Analysis of Decision Making Skills for Large Scale Disaster Response

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***Abstract*—A large scale disaster such as the detonation of an improvised nuclear device (IND) in a U.S. city would pose significant response challenges for all levels of government, private organizations, and the general public. Public officials and emergency managers would face difficult and high impact choices throughout the response effort, and they must prepare to make timely and key decisions throughout the effort. Decision making preparation may involve more than technical training and resources. It may extend to emergency managers being cognitively and emotionally prepared for the situations they may face. This paper presents the first step toward the larger goal of developing alternative disaster preparedness training methods that teach effective decision making. The project team interviewed highly experienced, disaster response professionals and analyzed decisions they emphasized as being both important and difficult during an IND response. The respondents also identified the critical skills needed to make those decisions effectively. This paper reports on the findings and analysis of specific decisions and skills required for an IND response.**

I. Introduction

The overall project [1] addresses the question of how government agencies can ensure that emergency managers have the appropriate knowledge, skills, and abilities to operate effectively during an incident of unprecedented size, scope, and complexity, such as an IND detonation [2] [3]. To help answer this question, we are exploring the use of gaming as a skill enhancement and evaluation technique to target 'soft skills,' which include personality traits, emotional intelligence, critical thinking, and inter-personal skills, as well as improving the retention of training 'hard skills,' such as technical knowledge, familiarity with best practice, and knowledge about an organization's structure and operation. The project evaluates the viability of expanding the use of serious games to augment classroom training, tabletop and full scale exercise, and actual disaster experience to better cover the critical skills needed for effective emergency management. This report documents the first phase of the project: analyzing the key decisions and skills relevant to the response effort for an IND detonation. Subsequent phases of the project will build on this catalog of decisions and skills to evaluate, design, and integrate new training and evaluation mechanisms that could better prepare emergency managers to respond to catastrophic incidents.

Serious games are used throughout the Department of Homeland Security (DHS) and other government agencies to support training, evaluation, analysis, and technology exploration. Those techniques have found successful niches, but their wider applicability faces several practical barriers. Those barriers can potentially be overcome by drawing on techniques, technologies, and expertise from the entertainment game industry. The recent surge of activity in attempting to do so has had successes [4] [5] but is hampered by the lack of a systematic approach for reliably building games to match a given application.

A. Learning Critical Skills

It is difficult and time consuming to gain expertise within a specific job or profession when the required skills are challenging to learn and opportunities to gain actual experience are infrequent. This challenge is especially prevalent in the field of radiological and nuclear (rad/nuc) emergency management where real world instances are extremely rare and many details are theoretical. Currently, emergency management personnel hone their professional competencies through a combination of classroom and on-the-job learning. Classroom-based learning provides professionals with the fundamentals of their position requirements, focusing on gaining technical knowledge, response terminology, and incident organization fundamentals, including the National Incident Management System (NIMS) and Incident Command System (ICS). On-the-job learning and experience-based job requirements help ensure that personnel have learned relevant skills by successfully tackling real problems and challenges.

The combination of classroom and on-the-job learning can be effective and can establish expertise and skill; however there are shortcomings with each method individually, and even with both methods combined. Classroom-style methods struggle to teach and help students retain abstract behavioral competencies. On-the-job learning can be highly effective, but for complex professions like emergency management it can be a slow method of gaining expertise, especially when incidents are rare (as is the case for large scale disasters). Some incident commanders and senior-level emergency managers spend decades becoming proficient. On-the-job learning is challenging to quantify in terms of improved skill and performance, and it is hard to determine if experience and skills gained in one type of situation transfer to similar situations (for example, between disasters of different types, of different scales, or in different locations). To be better prepared for a catastrophic response, new and innovative methods are needed to develop emergency managers' decision making skills.

The nature of the skills to be learned complicates the task of cultivating skilled experts. Within emergency management as a whole, the subjects of some of our interviews postulated that the distinguishing competencies of successful personnel are more behavioral than knowledge-based; the analysis described in this report supports this speculation. Usually, the most adept emergency managers and incident commanders possess

Distribution A: Public Release. This work is sponsored by the Department of Homeland Security under Air Force Contract #FA8721-05-C-0002. Opinions, interpretations, conclusions and recommendations are those of the author and are not necessarily endorsed by the United States Government.

a refined set of behavioral competencies, such as the ability to improvise, make correct inferences, and to selectively extract useful information to enhance their situational awareness. Such skills can be built up through lengthy experience, or are perhaps innate, but they are especially hard to develop and demonstrate in the classroom or via infrequent field experience. Waiting for candidate emergency managers to slowly acquire and demonstrate the skills during real incidents curbs the available talent pool and reduces confidence that key decision makers have the skills to handle large incident.

