Syrotuck Symposium
ABSTRACTS

Implementation of Formal Search Theory And Land Search Management In Iceland And How It Has Been Applied.

Dagbjartur Kr. Brynjarsson, ICE-SAR, Iceland

This presentation will discuss the implementation of formal Managing Land Search Operations to the ICE-SAR Rescue school curriculum and how it was adapted to fit the Icelandic SAR system and the natural environment. We will discuss the obstacles we encountered and the situation that exists today. This will include the conduct of search operations in Iceland from pre-planning through extended operations as well as the process for transition from initial response activities to extended operations in which formal search theory must be employed.

Lost Person Behavior - Statistics from Iceland*

Einar Eysteinsson, ICE-SAR, Iceland

To be able to find the missing person you must search in the right place. The sooner you do that the sooner you will find the person. By analysing previous searches, you are able to predict what others will do in similar situation

Since the 2010 the Icelandic Association for Search and Rescue (ICE-SAR) has recorded searches according to ISRID standards. The recording has not been continuous, but the ICE-SAR database has 189 incidents. At the conference Rescue 2018, held by ICE-SAR, statistics from ICE-SAR database was presented.

Virtual Search Planning

Paul Burke, Nevada State SAR Coordinator, USA

Virtual Search Planning is a process, by which relevant elements related to a missing person are examined and analyzed within a fixed period of time, and a solution set related to the subject and their location is developed and delivered to the requesting party. This is done remote from the search base or incident command post and benefits from the removal of emotions and personalities often accompanying the localized, on- site planning effort.

The items contained within the analysis include, but are not limited to, a comprehensive review of the following elements: Subject profile and specific actions; Subject clothing and equipment;

* Denotes that a paper is included in this issue.

Physical, Psychological, and Pharmacology review of the subject; Statistical data related to similar subjects in similar environments; past, present, and future weather related to the search location; terrain and geography; cell phone forensics; social media profile; radar forensics, and vehicle profile and dynamics.

Readily available and common software is used to gather and format the data, and to develop and deliver VSP components to the requesting agency. There is no specific software used to evaluate the data, and there is no computer generated solution. Technology is used only to gather and organize the data for the team of "VSP Analysts" to evaluate the sum total of the information gathered. Information is recorded and verified/annotated to reference the source of all information.

Search and Rescue Optimal Planning System (SAROPS)

J. R. Frost, SAROPS Program Manager, USCG Office of Search and Rescue, USA

The U. S. Coast Guard employs a sophisticated computer-based search planning system called SAROPS to plan searches for persons and craft in distress in the marine environment (although it could, in theory, be adapted for use on/over land). This system provides a robust list of over 80 search object types, including leeway for drift calculations and detection characteristics for estimating effective sweep widths and optimally allocating search effort. Up to four possible search object types may be simulated simultaneously to cover situations where the post-distress state of the craft and survivors is not precisely known. SAROPS provides a number of different scenario types that can be used alone or in combination. These are used to develop scenarios describing what is known or assumed about "originating craft" behavior prior to distress in order to develop thousands of estimates of possible times and corresponding positions where a distress may have occurred. Hazards can be added to Voyage/Flight scenarios to represent regions, such as heavy weather, of increased probability of distress. SAROPS is supported by an Environmental Data Service that provides a catalog of environmental data products from various sources. The search planner selects the sources to be used and SAROPS then computes drift trajectories for each of thousands of simulated search objects to produce a time-series of probability grids on search object location. Once the drift simulation is complete, the search planner enters the planning phase. Inputs include the available search assets, their sensors, the on scene conditions affecting detection, the on scene endurance of each asset, etc. Based on these inputs, SAROPS computes an optimal search plan that maximizes the Probability of Success. This includes simulating the simultaneous motions of simulated search objects and simulated search assets, which means SAROPS does a dynamic optimization. If additional searching is required, SAROPS properly accounts for the negative results of prior searching in order to maximize the cumulative overall POS when developing subsequent search plans.

Issues with Electronic Navigation Systems and Search Patterns

J. R. Frost, SAROPS Program Manager, USCG Office of Search and Rescue, USA

Electronic navigation systems allow both surface and airborne search assets to navigate very precisely. When combined with on-board computing systems and autopilots, search patterns can be computed and followed with the same precision. However, search planners use standard methods for specifying search patterns that have been in place for over 60 years. In addition, the standard methods for computing pattern waypoints also date back more than 60 years. These methods are described in the International Aeronautical and Maritime Search and Rescue (IAMSAR) Manual and in the national search and rescue manuals, supplements, and addenda of many countries. On the other hand, the inputs required for most pattern-capable electronic navigation systems do not follow these standards. The result has been a substantial number of different, navigation system-specific, input data sets and pattern waypoint outputs that do not necessarily match the tasking from the search planners. Aircraft and vessel crews must translate the search pattern specifications provided by search planners into the inputs required for their particular navigation system, a process that is susceptible to errors that may not be detected. In addition, even if the translation is done correctly, a single keystroke error or omission during the data entry process into the navigation system can completely alter the area that is searched, rendering the actual search ineffective. Errors of this nature are even more difficult to detect. Finally, even if the translation and data entry are both correct, the methods used by on-board navigation systems for computing waypoints is, in many cases, different from the standard methods used by search planners. These issues have been raised internationally and are illustrated by comparing search pattern plots as planned with those computed by on-board navigation systems of several USCG aircraft types. Formation of an appropriate international standards committee under the auspices of the International Standards Organization (ISO) is advocated so that the difficulties described above may be addressed and eliminated or at least substantially mitigated. A related set of issues is raised in polar regions where the standard methods of the IAMSAR Manual are not usable. Therefore, new standards will be needed to cover situations involving searches close to a pole.

