MEMIS: MULTIMEDIA EMERGENCY MANAGEMENT INFORMATION SYSTEM

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ABSTRACT

As a result of the rapid growth of information and communications technologies, it is expected that more than eighty percent of the management information systems (MISs) in use by the year 2000 will be developed to support the managers themselves [Steger and Bannister, 1992]. These MISs will be built within commercial software development environments, such as spreadsheet and database programs, geographic information systems, expert system shells, visual interactive simulation packages, and hyper- and multimedia authoring tools. The MISs will range from simple spreadsheet programs to complex multimedia spatial decision support systems.

There is no doubt that this development will also affect the emergency management community. In this paper we present a prototype MIS designed for emergency managers: MEMIS (multimedia emergency management information system). The purpose is to show the technological possibilities and ease of development, and the tasks that can be supported by such systems. MEMIS is based on the latest technology for the development of MISs: multimedia, animation, voice and video communication, LAN and WAN, and machine intelligence. MEMIS covers the three most important tasks of an emergency manager: (i) emergency planning (facility management, site selection for hazardous activities, designation of hazardous material shipment routes), (ii) emergency response (notification, monitoring, and response management), and (iii) the daily management work (communications by phone, fax, and e-mail; database and spreadsheet management). MEMIS communicates with (and can control) standard software packages and databases used in the emergency management community, such as CAMEO. Its open architecture makes it easy to incorporate features designed to meet the unique needs of a specified region or nation.

1. INTRODUCTION

Technological advances in communications, information, and computing technologies are revolutionizing the daily work of managers. The Internet system will cover in a few years the whole world, with hundreds of thousands of service providers and millions of users [Borsook, 1994]. All types of digitized code can be transferred via high-speed digital networks in asynchronous transfer mode (ATM).

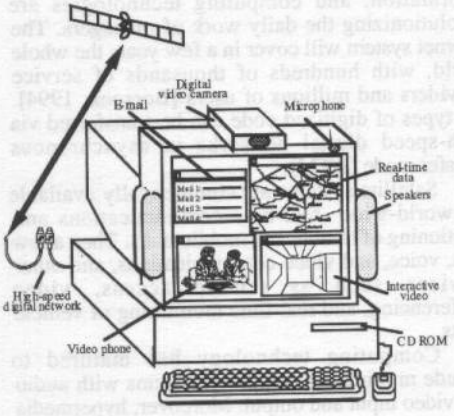
Satellite systems are commercially available for world-wide real-time communications and positioning of remote and mobile units. They allow data, voice, and video communications, and other services such as remote access, video conferencing, and real-time monitoring of vehicle fleets.

Computing technology has matured to include multimedia computer systems with audio and video input and output. Moreover, hypermedia and virtual reality are being considered to support decision making in emergency management [Beroggi et al., forthcoming 1995].

The combination of advanced communications, information, and computing technologies results in a desk-top multimedia computing system as illustrated in Figure 1. In a multi-finder system , such as provided by X-Windows under UNIX or the Macintosh

computers, multiple applications can run simultaneously. Text e-mail runs next to real-time data acquisition (e.g., for a real-time vehicle tracking system), and video phone (e.g. for a video conference and monitoring) runs next to interactive video (e.g. for a virtual reality application).

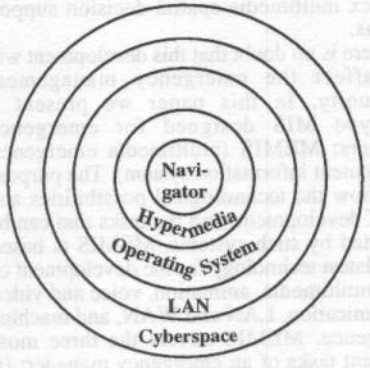
Systems for emergency management using some of these novel technologies have already been developed. An example is CAMEO, a PC-based multimedia emergency management software system for chemical production sites and transportation of hazardous materials [CAMEO, 1993]. Due to its of its user-friendliness it is implemented all over the world. Another example is InterClair, also a PC-based decision-support system, developed by the United Nations Interagency Program [InterClair, 1992]. It assists the practice of environmental modelling for risk assessment and management at basically all three management levels. It has been developed using the latest concepts, such as virtual instruments, animation, hypertext, and knowledge-based systems.



2. THE MEMIS ARCHITECTURE

MEMIS is built in a hypermedia environment in HyperCard on a Macintosh computer. The hypermedia environment is based on the concept of object oriented programming. Objects at lower levels inherit the characteristics of objects at higher levels. An object has the characteristics (attributes; e.g., the size of a card or the shape of a button), and it can perform activities. These activities can be as simple as activating an audio or video message, or as complex as performing an algorithmic procedure that has been coded, e.g., in Pascal.

