

[COMMITTEE PRINT]

**INFORMATION TECHNOLOGY FOR
EMERGENCY MANAGEMENT**

R E P O R T

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INVESTIGATIONS AND OVERSIGHT

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LETTER OF SUBMITTAL

CONGRESSIONAL RESEARCH SERVICE,
THE LIBRARY OF CONGRESS,
Washington, DC, May 14, 1984.

Hon. ALBERT GORE, Jr.,
Chairman, Subcommittee on Investigations and Oversight, Committee on Science and Technology, House of Representatives, Washington, DC.

DEAR MR. CHAIRMAN: I am pleased to submit this report entitled "Information Technology for Emergency Management," prepared at the request of the Subcommittee on Investigations and Oversight of the Committee on Science and Technology, of the United States House of Representatives.

This study presents an overview of the existing and emerging issues related to the application of information technology—computers, telecommunications, microform systems, audio and video devices—to all phases of emergency management: prevention, mitigation, response, recovery. Both natural and man-caused disasters are a focus of this analysis.

Subsequent to the presentation of an executive summary which sets forth the requisite factual information and related observations essential to a more full development of this critical topic, an introductory chapter provides a context for the ensuing treatment of the objective of the report, the myriad aspects of this increasingly significant problem area as perceived by authorities from across the country, and a number of identifiable alternatives for congressional initiatives in the future. Following two chapters which feature illustrative material on the various ways the array of information technologies are being utilized in coping with several kinds of natural and technological disasters, along with background and key statistical information on these focal areas, a discussion of the Federal role in striving to ensure greater resiliency in our information support infrastructure is presented. Next, a chronology of selected governmental actions and related events reflects the pattern of activity, especially during the past quarter-century. The underpinning of this full report is found in the six chapters which follow, for these include the highlights and commentary of the six major Subcommittee endeavors, including three days of hearings, a national workshop, and a technical forum, which spanned the 97th and 98th Congresses. Finally, a series of appendices provide selected background material designed to augment the core narrative.

The direction of this project was performed by Robert L. Chartrand, our Senior Specialist in Information Policy and Technology, who was the chief author and editor. Dr. Clark F. Norton, Specialist in American National Government, prepared Chapter V and reviewed the entire manuscript. Nancy R. Miller, Analyst in Information Science and Technology, contributed significantly to the preparation of Chapters III and IV, coauthoring the former with Madeline Seidner of the Office of Senior Specialists, and assisting Trudie A. Punaro, Research Assistant to the Senior Specialist, with the latter. Ms. Punaro also performed all of the research and drafting of material for Chapter II. Ms. Seidner performed a variety of crucial tasks in assembling, organizing, and further preparing a range of substantive and ancillary material for inclusion in the final manuscript. This contribution to the Subcommittee on Investigations and Oversight, House Committee on Science and Technology, was coordinated with and reviewed by Robert Nicholas, Chief Counsel and Staff Director, and Elizabeth Eastman, Assistant to the Staff Director, of the Subcommittee Staff.

On behalf of the Congressional Research Service, I should like to express our appreciation for the opportunity to undertake this challenging and timely assignment.

GILBERT GUDE,
Director.

LETTER OF REQUEST

COMMITTEE ON SCIENCE AND TECHNOLOGY,
HOUSE OF REPRESENTATIVES,
Washington, DC, May 4, 1983.

Hon. GILBERT GUDE,
Director, Congressional Research Service, Library of Congress,
Washington, DC.

DEAR GIL: Early in the 98th Congress, the Subcommittee on Investigations and Oversight of the House Committee on Science and Technology intends to explore further the role of information technology in emergency management. This effort will build on a set of highly successful hearings and a technical forum which were conducted with the assistance of your staff late in 1981.

This is to request that Robert L. Chartrand, your Senior Specialist in Information Policy and Technology, be authorized to continue his key supportive role with the Subcommittee. His grasp of this often complex topic and his proven ability to marshal the resources requisite to any serious analysis of its present status and potential are essential to our endeavor.

The Subcommittee anticipates holding a second set of hearings in this area during the fourth quarter of 1983. The preparation of a booklet highlighting salient issues and programs, for use during the hearings and a possible concurrent workshop, is also planned. Following these sessions, I should like to have Mr. Chartrand prepare a summary report that would present a synthesis of the various Subcommittee initiatives along with such supporting factual and interpretive commentary as is necessary to establish a useful overview of the topic. This contribution will be coordinated with Robert Nicholas, the Staff Director of the Subcommittee.

Congress has expressed a growing concern regarding our national emergency preparedness capabilities. It is the intention of this Subcommittee to examine the vital role of information technology in coping with emergency situations that prompts this request.

Sincerely,

ALBERT GORE, Jr.,
Chairman, Subcommittee on
Investigations and Oversight.

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Inspector Littlejohn reported to the group, when questioned by Hilary Whittaker, that New York City received \$500,000 last year in FEMA funds transmitted through the State of New York. This was "26 percent less than the year before." He also indicated that no useful assistance had been forthcoming from FEMA personnel. The final question for this speaker came from Mr. Chartrand:

Are there any files at all that you might have ear-
marked, even though you haven't implemented, for place-
ment in a computerized form so you could cope with cer-
tain categories of data?

Although no such file exists, the Inspector said that he would like to computerize data on "all the emergency equipment in the city," and while listings do exist in the sanitation and transportation areas, such "assets are not centralized."

