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Summary Report On

Emergency Operations Research

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INTRODUCTION

This summary report describes the documentation, scope of work activities, and the principal conclusions and recommendations of the research performed under contract OCD-PS-65-71, Emergency Operations Simulation Research. The applied research was conducted over a 12-month period commencing in May 1965.

PROJECT DOCUMENTATION

In addition to this summary volume, three final report volumes have been issued, which document in detail the contract work activities. The contents of each of these three are briefly summarized in this volume. The documents are:

Technical Memorandum 2938/001 - Final Report on Emergency Operations Simulation Research - This report documents those aspects of the research that were primarily laboratory oriented.

Technical Memorandum 2938/002 - Data Processing for Local Civil Defense: An Investigation of the Potentials - This report presents to OCD the necessary considerations that must be met before a local director decides to utilize data-processing equipment for local civil defense.

Technical Memorandum 2938/003 - Fire Data from the Watts Riot: Results of Preliminary Analysis and Evaluation - This report documents the results of a preliminary analysis and evaluation of data from the Watts Riot provided by the U. S. Department of Agriculture, U. S. Forest Service.

SCOPE OF WORK ACTIVITIES

The principal efforts of the research are summarized, each task in a separate section, on the following pages. The initial efforts were directed toward establishing the Emergency Operations Research Center, and in developing a prototypical environment of an urban area that would become the model base for the research experiments. These efforts are described in detail in TM 2938/001 and since they are support oriented, are not summarized herein.

Task I: The conduct of experimental studies directed toward the determination of information requirements for decision making by local executives. (Detailed in TM 2938/001.)

Two experiments were performed in the SDC Emergency Operations Research Center during the contract: the first involved a movement-to-shelter time period, the second an in-shelter period. The purposes of the experiments were:

1) To establish the information requirements for City Executive Staff decision-making during emergency operations.

2) To establish a display set to provide this information.

3) To establish a laboratory facility readied both for future experimentation and for use as an operational test-bed for equipment proposed for emergency actions.

These experiments were directed to the Chief Executive Level of city government for the following reasons:

1) Overall system performance is directly relatable to the performance of the final authority level within that system.

2) At this level, policy for emergency action is formulated, modified and implemented.

3) To this level, the most complex and important problems are routed for decision.

4) At this level, interaction with lateral and higher government echelons occurs.

In order to make timely and accurate decisions, the Chief Executive Staff must be provided with information that is specifically tailored to their requirements. The most straightforward way of investigating what these information requirements are is via display experimentation. To this end, three classes of display systems were tested:

1) Emergency Actions displays. In this system, each department informed the City Executives of the problems it faced as well as the actions it was taking.

2) Exception displays. In this system, the departments informed the Executive Staff only of conditions that deviated from a planned standard.

3) No pre-planned displays. This system was used as a base-line standard.

The Executive Staffs (consisting of city manager, assistant city manager and the civil defense director) of three city governments were simultaneously run in each experiment. Each group was rotated through the three display conditions, with the rotation progression counterbalanced to control learning. During each run, all three groups received identical problem inputs, and all groups were briefed and trained together. This procedure ensured that differences in performance are directly relatable to differences in display conditions.

Major conclusions from these experiments were:

- None of the display classes proved very beneficial. However, when both quality and speed of decision are considered, the Exception displays showed the best performance.

- Extraneous or too-detailed information materially reduced the quality and speed of decisions.

- Radiation information was frequently ignored, thereby subjecting personnel, on trivial missions, to dangerous doses. This occurred despite frequent questioning by the simulators.

- Public information announcements on EBS were generally poor in quality and often badly timed.

- Much greater importance was attached to telephone inputs than to written inputs. No telephone inputs were ignored, but over 20 percent of the written inputs received no response.

- Delays in response to written inputs were over four times as long as delays to telephone inputs.

- Less credence is placed on displayed information than on either telephone or written inputs. Frequently, information readily available on displays was ignored in favor of telephone or written inquiries.

- Important problems were readily identified and given priority attention, regardless of the display condition or form of input. However, even unimportant telephone inputs received faster attention than important written messages.

It should be pointed out that many of these shortcomings could readily be overcome by training, but at the same time it should be remembered that in the event of a national emergency within the near future, the level of training of these participants would be typical.

Specific recommendations made as a result of the experiments and their subsequent analyses are as follows:

- Experimental simulation is a definitive method for studying information requirements at the executive level of local government. Studies should be continued at this level on other information dimensions, and should be initiated at the staff and line department levels.

. Similar experimental simulation studies could profitably be undertaken for national, regional and state levels of government, preferably in the near future so that obtained results which indicate reporting needs from local government can be implemented without upsetting the local system.