Regulation, Reliability, and Creative Non-Compliance*

Scott C. Hammond, PhD, Utah State University, USA

Highly Reliable Teams (HRT) work in complex and extensively regulated environments where improvisation outside routine processes can be critical to success. Work teams in search and rescue, emergency medicine, surgery, aviation, and military solve complex problems in chaotic environments with high reliability. They must produce successful outcomes under the detailed and

conflicting regulations from professional societies, sponsoring agencies, and government.

This research project will identify how HRTs deal with regulation during times of high stress and chaos when solutions fall outside accepted process and regulatory protection. The Principle Investigator (PI) proposes to imbed with six different HRTs, and through observation, interview and participation, explore the relationship, regulation, reliability, and non-compliance.

Land Search and Rescue Probability of Detection: New sweep widths values, correction factors, models, and detection model validation*

Robert Koester PhD, dbS Productions, USA

Search theory allows for correction factors to account for conditions (such as night) that affect the sweep width value. Search theory also predicts that the coverage is proportional to the probability of detection by either the inverse cube curve or exponential function (random search). The objective is to determine the correction factors from night searching, use of IR detection devices and validate the coverage curves.

Effective Sweep Width experiments were conducted in the same location with the same medium visibility adult-sized targets during both the day and the night in a temperate forest. Additional experiments examined the impact of one, two, and three person teams. In addition, high and low visibility clue-sized objects were placed directly on the trail. Low visibility human subjects were used for infrared detection.

We found an effective sweep width of 64 meters during the daytime and 22 meters at night for a correction factor of 0.34 for the adult-sized targets. Both high (100% vs 94%) and low (83% vs 43%) visibility clues were more detectable during the day versus night ($P<0.001$). Searchers with dim flashlights (<200 lux at one meter) resulted in an additional correction factor of 0.5. The use of IR at night increased the sweep width to 68 meters. Two searchers increased the sweep width value by 1.3; however, three searchers didn't see a statistical increase. The probability of detection versus coverage plots of both day and night experiments fell between the inverse cube and exponential curves.

This single experiment for only one visibility class of search target showed that visual searching is significantly degraded by searching at night. The daytime coverage suggest the inverse cube model while the night coverage suggests an interim result. The use of effective sweep width, correction factors, and validated coverage curves can lead to more accurate assessments of the probability of detection.

Enhancements to statistical Probability of Area Models based upon updated ISRID data collection for Autism Spectrum Disorders and Typical Children*

Robert Koester PhD, dbS Productions, USA

The International Search and Rescue Incident Database (ISRID) previously contained 50,000 incidents which was the basis for information found in Lost Person Behavior. A new round of data collection increased the size of ISRID to 145,000 incidents. This latest effort resulted in new data standards and a new data collection tool called Search and Rescue data Collection & Analysis Tool (SARCAT) to improve data quality. A new spatial model called the point model was created which provides the probability that the subject is found within 100 meters of the IPP or the destination. The value of combining different spatial models such as the ring model and distance from IPP as scored by MapScore has been determined to statistically significant. Several new subject categories are defined including multiple scenario based profiles (medical, trauma, investigative, avalanche, etc.). Additional new subject categories will be presented. A more detail analysis of Autism profile is also provided. Significant differences are seen between Autistic Spectrum Disorders and Typical Children. The new ISRID data has also been used to determine enhanced and more detail survivability curves out to the 95%. The integration of multiple models together along with expression of the Probability of Success Rate (PSR) in the FIND tactical decision aid will be discussed.

A Pragmatic Approach to Applied Search Theory*

Guy Mansfield PhD, Joe Carlson BA, Danny Merrifield MS, Peter Templin BS, Eric Rosenberg, Washington State SAR Planning Unit, USA

The Washington State SAR Planning Unit (SSPU) was activated in 2018 with the goal of providing advanced search planning resources to regional incident commands during extended or complex search missions. The SSPU operates under the auspices of the Washington State Emergency Management Department, and is a team of experienced SAR volunteers with extensive training in search management and planning. In addition to providing search planning strategies and technical mapping, one of our primary objectives is to apply modern search theory to challenging search incidents.