Next appearing before the forum as a presenter was Dr. Jacques F. Vallee, President of INFOMEDIA Corp., noted for its pioneering introduction of a "computer-conferencing service on a commercial network" in 1976 and for its subsequent specialization in the development of software packages for executive communication. Dr. Vallee commenced by stating that he hoped to bring to this debate "a contribution drawn from our group's experience in four areas:"

- (1) The practice of computer-conferencing under demanding real-world conditions;
- (2) Our users' interest in the prevention of disasters through a nuclear safety network;
- (3) Their use of conferencing techniques in anticipation of a major accident through realistic drills; and
- (4) The identification of new research tools made possible by the existence of computer-conferencing systems.

Noting that previous testimony had "stressed the need for effective group communication during a crisis" and that radio and telephone links have characterized such linkages, the speaker emphasized such systems "are effective because they provide *instant access* to decisionmakers." However, he pointed out, they are hampered "by their reliance on the human voice (which is slow and demands a single speaker at a time), the lack of an accurate record, and the unavailability of multiple private channels."

To alleviate these difficulties, INFOMEDIA developed a technique of computer-conferencing utilizing the NOTEPAD system for work with customers in the public and private sectors.

Its major application is found in project management by utilities, oil and engineering companies. For instance, the Bechtel Corporation has used NOTEPAD in large mining projects so far, both on a domestic and international scale.

In describing the functioning of the NOTEPAD system, Dr. Vallee told how a user starts by typing a keyword "on a conventional computer terminal to complete a phone connection with our machine." Then being presented with a "menu" of activities—each representing a conference within a selected group of participants—available to him, the user may leave messages for these electronic

By virtue of the computer's storage and processing, both entries and notes can be transmitted instantaneously to remote sites, sorted for later retrieval according to complex criteria, or integrated with data bases or computer programs.

Following this requisite preamble, Dr. Vallee then centered his commentary on the role of such technology in an emergency management setting:

Emergencies are characterized by an increase in information flow, an explosion in the topological complexity of the information network, and a feeling of intense psychological pressure among the participants. This means that many people and organizations who should be talking to each other do not do so until communication is precipitated by an external emergency; the group members often find themselves confronted with unfamiliar procedures and with unknown partners in the crisis management process, and decisions have to be made under conditions of low group trust and inadequate information content.

Dr. Vallee chose the Three Mile Island incident to illustrate his thinking, stressing that while "the trigger for the accident was a physical malfunction, the real crisis was in many ways a crisis of communication."

- Plant operators and company personnel did not have access to outside experts who might have brought essential information to the discussion;

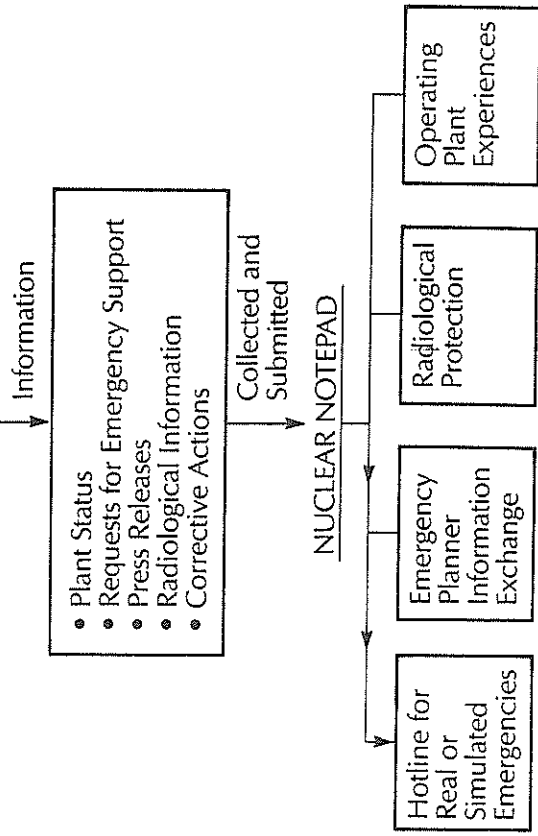
- There was a *low level of trust* between personnel in the industry and government officials; and

- It quickly became impossible to obtain accurate and reliable facts about the situation because the antagonism between industry and the press introduced into the perception of the crisis a third component whose role had not been anticipated, namely a *misunderstanding of that information which was communicated* [italics added].

The "linguistic and cultural differences" between these discrete communities were, the speaker opined, "exacerbated by the lack of an effective communication tool." He went on to say that "Nuclear NOTEPAD," a computer-conferencing network, was put in place as a response to the TMI situation. Dedicated to "the prevention of future accidents through the exchange of nuclear safety information among the industry," this system now links 64 companies which own 72 nuclear power plants. In addition, it ties the United States with seven foreign utilities in France, Japan, Italy, Sweden, Spain, Taiwan, and Canada. The structure of the computer conferencing utilized, and featuring Nuclear NOTEPAD, during a typical emergency is shown in Figure 57.¹⁵¹

¹⁵¹ Graphics provided by Dr. Jacques F. Vallee, President, INFOMEDIA Corp.

