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TO: List DATE: February 20, 1975

FROM: M. A. Rockwell

SUBJECT: EXPERIENCE WITH THE PARAMED SYSTEM AT NETHERCUT EMERGENCY CENTER

I. Introduction

Thanks to the television program "Emergency", most people know about paramedics. Those culturally deprived readers who have not watched television recently, however, may need some background information.

In brief, paramedics are specially trained ambulance attendants or firemen, who are qualified to render on-the-scene diagnosis and treatment of medical emergencies. All paramedic vehicles are equipped with two-way radio gear which allows the paramedics to communicate with a hospital base station; the transmitters can also send a patient's electrocardiogram to the base station for analysis.

The paramedic system goes into action when a medical emergency call is received by an emergency service dispatcher (usually in the fire or police department). At least in this area, the paramedics arrive at the patient's door in a full size, honest-to-god, firetruck complete with hoses, ladders, axes and Smoky-the-bear helmets.

The paramedics examine the patient and obtain a brief medical history. Next they contact a hospital base station, describe the situation, and ask for authority to treat. There are several hospitals equipped with base stations in this area. Within the hospital the base stations may be located in one of several sites; at Santa Monica the equipment has been installed in the emergency department.

Depending on the circumstances, either a physician or a specially trained nurse operates the hospital's base station. When the hospital receives a call, a dialogue commences between the paramedics and the hospital personnel in which the hospital personnel try to establish the patient's diagnosis and status, and instruct the paramedic how to handle the situation.

When the patient has been stabilized as well as possible in the field, he is handed over to an ambulance crew who transport him to a hospital (usually, but not necessarily, where the base station is located).

Contrary to the impression given by the television program, paramedics are relatively new and unproven members of the emergency medical system. Although paramedics are now being used in many cities, Los Angeles has been among the leaders in training and employing paramedics. In the northwest quadrant of Los Angeles, most paramedics are employed by either the Los Angeles fire department or the Santa Monica fire department.

The major private ambulance company serving Los Angeles, the Shaeffer Ambulance Company, also employs paramedics. Originally, some of Shaeffer's paramedics were assigned to this region, but because most of the calls requiring paramedic assistance were routed through the local fire departments, the Shaeffer paramedics have now been reassigned to other areas of Los Angeles.

The hospital base stations in the northwest quadrant of Los Angeles are located at the Nethercut Emergency Center, UCLA, Harbor General, Little Company of Mary, Torrance Memorial, Daniel Freeman and Redondo Beach Hospitals. It is left to the discretion of the paramedics to choose which base station they will contact for advice. They are supposed to select the base station to which the patient will be transferred, although other factors may be involved in their choice. For example, the patient may be located in an area which makes it topographically difficult to establish radio contact with the nearest base station, or the hospital base station may be already occupied with another paramedic call. Since each base station evolves its own procedures for handling paramedic calls, paramedics may choose base stations whose operating style and content is most acceptable to them.

There is good reason to believe that the quality of medical advice provided to the paramedics varies widely from hospital to hospital, and over time in each hospital. Apparently, the original conception of the paramedic's duties envisioned that most of his patients would have acute cardiac emergencies--cardiac arrest, acute myocardial infarction (heart attack), and arrhythmias. Since coronary care unit (CCU) nurses are allowed to provide immediate diagnoses and treatment of such conditions in hospitalized patients without specific doctors orders, it seemed reasonable to allow nurses with CCU training to supervise the work of paramedics. At least in Santa Monica, therefore, the original management paradigm envisioned that such nurses could handle most of the calls without the direct involvement of physicians.

The Nethercut Emergency Center (NEC) at Santa Monica Hospital Medical Center (SMHMC) established an operational base station on August 31, 1974. Prior to beginning operations, a group of senior emergency department nurses were sent through Mobile Intensive Care Unit (MICU) training; this course was essentially a renamed version of the Coronary Care Unit curriculum. These nurses handled the majority of the paramedic calls received from September through February, 1975. The base station hospitals also aided in training the paramedics themselves. The paramedic curriculum requires them to spend 4 weeks working on various hospital emergency and intensive care services. SMHMC has participated in training 24 paramedics to date.

II. Purpose of this Study

The purpose of this study was to assess the costs and benefits of SMHMC base station operations during this system's first months of operation.

The cost component of particular concern here is the amount of staff time required to operate the base station. Since neither the hospital nor the physician receive any direct payment for base station operation, the amount of time spent by the emergency department's medical staff essentially amounts to a charitable contribution. Although such charity is not necessarily inappropriate, it is of obvious interest to the department's management to determine how generous they are being.

Measuring the "benefits" of any health care activity poses a classical problem in health policy analysis, one which is generally left unsolved. In the case of the paramedic system some crude inferences can be drawn from the diagnoses of patients treated by paramedics, and their associated mortality.

The specific objectives of this study can be stated more exactly in the following series of questions:

1. How often is the service used?
2. When is the service used?
3. How much time is required to treat paramedic cases?
4. What diagnoses do the patients have?
5. What is the outcome of the patient's treatment?

III. Methods of Procedure

A base station log book is kept in which the date, time, and several items of clinical information are recorded from each paramedic "run" (a "run" is defined as the period from receipt of the first radio communication until the paramedics final communication regarding the patient). The first question (i.e. how often is the service being used?) was answered by counting the number of runs NEC's base station handled each month.

Answering the other questions required collection of additional data. To reduce the task of data collection to manageable proportions, two samples were chosen. Question two was answered using a 50% sample (every other run recorded from October 1, 1974 through December 11, 1974). The other questions were answered using a 25% sample from the same interval which was selected by choosing every fourth run recorded during that period. The paramedic log book, the emergency department log book, the emergency department medical records, and the hospital medical records were reviewed retrospectively by a single individual to obtain the following items of information:

1. Date and time first communication was received
2. Date and time patient arrived at Nethercut Emergency Center, or the last communication was received
3. Date and time patient was discharged from the emergency department
4. The hospital to which the patient was transported
5. The patient's diagnosis according to the following categories:
   - o cardiac related problems
   - o non-cardiac problem with cardiac complications
   - o non-cardiac diagnoses
   - o dead-on-arrival

For patients who were transported to NEC, the following additional items of information were recorded:

6. Diagnoses at admission to the emergency department
7. Disposition from the Emergency department (i.e. admitted to SMHMC, transferred for admission elsewhere, returned home, or died in the department)
8. Diagnoses at discharge from the emergency department
9. Condition upon discharge from the emergency department

For those patients admitted to SMHMC, the following information was recorded:

10. Date of discharge
11. Patient's diagnoses on hospital discharge
12. Patient discharge status (alive/dead)
13. Patient's discharge condition

IV. Results

1. How often is the service used?

As noted above, the service became officially operational on August 31, 1974; as of February 18, 641 runs have been logged.

The monthly usage rate is as follows:

Month	Total Calls	Calls/Day
September	76	2.53
October	82	2.65
November	81	2.70
December	93	3.00

Month	Total Calls	Calls/Day
January	169	5.45
February (18 days)	140	7.78
Total	641	

It is apparent that usage of the base station is steadily increasing. The implication for the department's work load is clear; the paramed program is adding a substantial additional burden.

2. When is the Service Used?

The runs in the 50% sample described above were distributed as follows:

Time of first call	No. of runs	Percent of Runs
Midnight to 3:59 am	17	12%
4 am to 7:59 am	8	5
8 am to 11:59 am	20	14
12 noon to 3:59 pm	34	24
4 pm to 7:59 pm	34	24
8 pm to 11:59 pm	24	17
Time not noted	5	4
Total	142	100%

Day of Week	No. of Runs	Percent of Runs
Sunday	17	12%
Monday	20	14
Tuesday	20	14
Wednesday	14	10
Thursday	25	18
Friday	26	18
Saturday	20	14
Day not noted	0	0
Total	142	100%

3. How Long Do the Cases Require Care?

Three time intervals are of interest--the time from:

--first call to ER arrival (Interval A)

--ER arrival to disposition i.e. admit, transfer, return home, or death (Interval B)

--hospital admission until hospital discharge (Interval C)

Date from the 25% sample revealed the following:

Interval	Average Time (Range)
Interval A (45 runs)	25.0 minutes (1 to 60)
Interval B--admitted patients (18 runs)	91.9 minutes (25 to 160)
Interval B--transferred patients (7 runs)	140 minutes (60 to 270)
Interval B--patients sent home (16 runs)	119.1 minutes (65 to 205)
Interval C--admitted patients	14.4 days (1 to 70+ days)

4. What Diagnoses do the Patients Have?

Using the 25% sample four types of diagnostic data were analyzed:

--the diagnostic "type" defined by the coding scheme contained in the paramedic log book
--the initial diagnostic impressions recorded in the paramedic log book
--the ER discharge diagnoses
--the hospital discharge diagnoses (if the patient was admitted)

In the 50 cases studied, the distribution of diagnoses using the paramedic coding scheme was as follows:

Diagnostic Type	No. of pts	Percent of pts
1. (cardiac diagnoses)	18	34
2. (noncardiac diagnoses with cardiac symptoms)	4	8
3. (noncardiac diagnoses)	28	54
4. DOA/DRA	1	2
Missing Data	1	2
Total	52*	100

*The 50 runs included 52 patients because one run dealt simultaneously with three patients.

Of the 52 cases, 45 were brought by ambulance to NEC. The ER discharge diagnoses of these patients were:

Diagnosis	No. of Cases	Percent of pts.*
1. multiple trauma	9	16
2. drug overdose	8	14
3. probable acute myocardial infarction	8	14
4. cardiac arrest	5	9
5. diabetes mellitus	2	4
6. hypoglycemia	2	4
7. suicide attempt	2	4
8. pneumonia	2	4
9. syncope	2	4
10. pulmonary edema	2	4
11. alcohol overdose	2	4
12. hyperventilation	2	4
13. congestive heart failure	2	4
14. coronary artery disease	1	2
15. small bowel obstruction	1	2
16. acute allergic reaction	1	2
17. fracture	1	2
18. cardiac arrhythmia	1	2
19. bleeding from colostomy	1	2
20. asthma	1	2
21. seizure	1	2

Of the 45 patients brought to NEC by the paramedics, 18 were admitted to Santa Monica Hospital Medical Center. The hospital discharge diagnoses of these patients were:

Diagnosis	No. of Cases	Percent of pts.*
1. acute myocardial infarction	4	22.2
2. severe concussion	3	16.6
3. fractures	3	16.6

*Percentages don't total 100 because several patients had multiple diagnoses.

Diagnosis	No. of Cases	Percent of pts.*
4. cardiac arrest	2	11.1
5. arrhythmia	2	11.1
6. unknown	2	11.1
7. drug overdose	1	5.5
8. congestive heart failure	1	5.5
9. bleeding from colostomy	1	5.5
10. anemia	1	5.5
11. arteriosclerosis	1	5.5
12. chronic arthritis	1	5.5
13. urinary tract infection	1	5.5
14. pulmonary edema	1	5.5
15. coronary artery disease	1	5.5
16. angina pectoris	1	5.5
17. severe gastroenteritis	1	5.5
18. gastric ulcer	1	5.5
19. irreversible cerebral damage	1	5.5
20. diabetes mellitus	1	5.5
21. obesity	1	5.5
22. hypertension	1	5.5
23. shock	1	5.5
24. hemmorhage (right upper extremity)	1	5.5
Total	35	

It is interesting to compare the paramed diagnoses with the ER discharge diagnoses. For a variety of methodologic reasons, it is difficult to make such comparisons but casual inspection indicates a clinically significant difference in diagnosis occurred in only 9 percent (4 of 45) cases. The differing diagnoses were:

Paramed diagnosis	Emergency Department diagnosis
1. cardiac arrest	multiple trauma with concussion
2. syncope	seconal overdose
3. nausea, dizziness	acute anaphyllactic reaction
4. syncope	concussion, skull fracture

* Percentages don't total 100 because most patients had multiple diagnoses

5. What was the Patient's Outcome?

Patient status was measured at three points: ER arrival, ER discharge, and hospital discharge. On ER arrive, patient condition could conveniently subsumed into only two categories: Dead-on-Arrival, and Alive. The distribution of the 45 cases admitted at NEC was:

Dead-on-Arrival	4	(9%)
Alive	41	(91%)
Total	45	(100%)

At discharge from the emergency department, patient status could be inferred by their disposition:

Disposition	Number	Percent
Returned home	16	35%
Transferred for admission	7	16%
Admitted to SMHMC	18	40%
Died in the department	4	9%
Total	45	100%

The discharge status of the 18 patients admitted to SMHMC was crudely established by the author. This was done by reviewing the inpatient medical record discharge summary, considering the patient's age, and the natural history of the patient's diagnoses. No claim is made for the reproducibility of the results, but they are as follows:

Category	No. of pts.	Percent of pts.
Dead	2	11
Permanent Residual Disability	8*	44
Probably Temporary Residual Disability	2	11
Full or Nearly Full Recovery	4	22
Still Hospitalized	1	6
Unknown	1	6
Total	18	100

*One patient sustained apparently permanent brain damage and was discharged from the hospital in an irreversible coma.

V. Comment

The paramedic program is being heavily used, and the load is growing steadily. The administrative, teaching and operational duties required by the program have increased the emergency department's work load by at least the equivalent of a half time physician and a full time nurse.

On the other hand, the paramedic program is now the source of more than 3 hospital admissions daily, each of whom stays more than 14 days. These patients contribute significantly to the hospital's inpatient revenues--a contribution which would presumably go elsewhere if NEC did not operate a base station.

More than half of the patients have noncardiac diagnoses. The nurses who operate the paramed station have received only a MICU course which focused primarily on cardiac related problems. As a result, more than half the runs involve medical problems the nurses haven't been trained to handle. This situation obviously poses severe risks to all parties involved.

In general, however, the program is working. The paramedics are usually able to supply pertinent and accurate medical history data. Most of the patients have done well, considering the severity of their problems, the difficulty in establishing diagnosis and treatment by remote control, and the system's resource constraints. The system can be significantly improved by broadening training and supervision of the nurses.

It would be interesting to compare the disease course and outcome of a similar group of patients treated before the system was installed with those treated by paramedics. Although such a study would be quite difficult to perform, I believe it would confirm that, on balance, the paramed program has substantially improved the community's emergency care.

LIST

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*SMHMC

Implementing Rural Emergency Health Service Systems

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The problems involved in providing emergency health services to a rural area are examined with Vermont serving as the example. Since most EMS studies have been conducted in urban areas, many of the resultant recommendations are invalid in a rural setting. Programs for training physicians, nurses and EMTs are inhibited by a lack of teachers, but the use of packaged teaching modules is proving worthwhile. A communications network utilizing the HEAR® is being implemented but basic problems include non-emergency use of the channel and inadequate staffing. A 12-point method of hospital categorization is underway with a goal of qualifying all Vermont hospitals at least at a "basic" level.

There is a new and refreshing interest in emergency health services research. While the product of this burgeoning interest is both exciting and encouraging, there remain endless questions to be answered. Few studies, for example, have attempted to link inadequacies of care and the frequency or degree of unsatisfactory outcome. Most of the studies are of urban areas and cannot help but reflect the properties of those areas alone. It is difficult, therefore, to document in quantitative fashion the different needs and resources of urban and rural areas. Lacking this information, differences in the corrective methods to be applied are not easily identified. But failure of precise documentation, simply because of lack of examination, should not obscure the fact that major differences do exist. These differences and their administrative implications are worthy of examination.

In referring to rural areas the term "rural" requires definition. Its application is generally limited to service areas of less than 30,000 to 40,000 persons. This usually involves population densities of less than 50 persons per square mile. As communities grow beyond this size, suburban patterns begin to emerge.

Prehospital Phase

In rural areas there may be substantial prolongation of the prehospital phase of care. This occurs for several reasons. Wider separation of houses means that calls for help are not always immediately heard. The frequent 'presence of a substantial proportion, even a majority, of non-residents suggests that some will not be missed when they go off the road or get in trouble in other ways. And there will be many who do not know how to enter or communicate with the emergency care system.

The relative inability to get into the emergency care system is not entirely unique to rural areas. There are the recluses and the isolated people in urban slums who have similar problems, who sometimes are not found for days after the onset of their injury or illness. But rural areas have such persons as well, probably in equivalent proportions. Thus the special problems already mentioned must be added to the common one of finding the social isolate.

Long delays during the prehospital phase of care may occur in rural areas because distances to the hospital or other medical facilities are generally great. In addition, police, fire, and ambulance services are often manned by widely scattered volunteers, or part-time personnel, who must be summoned from other activities. They are rarely just "ready to roll" at a moment's notice.

Rural emergency care personnel have extremely small per capita annual exposure to real, serious emergencies. No matter how excellent is their training, they may have difficulty in performing essential tasks because they have had inadequate exposure, under stress, to reinforce their skills. The combination of both problems, longer delays in obtaining aid and in transporting patients and the limitations of the personnel supplying the services, renders the prehospital phase of care a more frequent cause of unnecessary death and disability in

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rural areas than in urban areas. The implications of this observation do not appear very great when it is considered that most of the population in the United States is in urban or suburban residence. Yet it remains a frightening reality that 68% of highway fatalities occur in rural areas.

Hospital Phase

Once the patient arrives in the emergency department in a rural community he is likely to have to wait for a doctor, or even a nurse. When medical personnel do arrive, it is not unusual to find that their skills and judgments may be rusty from lack of use. Physicians or administrators associated with urban and suburban hospitals have some difficulty comprehending the nature of this problem. If a rural area physician or administrator sees a need for nighttime coverage of the emergency department, his urban counterpart suggests that a full time physician might be employed for this task. Similarly, with regard to nursing functions, the urban physician may be concerned with the need for triage among the many patients who wait in the emergency department. Yet on any one night in Vermont, in all except the largest hospital, there are on the average four or fewer emergency department visits after midnight. Nonetheless, there is a disturbingly large chance that the arriving patient may have serious problems, including multiple injuries from a highway crash. There is a constant challenge to provide medical coverage in a situation that usually cannot support a full time emergency physician, to cope with intrapatient triage instead of triage among several patients.

Training of Personnel

It is apparent that the training needs for personnel in rural areas differ from those of these same personnel in more densely populated regions. The emphasis, for the nurse and the ambulance technician, must be on simple procedures, not easily forgotten, which will maintain the patient for a sufficient time until the physician arrives. This means that an advanced 480 hour EMT course[1] probably is not appropriate to rural areas, although it might be essential in the urban setting. For the physician, the emphasis also has to be on diagnostic skills and procedures that are not likely to be lost, even if they are not called upon very often.

There remains an additional training problem that specially plagues the rural area, namely, that of finding sufficient instructors who are both competent and comfortable with the material to be taught. The 81 hour EMT course developed by Dunlap and Associates for the Department of Transportation[2] was pretested in Stamford, Connecticut where there was an adequate staff of physicians, including many specialists. But can the Dunlap package be taught as successfully in a service area with a total of eight physicians and osteopaths, including one pediatrician, one internist, one surgeon, and five general practitioners? Do they have the time? Are they comfortable with the material? Can they teach it? In too many cases the answer to one or more of these questions is "no."

Categorization

A system for the categorization of the capabilities of hospital emergency facilities, recently published if not endorsed by the American Medical Association,[3] clearly was not designed for rural areas. The unstated but basic assumption of the system is that the patient and his rescuers will have several hospitals from which to choose in a community, and that through categorization it will be possible to identify hospitals that should be bypassed in an emergency. Much more commonly, however, in rural areas there is at best only one hospital from which to choose. And that one, as already noted, may have staff who, despite excellent training, are hampered by the sparsity of their experience.

Communications

Special problems of communication exist in rural areas. This does not mean that the emergency communication systems of urban areas are free of difficulties. Two recent reports in *The New York Times* highlighted problems experienced in that city with its highly touted emergency telephone system utilizing the universal emergency telephone number, 911. They first stated that the system is clogged with relative non-emergencies, that persons calling 911 may have to wait ten minutes or longer before an operator answers the phone, and that once the call is taken there may be an additional delay, of as much as an hour or more, before those providing assistance arrive. The second report described the collapse of an old hotel in the city with the deaths of several among the over 300 residents. In this case emergency calls to the 911 system, made *before* the collapse, failed to reach the operator, and the opportunity was lost to evacuate the building and thus avert the tragedy.

Those are the problems with a single city-wide system involving several million persons. More common rural problems are emphasized by a recent study of emergency communications in Vermont.[4] For a population of 450,000 residents, there are over 250 separate townships, 94 ambulance services, 56 police departments, and 227 fire departments. Inquiries were made to determine how they currently communicate, both in and between organizations, as well as how they receive calls. A few examples of good interagency communication were found as well as many instances of quite acceptable internal communication within police departments. Communication in ambulance groups was especially good, partly as a result of the active promotion by the State Department of Health of the ambulance-to-hospital HEAR* communication system.* Communication patterns involving fire departments, however, were appalling. In particular, it was alarming to obtain entirely different descriptions of *interagency* communication patterns from two or more agencies located in a single community.

Further confounding communication coordination, Vermont is serviced by ten different telephone companies. In exploring the possibilities and costs of establishing central communication patterns involving the universal emergency telephone number 911, only one of these public utilities appeared to have any concept of such a system.

With these problems as background, possible solutions can be grouped under the headings of overall planning,

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* Hospital Emergency Administrative Radio. Motorola, Inc.

training, communication, and categorization of hospital emergency capabilities.

Overall Planning

The pattern of rural emergency services in Vermont and the problems of overall planning have been described in detail.[5,6] It is worthy of note that the state has been divided into 13 ambulance districts, each equivalent to the patient shed of one or, occasionally, more than one hospital. The districts are governed by elected district boards which in some cases have functioned both diligently and knowledgeably, and in other cases neither diligently nor knowledgeably. Those districts appear to function best in which there is a single identifiable and experienced person who becomes the focus and serves as the guide for planning activities. Despite the relatively small size of the state, the services of the Coordinator of Emergency Health Services of the State Department of Health are spread much too thin. For this reason the Department is planning to add three regional coordinators who can work more closely with the less active or effective districts.

Training

There are training problems which are common to all personnel involved, whether they be the first police officer or ambulance attendant called to assist in rescue, or the first physician called to the emergency department. With one exception, the material covered in the 81 hour EMT course[2] is quite adequate for the many volunteer ambulance personnel who provide the services. These people perform their rescue functions out of a sense of civic responsibility and pride, but with little or no previous background or other current activities in the field of health services.

Regarding the exception, there may be prolonged delays before patients with serious hemorrhage are given the specific life supporting treatment they require. This vexing problem is the product of the time consumed in transporting patients long distances from the scene of their emergency to the hospital, or from one hospital to another, and the delays introduced by inclement weather. Although some of these patients might benefit substantially from earlier therapy with intravenous fluids, IV techniques cannot be learned and retained effectively by most of the volunteers. In selected cases, however, such skills *can* be acquired and we have begun to teach them. The individuals receiving such training are chosen for high intelligence, have several years of continuous experience, and are under the close scrutiny of the director of the emergency department of the Medical Center Hospital of Vermont.

In a workshop for hospital personnel held in January 1973, emergency department nurses and physicians were asked to identify those procedures that they considered so crucial to saving life and limb that they must be known by every professional in the emergency department.[7] The nurses also specified those crucial procedures that could be performed in the absence of the physician. The nursing procedures given the highest priority by the attendees are now being taught under a Regional Medical Program grant. Similar training has been requested for physicians by the Vermont Medical Society.

In considering what should be taught to personnel in rural areas, there must be equal interest in who should do the teaching. Participation by local physicians and nurses in teaching of ambulance personnel promotes their understanding of the needs, capabilities, and limitations of these personnel. Fostering an ongoing case review by all emergency health care workers assures that relatively infrequent emergency experiences are efficiently garnered, conserved, and applied. The experience of a single ambulance driver and attendant can provide a review and learning session for the entire ambulance squad and for the emergency department staff as well.

The training given in the EMT course has been spotty, for the reasons already described, but the use of local physicians as teachers has not been abandoned. Instead, packaged teaching modules are being developed for the local physician so that he can observe, listen, and learn together with the students. Without the substantial class preparation which is required for use of the unmodified Dunlap material, the physician can thus participate in the teaching process in an undemanding, comfortable role, namely, making comments on the material and clarifying student questions.

For the nurses' course, it was not feasible to develop local programs for 18 hospitals, nor could a team of circuit riders be assembled. Therefore, the basic course is presented in one place and repeated five times during the year as an intensive 4-day program. The nurses stay at the Medical Center in Burlington for the course duration. The nursing coordinator has responsibility for course development and follow up in the local hospitals, to help ensure that what is learned is also implemented. Other rural areas are beginning to follow similar training patterns in response to comparable problems.

The option of using junior colleges for the courses carries the same inherent difficulties of obtaining faculty. The junior college does offer a more formal teaching setting, if desired, and the advantage of educational monies which may be earmarked to teach the course.

Communication

The HEAR® radio system is now installed, or on order, in all hospitals in Vermont. It is also being used in most ambulances. While it appears to be a good system, several transitional problems in implementation were encountered. First, a year full of difficulties was endured before the new equipment was entirely functional and before adequate training in its use had been given to those involved with its operation. The problems do not, however, appear to be unique to the system as they have been experienced in like measure with other communication systems.

Second, hospital administrators in several New England states became convinced that the system could serve a dual purpose, that it could be used as well for intrahospital, non-emergency communications. Such added "usefulness" was found to disastrously disrupt emergency communication. The New England Council for Emergency Medical Services therefore appealed to the Federal Communication Commission to prohibit non-emergency use of the FCC channel and

to provide more dedicated emergency communication channels.

Third, in several of the small Vermont hospitals the emergency department is entirely empty at night, the nurse being assigned duty elsewhere in the hospital. The radio at these hospitals usually is located at the hospital switchboard where it is in the hands of a person who does not have the requisite emergency training. Under these circumstances there should be an additional remote station located in the emergency department so that, once called to duty at that location, the nurse does not have to continue to communicate through the switchboard operator.

Concerning the issue of central dispatch, most Vermont communities are not ready to accept such a program. There is the possibility of linking police and ambulance communications; but in most cases the communication patterns of fire departments are in such serious disarray that to add them would only represent a step backward. Similar problems may exist in other rural areas.

