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RECONSTRUCTING COMBAT DECISIONS: REFLECTIONS ON THE SHOOTDOWN OF FLIGHT 655

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Prepared for: Michael Mudurian, NOSC, Code 421, San Diego, CA. 92152

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Reconstructing Combat Decisions:

Reflections on the Shootdown of Flight 655

Introduction

At approximately 1054 local time, 3 July 1988, the Aegis cruiser, USS Vincennes (CG-49), shot down a civilian airliner, Iran Air Flight 655, with two standard missiles. The airliner was on a routine, international flight from Bandar Abbas, Iran, to Dubai, United Arab Emrates, and was flying on a designated commercial airway. The missiles from the Vincennes intercepted the airliner at a range of eight nautical miles and an altitude of 13,500 feet. All 290 passengers and crew were killed.

Various inquiries have attempted to identify the factors that were responsible for the downing of the airbus. The first investigation, directed by order of General George B. Crist, Commander in Chief, U.S. Central Command, was conducted by Rear Admiral Fogarty, USN Director, Policy and Plans (J-5), and a team of seven officers. In conjunction with this investigation, formal hearings began on 13 July 1988 and terminated in the afternoon of 19 July 1988 in Bahrain. Drawing on all of the data collected from interviews, testimony, on site visits, and analysis completed by professional experts at Naval Sea Personnel and at the Naval Surface Warfare Center at Dahlgren, Admiral Fogarty issued a formal report on the findings to General Crist on 28 July, 1988 (Fogarty Report, 1988).

Additional investigations and hearings by other groups and organizations followed the formal report. A USN Medical Corps team, consisting of a psychiatrist and a psychologist, were

requested by the senior investigating officer and directed by the Chief of Naval Operations to determine if the dynamics on board ship impacted on the crew's ability to perceive and relay data. Originally scheduled to spend up to thirty days evaluating the crew, the team led by Commander John Matecvun departed on August 7 after spending three days interacting with the captain and the crew and issuing a report on the crew's psychological health (Rogers, Rogers, and Gregston, 1992).

On 8 September 1988, the Committee on Armed Services of the U.S. Senate, chaired by Senator Sam Nunn (D-Georgia), also took testimony from witnesses including Rear Admiral Fogarty and Rear Admiral Robert Kelly, USN, Vice Director for Operations, Joint Staff (Committee on Armed Services, 1988). In addition, the Defense Policy Panel of the House Armed Services Committee, chaired by Les Aspin (D-Wis), called witnesses on October 6 to present testimony on the psychological factors that contributed to the downing of the airbus. Five panelists representing the American Psychological Association gave testimony (House Armed Services Committee, 1988).

Further exploration of the factors contributing to the downing of the airbus came with the publication of Captain Will Rogers' book Storm Center in 1992. His personal account as Commanding Officer of the Vincennes during the downing of the airbus 655 expanded and elaborated on the formal record that had been presented in 1988. In addition, a Master's Thesis by Captain Kristen Ann Dotterway (USAF), completed at the Naval Postgraduate School, relied on his cooperation in its exploration of some of the unanswered questions from the 1988 formal report

(Dotterway, 1992).

The most recent examination of the Vincennes incident was spearheaded by Newsweek correspondent John Barry and retired Marine Lt. Col Roger Charles in collaboration with "Nightline," an ABC sponsored program. Their report, entitled "Sea of Lies" and detailed in a Newsweek article on July 13, 1992, provided additional information on the shootdown and its causes (Barry and Charles, 1992).

These investigations and accounts of 3 July 1988 pose interesting challenges to the reader. Discrepancies exist in the explanations and reconstructions ranging from the major to the minor. How is one to judge the reports' veracity and accuracy? Do all of them build on the same "facts" but yield different interpretations of those facts? Or do different frames of reference produce different "facts" and consequently point to different explanations surrounding the shootdown of the Iranian flight?

One discrepancy is particularly noteworthy in this regard -- establishing the trajectory of flight 655. While the tapes and system data revealed a flight pattern of ascent, crewmen in the combat information recollected a pattern of descent, one more characteristic of an attack mode. The correct interpretation of 655's flight pattern would in itself have been unlikely to have changed the outcome (Fogarty, 1988), yet how this discrepancy was treated provides interesting insights into the investigations and hearings that followed since all of them dealt with it in one form or anther.

The intention of this paper is not to resolve this discrep-

ancies nor any other involving the Vincennes. Such an assignment would require enormous resources to reopen the case and to collect and analyze additional data--an effort well beyond the scope of this paper. Rather, using the Vincennes case and the multiple investigations and hearings surrounding it as a backdrop, the goal of the paper is to illustrate the challenges of event reconstruction. No matter who launches and conducts an investigation, there are numerous difficulties involved. Perhaps with a better understanding of these difficulties, we will be in a position to make improvements the event reconstruction process. It is to this end that this paper is directed.

The Descent or Ascent of Flight 655?

The Vincennes, one of the Navy's newest and most technologically advanced cruisers, is equipped with Aegis, a sophisticated battle management system. Besides simultaneously processing and displaying several hundred surface and air radar tracks, the Aegis system records events on tape for reconstruction and analysis. Even radio circuits are recorded on audio tape, although internal voice communications are not.

