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Learning under Uncertainty: Networks in Crisis Management

Abstract

This paper examines the nature of learning in networks dealing with conditions of high uncertainty. I apply Koppenjan and Klijn's (2004) framework for understanding network uncertainty to an extreme example: an inter-organizational crisis taskforce dealing with an exotic animal disease. The paper identifies the basic difficulties involved in learning under crisis conditions. The taskforce had to learn most of the elements taken for granted in more mature structural forms – the nature of the structural framework in which it was working, how to adapt that framework, the role and actions appropriate for each individual, and how to deal with unanticipated problems. The network pursued this learning in a variety of ways. Most critically, the taskforce used standard operating procedures to provide a form of network memory, and a command and control structure to reduce institutional and strategic uncertainty.

Introduction

All organizations and networks face some measure of uncertainty. A way to reduce, or at least manage uncertainty is through learning. Koppenjan and Klijn (2004, 124) offer a functional definition of learning in networks as “the sustainable increase in shared knowledge, insights and methods of working between parties.” This paper examines ways in which networks learn under conditions of high uncertainty. A dramatic example are the networks of actors who come together to respond to crises. These networks feature prominently in the national incident management system created by the Department of Homeland Security (DHS). The idea of network learning to meet asymmetric problems combines what Kettl (2005) has identified as the three major drivers for action in building a government for the 21st century: the imperative for knowledge-driven organizations; the increase in non-routine problems; and the growing need for non-hierarchical solutions.

This paper begins by assessing the difficulties involved in learning during emergency situations. I then describe the challenge faced by a taskforce responsible for eliminating an exotic animal disease in California and some nearby states. The following section applies Koppenjan and Klijn’s (2004) model of network uncertainty to the case, examining the nature of substantive, strategic and institutional uncertainty. I then detail particular ways in which the network was able to learn. The purpose of the paper is to expand on Koppenjan and Klijn’s model of network uncertainty, apply it to a crisis setting, and categorize alternatives to trial and error learning under these conditions.

The Problem of Learning during Crises

Crises are characterized by high consequentiality, limited time, high political salience, uncertainty and ambiguity. Large scale crises overwhelm individual organizations, and demand a network of responders (Boin and 't Hart 2003). These conditions make learning difficult, and standard modes of organizational learning do not readily apply to crises. The basic barriers to learning during crises are summarized in Box 1.

Insert Box 1 here

Even in routine situations, learning is incomplete due to bounded rationality (Simon, 1991). Too much information is met with limited human cognition that restricts search and evaluation processes. However, routine environments will, through trial and error learning, facilitate the cumulative understanding of cause and effect factors, which is then transferred via organizational memory and heuristics. We can expect rationality to become more bounded in non-routine situations, where the range of what is certain is diminished, relevant experience is lacking, heuristics are not available or provide faulty guidance, and search processes will be even more incomplete. Administrative man may still be intendedly rational facing a crisis; he has a general goal of returning to normalcy, but the obstacles limiting his knowledge of *how* to return to normalcy are more extreme. Approaches to learning that allow actors to satisfice in routine environments may not be adequate, or may even prove counter-productive, during crises.

Learning during crises is more difficult because of the consequentiality of the event. We learn best from experience, observing our failures and remedying them in the future (Senge, 1990 23). With very high consequence events, relying on incremental trial and error learning is prohibitive, because errors are too costly (LaPorte and Consolini 1991). In such cases, it will be

cheaper to look for alternatives to trial and error learning. At the same time, the sheer scope of learning required during crises is inherently greater than in routine situations. Crises are non-routine problems that cannot successfully be overcome with previous responses. They demand new learning on the most basic aspects of the causes, consequences, and solutions; information which may be subject to consensus or conflict among participants (LaPorte 2005).

The potential to learn depends greatly on the availability of applicable lessons. Some situations will clearly be more applicable than others, depending on variables such as time, geography, nature and scope of crisis, relevant technologies, actors involved, etc. However, crises are, by their very nature, “rude surprises”, (LaPorte 2005) in that they tend to occur in unexpected and unique ways. Despite attempts to apply lessons from one crisis to another, the ambiguity of cause and effect relationships leads communities to frequently fail to learn from the mistakes of others, or even their own mistakes (Auf Der Heide 1989, 7). Even clear warnings of impending crises can be overlooked, misinterpreted or ignored (Boin and t’ Hart 2003, 547). Turner (1976) found that preventable disasters frequently could be connected to rigid institutional beliefs, ignoring outside complaints, difficulties handling multiple sources of information, and the tendency to minimize danger.

Even as crises make learning difficult, they demand that decisions be made. The urgent demand for knowledge may lead to ill-considered lessons being applied. Wishing to avoid past mistakes may blinker decision-makers and limit information-processing. Actors may react to threats by recycling previous responses to new problems (Staw, Sandelands and Dutton 1981). Lovell (1984) highlights the political dynamic of learning in politically salient incidents. He argues that learning will be shaped by the distribution of power and the negotiation of bargains. Such bargains may be compromises, weakening optimal solutions.

