DRAFT

THE ROLE AND LIMITATIONS OF HIGH TECHNOLOGY IN EMERGENCY MANAGEMENT:
some insights from Silicon Valley (*)

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Abstract

This presentation, which centers on the management of civilian emergencies, considers the potential role of the high-technology community in support of Federal, State and local government. Many of the concepts that are currently under development in Silicon Valley, and which are building blocks of the "Digital World", have direct relevance to the improved prediction and management of both natural disasters and man-made emergencies. At the same time, these new tools have their own limitations which should be clearly recognized, such as the continued inadequacy of communications standards. The author briefly presents several examples of currently-available solutions. A plea is made for the orderly integration of these technologies into emergency management planning.

Every crisis is a communications crisis

A decade or so ago, Bob Chartrand invited me to testify at two Congressional Hearings presided by then-Senator Al Gore, and devoted to information technology in emergency management(1). Most of the participants, understandably, came from Federal agencies and said impressive things like, "I am familiar with emergency

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*) To be presented before the 1994 Annual Meeting of the American Association for the Advancement of Science. Session on: "Predicting, Mitigating and Recovering From Disasters, The Role of the Information Infrastructure." (San Francisco Hilton Hotel, Sunday, 20 February 1994, 2:30PM, Room H/Continental Parlor 2)

management because I serve as National Intelligence Officer for Warning." There were a few local experts who said things like, "I am familiar with emergency management because the bomb squad for New York City reports to me."

Representatives of private sector firms, like myself, could be counted on the fingers of one hand, and our credentials in the field did not compare with those of the experts, so I introduced myself by saying, "I am familiar with emergency management because I live in California", which generated both laughter and sympathy on the part of the panel.

Today, two earthquakes later, I can only make a similar disclosure, with the added experience of surviving major fires and significant riots.

At the time of these Hearings, I was running a software company that was linking together all the major nuclear Utilities around the world through a computer conferencing system that enabled seventy-two plants from France to Japan to rapidly report, document and manage emergencies (2). It became apparent that such a network community could recognize and solve complex problems faster and more effectively than traditional hierarchical structures. These early findings about the major benefits to be derived from computer-based networking have since been verified in countless cases of national emergencies. As recently as last month in Los

Angeles, electronic mail proved to be the most reliable and direct means of contacting relatives and of disseminating information in the wake of the earthquake that disrupted telephone communications by voice. It also highlighted the feasibility of telecommuting through computer networks (3).

(figure 1)

The major lessons I learned from the Hearings that Bob had organized could be summarized in two points: first, "every emergency is a communications emergency" and second, "the greatest single advance that could be made in anticipation of future crises is better coordination of information."

In other words, the experts seemed to be saying that they did not need more tents, more trucks, more food or more medicine as much as they needed convenient channels to reach the people who had these resources, the specialists with the right skills and the information about what other groups or agencies were doing at the same time.

Two local examples come to mind in this respect. When the 1989 earthquake hit San Francisco, the emergency broadcast system which regularly interrupts our favorite music programs with its ear-piercing test tone, simply failed to function. Fortunately the earthquake occurred at a time when one local news station had its traffic aircraft in the air and the population was able to get superb information and timely advice from its reporters.

More recently, on September 10th of last year, a train of our local Bay Area Rapid Transit system, known as BART, derailed in Oakland. The accident cut off service for two and a half hours, creating havoc for thousands of rush-hour passengers. Compounding the physical problem, communications with riders were described as "horrendous" by BART director, Dan Richard. In the words of Chief Transportation Officer, Paul Overseir, the poor communications stemmed from the "logistical nightmare" the derailment caused for the central control staff (4). Because the derailed train severed communication cables, seventeen switches at the intersection had to be cranked manually. Amid the chaos, no one person was assigned to give information about what was happening. As a result, passengers were even given conflicting instructions.

(figure 2)

Another remark that struck me during the Congressional Hearings was made by the emergency coordinator for the New York City Police Department. His main problem was that the Police, the Fire Department and the FBI, each of which was equipped with superb crisis management capabilities, had no common frequency for communications. He told us there was a large room somewhere in Manhattan where an army of clerks with earphones were listening to one frequency and repeating everything they heard on another frequency for the benefit of the various agencies. When disasters involve the Federal level, State agencies and local law enforcement the problem of information flow poses a challenge which is as great as putting out fires, evacuating the wounded or setting up shelters.

This is where technological innovation, of the sort we see every day in Silicon Valley and in other centers of scientific excellence, can begin to play a significant role. Yet this potential contribution is often overlooked because such products tend to be developed by small private companies that do not have the resources or the contacts to approach the massive public organizations typically involved in emergency management.

Other speakers on this panel are providing current information on the use of the communications infrastructure to alleviate many of the problems we have identified. Therefore, I will confine the rest of my remarks to a few specific instances of novel technologies that are likely to improve not only our chances to recover quickly from disasters but our ability to prevent or mitigate them.

Available technologies for emergency management

The most obvious advance we are likely to see will come from the trend towards mobile communications. Many of us already rely on car phones or portable equipment to handle the little emergencies and delays of everyday business life. Larger-scale improvements in reliability will come from private networks utilizing high-power radio links that are not as vulnerable to disasters as large telephone facilities. In particular, I am familiar with one Silicon Valley company called P-COM that has developed a simple, rugged system exploiting a recently-allocated part of the radio spectrum. The millimeter-wave radios designed by P-COM operate either at 23 GHz or at 38 GHz and provide 2 Mb/s to 34 Mb/s for the European market and from 1.5 Mb/s to 45 Mb/s for the U.S. market (5).

Because such systems have low maintenance and high bandwidth, they provide superior performance in emergency situations. They can play a major role in linking together disseminated branches of an organization such as a campus or a cluster of buildings, and interfacing it with the major public networks at low cost. Such technologies are increasingly popular in Eastern Europe, where the telephone infrastructure is notoriously unreliable. They might also have been of help in the BART emergency I have mentioned above, since a radio link is less likely to be cut off than a ground-level cable.

(figures 3 and 4)

Please note that I am only mentioning specific companies and their products in the interest of making this presentation as concrete as possible. They are typical of the state-of-the-art and I do not mean to imply these are the only products of this class or even the best for a particular need.