The Aegis system data collected on tape from the Vincennes clearly indicated that Flight 655 was on a path of ascent from its takeoff in Bandar Abbass. Yet five people at five separate consoles in the Vincennes combat information center describe the airbus as decreasing in altitude on a path toward the Vincennes. Unable to account for this discrepancy, Admiral Fogarty requested a team of medical experts to conduct an evaluation of the crew. Crediting their conclusions, Fogarty report states that, "stress,

task fixation, and unconscious distortion of data may have played a major role in this incident" (Fogarty, 1988:45). Continuing, the report states that, "in an unconscious attempt to make available evidence fit a preconceived scenario, the tactical information coordinator (TIC) "appears to have distorted data flow," defined as "scenario fulfillment" in the report's text (Fogarty, 1988:45).

However, when Captain Rogers posed this question to the same medical team, he reports the following: "I had posed to the team the question of how five people at the five separate consoles could have seen something that hard data did not support. Like the rest of us, they didn't have the answer, but their response to the question was interesting:

> The question of perceptual distortion or misinterpretation of data in relation to combat stress was examined. It is well known that an expectant mind-set can lead to misinterpretation of data....Chances of occurrence can be related to combat stress and perceived threat, but other factors such as experience, uniqueness of data, lack of confidence in equipment or leadership and length of time to evaluate data must be considered pertinent. That five or more combatants, some with prior combat experience, most with extensive equipment experience, all viewing displays for cognitively significant periods of time would have the same perceptual distortion or misinterpretation of data is highly implausible (Medical team report in Rogers et.al., 1992:161).

According to Rogers, the draft report of the medical team's findings therefore concluded: "There are not identifiable clinical factors which would preclude immediate combatant roles and several which signify potential for highly competent functioning. The team considers the crew of USS Vincennes (CG 49) to be psy-

chologically prepared for operations in a hostile environment....Individuals were reviewed for evidence of overt psychopathology and none was found. No recommendations are made for change in crew or procedures as no objective clinical data supports it" (Rogers et.al., 1992:161).

Thus, Rogers has continued to insist that his combat information team formed a highly effective group, pointing to their skill in handling encounters of this type during their training and work-ups for the assignment. From his vantage point, the crew did not panic, nor were they suffering from stress, task fixation or scenario fulfillment. Captain Rogers has continued to search for other explanations to account for the downing of the Iranian airbus.

Yet in October 1988, when five psychologists, on behalf of the American Psychological Association, were called to testify before Congress on the Vincennes incident. They concluded, based on their reading of the Fogarty Report and its subsequent endorsement by General Crist, Admiral Crowe, Chairman of the Joint Chiefs of Staff, and Frank Carlucci, the Secretary of Defense, that this discrepancy among others were indicative of "predictable failings in human judgement (sic) under intense stress compounded by complex technology (which) clearly contributed to the accidental shooting of the Iranian airliner flight 655" (APA, 1988:4). Their testimony was particularly surprising in view of the earlier reports of the psychologists who actually had visited the ship.

Probes of the Vincennes incident continued. Four years

later, working with data provided by the crew and Captain Rogers (1992), Captain Dotterway (1992) offered an alternative interpretation of the discrepancy between the system data and the recollected data. (According to Captain Rogers, the Fogarty team were briefed on these data, although there is no evidence that the data were incorporated into the final Fogarty report).

Captain Dotterway explained the discrepancy by noting the existence of a second aircraft, a low-flying A-6 Intruder, descending in altitude, from the carrier Forrestal. By a bizarre series of events attributable to the Aegis system itself and not to operator error, she believes the track identification numbers of the Iranian airbus and the A6 were transposed. Under normal circumstances, the track coordinator would have identified the number conflict and rectified it. However, given the time compression of approximately 180 seconds, the confusion over track numbers was never resolved. Hence she concluded, because of the transposition of the track numbers and the time compression, what the system data actually recorded as flight 655 on the ascent, the crew actually saw on their monitors as the A6 on the descent.

Unaware of this interpretation, Barry and Charles, (1992) built on the language of the Fogarty report to offer a slightly different version of the Vincennes incident. They too maintained that the discrepancy between system data and the interview data was an example of "scenario fulfillment -- you see what you expect." The console operators had tagged the aircraft as descending in altitude and picking up speed. Yet the system tapes recording flight 655 revealed no descent pattern. The plane was in an ascending pattern traveling at 380 knots at 12,000 feet and

climbing.

But Barry and Charles (1992) added another twist. They concluded, based on recent revelations that the Vincennes was in Iranian territorial waters, and some interview data from Navy officers and crewmen charging that the Vincennes was a "Robo-cruiser" looking for trouble, that the Vincennes incident represented a coverup of "a naval fiasco, of an overeager captain, (and) panicked crewmen" (Barry and Charles, 1992:29).

Did the crew exhibit "scenario fulfillment"? Does the Vincennes incident illustrate the impact that stress can have on decision making under combat conditions? Or did the technical difficulties that surround the assignment and updating of track numbers better explain the "discrepancy" between system data and the crew's recollections of events? Perhaps we shall never know with any degree of certainty the answer to these questions, but we see in this one aspect of the Vincennes case, the range of interpretations and explanations that can surface, despite a grounding in essentially the same set of "facts." What makes event reconstruction of this type so difficult? Assuming that all those involved in the hearings and investigations of the Vincennes were operating with the best intentions and were motivated to find the "real causes" of the downing of the airbus, what accounts for this diversity in their interpretations? To answer that question, let us explore some of the complications of combat decision reconstruction.