NUCLEAR PLANT



STRUCTURE OF NOTEPAD ACTIVITIES IN A NUCLEAR PLANT EMERGENCY

FIGURE 57

The use of the Nuclear NOTEPAD capability during an actual emergency—incident at the Crystal River nuclear plant in Florida on February 26, 1980—in handling selected crucial information was then related by Dr. Vallee. Among the groups linked by the system were key personnel at the Nuclear Safety Analysis Center (NSAC) in Palo Alto, the Criteria Development and Analysis Division of the Institute of Nuclear Power Operations (INPO), and the nuclear support system at Florida Power. Continuous updates were sent to these and other organizations, such as this early message:

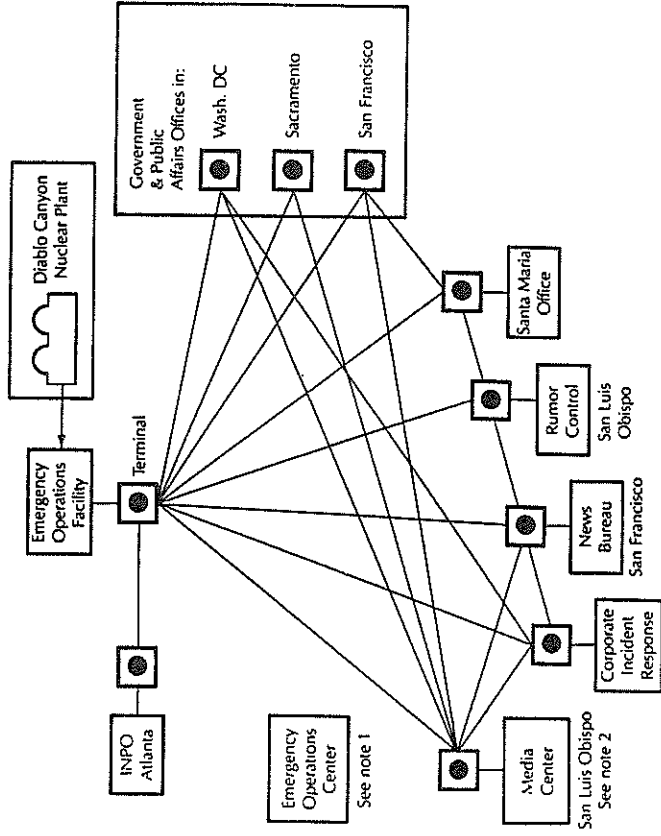
Continuation of Crystal River. NRC team is on site; NSAC and INPO teams in communication with plant. P. Baynard of Florida Power will update or revise this information as needed.

It should be known that "a power failure in the non-nuclear instrumentation at Crystal River led to a brief emergency shutdown: 43,000 gallons of radioactive water were spilled into the containment system as operators deliberately prolonged the high-pressure injection system to assure adequate cooling."

The next event to be reviewed by Dr. Vallee involved the use of Nuclear NOTEPAD in a nuclear drill, held on August 19, 1981 and organized by PG&E in San Francisco.

It involved an equipment malfunction at Diablo Canyon, consisting of the ejection of a rod from the reactor housing, fire in the switch gear room, and loss of transmission power to the plant.

For an eight-hour period, Nuclear NOTEPAD was used by the participating decisionmakers—the Emergency Operations Facility team at PG&E, the Diablo Canyon nuclear plant, and members of the Corporate Emergency Response Plan—to “rapidly disseminate statements regarding plant status, radiological release, corrective actions, and evacuation procedures.” The recipients of this information are shown in Figure 58.



NOTEPAD station: one terminal with two people already trained in the use of computer conferencing.

Note 1: In the drill this location was not using NOTEPAD. When a statement was to be made to the media the information officers had to travel by car (5 miles round trip) to the media center.

Note 2: At the time of the field exercise, appropriate telephone links had not been completed as required. NOTEPAD was the only link between the Media Center in San Luis Obispo and the Emergency Operations Facility.

FLOW DIAGRAM—DIABLO CANYON EMERGENCY DRILL

FIGURE 58

In designing its emergency response plan, Dr. Vallee reported, PG&E viewed NOTEPAD as a "communications medium whose unique features would allow PG&E to significantly augment and improve its existing communications capabilities, namely voice, radio, and data." It was recognized more specifically that NOTEPAD could:

- Create a single historical record of events, easily retrievable at any time;
- Simultaneously transmit information to concerned PG&E officials;
- Communicate through private channels; and
- Draw in outside expertise as needed.

Two "very important functions" were served by using this type of communications capability: "to guard against distortion of events and subsequent rumors—everyone has the same facts at the same time—and to obviate the flood of distracting phone calls to the Emergency Operations Facility." Drill statistics showed that 36 public messages and 148 private messages were sent in the eight-hour period; thus, each recipient received an average of 51 messages.

The fact that four times as many private messages as public were sent strongly underlined the importance of having access to private channels for problem-solving, questions, or any other type of communication that is more appropriately directed to an individual rather than to the whole group.

It turned out that NOTEPAD was the only functioning communications link between the Media Center in San Luis Obispo and the Emergency Operations Facility during the field exercise "because appropriate telephone links had not been completed as required."

The essence of the NOTEPAD capability, Dr. Vallee declared, was clearly demonstrated during this exercise. It proved to be effective in tying together the company experts and decisionmakers, and facilitating their ability to "present a unified and well-coordinated response to government authorities, the press, and the public." Figure 59 shows a typical NOTEPAD message transcript during this drill.

