DEEP OCEAN SEARCH PLANNING:
A CASE STUDY OF PROBLEM SOLVING

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INTRODUCTION

THE ACCIDENT

In late 1987 a Boeing 747 of South African Airways crashed into the Indian Ocean after an onboard fire. The crash location was 250 km north east of Mauritius, an island east of Madagascar. Despite modern technology the location of the wreckage was as uncertain as the location of the Titanic. A massive search and recovery operation was immediately launched. This effort covered various search phases, namely a surface search and recovery, an underwater sound beacon search, an underwater sonar search, and an underwater photographic survey and recovery. All searches faced unique technical challenges, of providing accurate navigation aids and the sheer depth of the ocean. Ocean depth was in places over 5 km deep and very mountainous. This depth was significantly deeper than that of the Titanic search, the deepest deep ocean search up to that time.

This situation resulted in the in the mobilisation of resources and personnel from more than a dozen nationalities. There eventually were six basic sources of information on where to conduct the search. Some of the nationality groups favoured one or more of these information sources over others, resulting in conflicting and widely dispersed opinions on where the search should be conducted. The stakes were raised by the perception that those groups whose information sources were seen to prevail, would be more likely to obtain the lucrative search and recovery contract.

THE NATURE OF THIS STORY

The approach followed in the search planning for the final two phases of the search planning (underwater sonar phase and photographic survey) was based on a systems approach. Both these search phases were successful firstly in finding the wreckage and secondly correctly indicating the location of the flight recorder. However, in these phases the "problem" of the search planning was not taken as predicting the location of the wreckage, but as a group learning process. The "problem" to be dealt with in this process was to arrive at *consensus* on the relevant information, and on where the search was to be conducted. Underlying concepts were group learning, alignment, shared understanding, rather that probability, simulation, etc. Specific and explicit use was made of the multiple perspective concept in systems thinking. Another

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principle used in conjunction with this was that of critical assumption surfacing. The planning process was conceived as a shared learning process, requiring wide participation and regarded as an organisation building process. The search planning process became the strategic planning process for this organisation, using principles from interactive planning, rather than quantitative analysis.

Classical operations research deals with such a search problem by developing a Monte Carlo simulation model for each “scenario”: Sceanrios are stories about what could have happened to the aircraft, using combinations of the informaton sources. The result of each simulation is then combined in proportion to the credibility of the different scenarios to develop a probability distribution for the wreckage location. This approach was in the end not completed in the SA295 search, as the wreckage was found before the probability distribution could be developed. We return to this point in the conclusion.

MY BACKGROUND & REFERENCE FRAMEWORK

This story has a very close link with my own background and way of looking at that situation. Some background on this is therefore in order.

I started working after four years at university, where my qualifications were in mathematics, computer science, statistics and a good dose of linear programming. My work situation was a classical operations research environment, with a focus on seeing the world in terms of problems. The problems ranged from hard technical systems problems ("With what accuracy can we...?") to soft systems management issues ("What kind of training do we need for...?"). In this environment I used literally all my technical background, from physics through to computer aids. Over time the diversity of these problem situations enlarged and I compensated by qualifying further in the quantitative sciences, in particular with a Masters and Ph.D. in operations research. It is fair to say that I assumed that a quantitative approach to problem solving is the appropriate way to tackle complex problems.

I did an enormous amount of practical and theoretical work on search planning type problems. This is the type of problem you are faced with if you want to find something on the ocean bottom or if somebody was lost at sea after a boating or aircraft accident. I was quite familiar with the most advanced theoretical and practical techniques used to think about and plan deep ocean and surface search problems. There was (is) a great emphasis on the careful processing using advanced quantitative tools, of the information inherent in a search planning problem. This is known as search theory in operations research. It needs to be emphasised that search theory, at least the successful application thereof, requires quite a good knowledge of the relevant search technology, such as navigation and detection systems. I knew and was used to this world; it was familiar.

OUTLINE OF THE PAPER

This paper relates a story of how the above following the quantitative and technical approach to the search problem exclusively amost lead to an intractable problem. This is covered in the following sections, giving the background to the search situation and the results of the search. The planning problem was dealt with in the end by switching to a different paradigm of problem solving, which is dealt with in the last sections. In the conclusion we indicate the role of the search theory approach in this expanded approach to problem solving.

HELDERBERG SEARCH SITUATION AND RESULTS

HELDERBERG AND TITANIC

The Helderberg crashed at night in the see very far from land. It crashed approximately 20 minutes after an on board fire was detected which occupied the crew with fire fighting attempts. Although requested by the Mauritian air traffic control the aircraft could not immediately give its location because of all the activity. When it did it used a wrong reference point that caused the search to be concentrated much too close to Mauritius. Only some twelve hours after the accident was the first surface debris located, by which time it had drifted significantly away from the geographic impact position. This was a major cause of the location uncertainty. In total, with other factors aggravating this location uncertainty, the wreckage was estimated to be anywhere within an area of between 80 and 250 square nautical miles. This estimate was valid some 6 weeks after the accident. It corresponds well with the estimated 100 square nautical miles location uncertainty of the Titanic before the final successful search for that was undertaken early in the eighties (Ballard, 1987). (More published information on Helderberg accident is in Watt(1990) and Kutzleb(1988).)