Time is always an important consideration in incidents of such human and international magnitude like the Vincennes because policy makers and the military chain of command need to explain to families, the American public and international community what happened, how it happened, and why. Beyond the press of the moment, and the moral, legal and political obligations to those affected, extracting the "lessons learned" from the experience is also important, especially if errors were made. Organizations need to know what happened in the hopes of preventing such occurrences in the future. And it also goes without saying, that if culpability is assigned, those responsible should be held accountable for their actions and dealt with as expeditiously as possible. Thus, time is an important factor.

Yet there is a tradeoff between time allocated to an investigation and the accuracy of any report. The push for immediate answers can create distortions and factual inaccuracies that not only cause confusion, but later can fuel the flames of conspiratorial theory if the earlier "facts" prove to be incorrect. For example, the earliest reports on the Vincennes incident had flight 655 flying outside the commercial corridor, descending, and picking up speed when it advanced toward the Vincennes. It was also reported that the was Vincennes rushing to defend a merchantman under attack by Iran in international waters. In reality, the Vincennes was in territorial waters; there was no merchant vessel; and the Iranian airliner, always ascending, remained in the commercial air corridor.

The nature of the data that investigators are required to

collect makes the reconstruction even more difficult. There will be literally mountains of systems and computer data on tape to retrieve and review, much of which requires expertise for its analysis and interpretation. To compound the problem, the expertise is usually located at sites quite distant from the ship. Dahlgren, half way around the world, provided the expertise to analyze the Aegis computer and systems data. In addition, interviews of potentially hundreds of individuals who are linked by task force assignment on the ship and in distant locations in the chain of command must be collected, analyzed and compared with the system data. Other data such as rules of engagement for combatants and noncombatants must be considered in the reconstruction to ensure that legal and military constraints were followed. Even environmental factors can play a part, because, as we see in the case of the Vincennes, the ducting pattern on July 3 enabled the Vincennes to pick up tracks well beyond its normal range.

Additional factors to be considered are the history and present status of the region and the combatants, as well as the training and experience of the crew, and the readiness of the ship. And in the case of sophisticated combat management systems such as the Aegis that have been "battle tested" more in training exercises than in combat, questions are always asked of the complex technology's performance and the crew's skills in its management. Thus, the data are wide-ranging and complex, requiring considerable time and expertise for their collection, analysis, and interpretation.

There are also complications in the selection of an investigation team. Who should be on the team -- those who have the technical and subject matter expertise, or those with the investigative experience, or those who are available, or can be "trusted" to conduct reviews of this type? And how many members should the team include? Answers to these questions, ideally, would depend on the nature of the incident and the amount of data to be collected and analyzed. In Vincennes case the main team consisted of seven officers. But reports that key witnesses important to the investigation were never interviewed, such as commanders on board the Forestal, and Captain McKenna, the surface-warfare commander in Bahrain (Barry and Charles, 1992), suggest, at the very least, that more manpower could have been assigned to the case to ensure that all key participants were contacted.

Another critical factor in event reconstruction is how the data are to be pooled and integrated. Thousands of pieces of information will have to be integrated to form a whole, complete picture of the incident. Yet this is an enormous task given the complexity of the event, the diversity of the data, and the physical separation of those involved the analysis. We see some evidence of the difficulty in the case of the Vincennes. As far as can be ascertained, data about the transposition of the track numbers was never fully incorporated into the Fogarty report, although it was briefed to the invetigation team and known to the Captain and some of the crew (Rogers, et. al., 1992:118).

One approach to pool the data and to integrate the separate analyses has been to establish a timeline. The advantage of this

approach is the graphic illustration of a sequences of activities to show how all the data can be pieced together relative to time. This traditional approach was followed by all investigating the Vincennes case, although the time sequences ranged from thousandths of a second in some cases, (Rogers, et.al, 1992:107), to minutes in others (Barry and Charles, 1992:31).

Time lines, however, have their disadvantages. Because one event precedes another in time does not necessarily establish a causal linkage between the two. The events may or may not be related to one another. There is also the danger that a focus on time may mask and obscure other patterns ard relationships that are even more important. Dotterway (1992) was able to demonstrate, for example, that other approaches to organizing and integrating data besides a time line could yield valuable insights. More will said of this below.

Another important issue in the reconstruction of combat decisions is how to deal with inconsistencies in the data. What happens when all of the data do not converge to form a coherent picture? When inconsistencies in the data exist, such as the incompatibility between the Vincennes' system data on the computer and interviewees' reports, how should such inconsistencies be handled? Should the investigation continue until such discrepancies are explained, or, given the press of time, should they remain as puzzles open to various interpretations, such as the "fog of war" or combat induced stress? We see the danger of leaving discrepancies unresolved, when a cover-up of the Vincennes case is charged four years after the fact due to this and

other inconsistencies (Barry and Charles, 1992).

