next section, we use these findings to provide practical recommendations for the firefighting community.

## Discussion

Our study revealed a mismatch between guidance and actual practice when it comes to radio communication. Based on our analysis of communication-focused training materials, observation of a course that all firefighters take and interview data, it is clear that wildland firefighters are working in an extremely complex communication environment, not reflected in initial training.

Our study presents opportunities to reflect on the connection between the cognitive aspects of HRO mindfulness and its linguistic manifestations. Our interviewees demonstrated a reluctance to simplify their listening and speaking practices as they operate in a complex world to which they are constantly attending and adapting in a mindful way. [Thomas \*et al.\* \(2015\)](#) sought to understand how cultivating HRO mindfulness is intertwined with our ability to articulate mindfulness. They conclude their article by claiming, 'How we talk to each other about risky situations, as we are trying to make sense of them, is a vital skill, and a better understanding of the language of HRO mindfulness is crucial in developing this skill' ([Thomas \*et al.\* 2015](#), p. 11). As these authors have argued, the cognitive processes involved in HRO mindfulness are reflected in the language choices of highly skilled individuals, and conversely these language choices shape cognitive processes. The interview data collected as a part of the current project support these claims.

We recognise that there is no way to prepare a student for all of the complexities associated with firefighting communication, but our interviewees have provided examples and strategies from their own experiences that can be shared and used in the classroom. In other words, the fire community has an opportunity to increase the effectiveness of its communication training using the creative ways experienced firefighters are already managing the communication environment. These 'deep smarts' ideas can be shared and integrated into supplemental materials for the classroom consistently and at a larger organisational scale, not just locally or where it happens to occur.

From an instructional design perspective, we found a misalignment between the pedagogical goals in S-130/S-190 and L-180, the instructional techniques used in the classroom and the knowledge needs of the firefighters in the field. Our analysis of the primary texts used in the S-130/S-190 and L-180 shows that communication is primarily framed as information transfer ([Shannon and Weaver 1948](#)) instead of a process of meaning

co-creation, negotiation and sharing influenced by multiple contextual factors. When problems with radio communication are discussed in the course manual, the focus is almost exclusively on equipment and channel use, although our interviewees reported having problems with misunderstandings and miscommunication as a primary issue related to 'trouble' on the radio. Common pitfalls in communicating size-ups, locations, directions, requests for resources, etc., were not addressed in the book or in the lecture. Although initial training suggests that communication skills will be a part of advanced courses or refresher courses in the student's future, mechanisms for self-practice are not provided.

To align the pedagogical goals of the classroom materials and instructional techniques in the classroom to better meet the needs of firefighters in the field, the organisation would need to reassess the pedagogical objectives that need to be met in the basic courses. The taxonomy of learning from [Bloom \*et al.\* \(1956\)](#) is a good tool for this. For example, if the goal is to develop listening and speaking *skills*, along with a deep *understanding* of radio communication challenges, students need to develop ways to *create* and *evaluate* messages along with opportunities to fail and get feedback in the classroom.

To improve system reliability, a reluctance to simplify communication should be cultivated consistently within the broader fire community, starting with initial training. To this end, and informed by our findings and the work-arounds suggested by experienced interviewees, we provide the following practical recommendations: (i) include experiential learning opportunities in the classroom dedicated to radio training; (ii) assess students' confidence in their radio skills at the beginning and end of the course; (iii) provide an opportunity for each student to practise with an actual radio in class; and (iv) use existing radio dispatch recordings as a teaching tool. (For specific pedagogical techniques, see [Appendix 1, Table A2.](#))

Finally, although the present paper focuses mainly on identifying and exploring simplifications about communication, we do need to address the fact that the processes of communication articulated by our interviewees is more complex than a simple information transfer model is able to accommodate. Therefore, grounded in a constitutive view of communication and informed by [Campos' \(2007\)](#) ecology of meanings model, we invite the fire community to consider the value of the ecology of meanings model and the abundant opportunities for future research that emerge from it.

## Conclusion

The present project sought to highlight the complexities surrounding radio communication in wildland firefighting. It offers a more holistic communication model that can be used in training and practice. Through textual analysis, classroom instruction and interviews, we identified multiple ways in which our training and everyday conversations might actually be conditioning us to think of communication as a simple activity, when in fact it is a complex activity emerging to manage a complex context. Because the context is complex, initial training, on-going refresher courses and our everyday practices need to reflect this complexity. By focusing on the speaking, listening and technical skills we identified in this paper, firefighters will

have a better chance of being prepared for the complex communication environment they will face.

### Conflicts of interest

The authors declare no conflicts of interest.

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## Appendix 1

### Interview protocol

#### *Demographic questions*

- Gender
- Forest or Park
- State
- How many fire seasons have you worked in wildland fire and in what capacities?
- What is the highest qualification you hold for incident management? Is this the position you most commonly fill while on assignment? If not, what is the most common assignment?
- With respect to the most recent fire you were on:
  - When was this?
  - What type of fire and what position did you hold?
  - Did you have a radio?

#### *Individual practices and habits*

- What are the most important practices you try to follow when it comes to talking on the radio during an incident?
- What do you find are the most difficult things to convey over the radio?
- What are the most common misconstructions or misinterpretations that happened to you over the radio?
- Think of a memorable experience, a standout moment when radio communication was important, maybe a near miss or accident where communication was at issue. Without naming anyone, specifically please briefly describe that experience. How was the situation resolved (or not)?
- How do you convey emotion on the radio? Was there a moment when you ‘went off the deep end’ on the radio? What response did you get?
- What does it sound like when someone goes off the deep end on the radio?
- When you are in a high-risk situation, how do you communicate urgency without sounding like you’re going off the deep end?