Crises can also limit learning by fostering defensive reactions and opportunism. If a crisis fosters defensive behaviors, actors may disassociate themselves from perceived negative outcomes, deny that a problem exists, that they made any error, or that they are responsible for a solution (Arygris and Schön 1996). Actors focus their attention on defending or rationalizing their role rather than dealing with the problem. Individuals at risk of punishment for exposing weaknesses and potential problems are less likely to do so, and damning information may be suppressed. After the crisis, actors focused on shifting blame are unlikely to learn useful lessons (Boin and t' Hart 2003, 548). Opportunism refers to an opposite reaction, as actors fail to learn because they have misframed a crisis to exaggerate the positive role they have played (Stern 1997, 78). The risk opportunity-literature suggests that actors can opportunistically favor special interests without detection as long as the crisis remains complex, as was the case during early stages of the Bovine Spongiform Encephalopathy (BSE) outbreak in the United Kingdom (Beck, Asenova and Dickson, 2005).

Stern's (1997) review of the relevant literature also found that crises can create opportunities for learning. Sometimes crises can have a catalytic effect, focusing political attention, widening the interest of involved publics, accelerating change processes and breaking down resistance to change. Crises are natural focusing events, widening the involvement of interested actors, incorporating new ideas and fostering a willingness to try new solutions that would not be considered in the absence of a crisis (Birkland 1997). In areas where actors perceive themselves as being closely accountable, crises may prompt them to process information effectively (Tetlock 1992). However, Schwartz and Raanan Sulitzeanu-Kenan (2004) warn that crises are likely to lead to lasting policy change only when there is a perception of a problem in need of a solution, a

perception that increased legal and hierarchical accountability is a feasible solution, and a political climate conducive to policy change.

Despite the possible catalytic impacts of crises on learning, the weight of the literature suggests that crises make the learning of lessons more difficult, and increase the likelihood of faulty learning. Crises, therefore, are situations demanding greater and more rapid learning than in routine situations, but with less likelihood that such learning will take place. Uncertainty is an inherent aspect of crisis learning. The remainder of this paper focuses particularly on the way in which a specific crisis network attempted to learn under conditions of uncertainty.

A Network under Stress: The Exotic Newcastle Disease Taskforce

To illustrate the possibility of learning under conditions of uncertainty and urgency, I present case evidence on the outbreak and eventual containment of Exotic Newcastle Disease (END) in the State of California. END is a highly contagious and generally fatal disease among poultry. It affects the respiratory, nervous, and digestive systems of poultry and other birds. The Animal and Plant Health Inspection Service (APHIS) of the US Department of Agriculture (USDA) describe it as “so virulent that many birds or poultry die without showing any clinical signs. A death rate of almost 100 percent can occur in unvaccinated poultry flocks. END can infect and cause death even in vaccinated poultry” (Federal Register 2003, 54797).

END spreads relatively quickly, making it difficult to track and contain. The virus survives for long periods in ambient temperatures, which increases the difficulty of limiting the spread of and eradicating the disease. The virus can travel both in the excrement of infected birds, and in bird saliva. The virus can transfer via contaminated water, implements, cages, boots and human clothing. The commercial poultry industry, by keeping chickens in close proximity, allows such

diseases to have a huge impact. END has the potential to cripple a poultry industry and the discovery of END in California prompted trade bans by major export markets.

An outbreak of END in California was confirmed on October 1, 2002, and subsequently spread to Arizona, Nevada, and Texas. Quarantines were also placed in Colorado and New Mexico. A taskforce was created to eradicate the disease, involving 10 state and federal agencies, including vets, forest service officials, health and human service officials, highway patrol officers, lab technicians, and short-term hires. Appendix 1 details the different participants and their respective roles. More than 7,000 workers rotated in and out of the taskforce, although the maximum taskforce size at any one time was approximately 2,500.

Once quarantines were established, taskforce teams visited private residences and commercial bird premises to diagnose whether an infection existed or was nearby. If there was a suspected case of END, the value of the birds was appraised, the birds were euthanized and the premises cleaned and disinfected. The taskforce found 932 premises to have been infected. By September 16, 2003, final quarantine restrictions related to END were removed.

The taskforce was relatively successful in terms of time and costs than the nearest parallel, the response to a 1971 outbreak of END in California. The previous outbreak lasted from November 1971 to July 1974, a period of 33 months. The cost of the eradication effort was approximately \$250 million in 2003 dollars (\$56 million in 1972) and about 12 million birds were destroyed. This compares with an estimated cost of \$176 million for the 11-month outbreak in 2002-2003, during which about 4.5 million birds were killed.

The case evidence comes from three major sources that provide detailed accounts of the outbreak. First, the Policy and Program and Development Unit of APHIS developed a 289-page After Action Review (Werge 2004). Second, APHIS also undertook an outside review of the

outbreak, leading to a four volume, 343-page series of reports by the CNA Corporation (Howell et al. 2004; Howell 2004; Speers et al. 2004; Speers and Webb 2004). Finally, this paper draws on interviews with senior managers involved in the taskforce.

The Nature of Network Uncertainty

Crises are defined by their relationship with uncertainty. Brändström, Bynander and 't Hart (2004, 191) define crises “as epochs of profound uncertainty and urgent challenges to the problem-solving capacities of the socio-political order in which they occur.” Crises are extreme examples of the wicked societal problems that cut across traditional public boundaries and require a network response (Koppenjan and Klijn 2004). Koppenjan and Klijn (2004) offer a categorizing three types of network uncertainty. Substantive uncertainty is lack of knowledge about the problem, or overload of non-definitive information. Strategic uncertainty arises because networks contain multiple actors who retain some measure of strategic autonomy, creating uncertainty about what choices they will make. Institutional uncertainty arises from trying to coordinate actors with their own perceptions, norms and objectives, and who come from different institutional backgrounds, administrative levels, organizations.