This last series of questions leads us to another important consideration in reconstructing combat decisions. Care must be taken to separate data from speculation and interpretation of those data. The line is a fine one, but nonetheless an important one to establish. The Forgarty report, unable to reconcile system data and interview data pertaining to the flight path of flight 655, offered the interpretation of combat induced stress, pointing to task fixation and scenario fulfillment to explain the discrepancy. But this speculation later became concretized and objectified to the point when five psychologists would assert in congressional testimony, based on their reading of the Fogarty report, that stress was indeed a factor in the downing of the Iranian airbus. Given this "finding," they advocated more research money be allocated to study of combat decision making under stress. Congress obliged and authorized the program entitled Tactical Decision Making Under Stress (TADMUS) (APA, 1989:1-2). It is not too surprising, then, that the studies spawned from this project use the Vincennes case to highlight "the question of how stress can affect decision making" (see for example, Klein and Zsambok, 1992:1).

Recommendations for Improvement

As outlined above, there are many complications in the investigations of high-profile events. While no investigation commands all the resources, time and manpower to complete the reconstruction, there are ways we can improve the process with the resources that are available.

Let us begin with the investigation team. The ideal team would be multidisciplinary in nature since real life problems do not present themselves in neat discipline-based categories. One of the most challenging aspects to combat decision reconstruction is **problem finding** rather than solution generation. Having a team explore "the problem" from various angles and perspectives broadens the base from which the reconstruction can be considered. If properly run, the team removes blinders that disciplinary training and experience impose. Rather than relying on psychologists to find problems attributed to individuals, sociologists to find problems attributed to structure, and political scientists to find problems attributed to power and politics, the search can be for "the problems" in whatever guise they take.

Such a multidisciplinary team would include experts in the appropriate military technologies, strategies, and tactics, as well as psychologists, system analysts, and sociologists. System analysts are useful because of their training and experience in identifying patterns and viewing a system as a whole. Sociologists are important because of their expertise in handling large data bases and their skills in data reduction. They also are more likely to have experience employing both qualitative and quantitative data collection and data analytic techniques. Trained to work at the group, organizational, and community level of analysis, both sociologists and systems analysts also complement psychologist's expertise at the individual level of analysis. Ideally, such a team would have worked together and learned from experience how to conduct an investigation of this type. Since such multidisciplinary investigations are rare, it stands

to reason that practice would improve their process.

The multidisciplinary team would be advised to begin data collection with a template. A template is nothing more than a list of all the factors that should be part of any data collection process. For example, a template for the Vincennes investigation could have included the political, economic, social, military, technological, and environmental factors that would have been expected to provide the figure as well as the ground in the investigation. While every factor may not be relevant to each event, they are less likely to be forgotten or overlooked if they are automatically considered in the reconstruction process. Data reduction can occur at a later point in time and "irrelevant" factors eliminated, if appropriate.

Dotterway used the template illustrated in Figure 1 to assist in her "data collection" process. She began with the contextual factors that represented the Vincennes's environment. Those ranged from the social and political forces, and the physical setting, to the threats and the other allied platforms in the region. This environmental scanning then enabled her to identify the key success factors in this context. Having concluded the analysis of the external environment of the Vincennes, she then turned her attention to the internal design of the ship. Four factors were particularly important: tasks, technology, organizational structure and design, and people. Tasks refer to the activities required to get work done; technology defines the manner in which tasks are accomplished; organizational structure and design identifies the basic grouping of people and their

tasks, as well as the operating mechanisms such as the information, control, reward, and training systems; and people describe the human resources in terms of their skills and experience, leadership, values and assumptions, among other things. Emerging from the design factors is organizational culture. This factor represents the ship's prevalent values and norms as well as its patterns of thinking and behaving. Lastly, the template identifies the outcomes flowing from all of the external and internal factors. One outcome for the Vincennes was the shootdown of flight 655.

As the data collection proceeds with the template, initial data integration or pooling can begin with a timeline. All events, regardless of their relationships should be anchored to one another relative to their occurrence in time. It is especially important to note any inconsistencies at this point. They become the focus for the next round of data collection. How, for example, could we resolve for the discrepancy between the system data and the interview data? What additional data might be helpful in addressing this question? Who would have access to information bearing on this question?

When all of the data have been collected and the timeline completed, an important step in the analysis is to integrate the data in such a way as to show critical linkages and associations. The point of this exercise is to see the system as a whole and to find patterns that may point to the underlying causes of the outcome. Using the template to help organize the data collection process has predisposed researchers to take this perspective since it assumes interrelationships and interconnections among