There was another correspondence with the Titanic in terms of the magnitude of the search problem. This was in the remoteness and depth of the ocean in the region of the search area. These placed enormous and very taxing demands on the technology required to locate the wreckage. The depths (4.4 km) and required navigation aids placed the search beyond that of the Titanic search (3.8 km). It is fair to say that at the time the Helderberg search was at the cutting edge of technology, which restrained the rate of progress and hampered success. (The later search for the Bismarck was under similar conditions of uncertainty (120 square nautical miles) and depths (4.7 km). (Ballard, 1989))

SEARCH SUCCESSES

Wreckage in search area

Despite the daunting technical challenges the aircraft wreckage was found two months after the accident. It was found in the primary search area decided on. The wreckage was found within two days after the sonar search was started, in the area judged to be the high probability part of the search area. What is more significant was that there was consensus at that stage about the location to search, in a situation characterised some weeks before with absence of consensus. This consensus was in my view more significant than the actual correct indication of the location.

CVR in search area

More than a year after the accident additional planning was done to determine a search area for the crash recorders within the widely dispersed wreckage field. A search area was determined which was small compared to the overall size of the wreckage field. The cockpit voice recorder was found within this area some two weeks after the publication of the search area; the second recorder was never found but was predicted in this search planning to be unlikely to be found. (There are technical reasons for this uncovered during the planning.)

It is rare in my experience to deal with such complex problem situations and then be able to say unambiguously after the fact that the solution was correct. In most successful problem solving situations there is often great disagreement afterwards whether the actual solution followed was in fact the correct one. The success in predicting three out of three (one albeit negatively) locations correctly is a rare feature in real world problem solving. This tends to make the Helderberg search planning a more dramatic illustration of different problem solving paradigms.

HELDERBERG SEARCH PHASES

The search, recovery and investigation process had four distinct phases that occurred in the first 15 months after the accident. These were, in chronological order:

1. SEA SURFACE SEARCH
2. UNDERWATER SEARCH: PINGER SEARCH
3. UNDERWATER SEARCH: SONAR SEARCH
4. PHOTOGRAPHIC SURVEY AND CRASH RECORDER SEARCH

Each phase had its own particular challenges and problems. The information available and used for search planning in each phase differed.

SEA SURFACE SEARCH

The sea surface search started with the emergency search hours after the accident and continued for approximately two weeks after the accident. Although the initial purpose was locate and rescue possible survivors, after the initial detection of the accident debris on the sea surface, no survivors were expected and the search was for drifting wreckage that could explain the accident.

UNDERWATER SEARCH: PINGER SEARCH

Aircraft are equipped with tape recorders that record flight information and conversations. These recorders are fitted with sound beacons that emit a pinging sound when submerged to facilitate recovery. The beacons have a working life of 30 days and a detection range of 4 kilometres. The implications were highly specialised equipment that had to be deployed within a very brief period to enable detection of the pinger sound in ocean depths far deeper than the maximum detection range. Despite the apparent short detection ranges the likelihood of detecting a target of several kilometres in size (the effective sound semi-sphere size) is considerably easier than detecting an even an aircraft. In terms of search efficiencies this warrants the expenditure of significant effort. Great logistical problems and time deadlines dominated the planning during this phase.

UNDERWATER SEARCH: SONAR SEARCH

The underwater pinger search did not conclusively locate the Helderberg wreckage. The search for the wreckage was continued using side scan sonar, a system of using sound reflections to record the presence of objects on the sea bottom. To achieve this in the ocean depths in the accident area a cable of 9 kilometres long was required to tow the sonar near the ocean bottom. The equipment again is highly specialised and brought its own logistical problems. It was this equipment that located the sea bottom wreckage.

Both the underwater pinger and sonar phases were searches where ships towed equipment on long cables behind them. Both required enormous effort and expenditure to have the required accurate navigation systems in place to support the search. At that time (end 1987) there was insufficient satellite coverage to use this for conducting an accurate search.

PHOTOGRAPHIC SURVEY AND CRASH RECORDER SEARCH

After the detection of the wreckage at a depth of 4.4 kilometres, planning was initiated for the survey and recovery of wreckage that could assist with the inquiry into the accident. This survey was carried out a year after the accident using a remotely controlled underwater vehicle with extensive photographic and recovery equipment. Enormous technical problems had to be overcome to survey and recover articles in the widely dispersed wreckage field. The extend of the field, caused by dispersion of the wreckage during the 80 or more minutes the wreckage took to sink, combined with the difficulty of carrying out a systematic search, made it important to concentrate on smaller areas to find and recover accident significant items such as the accident recorders.

SONAR SEARCH: PLANNING INFORMATION SOURCES

IMPACT POINT

Some 12 hours after the accident the first debris was sighted. One of the reasons for this delay was that the last position reported by the aircraft after declaring an emergency, was in error. The error was that in stead of referring to Mauritius as the reference point, another reference point was used in reporting its position. The debris was sighted close to flight path, along the flight direction near the (corrected) last reported position. Refer to Figure 1, which gives the geometric layout, plus an indication of the scale.

