Training Command and Control in Search & Rescue-Adaptive Behaviors in Uncertain Conditions

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ABSTRACT

In any situation where there are shifting goals, there is a need for real-time adaptation. In critical situations in military or emergency operations, time is of the essence. It is crucial for success to get on top of the problem as quickly as possible and start acting faster than the situation develops, to seize and keep the initiative. By reaching such a state, proactive rather than reactive measures must be taken. Shifting goals require a radically different approach than stable goals when it comes to the rationale for action. There is a known gap between work as done and work as imagined. Managers often have a too simplified model of how work is performed and thus many simulator training programs are not living up to their potential. In this theoretical paper, the Cynefin Framework is being used to argue for different approaches to simulation design depending on the character of the situation depicted. Four situations are considered: simple, complicated, complex and chaotic. Simulation is a powerful training tool if used with thought. A thorough understanding of the area and system character of application is of crucial essence to be able to successfully develop simulator training. Complex system implies the need for adaption. Linear systems imply rule-based operations. If the solutions fit for linear systems are imposed on complex systems the ability to adapt is lost and in some cases to great risk to the operators on the field. To be able to tailor training to the task and to use simulation close to its full potential, it is of essence to understand the character of the real-life situation the simulation is aimed to prepare the trainee for. Complex (uncertain) situations require adaptation which simulation can afford but too often is lost and forgotten in bureaucratic fulfilment of training curriculums.

ABOUT THE AUTHORS

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Captain Lars Axvi is an accredited work shop leader and head of training for Resource Management, Bridge Team Management and ship-handling courses and provides not only intimate knowledge on the effective use of simulators in learning but also solid competence regarding team work, resource management, command and communication. Being trained as both a naval officer in the Royal Swedish Navy and a Master Mariner, Captain Axvi is an expert concerning leadership having served not only as head of operations responsible for command, control and communications but also as liaison officer abroad and head of navigation branch in charge of war bridge team management and development of routines for navigation and route planning. In addition to his naval education and experience, Captain Axvi holds a BSc in Nautical Science (Master Mariner unlimited) and has sailed in senior positions in both the Swedish and Norwegian merchant fleet.

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INTRODUCTION

The captain of the vessel has just got a request over the radio from the Maritime Rescue Coordination Center (MRCC) to take on the role of On Scene Coordinator (OSC) in the Search and Rescue (SAR) operation that is about to start. He knows from experience and training that it is a demanding task that needs to be carried out by someone; even though he is not happy to do it, he is not unwilling and accepts. Little is known about the radio shout. It is the morning after midsummer, which in Sweden is a very popular holiday. Three people are missing; they were celebrating on an island in the archipelago and should have gotten home late last night but haven't shown up yet. Concerned family members have alerted the SAR organization. MRCC has made an initial investigation and determined that they had taken their boat homebound late the previous night. The same morning, a passenger on a commuter ferry told the deckhand, when he debarked, that he had seen a boat upside down on the ferry's starboard side half an hour earlier. Five vessels have reported in to assist in the search. Unfortunately the SAR helicopter is engaged in another SAR case which MRCC also is heavily invested in. It is now up to the captain to shoulder the role of OSC and coordinate the search with little help from MRCC due to the strained situation with multiple SAR cases going on simultaneously. On the bridge they are now trying to form a structure for how to work. Who should be on the radio, who is writing things down, who is talking to MRCC, who is operating the vessel, who is making the decisions… the questions and duties are many. Then comes the issue of what to do and where to start. There is just one thing that is sure in this moment and that is whatever they believe to be true at this very moment will turn out not to be. In every tough SAR case, few things are known from start and the challenge is to keep apart fact and assumptions and make as good decisions as possible in the uncertain conditions. Acting is key and it is only in retrospect that it is possible to find the optimal solution. Here and now, doing something is always better than waiting and trying to find the best solution, since the best solution will always come too late.