Categorization of Hospital Emergency Capabilities

Without the option of bypassing hospitals in rural areas, one must ensure that all hospitals at least meet minimum specifications. What should those be? It was clear that were criteria adopted for staff alone, these could be met without any improvement in patient care. Performance criteria were therefore selected. It was determined that there must be provided at all hours, as a minimum, capability for the resuscitation and stabilization of persons with severe problems threatening life or limb. If a hospital has a unit that can provide care for minor emergencies, but is unable to deal at such a basic level with serious emergencies, that unit should not be classified as an emergency department but rather as an outpatient facility.

Twelve criteria for designation of a hospital as a "basic" emergency facility were defined. Work is underway in all Vermont hospitals to ensure that they can meet at least these criteria and, if possible, those for two higher categories. A basic facility must meet these requirements:

1. A two-way radio must be available with the capability of contacting other hospitals and all emergency care ambulances in the ambulance district. There must be staff available 24 hours a day who are trained and proficient in its use.

2. A nurse must be in the hospital and available to the emergency department, 24 hours a day, trained and proficient in triage, resuscitation, maintenance of airway and respiration, and basics of ECG operation and interpretation. She must be able to identify cardiac standstill, ventricular fibrillation, and premature ventricular contractions, and must be skilled in the elements of cardiopulmonary resuscitation, application of pressure dressings, immobilization of fractures, venipuncture, and intravenous therapy.

3. Appropriate protocols (or standing orders) to cover the above emergency activities must be established for use while the physician is en route to the hospital.

4. There must be a physician in the hospital or on call, 24 hours a day, and available within 15 minutes of notification, who is capable of stopping external hemorrhage; performing cardiopulmonary resuscitation, including defibrillation, administration of cardiac drugs, tracheal intubation and chest intubation; immobilizing fractures, and initiating blood volume replacement. A portable page system (preferably voice) is recommended for the physician on call: this should not be a part of the HEAR® system.

5. Laboratory and X-ray technicians available in the hospital or on call and assessible within 30 minutes 24 hours a day.

6. The following equipment must be available as a minimum:

a) Examining tables with safety belts capable of being rolled from the emergency department to other locations in the hospital without the necessity of transferring the patient.

b) Laryngoscope

c) Oxygen

d) Suction

e) Airways—all sizes

f) Resuscitation equipment

g) Blood volume replacement equipment (and blood available within the hospital)

h) Long bone splints and backboards

i) Sutures, hemostats, and other routine materials for control of external hemorrhage

j) Cardiac emergency equipment

k) Incubator (within the hospital)

7. An active emergency department committee must be created, that meets at least four times a year (and preferably more often), with authority and responsibility to review the operation of the department. It should serve to audit patient care and to make recommendations to be reviewed by the governing body of the hospital. If such recommendations are not implemented, or if they are modified by the governing body, the committee should be informed in writing of the action taken and its rationale. It is recommended that such a committee include a physician, emergency department nurse, and representatives of the hospital administration and ambulance services. Minutes shall be kept of its deliberations. Criteria for committee operation are in process of development.

8. Signs of appropriate size and legibility are required to be placed at strategic locations throughout the community identifying the location of the hospital or related facility. There must be similar signs around the facility identifying the location of the emergency department.

9. The entrance to the emergency department must be well marked and illuminated so that it can be readily identified at all times, even by persons under severe stress. It is recommended that the area around the emergency department entrance be protected from weather.

10. A formal plan must be published, disseminated widely among the staff, and readily available in the emergency department, describing the medical coverage for all hours. The schedule must list the name of the physician with primary responsibility for the services outlined in item 4 above, and those responsible for back up specialty coverage in at least internal medicine and surgery. If possible,

back up specialty coverage in obstetrics, pediatrics, orthopedic surgery, and psychiatry shall be included.

11. A formal plan must be published, disseminated widely among the staff, and readily available in the emergency department, covering the management of specific patient situations. It should identify, by problems, those patients who are to be provided with basic emergency care only and then transferred, as well as the necessary procedures to be performed. The arrangements to be made with the ambulance service, other emergency transfer personnel, and with the hospital that is to receive the patient are to be defined. A patient record outlining problems and treatment shall accompany all patients who are transferred.

12. A record of patient problems, care, and outcome, that permits easy and comprehensive review by the emergency department committee, is to be prepared on all patients. Minimum informational requirements are being developed.

The implementation of this system will take time. It includes several philosophical, psychological, and administrative considerations, which have been discussed elsewhere,[8] involving participation in decision processes by many groups. Of major importance is an understanding of the character of the emergency care that the patient should be able to expect in each hospital. In evaluating hospitals it can be asked, very specifically, whether resuscitation and stabilization were achieved in all cases in which they were required; if not, why not; and what, if anything, has been done to avoid similar problems in the future? Thus, it can be determined whether we are really accomplishing our objective, that of implementing rural emergency health service systems. ◆

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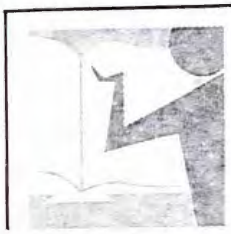

BOOKS

CASE STUDIES IN EMERGENCY MEDICINE

Frederic W. Platt, MD
Little Brown and Company, Boston, 1974 - $8.29

Dr. Platt has selected for discussion 80 cases from a busy inner city hospital emergency department. Each case is briefly presented. A few questions concerning the case are offered. A discussion of the case then follows which includes an examination of the appropriate or inappropriate way in which the problem or problems were managed.

If you spend any time in an Emergency Department, you will enjoy reading the book. Each case will remind you of similar cases you have seen and of mistakes and successes you have had. It is important to be reminded regularly of both.

One might wish Dr. Platt had chosen to arrange the cases in some particular order: Those that illustrate strictly therapeutic or management problems could have been placed in one group, those that illustrate administrative problems in a second group, while diagnostic problems might have been assigned to a third. On the other hand the random presentation of problems parallels the actual conditions that face emergency physicians. Some of the cases and their dispositions are illustrative of situations that apply only to Dr. Platt's Emergency Department. The majority of the lessons are applicable in any Emergency Department in the United States.

We wish Dr. Platt had utilized Emergency *Department* instead of Emergency *Room* throughout the text. One might also disagree with certain of the statements made, such as "The AMA form has little place in the Emergency Room," but these are minor matters.

The book should be "must" reading within those Emergency Departments where house staff do a substantial part of the patient care. The cases, as presented, could well be used as material for regular teaching conferences. I believe Emergency Department nurses will enjoy and profit from the material. You will want to leave your copy in the Department for the nurses when you have finished it.

William T. Haeck, MD

Elements of a comprehensive Emergency Medical Services system

*Judith Henson**
*Don M. Benson, MD***
Pittsburgh, Pennsylvania

A "systems" approach to the provision of emergency medical services allows community leaders to plan and implement a comprehensive program to meet their specific needs. Development of an effective EMS system requires familiarity with the components of which the system is made up. Among the necessary components are recognition of an emergency situation, the provision of first aid, the ability to communicate with emergency treatment facilities, transportation in appropriate vehicles, the availability of well-trained emergency care personnel, categorization of emergency care facilities, and data collection and audit. It is imperative that dynamic, informed civic and professional leaders assume responsibility for making comprehensive emergency medical services a reality rather than a much-discussed but unfulfilled "plan."

The potential for survival following sudden catastrophic illness and injury is maximized when the incident is promptly recognized and the cry for help is answered rapidly. Those who respond to the incident must be well trained, properly equipped personnel who can immediately initiate life support actions and perform rescue and extrication procedures.

Establishment of a communication channel between the rescuer and a physician or medical advisor extends the capability of the system still further. It provides a means by which the administration of definitive treatment may be guided by medical personnel.

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Therapy, in the form of intravenous fluids, resuscitative drugs and defibrillation, may be needed to stabilize the patient's vital systems at the scene and during transport. Personnel at the receiving hospital should be able to continue life support activities. If necessary, arrangements for orderly transfer of the patient to a higher echelon facility—one offering extended critical care—should be routine.

All elements of such a sophisticated, multilevel, multifaceted response system must operate in an expeditious, coordinated manner, following a general prearranged plan of action. Yet each must retain sufficient flexibility to deal effectively with unforeseen contingencies.

The various phases of medical emergencies will be examined and methods suggested by which the community response in each phase might be optimized. General recommendations for the implementation of such an emergency medical response system, will be offered.

RECOGNITION

Before any of today's resuscitative measures can be applied, someone must recognize that an emergency exists. In some instances, such as motor vehicle accidents, recognizing the existence of an emergency is no problem; but in others, it can be very difficult. The middle-aged man experiencing moderate chest pain may dismiss it as "indigestion" or "heartburn." He may take a patent medicine and wait for the pain to pass, failing to realize that the pain may be the harbinger of acute myocardial infarction. Since 60% of myocardial infarction deaths occur within one hour after onset of symptoms,[1-3] the present median delay of 3½ hours in seeking help[4] renders many of our present life-saving procedures useless.

Clearly, there is need to improve the public's knowledge regarding acute myocardial infarction and other common emergencies. Educational programs which attempt to alleviate this potentially lethal ignorance should not only emphasize the need for promptly requesting assistance in cases of suspected heart attack but also the favorable outcomes resulting from early initiation of high quality care for heart attack patients.[5] This latter aspect is important in helping to alleviate the anxiety and reticence associated with admitting, especially to oneself, that a potentially lethal event has occurred.

Having recognized that an emergency exists, those on the scene must initiate appropriate action if an optimal outcome is to be realized.[6-8]

FIRST AID

By including courses in emergency care and resuscitation in high school curricula and as a prerequisite for obtaining a motor vehicle operator's license, the general public would be better equipped to provide immediate on-site measures essential for survival.

First-aid courses for the general public should provide training in airway control including head tilt, mouth-to-mouth and mouth-to-nose breathing, forward displacement of the mandible, removal of an obstructing foreign body, and positive pressure ventilation.[9] Training in methods of controlling hemorrhage and immobilization of fractures (including possible fractures of the spine) is equally essential.

External cardiac compression cannot be learned to proficiency without actual practice by the student. Therefore, programs of instruction in cardiopulmonary resuscitation must include instructor-guided practice on life-like resuscitation manikins. A new resuscitation manikin (Fig. 1) automatically provides the trainee with a printed record of his performance. Such a manikin can reduce the number of instructor hours required to train a population, thereby increasing the feasibility of training large numbers of people. In addition, it can provide the opportunity for controlled practice in privacy, thus eliminating the potentially embarrassing situations created when students are required to demonstrate their proficiency, or their lack of it, in the presence of others.[10]

COMMUNICATION

After an emergency has been recognized and immediate first aid has been started, help must be summoned. In many areas of the country, this may be a monumental problem. Bystanders may not know who to call for help. Should a call be placed to the police, the fire department, the telephone operator, the hospital emergency department, a private ambulance company or a special rescue

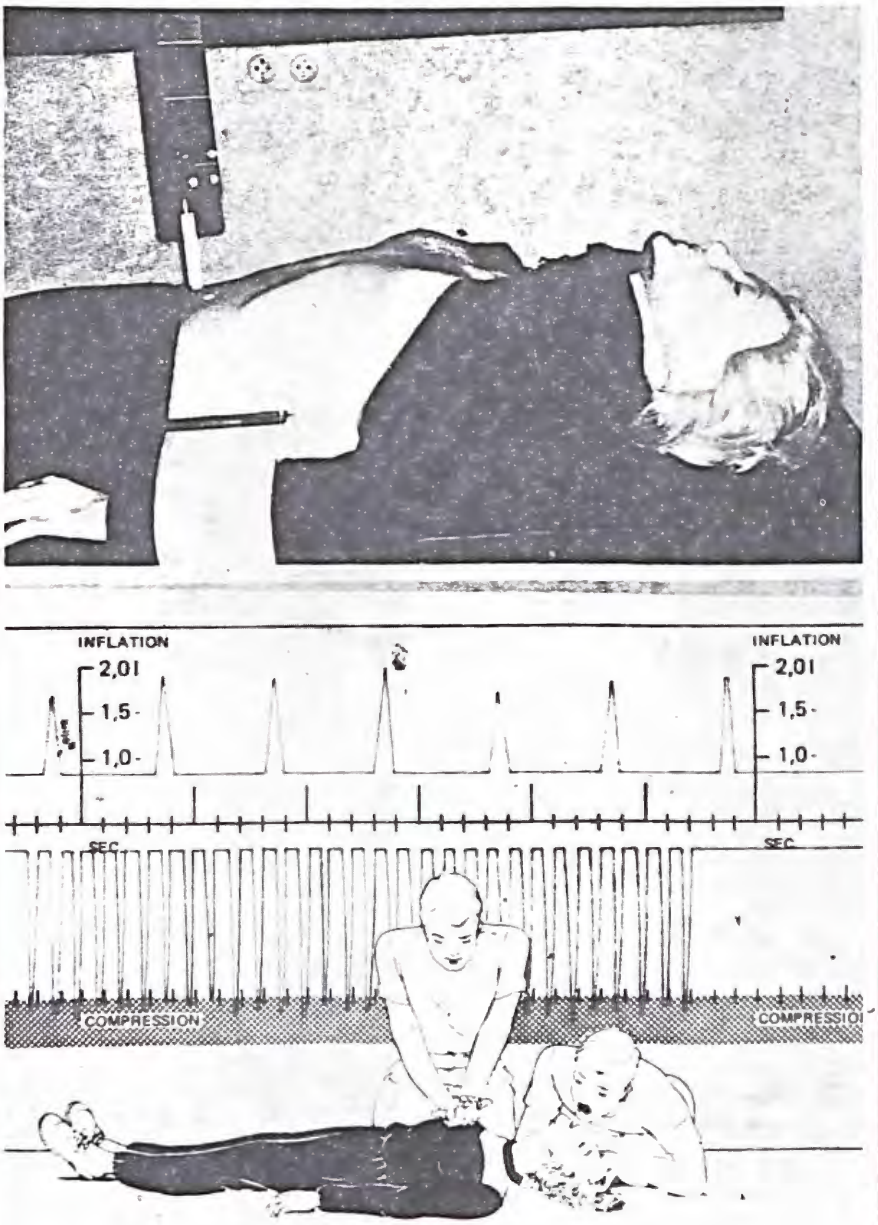

FIGURE 1. ***New Laerdal Resusci-Anne CPR recording manikin.*** *Top: battery-powered recorder in abdomen automatically delivers record from left flank. Pole on right hip with lights and metronome is for teaching correct rhythmic performance. Trainee learns by seeing correct ventilation performance (green light), correct external cardiac compression (ECC) performance (red light) and incorrect ECC hand position (yellow light). Instructor can control spontaneous pulse and pupillary constriction and dilation. Enclosed in manikin's suitcase are flip-chart pictures and tape-recorded coaching for manikin practice. Bottom: record of ventilation volumes and sternal compressions. Incorrect positioning of hands for compressions is also recorded.*

From: Kirimli, B and Safar, P: Ch. V/iv, Training Methods in Cardiopulmonary Resuscitation, pp. 453-477, in Meltzer, L.E. and Dunning, A.J. (Editors): Textbook of Coronary Care, The Charles Press, Philadelphia/Excerpta Medica, Amsterdam, 1972.

unit? Lack of a coin to place a call may delay communication with rescue personnel. Strangers in the community may be unable to determine the location from which they are calling. This can delay or prevent their providing direction of the rescue unit to the scene of the emergency.

Ideally, any person should be able to obtain access to the emergency medical services system by dialing the "universal" emergency telephone number from any telephone without inserting a coin.[11] In the United States, the number '911 is set aside and dedicated for use in emergencies. In areas where access to private or coin phones may be limited, such as beaches, expressways or crowded shopping plazas, two-way emergency telephones providing direct communication with an emergency center should be available. Where such telephones have replaced fire alarm pull boxes, the emergency response system capability has been improved and the incidence of false fire alarms has plummeted.[12] The ability to analyze the nature of the emergency, and dispatch the appropriate resources, has reduced cost as well as exposure to hazard for the public and rescue crews.

Where financial or technical limitations preclude prompt conversion to a 911 system, simple modifications of existing telephone systems can substantially enhance the community's ability to respond to a call for help. Existing coin telephone systems can be modified to allow access to the operator without first inserting a coin ("Dial tone first"). Posting the street address of each coin phone on the face of the instrument will enable callers unfamiliar with the neighborhood to identify their location when requesting help. Small adhesive telephone labels giving local emergency telephone numbers can be distributed throughout the community by enclosing them with the water or electricity bills.

The communication system component upon which all others depend is the Emergency Operations Center (EOC). EOC functions include receiving and analyzing emergency calls for assistance, dispatching and coordinating the response units (e.g., ambulance, rescue trucks, fire equipment), and issuing "what to do" instructions to the caller pending arrival of rescue vehicles.

Automatic EOC equipment should be capable of pinpointing the location of the caller. Reliable communication links must exist between the EOC and all organizations participating in the rescue response. Closed circuit telephone lines or two-way radio systems must be used to protect communications security under adverse conditions, such as civil disorder and mass disaster.

All units participating in the emergency rescue efforts should be linked by two-way voice communication equipment. When rescue efforts are made by specialized units with widely disparate functions (e.g., snowplow, fire rescue, and ambulance) all should share a common radio frequency so that plans and action can be directly coordinated.[13]

Like telephone systems, radio networks have limitations. Most commonly used two-way radio systems allow broadcasting of only one message at a time. Simultaneous broadcasting of two messages results in varying distortion of both. Since many potential users employ a single frequency, optimal use of available transmission time demands that all messages be brief and meaningful. Use of the communications code such as that shown in Figure 2 facilitates succinctness and also provides a modicum of privacy.[14]

TELEMETRY

Physiologic data requires interpretation by personnel specially trained in its evaluation. Telemetry is a communication technique which permits data to be collected and transmitted so that its interpretation may be accomplished at a distance. For example, the standard electrocardiograph signal can be broadcast (telemetered) to a physician with the proper receiving equipment permitting review and interpretation of the

FIGURE 2.
EMERGENCY COMMUNICATIONS CODE

Case	Region of Body	Ten Code
1. Breathing or Airway Disturbance	1. Head	10-4 OK
2. Bleeding or Open Wound	2. Face	10-5 What is the patient's condition
3. Bones, Poss. Fracture	3. Neck	10-8 Back in service, Available for call
4. CARDIAC ARREST	4. Chest	10-9 Repeat message
5. Burn	5. Abdomen	10-19 Return to station
6. Blunt or Closed Trauma	6. Perineum	10-20 What is your location
7. Heart Attack	7. Upper Extremity	10-23 Stand-by
8. Stupor or Coma	8. Lower Extremity	10-24 Police help needed
9. Dead at Scene	9. Multiple Regions Involved	10-30 Test count
12. Routine Case	11. Back	10-31 How are you receiving
13. O B Patient	12. No Specific Region Involved	10-96 Enroute to scene
14. Multiple Trauma Case	**Condition of Patient**	10-97 Arrived at scene
15. Pain in _____	2. Serious	10-98 Patient in amb. enroute to Hos.
18. Psychiatric Case	4. Life Threatening	
19. Intoxicated	12. Satisfactory	
20. Refused Service	13. Delivery Imminent	
21. No Patient		

ECG tracing at some distance from the scene.[15-17] Ambulance equipment should include devices which will permit telemetry of electrocardiogram.

VEHICLES

A comprehensive emergency medical services system requires that all ambulances be designed, equipped and manned to provide light rescue, life-support, extrication and transportation of the critically ill and injured. Minimal requirements for ambulance design and equipment have been published by the National Academy of Sciences Sub-Committee on Ambulance Services.[18] These requirements have been adopted, in part, by the U.S. Department of Transportation. The standards, written by an expert panel of physicians and non-physician emergency care specialists, describe the minimal spatial configuration of the vehicle and the essential fixed and portable life-support equipment to care for the critically ill and injured.

BASIC TRAINING OF PERSONNEL

Patient care attendants must have attained basic competency in emergency care procedures. These include, at a minimum, procedures required to sustain viability of essential organs until adequate spontaneous function can be restored by definitive care. They must further have knowledge of what and what not to do to prevent aggravation of the illness or injury.

Currently the standard basic training program for emergency medical technicians (EMT's) consists of 71 hours of seminars, demonstrations and practice conducted by physicians and lay professionals. The training course subject matter includes airway control, intermittent positive pressure ventilation, oxygenation, and cardiopulmonary resuscitation. Management of situations involving possible spine injuries, fractures, wounds, hemorrhage, emergency child birth, stroke and myocardial infarction, is presented. In addition, emergency vehicle operation, light rescue and extrication, and administrative aspects of ambulance services are included. The trainees must also spend ten hours observing patient care in hospital critical care areas such as the operating room, recovery room, intensive care unit and emergency department.[19]

Upon completion of this course, or its equivalent, the emergency medical technician is eligible to take the examination for the Registry of Emergency Medical Technicians — Ambulance.[20-21] Just as a nurse is "registered" at the state level, so also may ambulance personnel now be "registered" at the national level. After successfully completing written and practical examinations in emergency care methods, the emergency medical technician is issued a nationally recognized certificate of proficiency and is entitled to display the registry patch on his uniform. Registration is valid for a period of three years. Renewal is not automatic but requires submission for re-examination of competence.

MOBILE INTENSIVE CARE

Pilot projects in many areas of the country have demonstrated that mobile intensive care type ambulance services can substantially reduce pre-hospital mortality and morbidity.[6,12,23]

Mobile intensive care units (MICU's) are ambulances which meet national standards and carry equipment for the provision of definitive care as well as emergency care. Definitive care includes measures to prevent cardiac arrest and irreversible organ damage from anoxia, shock and other serious conditions. Diagnosis, defibrillation, drug therapy, and intravenous fluid therapy must be within the capability of the unit. Equipment and supplies for providing definitive care include an electrocardioscope, a defibrillator, intravenous infusion equipment, resuscitative drugs and equipment for emergency surgical procedures. The MICU may, in addition, carry equipment for telemetry of physiologic data from the site to an advising physician.[22]

HIGHER LEVEL TRAINING

Personnel on board the MICU should be trained to the intermediate emergency medical technician level.[24] The intermediate level, to be defined by the National Academy of Sciences/National Research Council Sub-committee on Cardiac Emergencies, will probably consist of 80 to 100 hours of training in addition to that required for the basic level EMT. The content of the intermediate level program will include medical observation and communication, review of airway control, oxygenation, ventilation, external cardiac compression, intravenous fluid therapy, defibrillation, telemetry-medical command systems, safe use of resuscitative drugs and maintenance of definitive care equipment.

In addition to the two levels of EMT training described above, a third program consisting of 480 hours of instruction is available.[25] This course reviews all the material presented in the basic and intermediate programs and provides the EMT with a more intensive education in emergency care, organization, and communication, which includes much clinical and administrative experience. The advanced EMT training is sometimes coupled with a physician's assistant program as in the program at Yale University.[26] Courses have also been provided through the junior colleges leading to the Associate of Arts or Associate of Science degrees.[27] Combinations of both these programs can be found.* Advanced programs of this type are designed to train EMT's for positions of responsibility in this field.

CONTINUING EDUCATION

A comprehensive emergency medical services system requires a program for continuing education of emergency care personnel. This program, delivered through annual or semi-annual meetings of professional associations as well as through

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professional journals[28] enables emergency medical technicians to maintain knowledge and learn improved methods of providing emergency health care.

Ambulance and mobile intensive care services should have a medical advisor who conducts frequent debriefing and practice sessions. At these meetings, which should be held at least monthly, the EMT's may present problems, discuss cases, or investigate innovations in emergency care. They may also practice skills learned earlier so that life-saving techniques, not utilized routinely, may be performed satisfactorily when they are required.

LEVELS OF CAPABILITY

Speed in getting the patient to the emergency facility is usually not crucial if rescue personnel are properly trained, adequately equipped and work in a well-designed vehicle. In fact, speed is frequently detrimental.[29] Far more important than speed en route is the level of capability of the receiving facility.[30]

Limitations in financing and manpower, as well as increasing demand for service, make it impractical and unreasonable for every hospital to offer a full spectrum of elaborate critical care services. While all hospitals which receive emergency patients should offer basic life-support services, not all hospitals should attempt to provide sophisticated care of the critically ill and injured. Instead, hospital capability should be inventoried and categorized according to the degree of sophistication available. Changes should be implemented as appropriate within the frame-work of a community plan to improve some and, perhaps, downgrade others.

The ultimate goal of hospital categorization is to offer critically ill patients the best possible care at the lowest cost. The immediate objectives of categorization should be two-fold: (1) to provide ambulance operators with a list, endorsed by both providers and consumers, of hospitals which should receive the critically ill patient; (2) to provide physicians attending the critically ill and injured with information on levels of critical care services available within the local referral region. Since less than 2% of present Emergency Department visits are for critical, life-threatening conditions, the present patterns of emergency department usage would be little changed. Instead, complex, expensive-to-manage patient problems would be selectively routed to the nearest appropriate emergency facility.

There are situations when terrain, weather or other circumstances make transportation to an emergency care facility impossible or impractical. Emergency receiving facilities, be they hospitals, industrial clinics or emergency care stations, should be capable of providing life-support functions and arranging for transportation via mobile intensive care unit to a definitive care facility.

CATEGORIZATION

Categories of emergency care offered by various types of hospitals[31] as well as methods for surveying and categorizing hospital emergency facilities[32,33] have been published. One categorization scheme has been proposed which divides medical facilities into four types.

The Type IV facility need not have a doctor available full time, but must be staffed by emergency medical technicians capable of sustaining the critically ill and arranging transportation, with on-going life support, to a more comprehensive facility.

A Type III facility is staffed 24-hours-a-day by a physician and has the capability of providing intensive nursing care and routine surgical care.

Type II facilities are staffed 24-hours-a-day by a physician as well as physician specialists of at least the resident level in those fields required for emergency life support, which includes anesthesia, surgery, internal medicine, pediatrics, obstetrics. The availability of nearby specialty hospitals may eliminate the need for pediatricians or obstetricians in the primary receiving hospital.