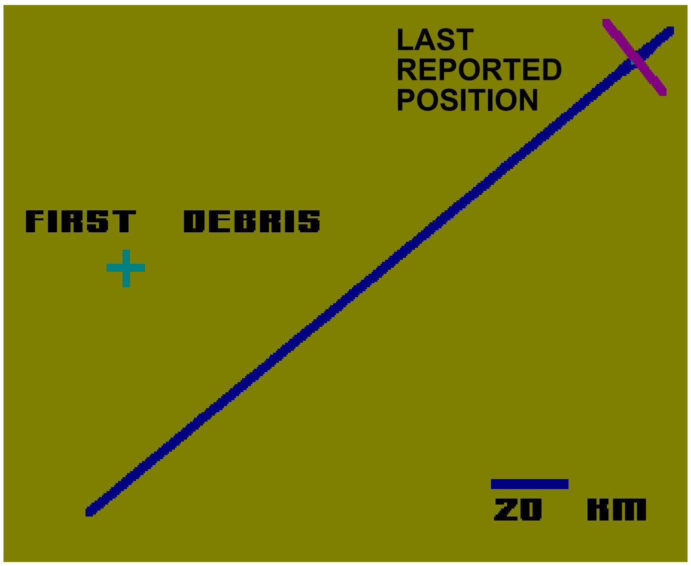

FIGURE 1: FIRST DEBRIS SIGHTING

In the sea surface search and recovery phase, a large number and variety of wreckage and accident debris was recovered in the area around the last debris position, and down current from that position. The very success of the operation lead people to believe that the best estimate of the wreckage position is the location of the first debris sighting. The logic of this argument was that the continued discovery of debris indicated surfacing of wreckage from the ocean bottom on an ongoing basis. The significant point of this information source was that the sea surface search was planned and controlled by persons not involved in the main investigation and search planning. The very success of "their" part of the operation gave credence to this location in their and in the view of others.

This "pacting" around viewpoints of where to search, based on different information sources accepted as the full truth by its adherents, was a characteristic of the planning situation. There literally were "power blocks" not only around the above information source, but around all of those listed below. This kind of issue takes the search planning process outside the ambit of objective simplistic problem solving.

FLIGHT PATH INFORMATION

Early in the sea surface search a purse with 3 watches was recovered. All three watches were analogue watches, with one still running at the correct Hong Kong time (the origin of the flight). The other two watches had both stopped due to impact damage, at the same minute (7 minutes past the hour) with one stopped at the correct hour of the accident. (The second hour hand was broken off.) This indicated that the aircraft had impacted some 4 minutes after the time of the last reported position. This left the aircraft speed as the only remaining major uncertainty before one could solve for the location of the impact. Figure 2 below gives this solution for where the aircraft should be given this information. Note that the area of uncertainty could move up or down along the flight path depending on the aircraft speed assumed.

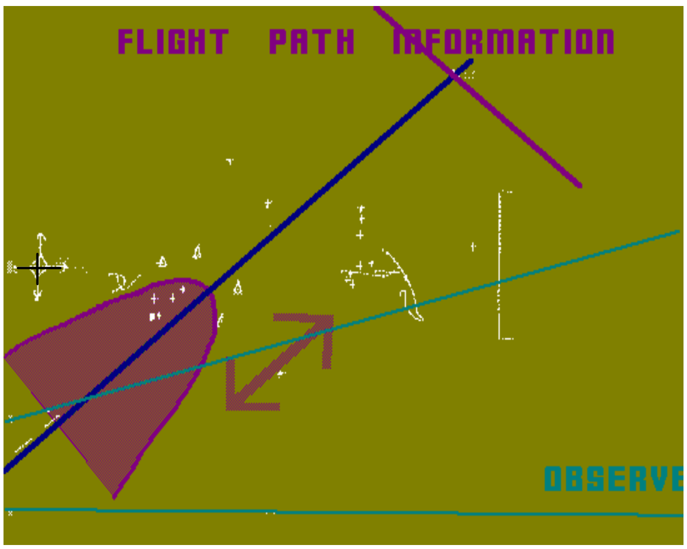

FIGURE 2: WRECKAGE LOCATION BASED ON FLIGHT PATH INFORMATION

OBSERVERS

There were people, including a mathematics teacher with a celestial knowledge, on an island north of Mauritius, on the night of the accident. They observed a phenomenon described as falling balls of fire for which they took accurate bearings. Through careful debriefing and surveying of their position and observations a cone of the location of the phenomenon could be derived. This is also indicated in Figure 2; what they observed fell in the area bounded by the lower two horizontal lines. (There were larger uncertainties in this location indication than in the other information sources.)

This information source was hotly debated and rejected, primarily by people from the aircraft industry (pilot associations and manufacturer) on the basis that for these observations to be accepted one had to accept that the aircraft broke apart in the air while on fire. At the time of this planning this fact was not well accepted. Despite very strong corroborating evidence (time and duration of observation, direction of observation, angle of observation), it became a political issue to accept this information. It was divisive information rather than a solution to everyone's question.