ACTION: Status (of Participant) All

The Title of Activity 2006 is:
EMERGENCY COMMUNICATIONS/DIABLO CANYON AUGUST 19, 1981

Name	Last Time Entered	Last Entry Seen
Girard (Paul)	Present	4
EOF (PG&E)	Present	4
EOC (County)	Never Entered	
CIRC (PG&E)	Present	4
NBSF (PG&E)	Present	4
NGSLO (PG&E)	Present	4
GPASACTO (PG&E)	Present	4
GPASF (PG&E)	19-AUG-81 9:23 AM	4
GPADC (PG&E)	Present	4
RUMOR (PG&E)	Present	4
SHARIA (PG&E)	Present	4
Lear (Jennifer)	Present	4
INPO (Atlanta)	19-AUG-81 8:48 AM	4

ACTION:

Now Typing: EOF (PG&E)

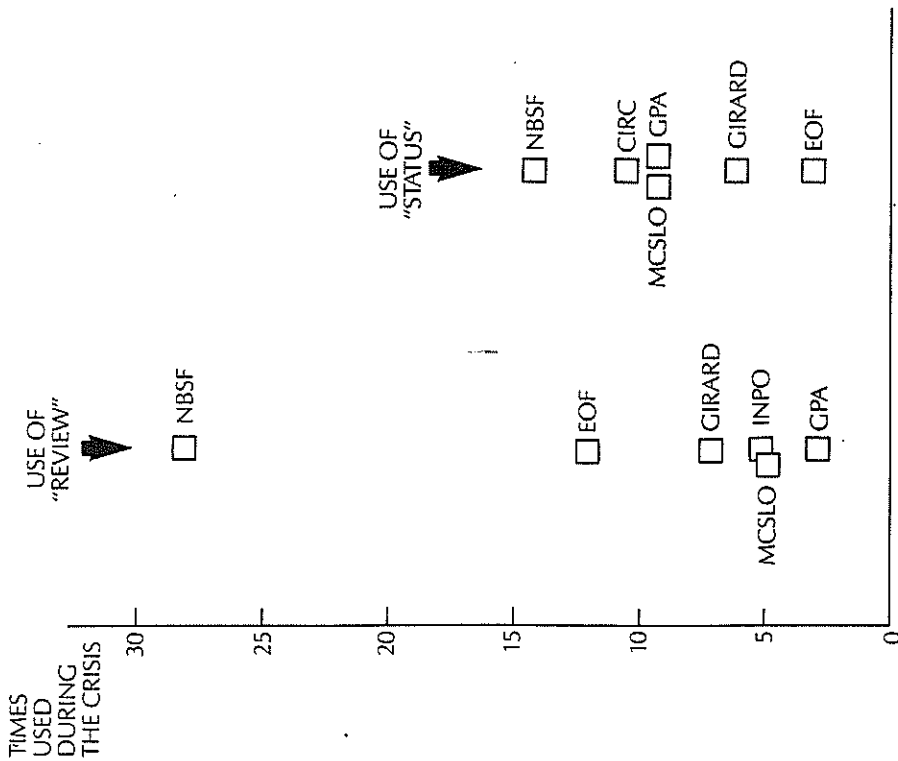
[13] EOF (PG&E)
This is a drill!!! GSP

THE STATE OFFICE OF EMERGENCY SERVICES HAS REQUESTED ASSISTANCE FROM THE FEDERAL DEPARTMENT OF ENERGY FOR RADIOLOGICAL ASSESSMENT OF AIRBORNE RELEASES, IN RESPONSE. THE DEPARTMENT OF ENERGY ACTIVATED ITS ATMOSPHERIC RELEASE ADVISORY CAPABILITY (A.R.A.C.) COMPUTERIZED DOSE ASSESSMENT SYSTEM AND DISPATCHED A HELICOPTER WITH RADIATION MONITORING INSTRUMENTS FROM ITS LAS VEGAS FACILITY. THE ESTIMATED TIME OF ARRIVAL OF THE HELICOPTER IS 1:00 PM. this is a drill!!! THE FOLLOWING IS THE LATEST PRESS RELEASE FROM THE COUNTY. GSP

Now Joining: INPO (Drill)

FIGURE 59 TYPICAL NOTEPAD TRANSCRIPT DURING PG&E DRILL.

Another facet of using NOTEPAD was the level of quantification that could be achieved in analysing some of the activities, "which in turn opens the door to a rich avenue of future R&D for the classification and management of crises." For example, Dr. Vallee informed the forum listeners, it is possible to "rank the participants according to their use of specific system commands, such as STATUS, showing who is up-to-date on message traffic, and REVIEW, retrieval of past messages." This type of analysis is depicted in Figure 60, with the statistics providing "a measure of the effectiveness of the system training" and a better understanding of "the information needs at specific points in the network."



NOTEPAD ANALYSIS: FREQUENCY OF USE OF SYSTEM COMMANDS (PARTICIPANTS ARE IDENTIFIED BY THEIR INITIALS)

FIGURE 60

As indicated, the participants felt a "high need" for retrieval of earlier statements, for example, "what exactly did the company say about evacuation plans this morning?" Dr. Vallee indicated that this exercise, to the best of his knowledge, "represents the first time that computer conferencing was used for public information response in connection with a simulated industrial crisis, which included actual evacuation of some areas."

Here, the speaker chose to stress that this capability provides a "powerful, adaptable framework," but "demands adequate training and careful, professional facilitation." Improvisation, and "relying on the computer to sort out relevant information from trivia in the heat of an actual emergency" are *not* acceptable *modus operandi*. Dr. Vallee called out these areas for careful consideration:

- The appropriate structure to be used during a crisis is a matter of careful selection and varies with the nature of the organizations involved; and

- The long-term impact of conferencing techniques of management styles and on informal networks is unknown. Concern over the lack of knowledge about these salient topics has caused INFOMEDIA to pursue its "aggressive program of research into the human factors of emergency management." To that end, a proposal has been submitted to INPO for:

The development of a class of simulations that will fill the gap between simple drills like the PG&E exercise, which involved information dissemination but no problem solving, and the intense, chaotic group dynamics revealed by the U.S. Government's retrospective analysis of the Three Mile Island episode.