Motivating this project is a set of research questions arising from the discussion above that skilled emergency managers are successful because they possess certain behavioral competencies. The most interesting research questions are listed below: 1) Do successful emergency managers, especially those with a lengthy track record of successful field experience, actually value and exhibit a certain set of behavioral competencies and are these skills common across types of disasters? 2) Which skills are the most important to each level or type of emergency manager, and what are the important hard decisions that require those skills? 3) Are there mechanisms to reliably determine if someone already possesses those critical skills or what potential they exhibit to acquire such skills? 4) Can the learning of those skills be accelerated or better retained through the use of non-traditional training mechanisms, such as serious games or game-like exercises?

The interview and survey analysis described in this report target research questions one and two above, laying the groundwork for subsequent phases of the project to address new evaluation and training techniques which is described in the following subsection.

B. Serious Games in the U.S. Government

While there is still organization stigma attached to the word "gaming" because it is often associated with entertainment, serious games are already widely used throughout DHS, the Department of Defense (DoD), and other agencies to improve employees', responders', and warfighters' skills and capabilities to execute their mission. Serious games are currently used in the form of immersive simulations, live exercises, scenario based training, red teaming, and war gaming. For example:

- DHS Transportation Security Administration uses a rehearsal game to train airport checkpoint screeners to quickly spot dangerous items, to identify their best employees, and to provide truth data for training automated detection algorithms. [6]
- Airline pilots and air traffic controllers gain valuable flight experience from detailed simulators, reducing the cost of gaining experience by augmenting true flying time and demonstrating their skills in a low risk environment.
- Emergency responders come together to participate in scenario-driven exercises to practice coordinating and communicating, and to build organizational ties and social networks of trust.
- Naval officers evaluate the relative effectiveness of different command structures and the potential uses of emerging technologies through war games, using a mix of virtual and tabletop materials. [7]
- Cyber security analysts often use a competitive exercise environment with a red team attempting to find exploits in a blue team's defenses, essentially crowdsourcing human ingenuity for finding gaps.

All of these approaches are types of serious games, which can be defined as any interactive system that replicates a key dynamic or decision space from the real world in a controlled, artificial environment that focuses participants on a particular aspect of the domain. Games provide success criteria to motivate participants to learn, exhibit, or explore skills and situations selected by the designer and of interest to analysts. These features of games can be exploited to reduce the cost of training, supplement real world experience, and target skills and situations that cannot be adequately captured in the classroom. While existing gaming techniques are effective within their specific applications, there is a potential for a much broader positive impact. That broader impact is currently limited by three key challenges that face potential users.

CHALLENGE 1: Historical niches and focus on rehearsal. Most current serious games focus on rehearsal; participants walk through the motions of known procedures and best practices. Rehearsal is a very important part of preparedness, but, as our analysis indicates, there are other important skills to target at both the individual and organization level. For example, dealing with unexpected situations, experimenting with alternative organizational structures, and building social networks of trust are sometimes addressed by current games, and anecdotally games that target those topics are very helpful, but generally take a back seat. Naval war gaming has a tradition of emphasizing such dynamics [7], but those practices are not frequently employed by DHS. This is understandable, as it would be difficult for an emergency response exercise designer to adapt a naval war game to their situation using current tools and techniques. A more systematic and data-driven understanding of serious games could offer a means for identifying when a game is an appropriate tool to use, which type of game would best suit the application, and provide guidance for adapting previous games to new applications.

CHALLENGE 2: Lack of reusable templates and infrastructure. The design, construction, and analysis of serious games are generally ad hoc and do not draw on a common set of tools or techniques. New games are generally created bottom-up, both in terms of their design and their implementation, even when they are quite similar to previous games. A catalog of game templates coupled with matching reusable infrastructure would reduce the cost of creating new games or adapting old games to new situations.