Other important advances in the handling and coordination of information are occurring in the field of software. In particular, the problem of electronic document interchange (EDI) is of concern within every large organization, and it becomes even more acute when documents need to cross organizational lines. Keep in mind that, in our happy new world of multimedia, the term "document" is no longer referring to text alone but may designate a mix of printed words, graphics, sound recordings, voice mail messages and video clips. This rapid development is stretching communications standards to their limits, as anyone who uses even the simplest E-mail system on a regular basis must have realized by now.

During emergencies the problem becomes magnified. Not only do the computing platforms used by various organizations differ because they come from different vendors but software interfaces often follow different standards. New systems are required to bridge the gap. A Los Angeles company called ISOCOR is building "next generation" messaging and EDI software to provide document transport systems for both commercial and government organizations that follow CCITT and ISO guidelines (6).

(figures 5 and 6)

These slides illustrate the capability to transfer information across boundaries not only within a large diversified entity such as a bank, an insurance company or a government agency, but among such organizations, a key requirement in the recovery phase of a major disaster.

Anticipating disasters: better detection and warning

Let me now turn to other technologies that may help us detect and possibly minimize disasters before they strike. Alternately, it is possible to anticipate an unavoidable emergency (such as an earthquake) and take quick action to reduce its destructive impact.

As an example of the latter category, we should mention an interesting firm called ESS (for Earthquake Safety Systems) (7). The company manufactures a family of process control products capable of detecting the two main seismic energy waves ("P" and "S" waves) with a typical response time of 1/20th of a second. Such devices are useful not only to warn employees through visual and auditory signals, but to switch over critical equipment such as computers, gas valves or pumps. In particular, the use of a detector could enable automatic saving of computer databases and transaction processes to permit orderly recovery at a later time.

(figures 7 and 8)

Seismic shutdown for toxic gases is an especially important concern for those of us who work daily in Silicon Valley which has one of the highest concentrations of hazardous gases in the world, with a highway traffic pattern that would make evacuation extremely difficult if a massive emergency occurred.

Under the heading of anticipating disasters, let me give two examples of novel detection and sensor systems that are directed at the prevention of man-made emergencies such as terrorist attacks or accidental explosions.

The machine shown on this slide, an IRT Corporation product known as SECURE 1000, is an inspection system based on the Compton effect. In contrast with the typical "portals" installed at airports and in many other facilities, it is capable of detecting non-metallic objects such as plastic guns, hidden explosives or other controlled substances (8).

(figure 9)

Another interesting device is currently at the development stage at DIAMETRIX DETECTORS, INC. (DDI) in San Diego. It is designed to detect the presence of contaminants in the air in the vapor phase (9). It uses the change in optical density of a small slide which is exposed to the vapor. The slide is a semimirror coated with an antibody reacting to the substance to be detected (10). In laboratory tests, researchers at DIAMETRIX have detected the explosive PETN at a vapor pressure of 18 parts per trillion and the military explosive RDX at a concentration of 6 parts per trillion. Although the major uses of the device will be found in workplace environmental monitoring for noxious chemicals or other contaminants, its potential applications in the detection of explosives are clear. Such a device, if implemented as part of a full security system, might have given a warning that an incoming van was loaded with explosives in the case of the World Trade Center bombing in New York.

The same principle may be used to warn of toxic gas leaks in industry, of unhealthy conditions aboard aircraft or in hospitals, or to augment the use of trained dogs in locating human bodies in the rubble following a major disaster.

Advanced technology is a double-edged sword

I would like to bring up another point in conclusion. We should all be aware that advanced technology is a double-edged sword. The same devices or substances we are using to improve our environment may also turn out to be hazards and threaten our safety under conditions we had not anticipated. The most obvious example that comes to mind is that of asbestos, which was hailed as a wonder material in controlling the spread of fires long before its cancerogenic properties were understood. Another example is PVC, which was once used in the formulation of pharmaceuticals because of its stability.

For those of us who closely follow the software business, similar concerns are looming on the horizon; it would be irresponsible to minimize them. While massive software systems have made life easier for people in advanced countries, they have also become a source of potential new disasters which their designers never anticipated. When a nationwide reservation system refuses to function, or when a credit card authorization system crashes (two situations which actually happened last year in Europe), the resulting disruption has many similarities with that of a natural disaster. Software bugs can even lead to loss of life, since our cars, aircraft, medical equipment and other critical devices we use everyday rely increasingly on programmed instructions embedded in chips that we take for granted.

The realization that few of these vital systems have been fully tested may be a shock to most users but it certainly cannot come as a surprise to a computer scientist. The problem of the feasibility of verifying the logical functions of an automaton is extremely complex. Even in the most common applications of software, such as spreadsheets or videogames, full testing of every new release is economically unrealistic.

How, then, can we expect the public to rely increasingly on complex networks in the age of information superhighways? The answer is that we will have to do a much better job of developing test systems that cover all the functions of a critical program, as well as software quality control tools that can be applied rapidly and economically to run massive quantities of tests and verify the answers, a task which is still done by hand in most software development centers.

A company called MERCURY INTERACTIVE (11) is among a handful of new entrants in this field.

(figure 10)

The products offered by MERCURY address the need to run tests at high speed and to validate the results on platforms that range from the IBM PC to X-Window workstations and even to client-server facilities that may have thousands of on-line users.

The systematic application of such tools to the testing of vital software systems can insure that they will be able to function under emergency conditions. But perhaps more importantly, it may decrease the probability that the software itself will be a cause of massive failures and a source of danger in our increasingly complex technical society.

Notes and References

(1) "Information Technology for Emergency Management." Report for the Investigations and Oversight Subcommittee of the Committee on Science and Technology, U.S. House of Representatives, Ninety-Eighth Congress, October 9, 1984.

(2) Vallee, J.: *Computer Message Systems*. NY: McGraw-Hill, 1984.

(3) Howe, K. and McCabe, M.: "Quake Gives Telecommuting a Push". *San Francisco Chronicle*, Thursday, January 27, 1994, page A10.

(4) Wildavsky, B.: "BART Trying to Improve 'Horrendous' Communications." *San Francisco Chronicle*, Wednesday, December 15, 1993, page A25.

(5) P-COM: Information can be obtained directly from the company at 3175 South Winchester Boulevard, Campbell, CA 95008. Phone (408) 866-3666.

(6) ISOCOR: The company is located at 12011 San Vicente Boulevard, Los Angeles, CA 90049. Phone (310) 476-2671.