MEMIS is built on a shell principle (see figure below). At the heart of the system is the navigator which controls the system's activities and communicates between the user (emergency manager) and the other levels. The first level, after the navigator, is the hypermedia environment. It has a prestructured architecture which supports the navigator. Codes written in the hypermedia scripting language can be compiled in memory. The code is attached to an object and it can easily be altered. This is especially useful during the development phase. Moreover, the designer of the system can define different user-levels which allow more in-depth access to the code. Thus, experienced users could have access to a lower user-level, while novice users would just have access to the higher levels. Moreover, code can be complied, or written in Pascal or C and attached as external commands. Finally, stand-alone applications can also be generated which make the system independent from the development environment.

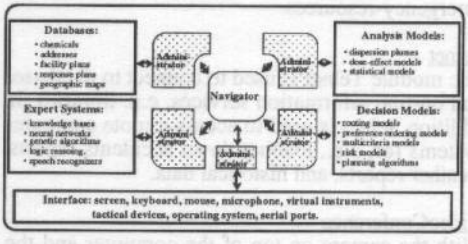


The third level is the operating system. Activities at this level are fired with an event handler, similar to the message handler in the hypermedia environment. This handler can start other application, e.g. a word processor, and also control them to a certain extend. In other words,

the navigator can also communicate to other frequently used applications (given that they are scriptable), such as word processors, spreadsheet programs, databases, drawing programs, etc.

The fourth level, the local area network (LAN), is basically identical to the previous level. However, it is required that the other work stations allow the navigator of MEMIS to access their file system and their applications. The major advantage of operating MEMIS on a LAN system is that applications and files can be shared among different users.

The last level is cyberspace, the world-wide information and communications network (Internet), based on phone lines, fiber optics, and satellite communications system. MEMIS attached to the Internet allows e-mail, video conferencing, real-time monitoring, remote database access, remote application access, etc.



At the functional level, MEMIS consists of databases, models, application programs, and expert system technology. The core of the system is the navigator that communicates between the human user, i.e., the emergency manager, and the system's main modules. The communications interface between the navigator and the human user is based on different devices, including the computer screen, the keyboard, the computer mouse, microphones, virtual instruments, such as slide bars and radio buttons, and, in the near future, tactical devices, such as gloves. Communications between the navigator and the modules is supported by special administrators. An administrator activates the appropriate model or database, depending on what fits the task best. The four main components of MEMIS are databases, analysis models, decision models, and expert systems components. The figure above shows the functional concept of MEMIS.

3. THE MEMIS MODULES

MEMIS consists of 25 different modules that are accessed or operate at different levels in the shell structure. While some modules are completely integrated into the hypermedia system, other modules reach all the way into cyberspace. Some of the modules are based on the ones used in the CAMEO system. The modules are shown in the navigator (see figure below); a short description of the modules follows.

Memo

The Memo modules is a note pad modules where the emergency manager can place and retrieve notes. Coupled with the E-mail modules, ticklers can be sent to other users.

Agenda

The Agenda module is a calendar which notifies the user automatically appointments, meetings, etc. The notification time can be set, e.g., minutes, hours, or days before the meeting takes place. Together with the E-mail modules, agendas of remote users can be checked. Dates can be entered with notification and confirmation of the other user.

Addresses

The Addresses module contains the database of persons, institutions, emergency response teams, persons to be notified in cases of emergencies, etc. Together with the Phone, E-mail, and WWW modules, phone, fax, and e-mail lines and personal home pages can be accessed by double-clicking on the appropriate numbers. Together with the GIS module, the location of the addresses on the geographic map can be shown.

Phone

The Phone module manages phone and fax messages. Together with the modem on a portable phone, MEMIS can be used as portable system.

Help

The Help module assists the user in the use of MEMIS or in cases of system errors. It can include video and audio instructions, as well as text.

E-mail

The E-mail module is used to communicate to other users and to receive messages from list servers. Examples of list servers in emergency management are: CMTS-L (chemical management and tracking; listserv@cornell.edu), DISPATCH (police, fire, and EMS telecommunications majordomo@comeng.com), EMERG-L (emergency services; listserv@vm.marist.edu), FIRENET (listserv@life.anu.edu.au), HELPNET (network emergency response planning; listserv@vm1. nodak.edu), LEPC (hazardous materials emergency response; listproc@moose.uvm.edu), SAFETY (safety issues; listserv@uvmvm.uvm.edu). Moreover, governmental agencies run also list servers; such as the different EPA lists (e.g., EPA-Waste with all hazardous and solid waste documents; listserv@unixmail.rtpnc.epa.gov).

Usenet

UseNet News is a service that manages articles prepared by people at educational, commercial, and government institutions all around the world. The articles are grouped into news-groups that focus on specific issues. The articles can be read with an appropriate software by contacting a news server. Some of these NewsGroups relevant to emergency management are: alt.disasters.planning, alt.med.ems, misc.emerg-services, sci.med.ems, and uiuc.safety (environmental health and safety forum). In the future, these articles will include graphics (displaying data), photo-graphs, and video, showing simulated situations and real disasters.