PINGER SEARCH RESULTS

The areas covered by the search for the sound beacons are depicted n Figure 3 below. What is not indicated in the figure is the relative intensity with which the different areas were searched, some areas being searched much more intensely than others. The implication is that false positive detections are much more likely to be clustered in intensively searched areas.

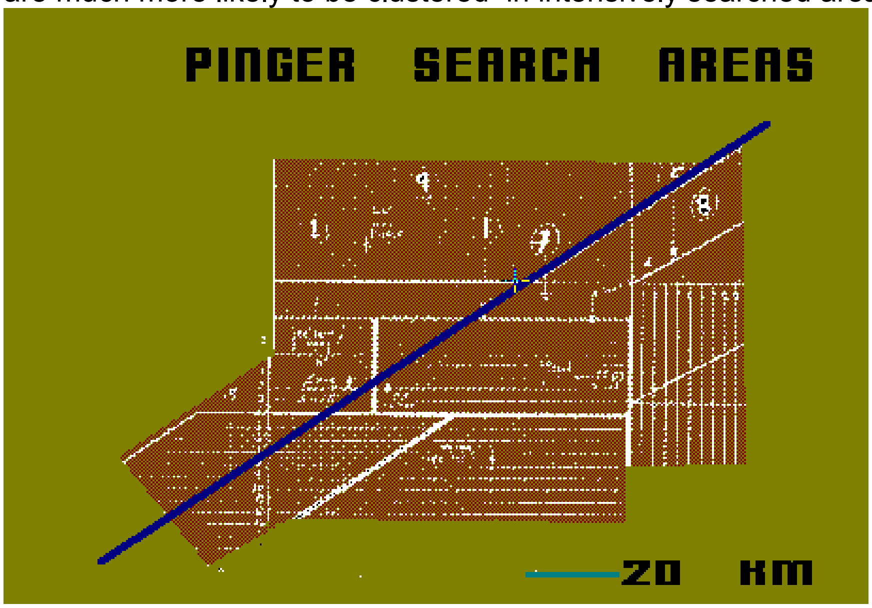

FIGURE 3: AREAS COVERED DURING PINGER SEARCH

The pinger search should have located a maximum of two pingers for the two recorders on board the aircraft. The conditions under which the search was conducted were beyond the designed situation for this type of search. The consequence was a large number of false alarms. Of the total number of pinger like sources that were recorded, 32 had to be considered, of which 13 could not be rejected as possible actual pingers. These are plotted in Figure 4 below. Note the scale indication and the very wide dispersion of the possible pinger locations. The locations marked a, b and c were in particular strong contenders as actual pinger sources.

FIGURE 4: LOCATIONS OF POSSIBLE PINGER DETECTIONS

The implication for search planning is clear. Rather than narrow down the possible area for searching for the wreckage, the pinger search generated possible contact over the whole region. The available evidence on each of these sources did not allow further narrowing down the possibilities. The issue of discounting false contacts to compensate for differences in the intensity with which different areas were searched was in particular problematic. There was tendency to react to apparent clustering of contacts that had to be countered.

It needs to be pointed out that after spending millions (any currency) on the pinger search there was moral, if no other, pressure to actually use the results. It was politically not wise to simply look at the results as in Figure 4 and reject it as too dispersed to narrow the search areas.

UNDERWATER PHOTOGRAPHY RESULTS

During the underwater pinger search, as possible pinger sources were located, an attempt was made to photographically investigate the locality of the suspected pinger. This was done by means of a non-manoeuvrable photographic sled of the German oceanographic research vessel 'Sonne'. Plots of the tracks of two of these investigations are shown in Figure 5 (a and b).

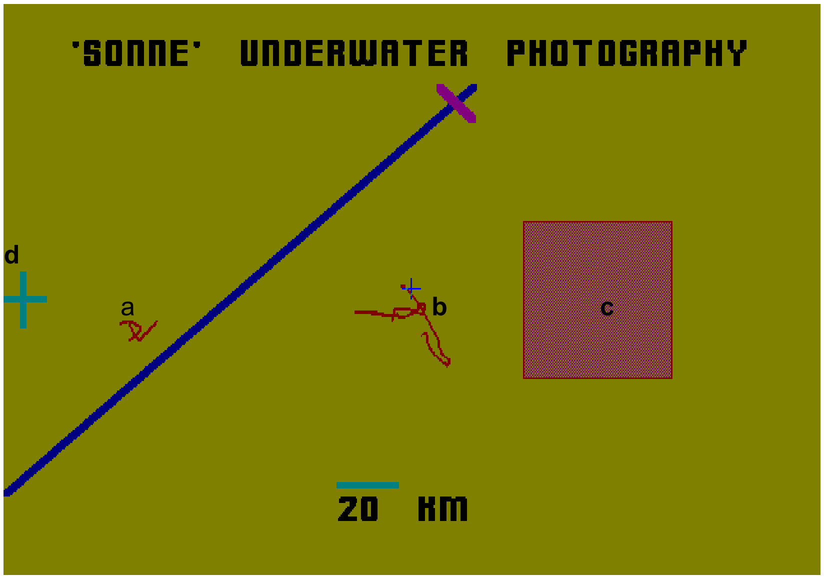

FIGURE 5: UNDERWATER PHOTOGRAPHIC INVESTIGATIONS

In position a in Figure 5 several objects like airmail envelopes, cardboard boxes, and printed matter were photographed; all objects were light and low density in nature. In location b heavier and more dense objects, like cool drink bottles, a toy car and pieces that appeared to possibly be twisted metal, were photographed. The difference in density could be related back to different sinking rates. This was done in a scientifically careful manner and, when combined with the difference in locations, one could estimate the location of heavy wreckage (area c in Figure 5).