(7) EARTHQUAKE SAFETY SYSTEMS: Information can be obtained directly from the company at 2064 Eastman Avenue, Suite 102, Ventura, CA 93003-9940. Phone (805) 650-5952.

(8) IRT: The company is located at 6020-300 Cornerstone Court West, San Diego, CA 92121. Phone (619) 450-4343.

(9) DIAMETRIX DETECTORS, INC. (DDI): The company is located at 6020-300 Cornerstone Court West, San Diego, CA 92121. Phone (619) 450-4343.

(10) Lukens, H.: "Binding of Airborne, Radiolabeled Hapten controlled substances to dry immobilized antibody." Journal of Radioanalytical and Nuclear Chemistry, Letters, Vol. 144, pages 223-228 (1990).

(11) MERCURY INTERACTIVE: The company is located at 3333 Octavius Drive, Suite 104, Santa Clara, CA 95054. Phone (408) 987-0100.

☑ NEW BELIEVERS IN DATA SUPERHIGHWAY

Quake Gives Telecommuting a Push

By Kenneth Howe and Michael McCabe
Chronicle Staff Writers

Los Angeles

With one devastating jolt last week, highway-addicted drivers and businesses became sudden believers in the so-called information superhighway.

Untold numbers of frustrated commuters, faced with long detours around knocked-out freeways, are ready to ride the ramps up to the much-ballyhooed but under-construction information superhighway.

Some who had been thinking about telecommuting someday find that someday is here. Mary Sue Maurer of Santa Monica said she started telecommuting Monday from her home to her office in Monterey Park, east of downtown Los Angeles.

"The modem is going to save me at least two hours in commuting," said Maurer, a public education specialist for the San Monica Bay Restoration Pro "I think telecommuting is to make a significant dif in the quality of li here in Los Angeles."

For those muting usu at home – phone a

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A10 San Francisco Chronicle ☆☆☆☆☆

Quake Gives Impetus to Telecommuting

From Page 1

out there, people forced to use telephones and other equipment because they are forced to stay home and off the highways."

But as tantalizing as the option is, experts warn that for now, the nascent superhighway will be lightly traveled. Most businesses — especially smaller ones — are simply not set up to operate with computers, modems, faxes or fiber optics, these experts cautioned. The nature of a business may preclude merging onto the superhighway, or the cost is out of reach, or the company simply lacks the agility to take quick advantage of the opportunity.

Even if th

over this, my guess is things will go back pretty much the way they are now," said Thomas G. Cummings, management professor at the University of Southern California and a productivity consultant to companies.

Among other things, he said, working at home bucks a powerful human need to build trust through face-to-face relationships.

Playing Office Politics

Tammy Aultman, a sales representative for Hewlett-Packard in Laguna Hills who has been telecommuting from home since November 199

①

BART Trying to Improve 'Horrendous' Communications

By Ben Wildavsky
Chronicle Staff Writer

BART officials say they are taking steps to improve emergency communications after a September 10 derailment that left many passengers wondering where to go and what to do.

The accident brought service at a crucial Oakland transfer point to a halt for 2½ hours, creating havoc for thousands of rush-hour passengers.

Communication with riders was "horrendous," said BART director Dan Richard.

"Worse than getting no information, they were getting contradictory information" from BART police and station agents, he said.

The derailment occurred when the operator of an out-of-service train leaving a storage track near the MacArthur station went through a red signal, triggering an emergency device that automatically pushed the train off the track.

Richard called for a report on the incident, which was presented at a BART committee meeting yesterday.

Paul Overseir, BART's chief transportation officer, said the poor communications stemmed from the "logistical nightmare" the derailment caused for the rail system's central control staff.

Because the derailed train severed communication cables, 17 switches at the intersection had to be cranked manually, he said.

Amid the chaos, no one person was assigned to give information about what was happening, the report says.

Compounding the problem was BART's 20-year-old station speaker system, which many riders had difficulty hearing at stations such as MacArthur and Rockridge, which are near freeways.

The report lays out plans for improved communication during future emergencies, including:

■ Adding a second communications specialist whose job it is to keep passengers informed about delays.

■ Providing better information about the reasons for the delay, how train service will be affected and where to catch replacement buses.

■ Buying equipment that permits recording of emergency messages in just a few minutes.

■ Adding speakers and amplifiers at freeway stations.