Observing that managers often treat simulation as a "game," Dr. Vallee reported that his group's observation reveals that "participation in a carefully constructed crisis simulation is a genuine revelation to the members of the group," and that they gain "new personal insight into the decision process." In training INFOMEDIA personnel, simulation exercises are designed "to place participants into conditions of psychological stress and information overload."

One such simulation, called CRISIS, creates a fictitious international conference and demands a high level of skill in negotiation and coalition behavior * * * developed by Dr. Garry Shirts as a management training exercise and has now been used over a dozen times by teams of our clients, often with participation from foreign countries and with multilingual exchanges.

A graphic depiction of "our technique of participation mapping in a crisis simulation conference," as shown by Dr. Vallee (see Figure 61),¹⁵² portrays each participant "in terms of his private and public message exchange, and the average length of his messages." Experience has shown that "participants moved from one area of the map to another as a function of their role in a conference."

¹⁵² Ibid.

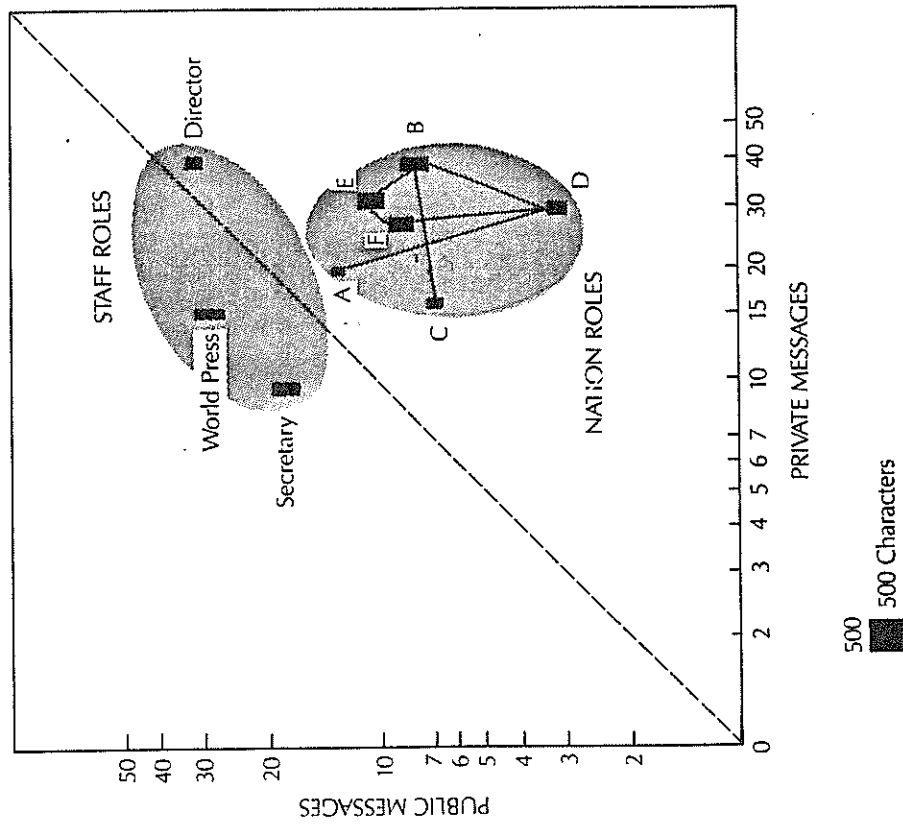
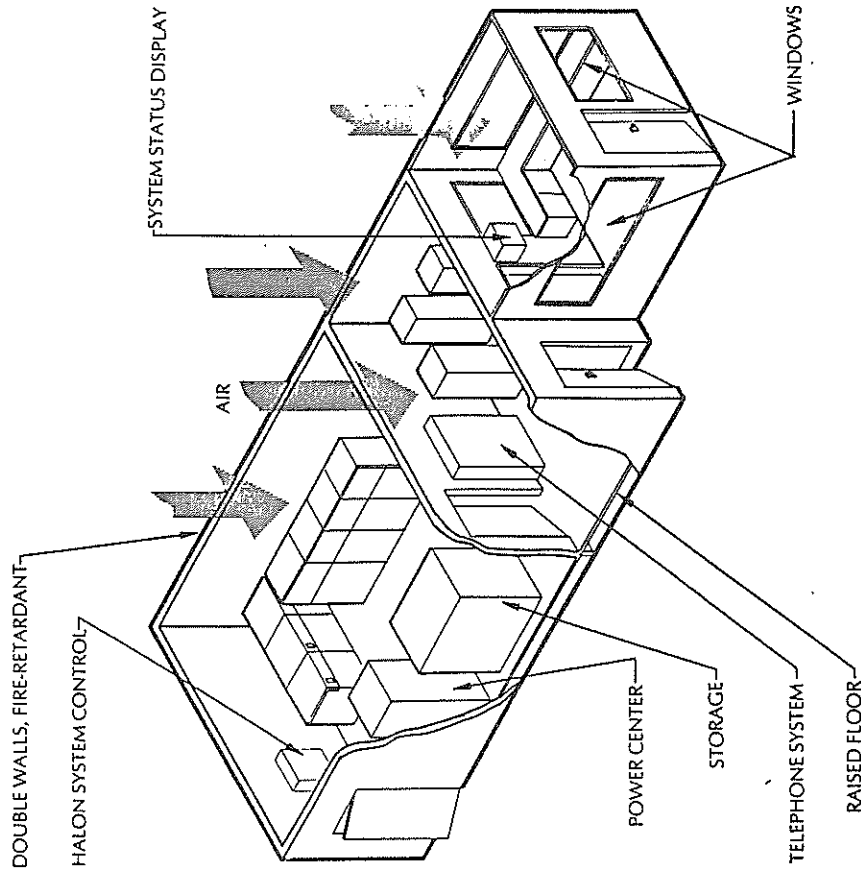


Figure 61 Participation Map for a typical crisis simulation conference.