The ability to learn networks manage uncertainty. According to Koppenjan and Klijn (2004, 10): “A central question in the network is how joint action can be achieved...these cooperation processes can be regarded as learning processes. Interaction processes are considered to be searches wherein public and private parties from different organizations, (levels of) government and networks jointly learn about the nature of the problem, look at the possibility of doing something about it, and identify the characteristics of the strategic and institutional context within which the problem solving develops. Hence, cooperation presupposes learning between

the actors, crossing the boundaries of organizations, networks and coalitions.” The remainder of this section examines substantive, strategic and institutional uncertainty in the END case.

Substantive Uncertainty with END

There was little substantive uncertainty about the nature of END, nor was there much uncertainty about the goal of eliminating it. The main area of substantive uncertainty was how to achieve this goal by identifying, tracking and eliminating the disease. The mobility of END was one factor that made its elimination difficult. Most emergencies are centered in a particular geographic area, moving slowly and observably if they move at all. One taskforce member compared an emergency such as fighting forest fires (which many in the taskforce had experience with) to battling END. “On this kind of disease outbreak situation there is a much higher degree of uncertainty. In a fire situation, there may be an uncertainty such as the direction in which the fire is going to go, but it's a fire. But in the case of Exotic Newcastle Disease, is it Newcastle Disease? Is it not? Is it mutating somehow? Is it increasing its virulence? Is it decreasing its virulence? Is it being confused with other diseases? Do we really know what's out there? Is it really in this particular flock? Is it not in this particular flock? Is it in this community? Is it not? There's a much higher degree of not knowing what is actually going on.” Because of the mobility of the disease, and its rapid spread, the taskforce was never able to resolve the basic question of how the disease entered California, although they suspected the initial carrier came from Mexico and was involved in the cockfighting industry.

Identifying and eliminating carriers was made harder by the outbreak of END among backyard flocks. Preplanning had assumed that any major avian disease would occur in the commercial population. According to the USDA area veterinarian in charge, Dr. Paul Ugstad, "I

don't think any of us in our planning had any idea of how difficult it is dealing with an outbreak in an urban neighborhood. I don't think any of us understood the magnitude of the backyard poultry population. We are very comfortable with, and become accustomed to, working with traditional agricultural production facilities." The search for infected backyard fowl dominated taskforce activities, accounting for 96% of premises investigated (Speers et al. 2004, 68).

If the outbreak had occurred only among commercial producers, managing the outbreak would have been simpler to deal with in many respects. Commercial birdowners are smaller in number, identifiable and easier to coordinate. They have a staff on hand that can help dispose of birds. Since commercial operations are similar, standard methods of appraising birds and cleaning and disinfecting premises work well. The backyard population was more challenging to deal with. Most obviously, there was a lower effort-to-payoff ratio. The average number of birds depopulated in a backyard premises was 59, while the equivalent number for commercial premises was more than 120,000 (Speers et al. 2004, 75). Each backyard premises was slightly different, making it more difficult to write standard procedures that would satisfy all situations. The type of birds might differ from one owner to another, making appraisal slower and more complicated. The disease spread more quickly and in more unpredictable ways because of the ability of birds to move around in neighborhoods, and because of their interaction with humans.

Detection was also more difficult in a backyard population. The taskforce did not know who these bird owners were, unless they self-reported. Chances of self-reporting were low, at least until awareness of the disease increased. Many backyard owners have limited discretionary income, which reduces the likelihood that they will contact a vet if their birds become sick, eliminating another source of contact for the taskforce. In addition, the disease was prevalent among the estimated 1 million game fowl in California (Speers et al. 2004, 16). Although

owning game fowl is not illegal, cockfighting is. As a result, there was deep suspicion of any sort of law enforcement officials in this community, further reducing the chances of self-reporting, or observing quarantine. Game fowl interacted regularly in the unsanitary conditions of cockfight meetings, providing ideal conditions for the spread of the disease. The cockfighting season runs from Thanksgiving to the end of December, occurring just as the taskforce was trying to discourage the movement of poultry.

The backyard dimension also added a cultural complexity to the work of the taskforce, since a high portion of the backyard owners were Hispanic. Taskforce members had to go into poor Hispanic neighborhoods and seek cooperation with the locals. This was a daunting task for many who did not speak Spanish, had little knowledge of local geography, were unfamiliar with the culture and were from parts of the country with a much lower percentage of Hispanics.

Substantive uncertainty translated into role uncertainty for individual taskforce workers. Many in the taskforce found themselves in an unfamiliar and very different environment, working with individuals they had not met before, and being assigned to tasks with which they had little or no experience with. The basic tasks that the taskforce had to implement needed to be identified (see Howell 2004, 24-25 for a list of these tasks). Procedures detailing tasks had to be developed and disseminated to taskforce members. There was not a readily available off-the-shelf set of management principles and tactics for END that taskforce members could turn to as they decided on questions of how to organize and how to operate.

The urgency of a crisis setting exacerbates problems of uncertainty. Both developing substantive knowledge about uncertain conditions and constructing a network take time. However, an emergency setting does not allow time. The network has to be constructed quickly. Decisions have to be made at a rate consistent with the pace of events rather than negotiated by

consensus. END required a rapid response, and failure to implement tasks quickly meant that the problem would have become exponentially worse. As the taskforce grew rapidly in size from 100 to over 2,000 people, the administrative resources of the agencies involved were increasingly taxed. The urgent nature of the task combined with the dramatic growth of the taskforce stretched the ability of the network to focus on anything other than day-to-day operations, demoting the development of policy or management systems to secondary concerns.