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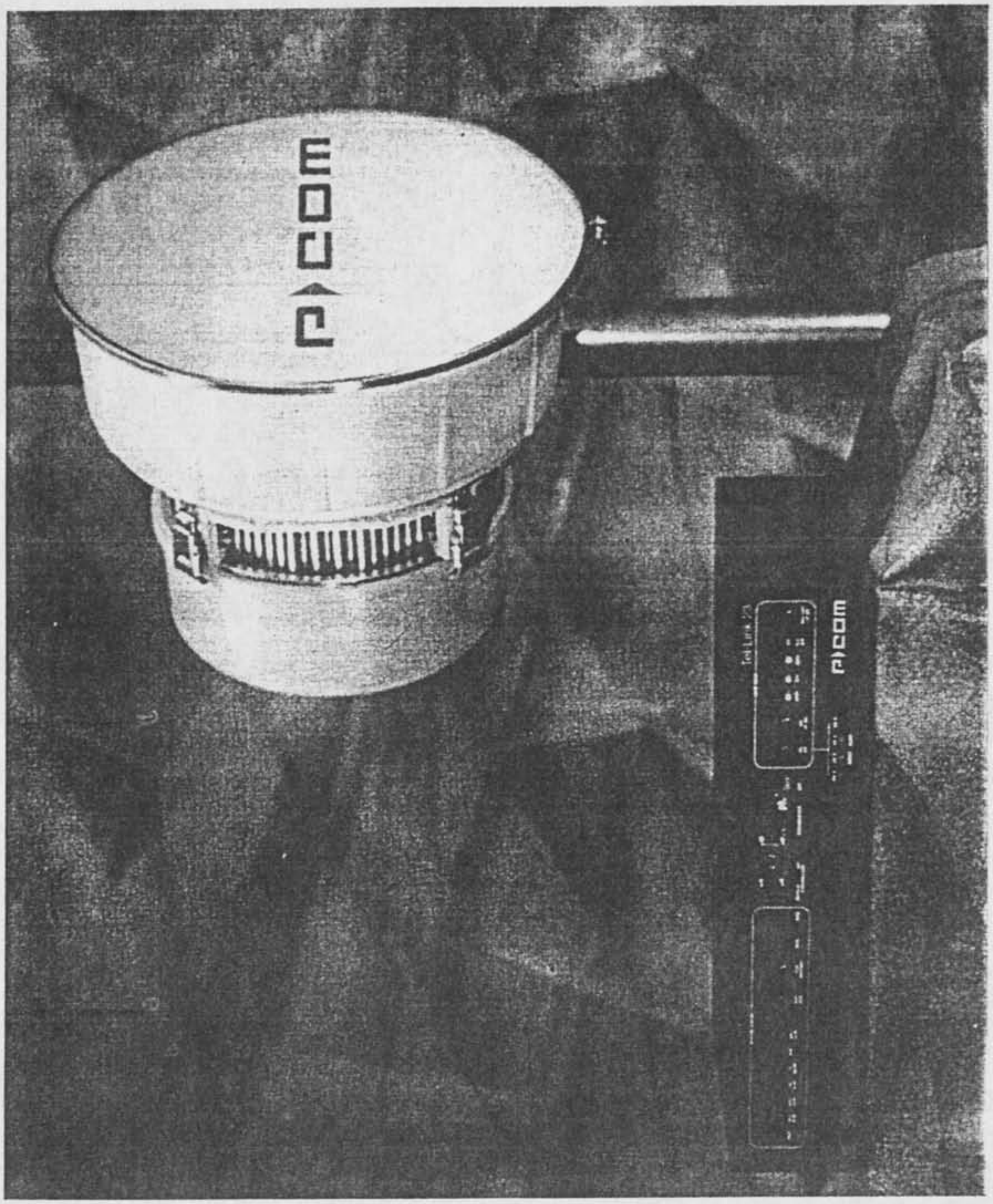