CHALLENGE 3: High operation and attendance costs. Serious games currently in use are heavy weight; they generally require specialized equipment, a considerable time commitment by participants and designers, and lengthy manual analysis of the outcomes. Simulations generally require participants to visit a particular location to use specialized equipment, limiting the volume of data that can be collected (to determine aggregate patterns and trends). Live exercises often require participants to travel to a common location and remain there for several days in a row, increasing the cost of such training

and reducing the chance that an agency will simultaneously send all its best personnel for training. There is an opportunity for additional styles and alternate implementations of serious games to allow asynchronous or remote participation, to require less specialized equipment to operate, to better target specific skills or situations of interest, and to overall place less burden on the participants and designers.

C. Project Mission

This project seeks to analyze potential carry-overs from the commercial gaming industry and determine their applicability to addressing existing needs and gaps within DHS. To accomplish this task, the project aims to:

- Identify an expanded set of challenges within DHS that could be addressed with games.
- Begin to build a systematic classification of game styles and quantifiably match those styles to suitable applications.
- Understand the types of collaborations between DHS and private industry that could create games to directly support DHS needs.

The project's initial focus is on an IND detonation as a concrete example of a DHS mission area where serious gaming is likely to be productively employed. An IND detonation would stress DHS and emergency response systems and resources, so an analysis of the relevant decisions and skills of such an incident is likely to identify areas of need not currently being sufficiently met by existing training and preparation methods. Furthermore, IND incidents are low probability, high consequence incidents, making preparation important but difficult to justify when it is costly. Thus, INDs represent an opportunity for lighter weight games to play a valuable role in preparation. Lastly, as our analysis indicates that an IND response effort requires largely the same skills as other emergency response but with unique challenges. The commonality to other incidents means that the outcomes of this project are likely to apply more widely, while the unique elements will drive the work to generate more general game templates (not just one-off games) that are flexible and that can readily be adapted to other scenarios.

II. Methodology

The first step in designing training and evaluation mechanisms for any skill set is to identify the important decisions and corresponding skills. Since no IND incidents have occurred in the US, there is no direct way to identify those decisions and skills. As a proxy for direct experience with an IND, we turned to hazard and planning documentation and subject matter experts (SMEs). Existing hazard and planning documentation covers the nature of radiation and response plans; however our primary source of information for the key decisions and skills required was SMEs with experience creating IND incident response plans and participating in non-IND large scale incidents.

This analysis is not designed to be a comprehensive guide to an IND response. The focus of this phase of the project is to identify trends in the decisions and skills SMEs emphasized and what concerns they expressed about current preparedness. These results and our interpretations are presented in the following sections, laying the groundwork for subsequent phases of the project.

Our work started with reviewing relevant IND incident response planning documents, including:

- Planning Guidance for Response to a Nuclear Detonation [2]
- Federal Emergency Management Agency's (FEMA) IND Response Planning Tool [8]
- Key Planning Factors for Response to a Nuclear Detonation in Houston, Texas [9]
- National Response Framework Radiological/Nuclear Incident Annex [10]
- DHS Strategy for Improving the National Response and Recovery from an IND Attack [11]

Next we interviewed 26 SMEs in the fields of large scale incidents and IND incident response planning. Our interviews were mainly with FEMA Incident Management Assistance Team (IMAT) emergency managers, state level emergency managers, federal level IND planning specialists, state level IND planning specialists, and radiological health experts. The SMEs have extensive experience in large scale emergency response decision making at the local, state, and national levels. The list includes high level coordinating officers from many notable major disasters such as: 9/11 (2001), Hurricane Katrina (2005), Haiti Earthquake (2010), and Hurricane Sandy (2012). While there is a wide range of people that would be involved in an IND detonation incident response beyond those that were targeted for this study, we believe that the group of SMEs chosen for this study is representative of those making the most critical decisions.