Strategic and Institutional Uncertainty

For the END taskforce, strategic and institutional uncertainty was less pressing than substantive uncertainty. While substantive uncertainty is driven by the nature of the problem, both strategic and institutional uncertainty are inherent to the network format. Actors came from different levels of government, but also from very different types of organizations (see Appendix 1). APHIS and their state counterparts, the Animal Health and Food Safety Services (AHFSS, part of California Department of Food and Agriculture) provided a high number of vets to the taskforce and dominated the senior decision roles. These vets were familiar with dealing with animal diseases. The US Forest Service (USFS), and the California Department of Forestry and Fire Prevention (CDF) were less influential in the taskforce, but had, unlike most of the vets, a great deal of experience in organizing emergency response.

Much of the strategic uncertainty that networks face arises from their relatively loose structural form. Membership tends to be voluntary, members can leave when they want to, and collective decisions depend on consensus rather than the giving and receiving of orders. The strategic uncertainty that arises is likely to be particularly high in new networks, as the various actors seek to maximize their position in the network, but know little about the intentions of

other actors. As network actors develop relationships and interdependencies with one another through repeated interactions, trust increases, as does knowledge of the strategic calculus of the other. Familiarity is also likely to reduce institutional uncertainty, as the different backgrounds of various actors become known, and as the ways in which these differences can acceptably shape behavior become defined. Networks that grow old are likely to resolve the strategic and institutional uncertainty that give rise to possible conflict.

Crisis networks lack the time necessary for network actors to develop on trust-based relationships. For the END taskforce, planning, prior relationships, and structure served to deal with the bulk of the issues related to strategic uncertainty, and to a lesser extent institutional uncertainty. Prior to the outbreak, the California mobilization plan for exotic diseases affecting livestock (CDFA 2002, 9) identified that in cases like END there is joint responsibility between the State Veterinarian from AHFSS and the Area Veterinarian in Charge (AVIC, a federal employee of APHIS permanently based in California). In California, the AHFSS and AVIC had strong working relationships, and communicated with one another on a daily basis on animal health issues prior to the END outbreak. Once the outbreak occurred, they essentially formed a partnership to deal with it, and maintained this partnership throughout the outbreak, even though federal money and human resources increasingly dominated the taskforce as it grew larger. This partnership formed the hub of the network, reducing the potential for possible power struggles.

Formal structure was a key in organizing the network. The taskforce employed an Incident Command System (ICS) approach to managing emergencies. Versions of ICS have been around for decades, but this approach has become more important since the DHS published of a new national policy on emergency management called the National Incident Management System (NIMS) (DHS, 2004). NIMS pushes all federal, state and local crisis responders to use ICS. ICS

gives and incident commander responsibility for organizing the basic managerial functions required for most emergencies: operations, logistics, planning and finance/administration. When an incident becomes too large or too geographically spread-out, additional incident commands are established, under the control of a single area commander.

ICS essentially overlays a hierarchical structure on a network, relying on hierarchical authority to manage conflict and coordinate action. By using the ICS approach, the taskforce reduced many of its network characteristics – such as a reliance on consensus – in the name of unified command and rapid response. Reflecting the partnership that the AHFSS and APHIS had developed, they resolved to form a joint command to run the ICS, with one commander from each organization. This appeared to work well, and taskforce members saw the ability of the key agencies involved to work together as a major success factor.

The adoption of the ICS helped to remove uncertainty. It limited strategic uncertainty by surrendering the autonomy of the member agencies to the incident command. It reduced institutional uncertainty by establishing a common management framework. One participant noted that the ICS “gives us that common terminology, common organizations so we immediately can start working closely with each other...when we are all trained on the same organizational model, it comes together seamlessly.”

The ICS created learning challenges of its own. Most of the taskforce had not worked with an ICS framework before, with the exception of forest service officials. So many taskforce members had to learn what the ICS was and how it was supposed to operate. The ICS, as presented in NIMS, is applicable to all crises, and is therefore sometimes vague. In applying the ICS, networks have to decide how to staff it, and how to adapt it to the peculiarities of the crisis. Most of the key staffing decisions were dictated by the AHFSS and APHIS, but members of the

taskforce did not consistently agree on how to adapt the ICS to the needs of END. As Koppenjan and Klijn (2004) suggest, institutional background shaped interpretation. The vets involved, who had little experience with ICS, were more likely to argue that the ICS model needed to be changed and adapted to the needs of END, in terms of both structure and the level of discretion given to teams executing tasks. The forest service officials had used ICS many times, and did not see the need to adjust a model they perceived as working well.

One factor that exacerbated the uncertainty was turnover in the network. The taskforce was tasked primarily by temporary workers. Many of the frontline workers came from temp agencies, and could be used for the duration of the taskforce. However, most supervisors and managers were borrowed staff. They rotated in and out of the taskforce, typically serving for no more than three weeks because of the continued needs of home agencies, as well as the burnout factor arising from performing a difficult and stressful task for long hours, and usually away from family. Organizational learning begins with the individual, and the lack of continuity limited the ability to build up experience among personnel. Turnover generally weakens learning.¹ New employees coming into a position had to learn their role, just as the old occupant had finally mastered his. Employees had to adapt to unfamiliar supervisors, with different preferences and ways of operating. Employees serving a second or third term in the taskforce might find themselves working in a different role than they had before.