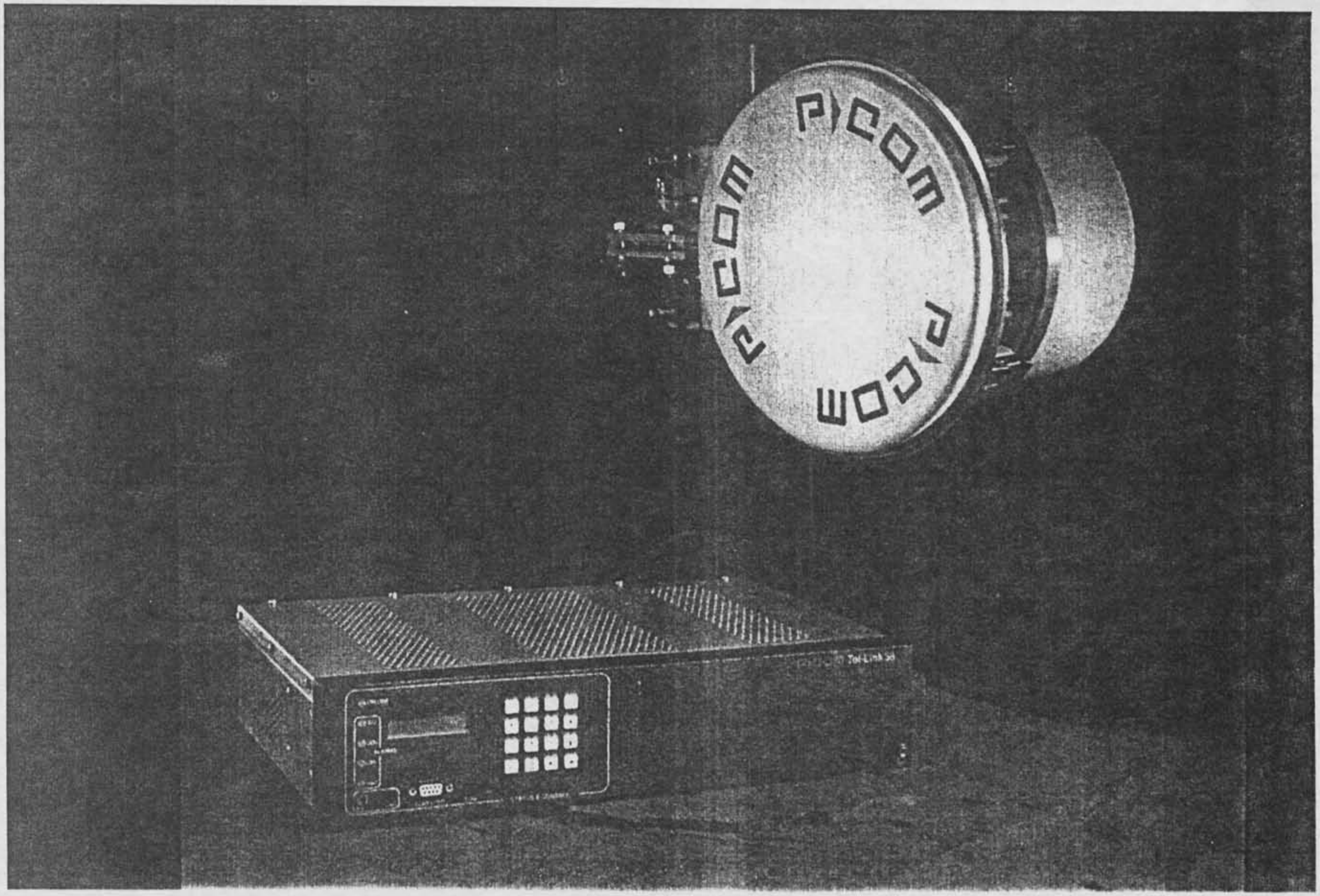
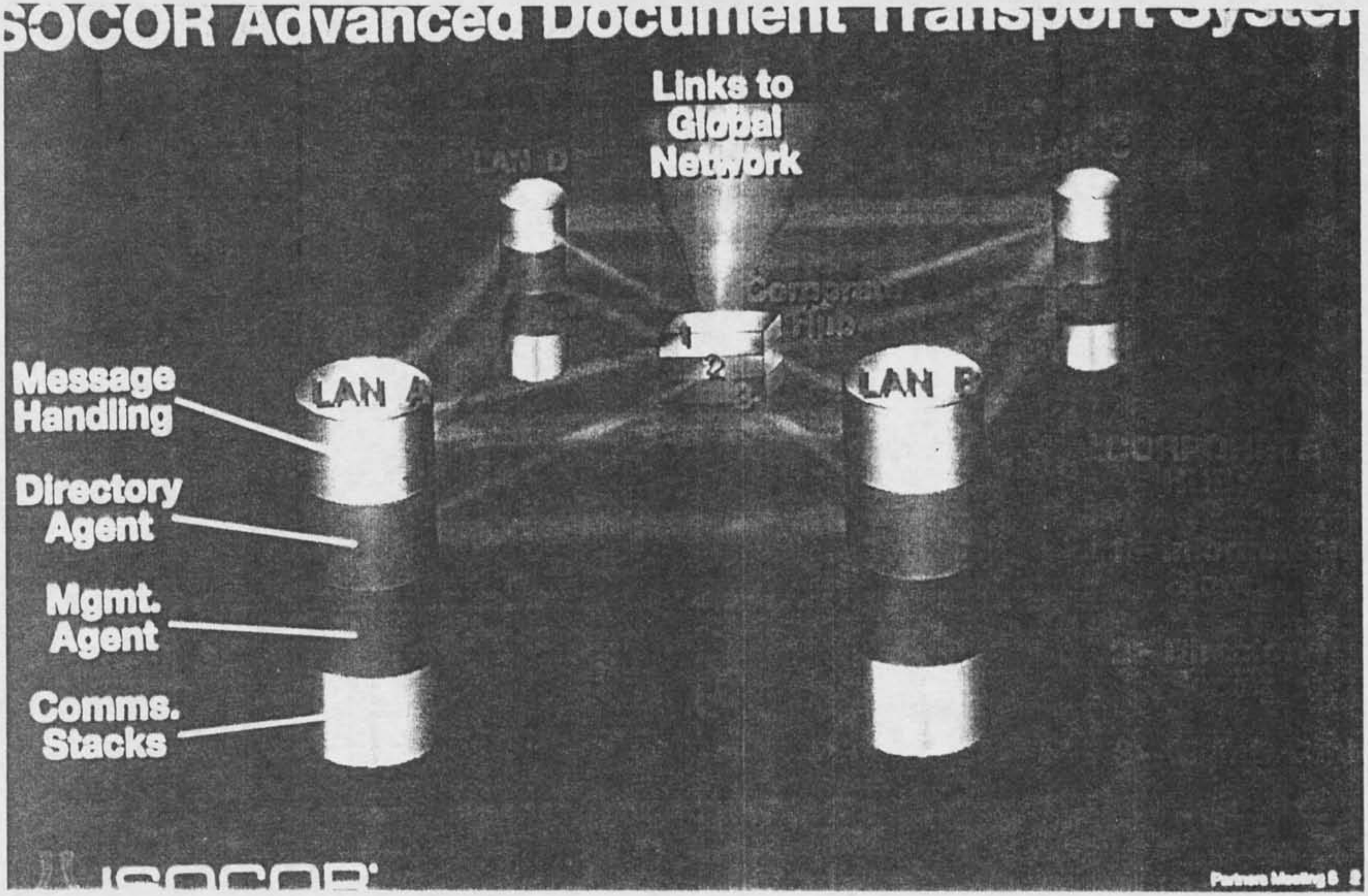
③