Figure 1. Full Mission Bridge Simulator

This scenario illustrates the challenges facing students in one of the simulations in the course for On Scene Coordinators (OSC) in maritime Search and Rescue (SAR), provided by the Swedish Maritime Administration together with Chalmers University of Technology. The class consists of about 15 students and at their disposal there are five full mission ship bridges as shown in Figure 1. In addition to the problem described in the scenario there is contradictory information planted in the exercise. Normally the participants find the vessel in distress they are looking for, quite quickly. It is afloat but shows clear signs of damage from running aground, and there are no people onboard. If the OSC asks for a search of the wreck, the instructors provide information of a purse containing a wallet and identification card (ID). The crux is that the ID doesn't match with the initial information on who was onboard and thus there is more ambiguity created. As the vessel is found quite some distance from the position initially reported, the students need to engage in some serious sensemaking (Klein, 2017) to figure out what has happened and where to continue the search. Consulting the sea chart is key to look from where they left and to what destination they were heading and, depending on the location of the found vessel and drift, where would it likely have run aground. If students in this scenario just start to look for Persons In Water (PIW), they will not find them as the boat has run aground a couple of nautical miles upwind of the location for the finding. For a successful outcome of the scenario, continuous adaption and adjustment is key. The scenario described is based on several SAR cases in the Baltic Sea and around the coastline of Sweden and is a good representation of the more difficult SAR cases to solve that occur on a regular basis.

THE CHARACTERISTICS OF SAR

A valid question is why to present the student with an enigma or a complex problem; why not teach them the best practices of SAR and let them apply these lessons in simulation. Of course there is basic knowledge that the student must be able to master, such as basic drift calculations and how to organize search patterns at sea and much more. However, it doesn't matter how good they become in these separate skills if they are applied in the wrong position or if an inappropriate action is chosen for the given situation. If pieces of information are not puzzled together there is a great risk that good efforts are spent in vain.

At the start of each course the students are asked to do an exercise to define the characteristics of SAR. First they silently and individually reflect on the topic, writing down their thoughts in bullet form. When the pens have stopped, usually after about 10 minutes, they are told to turn to their neighbor to share their thoughts with each other. This discussion takes about another 10 minutes, after which they are asked to tell the larger audience what they have come up with. All the comments are written on the whiteboard by the facilitator and if needed summarized into concepts – which are mirrored back to the participants to verify that the summarization is conveying the same meaning as initially intended. By conducting the exercise in the described way, Groupthink is mitigated. Groupthink is: *"a mode of thinking that people engage in when they are deeply involved in a cohesive in-group, when the members' strivings for unanimity override their motivation to realistically appraise alternative courses of action."* (Janis, 2008). A second aim with the exercise is to use writing as a way of enhanced reflection and the discussion in pairs as an enabler to increase the willingness to speak openly in the larger forum (Hammarén & Meneses, 2005).

It is worth noting that the participants aren't novices in SAR activities. They are skilled and senior personnel who are having a command or a senior position on a vessel with SAR obligations. The results from these exercises are very consistent. There is a great amount of uncertainty in any difficult SAR case and that uncertainty must be handled differently compared to problems that are more predictable. Comments often arising are: *"one never knows everything from the start", "what one first believes always turn out to be something differently in the end of the SAR operation".* Drawing from this, and the instructors' own experience, dealing with uncertainty is key for effective SAR operations. The success or failure of a SAR case is heavily dependent on the ability to deal with uncertainty and the in-situ adaption to changing conditions.

THE CYNEFIN FRAMEWORK

The Cynefin Framework (Snowden & Boone, 2007) is suggested to be used as a guide to design training to fit different kinds of situations with a great range from the simple to the complex (and even chaotic). Using the Cynefin Framework, training can be tailored to support a great variety of different kinds of skill development. However, if applied without thought and analysis there is an obvious risk to implement training that will be unsuccessful, and in the worst case, harmful.

Before the Cynefin Framework is to be further elaborated on, there is a need for defining the nomenclature. So far in this paper the concept of uncertainty has been mentioned and discussed. The Cynefin Framework uses a different nomenclature, and instead of uncertainty, the construct of complexity is used. However, complexity can be understood as uncertainty. *"…the greater the number of possibilities, the greater the uncertainty there will be about which of these possibilities will be realized at any particular time. Thus, coping with complexity is synonymous with coping with uncertainty! Or, in other words, a system is complex if its future is uncertain."* (Flach, 2012) From here on complexity and uncertainty will be used interchangeably referring to the same phenomena.

The Cynefin framework is a sensemaking model, a model to categorise systems' traits and what kind of behaviour is required by different system states (Figure 2). The essence is that different kinds of problem solving behaviour that fit different kinds of systems and unfortunately complexity, uncertainty and emergence (as an alternative to causality) are not well understood by the operators and especially managers in general (Argyris & Schön, 1997). Simulator training for complex and uncertain situations rarely focuses on the factors for success for that specific context, and instead focuses on minimising the potential variability of the controller by enforcing rule compliment and thus reducing the adaptive capabilities that are pivotal. It is important to stress that the Cynefin framework and the notion of complexity are not advocating anarchy. Procedures, rules and regulations have their place but they must be written differently depending on the system characteristics (Hale, David, 2013, part 1) (Hale, David, 2013, part 2). The five areas in the Cynefin Framework provide a model that can be used to understand the consequences of system characteristics when it comes to simulator training.