A Type I facility provides comprehensive medical care and is staffed 24-hours-a-day by physicians representing the major specialties required for life support. In addition, this facility should have advanced intensive care capability which includes a physician specialist exclusively committed to the care of the critically ill and injured. This facility should offer treatment for complex problems of patients with multiple organ failure.[34]

DATA COLLECTION AND AUDIT

A comprehensive emergency medical services system will include a mechanism for gathering data which describes the performance of all subsystem components such as bystanders, system-access ambulances, and referral hospitals. Such data should be processed by a central computer facility and should relate patient outcome to the performance of each subsystem component. This data should be used to improve the system and, hopefully, to decrease cost.

By installing computer terminals in accessible locations, physicians faced with difficult patient care problems may request information from the data bank on how such problems have been handled in the past and the outcomes that have been attained by various methods of management.[35]

COMMUNITY COUNCILS

Persons responsible for emergency medical system operations must seek input from health care consumers. Careful consideration of consumer comments may help to develop more efficient methods of dealing with patient problems. Where efficiency cannot be improved, or where consumer demands are unrealistic, the dialogue established between consumers and providers may alleviate much misunderstanding and hostility.

Since the emergency medical services system will undoubtedly be asked to accept new and improved treatment methods, a responsible group of providers and consumers

must be available to study and screen proposed alterations in the system. Such a group will ensure that responsible, humane, ethical, and medically sound practices prevail. Products and methods that are screened by such a committee and subsequently pass field tests, may then be introduced on a wide scale.

The tragedies in the operations of emergency medical services do not occur because knowledge and skills are lacking. The tragedies arise from failure to use existing knowledge and skills in a productive manner.

Since a comprehensive emergency medical service system impinges upon so many traditional lines of authority, interest and responsibility, the most effective way to plan and implement needed changes is through a Community Council on Emergency Medical Services. This local Council must have representatives from all parties concerned with local emergency medical services. Broad-based representation will encourage the discussion necessary to resolve conflicts and plan needed changes. Such a community council may be formed *de novo* or as an outgrowth of an existing organization such as a county medical society or a hospital council. Some areas of interest to community councils should be public education and training, communications, ambulance design and equipment, training for emergency medical technicians and allied health professionals, hospital categorization, regionalization of care, research and evaluation.

In summary, the development of an effective emergency medical services system that is responsive to the community's needs is a matter that should carry high priority with community planners. Although the difficulty of devising such a system may seem overwhelming, a concerted effort by consumers and providers joined in a community council can plan and implement an EMS system using technology that is currently available. It is doubtful if any other system can produce such widespread benefits to the community it serves. ◆

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JUNE 1,2,3, 1975

THE FUTURE OF THE PHOTOGRAPHIC BUSINESS

Purpose: To provide an objective assessment of the changing photographic markets, including the highlighting of new applications and the most promising market and product sectors expected to have the greatest potential for future exploitation. Attention will also be paid to the worldwide nature of the photographic business. Current and future market profiles will be presented and analyzed in light of the changing technology, market trends, industry patterns, and user characteristics and operational constraints. This will be done primarily for the U.S. but will be supplemented by international commentary where appropriate.

Major changes in the photographic industry have been occurring and will continue to do so in the future. The pocket instant load camera system in the amateur market; the present Polaroid and potential Kodak instant camera competition; new products and technology in X-Ray recording, duplicating and reproduction; changing status of microfilm and its areas of greatest promise; super 8 video cassette players and color TV; new graphic arts developments; available light movie photography and anticipated improvements in color available light still photography; home movie sound on film recording and playback; non-silver materials and dry processing – are but some of the examples providing good future growth of the market. Not all segments will share in this growth and these will be cited.

Market and technological factors and trends will be discussed in depth as will current and emerging applications for photographic products and processes. Advantages and disadvantages of current and proposed systems will be covered. This conference will provide you with the latest information on and the opportunities available in this large, evolving marketplace currently estimated at $5 billion per year at the manufacturers level.

Who should attend: All with a stake in the future of photographic markets should attend. Future decision-making in product and market planning, marketing, research and engineering could be influenced by what is learned at this conference. Anyone who needs to remain aware of the changes in the marketplace, who needs the latest information on trends in the technology or is seeking market or product opportunities within the photographic field, should attend this meeting.

Sessions will be held on the following topics:

- Photographic Industry Overview in the U.S.
- Dynamics of the Amateur Photographic Markets
- Graphic Arts – What Opportunities?
- Challenges to Photographic Imaging in Medical Diagnosis
- The Future Fit of Silverless Photographic Processes
- Audiovisual Field – New Products and Trends
- The Microfilm Business and Its Future
- The International Marketplace for Photographic Supplies and Equipment

Conference Leaders

- Elliott D. Novak, Chairman — Arthur D. Little, Inc.
- Dr. Ronald Francis — Rochester Institute of Technology
- Donald B. Grim — Eastman Kodak Company
- Thomas W. Hope — Audiovisual Consultant
- Paul Maraist — Bell and Howell
- Frank J. Romano — Graphic Arts Marketing Associates

Attendance: Restricted with registrations accepted on a first-come, first-served basis. This will allow an active dialogue to be established as an integral part of each session and ensure maximum information transfer between conference leaders and attendees.

Fee: $385.00 per registrant ($360.00 without room).
In addition to conference participation this fee includes accommodations, meals, beverages, conference materials and all necessary extras. Reduced rates are available for companies sending two or more representatives.

Location/Arrival: The Castle Hill Conference Center is located in Ipswich, Massachusetts, some thirty miles north of Boston. Participants arriving by air, between the hours of 2:30 and 5:30 P.M., will have transportation to and from Castle Hill provided. Participants should report to the Delta Air Lines Group Room, which is the first door on the right after Gate 12, at the Delta terminal.
For those coming by automobile, the Center is easily reached by taking Route 128 North to Route 1A (Exit 20N), following the signs toward Ipswich, and turning right at a large Castle Hill sign just before Ipswich Center. Participants will of course be briefed in detail on all such matters upon receipt of their applications.

For Further Information:
Contact —

INSTITUTE FOR GRAPHIC COMMUNICATION
375 Commonwealth Ave., Boston, Mass 02115
Tel. (617) 267-9425

During the Conference —
Castle Hill Foundation, Ipswich, Ma., Tel. (617) 356-4351
Professional Certificates will be awarded to all participants

PROGRAM

Sunday, June 1, 1975

4:00—5:00 P.M. — Arrival and registration at Conference Site (See Arrival Information), time to unpack and familiarize yourself with the site and its surroundings.

5:45 P.M. — Cocktails

6:30 P.M. — Dinner

8:00 P.M. — Introductory session, including a brief orientation on IGC; general introduction of conference participants and subject matter; outline of conference objectives.

9:00 P.M. – SESSION 1

Photo Industry Overview in the U.S.

- Size of total business – now and in the future
- Where the market will grow
- Amateur versus non-amateur
- Comments on professional and industrial markets
- Future growth markets and submarkets to watch
- Low growth sectors
- International impact – what areas?

Monday, June 2, 1975

When you wish – Wake-up (coffee waiting).

8:00 - 8:45 A.M. – Breakfast served.

9:00 A.M. – SESSION 2

Dynamics of the Amateur Photographic Markets

- Overall amateur perspective
- Legal considerations
- The key growth sectors and products
- Amateur film
  - New developments
  - Market size trends
  - Suppliers of 110 film
  - Significance of color film
  - Influence of Kodak
  - Kodak versus Polaroid
  - SX-70 film and Polacolor 2
  - Status of imports
  - Other film suppliers
  - Available light color
  - Outlook for film business
- Photofinishing
  - Consolidation trends
  - Value and growth
  - Major photofinishers
  - Effluent concerns
  - Importance of mail order
  - Outlook for finishers
- Equipment
  - Still camera markets and trends
  - 110 cameras available
  - Movies with sound
  - Role of the SX-70 – 1,2, and 3 and other instant cameras
  - Fully automatic high-priced cameras
  - Major companies in the field
  - Future expectations and growth areas
- Flash
  - Flip flash, flash array
  - Major lamp firms
  - Increasing impact of electronic flash
  - Auto exposure – electronic or conventional
  - Electronic flash – built-in or not?
  - Effect of available light systems
  - Future prospects
- New developments

- Instant versus conventional photography
- The pocket instant load – Kodak and others
- Successors to the SX-70
- Available light color still systems
- Make your own TV programs
- Home movie sound
- Unfulfilled needs

12:30 P.M. – Luncheon

2:00 P.M. – SESSION 3

Graphic Arts – What Opportunities?

- An overview of the printing industry
- Present and future industry market sizes and trends
  - Sensitized goods: films, plates and paper
  - Cameras and processing equipment
- Photocomposition Update
  - New developments in input, correction and editing: OCR, key to tape, CRT
  - New photocomposition hardware
  - Future role of computers
  - The need for direct photocomposition plates
  - Market trends and new applications
  - Market profiles and forecast
- Microform to plate: the new publication system?
  - An analysis of conventional platemaking
  - Some older projection systems
  - Newer projection platemaking systems
  - Areas of application
  - Cost reduction factors
  - Some problem areas
  - Future expectations
- Present status of offset lithography, its growth position new and in the future and its market importance relative to the other main processes
- Main photographic growth sectors in the graphic arts field

Challenges to Photographic Imaging in Medical Diagnosis

- Radiology as a vital factor in the health care industry:
  - Growth Potential
  - Rising Costs
  - Productivity Problems
  - Government Influence
- Technological advances in the x-ray image.
- Technological advances in radiographic systems.
- New developments in medical X-Ray equipment
- What's happening with radiograph minification
  - Analysis of Current Problems
  - Requirements for the Future
- Future Developments in X-Ray systems
  - Cassetteless systems
  - Generalization of see-thru film changers
  - Rare earth intensifying screens
  - Refinement of C.A.T. – Extension of examinations to the whole body
  - Tomofluoroscopy
  - Strobotomography

- Future role and impact of
  - Ultrasonic Imaging
  - Thermography
  - Electron Radiography
  - Video and Electronic Imaging
  - Radioisotope Imaging
  - Xeroradiography
- Influence of non-radiographic procedures on the radiologist.
- New directions: the radiologist and radiographic procedures.

5:45 P.M. – Cocktails

6:30 P.M. – Dinner

8:00 P.M. – SESSION 4

The Future Fit of Silverless Photographic Processes

- Are new imaging systems needed?
  - Has there been an overkill?
  - More dollars for research, or for engineering?
- What's wrong with silver?
- Resume for silverless processes
  - From a trickle to a stream to a river
  - Successes and failures
  - Current applications
- Update on electrophotographic film technology
- Status for organic dye imaging processes
- Threats to silver imaging processes
  - Taking films for original, camera speed photography
  - Copy films for duplication
  - Photographic papers for reproduction and recording
- Future perspective

Rap Session

If desired, each conference leader can lead a separate and small discussion group to provide more details on his area of expertise to interested parties.

Alternatively, small discussion groups can be organized to rap about specialized photographic markets, such as aerial, scientific, industrial, forensic, etc.

Tuesday, June 3, 1975

Wake-up and Breakfast

9:00 A.M. – SESSION 5

Audiovisual Products and Their Markets

- The $2 billion industry
- Products used for AV Communication
- Seven domestic markets, plus Canada and foreign – including education, industrial, governmental, medicine and public health, religion, theatrical and television
- Market analysis and forecast by products
- Delivery systems – Their influence on markets
- Hardware and software considerations – economic, operational, maintenance and distributive

(continued)

- Education vs entertainment applications
- VTR – Threat to classical photography?
  - Expected impact of new technical developments
  - Standards problems
  - Training and maintenance concerns
  - Current and emerging applications
  - Developments in video publishing
- Cartridge TV – When? Where? Why?
  - Update on video players
  - Current consumer and institutional statistics
  - Advantages/disadvantages of disc, tape and film
  - Roadblocks to future utilization
  - Future expectations
- Future AV markets
  - Where the strongest growth will be
  - VTR versus photo-optical
  - The role of color
  - Available light, color, sound systems
  - New AV photographic markets such as CTV
- An analysis of opportunities

12:15 P.M. – Luncheon

1:15 P.M. – SESSION 6

The Microfilm Business and Its Future

- Market Sements (Size & Growth Rates)
  - Scientific & Engineering
  - Security & In Transit
  - Business Records
  - Micropublishing
- System elements (Function & Relation To Market Segments)
  - Hardware
    - Cameras
    - Processors & duplicators
    - Readers & reader printers
    - IS & R Devices
  - Supplies
    - Roll Film
    - Microfiche
    - Jackets
    - Silver, Diazo & Vesicular
  - Services
    - Equipment servicing
    - COM service bureaus
    - Film processing labs
- Integrated systems – Where the action's at
- Microfilm market and technology changes
- The effect of competing technologies
  - Computer based
  - Conventional paper work systems
- Future expectations
  - The lap reader
  - Is COM catching its second wind?
  - Microprojection printing
  - Microfilm information & retrieval systems
  - Why, when & where SOM? (small office microfilm)

– Updatable microfilm systems
– X-Ray minification

The International Marketplace for Photographic Supplies and Equipment – A Panel Discussion

4:15 P.M. – Transportation departs for Logan Airport: estimated arrival time 5:30 P.M.

CONFERENCE LEADERS

Elliott D. Novak, Senior Staff Associate, Arthur D. Little, Inc., Cambridge, Massachusetts

In his current position at ADL, Mr. Novak is primarily concerned with long-range planning, corporate diversification, marketing research, and new product development. His work in the photographic and reprographic fields has encompassed marketing and general diversification opportunities in the U.S., European, and Japanese markets. For example, he has investigated acquisition opportunities in the photographic industry for present and potential material suppliers, conducted a broad analysis of the photographic industry as a diversification opportunity for a major consumer products company, and examined the potential of a mail-order photofinishing venture.

Prior to joining ADL, Mr. Novak was associated with American Cyanamid Company, The Fitchburg Paper Company, and the International Division of United Shoe Machinery Corporation. Mr. Novak received a Bachelor of Chemical Engineering from Yale University and an M.B.A. from Harvard Business School. He co-authored a broad study on the U.S. Photographic Industry recently.

Dr. Ronald Francis, Staff Chairman, Photographic Science and Instrumentation, School of Photographic Arts and Sciences, Rochester Institute of Technology, Rochester, New York

Professor Francis has been at RIT since September, 1969. In addition to providing instruction in photographic science and chemistry, his research interests include studies in silver halide and non-silver halide emulsion chemistry, mechanisms of photographic development and photochromic fatigue reactions. He teaches two courses in non-silver photographic systems. From 1966 to 1969, Dr. Francis was Manager of the Photographic Engineering Section at EG&G. Under his direction, research was conducted in silver halide emulsion chemistry, mechanisms of photographic image development, radiometric characterization of film, photochromic systems and oxide-sulfide photoconductors. Previous to EG&G, Inc., Dr. Franics was employed at ITEK Corporation from 1964 to 1966, where he was Manager of the Inorganic Chemistry Department. His programs were concerned with the relation of electrical and optical properties to the surface chemistry of single crystals, ultrafine particulate photoconductors, and

mechanisms in proprietary non-silver photographic systems. Previous to Itek, Dr. Francis was a Senior Scientist at Arthur D. Little, Inc., where he was involved in materials engineering and physical chemistry. He has many publications to his credit, one patent granted, and twelve pending which relate to photoconductor compositions and processes. Dr. Franics is active in the SPSE and SMPTE. He received his Ph.D. in Inorganic Chemistry from MIT in 1960, and an AB in Physics from Colby College.

Donald B. Grim, Manager, Product Planning, Radiography Markets Division, Eastman Kodak Company, Rochester, New York

Mr. Grim began his career with the Eastman Kodak Company in 1949 in the Industrial Engineering Division at Kodak Park and later became a Technical Associate in the Film Services Division, Kodak Park, working with a wide variety of Kodak products. In January, 1965, he was appointed Manager of Product Planning for radiography products in the Marketing organization, Kodak office. A native of Reading, Pennsylvania, Mr. Grim graudated from the University of Illinois in 1949 with a B.S. degree in Industrial Management. He also attended the University of Rochester for work in economics in 1950 – 1951. Mr. Grim has been a member of the Rochester Section of the Society of Photographic Scientists and Engineers, the Photographic Society of America, and the National Chapter of SPSE. He has also been a past Secretary of Sectional Committee PH-1 of the American National Standards Institute.

Thomas W. Hope, Audiovisual Consultant, Publisher of Hope Reports, Rochester, New York.

Mr. Hope is widely known from his 16 years on the staff of Eastman Kodak, where he first served as an advisor on non-theatrical films, and authored numerous magazine articles on related subjects, besides contributing or writing data books. He was also co-editor of the highly-regarded benchmark book published by the Association of National Advertisers, *Dollars and Sense of Business Films* as well as author of A.N.A.'s booklet, *Criteria for Business-Sponsored Educational Films.* As a market analyst for Kodak's six-year old Motion Picture and Education Markets Division, Mr. Hope conducted numerous product and market surveys specializing in business and education. Previously, Mr. Hope had been with General Mills, Minneapolis, for eight years, in charge of that company's film and AV unit. In this capacity, he produced 64 films and other visual programs. Three years of Army photographic work during World War II round out his background. Mr. Hope began his AV statistical work in 1956. His reports were published under his byline for 11 years in the Journal of the Society of Motion Pictures and Television Engineers. The present Hope Reports is an outgrowth of that effort.

Paul Maraist, Group Manager, Planning and Product Management, Business Equipment Group, Bell and Howell, Chicago, Illinois

Mr. Maraist graduated from Harvard College in 1952. From 1952 to 1963 he was employed by General Electric Company in a number of assignments in Manufacturing, Engineering and Product Development in a variety of product areas. From 1963-1967 he was employed by the Franklin Institute as a Senior Staff Engineer performing contract research in market research, evaluation of markets for new products and services, and performing economic analysis of Federal Programs. From 1967 to the present he has been employed by the Business Equipment Group of Bell & Howell in the areas of Technological Forecasting, New Product Development and Market Research. Recently, he was promoted to Group Manager with responsibilities for planning, market research and product management for the Business Equipment Group. He is a member of the Operations Research Society of America.

Frank J. Romano, Graphic Arts Marketing Associates, Salem, New Hampshire

Frank J. Romano is author of the authoritative "Handbook of Composition Input", "How to Build a Profitable Newspaper" and "Photocomposition and You", and is an independent consultant in the development, marketing and application of photocomposition systems. He serves as Technical consultant to the National Composition Association and as Photocomposition Editor for *Inland Printer* magazine. In the last ten years he has held marketing positions with Mergenthaler and Compugraphic as well as handling special marketing and development projects for other graphic arts manufacturers. He is a frequent lecturer and contributor to the trade press and holds an MBA in Marketing from the City University of New York.

CONFERENCE CALENDAR

May 4 - 6	What Now, Interconnect Systems
May 11 - 13	Paper Products for Tomorrow's Business Machines
May 18 - 20	The Future for IS&R Systems
May 18 - 20	The Future for Laser Beam Recording+
June 1 - 3	The Future of the Photographic Business
June 8 - 10	World Wide Telecommunications
June 22 - 24	Future for Optical Memories, Recording and Processing
June 29-July 1	Future for Printing Technology+

+to be held at Highlands Inn, Carmel, California; others are at Castle Hill, Ipswich, Massachusetts

THE INSTITUTE FOR
GRAPHIC COMMUNICATION

announces
for the first time

AUDIOVISUAL TRENDS FOR THE FUTURE

WHAT LIES AHEAD IN TECHNOLOGY, APPLICATIONS AND MARKETS FOR USERS, MANUFACTURERS, ENGINEERS, PRODUCERS AND MEDIA SPECIALISTS

an intensive conference
of limited registration
to be presented at

THE LEARNING CENTER
MARLBORO, MASSACHUSETTS

NOVEMBER 9, 10, 11, 1975

AUDIOVISUAL TRENDS FOR THE FUTURE

Purpose: To provide an objective examination of the state-of-the-art of and future for audiovisual technology, including its applications and markets. Conventional and novel hardware and systems as well as novel techniques and applications will be discussed in depth. Current market profiles and forecasts for future markets will be presented and analyzed in light of industry claims, operational constraints and user patterns. The role for film and tape producers will be explored.

A revised and updated version of the successful IGC conferences on "New Developments in Audiovisual Systems," one should acquire at this conference a solid perspective of what modern audiovisual is all about, what the trends are, the expected impact of new developments, and a forecast of likely future events. This conference will be led by a group of recognized experts who collectively represent all of the important viewpoints of the industry, including that of the manufacturer, producer, TV executive, AV consultant, sophisticated industrial user, closed circuit network manager, AV facilities designer and manager of promotion services.

Participants will have an opportunity to discuss and review the competitive forces shaping the future of the audiovisual industry. Many observers and forecasters are predicting substantial growth for audiovisual systems in education, industrial and professional training and home entertainment. Some believe that audiovisual systems will revolutionize education, change leisure and entertainment patterns and replace conventional communications media in business and in the home. We will also discuss new developments such as video disc, projection and cable TV and computer terminals. These will have a profound affect on the habits and thinking of our society.

Who should attend: All with a stake in the future of audiovisual equipment, supplies, systems, materials and software should find this conference of much value. Future decision-making in product planning, marketing, research and engineering could be influenced by what is learned at this conference. Those who must make critical decisions about purchasing audiovisual systems will also gain valuable insight from this conference, as will those who design and use such systems, including commercial and in-house film and tape producers.

The thrust of the meeting is to explore directions, trends, and opportunities so that individuals concerned with engineering, product planning, systems design, and production will find this an ideal setting to discover what others in this field are thinking, planning, and doing.

Conference Leaders:

- Dr. Arthur Cox, Chairman — Bell and Howell
- Thomas Hope — Hope Reports
- Neal Keehn — Byron Motion Pictures, Inc.
- John J. Leay — Magnaverde Productions
- Edward W. Palmer — New England Telephone Company

- Lee F. Roselle – Merrill Lynch
- Hubert Wilke – Hubert Wilke Associates, Inc.
- Ken Winslow – Public Broadcast Service

Attendance: Restricted with registrations accepted on a first-come, first-served basis. This will allow an active dialogue to be established as an integral part of each session and ensure maximum information transfer between conference leaders and attendees.

Fee: $425.00 per registrant ($385.00 without room).
In addition to conference participation this fee includes accommodations, meals, beverages, conference materials and all necessary extras.

Location/Arrival: The Learning Center is located on a 25 acre wooded site near the junction of routes 20 & 495 in Marlboro, Massachusetts. It is the first all-management training center in the Bell System and was opened in 1974. It boasts of the most modern accommodations, including training, AV resources, dining, TV workrooms, sleeping and recreation.
Participants arriving by air, between the hours of 2:30 and 5:30 P.M., will have transportation to and from the Learning Center provided. Participants should report to the Delta Air Lines Group Room, which is the first door on the right after Gate 12, at the Delta terminal.
For those coming by automobile, the Center is easily reached by taking Interstate 495 to Route 20 West to Felton St. (first right) to Elm St. (third left) to Locke Drive (first right) to the Learning Center. From South or West or East, route 495 may be accessed from the Mass Pike (route 90). From the North, routes 93 and 95 lead to 495.

For Further Information:
Contact –

INSTITUTE FOR GRAPHIC COMMUNICATION
375 Commonwealth Ave., Boston, Mass 02115
Tel. (617) 267-9425

During the Conference –

The Learning Center, Marlboro, Ma., Tel. (617) 480-1000
Professional Certificates will be awarded to all participants

PROGRAM

Sunday, November 9, 1975

4:00-5:00 P.M. – Arrival and registration at Conference Site (See Arrival Information), time to unpack and familiarize yourself with the site and its surroundings.

5:45 P.M. – Cocktails

6:30 P.M. – Dinner

8:00 P.M. – Introductory session, including a brief orientation on IGC; general introduction of conference participants and subject matter; outline of conference objectives.

9:00 PM – SESSION 1
Overview of the Audiovisual Industry

- What it is and what is isn't
  - Communication of ideas
  - Education
  - Entertainment

- Sound and/or pictures
- Who profits from AV systems
- Cost factors for AV systems
- Barriers to use of AV
- Types of presentations
- Means of producing pictures
- Future outlook

Monday, November 10, 1975

7:30 - 8:30 A.M. – Breakfast served.

8:30 A.M. – SESSION 2

Audiovisual Products and Their Markets

- The $2 billion industry
- Products used for AV Communication
- Seven domestic markets, plus Canada and foreign – including education, industrial, governmental, medicine and public health, religion, theatrical and television
- Market analysis and forecast by products
- Delivery systems – Their influence on markets
- Hardware and software considerations – economic, operational, maintenance and distributive
- Education vs entertainment applications
- VTR – Threat to classical photography?
- Cartridge TV – When? Where? Why?
  - Update on video players
  - Advantages/disadvantages of disc, tape and film
  - Roadblocks to future utilization
  - Future expectations
- Future AV markets
  - Where the strongest growth will be
  - VTR versus photo-optical
  - The role of color
  - Available light, color, sound systems
  - New AV photographic markets such as CTV
- An analysis of opportunities

Design and Engineering of Tomorrow's AV Facilities

- AV design - the new discipline of "communitronics"
- Corporate communication needs
- Changes in AV technology
  - Planning for centralized AV
  - Necessary interface with architect-space planners
  - Planning AV production area
  - Planning for AV distribution
  - Role of automation
- Providing for electronic signal distribution
  - Centralized distribution & retrieval
  - Interfacility distribution
  - Domestic & international
- The training room of today
  - Will it handle tomorrow's AV software?
  - Front or rear screen projection
  - Systems integration
- The AV facility of the future
  - Will it be comprehensive?
  - Will it be flexible?
  - Industrial colleges of the future

12:30 P.M. – Luncheon
1:30 P.M. – SESSION 3

Optical and Engineering Considerations in Photo-Optical AV Equipment

- Engineering point of view
  - Example of applied psycho-physics
- Product types to be considered
  - Movie projectors
  - Slide, overhead and opaque projectors
  - Front and rear projection systems
  - TV and TV projection systems
  - Embossed material systems
- Personal viewing vs group viewing systems
- Picture sharpness, resolution, contrast, acutance and brightness
- The question of ft.-lamberts vs ft.-candles
- Why a polar diagram
- Fresnel screens
- Comparison of lumen outputs
- Screen scintillation
- What resolution is needed
- The modern approach: modulation transfer functions
- Combination of lenses and films
- Mag tape vs film chain vs video disc
- Role of holography in AV systems
- Limitations of TV systems
- Interactive systems: random access vs repeated frames

Video Trends For the Future

- Open reel vs encapsulated systems
- Products used and who's using them
- Meaning of electronic news gathering
- Camera developments
  - Present status
  - Tomorrow's technology
- Standardization - what's happening
- Video programming
  - Sources
  - Users
- High speed video duplicating
- Applications update – ASPIRE
- Movement towards video systems
- Resurgence of cable television
- Future developments in VTR

5:45 P.M. – Cocktails and tour (optional) of facilities
6:30 P.M. – Dinner
8:00 P.M. – SESSION 4

Projection T.V. - Technology, Applications and Trends

- Technology of commercial projection T.V.
  - Schmidt CRT systems
  - Control layer systems
  - Gretag Eidophor
  - G. E. light valve
- Future large screen T.V. systems
  - Light valves
  - Lasers
  - Solid state

- Applications of large screen T.V. systems
  - Sports/Pay T.V.
  - Video magnification
  - Business
  - Education & training
  - Simulation
  - Multi media
  - Networking

Tuesday, November 11, 1975
Wake-up and Breakfast

8:30 A.M. – SESSION 5

Merrill Lynch is Bullish on Video: Case Study of a Video Distribution System

- How to convince one's management
- How to convince yourself
- Trials and tribulations
- How to obtain help
- How to succeed
- How to keep it alive
- How to do testing
- How to prove the network is needed
- How to avoid mistakes

The Film/Tape Service Laboratory - What It Will Take in the Future

- Current services
  - Post-production needs
  - Reproduction needs
  - Source of information
  - Guidance on new methods & materials
- Business perturbations
  - Need for specialization
  - Competition
  - New techniques
  - Mergers
  - Shake outs
- The effect of changing technology
- Additional customer services
  - Identification of problem
  - Solutions for the customer
  - Servicing new systems & materials
- Opportunities in today's electronic jungle
- Graphic communications service laboratories of the future

12:00 P.M. – Luncheon
1:00 P.M. – SESSION 6

Video Disc Systems: The Next Revolution?