SOCOR Advanced Document Transport Syste



Links to Global Network

LAN D

Corporate Hub

1
2
3

LAN A

LAN B

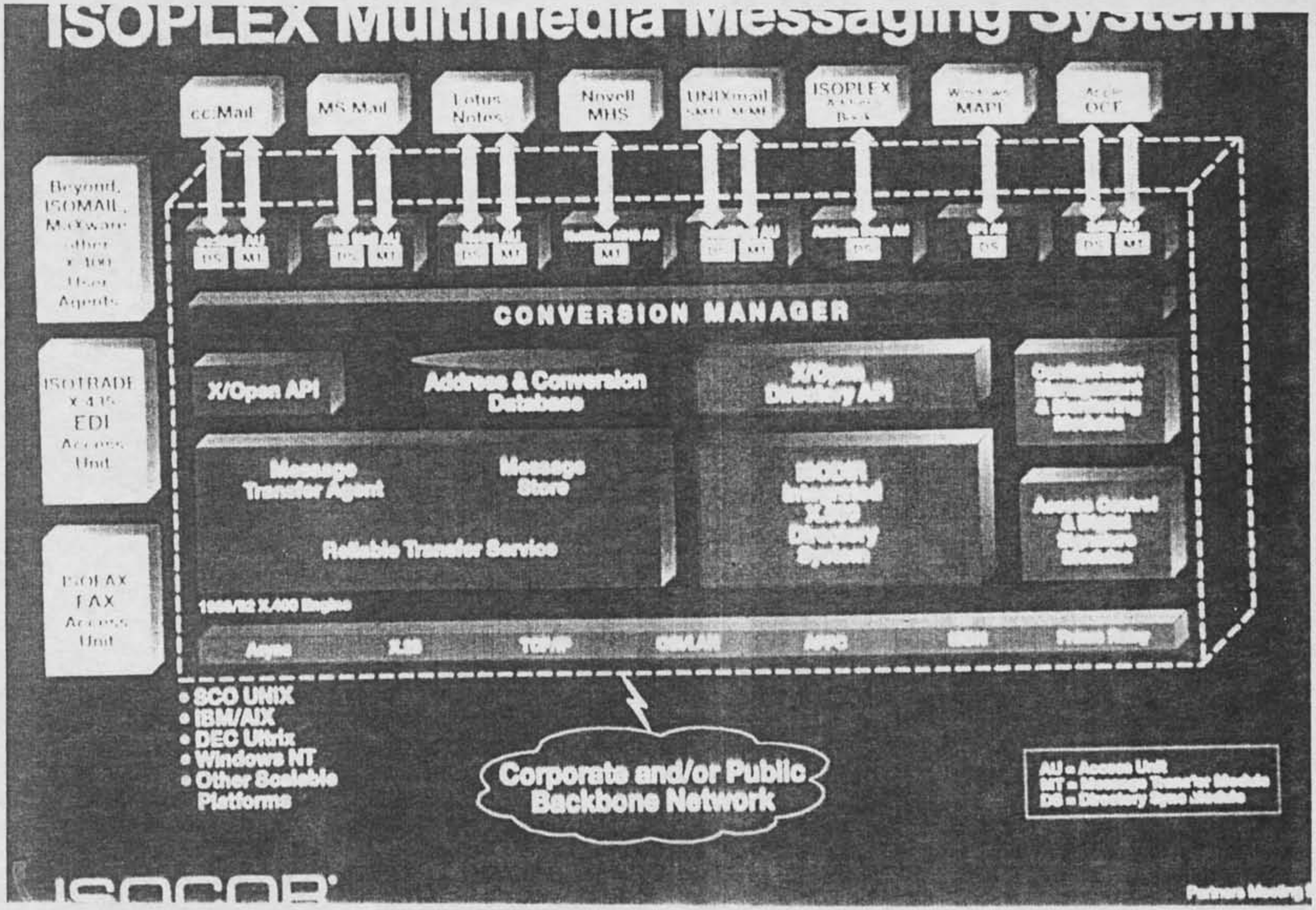
Message Handling

Directory Agent

Mgmt. Agent

Comms. Stacks

ISOPLEX Multimedia Messaging System



cc:Mail
MS Mail
Lotus Notes
Novell MHS
UNIXmail
ISOPLEX
MAPI
OCE

DS MT
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DS MT

Beyond, ISOMAIL, MaXware other X.400 User Agents

ISOTRADE X.435 EDI Access Unit

ISOFAX FAX Access Unit

CONVERSION MANAGER

X/Open API

Address & Conversion Database

Message Transfer Agent

Message Store

Reliable Transfer Service

1988/92 X.400 Engine

X/Open Directory API

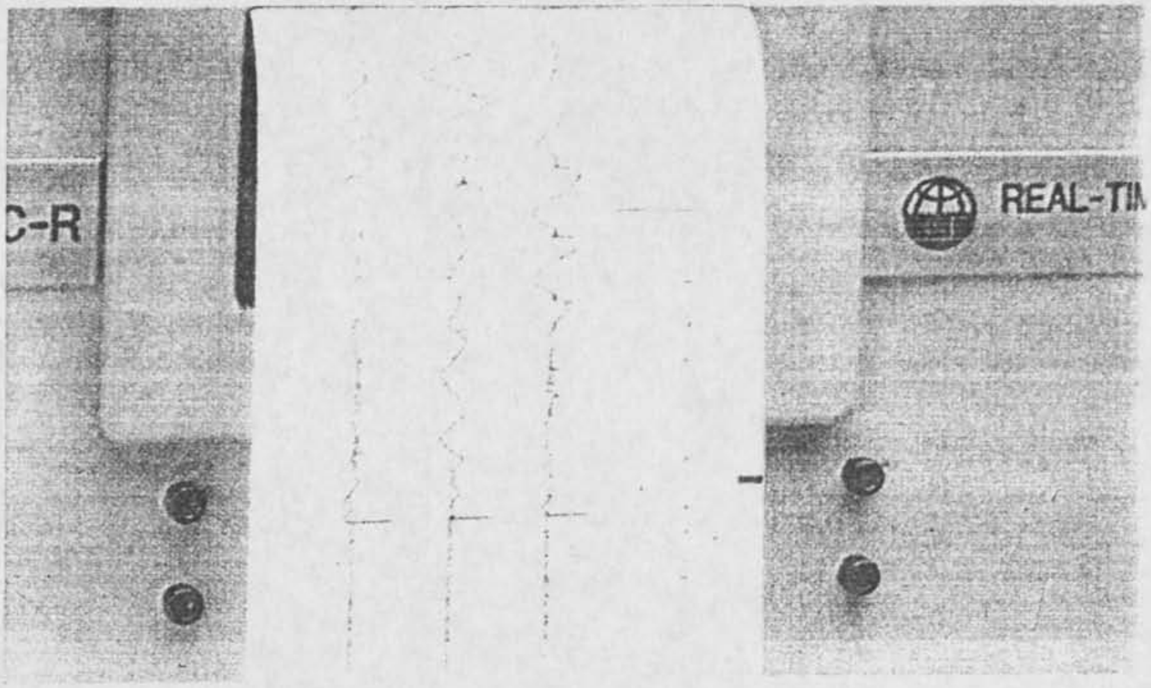
Access Control

- SCO UNIX
- IBM/AIX
- DEC Ultrix
- Windows NT
- Other Scalable Platforms

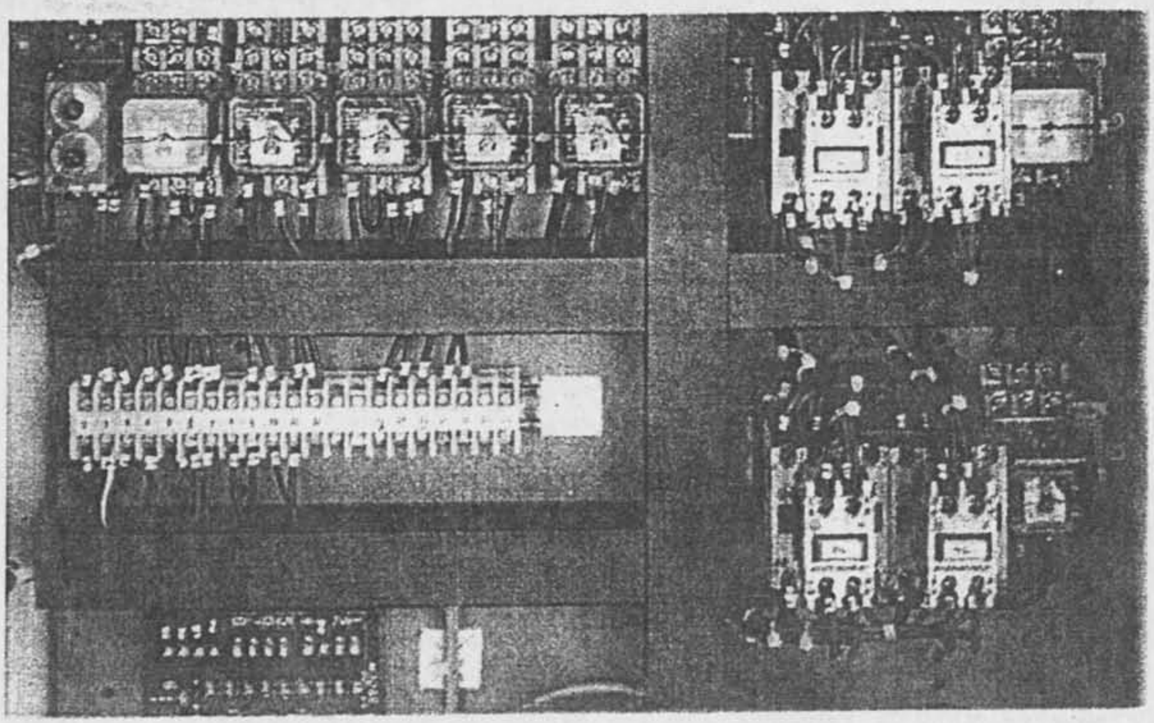
Corporate and/or Public Backbone Network