In the Cynefin Framework all the borders between the facets are gradual, apart from the border between simple and chaos, which is a hard one which will be discussed later.

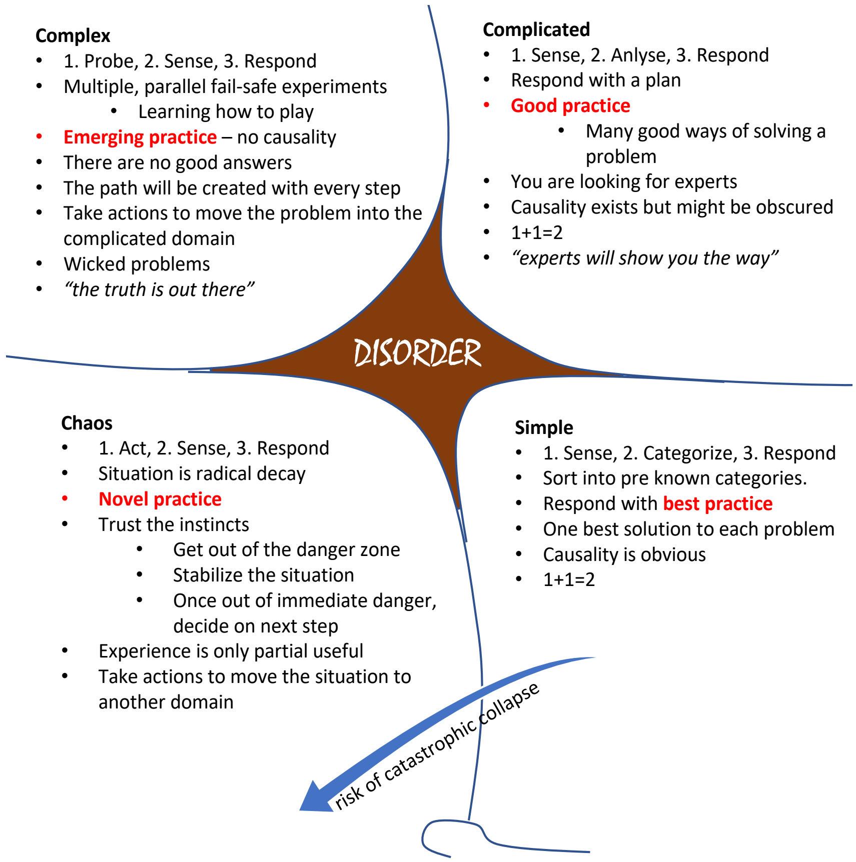

Figure 2. An Illustration of the Cynefin Framework

The Simple Domain

In the simple domain causality is evident to everyone engaged in the activity. The situation is transparent and it is easy to categorize a situation and choose the pertinent action. It is possible to create and use a single best practice for the situation at hand. Using best practices is a highly efficient way of dealing with these kinds of problems. It is very economical if the situation stays simple and stable. Many companies are pushing their business into this domain as it is cost effective to emphasize procedures and best practices. For stable conditions this is in economic terms a desirable state.

Training for operating in the simple domain infers the following, and the application of, procedures – finding and developing best practices. As the situation is relatively stable and most parameters are known, there is not much need for extensive communications. Communication can be done concisely. Management can be handled effectively by classical Command and Control, and decisions are based on known facts.

Many training paradigms create knowledge suitable for the simple domain both intentionally and unintentionally. Goal-based training is an example of this, where the student is taught how to do something but not necessarily why. It is not by default a negative thing. In some cases, this is a desirable outcome, especially when it comes to low skill tasks.

The Complicated Domain

In the complicated domain there is causality but its roots may not be obvious. The problem needs to be understood in a deeper way than in the simple domain. It is not sufficient to categorize a problem and act upon pre-defined solutions i.e. best practice, as the problem is complicated with multiple effecting conditions and extensive ramifications. The operators need to have a much deeper knowledge of the system and its components and their relations to each other to be able to create a plan to solve the problem or achieve the goals.