- The options of television
  - Public
  - Private
- The private's key: practical methods of storing programs
  - Film and camera chain
  - Magnetic tape
  - Video discs
- Characteristics of video disc systems
  - Playtime

(continued)

- Cost factors
- Ease of use
- Density of storage: B & W and color
- Random access

- Roadblocks to future utilization
  - Standards problem
  - Educational/training obstacles
  - Maintenance concerns
  - Software needs
  - Economic considerations
- Home entertainment: Needs/Demands/Wants
- Future expectations

From the User's Viewpoint

- WHO is the business and industry AV user
  - The "Forgotten person" for 30 years
- WHERE will the AV equipment be used
  - Many changes in the learning areas
- WHAT kind of training uses AV
  - School usage not the same
- Do the manufacturers of AV equipment:
  - Know WHERE training is done?
  - Care HOW their equipment is used?
  - LISTEN to the user, or their marketing department?
- WHERE is the testing lab for new AV equipment
  - The manufacturers' engineering department?
  - The industrial AV users' classroom?
- Need for better AV usage information
  - In the media courses in college
  - Photographs in AV manufacturers' advertising
  - Media publications
- Is the AV manufacturer ready for the future?
  - The needs of the visual generation
  - The needs of the industrial training centers
  - Next ten years, "proof of the pudding"!

Summary and Rap Session

3:45 P.M. – Transportation departs for Logan Airport; estimate one will arrive in time for 5:20 or later flights.

CONFERENCE LEADERS

Dr. Arthur Cox, Vice President, Optics, Bell and Howell, Chicago, Illinois.

Dr. Cox is an internationally recognized authority in the area of applied optics. As Vice President of Optics at Bell and Howell, he currently has responsibility for both optical engineering and manufacturing. From 1969 through 1971, he headed up Arthur Cox Associates, which provided design and engineering services in the fields of optical and electro-optical systems as well as in the preparation of special purpose computer programs for engineering and scientific applications. Until May of 1969, Dr. Cox was Vice-President and General Manager of the Optical Division of KMS Industries, Inc., of Ann Arbor, Michigan. Previous to that, from March 1952 to July 1966, he was with the Bell and Howell Company of Chicago and served as Vice-President, Optics, and General

Manager of the Optical Division. Dr. Cox's work at KMS Industries was primarily concerned with the application of lasers, holography and coherent optics to a variety of problems. His work at Bell & Howell extended from research on optical theory, through optical design, mechanical design, production engineering, tool design, methods engineering, production control, high and low volume manufacturing and quality control. Dr. Cox is a Fellow of Institute of Physics in London and a Fellow of the Optical Society of America. He holds more than twenty patents and his books have become standard texts, including "Photographic Optics" (thirteen editions plus Spanish and Dutch translations), "A System of Optical Design," and "Engineering Optics."

Thomas W. Hope, Audiovisual Consultant, Publisher of Hope Reports, Rochester, New York.

Mr. Hope is widely known from his 16 years on the staff of Eastman Kodak, where he first served as an advisor on nontheatrical films, and authored numerous magazine articles on related subjects, besides contributing or writing data books. He was also co-editor of the highly-regarded benchmark book published by the Association of National Advertisers, **Dollars and Sense of Business Films** as well as author of A.N.A.'s booklet, **Criteria for Business-Sponsored Educational Films.** As a market analyst for Kodak's six-year old Motion Picture and Education Markets Division, Mr. Hope conducted numerous product and market surveys specializing in business and education. Previously, Mr. Hope had been with General Mills, Minneapolis, for eight years, in charge of that company's film and AV unit. In this capacity, he produced 64 films and other visual programs. Three years of Army photographic work during World War II round out his background. Mr. Hope began his AV statistical work in 1956. His reports were published under his byline for 11 years in the Journal of the Society of Motion Pictures and Television Engineers. The present Hope Reports is an outgrowth of that effort.

Neal Keehn, Vice President — Sales & Services, Byron Motion Pictures, Inc., Washington D.C.

After an intial stint in radio at CBS stations and then NBC Blue Network, Mr. Keehn joined the Calvin Company in Kansas City where he became involved in several areas of film production from writer-producer to operations manager to V.P. Sales. He then joined General Film Laboratories in Hollywood as Vice President of their sales. He retained that position when General was merged into Deluxe General, the 20th Century Fox laboratory. After his retirement from Deluxe General, he joined Byron Motion Pictures, a film and TV tape service laboratory. While at Calvin, Mr. Keehn produced and directed the Calvin Workshop. He established customer information publications for the various labs, including Calvin's Aperture, General's rewind, and now the Byron personal report. Mr. Keehn was a founding member of the Association of Cinema Laboratories, and is a member of the

Academy of Motion Picture Arts & Sciences, Academy of Television Arts and Sciences, University Film Association and the American Society of Cinematographers. He received his BA from the University of Wisconsin.

John J. Leay, Staff Consultant, Magnaverde Productions, New York, New York.

Mr. Leay has over 20 years of experience in all phases of television from engineering to design to operations to production to the management of closed circuit productions in which he is involved currently. From 1972 to recently, he was associated with Imero Fiorentino Associates. Assignments included: network manager for pay TV closed circuits of Fraiser/Forman and Ali/Forman fights; network manager for closed circuit medical conferences for Pfizer, Roerig and Lederle Labs; AV design for GTE headquarters and Panasonic multimedia theaters; and TV consultant to Lincoln Center. While a Vice President at Robert F. White and Associates in 1972, Mr. Leay served as TV producer of GM Truck & Coach industrial show, and designer of a live TV network for Pfizer Pharmaceuticals. As a Vice President of Management Television Systems from 1968 to 1972, he managed several closed circuit productions and networks, including a portable TV production facility, a 26 city network with live Q & A to the U.S. Cabinet and White House and the Ali/Fraiser fight. From 1967 to 1968, Mr. Leay was Chief Engineer of WOR-TV where he administrated the engineering operations of over 100 engineers. From 1961 to 1967, he was Chief Engineer of Theatre Network Television, and designed/installed Eidophor projection display systems at many sites. From 1954 to 1961 he was Engineer-in-Charge of Columbia Boradcasting System. Mr. Leay has served as Chairman of the Academy of Television Arts and Sciences Engineering Committee, and is a member of SMPTE.

Edward W. Palmer, Supervisor, A-V Section, New England Telephone Company, Boston, Massachusetts.

Mr. Palmer has been a energetic user and innovator in the use of audio visuals for training over the past 30 years. He was an early pioneer in the use of audio visuals in the U.S. Navy during World War II, and served as an instructor at the U.S. Naval School of Photography, Pensacola, Florida. He presently supervises the A-V Section at the New England Telephone Company in Boston. Mr. Palmer is a well-known pioneer in the use of television for training and employee information. He designed and operated the first CCTV studio in the Bell System in 1963. Mr. Palmer is a regular lecturer to graduate AV students at Boston University, Emerson College and at the University of Rhode Island on audio visual design, planning, production and distribution. He has designed — and assisted in the design — of many industrial and educational audio visual facilities. Mr. Palmer has authored many magazine articles on AV and TV usage. He is an active member of many professional AV associations, including AECT,

ASTD, IFPA, NAEB, NAVA and SMPTE, and has held offices in the Industrial Audio Visual Association (IAVA), serving as its National Secretary, its Technical Chairman, and Chairman of four National meetings. He is a former President of the National Industrial Television Association (NITA), and former member of the Board of Directors for the Educational Media Council. He is presently a member of the Board of Directors of the International Industrial Television Association (ITVA).

Lee F. Roselle, Assistant Vice President, Merrill Lynch, New York, New York.

Mr. Roselle joined Merrill Lynch in 1969. As Manager of Promotion Services, he is in charge of the Merrill Lynch video network and audiovisual center, including the exhibits and displays at Grand Central Station and all travel exhibits. Mr. Roselle is also responsible for the Corporate Identity Program, and for booklets, pamphlets, graphic materials, and forms. The video network consists of 208 domestic offices and regularly communicates sales information, employee and management information and training material. It is planned to expand the network internationally in the near future. Prior to Merrill Lynch, Mr. Roselle was with the Bell System for 17 years engaged in various public relations and video activities. He is a member of the National Academy of Television Arts and Sciences and ITVA.

(Biographies Continued on Back of Registration Panel)

CONFERENCE CALENDAR

INSTITUTE FOR GRAPHIC COMMUNICATION

CONFERENCE TITLES OCTOBER – DECEMBER 1975

Oct. 19-21	The Future for Medical Imaging	☐
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Nov. 30-Dec 2	The Future for Video Disc Systems	☐
Nov. 30-Dec 2	Automated Composition and Imposition Systems of the Future	☐
Dec. 2-4	Laser Imaging in the Graphic Arts	☐
Dec. 14-16	Product Opportunities in Graphic Communications	☐

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INSTITUTE FOR GRAPHIC COMMUNICATION
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Ken Winslow, Associate Director, Non-Broadcast, Public Television Library, Public Broadcast Service, Washington, D.C.

Mr. Winslow is a noted authority on new developments in the video and television industries. His past experience eminently prepared him for this position of prominence, including employment as engineer, program director, program producer, technical director for public television (KQED-TV, San Francisco), and various commercial stations and service companies; university television coordinator (Univ. of California at Berkeley); video management, operations, production, programming and applications consultant for business, industry, education, manufacturers, advertising & marketing agencies (Ampex, Bell & Howell, Equitable Life Assurance Society, Videorecord Corporation of America, Grey & Davis, GTE Labs, Far West Labs, PPG Industries, etc). Mr. Winslow also serves currently as Editor of *Videoplay Report* and *Video Program Catalog & Source Guide,* as well as being a contributing editor to many leading AV journals. He also serves as Director, Video Systems Exposition & Conference (VIDSEC), Electronic Industries Association, Consumer Electronics Group; Conference Director, VideoShow, Tepfer Publishing Company; Director, Professional Development, International Industrial TV Association. Mr. Winslow serves on several editorial boards and frequently addresses professional groups. He received an M.A. in Radio & Television from San Francisco State University.

Mr. Hubert Wilke, President, Hubert Wilke Associates, Inc., New York, New York.

Mr. Wilke has over 20 years experience in the audiovisual communications field, and is a noted pioneer in the AV and communications facilites consulting field. In applying the new elements of electronics to the age old need to communicate, Mr. Wilkie specializes in what he calls today's science of communitronics. Extensive marketing experience in the field of audio visual systems for both education and industry, gave him the impetus to set up his own firm in 1965, which specializes in the design of AV and communications facilities. Today the firm serves the audio visual communications needs of such clients as AT&T, Chase Manhattan, Eastman Kodak, Dupont, Exxon, General Electric, Hallmark, IBM, Merrill Lynch, Monsanto, RCA, Sears Roebuck, Morgan Guaranty, World Trade Center, Xerox, Down State Medical Center, Prudential, Johns Manville, Intercontinental Hotel, etc. Mr. Wilke is a former director of industrial and educational services for TelePrompTer Corporation, where he helped develop the concept of remotely controlled multi-screen corporate conference, training, and board rooms, as well as large-group academic instructional facilities. Shortly after the Soviet Union launched Sputnik in 1958, he became a member of the TelePrompTer team responsible for the first remotely controlled multi-screen system designed for General Medaris and Werner Von Braun at Huntsville, Alabama.

THE INSTITUTE FOR
GRAPHIC COMMUNICATION

announces

ELECTRO-PHOTOGRAPHY

UPDATE AND FUTURE OUTLOOK

an intensive conference

to be presented at the

IGC Conference Center

Castle Hill

Ipswich, Massachusetts

JULY 13-15, 1975

ELECTROPHOTOGRAPHY

UPDATE AND FUTURE OUTLOOK

Purpose: Although the electrophotographic revolution commenced about fifteen years ago, growth continues to be dramatic and changes continue to come fast. This conference will explore in depth those new techniques, hardware, materials, processes, systems concepts and markets which can be expected to guide the future design and applications for the electrophotographic process. Particular emphasis will be placed on the role of plain paper copiers and copier/duplicators, color copiers, film technology, novel processes, new applications and the changing marketplace. A critique will be presented of competing systems as the effect of technological developments and the impact of changing user requirements will obviate some systems in favor of others. There will be a full discussion of interfacial problems encountered in the system, including the imaging material and its interaction with the machine, the substrate to be imaged and/or the ultimate image carrier. Both the current status and future trends for a variety of "novel" imaging systems will be presented covering the techniques and imaging materials required. Market profiles, forecasts, and strategies will be made and research and marketing trends will be fully explored by a renowed group of experts. The opportunity to interact with them for almost three days is indeed unique.

Sessions will be held on the following topics:

- An Overview of Electrophotography
- Update on Electrophotographic Film Technology
- Current Status and Future Requirements for Toners
- Observations on Current Copying Techniques
- The Xerox 9200: Technical Description and Cost/Performance Analysis
- Copier System Architecture — Technical Considerations for New Systems
- Novel Electrophotographic Processes
- The Fit of Electrophotography to Emerging Needs
- Market Analysis and Projections

Conference Leaders

- John Van Auken, Chairman — Innovation, Inc.
- Frank E. Dailey, Jr. — Scott Graphics, Inc.
- Michael N. Fenlon — Management Consultant
- Dr. George C. Hartmann — Xerox Research Center of Canada, Ltd.
- Philip A. Hennis — Winston Magneto Chemical Corporation
- Lawrence P. Lorah — Consultant
- Riehard D. Murray — Institute for Graphic Communication

Attendance: Restricted with registrations accepted on a first-come, first-served basis. This will allow an active dialogue to be established as an integral part of each session

and ensure maximum information transfer between conference leaders and attendees.

Fee: $385.00 per registrant ($360.00 without room).
In addition to conference participation this fee includes accommodations, meals, beverages, conference materials and all necessary extras. Reduced rates are available for companies sending two or more representatives.

Location/Arrival: The Castle Hill Conference Center is located in Ipswich, Massachusetts, some thirty miles north of Boston. Participants arriving by air, between the hours of 2:30 and 5:30 P.M., will have transportation to and from Castle Hill provided. Participants should report to the Delta Air Lines Group Room, which is the first door on the right after Gate 12.

For those coming by automobile, the Center is easily reached by taking Route 128 North to Route 1A (Exit 20N), following the signs toward Ipswich, and turning right at a large Castle Hill sign just before Ipswich Center. Participants will of course be briefed in detail on all such matters upon receipt of their applications.

Castle Hill overlooks Crane's Beach, famous for its sand dunes and natural beauty. A private beach is available for registrants. Ipswich is located in historic Essex County. Tourist attractions include Gloucester and its fishing fleet, Rockport — a century old Art Colony, Marblehead — The Yachting capital of the world — and its beautiful harbor, and Salem with its House of Seven Gables and Peabody Museum. A brochure describing the cities and towns of Essex County will be mailed upon request.

For Further Information:

Contact —
INSTITUTE FOR GRAPHIC COMMUNICATION
375 Commonwealth Ave.
Boston, Mass. 02115
Tel. (617) 267-9425

During the Conference —
Castle Hill Foundation
Ipswich, Massachusetts
Tel. (617) 356-4351

Professional Certificates will be awarded to all participants

PROGRAM

Sunday, July 13, 1975

4:00-5:00 P.M. — Arrival and registration at Castle Hill (See Arrival Information), time to unpack and familiarize yourself with the Center and its surroundings.

5:45 P.M. — Cocktails

6:30 P.M. — Dinner

8:00 P.M. – Introductory session, including a brief orientation on IGC; general introduction of conference participants and subject matter; outline of conference objectives.

8:45 A.M. – SESSION 1

An Overview of Electrophotography

- From a trickle to a stream to a river
- Past perspective on electrophotography
  - Why certain systems evolved
  - Why customers accepted them
  - Why other systems failed
- Current status
  - Photocopiers
  - Microfilm printout
  - Computer output
  - Facsimile
  - Color copying
  - Others
- Update on business developments
- – Xerox position and outlook
  - Reception to date for the IBM II
  - Expected impact of Kodak
  - IBM's encore
  - Pitney Bowes plain paper entry
  - IBM 3800 announcement
  - Competition in the next decade
- Growth trends

Monday, July 14, 1975

When you Wish – Wake-up (coffee waiting).

8:00-8:45 A.M. – Breakfast served.

9:00 A.M. – SESSION 2

(Coffee breaks midway through each session)

Update on Electrophotographic Film Technology

- Commercial application – One success, many failures
- Focus on a new application area
- Technology update
- Product and processor development
- Application possibilities
  - Laser recording
  - Holography
  - Oil well logging
  - Photoplotting
  - COM
  - Graphic Arts
- Directions for the future

Current Status and Future Requirements for Toners

- Matching toner to copy machine features
- Quality tests applicable to toner
- Q.C. equipment required
- Quality vs. cost trade-offs
- Cost considerations of producing toner for Xerox machines vs.

- Small copier importer
- Manufacturer

- Xerox spec's on toner for 9200 copier
- Future problems for independent toner manufacturers

12:30 P.M. – Luncheon

1:30 P.M. – SESSION 3

Observations on Current Copying Techniques

- Customer needs
- Relative importance of features
  - First copy time
  - Copies per minute
  - Document handling
  - Sorting
  - Two-sided
  - Reduction
  - Size
  - Cosmetics
  - Copy quality
- Trend in applications
  - Coated paper copiers
  - Plain paper convenience copiers
  - High-speed plain paper copier-duplicators
  - Automated offset systems: Quick-copy and hybrid
- Recent product introductions
  - Agfa-Gevaert X-20
  - Copyer Selex 900
  - Konishiroku Mark 3 and Mark 4
  - Sharp SF-701
  - Toshiba BD-702
  - Xerox 4500
  - Pitney Bowes PBC
  - A.B. Dick 901
  - Van Dyk 8000
  - Canon NP-L7
  - Copia 405
  - Minolta Electrographic 101
  - MITA Copystar
- Future outlook

Copier System Architecture – Technical Considerations for New Systems

- Technical implications of initial product planning
  - Target market
  - Product distinction
  - Resources
  - Industry standards
- Copier throughput
  - Photoconductor/illumination
  - Toner/fuzing
  - Paper handling
- Image quality
  - Resolution
  - Density
  - Pictorial quality
  - Process artifacts

- Operator control
- Reliability
  - What is reliability?
  - Photoconductor
  - Paper handling
  - System controls
- Hardware cost
  - Elements of total equipment cost
  - Manufacturing cost distribution in a typical machine
  - Impact of new manufacturing techniques
- User Interface
  - Size of machine
  - Controls
  - Document input
- Review of major architecture decisions
- Examples
  - Good
  - Bad
- Considerations for future system growth

5:45 P.M. – Cocktails

6:30 P.M. – Dinner

8:00 P.M. – SESSION 4

The Xerox 9200: Technical Description and Cost/Performance Analysis

- The 9200 design goals
- Automatic document handler
- Optics, scanning and reduction
- Photoreceptor and developer
- Paper trays and handling
- Fuser system
- Output tray and sorter
- Duplexing and productivity
- Quality and special features
- Direct cost and total cost
- Market potential

Tuesday, July 15, 1975

Wake-up and breakfast

9:00 A.M. – SESSION 5

Novel Electrophotographic Processes

- Particle migration imaging
- Manifold imaging
- Color copying by xerography
- Copying with ink jet technology
- New electrographic imaging methods
  - Optically addressable
  - Electrically addressable

The Fit of Electrophotography to Emerging Needs

- The electrophotographic processes
  - Capabilities
  - Limitations
- Are new systems needed?

(continued)

- Inroads made to date
- Future opportunities
  - Microfilming
  - Projection Platemaking
  - Phototypsetting
  - Demand printing
  - Impactless printing
  - Transparency makers
  - Photographic prints
- Future directions

12:30 P.M. — Luncheon

1:30 P.M. — SESSION 6

Market Analysis and Projections

- Analysis of the copier market
  - Sources of demand
  - User types
  - Machines
  - Supplies
  - Revenues
- Other markets for electrophotography
  - Micrographics
  - Computer printout
  - Engineering reprographics
  - Facsimile
  - Others
- The Future
  - Technology
  - 9200 and other new products
  - New competitors
  - New strategies
  - Creation of new markets
  - Implications with regard to paper demand
  - Unknowns

Rap Session

4:15 P.M. — Transportation departs for Logan Airport; estimate arrival time 5:30 P.M.

CONFERENCE LEADERS

John A. Van Auken, President, Innovation, Inc., Miami Beach, Florida.

Since September 1973, Mr. Van Auken has served as President of Innovation, which company has been organized to develop new graphic communication systems. Mr. Van Auken has been for fifteen years an acknowledged pioneer and innovator in the electrostatic reproduction field. For a number of years he directed manufacturing operations for the American Photocopy Equipment Company and was the founder and General Manager of the Microstatics Division of the SCM Corporation. Under his direction the highly successful SCM line of electrostatic copiers was developed and put into production. In 1963 he left SCM and formed Copystatics, Inc., which in 1966 became Copystatics Manufacturing Corpora-

tion, after being sold to Saxon Industries. As President of Copystatics Manufacturing he directed the development of the current line of Saxon copiers including the high speed P-50, the CBC-1 convertible copiers and the C-500, together with accessories. At Saxon Development Corporation, Mr. Van Auken masterminded the development of the Saxon CD-7500 copier-duplicator and a line of microfilm cameras and printers.

Frank E. Dailey, Jr., Vice President, New Business Development and Vice President, Corporate Research, Scott Graphics, Inc., Holyoke, Massachusetts

Mr. Frank Dailey graduated from the United States Naval Academy in June 1942 and went to sea on a destroyer in World War II. He returned to the U.S. for flight training in 1944, becoming a Naval Aviator in 1945. Mr. Dailey attended the U.S. Naval Postgraduate School receiving a B.S. in E.E. and then from the University of California he received an M.S. in Applied Physics. He served in Air Development Squadron II in the Korean War and then became the Undersea Weapons Officer at NOL Whiteoak, Maryland. Resigning his commission as Commander USN, he founded the Applied Science Laboratory for Stromberg Carlson in 1956 and became Manager Engineering Operations - Stromberg at San Diego (now Datagraphix) in 1959. Mr. Dailey became Treasurer of Stati-Systems, Inc. in Springfield, Massachusetts in 1962, and Associate Director of Research for The Plastic Coating Corporation in 1966. Since 1967 he has served as Director of Business Development for Scott Graphics, Inc. In addition to this responsibility, in 1974 he was appointed Vice President, Corporate Research. Mr. Dailey has authored many papers on imaging technology, and presented a presentation on the "Advent of Updatable Microfilm Systems" at the 1974 Annual SPSE Conference.

Michael N. Fenlon, Management Consultant, Cambridge, Massachusetts

Mr. Fenlon is an independent management consultant. He has 10 years of experience in the office equipment, graphic arts and information technology industries. His consulting practice includes: market research, sales force training, product planning, and various other marketing related functions in addition to other assignments, involving financial planning, and new product design and engineering assistance. He was for 6 years a member of the management counselling staff at Arthur D. Little, Inc. For two years thereafter he was a partner at San Francisco Consultants, a small west-coast firm. Currently he is a principal member of Cambridge Management Associates, a professional and business collaborative of marketing, manufacturing, finance and engineering specialists who have long established independent consulting practices, many of whom are affiliated with universities and other research institutions in the Cambridge area. He also is affiliated with L.B.A. Inc., an industrial design firm located in Boston. Mr. Fenlon also is the director of IGC's Technology Survey Program, a

unique consulting service which provides powerful, newly created patent research techniques to help individual clients keep abreast of the most recent world-wide laboratory developments in their particular field of interest. In May, the Technology Survey Program is planning to begin a large, multi-clients sponsored, investigation of world-wide new inventions in Photocopy Technology.

Dr. George C. Hartmann, Manager, Imaging Sciences, Xerox Research Centre of Canada, Ltd., Mississauga, Ontario, Canada

Dr. Hartmann has been engaged in research activities at Xerox since 1968. During the past year, he has been very involved in establishing Xerox's new research laboratories outside of Toronto, where research capabilities are being established for the investigation of physical mechanisms which underlie novel electrophotographic systems, and for image characterization of electrophotographic processes. During 1973, Dr. Hartmann was Manager of Process Physics Research at the Webster Research Laboratories in New York, during which period he investigated the physics of charge transfer in novel electrophotographic systems. From 1966 to 1968, he was involved in the Stanford Linear Accelerator program. Dr. Hartmann has many publications to his credit in the general areas of electrophotography and the physics of charge transfer. He has several patents pending, and is a member of the American Physical Society. Dr. Hartmann received his B.S. and Ph.D. degrees in Physics from MIT.