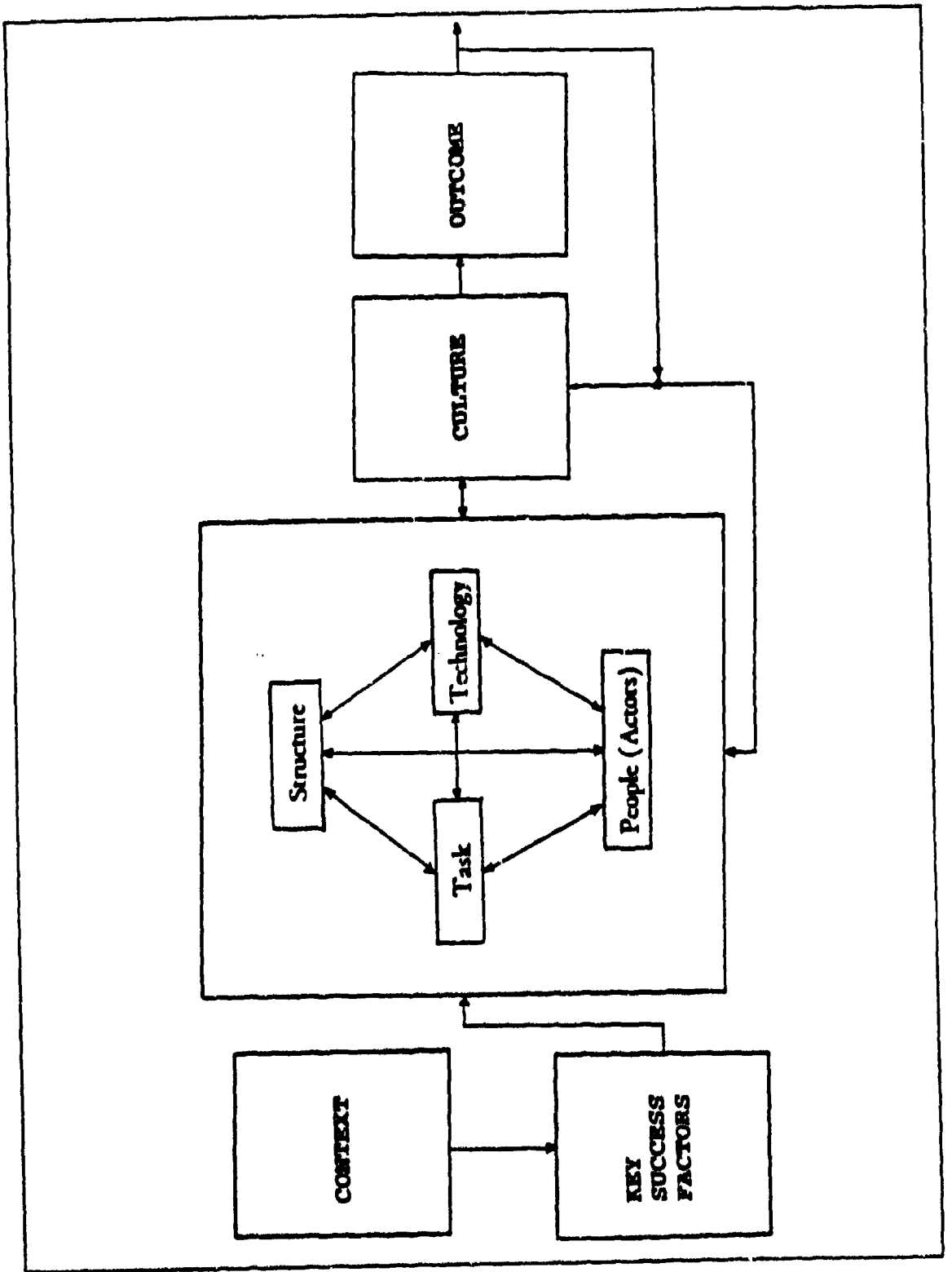


Figure I Template From Dotterway, 1992:132

all the factors via feedback loops. Thus, Dotterway was able to use the template and make interconnections among the ship's context and success factors (time compression), with tasks and technology (track number confusion), and the outcome.

Yet this system's perspective can be taken a step further into the realm of cybernetic theory. Cybernetics is a term coined in the 1940s by Norbert Wiener, a mathematician, and taken from the Greek word kubernetes, which means steersman. It refers to a system that regulates its behavior through information exchanges with its environment.

Cybernetics is based on four basic principles: systems have the capacity to sense their environment; systems can relate this information about their environment to norms that guide their operations; systems can detect significant deviations from their operating norms; and systems can take corrective action when discrepancies are detected (Morgan, 1986:86-87). If these four principles are satisfied, then through a continuous process of information exchange between the system and its environment, a system can initiate appropriate responses. and operate in a self-regulating manner (Morgan, 1986:87).