We concluded the interview process when we no longer heard new topics from the interviewees, giving us reasonable confidence that the quantity of interviews conducted was sufficient to represent the dominant views of this type of emergency manager. As described later in this report, there were strong consistencies in the topics that the SMEs choose to emphasize when asked open ended questions. The interviewees responded to questions by phone and the interview sessions lasted one hour. The majority of the interviews had a single SME present; two interviews had two SMEs each. For those two interviews, the opinions of the two SMEs were combined into a single entry in our results. A project summary similar to the introduction of this paper was provided to each SME ahead of time. The majority of the interview time included a discussion about the difficult decisions and required skills in the context of IND and large scale incidents. The discussion had a few opened ended questions, but the bulk of the time was open for the interviewee to discuss any topics relating to rad/nuc response of their choosing. Examples of the open ended questions are:

- What are difficult decisions or activities in an IND or large scale incident?
- What are difficult positions or roles in an IND or large scale incident?

- What skills are most important to those decisions?
- How comfortable are you that the people making these decisions have the skills needed?
- Which skills are hardest to teach, select for, or validate?

This interview method encouraged discussions that allowed each SME to emphasize the most challenging and important aspects of emergency response as they relate to his/her experiences and concerns. The topics discussed were spontaneously emphasized by the SMEs, and not intended to be a comprehensive list. The interviews were meant to verify, prioritize, and augment the topics discussed in more comprehensive reports (see the references section) not to supersede planning documentation. Our final step was to validate the findings from the interviews. This was done by surveying the same group of SMEs plus an expanded group of similar SMEs to rank the importance and level of concern of information collected during the interview process. Answering questions on a provided list of topics reduces the chance that an important topic was accidentally omitted by some SMEs during their interview. Note that a ranking approach would not have been appropriate before the interviews, as ranking a provided list would not allow the SMEs to express their own ideas and could bias them toward theories we already had. However, once the SMEs provide a list in an open ended fashion, a more structured follow-on analysis can be useful and complementary. The survey specifically asked the SMEs to rank the importance of items in two lists, corresponding to the impactful decisions and required skills of an IND incident response. When the SMEs ranked the items, they received guidance to incorporate their opinions about two topics: the effectiveness of existing decision or skill training, and the importance of that decision or skill.

A. Limitation of this Analysis

We interviewed 26 experts over the course of 24 interviews, including professionals from state, local, and national roles and including both operational decision makers and domain experts. Only 11 experts responded to the subsequent survey, providing us only a limited form of cross-validation of the two approaches. However, there was strong consistency between the survey and interviews, increasing our confidence in the results despite the sample size. Specific discrepancies are discussed and interpreted in the full manuscript [12].

Our interview approach relies on several key assumptions. For example, we interpret emphasis by experienced professionals as being reflective of the actual skills that are important. We assume that current emergency managers have the requisite skills, that they know what those skills are, that those skills will continue to be relevant in the future, and that skills for IND incidents carry over to non-IND incidents. Our intuition and informal feedback from the interviewees supports these assumptions, but it is non-the-less important to keep these limitations in mind when interpreting the results or applying them to the development of training materials.

III. Results

A. High Impact Decisions

Figure 1 lists all nineteen decisions emphasized by three or more SMEs as being critical during the response to an IND detonation or other large scale disasters; decisions mentioned by only one or two SMEs were omitted as non-representative. The rest of this section provides a more detailed definition and explanation for each decision based on the information and examples directly provided by the SMEs. The level of detail devoted to each item in this section reflects the detail provided by the SMEs, the number of SMEs who discussed the topic, and the importance placed on the specific decision by the SMEs as a whole.