Philip A. Hennis, President and Director, Winston Magneto Chemical Corporation, Buena Park, California

Philip A. Hennis received his BS degree from Western Reserve University and has done graduate work at UCLA, Claremont Graduate School, Woodbury College, and the University of California at Irvine. He was co-founder of a local division of the National Management Association and the National Association of Professional Contracts Administrators. He is also a member of the American Institute of Corporate Controllers and several other technical associations. He spent his first years with the American Steel & Wire Division of U.S. Steel and the Anaconda Copper Corporation. He reached the position of officer and director of a major concern n 1956; this was the Guantanamo Sugar Company in Guantanamo, Cuba. Since leaving Cuba he participated in the management teams of various aerospace California firms until he became involved in toner manufacturing in 1971. In March '72 he was elected President and Director of the Winston Magneto Chemical Corporation. Insisting on the policy of manufacturing and wholesaling only, he increased sales from a few pounds a month to its current rate of around 750,000 pounds per year, probably the third largest independent producer of dry toner. He is currently applying for a patent on the magnetic toner which he developed and started marketing toward the end of 1974.

Lawrence D. Lorah, Consultant, Concord, Mass.

Mr. Lorah is a consultant working on the technical and management aspects of product planning, product development, and venture management. His primary fields of interest encompass office machinery, computer peripherals, the graphic arts, and electro-optical instrumentation. Prior to establishing his independent practice, Mr. Lorah was with Arthur D. Little, Inc. for eight years. There he advised clients on the technical, financial and management aspects of the areas noted. His prime responsibility, however, was the management of a development group which specialized in the design and construction of prototype hardware. This group built such devices as office copiers, optical character readers, microfilm equipment, facsimile equipment, and optical instrumentation. In the early 1960's he helped found Mithras, Inc. which was an aerospace R & D company which eventually became part of Sanders Associates. Mr. Lorah holds both a BS and an MS in Aeronautical Engineering from MIT.

Richard D. Murray, Director of Conferences, Institute for Graphic Communication, Boston, Mass.

Mr. Murray has sixteen years of broad reprographic technical and market research experience in the imaging industries. Prior to IGC, he functioned as a Reprographic Specialist for EG&G's Graphic Systems Division. He has developed several novel imaging processes including thermographic, heat developable diazonium, Itek RS, chargeless electrophotographic, and dielectric recording at Itek, Cue and EG&G. He was responsible for the evaluation and process design of a dielectric recording process which is used in a modern Air Force facsimile recorder. Mr. Murray is a member of ASIS, SPSE, TAGA, SPIE, AECT, NMA, and VITA. He has organized and chaired seminars for SPSE on "Applications of Lasers to Photography and Information Handling," "Novel Imaging Systems" and "Computer Handling of Graphical Images" and edited Proceedings for each. Three U.S. patents have been granted and one is pending. Since 1967, Mr. Murray has organized over 150 meetings for IGC and SPSE. He has consulted for leading organizations in the fields of visual and graphic communications, including such areas as the inplant market, laser beam recording, electrographic imaging, toner industry, impactless printing, ultramicrofiche, printing plate developments, reversal processing, microform to plate systems, and markets for CRT hardcopy, computer plotting and facsimile equipment. Mr. Murray is authoring a chapter on "Silverless Imaging Processes" for the New Edition of Neblette's *Photography — Its Materials and Processes.*

A BIBLIOGRAPHY OF

Selected Rand Publications

The Rand Corporation
1700 Main Street
Santa Monica
California 90406

May 1975
SB-1027

HEALTH-RELATED RESEARCH

This bibliography contains abstracts of selected Rand studies dealing with various aspects of health-related research. The studies selected have all been issued during the period January 1967 through April 1975. The intention is to revise the bibliography at periodic intervals to incorporate new publications.

Both subject and author indexes are provided. Abstracts are arranged serially by publication number. In the subject index, the numbers under the various subject headings refer the user to the publication number. The author index gives both publication number and title for each study.

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RM-5407-PR A Multitype Stochastic Population Model.

PURNELL, S.

R-1651-CF Review of Federal Programs To Alleviate Rural Deprivation.

System for the Handicapped.

YOUNG, R. J.

R-1096-NYC/OEO Population Health Survey 1968: Codebook and Marginals.
R-1161-NYC/OEO Population Health Surveys for 1964, 1965, and 1966: Codebook and Marginals.
R-1162-NYC/OEO Population Health Survey for 1969-70: Codebook and Marginals.

YURA, H. T.

P-4458-1 Induced Fields and Heating within a Cranial Structure Irradiated by an Electromagnetic Plane Wave.

ZUCKERMAN, A. E.

P-4790 FLUIDMOD: A Versatile CAI System for Medical Students.
P-4799 FLUIDMOD: A Program for Computer-Based Instruction in Clinical Fluid Therapy.

ABSTRACTS

BOOKS

Book Thinking About Cities: New Perspectives on Urban Problems. Edited by A. H. Pascal. 1970.
A collection of papers originally prepared for a 1968 workshop on U.S. urban problems, jointly sponsored by Rand and The Ford Foundation. The workshop's purpose was to define and initiate a comprehensive, long-term research program within Rand on urban policy issues and to interest other organizations in undertaking related work. Participants included scientists, scholars, federal and NYC officials, and Rand staff members. Contents, grouped thematically, cover (1) race relations in the city, (2) municipal objectives and organization, (3) the reform of urban programs, and (4) urban violence and public order. Specific consideration was given to recommendations for program initiatives, research, and experiments in education, health services, welfare/public assistance, jobs and manpower training, housing and urban planning, police services and public order, and municipal finance and administration. 198 pp. (Published by Dickenson Publishing Company, Inc., 1970, $4.95. Available only from booksellers or the publisher.) (Also published by Rand as P-3868, August 1968.) (TC)

Book Human Color Perception: A Critical Study of the Experimental Foundation. J. J. Sheppard, Jr. 1968.
An introduction to the critical study of the experimental foundation of human color perception. This book is addressed to all scientists and engineers who are interested in the human visual process as an area for active research participation. Supplementing available encyclopedic treatments within the various scientific subdisciplines concerned with human color perception, the study presents the minimum material necessary for a comprehensive view of the subject and its many unsolved problems. The approach chosen is an ordered discussion of experimental results selected from physics, physiology, and psychology. These results are reanalyzed and formulated into conclusions that at times depart substantially from orthodox interpretations. Principal conclusions are discussed in relation to the three distinct fields of colorimetry, visual biophysics, and visual psychophysics. The general conclusion reached is that the available experimental evidence does not clearly dictate the fundamental physiological processes mediating human color vision. 209 pp. (Published by American Elsevier Publishing Company, Inc., 1968, $10.00. Available only from booksellers or the publisher.) (Also published by RAND as RM-4196-ARPA, January 1966.)

REPORTS

R-256 A Survey of the Mathematical Theory of Time-lag, Retarded Control, and Hereditary Processes. R. E. Bellman, J. M. Danskin, Jr. March 1954.
A summary of the mathematical techniques required to analyze physical phenomena involving time lags, retarded control, or hereditary effects. Applications of these methods are significant in various fields (e.g., guided missile design, economics, psychology, medicine, and biology) and in theories of elasticity, magnetism, and fission processes. 118 pp.

R-336-RC Research and the Ulcer Problem. I. S. Blumenthal. June 1959.
A Report on one particular group of chronic diseases: the ulcerative disorders of the gastro-intestinal tract. The group includes peptic ulcer and ulcerative colitis. An attempt is made to answer questions concerning the social magnitude of the problem, the adequacy of current medical solutions, and the scope of certain research efforts in the ulcerative-disorder field. Money devoted to research in this area has been less than 1 percent of the estimated economic loss to the nation because of these diseases. It is hoped that this analysis may be of interest to governmental agencies and private foundations supporting research in the biomedical field. 90 pp.

R-449-RC A Simulation of the Initial Psychiatric Interview. R. E. Bellman, M. B. Friend, L. Kurland. December 1966.
A description of a computer simulation of the initial psychiatric interview based on a combination of psychiatric and dynamic programming concepts. The set of questions and answers is given, along with some typical dialogs and the computer program. 270 pp. Refs. Bibliog.

R-596-PR A Photographic Technique for Image Enhancement; Pseudocolor Three-Separation Process. R. H. Stratton, J. J. Sheppard, Jr. October 1970.
Describes a simple, rapid, comparatively inexpensive three-separation method for transforming black-and-white photographs into pseudocolor transparencies, with each shade of gray represented by a different color. Since the eye can distinguish many more colors than shades of gray, such pseudocolor prints allow observers to extract more information from a photograph. The three-separation techique manipulates the density of the original, uses modified masking techniques to achieve red, blue, and green separations, and prints them successively in register on color negative material for the final pseudocolor transparency. This can be done in less than 2 hours in a modestly equipped photo laboratory, semi-manually, and would be suitable for use in a mobile reconnaissance unit. A fully automatic processor would reduce the time sharply. The report includes color plates of sample pseudocolor transformations--chromosome karyotypes, breast X-rays, aerial photographs--showing how the pseudocolor can be manipulated to bring out interesting details. Two other pseudocolor techniques will be reported separately. 47 pp. Ref. (MW)

R-597-PR A Photographic Technique for Image Enhancement: Pseudocolor Two-Separation Process. R. H. Stratton, C. Gazley, Jr. July 1971.
A method for transforming each tone of gray in a black-and-white image into a different color, enabling viewers to extract more information. Using only two intermediate separations, red and blue, the process is even simpler and faster than the red/green/blue process reported in R-596. It also gives a more evenly spaced range of hues. However, with the improvements described in this report, the three-separation technique has the greater flexibility. In the two-separation process: (1) One separation is made from the original positive and developed. (2) Another is contact-printed from the first--not emulsion-to-emulsion--and developed. (3) The first is contact-printed, emulsion-to-emulsion, on color film, using a red light source. (4) With careful image registration, the second is contact-printed, emulsion-to-emulsion, on the same material under a blue light. (5) The print is processed. Examples are included. 43 pp. Ref. (MW)

R-617-NIH BIOMOD: An Interactive Computer Graphics System for Modeling. G. F. Groner, R. L. Clark, R. A. Berman, E. C. DeLand. July 1971.
An overview of BIOMOD, an operational system designed to enable unsophisticated computer users to study models of dynamic systems, this report presents a scenario describing the construction and simulation of a drug effect model, briefly describes the system implementation, and discusses experience with users. BIOMOD employs a graphics console comprising a television screen, a data tablet, and a keyboard. A user constructs a model by drawing block diagrams and handprinting or typing text while receiving immediate feedback about

the interpretation of his actions. Each component of a model block diagram may be defined either by another block diagram, or by one of the other user-oriented languages: analog-computer-like elements; algebraic, differential, or chemical equations; or FORTRAN statements. During model simulation, displayed curves are continually and automatically updated; the user may stop the simulation and plot different variables, change scales and/or parameter values, and then continue the simulation. 36 pp. Ref. (See also R-746, R-747.) (Author)

R-642-RC Intrinsic Oscillations in Neural Networks: A Linear Model for the nth-Order Loop. R. J. MacGregor. February 1971.

A preliminary study of the inherent dynamic properties of feedback pathways composed of millions of brain cells. The ultimate aim is to predict feelings and behavior from the anatomical arrangement of nerve cells. This report maps the characteristic modes of oscillation for cells in a single closed loop--a linearized generalization of the interconnection pattern found in the hippocampus of the mammalian brain. Any or all cells may be externally stimulated, may activate or be activated by any other, and may contribute output individually or jointly, all with time lags. The analysis suggests that to possess many different persisting modes, a loop should have many cells with high average interunit conduction time and a large mean connective coefficient. This may be expected in cell networks with long, thin, unmyelinated axons and strong interconnections, such as the "open system" networks of the lateral hypothalamus and the brain stem reticular formation. 47 pp. Bibliog. (MW)

R-724-RC State Health Manpower Planning: A Policy Overview. J. P. Acton, R. A. Levine. June 1971.

Suggested approach to state health manpower planning within the context of uncertain demand and incomplete supply. Rather than attempting to estimate future health manpower imprecisely, the emphasis of this report is on planning and manipulating the supply of health personnel without precise estimates of supply and demand. The key to this planning is the recognition of imprecision in (1) estimates of demand for medical care, (2) predictions of future medical production functions, and (3) advance estimates of the results of policy decisions. As a result of this imprecision, planning must be flexible enough to meet uncertainty. Instead of concentrating on the existing supply to meet long-run demands, health planning should design supply systems that can respond rapidly to changes in demand or to firmly based short-run predictions of demand change. Existing literature on health manpower location is reviewed and its application to the state of Illinois is discussed for the availability of physicians, nurses, and allied health personnel. 37 pp. Biblioq. (KB)

R-729-IHEC An Analysis of Dental Manpower and Education in Illinois. J. A. DeiRossi, J. E. Eckles, P. D. Fleischauer, R. J. Melone, J. F. Mills. June 1971.

Analysis of the current supply of dental manpower in Illinois (1969 year end) shows that, adjusting for expected age-related activity rates, the estimated number of full-time equivalent dentists is substantially lower than the nominal supply: 4486 versus 6676. There is a significant variation in the distribution of dentists relative to the population. For example, a 10% increase in the total number of dentists would be necessary to bring all the county ratios up to the state-to-population ratio of about 45 dentists per 100,000 population. A 10% increase in productivity would reduce the number of dentists required to bring all counties up to the state average by about 30%. These estimates are based on the calculated rates of migration, retirement, and death. The analysis suggests that the growth of dental manpower supply in the state will only be able to keep pace with population, despite significant planned increases in dental manpower training. 73 pp. Bibliog. (KB)

R-746-NIH The BIOMOD User's Reference Manual. R. L. Clark, G. F. Groner, R. A. Berman. July 1971.

A detailed description of BIOMOD, Rand's interactive graphic modeling and simulation system, this report is designed primarily for users of the system. The user deals with 2 phases of BIOMOD--construction and simulation. The section of this report dealing with the construction phase provides the information needed to enter a model into BIOMOD, using any of the languages provided. The section on the simulation phase describes how to select variables, e.g., for plotting, changing scales, altering parameter values, changing integration techniques. The report includes aids to recovery from system failures, lists of system-supplied functions and error messages, and an extensive glossary. 148 pp. Ref. (See also R-617, R-747.) (Author)

R-747-NIH The BIOMOD System Implementation. R. L. Clark, G. F. Groner.

July 1971.
Outlines the more important design concepts behind BIOMOD, Rand's interactive graphic simulation system. During a construction phase based on GRAIL, the user describes his model via diagrams; algebraic, differential, or chemical equations; and/or FORTRAN statements. BIOMOD automatically checks each statement as completed, for syntactic validity. The data are filed in ring structures for rapid access and association. The BIOMOD compiler transforms the rings into a complete program in IBM's Continuous Systems Modeling Program language. Standard CSMP translation routines then complete its translation into machine code. The simulation phase consists of the standard CSMP routines plus special routines that solve chemical equations, display results, and allow user interactions. Except for compilation, BIOMOD is entirely "interrupt-driven," using no processor time until the user inputs data or directives. 40 pp. Ref. (See also R-617, R-746, RM-5999.) (MW)

R-751-RC/NLM Decision Analysis in Clinical Patient Management with an Application to the Pleural-Effusion Syndrome. A. S. Ginsberg. July 1971.
Patient management is defined as the sequential decision problem faced by the clinical physician or other health worker when a course of action must be chosen for a patient exhibiting some set of abnormal symptoms. The proposed approach relies heavily on the concepts of decision analysis. It considers (1) the uncertainties and risks inherent in the decision problem, i.e., dollar costs and risks of complications associated with a diagnostic test or treatment, including death; (2) the diagnostic value of the tests; (3) patient characteristics; and (4) changes in the state of the patient with the passage of time. A model and set of data are presented for the syndrome of pleural effusion. The data include the 43 disease states related to pleural effusion, more than 50 associated diagnostic tests, and the deterministic and probabilistic data necessary for solution of the model. Suggestions are offered for implementing the proposal as a clinical tool, and techniques for validating the methods are described. 138 pp. Ref. (KB)

R-767-NIH Pulsatile Flow in Small Blood Vessels: I. Casson Theory. J. Aroesty, J. F. Gross. April 1971.
The Casson model of printing ink flow has been shown to represent the steady flow of blood <u>in vitro</u>. This study extends the Casson model of fluid with yield stress, shear-dependent viscosity, and a power law of one half, to the pulsatile flow in arterioles, venules, and capillaries. The bloodstream is modeled as a Casson core with a much less viscous Newtonian wall layer. Velocity profiles are calculated over time for various physiologically representative cases. In the small vessels considered, inertial effects are negligible, pulsatile flow phenomena are quasi-steady, and viscous stress and pressure gradient forces are in instantaneous balance. These conclusions agree qualitatively with observations by Bugliarello and Sevilla. The plasma layer has a surprisingly large lubricating effect during periods when the effective shear viscosity is significantly higher than the ultimate high shear viscosity. These effects may be important throughout the circulation in cases of hemorrhagic shock. 30 pp. Ref. (See also R-768, R-769, RM-6214.) (MW)

R-768-NIH The Mathematics of Pulsatile Flow in Small Vessels: I. Casson Theory. J. Aroesty, J. F. Gross. April 1971.
Primarily a mathematical analysis of the Casson model of blood rheology, in which the fluid possesses finite yield stress and shear-dependent viscosity when it is subjected to a periodic pressure gradient in a long, rigid tube. In this report, the fluid is applied under pulsatile pressure conditions, assuming a low-viscosity plasma wall layer and a Casson core. The coupled nonlinear equations of motion and constitutive relations are nondimensionalized, and solutions valid for small tubes are derived by perturbation analysis. The inertial or time effects are shown to be negligible for conditions of physiological relevance. Thus, blood flow in the larger arterioles and capillaries can be accurately approximated by the quasi-steady solution, despite its pulsatility. 32 pp. Ref. (See also R-767, R-769, RM-6214.) (MW)

R-769-NIH Rheological Properties of Biological Flow Systems. C. Gazley, Jr. April 1971.
A brief description of some of the non-Newtonian flow phenomena encountered in the flow of biological fluids. Primary emphasis is on the interaction among shear-dependent and scale-dependent effects that occurs when the flow is slow and the tube small. Non-Newtonian fluid models are discussed and the experimental data for the pressure drop and velocity distribution of blood flow in small tubes are reviewed. A transformation parameter is described that stretches the radial dimension in such a way that the velocity distribution directly indicates the viscosity variation across the flow. Simple

analytic models are described that reproduce many features of the experiments. (Invited lecture, 1970 International Seminar on Heat and Mass Transfer in Rheologically Complex Fluids.) 43 pp. Ref. (See also R-767, R-768, RM-6214.) (Author)

R-787-NIH Computer Techniques for Pseudocolor Image Enhancement. J. V. Lamar. June 1971.
Description of computer methods of creating color separations for pseudocolor transformations, made possible by improvements in microfilm-generating equipment. A halftone process is chosen in which a picture is divided into many small areas and pseudo-random patterns are plotted in each. Twenty-one patterns are designed. The Datagraphix 4060 is programmed to produce 35mm microfilm frames containing plots of the patterns; their densities are established by densitometer reading. The examples described are for creating pseudocolor transformations based on the two-separation process, but the techniques are applicable for processes requiring any number of separations. A FORTRAN program has been written to create a 21-step gray scale, with each step a rectangle constructed from the patterns. Two separations of the gray scale are generated by the 4060, and a color scale is produced using the separations as the red and blue records in the two-separation process. A pseudocolor transformation of an image is created also from digital data. 44 pp. Ref. (See also R-596, R-597, RM-5297.) (KB)

R-808-IHEC An Information System Supporting Health Manpower Planning in Illinois. F. W. Blackwell, P. D. Fleischauer. August 1971.
Description of the information system developed for the Illinois Health Education Commission for the support of health planning in the areas of manpower, facilities, and education. Three major types of files are described. The manpower file contains extensive data on several health manpower categories: dentists, physicians, nurses, and veterinarians. Procedures for obtaining and using files are indicated. The health facilities file contains data on all hospitals and other health facilities in the state, together with related data on internship and residency programs. The health education file is a comprehensive source of information on all health education programs in Illinois, ranging from physicians and dentists to health technicians and assistants. The information system is designed so that each file can be used singly as well as in combination with other files. Philosophy and objectives of the design are discussed with respect to both present and future systems. 82 pp. Ref. (KB)

R-831-HEW/RC An X-Y Platform for RANDSIGHT-Type Instruments. R. W. Clewett, S. Genensky, H. E. Petersen. August 1971.
Describes a hand-operated mechanical device called an X-Y Platform that, when used with RANDSIGHT-type closed circuit TV systems for the partially sighted, permits design simplifications that lead to lower costs without sacrificing instrument quality or effectiveness. The device is placed on a desk or table below a fixed TV camera. Reading or writing materials are placed on its upper surface, which may be easily moved to the left or right and toward or away from the user so the camera can traverse a line of print or shift from line to line. The platform thus eliminates the need for a movable camera. A detailed discussion of the construction of the platform, illustrations, and recommendations for its operation should be of value to those who wish to construct their own platforms. 39 pp. Ref. (KB)

R-836-NYC The Supply of Professional Nurses and Their Recruitment and Retention by Hospitals. K. A. Archibald. July 1971.
Detailed review of the literature on nurses that deals with the supply of professional nurses and with factors that can be expected to influence their recruitment and retention by hospitals. The six chapters of the report cover the following topics: (1) professional nursing personnel: numbers, characteristics, and needs; (2) inactive nurses; (3) part-time employment of nurses; (4) child-care facilities for hospital personnel; (5) job satisfaction among nurses; and (6) nurses' earnings, i.e., salary and fringe benefits. The report pays particular attention to data on nurses in the New York area because it was prepared as part of a project evaluating alternative strategies for alleviating the nursing shortage in New York City municipal hospitals. 105 pp. Bibliog. (Author)

R-950-RC Evaluating Public Programs To Save Lives: The Case of Heart Attacks. J. P. Acton. January 1973.
Analyzes public programs to reduce heart attack mortality. The analysis is structured for a decisionmaker who must make a program-funding decision for a community of 100,000 whose characteristics are similar to those of the metropolitan United States. Since the decisionmaker must work within a budget, this report identifies alternative programs that are economically

viable and suggests measures of worth for evaluating the potential results of each program. A willingness-to-pay questionnaire is used as one basis for valuing the outcomes. The five programs analyzed in this report include (1) screening for high-risk persons and pretreating those whose ECGs show abnormalities; (2) ambulance with trained nonphysician personnel; (3) mobile coronary care unit with physician; (4) community triage center; and (5) triage center plus ambulance. Results of the cost-effectiveness and cost-benefit analysis are given. The report concludes that evaluation of lifesaving programs can be approached systematically and preferences of citizens can be incorporated into the evaluation. 154 pp. Bibliog. (MIM)

R-964-1-OEO/NC Coinsurance and the Demand for Medical Services. C. E. Phelps, J. P. Newhouse. October 1974.
Using a formal model of utility maximization, a model of demand is developed for medical services when reimbursement insurance is present, and when time costs are involved in purchasing medical care. Responsiveness to changes in insurance coverage is shown to diminish as the cost of time becomes a relatively more important (and money price a relatively less important) proportion of total costs for medical services. Under plausible (and weak) conditions, the observed responsiveness of demand for medical care to either money price changes or insurance coverage changes approaches zero as insurance coverage becomes complete. The arc-elasticity for all medical services in the zero to 25 percent coinsurance range is shown to be on the order of 0.1. It is estimated that around 8 to 17 percent more services would be demanded at a zero coinsurance rate than at a 25 percent rate. 63 pp. Bibliog. (BG)

P-965-1-OEO The Health Insurance Study--A Summary. J. P. Newhouse. March 1974.
Describes the design of an experiment to test the effects of varying the extensiveness of health insurance benefits. Two thousand families from four sites are selected at random and are assigned to one of sixteen types of insurance plans. The plans vary the fraction of the bill the family must pay from zero to 100 percent. In all plans that require some out-of-pocket payments, such payments are limited to 5 or 15 percent of the family's income. Some plans apply coinsurance only to inpatient services (outpatient services are free), and some participants are to be enrolled in a Health Maintenance Organization. 55 pp. Ref. (Author)

R-966-HEW An Annotated Bibliography on Rural Medical Care. K. A. Heald, J. K. Cooper. April 1972.
An annotated listing of 178 books and articles concerned with the problems of rural health care and manpower. The bibliography includes a subject listing of reviewed books and articles, as well as a table summarizing selected factors affecting physician location and factors related to rural living. 42 pp. (LC)

R-976-OEO The Effects of Coinsurance on Demand for Physician Services. C. E. Phelps, J. P. Newhouse. June 1972.
Analyzes effects of coinsurance on demand for physician services. In a natural experiment, the coverage of 2567 persons varied from full coverage in one year to 25 percent another year. Physician visits and expenditures declined by roughly 25 percent. Decline in ancillary services, while statistically significant, was only about half as great. Usage of different groups of individuals varied inversely with their assumed prices of time. The hypothesis that there was an equal absolute decline in visits and expenditures among all individuals cannot be rejected. It is possible, however, that utilization is a function of both a money price and a time price, and that the time price is lower for female dependents. 30 pp. Bibliog. (HT)

R-984-RC Intrinsic Oscillations in Neural Networks: A Linear Model for Parallel, Single-Unit Pathways. R. J. MacGregor. August 1972.
Describes research which explores the characteristics of neuroelectric activity that reflect the intrinsic physical and configurational properties of neural systems. The report presents an analytical exploration of neuroelectric oscillation in configurations consisting of two parallel, single-unit pathways feeding back on a single primary cell. A linear model with time-lag is used to derive theoretical maps of the characteristic states of such systems. It is found that increasing the mean interconnection coefficient increases the endurance of the leading characteristic state, and increasing the average interunit conduction time increases the number of states that endure for relatively long times as compared with representative times of the system. A differential in conduction time between two parallel pathways essentially tends to (1) increase the number of characteristic states in a given frequency range; (2) slightly increase the endurance of a given characteristic state; and (3) somewhat relax the conditions for stability