FIGURE 61

Dr. Vallee underscored a point made by Dr. Robert Kupperman during the September hearings regarding "the importance of proper training and user support before an actual emergency." Also, he reminded the forum that "technology itself represents *only a tool* * * * which can often be misused if applied to the wrong task."

Arguing that greater attention should be paid to "the human factors of group communications in emergency situations," the speaker told of the careful attention which should go into designing crisis rooms. His company has constructed two "Decision Support Centers (DSC) which embody the knowledge we have derived from the technology of computer conferencing." Figures 62¹⁵³ and 63¹⁵⁴ provide a general overview and additional details of this DSC, which was designed "to enhance the quality of decisions made by the management of the organization." Dr. Vallee noted that oftentimes such decisions "are made at remote locations linked by the NOTEPAD system."



INFOMEDIA'S DECISION SUPPORT CENTER IN SAN BRUNO, CALIFORNIA

FIGURE 62

Four conditions were identified by the speaker "under which a face-to-face meeting in a specifically designed room" can be of particular importance:

(1) *Problem solving.*—Two or more individuals meet to examine documents or to review data in the context of a larger process of group interaction. The other participants are located at remote sites and use NOTEPAD to communicate * * * The process may involve modeling, planning, forecasting, or business decisionmaking.

(2) *Process Analysis and Integration.*—A complex operation in progress at a remote site requires continuous management attention and careful recording of the key actions taken. Various models may be involved, and several points of view need to be integrated through NOTEPAD. Examples of this situation include engineering management, and some negotiations meetings.

(3) *Information Control.*—A group assembled in the situation room is seeking to gather information from remote resources. This may involve synchronous conferencing displayed on large monitors and telephone interaction with the participants. This process will * * * poll group members and aggregate their judgment in graphic form.

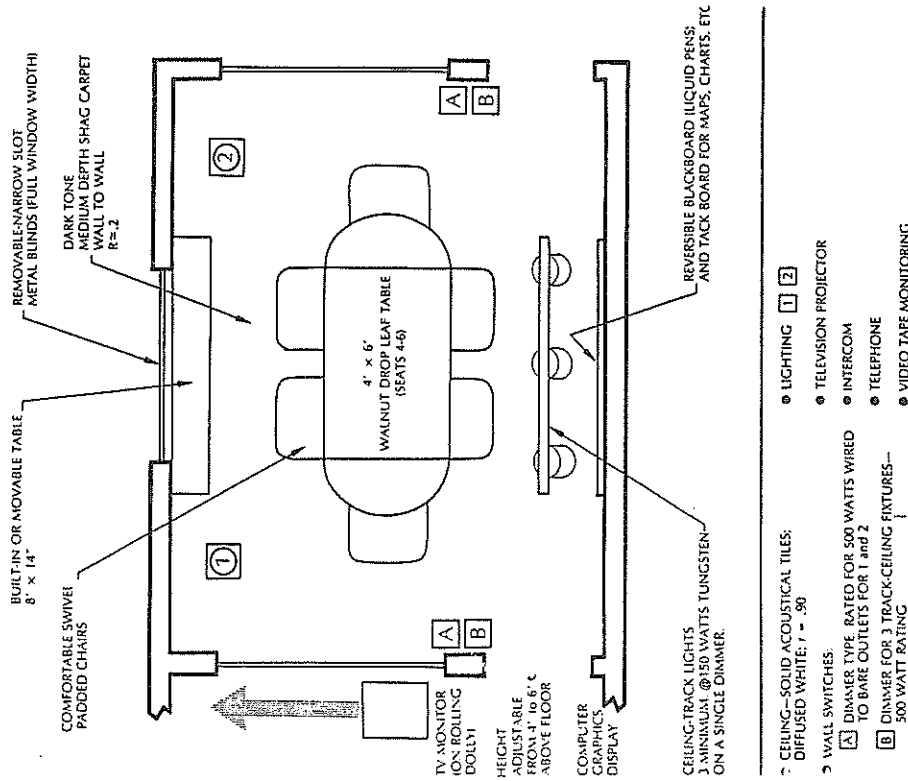
(4) *Crisis Management.*—In an emergency a large, complex process loaded with emotional issues may have to be controlled from a single point. Accordingly, the situation room of the DSC must be easily convertible into a crisis center where every essential information element can be centralized in a form which is easily understandable in its context, magnitude, and relevance to the emergency at hand.

To optimize such interactions, Dr. Vallee said, special attention has been given to the design and placement of telephone circuits, walls, carpets, air conditioners, lighting, and furniture. Conversions of such a room for videoconferencing would "simply involve placement of additional monitors and controls. The cameras may be located in the adjacent room and shot through glass partitions."

In conclusion, this speaker encapsulated the theme which he had referred to throughout his presentation:

Our ability to install computers and build communications channels far exceeds our understanding of decision-making behavior under stress conditions. Our knowledge of programming and engineering outweighs our grasp of the human and organizational factors that foster creativity. It is a fact of life that, by their very nature, good information systems tend to attract crises.