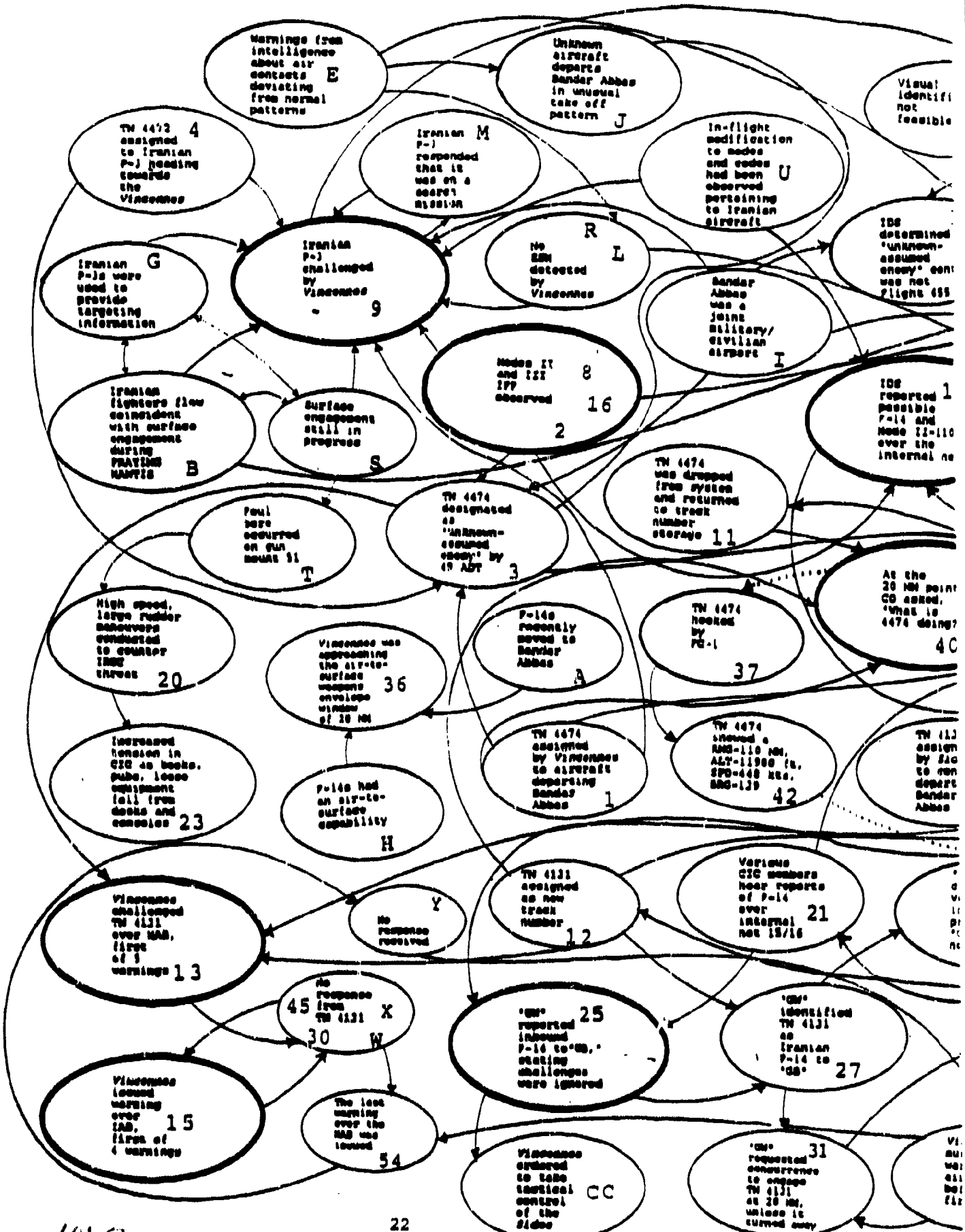
These self regulating processes can best be thought of as occurring in loops, and are referred to as either positive feedback loops or negative feedback loops. Negative feedback loops occur when a change in a variable initiates changes in the opposite direction and are important in keeping a system stable. Positive feedback loops, on the other hand, when more of a variable leads to more, or less of a variable leads to less, account

for system change. Taken together, these feedback loops explain how a system preserves its form or transforms it over time (Morgan, 1986:247).

Piloting an airplane illustrates the difference between the two types of feedback loops (Dotterway, 1992:161-162). In flying an airplane, assume a pilot uses too much rudder in a particular direction. Once the pilot detects that the airplane is veering off course, she moves the rudder control in the opposite direction (negative feedback). Continual adjustments through the rudder control (negative feedback) enables the plane to stay on course. However, if no correction is made to the rudder, the pilot flies farther and farther off course (positive feedback). If left unchecked, the positive feedback produces a deviation-amplification process in which the change (going off course) becomes more pronounced and transforms the system -- either the plane runs out of gas and crashes or it lands in a different destination than originally planned.

We can see an excellent example of the application of cybernetic theory to event reconstruction in Dotterway's research. Depicting the Vincennes incident as a series of loops as illustrated in Figure 2, she was able to offer an even finer grained analysis than had been possible using either the timeline or the organizational template in Figure 1.

These loops reveal, according to Dotterway, a preponderance of positive feedback loops and only one instance of a negative feedback loop in the entire Vincennes incident. The positive feedback loops are represented by the solid lines while the negative feedback loop is indicated by a dashed line and can be


Warnings from intelligence about air contacts deviating from normal patterns E
Unknown aircraft departs Bandar Abbas in unusual take off pattern J
Visual identifi not feasible
TN 4473 assigned to Iranian P-J heading towards the Vincennes 4
Iranian P-J responded that it was on a secret mission M
In-flight modification to modes and codes had been observed pertaining to Iranian aircraft U
IDS determined "unknown-assumed enemy" cont was not flight 655
Iranian P-J challenged by Vincennes 9
R
No IFF detected by Vincennes L
Iranian P-Js were used to provide targeting information G
Bandar Abbas was a joint military/ civilian airport I
Modes II and III IFF observed 16 2 8
IDS reported possible F-14 and Mode II-110 over the internal ne 1
Iranian fighters flew coincident with surface engagement during FRAYING MANTIS B
Surface engagement still in progress S
TN 4474 was dropped from system and returned to track number storage 11
Foul have occurred on gun mount 51 T
TN 4474 designated as "unknown-assumed enemy" by 49 AOT 3
At the 20 NM point CO asked, "What is 4474 doing? 40
High speed, large rudder maneuvers conducted to counter IRGC threat 20
F-14s recently moved to Bandar Abbas A
TN 4474 hooked by F-14 37
Vincennes was approaching the air-to-surface weapons envelope window of 20 NM 36
Increased tension in CIC as books, pubs, loose equipment fall from desks and consoles 23
TN 4474 assigned by Vincennes to aircraft departing Bandar Abbas 1
TN 4474 showed a RNG-110 NM, ALT-11900 ft, SPD-448 kts, BRG-139 42
F-14s had an air-to-surface capability H
TN 4131 assigned as new track number 12
Various CIC members hear reports of F-14 over internal net 15/16 21
Vincennes challenged TN 4131 over MAB, first of 5 warnings 13
Y
No response received
No response from TN 4131 45 30 X W
"CM" 25 reported inbound F-14 to "CM," stating challenges were ignored
"CM" identified TN 4131 as Iranian F-14 to "CM" 27
Vincennes issued warning over MAB, first of 4 warnings 15
The last warning over the MAB was issued 54
Vincennes ordered to take tactical control of the Sides CC
"CM" requested concurrence to engage TN 4131 at 20 NM, unless it turned away 31