AU = Access Unit

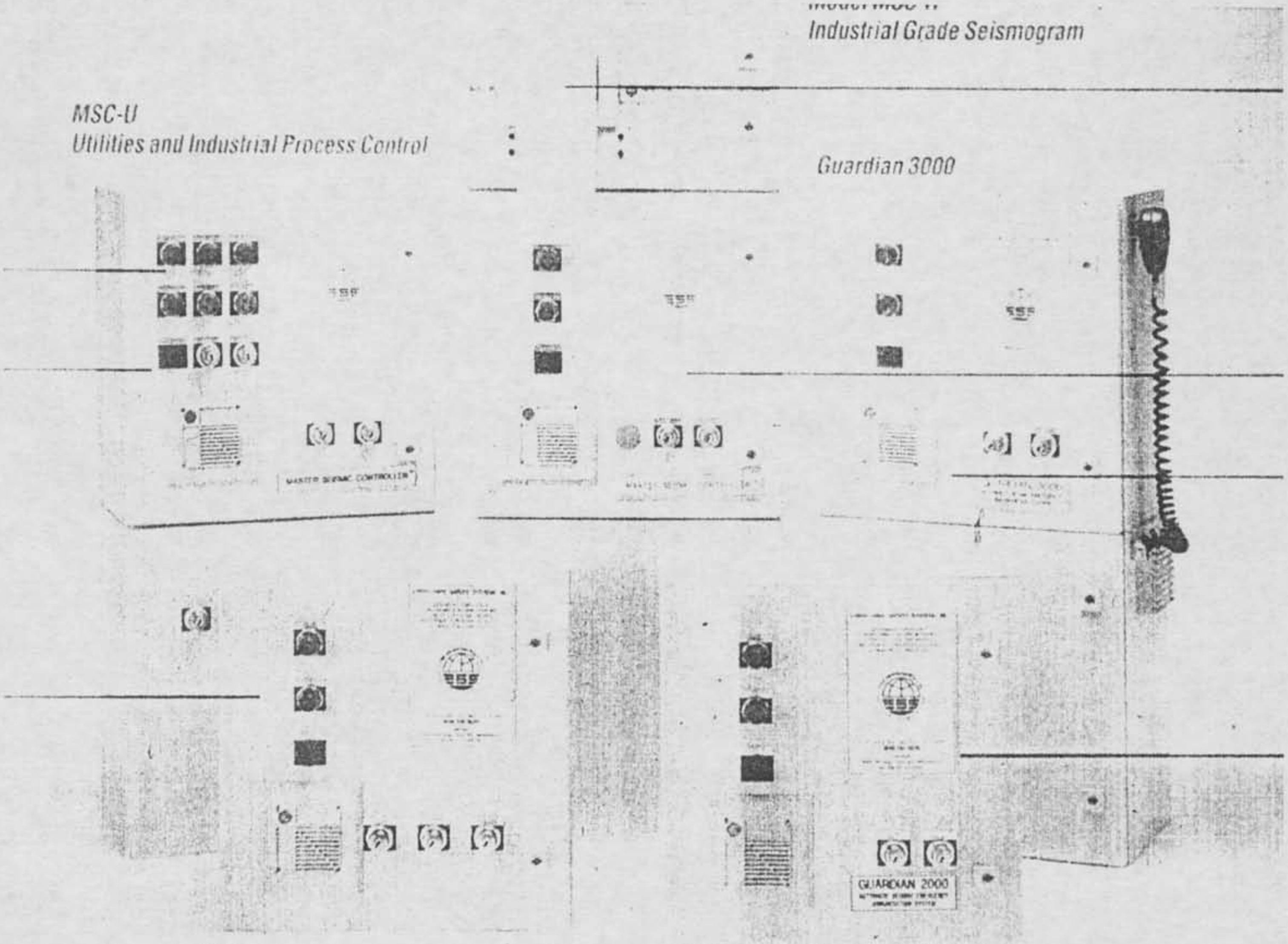
ISOCOR®



ulti-channel Seismogram



teractive Control Logic



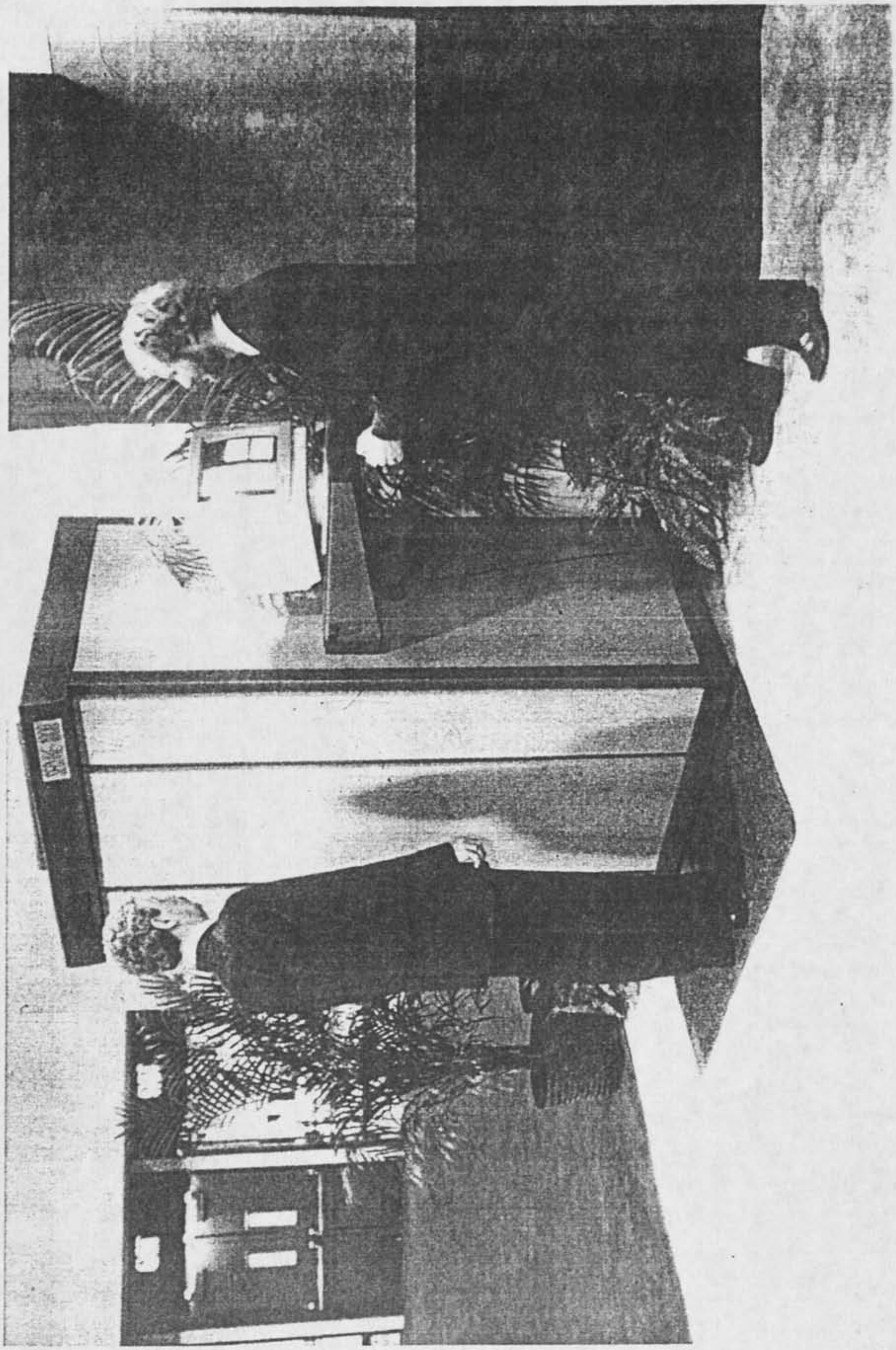
Model MSC [illegible]