Methods of Learning

The experience of the taskforce suggests six ways in which learning took place: virtual experience, learning from others, learning from information systems, learning forums, standard operating procedures (SOPs) and learning from the past. I examine each in turn, and focus on

the particular importance of SOPs, since they represent substantive knowledge, a method of learning, and the institutionalization of learning. Case findings are summarized in Box 2.

Insert Box 2 here

Virtual Experience

Virtual experience provides understanding of the task demands by simulating these demands, through preplanning, role-plays, training, simulations, etc. Such virtual experience avoids the risk of costly error inherent in trial-and-error learning. Three types of virtual experience were relevant for the END taskforce: pre-training that occurred as part of the home organization's regular training, pre-planning, and on-the-job training that took place during the emergency.

There was some pre-training in the concepts of ICS among both federal and state actors, although not enough and largely uninformed by practice. One vet notes his limited familiarity with ICS: "I think I had taken an online, very introductory course several years ago but I had no specific training at all for that position that I was in." This is not to suggest that pre-training is not useful – indeed it forms the basis for the expertise of the various taskforce members, and the rationale for their inclusion. But pre-training that is unrelated to practice is less likely to be perceived as relevant until a situation arises where those skills are actually required.

Pre-planning suffers similar risks. There was pre-planning for the general threat of exotic animal diseases, but little specific attention paid to END. In any case, the backyard nature of the outbreak ran counter to expectations about how END would occur, and detailed pre-planning based on this faulty assumption would have offered limited help in developing specific response

techniques. The main benefit of pre-planning meetings was that it brought together the relevant actors, fostering working relationships before the crisis occurred.

To complement the limited pre-training and pre-planning, there was a good deal of highly specific on-the-job training. The after action review of the outbreak notes that "The 2003 END outbreak represents the largest on-the-job training experience in animal health incidents in the last thirty years" (Werge 2004, 9). Taskforce employees were given training for the particular tasks they were to implement, e.g. cleaning and disinfection, euthanization and disposal. This training was particularly critical for front-line employees who had no relevant experience. As part of their training process, employees had to read the parts of the SOP manual relevant to their job, and sign a statement confirming that they understood these SOPs. This was true even of employees who were returning to the taskforce for a second or third rotation. On-the-job training had a clear relevance to the taskforce employees. It was not a set of intangible skills that might serve at some uncertain point in the future. Instead, training provided skills that needed to deal with an immediate and vital task. The major disadvantage of on-the-job training was that it delayed the point at which responders were ready to enter the field.

Learning from Others

Organizations learn from one another (Levitt and March 1988), and one of the expected benefits of networks is to facilitate this learning. Networks speed up the diffusion of information, and provide more detailed and credible sources of information. Network members tend to imitate the practices of one another and are particularly likely to look to other members with expertise in an area rife with uncertainty (Brass et al. 2001, 805). By pooling knowledge,

inter-organizational learning is expected to reduce uncertainty about the task and foster a collective action that is greater than the sum of its parts.

The logic of learning from the experience of others is similar to that of virtual learning. It allows learning from failure without experiencing the cost of failure. The most prominent example of learning from others within the END taskforce was the reliance on state and federal forest service officials to provide advice and leadership on how to use ICS, and to transfer this knowledge to others. One taskforce member noted: “The use of ICS for END represented a steep learning curve for animal health agencies and for others involved in the incident.” Another recalled: “I was lucky enough to have a Forest Service mentor....It was really the organizational structure, the ICS structure that they were mentoring us on and specific functions because a lot of us were going into positions we had never ever done before.”

In some cases, the organizations in the network might not actually try to learn from others, but instead expect that other members become responsible for tasks relevant to their specialization. This is a logical response when the expertise involved is complex enough that the costs of learning it are higher than the costs of having another do it, and the cost of learning will not be offset by future use of that knowledge. For instance, firefighters do not need to learn about epidemiology. It did not make sense for the entire taskforce to learn Spanish if they could contract out to workers with those skills. The taskforce supported teams in the field by hiring guides who had knowledge of local geography, culture and language. By hiring this expertise, the backyard aspect of the outbreak became less formidable.

Learning from Information Systems

A well-established management technology is predictable, reducing the need for constant monitoring. By contrast, the technology of eliminating END was developed as the outbreak occurred, and its effectiveness had to be constantly assessed relative to goals. In addition, a system was needed to task actions to multiple teams as they covered different geographical areas. The Emergency Management Response System (EMRS) provided such a mechanism. EMRS is a tasking system for incident response. A manager looking at EMRS could tell whether premises had been visited, and what actions had taken place or needed to occur. EMRS kept track of the location of personnel and other resources, and reduced the potential for personnel to visit the same premises twice or report inconsistent information.

Information technology such as the EMRS is critical in facilitating crisis network response. “Coordination, from previous evidence, occurs most reliably with timely, accurate information search and exchange processes” (Comfort, 2005, 4). The EMRS ensured an information flow consistent with the structural design of the ICS. The EMRS was flexible enough to incorporate changes required by the emergency. For example, a tool to centrally track financial costs was added during the outbreak. An administrative component was also added to track equipment, vehicles, personnel, their contacts, training, and assignments. Finally, a task management component allowed the inclusion of information related to meetings and tasks.

Another addition to the EMRS was a mapping module, which allowed the taskforce to see where the disease was occurring, and the nearby locations where the disease was likely to spread. This helped to prioritize where to send survey teams. Each field worker had a global positioning system receiver and a map which showed the grid which the survey or surveillance team was responsible for. Once premises in that zone were visited, the information was entered in the EMRS and future maps would show that these premises had been completed.