183

Figure 2 Cybernetic Model from Dotter

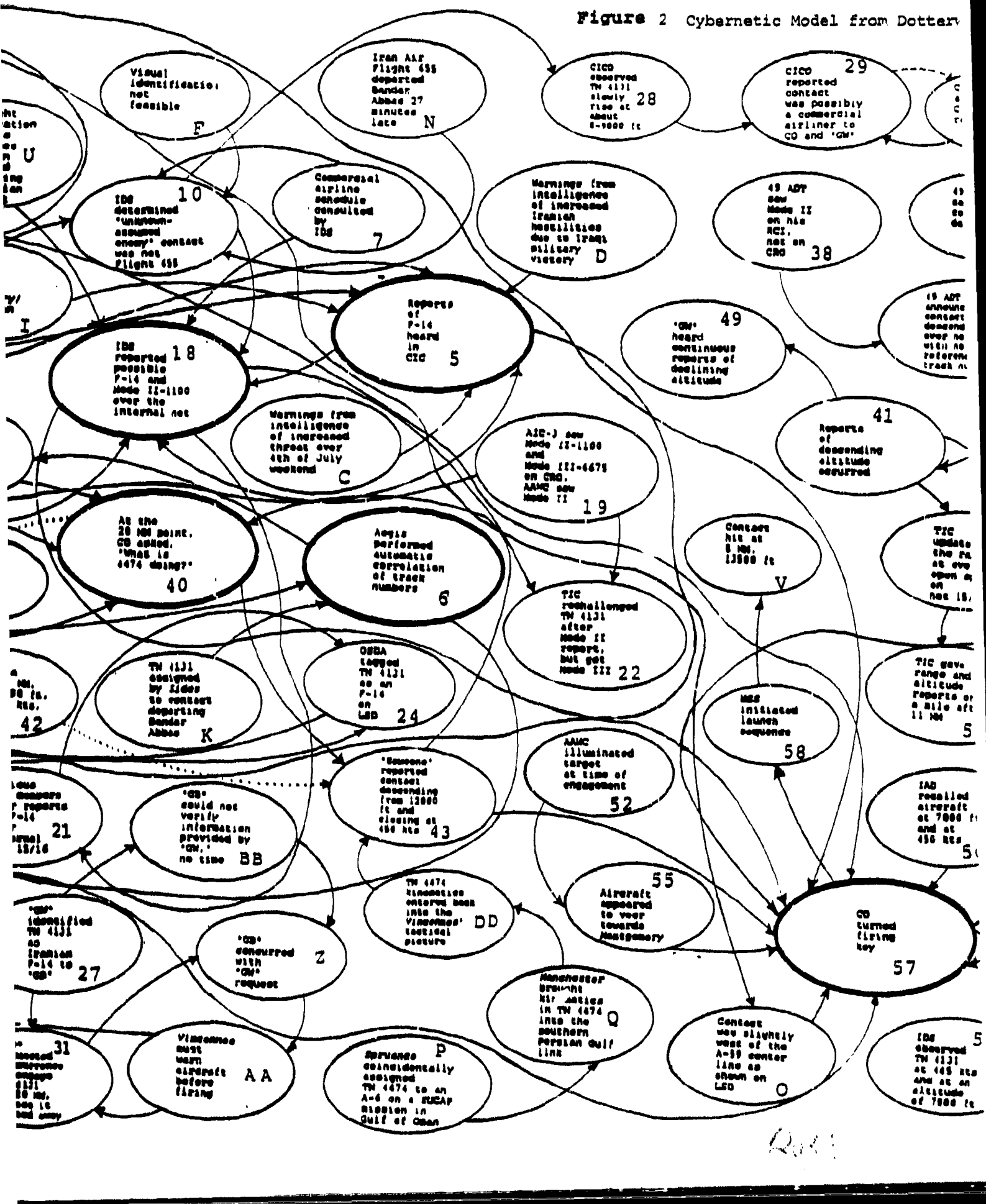
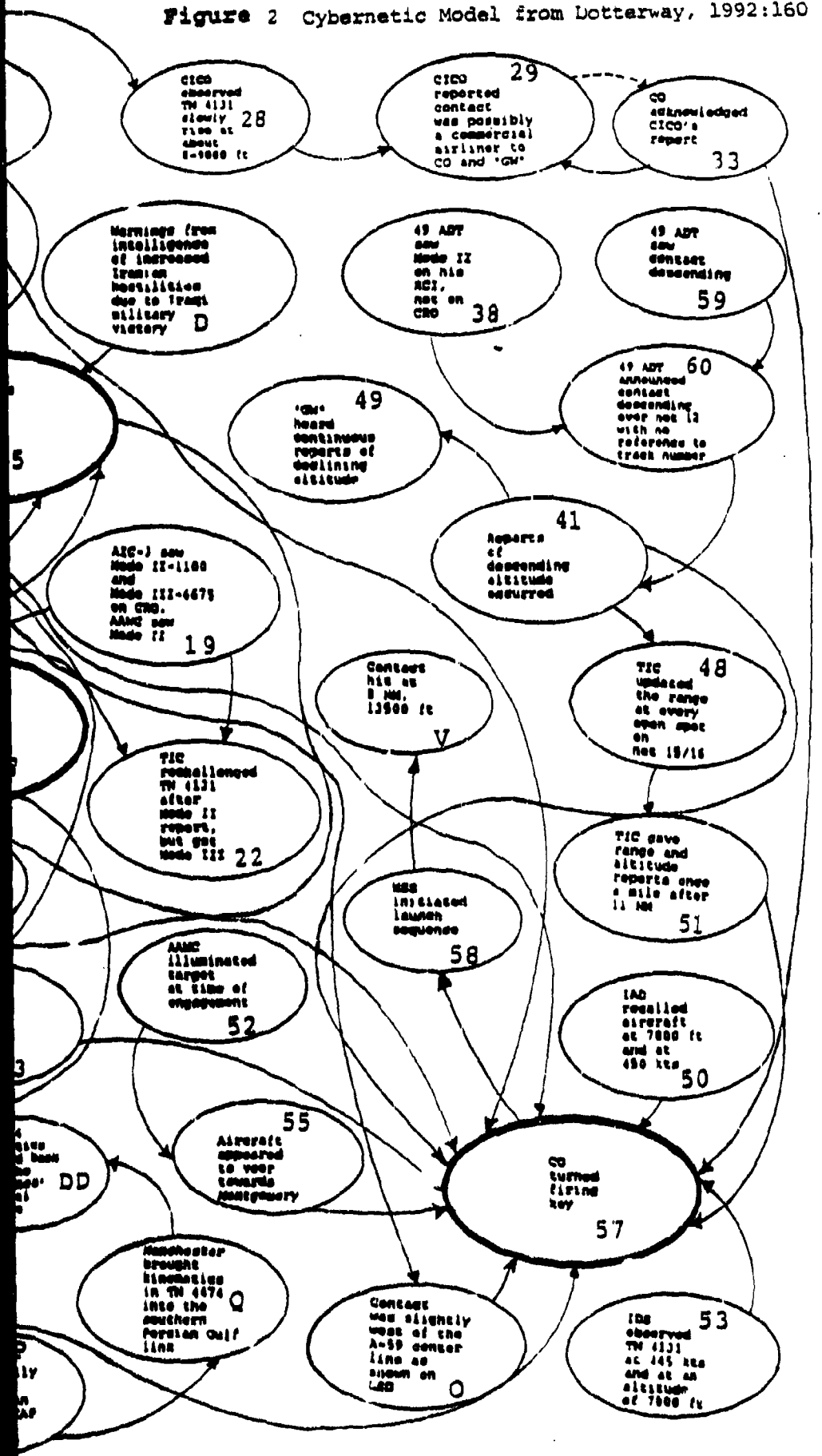