The light material in position a was down current of that at b, strengthening the credibility of this calculation. There was evidence that the material at a originated from the aircraft, and at location b the objects were clearly fresh on the bottom compared to other silt covered bottles for example). The overall credibility of this information source was quite high. The problem was that it indicated a search area unrealistically far from the initial surface debris location (d in figure). However, hard photographic evidence is very difficult to dispute.

WRECKAGE DRIFT CALCULATIONS

A standard technique for locating an object last at sea is to "back-drift" to the time of the incident. In this case there was a position for surface debris (a in Figure 6) for some 12 hours after the accident and another for some 26 hours afterwards (area b). Using drift vector calculations used in search and rescue planning one can then estimate the initial impact area (c and d in Figure 6). The uncertainty in the back-drift calculation is in knowing weather conditions for the interim period, and the effect of wind and current on the drifting objects. These uncertainties were relatively low in this case. In addition, although there was initial scepticism around the accuracy of the positions a and b, evidence that emerged out of very careful investigation some six weeks after the accident indicated a very high accuracy and reliability in these positions. Compared to other situations in which one uses this back-drift approach, the calculation in this situation was noticeably more reliable and trustworthy. This information source was supported by the US Navy Supervisor of Salvage, who had an extremely experienced team in support. The only problem was that it did not fall in place with much of the other information.

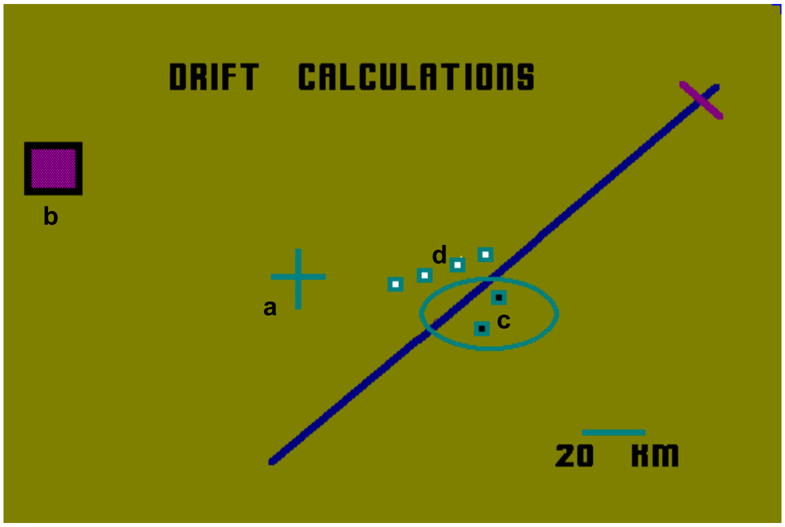

FIGURE 6: POSITION ESTIMATION FROM SURFACE DEBRIS

THE PLANNING SITUATION

The overall search planning information is summarised in Figure 7. This figure shows the overlap and dissonance between the different information sources discussed above.

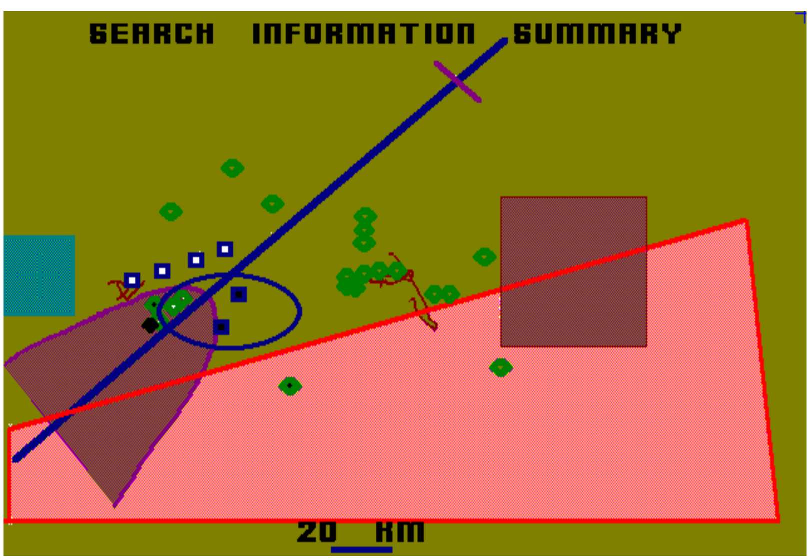

FIGURE 7: COMBINATION OF SEARCH AREA INDICATIONS

It is the consideration of the above information that lead to the 31 December 1987 conclusion that an area of between 60 and 240 square nautical miles will have to be searched in order to locate the wreckage.