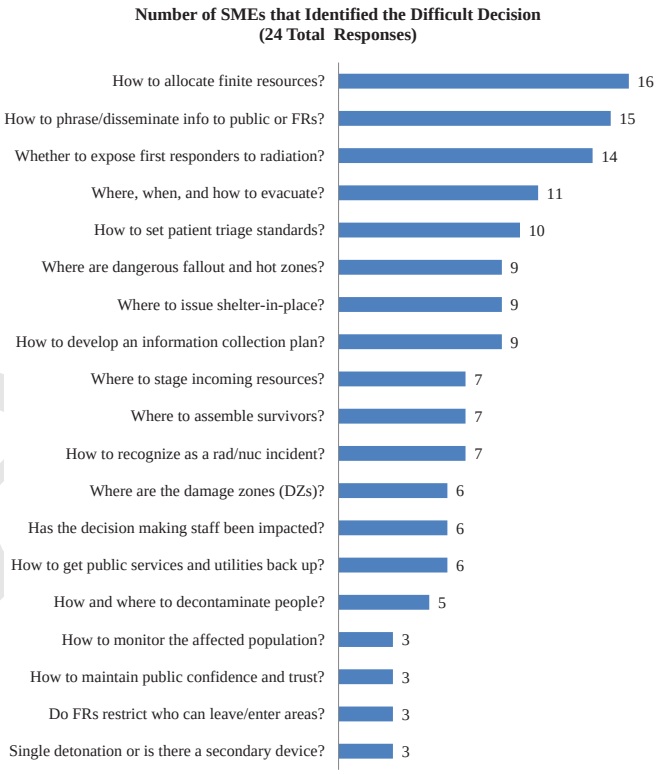

Fig. 1. Difficult decisions emphasized by SMEs

The majority of the difficult decisions identified by the SMEs are required in some form for other large-scale incidents; however the SMEs highlighted many specific challenges and complexities of a rad/nuc incident in making nearly every decision. Their emphasis indicates that IND incidents, and more generally rad/nuc emergencies, do present distinct challenges.

Table I shows a timeline of an IND incident response planning operations from the IND Response Planning Tool [8]. The eight most common difficult decisions as identified by the SMEs are highlighted in red, representing decisions mentioned in at least one third of the interviews. There is not a direct 1:1 mapping from our list to the response planning list, but all of the eight most difficult decisions are represented in the ten items highlighted below except for ”developing an information collection plan” which touches many of the operations in the 0-6 hour range. Interestingly, the majority

TABLE I. IND RESPONSE PLANNING TIMELINE [8]

0-1 Hour	1-6 Hours	6-24 Hours	24-48 Hours	48-72 Hours
• **Assess Comm. Availability** • Characterize the Weapon • Determine Down Wind Direction • Establish Area Command • **Give Shelter-in-Place Command** • **Inform the Public** • **Notify Responders** • **Recognize Incident as an IND**	• Assess EOC Integrity • Assess Utilities • Characterize the Incident • Determine and Monitor Weather • **Determine Damage and Fallout Zones** • Determine Medical Center Conditions • Establish Dose Turnback Levels • Establish Multiple Incident Commands • Perform Operational Risk Assessments • **Perform Radiological Risk Assessments** • **Plan and Allocate Resources** • **Plan and Initialize Evacuation** • Preserve Evidence • Set PPE Standards	• Control Access • Control Crowds • Control Fires • Decontaminate People and Pets • **Initial Mass Casualty Triage** • Monitor Population • Perform Sampling & Laboratory Analysis • Search Damaged & Collapsed Buildings	• Clear Highways / Freeways • Establish RTRS and Other Centers • Integrate Regional & National Assets • Locate & Extract Survivors	• Distribute Food & Water Supplies • Establish Medical Aid Stations • Manage Fatalities / Casualties • Manage Pets & Service Animals • Recover Decedents • Relocate Population • Reunify Families • Disease Prevention & Control Measures

of the difficult decisions are split between the 0-1 hour and 1-6 hour ranges, and all within 24 hours after detonation. This provides evidence that a driving factor in the difficulty of decisions is time pressure.

B. Critical Decision Making Skills

Figure 2 lists all skills emphasized by two or more SMEs as being critical during the response to an IND detonation or other large scale disaster. Skills mentioned by two or less SMEs were omitted as non-representative. The rest of this section provides a more detailed definition and explanation for each skill mentioned, accompanied by examples when provided by the SMEs for clarification. Similar to the explanations for the key decisions, the level of detail of the skills given below is reflective of the detail provided by the SMEs and the number of SMEs that discussed the skills. Our interpretation is that skills emphasized by more SMEs and discussed in greater detail are likely to be the more important skills or skills that the SMEs are concerned will be lacking during an incident.

Note that the low mention rate of a skill does not mean that the skill is not important. A low rate of mention might simply indicate one of the following:

- The SMEs believe that everyone under consideration for those roles has that skill (i.e. it is not a distinguishing characteristic of the best emergency management decision makers).
- The skill is easily taught or measured for currently; or that it is not a critical skill for a specific type of emergency manager (i.e. it is not of high importance to FEMA IMAT emergency managers but it may be critical to a first responder).
- The skill may still need to be prioritized through conventional preparation techniques and included in evaluations.