Having ended his previously prepared material, Dr. Vallee shared some pertinent background material on INFOMEDIA endeavors with his colleagues at the forum. Included were mentions of work done on ARPANET (1971-1972) which was supported by DARPA and NSF; the latter funded effort led to the observation that "this is the kind of technology that could be used by people other than experts."



DESIGN FOR A SMALL SITUATION ROOM

FIGURE 63

At the end of the research, which took about four years, we had a community of approximately 500 users then using a system [called] PLAN/NET, which was running on the TYMNET system, a commercial version of the type of packet switching network Colonel Adams described this morning.

The current NOTEPAD operation is "more than emergency management," he continued. The nearly 1,300 system users, in both the private and public sectors, utilize two applications: "project management and linking together communities." After describing the types of commands that may be employed in using the system, as well as mentioning the electronic mail and record review activities, he told of work performed for the Bechtel Corporation, including an early project involving a gold mining plant sited 75 miles north of Ely, Nevada:

Only one telephone on site and 300 contractor personnel trying to use that same telephone. It took two days for the mail to go from Bechtel headquarters to the site, including engineering drawings critical to the development of the gold mining operation.

With the installation of two NOTEPAD terminals, the ability to run the project was greatly expanded, and it was completed ten days early.

On one occasion at least they averted a crisis by having access to the system to stop the pouring of concrete at the wrong place * * * new drawings had not arrived at the site.

Shifting from program management to "linking together a community of people interested in nuclear safety," Dr. Vallee told of service support provided INPO, through linking together some 70 utility companies in the U.S. and seven foreign utilities, identified earlier. The emphasis there is more on "crisis avoidance" through daily conferences which report on "incidents, abnormal conditions, [and] conditions relevant to the maintenance and upgrading of nuclear facilities." Each utility has a designated "NOTEPAD specialist whose role it is to go into the system."

You have to log in every day and find out what new information is available and then decide whether that information is relevant to that particular company.

An initiative is now underway within INFOMEDIA to look with INPO at "the possibility of using NOTEPAD in an emergency situation, a crisis." Dr. Vallee explained further:

They have anticipated the use of the system in that fashion by creating a structure in which the nuclear planning information is broken into plant status, requests for emergency support, press releases, radiological information, and corrective actions. Those go to different people. So they have created a list of who in each company is on that list for each conference.

The information is submitted into Nuclear NOTEPAD. It is broken into a hotline for real or simulated emergencies, emergency planner information exchange, radiological protection, and operating plant experience * * * it does not replace other systems * * * It is used to augment * * * to create an audit trail of all information accumulated about the particular technology.

An example of this, he continued, would be the failure of a Westinghouse valve at a particular plant; by using the system it would be possible to "go back into the record of the last year" to check other such failures and responsive action taken.

It is a case, essentially, of knowing "there is somebody somewhere who knows what to do about the situation, but you don't know who it is."

There was a case where the utility in Arkansas had an accident, in fact contamination in one of the buildings, and described the problem in NOTEPAD and within eight hours had four different technical answers on how to manage the particular emergency from various experts in various parts of the country who had had experience with that particular technology.

Dr. Vallee also told of the search, at the time of the Three Mile Island episode, for "people who had done calculations about the size of the hydrogen bubble." One such person, reached in the early morning hours, had notes on this problem, but they were in his office. It would not be difficult to imagine the value of linking such key individuals together "in a way conducive to managing that kind of emergency," the speaker declared.

After talking further about the Diablo Canyon exercise and offering additional details about NOTEPAD utilization—all-hours access, usage monitoring, simultaneous user participation, command alternatives—Dr. Vallee focussed on the nature and value of simulations, and returned again to his company's adaptation of CRISIS, developed at the Western Behavioral Sciences Institute. The decisionmaking process was then commented upon at some length:

All of our equipment, software, tends to be organized around rational decisions. Crises, by their very nature, are *irrational* processes. People who are good at managing crises tend to be people who have gotten very, very good at making decisions in almost the total absence of information, making gut decisions based on who they could trust and couldn't trust. A game like this brings it out, and also brings it out in writing.

This process, covered earlier in his formal presentation, was than expanded upon by Dr. Vallee. Finally, he offered iterative information about the decision centers developed by his firm and the emphasis placed on the functioning of the human beings in such environments, for "we know much more about how to deploy the technology, both hardware and software, than we know about the human factors of that kind of communication."

Following a demonstration of the quick NOTEPAD file retrieval capability which in this instance showed NRC access to the hotline, Mr. Heyman—who had participated in a recent panel at a convention of Associated General Contractors of America where Bechtel was represented—asked the question:

Is not the system that you have designed a way for the private sector to avail itself of pockets of information and expertise on the subject of risk assessment, through libraries and other academic institutions?

In response, Dr. Vallee indicated that the system does contain "provision for doing Delphi-type forecasts * * * [and] could be used not only to link experts together for risk assessment, but also for estimating reserves, forecasting budgets." Mr. Heyman said that it was his perception that the private sector is "light-years behind on the issue of making experts available through technology on these kinds of subjects." Dr. Vallee then emphasized his belief that:

The first step is to make the technology available in a very casual, everyday environment, and when people are used to the technology for sending messages around, then they become aware of the capabilities for more sophisticated tools.

Mr. Chartrand shared with the discussants the experience of those on the Advisory Committee for the 1979 White House Conference on Library and Information Services. Each person was given a Texas Instruments' portable terminal for purposes of teleconferencing, including the exchange of factual information and personal commentary regarding the plans for this milestone event. There was considerable variance in the nature and extent of usage, with some individuals generating large volumes of material and others far less.