(except for the case of two parallel excitatory pathways). 29 pp. Bibliog. (PB)

R-1002-PR Altitude Bends in Humans: An Investigation Using Mathematical Models and a Computer. J. H. Bigelow, J. C. DeHaven, M. Shapley. August 1972.
Uses biomathematical modeling techniques and a computer to derive predictive formulas and other information about the incidence of altitude bends in humans with relation to prior denitrogenation, activity at altitude, and individual physiological characteristics. The models represent pertinent human functions, such as respiration and metabolism, and predict the effects of changes in these functions, as induced by alterations in total pressure, work level, and denitrogenation, on the formation and composition of bubbles in tissues. Bends is believed caused by the growth of gas bubbles in the blood and other tissues and their accumulation at specific locations, especially at the joints. The computer models are exposed to the range of conditions known to cause bends at altitude. Among other findings, model results strongly suggest that the rise in body-core temperature that accompanies exercise increases the incidence of bends at altitude. Thus, techniques that control core temperature near normal at altitude may be useful preventives. 112 pp. Ref. (PB)

R-1008-RC Rand's Work in Health and the Biosciences. M. A. Rockwell. March 1972.
An overview of Rand's health-research program, this report briefly describes progress to date in the five topics with which Rand is concerned. They are (1) an analysis of broad issues of governmental health policy, (2) improving the system by which health care is dispensed, (3) improving the prevention, diagnosis, and treatment of disease, with an emphasis on decisionmaking by physicians, (4) understanding the physiological mechanisms of life and disease, and (5) developing tools and methods for studying problems of modern society that have a bearing on health care. 25 pp. (CD)

R-1040-HEW/RC Advances in Closed Circuit TV Systems for the Partially Sighted. S. Genensky, H. E. Petersen, H. L. Moshin, R. W. Clewett, R. I. Yoshimura. April 1972.
Two Rand-designed CCTV systems called RANDSIGHT I and II are described which permit the partially sighted to read printed material or write with pen or pencil. CCTV systems are of value to over 800,000 partially sighted Americans. A testing program involving partially sighted subjects using RANDSIGHT I with an X-Y Platform is described and results are given. The Rand X-Y Platform (described in detail) has revolutionized design and lowered cost of similar commercial systems. In RANDSIGHT II, a research instrument, the motor-driven camera scans a line of text automatically or under foot or hand control. Tests indicate that no x-ray hazard exists from monitors operating at acceleration voltages not exceeding 19 kv. A simple lightbox test for determining roughly whether a CCTV system will benefit the partially sighted and which can be administered in a physician's office is presented. A comprehensive list of criteria for constructing a rationally designed CCTV system is given. (The word RANDSIGHT is the Certification Mark of The Rand Corporation.) 98 pp. Ref. (Author)

R-1054-OEO Demand for Health Insurance: A Theoretical and Empirical Investigation. C. E. Phelps. July 1973.
Develops a theory of demand for reimbursement health insurance that incorporates the effects of the insurance on demand for medical care. This theory applies to insurance with a limited number of parameters available for consumer choice (a coinsurance rate and a maximum payment). Household interview data from a 1963 survey are used to study actual insurance parameters chosen by the sampled families. Demand for reimbursement insurance is also estimated from aggregated (annual) time series data, where the variable studied is average coverage level of the population. Key results of the studies show that the estimated income elasticity for insurance is .2 to .4 and that estimated own-price elasticity is -.25 to -1.1, depending on the type of insurance. 210 pp. Bibliog. (Author)

R-1080-PR Mathematical Models for Simulating Physiological Responses to Severe Military Stress: Renal Function Details. J. H. Bigelow, J. C. DeHaven, M. Shapley. June 1973.
A previous model of the renal function and compartmented whole body, which incorporated actions of antidiuretic hormone on urine flow and composition, is extended to include the influences of additional phenomena, many exogenous to the kidney. These include the intrinsic-osmotic effect of water; details of the body's antidiuretic hormone cycle; gastrointestinal exchanges; changes in glomerular filtration caused by alternation in blood volume and pressure; and resistance to flow across kidney tubular walls. The responses of the model were validated by comparison with

responses of actual subjects, as reported in the literature. The model was exposed to and responded correctly to the following stresses: water loading through ingestion; hypertonic saline infusion; hypertonic urea solution ingestion; antidiuretic hormone dysfunction, as in diabetes insipidus; controlled rehydration after dehydration; and two combined stresses--hypertonic saline solution ingestion followed by water ingestion, and the converse experiment. 60 pp. Ref. (BG)

R-1096-NYC/OEO Population Health Survey 1968: Codebook and Marginals. J. P. Acton, L. J. Clark, R. J. Young. January 1973.
Documents of a household survey of approximately 13,500 persons in New York City. The survey was conducted by the Survey Research Center of CUNY for the Health Services Administration of the City and deals primarily with health status and medical service utilization of this cluster sample of City residents. This is a first publication of most of the content of this survey. An abbreviated version of the original questions, the valid responses, and their frequency is provided. 90 pp. (Author)

R-1131-OEO Supply Responses of Young Physicians: An Analysis of Physicians in Residency Programs. F. A. Sloan. March 1973.
Reports empirical findings related to work practices and practice mode choice of resident physicians, using data from Hospital Physician survey of interns, residents, and fellows. Many residents earn extra money by moonlighting, mainly in medical activities outside the training hospital. Borrowing is not an important source of funds on average, but some residents borrow a considerable amount. The effect of wages on hours is positive but small; the effect of income is greater. Children exert a positive effect on male and a negative effect on female resident moonlighting hours. In a model of physician supply, total current consumption, leisure, spouse's leisure, and current dissaving are related to nonmarket income, number of children, and factors reflecting ability and willingness to borrow. Recent graduates rate solo practice low, partnerships and groups higher. Practice mode decisions are usually made during residency; academic medicine is often chosen during medical school. Both financial and nonfinancial factors influence choice. 96 pp. Biblioq. (HT)

R-1149-NC On Having Your Cake and Eating It Too: Econometric Problems in Estimating the Demand for Health Services. J. P. Newhouse, C. E. Phelps. April 1974.
Discusses certain methodological problems in the economics literature related to the demand for medical care. There are two principal problems examined: misspecification of how insurance affects demand, and aggregation across services or across individuals. It is shown that in both cases estimates contained in the literature are inconsistent. Where possible, the direction of the inconsistency is obtained a priori. The paper also makes estimates of the magnitude of the inconsistency; the demand elasticities estimated in the economics literature may be overstated by a factor of three or more. 65 pp. Bibliog. (Author)

R-1151-OEO/NYC Demand for Health Care among the Urban Poor, with Special Emphasis on the Role of Time. J. P. Acton. April 1973.
The demand for health care is estimated using household survey data from poor neighborhoods in New York City. A theoretical model is developed such that people pay for alternative types of medical care with money and time. Implications of the model are examined by performing Tobit regressions. The time needed to consume alternative types of care are explanatory variables as are earned and nonearned income and selected socio-demographic variables. Time plays a significant role in determining demand in these populations. This has important policy implications in light of the continued spread of private health insurance and the possible enactment of National Health Insurance. The effects of changes in clinic locations, waiting room policies, and substituting income maintenance for direct provision of care are examined for increasing access of the poor to health care. 61 pp. Bibliog. (Author)

R-1161-NYC/OEO Population Health Surveys for 1964, 1965, and 1966: Codebook and Marginals. J. P. Acton, L. J. Clark, R. J. Young. January 1973.
Lists, in abbreviated form, the questions asked and the frequency of coded responses for the Population Health Surveys of New York City residents in 1964, 1965 and 1966. The Survey Research Center of the City University of New York performed most of the field work and coding, using cluster sampling in five New York City boroughs. The questions dealt chiefly with health conditions and use of health services, although there are also questions on many relevant sociodemographic characteristics of the respondents. The code-

book gives the meaning and frequency of responses to questions that are on magnetic tape. The marginals are not weighted in this report, although the weight column remains on tape. This work is designed to facilitate future analyses of the data as well as to provide a ready reference for rapid overviews of the status of health conditions and the use of existing services. 156 pp. (RS)

R-1162-NYC/OEO Population Health Survey for 1969-70: Codebook and Marginals. J. P. Acton, L. J. Clark, R. J. Young. January 1973.
Lists, in abbreviated form, the questions asked and the frequency of coded responses for the Population Health Survey of New York City residents in 1969-1970. The Survey Research Center of the City University of New York performed most of the field work and coding, using cluster sampling in five New York City boroughs. The questions dealt chiefly with health conditions and use of health services, although there are also questions on many relevant sociodemographic characteristics of the respondents. Approximately 516 "columns" of information are available on 13,356 respondents. The codebook gives the meaning and frequency of responses to questions that are on magnetic tape. The marginals are not weighted in this report, although the weight column remains on tape. This work is designed to facilitate future analyses of the data as well as to provide a ready reference for rapid overviews of the status of health conditions and the use of existing services. 146 pp. (RS)

R-1189-OEO/NYC Demand for Health Care When Time Prices Vary More Than Money Prices. J. P. Acton. May 1973.
A survey of users of New York Municipal Hospital Outpatient Departments was used to examine factors that determine demand for medical services. In particular, this study concentrates on nonmonetary factors that may be important as money prices fall (due to spreading health insurance or the enactment of National Health Insurance legislation). After developing predictions with a utility maximization model, a simultaneous equation system was specified such that the distance one travels to receive free ambulatory care is endogenous. The empirical results support the major predictions of the formal model. A number of suggestions are made for policymakers either at the federal or city level. 47 pp. Bibliog. (Author)

R-1197-NC/OEO Price and Income Elasticities for Medical Care Services. J. P. Newhouse, C. E. Phelps. June 1974.
Presents a theory of the demand for medical care services that is a generalization of Michael Grossman's investment model in three ways: Medical care is not treated as a homogeneous commodity but disaggregated to hospital and physician services; the price of the provider selected and medical insurance are treated as endogenous; variation in price per unit of services among providers is allowed for and explained. Preliminary estimates of price and income elasticities are presented using data on heads of families in the labor force from the 1963 Center for Health Administration Studies survey. These data show price elasticities to be on the order of -0.15 for hospital length of stay and physician visits and wage income elasticities to be near zero. 41 pp. Bibliog. (Author)

R-1216-OEO Mental Health, Dental Services, and Other Coverage in the Health Insurance Study. L. A. Clasquin. November 1973.
Cost, transitory demand under experimental conditions, and likelihood of inclusion of mental health and dental insurance benefits in a national plan are discussed as criteria for determining the scope of coverage in the Health Insurance Study. The cost of a dental program is affected by the mean age of the covered population. Dental coverage appears likely for children under 18. The cost of outpatient psychiatric services is related to an observed correlation between the demand for mental health and that for general medical services and to the nature of the covered population. Coverage of psychiatric benefits to an uninsured population would result in some transitory demand, but, based on available data, a precise estimate cannot be made. Inclusion of some mental health services appears possible, but coverage would probably be restricted. The provisions for other benefits are also reviewed. 38 pp. Bibliog. (Author)

R-1220-HEW Services for Handicapped Youth: A Program Overview. J. S. Kakalik, G. D. Brewer, L. A. Dougharty, P. D. Fleischauer, S. Genensky. May 1973.
A cross-agency evaluation of government programs for the more than 9 million mentally or physically handicapped youth aged 0-21 who are impaired enough to require services not needed by "normal" youth. The programs are grouped into areas and discussed by the five different types of agencies that administer them: health, welfare, education, vocational

rehabilitation, and mental health and retardation. In recent years all such programs expended nearly $5 billion annually for services. The report provides a descriptive overview of the handicapped youth population, the structure and functioning of the system, the current state and Federal service programs, the resources devoted to various classes of handicapped youth, and the services delivered. Also identified are major problems of the present service system, both in the services delivered and in the institutional structure of some of the programs. 354 pp. Bibliog. (RS)

R-1220-HEW (Abridged) Services for Handicapped Youth: A Program Overview. J. S. Kakalik, G. D. Brewer, L. A. Dougharty, P. D. Fleischauer, S. Genensky. May 1973.
Executive summary of R-1220. 29 pp.

R-1222-OEO Health and Taxes: An Assessment of the Medical Deduction. B. M. Mitchell, R. J. Vogel. August 1973.
Indirect tax subsidies to health insurance and medical expenses totaled $3.8 billion in 1970 and will reach $7.6 billion in 1976. These subsidies create incentives to purchase health care through insurance rather than directly. Above $6000 of income most families can obtain a subsidy that exceeds the administrative costs of group insurance policies. Increased health insurance coverage, by reducing the net price of health care, increases the demand for health care and, with limited medical resources, leads to higher hospital and physician prices. The medical deduction under the personal income tax is a last-resort health insurance plan. Despite its income-related deductible and coinsurance parameters, the deduction provides larger benefits to high income taxpayers and limited catastrophic protection. Tax subsidies are distributed in near proportion to income. The study considers several alternative tax policies that would provide greater health benefits to lower income families and increase protection against the expense of catastrophic illness. 52 pp. Bibliog. (Author)

R-1281-OEO Welfare Analysis of Changes in Health Coinsurance Rates. K. J. Arrow. November 1973.
This report develops a general equilibrium theory of demand for and supply of medical care when medical care purchases are insured by a plan with a coinsurance rate r. The report then investigates welfare effects of a change in r. Random levels of health are considered, and utility is allowed to vary with the state of health. If supply is totally inelastic, decreases in coinsurance only transfer income to suppliers of medical care with no changes in welfare or efficiency. For other supply elasticities, welfare effects depend upon both supply and demand elasticities and upon the health status-marginal utility of income covariance. It is also shown that welfare unambiguously increases with the introduction of some insurance coverage, but the optimal level of coverage cannot be determined theoretically. 39 pp. Ref. (Author)

R-1347-ARPA/DDPAE Physical Standards in an All-Volunteer Force. D. S. Chu, E. M. Norrblom, K. A. Brown, A. B. MacInnes. April 1974.
This report analyzes physical disqualification among enlistees in a zero-draft environment. To help determine the standards that might reasonably be set, it compares U.S. standards with those used by the armed forces of other advanced nations, and with those used by the private sector. To analyze directly how chronic physical conditions affect time lost from work and hospitalization, it uses data from the Health Interview Survey. Based on these results, nine areas are identified where current standards might be relaxed, the effect of these changes on enlistments is calculated, and cost estimates are presented for the increased medical discharge rates that might result. 145 pp. Bibliog. (Author)

R-1402-HEW Binoculars: A Long-Ignored Aid for the Partially Sighted. S. Genensky. November 1973.
Of the 1.77 million visually impaired people in the U.S. today, 1.64 million are partially sighted and not blind. This population has been neglected or misguided by both public and private institutions, because many could have been trained to participate more fully in a sighted society. Binoculars are one important visual aid that have long been ignored by clinicians. They are simple to operate, easily obtainable, and relatively inexpensive, and can be used in the home, in school, at work, while traveling, and while relaxing. Practical uses--which are demonstrated in this report both in words and pictures--include determining the status of a traffic light, ascertaining a street address, taking notes from a chalkboard, or watching television. For some, binoculars magnifying as much as twenty times can be useful. They can be supplemented with specialized equipment, such as close-up lenses. Also of interest are zooming binoculars, controllable in-

ternal irises, and telescopic spectacles. 60 pp. Ref. (ETG)

R-1420-HEW Improving Services to Handicapped Children. J. S. Kakalik, G. D. Brewer, L. A. Dougharty, P. D. Fleischauer, S. M. Genensky, L. M. Wallen. May 1974.
Evaluates current policies and recommends new policies for improved delivery of services to handicapped youth, with emphasis on children with impaired hearing or vision. Over 50 major federal programs and hundreds of state and local programs spend nearly $5 billion a year on services to all handicapped youth. Most of the programs are worthwhile but the system could do far better. Any large-scale effort to improve it must begin with basic service needs, such as prevention, identification of handicapped youth, direction to service providers, medical treatment, corrective aids, special education, counseling, vocational training, job placement, financial assistance, and research and development. The report develops several models of government roles for providing services, and presents an array of recommendations keyed to various levels of effort the government may be willing to undertake. (See also R-1220, R-1420/1.) 342 pp. (WH)

R-1420/1-HEW Improving Services to Handicapped Children: Summary and Recommendations. G. D. Brewer, J. S. Kakalik. May 1974.
This is a summary of R-1420. See abstract above. 64 pp. (WH)

R-1464-HEW Federal Manpower Legislation and the Academic Health Centers: An Interim Report. G. M. Carter, D. S. Chu, J. E. Koehler, R. L. Slighton, A. P. Williams, Jr. April 1974.
Medical school admissions decisions have been responsive to federal policies and social concerns regarding equality of access for women and minorities. State schools and state-supported private schools discriminate in favor of residents. Primary care physicians are choosing specialty training. The more ambulatory care this training includes and the earlier it is introduced, the higher its costs. Limitations of cost allocation in joint production precludes any unambiguous determination of education costs. Strong interdependencies among patient care, research, and education mean strong interdependencies between federal decisions in health manpower and other health care areas. Capitation grants succeeded financial distress grants for financing medical school operating costs, but they could not affect factors underlying past financial difficulty. Academic health centers would react to cutbacks in institutional support by seeking replacement funds and altering programs; replacement funds will come from tuition increases, state appropriations, and clinical faculty practice earnings. Greater reliance on faculty earnings will require that clinical care in teaching hospitals be oriented away from primary care. 100 pp.
(Author)

R-1469-NYC Methods for Assessing Inpatient Nurse Staffing Requirements. J. M. Tien. April 1974.
A Johns Hopkins model for determining nursing needs of hospital patients is modified and applied to NYC's municipal hospitals. Statistical models reveal demands for nurses in light of (1) patient needs and (2) nurse days off (absenteeism and sickness). The analysis considers demands for permanent and per-diem nursing staffs. A new staffing standard, derived from the nurse requirement model (using data from the Hopkins study and from a survey of patient needs in HHC hospitals), is used to assess the requirements of two large municipal hospitals. A nurse floating pool should be established in each HHC hospital to meet patient demands beyond what can be satisfied by the fixed staff. The pool should include all per diems and between 5.5 and 12.2 percent of the fixed staff. The flexibility inherent in a floating pool would eliminate the need for each hospital to hire between 3 and 9 percent additional fixed staff. Procedural problems in establishing such a pool are discussed. 87 pp. (Author)

R-1481-CHD Medical Manpower Models: Need, Demand, and Supply. J. R. Lave, L. B. Lave, S. Leinhardt. March 1974.
How many physicians are needed? Can they be obtained? A framework within which to explore these two questions is proposed together with a review of recent literature. Section I outlines the increase in planning. Section II defines the goal of the delivery system as an improvement in the health of the population and raises the difficulties of implementing the goal. Section III reviews methods for forecasting need: (1) professionally defined standards, (2) physician/population ratios, (3) economic models of demand, and (4) system models of the delivery system. The first two bear little relation to the expected utilization of physicians or to the goal of improving health. Economic models reflect utilization, but neglect access costs. System models suffer from estimation problems and the lack of outcome measures. Section IV focuses on the sup-

ply of physicians; they seem to respond to environmental and other amenities, with less emphasis on income; they seek proximity to colleagues and modern facilities. Six ways to determine if a shortage exists are reviewed in Section V. Section VI demonstrates that the supply of physicians has continually been underestimated. Locational inequity appears to be the major unsolved problem. 68 pp. Biblioq. (Author)

R-1484-OEO Issues in the Analysis and Design of the Experimental Portion of the Health Insurance Study. J. P. Newhouse. June 1974.
Discusses two problems in the analysis of data and four problems in the design of the Health Insurance Study. Analytical problems discussed are measurement of price elasticity when price changes with total expenditure and measurement of the purchase of supplemental insurance. Design problems discussed are number of individuals to be assigned to any one plan, method of assignment, choice of individuals from given communities, and choice of communities. Includes brief description of Finite Selection Model, developed for this experiment to choose the optimal subset of observations (families) from a finite set of possible observations (families) in order to estimate a specified equation or equations. 29 pp. Ref. (Author)

R-1514-OEO/NC Deductibles and the Demand for Medical Services: The Theory of the Consumer Facing a Variable Price Schedule under Uncertainty. E. B. Keeler, J. P. Newhouse, C. E. Phelps. December 1974.
A theoretical model of a consumer who faces a price that varies with the number of units bought, and who faces random future changes in his demand for the good. An example is cumulative deductibles in health insurance policies. The problem is treated as a dynamic program involving medical demand under an insurance policy with a deductible. In this model, the perceived price of care falls (following a non-linear path) as the consumer approaches the deductible. The model suggests: (1) Because demand and administrative costs are likely to be insensitive to the size of the deductible above a certain range, deductibles above that range will not be optimal; they add risk with no return. (2) Demand estimates will be biased if insurance policies in the sample contain deductibles, and if the dependent variable is annual medical demand. (3) Demand analysis by episode of illness is the appropriate framework in such circumstances. 57 pp. Bibliog. (Author)

R-1528-HEW/OEO Policy Options and the Impact of National Health Insurance. J. P. Newhouse, C. E. Phelps, W. B. Schwartz. June 1974.
Estimates the effects of various prototypical health insurance options on demand for medical services. The data indicate that under full coverage or 25 percent maximum coinsurance, demand for hospital services would rise modestly. However, either program would greatly increase demand for ambulatory services and would stress the delivery system, with resulting increased price of physicians' services, queueing, or less physician time per patient--all without increasing total delivery of ambulatory services. Ambulatory services would be redistributed from the affluent to the poor. A catastrophic health insurance program would not stress the ambulatory system. Reorganization of the delivery of ambulatory services into prepaid groups will probably not increase productivity, nor will emphasis on preventive medicine reduce overall demand for health services. National insurance providing more health services would not appreciably affect objective indexes of health (life expectancy), but should improve subjective but unquantifiable elements such as quality of life. 68 pp. Ref. (Author)

R-1537-HEW Interactive Classroom TV System for the Handicapped. S. M. Genensky, H. E. Petersen, R. I. Yoshimura, J. B. VonDerLieth, R. W. Clewett, H. L. Moshin. June 1974.
A description of a highly interactive multicamera-multimonitor closed circuit TV system that permits a teacher and her handicapped students to be in continuous visual communication with one another. This system is being proof-tested in a resource room for handicapped children in an elementary school in Santa Monica, California. Although it is too soon to make definitive statements regarding the value of the system in educating handicapped children, teacher and project staff observation to date indicates that it is not only proving to be of great help to partially sighted children, but that it is also assisting those who are educable mentally retarded or hearing impaired. 61 pp. Ref. (Author)

R-1539-NIH A Survey of Clinical Investigators and Their Information Processing Activities. N. A. Palley, G. F. Groner. July 1974.
Discusses the design, execution, and preliminary results of a personal interview survey of clinical investigators at 23 General Clinical Research Centers. The aim of the survey was to develop a characteri-

zation of the clinical research process, to verify the existence of problem areas amenable to information science solutions, and to provide a data base for initial design specifications of a computer system to assist clinical investigators in their data manipulation tasks. The results (1) verify the low utilization of large computer centers by clinical investigators; (2) identify data processing impediments to clinical research; (3) suggest benefits that might result from their alleviation; (4) provide broad design parameters for a data storage, retrieval, and manipulation system; (5) underline the need for human assistance as well as hardware and software; and (6) document the enthusiasm of clinical investigators about the development and support of a well designed data manipulation tool. 82 pp. Ref. (Author)

R-1542-NIH A Plan for the Development and Evaluation of a Data Management and Analysis System for Clinical Investigators. G. F. Groner, M. D. Hopwood, N. A. Palley, N. Z. Shapiro, W. L. Sibley. August 1974.

A plan, part of the NIH-sponsored CLINFO project, for developing, installing, operating, and evaluating a prototype, minicomputer system designed to meet many of the information processing needs of medical researchers that are reported in R-1539 while being economical, easily accessible, and widely usable. The three-year plan calls for developing an initial prototype system aimed at helping clinical investigators collect, organize, store, retrieve, and analyze their research data; installing copies at two clinical research centers where they will be experimentally evaluated; modifying the system to maximize its acceptability; developing operating and maintenance procedures and requirements for personnel; estimating benefits and operating costs; and possibly testing conclusions at an additional site. The report describes the initial system, operating and personnel characteristics, and how the plan will be effected. (See also R-1621.) 61 pp. Ref. (Author)

R-1551-RWJF Some Trends in the Delivery of Ambulance Services. J. Chaiken, R. J. Gladstone. July 1974.

A discussion of the organization of emergency ambulance agencies and their communications systems, levels of training of personnel, and travel time characteristics. The report is based on data obtained from 179 grant applications to the Robert Wood Johnson Foundation, representing agencies that serve about two-thirds of the population of the U.S. Findings include: Purveyors for whom emergency service is a secondary function are gradually being phased out. Nationwide standards concerning citizen access to emergency medical help, training of personnel, and communication systems, which have been developed without evaluative studies showing they are valid, are not now met by most agencies. Obstacles to rapid installation of dial 911 systems are still severe, with many regions opting temporarily for alternative access systems, such as use of area code 800. However, ambulance agencies believe they can correct existing command-and-control deficiencies within a 2-year period, given sufficient funding. 49 pp. Ref. (Author)

R-1572-CHD California Health Manpower: An Overview of Trends and Policy Issues. A. J. Lipson. March 1974.

Based primarily on review of health manpower literature and interviews with state officials, researchers, and providers of health services, this report is an overview of state activities that influence health manpower supply and distribution. To maintain an adequate supply of health manpower, the state is not only concerned with the output of training institutions and retaining health professionals educated in the state, but also with inmigration from other states and countries. Responsibility for decisions and action to determine and achieve manpower objectives is now fragmented among many state agencies, providers of health care, and public and private training institutions. An important question for the state is how to develop institutional arrangements that will provide a framework for continuously determining its health manpower goals and coordinating policies to achieve them. A key element in such a system is the development of analytic capability and data that will permit examination of alternative manpower goals and policies. 160 pp. Biblioq. (BG)

R-1583-HEW Peer Review, Citations, and Biomedical Research Policy: NIH Grants to Medical School Faculty. G. M. Carter. December 1974.