#### *Evaluative statements about communication*

- What does ‘competent’ language sound like?
- Or think of someone who you believe to be really good at radio communication. Without identifying this person specifically, how would you describe their communication?
- Conversely, when you think of a bad communicator, without identifying this person specifically, what does his or her communication sound like?

#### *Team practices on an incident (or depending on the level, IMT practices)*

- What gets communicated over cell phones during fire events?
- How is conflict expressed over radio v. face to face meetings?
- How are risk perceptions communicated over radio (during an initial size-up for instance)?
- What cues do you rely on to detect risk or potential errors expressed over radio?
- Are misunderstandings corrected? How?
- How do the physical demands of the job reflect in radio communication performance?
- How do crew leaders use tone of voice to construe what another firefighter is thinking or feeling? An example?
- How does remote communication change as wildfire transitions from a Type V to a Type II complexity?

#### *Questions about training in radio communication*

- Describe your training in radio communication – Was it formal or informal? When did it take place? How long was the training?
- What knowledge or skills were emphasised? Who taught you? Did you shadow or apprentice?
- Have you ever participated in a simulation that included practice with radio communication? If so, please describe this experience.
- When you have a ‘newbie’ in your crew, what do you teach him or her about radio communication? What advice would you give him/her about communicating on the radio?
- Knowing what you know now, what do you wish you would have learned about radio communication during your training?

#### *Questions about meanings for communication*

- When we say we are interested in studying incident communication, what are all the things that come to mind that we should be looking at?
- Have we missed anything or any issue that is important for us to learn or know about with respect to risk perception, sense-making and resilient performance that we haven’t covered?

#### *Additional questions for dispatch*

- What kind of records do you keep? For how long? In what format? Do you ever go back and study past recordings?
- When things are going well in dispatch, what does communication sound like?

**Table A1. Table of participants**

Number	Gender	Position in organisation	State
1	F	Zone Forest Management Officer	Idaho
2	M	Fuels Forest Management Officer	Idaho
3	M	Forest Management Officer	Idaho
4	F	Helitack	Arizona
5	M	Task Force Leader	Arizona
6	M	Helicopter Crew Supervisor	Arizona
7	M	Forestry Technician	Arizona
8	F	Engine Crew Member	Arizona
9	M	Dispatcher	Arizona
10	F	Communication centre Radio Operator	Arizona
11	M	Forest Management Supervisor	Hawaii
12	M	Wildlife Manager	Hawaii
13	F	Dispatcher	Idaho
14	M	Branch Chief; incident communications operations	Idaho
15	M	Fixed-Wing Inspector Pilot	Georgia
16	F	Dispatcher	Nevada
17	M	Training and Standardisation Pilot	Utah
18	M	Zone Fire Management Officer	Colorado
19	M	Forest Management Officer	Texas
20	F	Dispatcher	Texas
21	M	Dozer Operator	Texas
22	M	Firefighter Type 2	Texas
23	M	Forest Management Officer	Texas
24	M	Firefighter Type2	Texas
25	M	Firefighter Type 2	Texas
26	M	Helicopter Manager	Texas
27	M	Dozer Operator	Texas

**Table A2. Pedagogical techniques**

Develop radio speaking skills	Developing radio listening skills	Developing radio technical skills
Use experiential activities, such as exercises that require students to tune the radio to the specified channel, identify themselves, provide a mock size-up (including ordering resources), listen to and provide feedback, and sign-off properly	Visit a dispatch office and listen to the radio communication	Demonstrate technical features of the radios with actual radios used by the fire organisation
Practise communicating typical types of messages including the taken-for-granted skills of 'creating a picture', giving directions, reporting location or position, reporting weather and providing space and time information	Invite representative from dispatch, air attack, ground operations (dozer operators, hotshots) to describe how radio communication is influenced by their work environment (or have their testimonies recorded)	Learn how to troubleshoot technical problems – batteries, cloning radios, programming frequencies; learn about the different frequencies – squirrel channels, command channel, air-to-ground, etc.
Practise communicating with different people up and down the chain of command and know what may be important to them (the 'how' for a rookie; the 'why' for dispatch or supervisor)	Keep a radio in the room to listen to communication on an active fire. During off-season use a dispatch recording to familiarise students with the sound of fire	Learn the location of repeaters on the map and how reliable they are
Practise communicating under pressure (the presence of noise, increasing fire complexity, managing uncertainty, etc.) while maintaining a calm vocal tone	Learn to interpret the presence and absence of emotion in radio transmissions through radio recordings	

*(Continued)*

Table A2. (Continued)

Develop radio speaking skills	Developing radio listening skills	Developing radio technical skills
Practise the mechanics of sending messages, maintaining a distance from microphone, accommodating for noise in the environment, getting used to dexterity issues associated with using a radio while wearing gloves, counting to three before keying the microphone, etc.	Learn regional language differences, slangs and accents	
Practise managing rate, pitch and volume by delivering 'difficult' messages and receiving feedback during training exercises		
Learn to write down messages while listening to radio communication		
Role-play a human repeater		
Reflect on effective language use that takes into consideration jargon, regional and cultural differences, and the differences in taken-for-granted 'common' language		
Practise previewing messages by saying things like 'I will be sending you this message in three parts' and using transition language like 'I'm moving into the second part of this list' provide the opportunity for the listener to keep up with the message being sent		