Shifting to another area, Dr. Belden said he understood that NOTEPAD could operate in conjunction with an audio facility, to which Dr. Vallee replied that "the audio conferencing system we use is a commercial system from Bell, and * * * the only times when we have used it was to link this room with one other room."

We never used it in the true conference where there were many other sites. We found that there were cases where it was necessary to have much faster types of interaction than the computer system itself permits from group to group.

There was also some information that wasn't valuable enough to be retained on the record. Also, there were situations where, for training purposes * * *, you need both an audio channel and a computer channel.

"We found it was synergistic," Dr. Belden observed, if used "in conjunction with a real-time data system. And we used it with the display conferencing system." This provided "all the elements that people normally used in any conference." Indeed, he concluded, had this conference (forum) been conducted from remote locations, "we don't need to see each other's faces, but everything else we have done."

Before turning over the program to the final speaker of the day, the moderator asked the attendees to consider "whether or not there are specific recommendations that you might care to tender to us" for use by the Gore Subcommittee. Also, Mr. Chartrand called the participants' attention to copies available in the room of the *HaZard Newsletter*, "which does contain the first coverage of the hearings that was written by Jim Morentz," and the presence of a representative from the National Computer Graphics Association, which produces an "excellent newsletter" dealing with "developments in the world of computer graphics."

In commencing his talk, Dr. Frederick Hayes-Roth, formerly with the RAND Corporation and now with Teknowledge, asked his listeners to return to the year 1956 with him. It was then, he said, that "artificial intelligence was essentially born," and a major national conference was convened "which pulled together people who had discovered that computers could help address symbolic reasoning problems."

It was a very heady period. People thought that certainly by 1981 most of the world's most challenging problems would be solved by computers * * *. And that really hasn't happened.

In that same time frame, he noted, the military was installing computer information processing systems, many of which "to the chagrin and horror of everybody involved" are still in service. The lesson to take away from all of that deals with "whether the technology that you have seen today is really the answer to the problem that you want to put in place for the next decade or two."

Earthquake management was an area in which Dr. Hayes-Roth was most interested he said, "because I thought that it would be "the greatest economic disaster to strike this country since the Civil War." He reported going to:

The 10th anniversary of the last big Southern California quake where the command and control game was being played through, by which the authorities attempt to train their people with procedures for dealing with such an earthquake.

The National Security Council has predicted, "based on good geological evidence, that there will be an earthquake greater than magnitude 8, with probability about .75 in the next 30 years." As a result of observing the exercise, Dr. Hayes-Roth was "horrified by the lack of preparedness."

So I began to ask myself, well, if it is going to take a while to try and put together a technical solution to this kind of problem, what would the shape of that technical solution be like?

Would it stand the test of time and would it be worth the investment? So I come to you today as * * * a high priest of technology * * * with the point of view that * * * it is absolutely necessary.

Dr. Hayes-Roth next articulated his strong belief that the United States "cannot afford to try and get by without preparing technical-

ly for certain impending disasters, and that we do not have the technology base on which to put together a solution." He went on to say that "everything we have heard about today may be a piece of the solution." At this juncture, the speaker began employing his visual aids, the first of which (see Figure 64) set forth six cardinal "ideas" which merit serious attention.

THE IDEAS

1. Effective crisis decisionmaking takes knowledge and skill
2. Pre-planning can't solve the problem
3. Real-time replanning doesn't work
4. Replanning can be done efficiently by recycling/revising old plans
5. Knowledge engineering is the key technology
6. An intelligent system for emergency management should be developed

FIGURE 64

His comments regarding "preplanning" included the "rule of thumb that crises happen in ways you don't expect and most of the problems are surprising to you in one way or another." And as concerns "replanning," Dr. Hayes-Roth stressed that "it does make sense" to look at crisis management tasks as "tasks that require modifying old plans, by recycling them." To do this, however, may mean that "you have to store more than what is currently meant by a plan." Most plans contain a "list of responsibilities or actions that agencies are supposed to take * * * they don't provide much of a basis for helping you rethink the situation that you may find yourself in."

There are many technologies that will be required before we put together a system that is as successful as any one of these * * * I happen to think that the applied part of artificial intelligence, called *knowledge engineering*, is the key technology, because it * * * emphasizes knowledge [that is] storable and exploitable.

Next, the speaker outlined the major points that he would cover during the remainder of his presentation. He explained that he wanted to describe a geographically distributed system "that knits together different organizations that are required to solve the problems that come up in emergency management." Furthermore, it must be capable of fulfilling "both training and integration roles." An information system must exist which "ties the organizations together." Simulations will be used for training key personnel. "A repository of knowledge" must be established, including "decisions, constraints, strategies, tactics, procedures that help people." To achieve the system capability needed, it will be necessary to "network powerful computers, not micros, and use advanced communication technology." Dr. Hayes-Roth expressed his belief that "this is a national technical opportunity of great importance" and represents "the right problem as a follow-on to things that have previously galvanized our national technical assets."

Recalling that Inspector Littlejohn had told of emergencies where many organizations were involved, Dr. Hayes-Roth said that in the case of a Northern California earthquake, "it might be 50." And, he declared, "these organizations each need to have a comparable set of capabilities." In his schematic diagram, the speaker showed a "distributed gaming/control system" and he dealt with its components through a scenario of "preparing for dealing with the danger of a dam breaking as part of an earthquake simulation." (See Figure 65)