SEARCH RESOURCES

For the type of sonar search envisioned at that stage, the actual rate of searching was 3 square nautical miles a day. This gives a required search duration of between 20 and 80 search days, which in turn practically means three or more times this in actual days. The cost estimation of this is quite an incentive to spend considerable effort to come up with a better location estimate.

THE CONFLICT SITUATION

This was a big search in anybody's terms, and potentially quite lucrative for the contractor. The problem was that some of the potential contractors had identified ("bonded" is a more accurate description) with the different planning information sources. This lead to a dynamic where the positioning for the search contract was played out in terms of support for the different search locations as derived by a particular approach. This problem was confounded by the various groups being mostly from different nationalities.

CLASSICAL OR SEARCH PLANNING APPROACH

The problem from the author's perceptive at that point in time is captured by the instruction addressed to same (accompanied by a slap on the back after explaining Figure 7 to the person in charge: "Johan, you are my technical expert; sort it out." It is in this context where my metal reference framework and background described above come to the fore.[2]

DESCRIPTION OF METHOD

The classical Operations Research approach to search planning problems of this nature is to develop a probability distribution of the location of the object and to allocate search effort on this basis(Stone 1977, 1983). Search effort is used to update the probability distribution for effort expended unsuccessfully, taking into account local search efficiencies. The planning problem becomes a mathematical optimisation problem with enough technical intricacies to give an operations researcher goose bumps.

The problem in practice is to come up with the search object probability distribution. For this a Monte Carlo simulation approach has proved very useful (Richardson and Stone, 1971, Stone 1992). This method is also in daily use by the US Coast Guard (Richardson and Discenza, 1980) and has become accepted a the preferred method in cases where there are different and conflicting information sources. The approach work essentially by defining a simulation model for each information source or scenario and

[2] Because this story becomes very personal for this reason, I will abandon any pretext of writing in the third person.

running the simulation to estimate positions given probability distributions on the uncertainties in each information source. In the case of the flight path information above one would vary the flight path direction and speed slightly to come up with a density estimate of final positions. The different information sources are simulated in turn. The resultant series of probability densities are combined in proportion to --you guessed it-- the relative credibility assigned to each information source. As the quoted references as well as years of practical use of this approach show, the approach has undeniable success in practice.

This approach essentially is quite a sophisticated approach to process the information inherent in a search problem. With my background and experience it is no surprise that this was my preferred route to resolving the above search planning problem. It is important to realise that this approach is essentially reductionistic and analytical in approach, and attempts as far as possible to employ the principles of classical scientific method to process the information as objectively as possible..

IMPLICATIONS OF METHOD FOR THIS SITUATION

It is also important to understand the implications if I had followed this approach *alone*. Because of the mathematical, statistical and computer wizardry involved in this demonstrably effective approach, the result would have carried significant credibility. The result would have been further more credible because it clearly takes all sources into account. With the advantage of hindsight one can even add that the probability distribution would have covered the actual wreckage location. This approach would in effect have become a seventh information source, with high credibility because of the holes in the sides of the paper printouts.

Had the search theory approach been applied directly to the information sources as listed above, the probability density distribution would have covered practically the whole of the area in Figure 7. There would in all likelihood have been slight peaks in two or three regions but the distribution would have been rather flat overall because of the number of information sources involved.

The implications are that in stead of reducing the conflict around search areas it would have added to the overall confusion and conflict. In addition this approach would not have been able to reduce the search areas significantly.

PLANNING RESULTS

The above approach was not followed. An approach, discussed below, resulted in the search areas indicated in Figure 8 below.

SEARCH AREAS

The search areas that were decided on at the end of January 1988 are numbered 1, 2 and 3 in Figure 8. What is not indicated graphically is the relatively high belief in area 1 versus areas 2 and 3. Area 2 was selected because of the very high credibility of a pinger-like sound source in that area, and Area 3 was based on the underwater photographs and pinger sources.

Area 1 was indicated by the information sources with the two highest credibility (discussed below) information sources, whilst being commensurate (not in conflict) with three of the remaining information sources. In addition there was an expectation that the aircraft should be in the middle of the eastern half of this area. The area itself was extended in the East to make for longer straight line searches, to cut down on the number of three-hour turns required between search lines; it was in fact larger than the information required strictly. Note the location of the area with respect to the initial debris position (a), the last reported position (b) and the flight path (c).