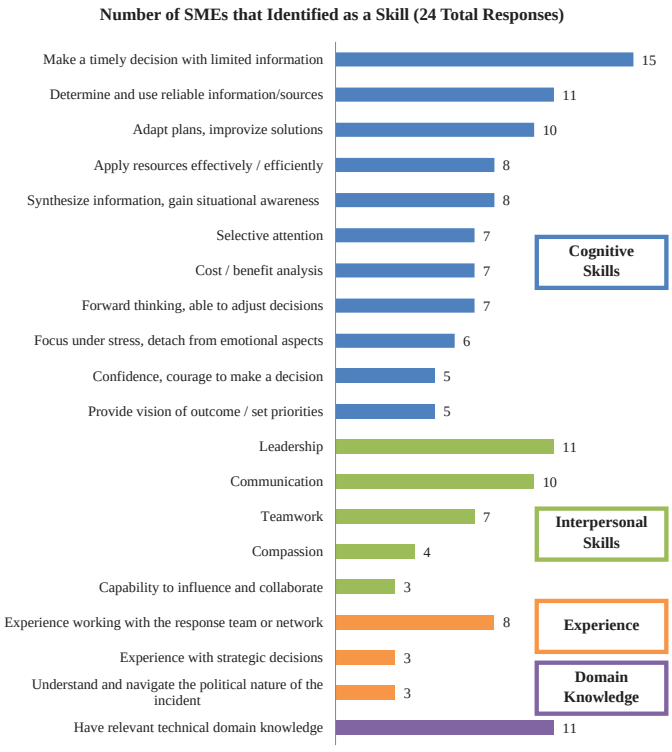

Fig. 2. Skills emphasized by SMEs

We interpret a low mention rate to mean that these skills do not need to be a focus of augmentation of training and evaluation, and thus they are of lesser interest to this project's goals.

The skills emphasized by the SMEs have been organized

into four categories:

- Cognitive Skills are mental abilities that aid in performing data processing tasks
- Interpersonal Skills refers to skills a person uses to interact with others
- Experience is having prior opportunities to practice or directly encounter a situation
- Domain Knowledge refers to information retention relevant to a given subject

Figure 3 shows the relative proportion of reports of skills according to these four categories. There were 149 total skill reports (the sum of the counts in Figure 2). The majority of skill reports were for skills classified as cognitive (89 reports), about a quarter of reports were for skills classified as interpersonal (35 reports), and the remainder were classified as either experience based (14 reports) or domain knowledge (11 reports). This breakdown suggests that extensions to current training and preparation methods should primarily focus on targeting cognitive and interpersonal skills. Note that this does not mean that knowledge and experience based skills are not important (indeed, there is no doubt that they are essential), merely that they are already well addressed by current training and preparation and thus were not emphasized as an area of concern. Also note that both of those categories contained skills that individually rated high on the list, indicating value in better addressing all four areas in training.

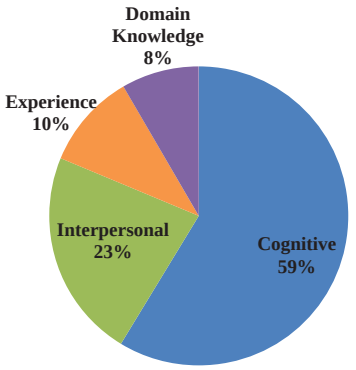

Fig. 3. Breakdown of skill reports by type of skill

C. Observed Trends

While most of the skills identified were valued and described consistently by all types of interviewees, some of the responses strongly correlated to the role that the professional holds. We observed trends between rad/nuc SMEs and emergency managers in operational decision making roles, trends between National vs. Regional FEMA, and trends between federal roles overall and state/local roles overall.

1) Rad/Nuc SMEs vs. Operational Decision Makers: We interviewed a range of rad/nuc SMEs with extensive knowledge on INDs but without direct experience in operational decision making roles, including IND planners, health physicists, and public health professionals. Their assessment of decisions and skills were closely coupled to those in operational roles in most regards, suggesting that the theoretical and practical sides of the community are in alignment. In one aspect, however, the two groups routinely differed.