Industrial Grade Seismogram

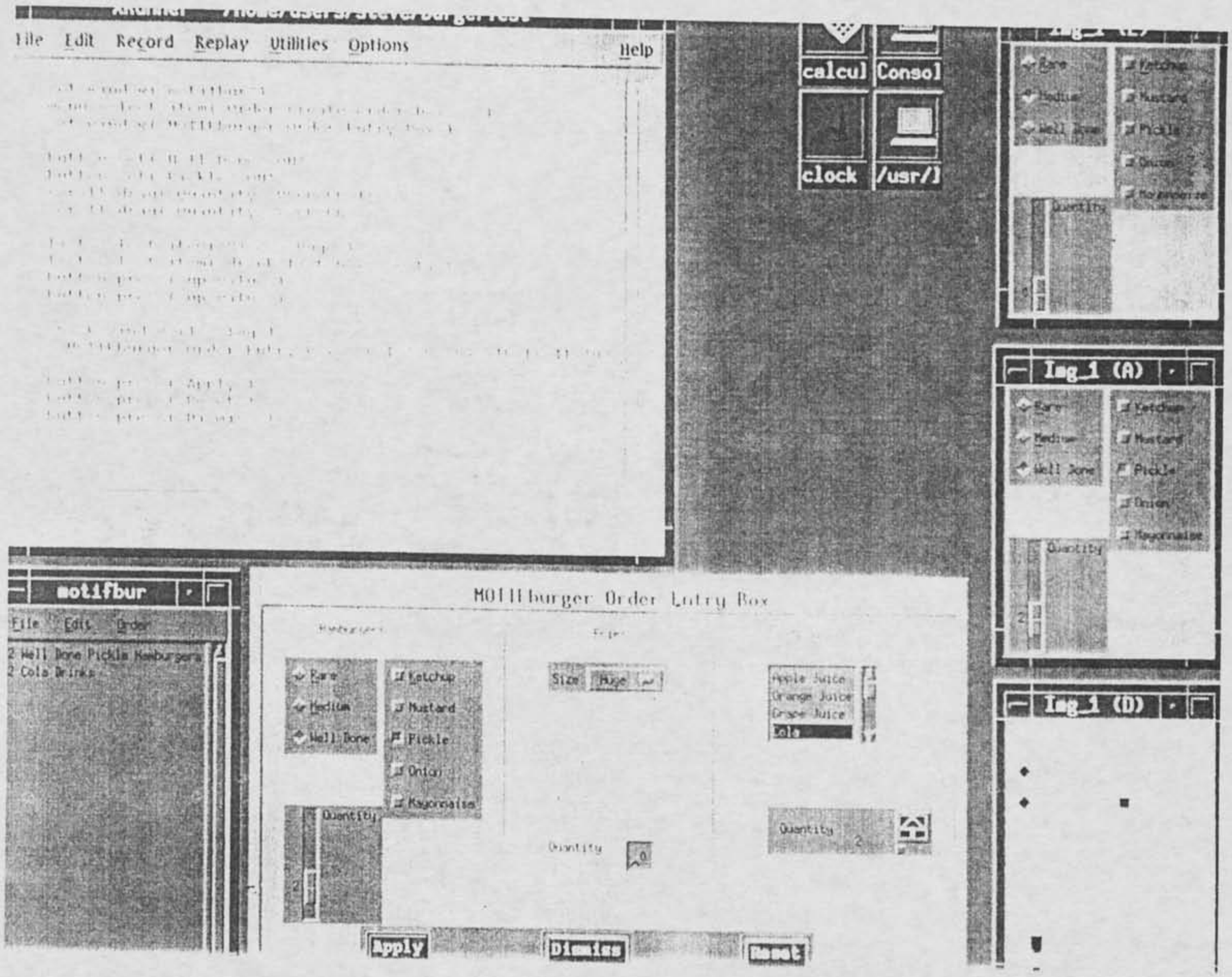
MSC-U
Utilities and Industrial Process Control

Guardian 3000

MSC-7

Guardian 2000





2 Well Done Pickle Hamburgers
2 Cola Drinks