WWW

World-wide-web (WWW) is a hypertext client-server-based cross-referencing tool initiated by CERN. It includes file transfer protocol (FTP) and gopher. Further information about WWW can be accessed through anonymous telnet or ftp at info.cern.ch. An interesting WWW site for emergency management is, e.g., Global EMS Archives (http://herbst7.his.ucsf.edu). More information about related WWW, gopher, and ftp sites for emergency management can be obtained through "ftp://hairball.ecst.edu/pub/ems/internet.emergency-resources.

Telnet

The module Telnet is used to connect to databases and on-line information services, e.g. libraries. In addition, telnet is used to access remote computer systems for, e.g., loading down accidents reports, weather reports, and historical data.

VideoConference

With the camera on top of the computer and the appropriate software (e.g., CU-SeeMe from Cornell University), video conferences and monitoring can be performed.

TextEdit

The module TextEdit connects to a common word processor.

TableEdit

The module TableEdit connects to a common spreadsheet program.

Calculator

The module Calculator connects to a calculator system.

GIS

The module GIS connects to a geographic information systems. This can be a commercial

system or a task specific system such as used in CAMEO. The internal system has also zooming capabilities but not all the functionalities of a commercial GIS. This module can be connected to other modules, e.g., Phone, Addresses, Alarm, Emergency, etc. In addition, this module will include global positioning systems for the control of mobile units.

Alarm
The module Alarm dispatches warnings to emergency units and to groups affected by an emergency. It can be coupled with an automatic dialing telecommunications system. An example of an automatic dialing systems is the QuickCall telephone notification system used in the U.S. It is capable of simultaneously and automatically dialing around 1,000 numbers in 15 minutes.

ResponsePlan
The module ResponsePlan contains pre-planned response activities and evacuation procedures. It can be accessed in cases of emergencies.

HazMatDatabases
The module HazMatDatabases contains data about the hazardous substances, such as physical state, level of concern, reportable quantity, etc.

DispersionModel
The module DispersionModel accesses dispersion models for the computation of diffusions. The models can be integrated at the hypermedia level or also at the cyberspace level.

Scenarios
The module Scenarios can be used to devise response strategies. Dispersion plumes in stationary or dynamic systems can be computed.

Weather
The module Weather provides data on storms, local and regional weather conditions, etc., The reports can be accessed by Gopher.

AccidentReports
The module AccidentReports is used to record and compile data on accidents for storage and reporting purposes.

AccidentStatistics
The module AccidentStatistics is a database with historical accidents, which can be purchased by professional accident statistics databases.

InstallationPlans
The module InstallationPlans contains the plans of installations. These includes floor plans, lay-outs of technological systems, and emergency escape routes. The plans are interconnected in a hypermedia system.

Inventory
The module Inventory is a database that supports the management of the facility. It tells what hazardous material is present and where it is stored.

Emergency
The module Emergency is used to manage the response to emergencies. It connects to different other modules, such as Inventory, ResponsePlans, Addresses, Alarm, etc.

TASKS TO BE ADDRESSED IN MEMIS

The MEMIS system can be used for three tasks: daily work tasks, emergency planning, and emergency response.

Daily Tasks
MEMIS is a desk-top system that can be built around a workstation that is used in day-to-day operations in emergency management. Therefore, it integrates the administrative tasks of an emergency manager with the emergency-specific tasks. Text processing, spreadsheet work, database management, and e-mail communications are performed in the same system as emergency management and planning. The advantage is that the user does not need to switch between two different system but all the work is done in one integrated system - MEMIS. With the access to cyberspace, the emergency manager can be kept up to date about new developments. The workstation can be replicated in a labtop configuration for

portability.

Emergency Planning
Scenario analysis, development of response plans, analysis of statistics, etc., are routine tasks. The system can also be used for training and simulating actual incidents event.

Emergency Response
This module includes capabilities such as automatic dialing, alarm, and real-time monitoring. GPS capabilities provides for real-time control of response resources. Routing models and expert systems provide recommendations to the emergency responders. CAMEO and similar models provide predictions of various impacts of the event.

5. CONCLUSIONS

MEMIS was developed in a prototype version to demonstrate how commercially available software and hardware could be integrated to provide emergency managers with an MIS, specifically designed for their needs. It shows that, at a relatively low cost, since most of the capabilities are already installed on personal computers, an emergency manager can have his or her system, and not be dependent upon local, regional, federal, etc. workstations and information systems. In addition, the system can either be installed on or duplicated in a labtop computer for portability and personal use.

The development of a MEMIS can be done by the emergency manager, in concert (if needed) with a person knowledgeable about PCs, word processing, and spread sheets. The addition of modeling capabilities, such as CAMEO, would require knowledge of dispersion models and traffic routing - topics familiar to emergency managers. It is certainly conceivable that every emergency manager could have his or her own MEMIS.

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