Almost every decision on the list requires some understanding of INDs or radiation, indicating that all SMEs placed importance on technical knowledge. However, not all SMEs called it out as an area of concern in its own right, and the relative emphasis of technical knowledge versus other skills differed. The rad/nuc SMEs tended to identify a lack of basic technical knowledge about radiation among their highest concerns with current preparedness. Several explicitly said that they trusted that the people filling emergency management roles had all the soft skills and proficiencies necessary, but they believed those emergency managers lacked basic familiarity with radiation or with the network of SMEs available to provide such information. In contrast, emergency managers in decision making roles (of all levels) were much more likely to emphasize the relative importance of the cognitive and interpersonal skills needed to effectively apply the technical knowledge, and more likely to downplay the presence of the technical knowledge as a critical gap (or, at least, downplay it as a gap that is hard to fill with traditional training methods).

Several of the rad/nuc SMEs noted that the necessary technical material can be covered in a classroom, but they worried that such methods did not result in the knowledge being retained since the majority of responders did not have much opportunity to practice or apply IND-related knowledge. Their concerns suggest a slightly different opportunity that augmented training techniques might support improving retention of technical knowledge by providing more concrete and interactive rehearsal without a full scale exercise.

2) National vs. Regional FEMA: National level FEMA professionals consistently emphasized navigating politics carefully, building cohesive and effective teams, and being aware of the advisory role that FEMA plays to state and locals. Regional FEMA and federal domain SMEs consistently emphasized preparation and training, trusting SMEs over political advisors, and the importance of making good decisions. Table II provides a comparison between typical responses from the regional and national level FEMA responders.

Given the lengthy experience of all the interviewees, we assume that the discrepancies shown in Table II are not an indication of one group being right or more knowledgeable and that the two stances are not contradictory but instead differ in their emphasis. We interpret the differences in response as reflecting real differences in the skills and priorities most pertinent to different types of emergency managers. From this characterization, we can start to form a picture of how training for such skills might be different for these distinct roles, and how alternative methods may be required to meet the needs of these groups. Recognizing these differences could be especially valuable when supporting professionals moving between national and regional roles.

3) Federal vs. State/Local: There are strong similarities in how the federal and state/local participants prioritized critical skills. Many of the skills (e.g. timely decisions, resource allocation, and selective attention) ranked highly by both groups were described in nearly identical manners. For other skills, the same underlying competency was described as manifesting in different ways, reflective of the varying roles local, state,

TABLE II. COMPARISON OF REGIONAL AND NATIONAL LEVEL FEMA RESPONSES

Subject	Typical Regional FEMA Stance	Typical National FEMA Stance
Decision Making	It is important to make the right decision quickly, as the early stages of the incident are critical.	It is important to maintain an advisory role until asked to do otherwise.
Basis for Strategic Decisions	Strategic decisions should be informed by factual knowledge and aimed to save lives. They should not be swayed by political factors, which are distractions.	Strategic decisions need to be reflected in organizational structures and take into account the social and political environment for them to be effective.
Setting Priorities	Be ready to make hard decisions to maximize the ultimate goal of saving lives.	Priorities differ in different situations, and it is important to understand and communicate your goals.
Key Skills	Decision making under pressure, without sufficient information, and with no perfect options.	Organizing teams, bringing SMEs to bear on the appropriate problem, and creating a cohesive response.

and federal emergency managers play.

For example, for the skill "Ability to adapt plans and improvise solutions based on changing conditions" (ranked 3rd among cognitive skills in the interviews), the federal-level emergency managers generally emphasized the importance of adjusting a prepared plan as the incident unfolds and improvising on the fly. Conversely, the state and local emergency managers generally emphasized adapting a plan to the particular needs of an agency or community prior to an incident. We tallied both responses as a single skill, defined as the ability to interpret a plan's intent and decide when to execute it as written and when to modify it based on incident specifics. We believe the differences are worth noting, as they could affect the design of training materials or exercises targeting the same skill for different types of emergency managers.

A similar pattern was observed with the skills "Determine reliable information and sources" (ranked 2nd among cognitive skills in the interviews) and "Experience working with the response team or network" (ranked 1st among experiential skills). Both skills describe the importance of having and knowing how to request the network of SMEs that can be leveraged for technical guidance for decision makers. Federal emergency managers generally described these skills in terms of identifying SMEs and integrating teams under the pressure of an incident. State/local emergency managers generally described this integration in terms of building social and organizational connections prior to an incident.