Learning Forums

Learning forums are “routines that encourage actors to closely examine information, consider its significance, and decide how it will affect future action” (Moynihan 2005, 205). Learning forums are consistent with what Arygris and Schön (1996) refer to as dialectical learning - a form of debate that reveals assumptions, biases, and facts, and evaluates different alternatives. Such debate increases cognitive differentiation and integration (Stern 1997, 72). Established organizations or networks may be able to survive without a discursive analysis of routine processes and performance information. However, the demands and uncertainty of crisis response make learning forums essential to management.

During the most critical stages of the END outbreak, each incident command had a mandatory meeting that occurred early each morning.² At the meeting, taskforce members received updates on the status of the incident, new changes to practices, weather briefings, and operation plans for the day, including what and where tasks were to be achieved. The incident command meetings were accompanied by an incident action plan that summarized much of the information being exchanged, such as the number of birds depopulated, the number of premises quarantined, the number of infected premises, and the number of premises yet to be depopulated. Area commanders also held daily conference calls with the incident commanders.

Early in the outbreak, when there was a single incident command and a relatively small number of people working on the taskforce, meetings were the dominant process by which information was shared and tasks were allocated. As the taskforce grew it relied more on formal rules. One taskforce participant said: "Initially the group was small enough that we could use informal communications, but as the group got bigger it had to be formalized because, as you

bring in that number of people, you have to have a working chain of command." Written SOPs became "very important as well. With the numbers of people coming in and the numbers of people rotating, you have to have procedures in place so that people coming in can understand what they need to do and what they shouldn't do." However, even as they were increasingly relying on SOPs to guide employees, senior managers continued to use regular meetings to identify process and performance issues.

Creating Network Memory through SOPs

The increasing formalization of the taskforce made SOPs the critical method by which lessons were stored and disseminated. Levitt and March (1988) point out that SOPs encode inferences from history that guide organizational behavior.³ SOPs are a form of learning known as competence acquisition, involving the learning of practical skills to transfer intention into outcomes (Stern 1997, 71). SOPs serve to institutionalize learning (Crossan et al. 1999), a process by which experience is recorded, conserved, and retrieved through routines. SOPs become, in effect, the organizational memory – or in this case, the network memory. By formalizing routines via SOPs, lessons from previous experiences become highly accessible.

SOPs had to be written, and sometimes rewritten, as the END outbreak was occurring. SOPs were developed based on the insight of taskforce members as they learned more about the disease, as the following quote from a taskforce participant illustrates:

Operationally, we knew what to do. We had to make certain adjustments. For example, cleaning and disinfectant, we know basically how to clean and disinfect something. We know how disinfectants work, how to use them. But we did not know how much you had to

do to disinfect these backyards. How do you know these yards are clean? So we had to do some trials and studies during the course of the outbreak to come up with some SOPs.

Another taskforce member noted that: “Some of those [SOPs] were designed by doing.”

Feedback from the public, including complaints about a lack of consistency in operations also led to SOPs:

There were literally thousands of SOPs that were created, and I think that, in fact, that standardization is something that is needed in those kinds of situations because you have this tremendous pressure of rotation all the time. You know, people coming on not knowing how to approach things. The lack of standardization when we went out and talked to people in communities was one of the things that drove the community people crazy because the way you treated this person was different from the way you treated that person and the way this other person got treated.

While the development of SOPs therefore appears to be a mostly bottom-up process, they were subject to review at area command, and in some cases were also initiated by area command staff. The SOP manual created during the taskforce ultimately exceeded 400 pages, and provided procedures for every aspect of operations.⁴

Learning from the Past

Previous crises are an obvious source of lessons. However, learning from the past is risky and may provide faulty guidance. Biased or divergent interpretation (often driven by a defensive instinct to block blame, or an opportunistic tendency to claim credit) can foster ambiguous

feedback (Stern 1997). Historical analogies may have a constraining impact, creating blindspots or cognitive prisons (Brändström et al. 2004).

The ability to transfer lessons depends on how similar the conditions of the crises are. For END, a perfectly similar crisis implies an outbreak of the same disease in a similar area, during a similar time period and under similar conditions. For instance, APHIS staff who had worked in California during the 2002-2003 taskforce proved invaluable in helping the END incident command in Arizona.⁵

Any difference in conditions across outbreaks reduces the ability to transfer lessons. The major barrier was the lack of relevant parallels, what Levitt and March (1988) refer to as a paucity of experience problem. There had not been a major outbreak of END in the United States since the early 1970s. Although the 1970s outbreak involved the same disease in the same state, the passage of three decades and the backyard aspect of the most recent outbreak limited the applicability of the previous experience. Members of the taskforce did read reports from that outbreak, and brought back a manager from that period to offer insights. But the past could only teach the current taskforce so much, because of limited information from that period, because of dramatic changes in technology and biosecurity, and because the previous taskforce was not consistently well-managed. One lesson that did emerge from the previous outbreak was the importance of biosecurity training, since it was suspected that government employees had inadvertently helped to spread the disease in the 1970s due to lax biosecurity procedures.⁶

The END taskforce may have faced a paucity of experience problem, but the END experience may provide lessons for future emergency taskforces on how to manage exotic animal diseases. In the aftermath of END, the USDA commissioned both an internal after action review, as well as an external review. APHIS hopes that the SOP manual developed during END

can be applied elsewhere, with some adaptation. Advances made with the EMRS system during the END outbreak make it likely that it will be used again in the future.