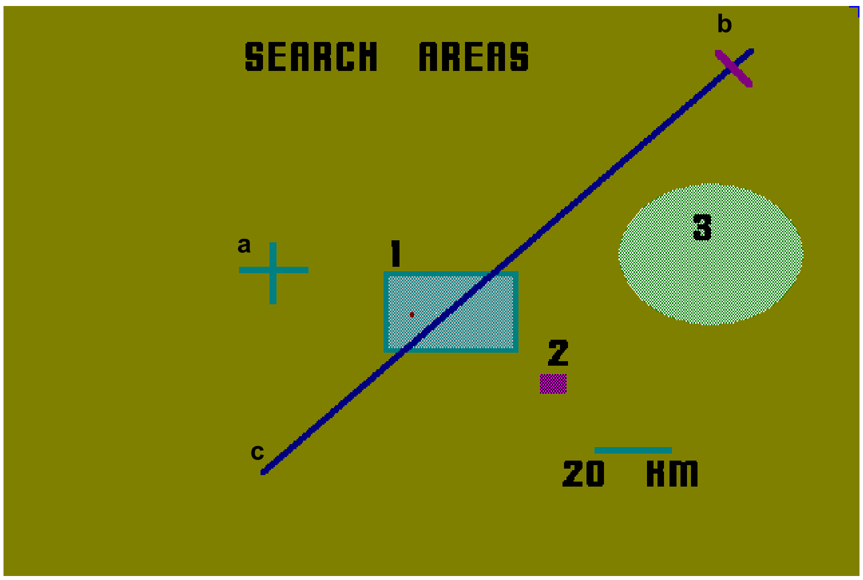

FIGURE 8: HELDERBERG SONAR SEARCH AREAS

The aircraft wreckage was found at the dot in area 1 within two days after the sonar search was started. (If you have trouble seeing it image our problem of finding it in the ocean.)

CONSENSUS

What is more remarkable in my view than the success and the dramatic reduction in search area, was the remarkable high levels of consensus achieved at this stage. The search areas were consensus decisions, based not on compromise but on agreement as to the meaning of the underlying information sources. This was built up over a period of some four weeks, subsequent to the Figure 7 status of disagreement.

ACTUAL SEARCH PLANNING PROCESS FOLLOWED

CRUCIAL UNLOCKING INSIGHTS

During the planning process I took my assigned role, of determining where the search should be conducted seriously. Not surprisingly, given my background this meant for me the careful information gathering and working towards a probability distribution of where the wreckage could be located. On one of these fact finding trips I was walking and reflecting on the management situation we were faced with in the so-called Search Committee. This was a group of between 3-9 people who essentially were in control of the operation. We met at least once per day and for the duration of the search this was the management team of the operation. This meant that all conflicts and issues ended there and it simply was not possible to think of the functioning of this group as individuals with assigned and clear functional responsibilities.

Organisation building

During this reflection a thought struck me: "What we are busy with here is to build an organisation". I promptly named the organisation the Search Organisation. The significance of this insight is not immediately apparent. What it did for me was to mentally shift me out of the mind trap that I was in, allowing me to draw on a whole new set of tools for inquiry. The trap was to see my role in the technical, analytic terms, of determining the search area using quantitative approaches. Saying to myself that the purpose is organisation building helped me to think about the situation as a social system, and asking myself what is needed for organisation building(Gharajedaghi, 1985). The significance here was that these were concepts high on my mind and in use outside of the actual search planning. I was used to thinking in these terms but had regarded them as not applicable in the search planning problem. (What is worse is that I had not questioned the relevance of any of the problem solving methodologies.)

Strategic planning process

Out of the question: "What does social systems thinking have to say about this situation?", came a second crucial unlocking insight for me. This was that the search planning was actually the long term strategic planning process for this search organisation. What this perspective did for me was to make me think about the situation using two methodologies, namely interactive planning (Ackoff, 1981) and strategic assumption surfacing and testing (Mason and Mitroff, 1981). I started to look at the process of planning and at the soft deliverables from such a process in a very conscious manner.

Shared vision and Alignment

Thinking about the situation in social system and strategic planning terms made me think of concepts such as the need to create alignment and shared understanding amongst those involved. I started to see my role as that of creating this alignment as opposed to saying where the search should be conducted. I did not say that that was unimportant, or that a definite statement in hard numbers as to where the search should be conducted would not be needed. I only accepted that such a statement would need to based on shared understanding of all participants, agreement and consensus about the meaning and implications of the underlying information. I understood that I had to create alignment on why and where the search had to be conducted and that this alignment would be the guiding vision of every actor in the situation.

Multiple perspectives

In my mind one of the key unlocking insights was when one day, when looking at a chart with a version of Figure 7 on it, I said to myself: All of this is true at the same time. Now a quick peek at Figure 7 will show that the aircraft could simply not have been in all those locations simultaneously. What this statement actually meant to me was that each of these information sources represented a viewpoint, a perspective on the reality. Each viewpoint was true in the sense that it saw a part of reality but not the full truth. If any perspective had the full truth it would have indicated the exact location of the aircraft. The point was that each perspective was as true as the next one, they only differed in the part of reality that they were able to see. The idea that Figure 7 represents different views of the same reality was extremely powerful, when combined with the notion of critical assumptions. The implication is really that each viewpoint makes certain assumptions about reality, for it to come to a conclusion as to where the aircraft is to be found. The question is, what assumptions are critical, in the sense that if that assumption was invalid, that particular viewpoint would not be able to come to a conclusion as to the location of the aircraft.

Group learning facilitator

Another insight related to my actual role. This was that if I stick to my "official" role of search planner, I will add to the confusion. The implication was that I could do more for ensuring success by acting as a group learning facilitator for the process. The emphasis was on facilitation, facilitation of a process of planning and group learning.