. Information dimensions of the executive level of local government that deserve priority study by experimental simulation are:

a. Tempering decisions in terms of radiation and other hazards.

b. Improving the quality and timing of emergency broadcast information.

c. Improving the match of resource allocation to emergency need.

d. Establishing the desirability of colocation of executive Staff and Department heads.

. The displays proposed in the Draft Federal Civil Defense Guide, Part E, Chapter 2 (essentially the Emergency Actions Display set of the present experiment) should not be used for local government city executives, and should be further investigated for applicability for staff and line department use within the EOC.

. Verbal communications should be provided the executive staff. However, incoming calls should be controlled to prevent unimportant verbal messages from precluding consideration of important written communications.

. Participants in experimental simulations should continue to be professional employees, rather than relying on role-playing by participants who are not actively engaged in government.

. The procedure guides developed for these experiments should be field tested for application to local government needs.

. The exception display set, incorporating the improvements presented, should be used for future executive level studies.

These experiments have served the purpose of readying the laboratory for future work, as well as indicating the level of detail and format requirements for the Chief Executives of local city government. The advantages of the Exception display set were not very pronounced. However, this set will admirably serve as a comparison standard for future work, thus eliminating the need to perform similar research again.

Task II: The investigation of the potential application of electronic data processing within Emergency Operating Centers. (Detailed in TM 2938/002)

This report was prepared for the Office of Civil Defense to assist them in providing a guide for the local civil defense director to help him determine whether to conduct a feasibility study regarding the use of electronic data-processing equipment for civil defense functions within his jurisdiction.

Initially, this report presents the civil defense director with the system considerations required to determine the time period(s)—pre-emergency, emergency, and recovery—during which his electronic data-processing equipment should be used. Those considerations related to an extreme emergency time period are:

- Full-time availability of the computer for civil defense purposes.
- Adequate, reliable and stable alternate power source for the computer system.
- Skilled personnel to operate the computer system.
- Total system (equipment and personnel) protection and essentials for survival to assure operational capability.
- Survivable communications between components of the information system.

Secondly, questions are posed about these system considerations, with the answers determining the range of potential application available to the local civil defense director. These potential applications, organized by time period, are grouped under sub-headings for ease of consideration.

Thirdly, the constraints and considerations of the non-computer information-handling equipment of a model computer information system are discussed according to the five phases of an information system; namely, input, output, storage, processing, and communications. A subphase, inquiry, is also presented because it involves a combination of both input and output at a single remote location.

Fourthly, the civil defense director is guided to consider the factors that determine the capability of his organization to manage and operate a computer-based data-processing system. Some factors are related to the analysis and application of the system data. Specifically they are: identifying specific items of data, organizing the data into a meaningful form, and evaluating the size and the cost of the data maintenance activities. Other factors are related to the computer programming, or to providing the computer with the detailed instructions on how to process the data. Those factors that contribute to the cost of the programming effort are:

- The complexity of the data-processing functions.
- The number, types, and frequency of inputs and outputs to the computer.
- The extent of the system constraints on the computer program design.
- The extent of innovation required in the computer program system.
- The extent to which programming "tools" are available and usable.
- The efficiency of the programming language as well as of the compiler or assembler.
- The extent to which data for the data base is available.
- The number of entries (total size) for the data base, the number of different types of data needed for it, and the extent to which each can serve many computer programs or subprograms.
- The degree to which the computer program design characteristics—maintainability, changeability, usability, and flexibility—should be recognized and incorporated.

Lastly, the course of action for the local civil defense director to follow in order to undertake further studies toward integrating civil defense functions into local government data-processing operations are indicated, dependent upon answers to the constraints and considerations posed.

Task III: An Analysis of fire data pertaining to the Watts Riot in Los Angeles in August, 1965. (Detailed in TM 2938/003)

Work was begun on this study on 15 February 1966, and consisted of examining and making a preliminary analysis of the Watts Riot fire data gathered by the U. S. Department of Agriculture, U. S. Forest Service. This preliminary analysis and evaluation was made relative to fire spread and fire service operations. Emphasis was placed on identifying those aspects of fire spread and fire service operations that might occur in an environment analogous to that created by nuclear fallout. An estimate was made of the impact of data and findings on future Emergency Operating Center (EOC) research.

The following recommendations are given in light of the findings:

Fire Spread

In light of the findings of this preliminary analysis and evaluation, the following recommendations are offered regarding fire spread:

1. The data have potential value for specific studies of fire spread (e.g., studies of logistical requirements) where rigorous quantitative or qualitative definition is not required. It is recommended that they be considered for use in these types of studies.