For operators to be able to handle complicated situations or problems they need expertise. This is of course costly to build up and takes time. Using simulation to create expertise is rarely realistic from two perspectives. First, all simulations are simplifications of the reality and thus there are aspects of the reality that by necessity can't be covered with learning experiences in a simulated environment. Second, few trades have enough resources to spend on simulation to develop some level of expertise.

There are generic skills when it comes to planning, problem solving and teamwork that are essential to creating the plan needed to solve problems in the complicated domain and it is probably here where simulation can make the largest contributions. The deeper understanding of the system itself is maybe best achieved with a balance between simulation and on the job training combined with experiences from doing and acting.

The Complex Domain

The complex domain creates an interesting shift of perspective. In the complex domain the future is uncertain, as causality does not exist or only partially exists. The rationale becomes to try to reveal what is successful, not by building on prior experience alone but to use it to create fail-safe experiments that aim at exposing the nature of the situation at hand and what actions yield progress. This technique has been coined Muddling Through or Incremental Adjustments (Flach, 2012).

In the complex domain things happen without a cause; they emerge. The actions taken to achieve a goal, in relation to emerging phenomena, can thus be said to be emergent too – emergent practices.

Organizing work in the complex domain differs radically from organizing in the simple and even complicated domains. Training must by necessity mirror this relationship. The classical hierarchical feedback loops of Command and Control must be relaxed, with control distributed to the persons dealing with the actual problems. General goals or aims are used as guidance, as too detailed goals can impede the process of achieving the main goal. The procedures from the simple domain are not useful, and efforts to enforce best practices in the complex domain are bound to fail. It increases risk to superimpose best practices on complex situations. Many ambitious and well-meant interventions have been made due to the choice of a non-adequate ontology of causality over emergence (interpreting the situation as simple when it is complex). Even though simulation is a less open system than any non-simulated system (Flach, Fred, 2016), it is probably a highly suitable environment to train to cope with complexity and to learn the art of Muddling Through.

The Chaotic Domain

In the chaotic domain things are in radical decay. This is a situation which one must get out of as soon as possible. The house can be on fire; it can be a case of drowning or heavy incoming enemy fire. The priority is to stabilize the situation and then move into any of the other three so that the situation can be dealt with in a safer way. Doing something is better than doing nothing. Rapid response is crucial. It is a question of simple trial and error. Do something, see if it works and if so, get out of the situation. This is the domain of the authoritarian leadership and direct communication.

The Danger of Not Recognising the Other Domains

As with the simple domain there is a risk in not being vigilant for other perspectives, regardless of which domain in the Cynefin Framework one is situated in. People working with complex problems inherently see most problems as complex. The same goes for people in the simple domain; they see most problems as simple. Contrasting the complex and the simple domain in this respect demonstrates that being too focused on simplicity and causality creates risks of plunging down into chaos. There is always a need to invest efforts in adaptive behaviour as change is a fact. Where this balance should lie and who and how it is to be monitored this is an important issue. Many companies have fallen into chaos and more or less vanished as they didn't manage to recover. The story of Kodak is a good example of such catastrophic collapse. Kodak's main business was about selling film but cameras went digital and then disappeared into cell phones. People went from printing pictures to sharing them online. *"Where Kodak failed was in realising* *that online photo sharing was the new business, not just a way to expand the printing business."* (Anthony, 2016). On the other hand, being too focused on complexity will generate huge costs and inefficiency if the working methodology is applied on a simple system. Neither are desirable. There is a need for the controller of a system to be able to reflect upon the characteristics of the system and identify the system state, what future developments might look like and if there is a change of domain happening. If not, the system can drift to another state and the behaviour of the operators will have a poor fit to the needed actions, with potential negative consequences.

Another aspect entailed by the Cynefin Framework to consider is that situations might be interpreted as being either-or but they can very well be "both and." A situation can very well be complicated in a broad perspective while there are subsets of the situation that are simple, where a best practice is preferred rather than good practices.

HOW THE CYNEFIN FRAMEWORK CAN BE USED IN TRAINING

SAR is inherently uncertain. In the beginning of any SAR case the information is scarce and often distorted or partially false and misleading. To try to come up with a bulletproof plan beforehand is bound to fail, as what is known from the start rarely resembles what is true at the end state of the mission. Many times, the only way of exposing the nature of the SAR case is to engage with it, by interacting with the situation more information will be exposed that otherwise would have remained hidden. By using the initial information, a search area can be calculated, but if nothing is being found in that area, previous assumptions need to be questioned and new search areas must be recalculated. In the same way wreckage might be found outside of the calculated search area, that will overthrow previous assumptions. This is Muddling Through, doing fail-safe experiments to reveal what yields progress.