Management systems such as the EMRS and the ICS are generic form of knowledge that is relatively easy to transfer. The ICS was developed in the early 1970s to help coordinate the response to forest fires, and has since been used in a wide variety of crises. Because it is not specific to forest fires, forest service officials were able to adapt ICS principles to eliminating an avian disease. For the same reason, the ICS experience developed among APHIS personnel is likely to be the most crucial knowledge transferred to other emergencies. As a result of END, APHIS has developed emergency management teams – specific groups of people with complementary ICS experience – that can be deployed together during future outbreaks.

Conclusion

This paper has detailed how networks learn under conditions of uncertainty, using the experience of a taskforce of emergency responders. Starting with limited relevant experience and high uncertainty, the taskforce largely learned its job while on the job. The END case showed evidence of learning in changes to policy procedures and processes in ways that acknowledge the ‘lessons’ of experience.⁷ The establishment of SOPs documented the creation, ongoing adjustment, and diffusion of procedures intended to govern taskforce actions. Learning of generic management systems also occurred, specifically the development of the EMRS and application of ICS to managing exotic animal diseases. The relative success of the END taskforce may reinforce the conventional wisdom that the ICS is an appropriate and widely applicable approach to emergency management (DHS 2004). Applying the ICS to dissimilar types of crises or more catastrophic events could reveal different results.

Koppenjan and Klijn's (2004) model is not intended to provide a cause-and-effect explanation of learning amid uncertainty. Instead, it provides a framework for empirical research that will further theory development. The evidence from the END case study is not generalizable enough to develop a general theory of learning under uncertainty – there is clearly much room for future research in this area – but it does provide some empirically based insights. One contribution is to categorize the particular nature of uncertainty faced by crisis responders. Another is to describe the nature of learning in the taskforce, as summarized in Box 2. Two additional points merit further discussion: 1) the role of structure in learning, and 2) the balance between exploration and exploitation of knowledge in a crisis context.

The experience of the taskforce points to the ways in which learning can reduce uncertainty. Structure plays a role here. The use of the ICS structure reduced much of the strategic and institutional uncertainty that any network faces. Many network members still had to learn what the ICS was, and how to adapt it to the particular context of END. This process was not without disagreement and conflict, but was a more expeditious and harmonious solution than allowing the network actors to come to some agreement about how to coordinate with one another and resolve conflict. The use of ICS effectively reduced the learning challenge that the network faced. Many of the issues of strategic and institutional uncertainty that Koppenjan and Klijn (2004) identify were resolved through the use of the ICS. This finding suggests the importance of a predetermined structural as a means for networks to manage uncertainty.

ICS is a structural design that reduces uncertainty and provides an easily understood architecture for action. Structure can also be understood as rules (Lynn, 2003). Indeed, this is what Lipshitz et al. (1996) mean when they argue for a more structural approach to learning: "institutionalized structural and procedural arrangements that allow organizations to

systematically collect, analyze, store, disseminate, and use information that is relevant to the effectiveness of the organization" (Lipshitz et al. 1996, 293). The most basic structural approach to learning is through the use of SOPs, and SOPs were crucial in ensuring clarity, standardization, and consistency in operations as the taskforce grew.

The importance of SOPs in this case informs Milward and Provan's (2000) argument that networks must find a balance between rigidity and flexibility. We so frequently hear of the constraining impact of red tape on managers that it becomes easy to dismiss any type of formalized routine as a barrier to learning and innovation. However, in the evolution of every organization/network there is a point when there is little organizational memory beyond what is carried about in the minds of the employees. This can be expected to occur early in the development of the organization/network, or when new tasks or uncertainty are prominent. At this point, formal routines represent a way of institutionalizing lessons learned, and disseminating them to others. The challenge for established organizations and networks is to keep institutionalized learning from becoming so embedded that it acts as a barrier to new learning.⁸ In the END outbreak, there was no organizational memory. More pressing than the risk of inflexibility was the need to convert individual and group level learning into established routines that transferred the advantages of new lessons to the entire network.⁹ The END case demonstrates that the need for formalization is particularly pronounced when the degree of uncertainty faced by the network is high. This insight is relevant to one of the basic tensions in the organizational learning literature – that between exploration for new knowledge and exploitation of old knowledge (March 1991). In situations of high uncertainty, such as crises, there is little choice but to explore for new routines before the organization/network is in a situation to exploit learned routines.

Box 1: Barriers to Effective Learning During Crises

1. High consequentiality of crises make trial and error learning prohibitive
2. Crises require inter-organizational rather than organizational learning
3. Lack of relevant experience, heuristics, SOPs or technologies to draw on
4. Scope of learning required is greater than in routine situations
5. Ambiguity of previous experience gives rise to faulty lesson-drawing
6. Crises narrow focus and limit information-processing
7. Rigidity of response: actors recycle old solutions to new problems
8. Political dynamic gives rise to bargaining and sub-optimal decisions
9. Crises provoke defensive posture, denial of problem, responsibility or error
10. Crises provoke opportunism as actors focus on their positive role

Box 2: Learning in Emergency Networks

- Virtual Experience: Identify which categories of lessons are suitable for pre-training and on-the-job training.
- Other Network Members: Bring together appropriate complementary skills; identify skills that are capable of being learned, and those which are better left to specialists.
- Information Systems: Create timely information systems that monitor allocation and achievement of tasks.
- Learning Forums: Ensure that information is examined and discussed on a regular basis, and shapes operational decisions.
- SOPs: Build and disseminate formal routines where none exist.
- The Past: Draw lessons from the past cautiously and sparingly, with awareness of differences with present. Generic management systems and skills are easier to transfer.