Figure 2 Cybernetic Model from Dotterway, 1992:160



seen in the upper right hand corner of the figure. (The dotted lines mean that there is an implied connection between the set of relations. Readers interested in a full discussion and interpretation of this figure should consult Dotterway, 1992).

Using cybernetic theory and mapping the Vincennes incident as series of loops to show interaction, Dotterway concluded that the Vincennes incident represented a deviation amplification process designed for transformation and change. With only one negative feedback loop to counter deviations, there was little opportunity to maintain stability and control in the system. Having viewed the problem in cybernetic terms, she then recommends solutions to correct the "errors" of the deviation amplification process.

Conclusion

Reconstruction of combat incidents is difficult. Despite the recommendations for change summarized above, we have no guarantees that the process will be without error or complication. It is unlikely that everyone will agree on the "facts" or on their interpretation, however they are derived.

Yet this review of the Vincennes' reconstructions has been useful in underscoring the importance in taking a system's perspective. Rare is the reconstruction in which one factor or variable is found to be responsible for the outcome. Instead, what we often find is a complex set of factors, when taken together, due to unanticipated interactions and combinations, leads to an outcome that each factor, operating independently was unlikely to produce. It is important that we expand our data collection and data analytic processes and tools to mirror this

complexity. And it was to this end that this paper was written.

We should be aware, however, that taking a system's perspective does not resolve all of the issues in event reconstruction. There are those who predict, given the complexity and the interdependencies of our systems, that we can expect more rather than less incidents like the Vincennes. In fact, they claim, efforts to correct the "errors" will produce greater interdependencies and complexity in our systems which in turn increases rather than decreases the potential for disastrous outcomes in the future (Perrow, 1984).

Despite these unhappy predictions, the quest for ways to minimize system accidents continues. The search for improvements in the human, informational, organizational, and warfare subsystems systems, especially in their coordination and fusion, goes forward. Acknowledging that combat can be viewed as a complex dynamic system, the question is whether we can design our systems for better communication, coordination and control, or failing that, teach people to make decisions and solve problems despite the system's complexity and dynamism. Research on these topics is in its infancy, but we can expect in our increasingly interdependent, technologically-based, complex world, more attention and focus will be devoted to them in the future.

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