Our application of search theory can be parsed into three related planning tasks: (1) Defining initial search regions and segments; (2) Assessing search effectiveness; (3) Prioritizing search segments for subsequent operational periods. A major challenge faced in achieving these objectives, is that the SSPU can be activated by any of the 39 counties in Washington State, all with different search planning approaches, different search data collection practices, and different experience with search theory principles. The SSPU typically engages after the first operational period of a search, and must adapt our search planning methodology to make optimal use of the

data and practices of the requesting jurisdiction.

To this end, the SSPU is developing a pragmatic approach to applied search theory that can be characterized in one phrase: “When objective data are available, use it according to search theory best practices; when only subjective input is available, at least be systematic”.

In our presentation, we will share the decision-tree used to guide our application of search theory under different conditions, along with tools and resources that have been developed to support our work. In addition, we will describe our pragmatic application of components of search theory to recent complex search incidents in Washington State.

Exercise Northumberland[1]

Peter Roberts, Carl Hamilton Center for Search Research, UK

Exercise Northumberland[1] was a major exercise set up to evaluate the performance of aerial and ground-based search assets, based on earlier work, in 1987, by the UK Home Office known as 'The O'Donnell Theory'. It set out to update these historical findings based on current approaches and methodologies for searching on the ground and developments in aerial technology.

Both Initial Response and Intermediate Phase search techniques were employed by both ground searchers and aerial assets including fixed and rotary wing piloted aircraft and fixed and rotary wing drones. An evaluation of the performance of each search asset was made. The challenges and logistics of setting up such an exercise will be discussed; the performance and effectiveness of each asset will be reported on and an outline of future research based on the outcomes of the exercise will be given. Future research will involve the Departments of Computing, Geomatics, Engineering and Neuroscience from the University of Newcastle upon Tyne in a collaboration to better understand this new search asset and to go beyond simply putting 'an eye in the sky'.

The U. S. National Search and Rescue School – Curriculum and Methodology*

Gregory C. Rockwood, Lt Col, USAF, USA

The Inland SAR Planning Course is a 5-day course for experienced SAR decision makers and planners taught free of charge across the United States. It presents a broad understanding of inland search theory and its application for air and ground searches for missing persons and aircraft with a focus on wilderness and rural area searches. The course consists of classroom lessons and practical, tabletop exercises. Emphasis is on the planning necessary for effective area-type search planning during an extended search using Probability of Success (POS), rather

[1] A copy of the full exercise report is available at http://searchresearch.org.uk

than just a few elements of POC (POA), or POD, to predictively allocate limited resources to their best effect. An additional objective of the course is to strengthen the U.S. Federal Government's role in its support to civil SAR through education, including promoting the capabilities of the RCCs, and requesting and coordinating the use of other federal resources with the goal of saving lives.

This presentation will begin with an overview of our curriculum, and an explanation of why we teach the methods of applying search theory for both aeronautical search and ground search to such a broad audience the way we do. Furthermore, in recognizing that there are alternate methods and countless variations used throughout the U.S. and the world, this presentation seeks to encourage dialogue about how the U.S. National SAR School could improve toward its own objectives, and standardize its curriculum with the international community.

The SAR Planning P Process – A Framework for Transitioning from Initial Response to Extended Operations*

Scott Wright PhD, President SARVAC Canada and Richard Smith, SAR Alberta, Canada

The Planning P is a familiar framework to Emergency Management for transitioning from the Initial Response for a more a formalized, structured response. In this presentation a SAR-specific P framework is proposed that retains the simplicity of the OODA Loop and Six Step Response Process in the Initial Response Period, with a critical decision point to continue as is, or activate the Incident Management Team in a more Formalized response for Second Operational Period and beyond. Each step and the associated Goals, Objectives, Strategies and Tactics will be explored through to the Subject being located, or Search Suspended.

The Search Intelligence Process*

Christopher S. Young, Chairman Bay Area Search and Rescue Council (BASARC), USA

The Search Intelligence Process of gathering information regarding the missing subject occurs during every search incident. We recognize intelligence information is used to build a subject profile; gather lists of people with firsthand knowledge of the missing subject that we want to talk to; and task investigators to research and mine information from various sources, like social media or cell phone data, to determine where to look and what to look for.

However, during the initial stage of an active search for a missing person, intelligence gathering can be very daunting, chaotic, haphazard or worse not initiated thus delaying the compiling of crucial information that could shorten the time it takes to locate the subject. In any other aspect of the search operation like ground searching or technical rope rescue we preplan, train and develop processes to be more efficient.

This presentation will discuss the search intelligence process by: defining the various sources of information available to use developing pre-plans for the gathering of intelligent information, developing decision trees, developing lists of reflex tasks, developing algorithms for transitioning between the initial actions into multiple operational periods and eventually to the termination of search operations, and develop ongoing training curricula with the goal of creating efficiencies and hone the necessary skills to perform the intelligence gathering process.