Appendix 1: Main Network Participants and Skills

Agency	Skill
Animal Health and Food Safety Services (part of California Department of Food and Agriculture)	<ul style="list-style-type: none"> • Veterinary expertise • Understanding of END; how to identify disease, cleaning and disinfectant procedures • Local knowledge • Pre-planning for animal disease response in California
Veterinary Services (part of APHIS, part of USDA)	<ul style="list-style-type: none"> • Veterinary expertise • Understanding of END; how to identify disease, cleaning and disinfectant procedures • Experience with other types of animal disease outbreaks
California Department of Forestry and Fire Prevention US Forest Service (part of USDA)	<ul style="list-style-type: none"> • Experience with applying ICS in emergency situations • Hiring flexibility • Expertise on emergency logistics • Experience in training and managing large number of emergency workers • Experience and expertise in emergency planning
Office of Emergency Services	<ul style="list-style-type: none"> • Awareness of the emergency resources available in different parts of the California state government • Authority to coordinate the actions of state agencies toward emergency response • Pre-planning for animal disease response in California
Temp agencies	<ul style="list-style-type: none"> • Personnel management of temporary workers • Hiring flexibility
Temporary employees	<ul style="list-style-type: none"> • Volume of work support • Continuity at frontlines • Knowledge of local environment, language and customs
California Animal Health and Food Safety Lab and National Veterinary Services Laboratory	<ul style="list-style-type: none"> • Ability to identify disease • Development of rapid diagnostic test
National Response Management Team (NMRT, part of USDA)	<ul style="list-style-type: none"> • Coordination of federal agencies • Develop interagency cooperation agreements with other USDA agencies • Develop financial requests and reports for US Office of Management and Budget
California Highway Patrol	<ul style="list-style-type: none"> • Ability to enforce quarantine: created checkpoints at weigh stations to ensure that commercial vehicles observing quarantine; inspected trucks stopped for routine traffic violations
California Environmental Protection Agency	<ul style="list-style-type: none"> • Understanding of disposal and decontamination procedures
California Department of Health Services	<ul style="list-style-type: none"> • Understanding of health risk to humans • Understanding of risk communication to the public

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Endnotes

¹ March points out (1991, 124): “Since there is a positive relation between length of service in the organization and individual knowledge, the greater the turnover, the shorter the average length of service and the lower the average individual knowledge at any point.” In some cases, turnover can strengthen learning if the actors involved enter with new knowledge, and the knowledge of the actors exiting has been incorporated into organizational routines. Given that much of the knowledge in dealing with END was learned on the job, and that the tenure of members was so short, these conditions do not apply.

² Comfort (1994) also points to daily meetings as critical to learning. In particular, she notes that such meetings establish a “common knowledge base” about the nature of the task that facilitate mutual coordination and adjustment. Through such interactions, the participants learn each others capacities and preferences.

³ Levitt and March (1988, 16) define routines broadly. “The generic term *routines* includes the forms, rules, procedures, conventions, roles, strategies, and technologies around which organization are constructed and through which they operate. It also includes the structure of beliefs, frameworks, paradigms, codes, cultures, and knowledge that buttress, elaborate, and contradict the formal routines. Routines are independent of the individual actors who execute them and are capable of surviving considerable turnover in individuals” (emphasis in original).

⁴ The SOP manual covered vehicle use, reporting accidents and injuries, policy on media contacts, and policy on overtime. Under finance, the manual covered processing purchase orders, processing indemnity claims, and budget reconciliation. There were mobilization and demobilization SOPs aimed to help orient employees. There was a section on personnel conduct and interacting with the public, and another section covered animal control, human health, pet bird protocols, biosecurity and safety, non-commercial site surveillance, commercial site surveillance, quarantine, diagnostics, epidemiology, regulatory enforcement in quarantines, disposal, euthanasia, cleaning and disinfection, movement and permitting, indemnity, sentinel birds, area quarantine release, and commercial poultry planning.

⁵ Another example comes from Comfort (1994), who points to the benefits in state response of the experience accumulated during six significant earthquakes over seven years.

⁶ Another past experience that informed the taskforce was the foot-and-mouth outbreak in the United Kingdom in the late 1990s, prompting state officials in California to plan for outbreaks of exotic animal diseases. This plan identified some lessons from the foot-and-mouth experience, such as the need for continuous surveillance, early detection, and working with the media (OES and CDFA, 2001). But as noted above, the guidance arising from pre-planning was relatively vague.

⁷ This meets one of the four standards for learning that Stern (1997, 80-81) suggests: “modifications of the doctrine and ‘conventional wisdom’ that provide institutionalized guideposts for actions; changes to policy procedures and processes in ways that acknowledge the ‘lessons’ of experience; an alteration of policy structures to reflect such lessons; and a revision of policy commitments and budgetary commitments on the basis of experience.”

⁸ Levitt and March (1988) refer to this as a competency trap. Organizations may adapt routines that are initially superior, but become fixed, and over time are inferior to newer alternatives. In such situations, employees who discover superior alternative procedures may surreptitiously work around the formal SOPs (Ban, 1995).

⁹ As Crossan et al (1999, 529-530) note: “Organizations naturally outgrow their ability to exclusively use spontaneous interactions to interpret, integrate and take coherent action. Relationships become formalized. Coherent action is achieved with the help of plans and other formal systems. If the plan produces favorable outcomes, then the actions deemed to be consistent with the plan become routines.”