Considers two descriptions of the scientific output of grants from NIH to medical school faculty: the judgments rendered on grant applications by NIH study sections and counts of citation data. Average priority scores and the fraction of applications disapproved between 1968 and 1973 are presented and changes over time are analyzed. A sample of 747 research project grants and all 51 program project grants awarded to medical school faculty on a competitive basis in fiscal year 1967 was selected and publication and citation data retrieved. The correlation between the

two output measures is found and they are used to compare research projects to program projects, to examine quality of investigators who responded to the war on cancer and the effect of levels of support lower than those of FY 1967 for the NIH extramural research program. 90 pp. Ref. (Author)

R-1614-HEW A Double X-Y Platform for RANDSIGHT-Type Instruments. S. M. Genensky, H. E. Petersen, R. W. Clewett, M. L. Moshin. December 1974.

The third in a series of reports to study the information transfer problems of the partially sighted. This report contains a detailed description of a double X-Y Platform, which can be used in conjunction with a closed circuit TV system for the partially sighted and substituted for the single X-Y Platform that has proved so useful in such systems. The double X-Y Platform permits the partially sighted to read printed and handwritten material and to comfortably copy from or take notes on what has been read. The platform's two rectangular working surfaces are designed to allow the user to change from reading to writing (or writing to reading) without having to search for the line where he left off. Other techniques were explored, and a series of experiments were performed with the cooperation of four partially sighted people using the different techniques. See also R-1402 and R-1537. 43 pp. Ref. (EDS)

R-1621-NIH A Prototype Data Management and Analysis System for Clinical Investigators: An Initial Functional Description. W. L. Sibley, M. D. Hopwood, G. F. Groner, N. A. Palley. August 1974.

The initial functional specifications for a minicomputer-based prototype data management and analysis system to be used in investigating the role of such systems in clinical research. This prototype is being developed as part of the CLINFO project, which is sponsored by the Division of Research Resources of the National Institutes of Health. In addition to its data management and analysis capabilities, the prototype will collect data that will be used to evaluate its effectiveness in clinical research centers, where the prototype will be installed on an experimental basis. The discussion of the functional specifications is preceded by a review of the requirements leading to the need for the functions. The requirements and the specifications form the foundation for the detailed design documents that will be produced before actual system implementation begins. See also R-1539 and R-1542. 48 pp. Ref. (JDD)

R-1635-OEO Forecasting Demand for Medical Care for the Purpose of Planning Health Services. J. P. Newhouse. December 1974.

How complex a model is needed to predict the demand for health services in the U.S.? To overcome the high cost of obtaining information for sophisticated models, Newhouse estimates a simplified version of a model for predicting the demand for hospital and physician services to ascertain the model's properties. "Simplification" involved making demand a function of only demographic variables, which can readily be obtained, and omitting measures of health status, price, and insurance coverage, which are unavailable. Unfortunately, this simplification is impractical for today's health planning because changes in insurance influence demand too greatly to be omitted from predictive equations, even if data on labor force participation, income, and education are available as explanatory variables. These variables are not satisfactory proxies. Over time, insurance may cease to be as critical in predicting demand, but for the next several years it is likely to remain important. 24 pp. Ref. (DGS)

R-1651-CF Review of Federal Programs To Alleviate Rural Deprivation. P. A. Morrison, S. M. Mazie, R. B. Rainey, Jr., S. Purnell, H. J. Boissevain, B. Coleman. December 1974.

Reviews programs to alleviate rural deprivation in material well-being, health, and legal services. Human resource development programs worthy of expansion are Operation Hitchhike, Area Concept Expansion, Concerted Service in Training and Education, Operation Mainstream, and Neighborhood Youth Corps. Area development programs are expensive and have diffuse effects. Job placement and migration programs suggest that relocation assistance is an inexpensive way to provide jobs for the unemployed. OEO's successful Legal Services Program attacks the vast unmet demand for individual case handling; there is equal need for legal aid in economic and civil rights matters. Unmet health needs exacerbate rural poverty. Various programs influence the geographic distribution of doctors, encourage clustering of health facilities, and promote the use of paramedical personnel. All such supply-side programs will be deficient, however, until the rural poor are enabled to speak for themselves and provide diagnostics from within. (See also R-1081, R-1103.) 75 pp. (WH)

RAND MEMORANDA

RM-2519-PR A Mathematical Model of the Human External Respiratory System. G. B. Dantzig, J. C. DeHaven, I. Cooper, S. M. Johnson, E. C. DeLand, H. E. Kanter, C. F. Sams. September 1959.
The results of a mathematical simulation of the external respiratory function to illustrate the thesis that important subsystems of the human body can be studied by mathematical programming techniques that have been used to program and control complex military and industrial systems. Two mathematical models were set up to represent the more important of the known interrelated physiological functions and chemical reactions involved in the human respiratory system. Model I uses a simplified concept of the hemoglobin molecule, and Model II is based on Linus Pauling's theory of the complex hemoglobin molecular structure. 109 pp.

RM-2907-RC A Mathematical Model of Drug Distribution and the Solution of Differential-Difference Equations. B. Kotkin. January 1962.
Consideration of a mathematical model of drug distribution to study the time course of the concentration of a drug injected into the body and of the concentration of the compounds formed in the various organs. This leads to a system of differential-difference equations that arise from the time delays inherent in the physical process of the recirculating blood. The solution of such a system presents computational difficulties not encountered in ordinary differential equations, particularly in its demands on machine storage. The author describes some digital-computer parameter experiments designed to study a two-organ model as a guide to the biologist in selecting drugs and injection procedures for optimal effect. A new method for the computational solution of differential-difference equations is suggested. 30 pp.

RM-3212-PR Reactions of Hemoglobin and Steady States in the Human Respiratory System: An Investigation Using Mathematical Models and an Electronic Computer. J. C. DeHaven, E. C. DeLand. December 1962.
A report on results of mathematical experiments performed with a detailed model of the human external respiratory subsystem. An earlier study (RM-2519, "A Mathematical Model of the Human External Respiratory System") discusses the mathematical basis for the model and demonstrates the general feasibility of the approach. This memorandum describes the considerable improvements in the theory and the structure of the model. It also demonstrates the ability of the improved model to simulate satisfactorily, and in detail, the responses of the subsystem under a wide range of conditions. 193 pp.

RM-3393-PR A Neural Net for Consummatory Behavior. E. W. Paxson, I. Barr. January 1963.
A description of a neural-net representation of eating behavior in animals. Using the apparatus described in RM-3406, A General Neural Net, the authors design a neural net that approximates the observed behavior of a feeding animal in that (1) the duration of eating time depends on the amount of deprivation, (2) eating ceases before ingested material can be metabolized and thus affect the central nervous system, and (3) bursts of eating alternate with brief resting periods as satiety is approached, the former decreasing in duration and the latter increasing. 21 pp.

RM-3405-PR An Elementary Cortical Cylinder. E. W. Paxson. November 1962.
This Memorandum is concerned with an electronic digital simulation of a cortical cylinder. A simple initial model designed to check out the 7090 program for neural nets is described, and the results of computation are given. The model is grossly analogous to a small cylinder through the cortex. 14 pp.

RM-3406-PR A General Neural Net. E. W. Paxson, J. W. Smith. November 1962.
This Memorandum is concerned with an electronic digital simulation of a general neural net. For example, connectivity and transmission times along links are at the pleasure of a net's constructer. Time is not quantized (except as demanded by the "grain" of the computation). Eight of the synaptic mechanisms distinguished by Bullock are permitted, and the assisted synaptic learning theory of Milner is included. The net described has been coded for the IBM 7090. 17 pp.

RM-3416-PR A Programming System for General Neural Nets. J. W. Smith. January 1963.
A description of the electronic digital simulation aspects of the computer programming system used in the study of general neural nets presented in RM-3406-PR, "A General Neural Net." The system, called NETI, allows investigators to construct nets, maintain files of nets, and compose and execute preplanned programs of exper-

imentation on nets. Such experimental programs may effect repeated simulations of a single net or collection of nets with intersimulation variation of net components, parameters, and stimuli, and may interrogate, test, and vary such elements within an individual simulation. 48 pp.

RM-3541-PR Analysis of Chemical Constituents of Blood by Digital Computer. J. V. Malonev, J. C. Dehaven, F. C. DeLand, G. B. Bradham. April 1963.
A report on results of a blind competition between experiments performed with a mathematical model of the human respiratory subsystem using an electronic computer and others performed by a team of physicians and chemists working in a surgical laboratory on the same biochemical problems. The model proved adequate to forecast accurately the changes that will occur in this subsystem when it is subjected to various forms of stress. 40 pp.

RM-3665-NIH A Mathematical Model of Radiation and Population of Cell Colonies--I: Two-Dimensional Random-Walk Model. R. E. Bellman, M. Elkind, B. Kotkin. July 1963.
A mathematical model designed to study the effect of radiation on the population of cell colonies for cancer research. It is a simple model that follows a cell through a two-dimension random walk, where one dimension represents state of growth and the other, state of health or number of sites damaged. The cell is subjected to radiation exposure at prescribed times and doses, which can be varied. The cell will eventually either divide or become sterile. An IBM 7090 FORTRAN program of the Monte Carlo procedure presents a statistical summary of results at the absorbing barrier. 17 pp.

RM-3677-PR Conditions for a Homogeneous Mixture To Be Ideal. N. Z. Shapiro. June 1963.
A study establishing conditions for the use of certain techniques to determine chemical equilibrium in such areas as physiology and biology. Homogeneous mixtures of three or more chemical species at fixed temperature and pressure are considered. Conditions are obtained for such mixtures to be ideal over some range of chemical compositions. Classically, ideality has been obtained as a result of various assumptions concerning the intermolecular forces operating in the mixture. The conditions presented here are independent of any such explicit assumptions. The work applies to a continuing program of biological research, dealing especially with physiological responses to unusual environments. It also applies to chemical problems in rocket propulsion systems studies, upper atmosphere studies, re-entry studies, etc. 20 pp.

RM-3707-PR The Linear-Logarithmic Programming Problem. R. J. Clasen. June 1963.
The development of the algebraic solution of the linear-logarithmic programming problem, derived by means of Lagrange multipliers. Two numerical methods for solving the problem are then given, one of which is a generalization of a method previously used to solve the chemical equilibrium problem. Convergence has not been proven for either of these methods; a number of large chemical equilibrium problems, however, have been solved using one or both of the methods. 17 pp.

RM-3716-NIH A Numerical Approach to the Convolution Equations of a Mathematical Model of Chemotherapy. R. E. Bellman, B. Kotkin. July 1963.
A discussion of the physical assumption of laminar flow in the large blood vessels. This flow complicates the mathematical model of drug distribution in the body by introducing convolution terms which are difficult computationally. This Memorandum tackles the new equations of the chemotherapy model and presents a method suitable for programming this as well as other biological systems involving equations of this type. The method of differential approximation applied to the convolution equations reduces this model to a system of differential-difference equations that can be solved computationally. 18 pp.

RM-3777-PR Dynamic Programming, Learning, and Adaptive Processes. R. E. Bellman. September 1964.
An indication of how the mathematical technique of dynamic programming can be used to handle a number of processes that arise in biology, engineering, economics, and psychology and, in general, to deal with a wide class of problems that require learning and adaptation because of insufficient information about the nature of the underlying process. 18 pp.

RM-3835-NIH A Note on the Computational Solution of a System of Differential Equations with Varying Time-Lags. R. E. Bellman, B. Kotkin. November 1963.
A description of how a technique for the reduction of the solution of differential-difference equations with one time-lag to the solution of systems of ordinary differential equations can be extended to the more complex situation

involving different time-lags. The method is important to the study of more realistic models of chemotherapy. 9 pp.

RM-3868-PR A Neural Net for Adaptive Behavior. S. H. Block. December 1963.
Using the apparatus of RM-3406-PR, a neural net is designed to demonstrate the concepts of adaptive biological processes as described by W. R. Ashby. The basic assumption is that there exist certain cells whose firings represent a state of warning and that, to survive, the organism must keep the activity of these cells within certain limits. This net consists of four groups of cells that represent the organism and a single group of input cells that represent the environment. When the organism is presented with environmental conditions, it will demonstrate adaptive behavior, i.e., it will attempt to minimize the length of time needed to counteract the adverse effect of the environmental conditions upon the organism. 28 pp.

RM-3872-PR A Neural Net for the Recall of Sequences. E. W. Paxson. December 1963.
A report on a neural net used to study certain elementary aspects of the overt behavior of the central nervous system. The net presented in this Memorandum is based on the requirement that all the elements in a sequence, presented as stimuli during a short interval of time, must remain present as a serial memory trace and be available for serial recall in the order given. Time may be represented by space storage along a chain of neutrons. Consequently, a mechanism equivalent to scanning is needed to lay down the trace and to replay the sequence. 30 pp.

RM-3935-1-PR Mass Action Laws and the Gibbs Free Energy Function. N. Z. Shapiro, L. S. Shapley. September 1964.
A discussion of problems arising in the computation of chemical equilibrium. This report contributes to our ability to apply electronic computer techniques in the analysis of complex chemical systems. The Memorandum considers certain previously unresolved questions of mathematics and chemistry concerning the existence and uniqueness of a solution to the equations arising from the mass action laws, the existence and uniqueness of a composition that minimizes the free energy, and the precise relationship between the two. Mathematical tools unavailable in Gibbs' time are employed in an attempt to answer these questions. 61 pp. Biblioq.

RM-3948-NIH Numerical Solution of Functional Equations by Means of Laplace Transform--I: Renewal Equation. R. E. Bellman, R. E. Kalaba, J. Lockett. December 1963.
Earlier mathematical and computational studies of cancer chemotherapy showed the need for the development of methods to handle convolution integrals computationally. The Memorandum gives techniques for the numerical inversion of Laplace transforms. The methods are also useful in treating wide classes of equations arising in biology, chemistry, operational research, and similar studies. 19 pp.

RM-3983-NIH Stable Modes of Activity in Pacemaker Neurons with Open Loop Synaptic Output. T. H. Bullock, G. P. Moore, D. H. Perkel, J. H. Schulman, J. P. Segundo. February 1964.
The consequences of inhibitory or excitatory interactions between pacemaker neurons were predicted mathematically and through digital-computer simulations, and were then confirmed experimentally in abdominal ganglia of Aplysia californica and in stretch receptors of Procambarus clarkii. Characteristic self-stabilizing discharge patterns occur under conditions that do not involve feedback. Increased arrival rates of inhibitory or excitatory input can cause a "paradoxical" increase or decrease in firing rate. 19 pp.

RM-4088-NIH Numerical Solution of Functional Equations by Means of Laplace Transform--IV: Nonlinear Equations. R. E. Bellman, R. E. Kalaba, J. Lockett. May 1964.
A demonstration that the method of successive approximations, coupled with the numerical inversion of Laplace transforms, provides an effective computational approach to mathematical studies of biological systems with their main nonlinear functional equations. 21 pp.

RM-4128-PR On the Behavior of a Chemical Equilibrium System When Its Free Energy Parameters Are Changed. N. Z. Shapiro. May 1964.
Computation of an inequality furnishing information about the behavior of a chemical equilibrium system when its free energy parameters are changed. The result is proved by viewing the solution of a chemical equilibrium problem as the result of minimizing the free energy function. If the solution were viewed in terms of the mass action laws, the proof would become more difficult. 13 pp.

RM-4132-NIH A Digital-Computer Model of Nerve-Cell Functioning. D. H. Perkel. June 1964.
A description of a mathematical model of nerve-cell functioning embodied in digital-computer programs that simulate the behavior of nerve cells, their interconnecting fibers, and extrinsic sources of impulses. The simulation is not performed over a sequence of equally spaced time steps, but rather utilizes a continuous time parameter. The memorandum describes the workings of two programs embodying the model: one for a single cell, the other for a network. Some proposed modifications of the model are also discussed. 51 pp.

RM-4138-NIH Estimation of Heart Parameters Using Skin Potential Measurements. R. E. Bellman, C. Collier, H. H. Kagiwada, R. E. Kalaba, R. Selvester. May 1964.
A sketch of a mathematical model relating ventricular dipoles to surface potentials. It is shown that the inverse problem--that of determining heart parameters on the basis of skin potential measurements--may be viewed as a nonlinear multi-point value problem. Some numerical experiments show that quasilinearization provides a feasible method of solution. 18 pp.

RM-4175-NIH A Three-Organ Drug Distribution Model Including the Kidney. J. A. Jacquez, B. Kotkin, I. Cooper, J. D. Buell. August 1964.
The Bellman-Jacquez-Kalaba mathematical model of drug distribution was designed to investigate the effect of injecting an active chemical agent into the blood stream by studying the time course of the resulting drug concentrations throughout the body. In the initial studies of a two-organ being, where both organs were linked in parallel with the circulatory system, one of the organs represented an area of particular interest that was marked for selective localization and the other represented the remainder of the body. The model described in this memorandum includes a third organ, which performs certain functions of the kidney. The preliminary investigation is concerned with the effect of excretion on the concentrations of the drug in the body, rather than with a detailed model of the kidney itself. 25 pp.

RM-4205-PR A Generalized Technique for Eliminating Species in Complex Chemical Equilibrium Calculations. N. Z. Shapiro. September 1964.
A consideration of multi- or single-phase chemical equilibrium problems, showing that under certain circumstances a problem involving a very large number of different chemical species may be replaced by one, of relatively few species, more amenable to numerical solution. 31 pp.

RM-4211-NIH Details of the Program for a Mathematical Model of Drug Distribution Assuming Mixing in the Large Blood Vessels. S. P. Azen. October 1964.
A report on an aspect of research to develop a mathematical model of chemotherapy as an aid in studying problems relating to distribution and localization of drugs in the body. Specifically, the Memorandum presents the completed equations for a two-organ model in which there is exchange between the stationary and flowing phases in the large blood vessels. Results of a computer program are also given. 37 pp. Bibliog.

RM-4213-NIH Numerical Solution of Functional Equations by Means of Laplace Transform--VIII: Determination of Weighting Functions. R. E. Bellman, R. E. Kalaba, J. Lockett. September 1964.
A mathematical method for obtaining a numerical solution to a type of functional equation that arises in biochemical tracer experiments. 8 pp.

RM-4234-NIH Detection of Functional Interactions among Neurons: A Technique Using Repetitive Presentations of Stimuli. D. H. Perkel. August 1964.
Description of a procedure for predicting the change in the cross-correlation function when a fixed stimulus is presented at regular intervals, under the assumption that the stimulus modifies the firing sequence of one or both observed neurons, but does not affect any interaction paths between two nerve cells. A comparison between the predicted and observed cross-correlation densities then serves as a means of detecting the activation or modification of such interaction pathways by the stimulus. In this experimental situation, observations of spike trains and application of the prediction procedure enable differentiation among: (1) no interaction between the two cells; (2) interaction unaffected by the stimulus; and (3) interaction through pathways themselves affected by the stimulus. Digital-computer simulations of the corresponding neural networks illustrate these cases and the application of the technique. 37 pp.

RM-4247-NIH Neurophysiological Models: Methods and Applications. D. H. Perkel.

August 1964.
A summary of research in neurophysiological models done at RAND during 1963. The author describes computer programs used to simulate certain activities of nerve cells and networks. Outlined are some applications of these programs to experimental questions in neurophysiology. 63 pp.

RM-4345-PR The Numerical Solution of the Chemical Equilibrium Problem. R. J. Clasen. January 1965.
In physical chemistry, the chemical equilibrium problem is that of determining the distribution of chemical species minimizing the free energy of a system while conserving the mass of each chemical element. This Memorandum presents the numerical solution for this problem by describing methods for starting the solution when an initial estimate is not available, and for making an initial estimate feasible: (1) both a first-order and a second-order method for solving the problem in context of the linear-logarithmic programming problem, and (2) convergence criteria for most problems of this type. 91 pp.

RM-4347-PR Fluid Balance and Electrolyte Distribution in the Human Body. E. C. DeLand, J. B. Bradham. February 1965.
Presentation of a conceptual model and a mathematical method for computing the physiological fluid and electrolyte distribution for selected body compartments of an average, young, 70-kilogram human male. The mathematical procedure simulates the physiological subsystems by incorporating all the known chemical reactions and electrochemical relations that seem necessary to establish the fluid and electrolyte distribution. The construction of the model and the mathematical background are given in heuristic form only, with reference, for rigorous development, to earlier reports (RM-2519, RM-3212, RM-3707, RM-3935-1). The results of validation experiments, consisting of chemical stresses applied to the model, are discussed. 122 pp. Biblio.

RM-4375-NIH Numerical Integration of a Differential-Difference Equation with a Decreasing Time-lag. R. E. Bellman, J. D. Buell, R. E. Kalaba. December 1964.
Systems with variable time-lags occur frequently in biology; the common cause is variable flow rates. Although little is known concerning the effects of these variable lags, this Memorandum demonstrates how some differential-difference equations with variable time-lags can be reduced to a system of differential equations with known initial conditions. These can then be studied with ease. 16 pp.

RM-4406-NIH Computer Studies of Respiration. T. W. Murphy. May 1965.
Part of a continuing study on the application of modern data-processing technology to the analysis of the respiratory and circulatory systems. The calibration of the system is described and the abilities of the device are demonstrated in an investigation of the tidal volume-dead space relationship. Advantages of this approach are discussed. 78 pp. Biblio.

RM-4464-PR On Membrane Equilibria. N. Z. Shapiro, L. S. Shapley. July 1966.
A mathematical study of the equilibrium properties of two-phase, constant-pressure-temperature chemical systems in which there are no changed particles or intraphase reactions, and the substances are miscible in all proportions. The different types of equilibrium compositions and the conditions that govern them are determined. The effects of linear variation in the chemical inputs are studied, such as the effects on a multisubstance fluid, separated by a semipermeable membrane, to which another fluid is slowly added. Among other results, it is shown that the relative sizes of the two phases will always change monotonically, but that the absolute sizes may fluctuate. 71 pp. Refs.

RM-4476-PR A Neural Net for Motivated Elementary Problem Solving. E. W. Paxson. August 1965.
Discussion of a neural net that reproduces the behavior of a simple "animal" that explores for food when hungry and returns to a "den" under the drive of homing. The behavior of the net is demonstrated by digital computation. A brief critique of neural net simulation of problem solving is given. 56 pp. Biblio.

RM-4579-NIH Spike Probabilities in Neurones: Influence of Temporal Structure in the Train of Synaptic Events. J. P. Segundo, D. H. Perkel, G. P. Moore. December 1965.
Report of experimental work involving electrophysiological measurements and computer simulations of interacting nerve cells. Certain input-output relations are studied by way of intraneuronal recordings in isolated visceral ganglia of Aplysia californica. Experiments in computer-simulated neurons reproduced and extended the results of the animal experiments. One aim of the study is to determine: (1) What

temporal configurations of successive presynaptic spikes, imbedded in the presynaptic spike train, presage the occurrence of a spike in the postsynaptic cell? (2) How many presynaptic spikes are significantly involved in influential configurations? (3) What is the effective duration of influential configurations? and (4) What is the effect of postsynaptic refractoriness? 84 pp.

RM-4609-PR Intrinsic Control of Body Fluid and Electrolyte Distribution and Urine Formation. J. C. DeHaven, N. Z. Shapiro. July 1965.
A report of investigation of certain physicochemical hypotheses that appear to explain how the human body controls fluid and electrolyte distributions over time. A simple model intended to predict compositional changes in the several body compartments is shown and the predictive abilities of larger models that encompass much of the present knowledge of the chemical detail of the body's physiological compartments are described. Various methods are presented for introducing time into these models. 143 pp. Biblioq.

RM-4642-RC On the Computational Solution of an Equation Arising in Chemotherapy Using Numerical Inversion of the Laplace Transform. R. E. Bellman, J. D. Buell, R. E. Kalaba, J. Lockett. March 1966.
A demonstration of how a combination of the Laplace transform plus a numerical inversion technique yields a quick numerical solution of a set of linear functional equations arising in chemotherapy. 10 pp. Biblioq.

RM-4716-NIH Segmental Differential Approximation and Biological Systems: An Analysis of a Metabolic Process. R. E. Bellman, R. Roth. February 1966.
Mathematical formulation of a complex system suggested by a metabolic process. The formulation allows for certain subprocesses to operate over finite time spans within the time intervals. Central to the mathematical formulation are the observed experimental data. It is assumed that some information is available for each operating subprocess. A computational method of solution is suggested. 26 pp. Biblioq.

RM-4721-NIH Quasilinearization and the Estimation of Chemical Rate Constants from Raw Kinetic Data. R. E. Bellman, J. A. Jacquez, R. E. Kalaba, H. S. Schwimmer. August 1965.
Description of a computational technique for determining chemical reaction rate constants, based on measurements of observable kinetic data. Problems are viewed as nonlinear multi-point boundary value problems for systems of nonlinear ordinary differential equations, for which the quasilinearization procedure offers an effective means of numerical solution. The method is illustrated using kinetic data on some gas phase reactions of nitrogen and oxygen. 16 pp.

RM-4733-NIH Inverse Problems in Ecology. R. E. Bellman, H. H. Kagiwada, R. E. Kalaba. November 1965.
A study of the question of describing interactions of populations. From observations of population growths, parameters in models may be estimated. This concept is illustrated by two interacting species. The sensitivity of the parameters to the accuracy of the observations is computationally investigated, using the technique of quasilinearization. 16 pp. Bibliog.

RM-4816-PR Neuronal Spike Trains and Stochastic Point Processes. D. H. Perkel, G. L. Gerstein, G. P. Moore. March 1967.
The mathematical theory of stochastic point processes in its probabilistic and statistical aspects is applied to nerve-impulse sequences. Mathematical results are extended and illustrated through the application of statistical techniques to the results of computer experiments on simulated nerve cells. Statistical techniques at several levels of complexity are used in the analysis of single stationary spike trains. A set of techniques is presented for analyzing two spike trains simultaneously in the presence and absence of stimulation. It is shown how to test for independence of the two cells and to diagnose the sources of dependence when found. The effects of trends in the data on the computational results are discussed and illustrated. 147 pp. Ref.