Considering the roles that federal vs. state/local emergency managers typically play in an incident and the types of incidents they typically encounter, these differences are not surprising. Federal responders work in support of state/local teams when the incident is abnormal or of a scale that overwhelms the available local resources. Federal teams may be called on to support a wide range of incidents, so plans and networks must be revised and learned on the fly, as it is not possible to rehearse with every possible partner and scenario. In contrast, the state/local teams deal with more routine incidents, allowing them the opportunity to collaborate with the same agencies. In such cases, it is feasible to adapt plans and build networks ahead of time to preempt needs that arise during the incident. If anything, the surprising result is not that the two groups differ in their expression of those skills, but that their different needs boil down to such similar underlying skills. Hence, similar materials can likely be used to augment training for both types of emergency managers, but those materials will need to be grounded in different examples and exercise scenarios.

IV. CONCLUSIONS AND NEXT STEPS

This document has described an analysis of the key decision points and corresponding skills where current training and preparation may leave emergency managers and responders unprepared during an IND incident or other large scale disaster. Through reviewing documentation and conducting interviews with 26 SMEs and survey responses from 11 SMEs, we can better understand common threads in the difficult decisions in an IND incident response and the corresponding skills possessed by experienced responders who make them. Unique challenges and decisions exist in an IND incident response, but the underlying skills identified as addressing those decisions were not IND specific and would likely apply to any moderate to large scale incident. We observed that most critical decisions are made especially difficult by time pressure, amplifying the importance of cognitive and interpersonal skills. If time were not a constraint, then all of the requisite information could be gathered, the team could come to a consensus on each issue as it arose, and the task would be a more straight-forward technical question.

When we look at the decision making skills emphasized by the SMEs, cognitive and interpersonal skills were highlighted significantly more than technical knowledge and experience. As stated in the Skill Analysis section, we believe that this is because all responders who are in important emergency response positions already have the necessary technical knowledge and experience. These skills are effectively taught and selected for using the traditional methods of classroom and on-the-job training, although there are concerns that retention may be poor for skills that are not applied in practice (such as IND-related knowledge). The cognitive and interpersonal skills emphasized by expert emergency responders are much more difficult to quantify and teach. Those skills are currently developed only over years of experience, limiting the pool of qualified emergency managers and making it difficult to fill all the decision making positions. We see this gap as a possibility

to bring training and evaluation of cognitive and interpersonal skills through the use of serious gaming, and to improving the retention of relevant technical knowledge. Several SMEs expressed the sentiment that well run exercises can address those needs, but that exercises are a time consuming way of accumulating knowledge and require SMEs to be taken away from their posts to participate. We also hope to explore the ability for techniques and technologies from gaming to provide a less burdensome format for exercises or as augmentation to existing exercise regiments.

A central concept of the larger effort is identifying how to use repeatable and interactive experiences outside of the field of radiological and nuclear disaster management to help disaster management professionals develop and demonstrate relevant expertise [1]. The next steps in the project will be to investigate how the findings from this initial report can inform the development of training, evaluation, and research platforms. These platforms may be in the form of strategic games to help individuals and teams of radiological response officials and emergency managers rapidly improve pertinent behavioral competences or rehearsal exercises augmented with gaming techniques to impose reduced burden on participants. The effort will explore classifying what types of game mechanics are most suited to different types of skills pertinent to emergency management.

ACKNOWLEDGMENT

The authors would like to thank Ben Stevenson, Orly Amir, Geoff Buteau from the DHS National Urban Security Technology Laboratory and Chad Gorman and Jeff Blizzard from FEMA.

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GLOSSARY OF ACRONYMS

CBRNE	Chemical Biological Radiological Nuclear and high- yield Explosives
DoD	Department of Defense
DHS	Department of Homeland Security
DHS	S&T Department of Homeland Security Science and Technology Directorate
DZ	Damage Zone
FEMA	Federal Emergency Management Agency
FR	First Responder
FZ	Fallout Zone
ICS	Incident Command System
IMAT	Incident Management Assistance Team
IND	Improvised Nuclear Device
NIMS	National Incident Management System
NYC	New York City
Rad/Nuc	Radiological or Nuclear
RDD	Radiological Dispersal Device
SAR	Search and Rescue
SME	Subject Matter Expert
STEP	Shelter and Temporary Emergency Power