SOLUTION PROCESS

The actual solution process was to use the above insights and conclusions. The biggest difference was in my assumed role and manner of thinking about the situation. These had some recognisable implications:

Participation

In stead of trying to limit conflict by limiting the range of people participating in the search committee meetings I consciously tried to enlarge participation in the planning process. I, for example, took it on myself to draw into the panning meetings the people responsible for set-up and operation of the navigation system. Their participation does not make sense from a function viewpoint, but makes a lot of sense when regarding the planning process as one on building alignment.

Information research

The idea of critical assumptions underlying each of the different information sources gave rise to a very critical review of each viewpoint and its supporting evidence. This involved very careful investigation and gathering of data that proceeded over a period of some six weeks. In each case the basic facts were established through careful checking. In many cases this involved particular efforts not to accept at face value any information but to dig deeper and verify, verify and verify. As part of this process we identified critical assumptions for each information source. Each source was examined with the question: What assumptions are we making in order that we can use this information to calculate a search area. For example, in the case of the underwater photography, unless one assumed that the objects photographed came from the aircraft, one cannot come to the conclusion that the area in Figure 5 should be searched. In each case once a critical assumption was highlighted, any supporting or disconfirming evidence for that assumption was purposefully and clinically searched out. For this information there as supporting evidence that the photograph of the lighter material was of objects from the aircraft, while there was no specific, only circumstantial, evidence that the heavier material photographed came from the aircraft. In the process the idea of critical assumptions became established within a core group of people involved in the information gathering.

Neutral facilitation

There is no doubt in my mind that actively shifting to a facilitation role helped move the situation along. I did not view the process of information gathering as a clinical gathering of data, but as a process of involving people and getting new information to them. In this role I came to be accepted not as a proponent of one of the information sources but a one with most of the facts. This removed some of the disagreements as different viewpoints were presented not by the proponents but by myself. In each case this helped the proponents to understand that their viewpoint was being considered but also that there other information sources.

Perspective sharing

In this process there was a build-up of a much richer understanding of the overall picture than what any single group or information source entailed. What happened as a result of consciously working with the different information sources as different viewpoints, was that gradually there was a de-politicising of the respective information sources. Individuals came to accept the whole set of information and let go of singular and narrow views. This worked better with some people than with others but overall the neutral facilitation was critical to this process of sharing perspectives.

Process objectives

It is important to understand that the purpose of this search planning process was group building and group learning. Although it was never the idea not to produce co-ordinates for the search area, the purpose was rather one of building shared understanding and alignment through the planning process.

SUMMARY OF RESULTS

Sonar Search Success

The sonar search was the search phase that actually found the aircraft wreckage some two months after the accident. The wreckage was found two days after the start of this phase of the search. It was found within the primary search area determined through a process of group learning supported by conscious use of systems thinking principles. These principles together succeeded in creating shared understanding and levels of consensus that were patently missing before this approach was used.

Crash recorder search process and results summary

More than a year after the accident resources were in place to conduct an underwater photographic survey and limited retrieval of wreckage. The total wreckage field comprised several square kilometres, too great an area to photograph systematically with the available resources in order to locate the flight recorders. A search plan was developed using photographic survey results to arrive at a search area for the flight recorders. A relatively small area was determined in this planning process. The process was based on similar ideas than that of the sonar search phase. There were however differences in the specific use of eclectic research approaches. Another difference was a much more direct control of the composition of the team involved in the search planning. Again the location of the one recorder was indicated correctly, whilst the location of the second recorder was predicted to be far more uncertain. (It was also never found.) The cockpit voice recorder was found during a routine pick-up dive in the area designated search area. I credit the conscious use of similar principles for this second success.

CONCLUSION

What about search theory?

We had reduced the search are for the sonar search phase tremendously, from the initial large estimates. This was done through the process described above. There was a nagging issue: What if we were wrong? There simply was no way in which we could reduce the search areas more through research of the data or consensus building. For these reasons, the intention was to switch to a search theory approach, namely first build up a probability distribution, and guide the search to new areas as the search progressed. We were engaged in developing software to do these simulations when the aircraft was found. This work was not completed.

On reflection, I believe that search theory would have produced what we refer to as a “shared workspace”, had we completed this work, after reaching consensus on the information sources. Shared workspace serves to capture the groups’ understanding of the situation, and can guide the collective effort.

It needs to be noted that developing the shared workspace too early in the process, would have resulted in a very large search area, and secondly, would not have had the desirable consensus building effect.

With the advantage of hindsight it is clear that the analytic thinking tofu search theory that characterised my initial way of thinking about that situation was the mental trap (Vickers, 1970, p15). By the same token I am under no illusion that the quantitative thinking style fulfilled a key supporting role. Without recourse to that no amount of systems thinking would have succeeded. Nevertheless, the blind adherence to this as the sole reference framework would not have resolved the situation with the same effectiveness. Perhaps a bigger trap was the unquestioning acceptance of a particular mode of problem solving, without critically reflecting on the mode of problem solving actually required.[3]

[3] This paper is dedicated to the 159 people who died in the accident, including the father of my friend Karin Osler. The deep pain and tragedy of the situation should not be lost in the rational discussion of problem solving.

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