2. The fire-spread data have potential value for studies of disasters in general (e.g., identification of factors that appear frequently in disasters). It is recommended that they be considered for use in studies of this kind.

3. A major study involving a comprehensive and detailed fire-spread analysis of the Watts Riot data (as provided) is not recommended for reasons set forth in the findings:

a. The data hold limited promise of yielding more than rather gross information; and

b. It is unlikely that sufficient uniqueness existed in the Watts fire spread.

Fire Service Operations

The following recommendations regarding fire service operations are presented based upon the findings of this study:

1. The data substantiate the need for continuing study of fire service command-and-control and information-processing rationale and procedures. These investigations should include both upward (i.e., EOC) and downward (i.e., field units) command-and-control considerations. It is recommended that future research work in fire protection be responsive to these needs. Specific topics for investigation might include, for example:

a. Feasibility of computerizing those command-and-control functions (e.g., computer-assisted dispatching of fire companies) susceptible to computerization.

b. Sensing and reporting of emergencies.

c. Display of data.

d. Filtering of irrelevant information.

e. Delegation of routine decisions to computers.

f. Provision of appropriate action mechanisms for command personnel.

g. Recording of significant fire operations events on a real-time basis.

2. The fire service operations data have potential value for studies of disasters in general. It is recommended that they be considered for use in studies of this kind.

3. An EOC structured to handle major emergencies (both man-made and natural) would have facilitated overall coordination and implementation of operations during the Watts Riot. It is recommended that future EOC research efforts take into consideration the operational findings cited in this study.

4. Examination of the data reveals that fire personnel in the Watts Riot often were handicapped in not having adequate law-and-order protection during the performance of their fire suppression functions, particularly in the early stages of the Riot. It is recommended that this problem be considered as a topic for future study.

5. A major study entailing a comprehensive and detailed analysis of the fire service operations data (as provided) is not recommended because it is doubtful that the anticipated gains would justify a major expenditure for this effort. Furthermore, the question remains as to the degree of correspondence between such operations during the Watts Riot and expected fire operations in a nuclear environment.

Task IV: The investigation of various types of input, display and simulation equipment, including their uses within an Emergency Operating Center. (Detailed in TM 2938/001)

Principal equipments utilized in the experimental EOC are described in considerable detail in the above report document. These equipments are:

1) An internal telephone system.

2) An Emergency Broadcast System with internal playback capability.

3) Special data recording and monitoring equipment.

A brief investigation was made of the feasibility of using rear screen projection of multi-colored, merged data displays. A method of annotating projected map displays through the use of transluscent, erasable colored pens was developed. The technique was determined to be practical from the standpoint of visibility, speed of update, and ability to bring together on a single display surface the necessary data elements for a command post display. The technique has not yet been evaluated from an operational use aspect.

Task V: The evaluation of operations simulation as an applied research technique. (Detailed in TM 2938/001)

Using simulation as a vehicle for research has several advantages compared with obtaining results from an analytical process. This follows because results obtained analytically are often not credible until they have been tested in the context of an applicable environment. Results obtained from

research conducted under a controlled, simulated emergency environment are more readily acceptable by operations personnel and have a greater probability of being operationally sound.

The use of operations simulation as a research tool allows several operational questions to be answered that would be unanswerable if any other research method were used. No other technique allows the collection of quantifiable operational data under a controlled level of stress. The number of times certain events occurred, and the time delays and movement patterns of personnel are examples of data that can be collected accurately only during emergency operations or during properly conducted simulated emergency operations. Simulation also provides the only adequate method of checking out new operational concepts and procedures prior to their field implementation.

Following are some distinct advantages of using operations simulation as a research technique:

1) Quantitative measurements of system operations are often more easily taken on a system simulated than on the system in actual operation.

2) In simulation, there is the ability to compress or expand real time.

3) There is a more precise control of the variables in a simulation experiment, thus permitting more accurate analysis of results.

4) In simulation, there is the ability to replicate experiments under different conditions.

5) Laboratory simulation offers the capability to study systems that have complex operations and interactions and that are not normally available or accessible for observation.

6) In simulation, the control of events can be absolutely adhered to. An identical sequence of events can be prepared and run for each change of the variables that are under investigation. Also, changes within the model may also be easily introduced to study effect upon responses.

7) Simulation offers the ability to experiment, test, and evaluate new systems or proposed changes to existing systems in advance of having to make firm commitments about the development, production and implementation of these systems.

Please refer to the basic report documents for an elaboration of the above task descriptions.

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