In the simulation the scenarios are being designed based on real cases which would be considered to be focused towards the complex domain. The students are being instructed on how to handle a complex problem, as a SAR situation can be. They are then manning the ship bridges with a crew of two to four in each team where one bridge acts as the coordinator of the others (the OSC bridge). The success and failure of the coordinating crew is dependent on many factors. They need to recognise the need of planning, and replanning (Muddling Through) and adjust their plan to any new piece of information. It thus also becomes a matter of sensemaking (Klein, 2017) or pattern recognition (Klein, Calderwood, & Clinton-Cirocco, 1986), when a new piece of information is revealed and requires both experience and creativity. The participants aren't told what to do to solve the problem. They are trained in a way of working, a mindset and an approach. There are no right answers beforehand on how to solve a SAR case. It is only in hindsight that the optimal solution can be found. However, believing that such a solution was at hand to the operators in a complex situation is a grave misinterpretation – a clear case of the hindsight bias (Woods & Cook, 1999). The most important sources of uncertainty in these simulations are the scenario itself and the participants themselves. Each crew will behave according to their understanding, beliefs and competencies. This varies a lot and thus the OSC is forced to deal with this variability and uncertainty. When designing training in a closed simulator system as a simulator, it is argued that the normal human performance variability is a very important asset to be utilized to train the adaptive behaviour that is needed in the complex domain. Table 1 summarises the recommendations given for training in the different domains, using the Cynefin Framework as a model.

Table 1. Perspectives on training for different situations.

	SITUATION	TRAINING FOR THE SPECIFIC SITUATION	TRAINING TO BE VIGILANT FOR CHANGE OF DOMAIN
SIMPLE	• Causality evident to everyone • Right answer exists • Known knowns • Fact-based management	Sense, categorize, respond • Training of following of procedures. • Make sure that proper processes are in place. • Use best practices. • Communicate in clear, direct ways.	• Read the situation - challenge the assumption that the situation is Simple. • Watch out for the risk of falling into chaos
COMPLICATED	• Causality discoverable but not apparent • More than one right answer possible • Known unknowns • Fact-based management	Sense, analyze, respond • Finding pertinent procedure. • Train the ability to plan. • Incorporate expert advice in the plan. • Require a deeper knowledge of the system than in the simple domain. • Make use of conflicting advice.	• Read the situation - challenge the assumption that the situation is Complicated; can it be handled as simple or is there a need for moving to the Complex domain?
COMPLEX	• Variability and uncertainty • Emergence rather than causality • No right answers • Emergent patterns • Unknown unknowns • Many competing ideas • Need for innovative approaches	Probe, sense, respond • Train for adaptability by doing multiple fail-safe trial-and-error experiments that exposes patterns or make them emerge. • Identify and follow principals rather than procedure. • Effective and intense communication to aid sense-making • Disruptive thinking, pluralism of ideas, welcome and invite new/other perspectives • Monitor for emergence. • Coping mechanisms: Muddle through/incremental adjustments. • Utilize the participants themselves to generate variability by letting them perform freely and thus create true uncertainty.	• Read the situation - challenge the assumption that the situation is Complex; can it be moved into Complicated or even Simple?
CHAOTIC	• High turbulence, radical decay • No causality so no right answers • Unknowable • Only way to know if an action will be successful is to try. • Time critical decision making • High tension	Act, sense, respond • Train to make people act. • Do something to see if it works i.e. stabilizes the situation. • Decisiveness, reestablish order (command and control). • Communicate in clear, direct ways.	• Read the situation - challenge the assumption that the situation is Chaotic; can it be handled as Complex, Complicated or even Simple?

CONCLUSIONS

In any situation where people are to be trained there is need to reflect upon what kind of situations they are supposed to perform in (simple, complicated, complex or chaotic). Depending on what the expected situation the training aims at, different training regimes and training goals will be pertinent. There is an over-confidence in developing and following best practice which has its place in the simple domain but will not support the adaptability that is pivotal for dealing with uncertainty in the complex domain. In simulation environments the normal human performance variability (Hollnagel, 1998) is the most important recourse to utilize to induce uncertainty which is needed to be able to train adaptive behaviors. This goes across domains and is not merely a phenomenon concerning SAR, but SAR makes a good and transparent example of how uncertainty can be an important parameter and how to cope with it.

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