RM-4833-NIH A Two-Compartment Model of the Lung. T. W. Murphy. January 1966.
A report on the modeling of gas exchange in the lung. The author derives the differential equations for changes in gas concentration with time in the two-compartment model of the lung, and graphs the solutions by digital simulation. Estimates of the fluctuations in alveolar gas partial pressures and in exhaled gas partial pressures are given, and it is shown that the model simulates cardiogenic oscillations in the exhaled gas curve. It is also shown that the consequences of cyclic ventilation and perfusion of the lung, coupled with non-linearities in the content-pressure re-

lationships for blood and gas, cause some differences between the mean partial pressure of a gas in the lung gas and in the lung blood. This effect is demonstrated in both an intuitive and mathematical manner, and a computational approach is described. The magnitude of the effect is computed for carbon dioxide and oxygen. 43 pp. Bibliog.

RM-4870-ARPA Pulse Trains in Lateral Geniculate and Retinal Ganglion Nerve Cells. R. J. MacGregor. November 1966.
An examination of the relationship between the physical stimulus and the neuroelectric events involved in visual perception and discrimination. The data indicate that certain elemental relations of psychophysics reflect properties of retinal behavior. Electrical correlates of flicker fusion, intensity encoding, and spatial and temporal contrast are seen in the spike trains of ganglion cells. The concept that some psychophysical relations are mediated primarily in the retina, along with the neuroelectrical and neuroanatomical indications that centrifugal control at this level is small, suggests that the retina would be a promising point of entry for understanding some of the neural mechanisms subserving vision. 66 pp.

RM-4877-ARPA A Digital-Computer Model of Spike Elicitation by Postsynaptic Potentials in Single Nerve Cells. R. J. MacGregor. September 1966.
A simulation of the information-processing function of nerve cells. The computer model simulates the portion of the neuron at which spike potentials are initiated. Values for parameters were specified on the basis of neuroelectric recordings so that the results obtained might be pertinent to actual nerve cells. Trial runs verify that the model is accurately reproducing the functional forms of neuroelectric data. Input-output relations under regular input are given for a wide range of input frequency and pulse amplitude. 45 pp.

RM-4912-ARPA Neural Organization in the Primate Retina. R. J. MacGregor. November 1967.
A survey of the neurohistological, neuroelectrical, and neurophysiological data relevant to retinal organization. The data are derived from studies of the neural organization of the primate retina. Major current problems include mechanisms of adaptation, spontaneous activity, and efferent influence, details of interconnection patterns, and amacrine function. A theoretical framework for an initial consideration of retinal organization is developed and a model that attempts to account for the properties of graded potentials in the external plexiform layer is presented. The model specifies a hypothetical mechanism as the fundamental source of logarithmic intensity encoding. 88 pp. Refs.

RM-4939-PR Statistical Techniques for Detecting and Classifying Neuronal Interactions. D. H. Perkel. June 1966.
An examination of mathematical techniques for comparing two simultaneously recorded neuronal spike trains and a presentation of a computer simulation using these techniques. 39 pp. Bibliog.

RM-4962-PR The Classical Structure of Blood Biochemistry--A Mathematical Model. E. C. DeLand. July 1966.
A mathematical simulation of human blood biochemistry that includes the results of a detailed chemical analysis of human blood under a variety of chemical stresses. Mathematical simulations of increasing degrees of complexity are developed. A rudimentary blood model assumes the conventional roles of the fixed proteins, the neutral electrostatic charge constraints, and the active cation pump as the major characteristics of hemostatic blood. The microscopic properties of the proteins, particularly their buffering behavior, are incorporated into the model by a mathematical procedure that assumes that the serum albumin and the various globulins represent all of the important buffering power of the plasma fraction. A model of the respiratory biochemistry of the blood, embodying the results of the previous biochemical structural detail, is tested under various conditions. Properties of the mathematical model, such as gas exchange, buffering, and response to chemical stress in the steady state, are practically indistinguishable from those properties of real blood within the limits of the present validation program. 135 pp. Ref.

RM-4968-TAB Plague in the United States: An Assessment of Its Significance as a Problem Following a Thermonuclear War. H. H. Mitchell. June 1966.
An investigation of the possibility that bubonic or pneumonic plague could appear in the U.S. in a postattack situation. Although modern methods of control and treatment make it unlikely that a plague of vast proportions could occur, a study of plague ecology and projected disturb-

ances in a postattack environment suggests that it is a possible danger. The memorandum suggests current planning that includes surveys for locating endemic foci of plague in wild rodents and for coordinating the results with evacuation plans of the civil defense system. 60 pp. Biblioq.

RM-4990-NIH Quasilinearization and the Estimation of Time Lags. R. E. Bellman, H. H. Kagiwada, R. E. Kalaba. May 1966.
A numerical study of inverse problems (as observed in mathematical theories of cancer chemotherapy, in theories of control mechanisms in the heart-lung system, and in engineering and operations research) through quasilinearization. The authors show how to determine the parameters in a nonlinear differential-difference operator to obtain the best agreement (in the sense of the least-squares method) to certain given experimental data. The method hinges on reducing the differential-difference equation to a system of ordinary differential equations and using quasilinearization to solve the resulting multipoint boundary-value problem. Results of some numerical experiments are given. 15 pp.

RM-5048-TAB The Relationship Between Post-Irradiation Recovery and Equivalent Residual Dose. J. P. Okunewick. October 1966.
An investigation of the problem of estimating the effective residual dose (ERD) of radiation retained by a man or an animal, with a view toward developing a model that will simulate experimentally observed recovery behavior. Such a model should prove useful in making post-nuclear war recovery predictions. The relationship between the establishment of an ERD for men and animals and the physiological mechanism underlying radiosensitivity is examined in detail, and it is found that recovery may be oscillatory in nature rather than exponential. Applicability of current models is discussed, and some factors that must be considered in developing a generally applicable recovery model are listed. 36 pp.

RM-5052-TAB Nutrition in the Post-attack Environment. R. S. Pogrund. December 1966.
An investigation of the problem of providing an adequate diet for the population surviving a nuclear attack on the United States. American dietary habits and the extent that they contribute to the inefficient use of land in the United States are examined. Alternative food sources and the human ability to adapt to unfamiliar foods are considered in the context of a postattack environment. 71 pp.

RM-5083-TAB Long-Term Radiation Damage: Evaluation of Life-Span Studies. B. Brown. December 1966.
A statistical evaluation of 39 experimental reports of the life spans of laboratory mice which survived whole-body exposure to acute doses of X rays or gamma rays. For the same age, life shortening increases roughly linearly with dosage. For the same dose, life shortening decreases linearly with age at exposure. Data are lacking for assessing radiation effects on man; however, extrapolation by using comparative life span, life expectancy, or mortality rates, gives an estimated range of 7 to 12 days life shortening per roentgen. Theories of radiation damage are summarized, as well as the underlying theories of aging. Methodology for testing hypotheses nonparametrically is given in the appendix. 73 pp. Ref.

RM-5090-TAB Survey of the Infectious Disease Problem as It Relates to the Postattack Environment. H. H. Mitchell. August 1966.
The incidence of infectious diseases and methods of control are examined to indicate measures that might be taken to prevent the occurrence of epidemics in a postattack environment. The possible collapse of quarantine regulations and a lack of immunization facilities after a nuclear attack suggest that public health measures may have to include compulsory immunization against diseases not now prevalent in the United States. As tuberculosis may well be one of the great problems of a postattack environment, current tuberculosis control measures should be evaluated. A study that projects the epidemiology of various diseases into the postattack environment will help to indicate the resources that will be needed and reveal where emphasis should be placed in planning for postattack recovery. 91 pp. Ref.

RM-5096-TAB The Genetic Effects of Radiation: Postattack Consequences. N. W. Arnheim, Jr. November 1966.
An analysis of the sensitivity of human genetic mechanisms to mutations induced by irradiation and the effect of new mutations on the population in a postattack environment. Increased levels of radiation in the postattack environment will increase the frequency of mutant genes. Based on the concept that most new mutations are harmful, the population could suffer the effects of genetic damage

through subsequent generations. An extension of the genetic death concept to the postattack environment indicates that mutant genes harmful to the population will eventually be eliminated. Experimental irradiation of animals shows that the total dose received, the dose rate, and the kinds of cells affected influence the frequency of mutation. Prevention of conception for a period after radiation exposure can reduce genetic damage. 31 pp.

RM-5244-PR Mathematical Analysis and Digital Simulation of the Respiratory Control System. F. S. Grodins, J. D. Buell, A. J. Bart. March 1967.

A numerical simulation of the lung-blood-brain-tissue gas transport and exchange system. The basic material balance relationships are expressed in a set of differential-difference equations containing a number of dependent time delays based on blood flow rate and vascular capacity. Other equations define the chemical details of transport and acid-base buffering, concentration equilibria, and blood flow behavior. A control function is given defining the dependence of ventilation on hydrogen ion concentration in the cerebrospinal fluid and oxygen content at the carotid chemoceptors. A 500-statement FORTRAN program simulates the responses of the system to a variety of forcings, including carbon dioxide inhalation, hypoxia at sea level, altitude hypoxia, and metabolic disturbances in acid-base balance. Both dynamic and steady-state behavior were reasonably realistic. About one minute machine time on a CDC 3400 computer was required for every four minutes of simulation. To the authors' knowledge, this is the first digital solution of a set of differential-difference equations whose time delays are themselves dependent variables. 56 pp. Ref. (See also RM-4962-PR, PM-4990-NIH.)

PM-5254-PR Protein Binding of Small Ions--A Mathematical Model of Serum Albumin. F. C. DeLand, P. M. Heirschfeldt. April 1967.

Examines the role of serum albumin in blood chemistry with respect to the binding of hydrogen, chloride, and calcium. Serum albumin is considered as a mathematical entity. Emphasis is on the interpretation of binding data using the Linderstrom-Lang theory, which treats the molecule as a charged sphere. The mathematical procedure is based on the calculation of a chemical equilibrium by minimization of the Gibbs' free energy function under the conditions of the experiment. It is found that, although in each of the cases studied the charged-sphere theory can be stretched to fit the laboratory data, the consequent Debye-Huckel parameter bears little relation to the predicted values. Indications are that a much improved theory must be developed. Adequate explanation will probably have to begin with determination of the exact geometry of the molecule and the consequent molecular interactions. 55 pp. Refs.

RM-5262-PR A Mathematical Model of Placental Oxygen Transfer. T. H. Kirschbaum, N. Z. Shapiro. August 1969.

A mathematical model of placental oxygen transfer is used to argue that the experimentally observed control of fetal oxygen concentration in fetal lambs can be explained by the nature of oxyhemoglobin dissociation functions and the differences between these functions in fetal and maternal blood. It is not essential to the explanation to posit any mechanisms responding to a pO2 sensor or any changes in fetal, maternal, or placental vascular structures. Equally unnecessary are assumed alterations in the physical or chemical structure of placental membranes. 53 pp. Refs. (Authors)

RM-5272-PR A Mathematical Model for Post-Irradiation Hematopoietic Recovery. J. P. OKunewick, A. L. Kretchmar. July 1967.

A mathematical model of the recovery after irradiation of the system producing blood cells in the body. The model is based on the hypothesis that hematopoietic stem cells, which are unable to reproduce as stem cells following irradiation, may still retain an ability to differentiate. The model demonstrates both an abortive recovery rise and a true recovery rise following irradiation. As a first approximation, the model shows no irreconcilable differences from experimental data and generally represents the phenomena observed in the recovery of erythropoiesis following acute irradiation. In addition, certain postulates basic to blood-cell development are derived. 42 pp. Refs.

RM-5297-PR Pseudo-Color Processing of Electronic Photographs. C. Gazley, Jr., J. E. Rieber, R. H. Stratton. April 1967.

A method of using a computer-driven graphical plotter to transform a black-and-white photograph from shades of gray to shades of color corresponding to the relative intensity. The human eye can distinguish thousands of colors, but only about 15 shades of gray. This method of enhancing visibility is applied to the JPL Mariner IV photographic system test tapes of a relief map.

The digital output of the camera system consists of 200 lines of 200 elements each. Each element is coded with two octal digits representing its intensity, from 0 (lightest) to 63 (darkest). By use of the IBM 7044 with Stromberg-Carlson 4020, the tape data are converted to 64 black-and-white frames, one of each intensity level. The 64 frames are then copied onto a single frame of color film, using a different color filter for each, from red for 0 through orange, yellow, green, and blue for 63. The resulting pseudocolor photograph appears on the cover of the April 1967 Astronautics and Aeronautics. The internally documented FORTRAN programs and control cards used are appended. 29 pp. Ref.

RM-5362-PR The Problem of Tuberculosis in the Postattack Environment. H. H. Mitchell. June 1967.
An assessment of the problem of tuberculosis in an environment created by a nuclear attack in the United States. Tuberculosis is still a relatively important public health problem, and even with current rates of decline continuing, eradication will not have been accomplished by the year 2000. Any postattack population must expect to have individuals infected with tuberculosis among its members. The conditions that have been correlated with high tuberculosis rates in the past are to be expected in the postattack environment: malnutrition, poor housing, overcrowding. The modern chemotherapeutic and chemoprophylactic agents and BCG vaccines, if available in the postattack environment, make tuberculosis control a reasonable goal if accompanied by an adequate public health program. In the absence of active control, tuberculosis could well be the most serious infectious disease problem of the postattack environment. 81 pp.

RM-5376-PR A Mathematical Model of the Chemical Distribution in a Disease State: Hypothyroidism. M. B. Wolf, E. C. DeLand, J. V. Maloney. June 1969.
Models of fluid and electrolyte distribution in a standard (euthyroid) dog and a hypothyroid dog. The model of the euthyroid dog was altered by adding a new fluid compartment, Colloid, to conform to a hypothesis of body chemistry changes in hypothyroid animals as determined from the literature. Both euthyroid and hypothyroid laboratory dogs received injections of acid solution to provide chemical data for comparing chemical distribution and for validating the models simulating these states. The results proved statistically that hypothyroid dogs respond differently from normal ones to acid infusion. However, the hypothyroid model did not predict these experimental results well. Although laboratory technological problems accounted for many of these discrepancies, additional experiments and other chemical perturbations are necessary to test the biochemical hypotheses formulated in this study. 72 pp. Refs. (MJP)

RM-5392-PR Speculations on Physicochemical Fluid Properties in Physiological Regulation. J. C. DeHaven, N. Z. Shapiro. October 1968.
An examination of the proposition that certain physicochemical properties of biological fluids contribute to maintaining the steady-state concentration gradients that occur in physiological systems. Simple electrostatic solution theory is used to demonstrate that differences in ionic strength and dielectric constants of fluids separated by simple membranes can produce large concentration gradients for uncharged organic substances between the fluids. The magnitude of the gradients, and whether they are greater or less than one, depends on the electrostatic characteristics of the fluids and on the size and signs of the dielectric increment of the substances. Hormones are among the most potent chemicals that affect the distribution of substances between body compartments. With antidiuretic hormone as an example, computations are made that show that this hormone can alter the dielectric constant of plasma so as to change the activity of water from that of diuretic urine to that of concentrated urine in the hydropenic static. This protein-interactive, bulk fluid mode of hormonal influence is suggested as a basis for explaining certain presently unexplained hormonal actions and interactions. 63 pp. Refs. (LK)

RM-5396-PR Unique Mathematical Models of Individual Blood. E. C. DeLand, F. Magnier, J. V. Maloney. May 1970.
Investigates mathematical, computer-based methods of simulating the blood composition of individual clinical patients. Earlier studies developed procedures for constructing models of the respiratory function and acid-base biochemistry of statistically normal human blood. This memorandum extends these procedures and shows that, with sufficient laboratory data, such a model can be derived from individual patients, and conjectures that the blood's chemical pattern may indicate the patient's physical condition. Such models may be useful for clinical and experimental fluid therapy. The models described simulate the steady-state distribution of chemical species (particularly proteins, electrolytes, and water) between the plasma and

red blood cells at one instant, but not the kinetics or time-dependent states of such systems. In 30 separate laboratory experiments, a model of individual blood was tested against real blood in vitro, under various chemical stresses. Results indicate satisfactory agreement. 108 pp. Ref. Biblioq. (LC)

RM-5404-PR CHEMIST--The RAND Chemical Equilibrium Program. E. C. DeLand. December 1967.
A detailed report on the structure and use of CHEMIST, a RAND computer program designed to simulate complex chemical equilibria. The study was compiled in response to a growing demand for a reference manual to accompany and document the program. CHEMIST is a program for use by professionals not trained in computer programming. Communication with the program is in English, chemical, and FORTRAN languages. The computer code currently exists in FORTRAN IV for the IBM 7044. In its present form it occupies approximately 25,000 words for the principal part. Additional specialized subroutines not essential to the operation can increase space requirements. The program uses an iterative mathematical programming technique to determine the composition that minimizes the total free energy of a chemical system, subject to system constraints. A detailed program description with examples is given, along with the program subroutines. The References and Selected Bibliography comprise as complete a listing of the literature as is currently possible. This manual will be updated as the CHEMIST program evolves further. 143 pp. Refs. Bibliog.

RM-5405-RC/AID A Family Planning Hypothesis: Some Empirical Evidence from Puerto Rico. T. P. Schultz. November 1967.
An analysis of the hypothesis that the frequency of births in a population can be understood in terms of three factors that influence the desire for births: (1) a family size goal that is determined by characteristics of the environment; (2) the incidence of death among offspring; (3) the effect of uncertainty in the family formation process. The hypothesis implies that these factors determine the average level of preferred birth rates and that they exert a systematic effect on actual births in following periods. These implications are tested by empirical evidence from Puerto Rico for the 1890's and 1950's by juxtaposing birth rates and environmental variables that include mortality, education, and the economic activity of women and children. The association between birth rates and environmental variables is consistent with the implications of the hypothesis. Other factors that are not accounted for by the family planning model are also considered as sources of variation in birth rates: urbanization, agricultural activity, age/sex, and marital status. These factors do not emerge as significant when the other variables of the family planning model are also considered. 85 pp.

RM-5407-PR A Multitype Stochastic Population Model. S. C. Port. September 1967.
This study introduces a simple multitype population model and analyzes some of its mathematical properties. The model incorporates several key features of more complicated real situations arising in the theory of inventories, maintenance, health, and personnel selection. The approach is purely theoretical: mathematical proofs and consequences of the model are given but no attempt has been made to fit real data to the model. 21 pp.

RM-5426-PR Specifications for a New Jacobian Package for the RAND Chemical Equilibrium Program. M. Shapley, L. Cutler, J. C. DeHaven, N. Z. Shapiro. January 1968.
This study describes and gives instructions for using a new and improved Jacobian package consisting of a group of subroutines for RAND's chemical equilibrium program. This new package, which has a much greater scope than the earlier version, computes Jacobian matrices consisting of partial derivatives of certain quantities in the solution of a model (dependent variables) with respect to certain parameters in the model (independent variables). With the use of these derivatives, it is possible to predict how a change in a model parameter can affect the model solution. In many cases the user can obtain a good approximation for how much effect a certain type of change will have without resolving the problem. The derivatives might be used, for example, to see how much the pH of a model might change with an increase in the pressure of carbon dioxide, or with an increase in the amount of sodium hydroxide. 55 pp.

RM-5451-PR Acid-Base Metabolism and the Proton Condition. C. D. Russell. December 1967.
Application of the proton condition of inorganic chemistry to the problem of describing the net acid content in a biological system. A "proton content" is defined that expresses the net acid content in terms of the detailed chemical composition of the system. This approach is compared with previous approaches to the quantitative description of acid-base

metabolism and is then applied to the interpretation of experimental metabolic balances. The principal advantage of the mathematical formalism described in this study is that its use pinpoints the assumptions and makes it possible to handle unusual cases simply by including terms that are normally neglected. 53 pp. Refs.

RM-5598-RC A Simulation Study of Coincidence Detection in the Dendrites of a Single Nerve Cell. F. J. MacGregor. December 1969.
Results of simulations indicating the ability of a typical nerve cell to discriminate between coincident pulses as compared with two pulses a short time-interval apart. The simulations are performed with a model for neuroelectric coding processes in a single cell, which includes a representation of dendritic geometry. For this model: (a) the probability that an output spike will be associated in time with a coupled pair of input pulses originating at dendritic synapses is greater when the time interval between the pulses is 0 than when it is 2 msec; (b) both the actual values of probabilities and their differences are generally larger for smooth than for irregular background activity; and (c) the difference is greater the closer together the two synapses. 48 pp. Ref. (Author)

RM-5603-RC Cities in Trouble: An Agenda for Urban Research. Edited by A. H. Pascal; S. Genensky, W. A. Johnson, D. F. Loveday, I. S. Lowry, R. Rosenkranz, D. Weiler, C. T. Whitehead. August 1968.
An examination of the problems of the cities and a proposed agenda for research in urban housing, employment, welfare, public order, and health services. This study is the result of contributions prepared by members of the RAND staff following a Workshop on Urban Problems financed by the Ford Foundation and The RAND Corporation. Little systematic data on American cities exist, and there is an inadequate catalog of policy alternatives and of the consequences that may result from the choice of particular alternatives. The unsolved problems of the cities are not likely to respond to superficial attacks with limited resources. Solid analytical work is a prerequisite to successful programs. In the effort to solve the problems of the cities, universities and private research organizations have a role to play in work that cuts across disciplinary lines--gathering data in the field as well as in the library, and maintaining and renewing an openness to ideas. Even the most effective research will not be enough to solve the problems of the cities, but, without it, those problems will not be resolved even in part. 166 pp.

RM-5635-DOT Alcohol and Traffic Accidents. H. H. Mitchell. April 1968.
A collection of statistics from selected studies showing the drinking driver's involvement in traffic accidents, the relationship between blood alcohol levels and impairment of driving ability, and the significance of drinking patterns in alcohol-implicated traffic accidents. Alcohol is shown to be a significant factor in traffic accidents, especially those involving serious injury and death. Impairment of driving ability is demonstrated at blood levels of alcohol below the legal definition of intoxication, and the risk of having an accident is shown to increase as blood alcohol concentrations rise. About 15 percent of all accidents involve a driver with 50 mgm percent blood alcohol concentration or higher. Other studies show that alcohol is probably a causal factor in 50 percent of the single vehicle fatalities. Control measures need further study to provide information leading to more effective handling of the drunk driving problem. 37 pp. (See also RM-5631, RM-5632, RM-5633, RM-5634, RM-5636, RM-5637.) (BG)

RM-5636-DOT Medical Problems and Physical Fitness as Related to Occurrence of Traffic Accidents. H. H. Mitchell. April 1968.
A survey of the literature on medical problems and physical fitness as they relate to the occurrence of traffic accidents. The published data do not provide sufficient evidence for an estimate to be made of the contribution of various medical conditions to the accident rate. There are also insufficient quantitative studies to form a rational basis for action by regulatory authority in charge of licensure for driving. If done at all, the current screening of drivers before licensure is apparently based on qualitative medical judgment. It is suggested that controlled studies be made to evaluate the contribution to the accident problem of the various medical conditions that might be significant, for example, epilepsy, diabetes, cardiac disease. These studies should determine the effect on the accident rate of removal of specified categories of diseased individuals. Particular attention should be paid to the number of licenses that would have to be denied for each category studied. 30 pp. Refs. (See also RM-5631, RM-5632, RM-5633, RM-5634, RM-5635, RM-5637.) (LK)

RM-5637-DOT Emergency Medical Care and Traffic Fatalities. H. H. Mitchell. April 1968.
An examination of U.S. military emergency medical care in order to provide a basis for determining how improved civilian emergency medical care might affect traffic-accident fatalities. Since data are lacking on emergency care of civilian traumatic injuries, military records were studied for information on the results to be expected for various types of trauma in relation to the skill and resources applied to their care. Examination of traffic casualty descriptions provided a statistical picture of the types of injuries that kill accident victims. By juxtaposing the military experience and traffic fatality descriptions, some insight was gained into the potential for lowering traffic-case fatality rates in terms of resources. Although improving the case fatality rates will be difficult, a signal device could be devised to locate the accident, followed by helicopter or ambulance dispatch of trained personnel to the scene to give first aid to those who now die because of hemorrhage, respiratory difficulty, early shock, etc. A triage system (for storing and classifying the wounded) could then be used to send the injured to special trauma centers. 37 pp. Refs. (See also RM-5631, RM-5632, RM-5633, RM-5634, RM-5635, RM-5636.) (BG)

RM-5672-RC A Closed Circuit TV System for the Visually Handicapped. S. Genensky, P. Baran, H. L. Moshin, H. Steingold. August 1968.
A description of an inexpensive, experimental closed circuit TV system that can help the visually handicapped to read, write, or perform precise manual operations. The system is of potential value to any partially sighted person who has difficulty reading and writing even with eyeglasses, but who would be helped by a visual aid that increases magnification, brightness or contrast, or a combination of these factors. The prototype system consists primarily of (1) a TV monitor resting on a shelf, which can be moved toward or away from the user and raised or lowered slightly for convenience; (2) a TV camera that can be rotated about a fixed but arbitrary horizontal axis by means of an electrically operated servo-mechanism; and (3) a working surface used to support reading and writing materials. The hardware for this instrument costs less than $1000. A modification of the prototype system, produced commercially, could be of value to visually handicapped people in schools, at work, and at home. 29 pp. (LK)

RM-5691-PR Prerequisites for Chemical Thermodynamic Models of Living Systems. J. C. DeHaven. November 1968.
A discussion of the mathematical techniques and physicochemical concepts involved in the construction of certain types of biological models for use in computer simulation. The basic tools employed are a mathematical method and a computer program to calculate the composition of multiphased chemical systems, given the values of certain combinations of state-determining parameters (chemical inputs, temperature, pressure). A steady-state approach is used because the scientific basis of thermodynamics is better developed than that of kinetics, the mathematical treatment is easier, and many biological systems are either in or closely approach steady states in their chemical composition. Selection of a physiological function or subsystem to be investigated depends on (1) the availability of technological tools; (2) established data; (3) whether it is conveniently factorable from a larger system so that it can be studied over a range of conditions when removed from its normal environment; (4) no feedback effects as a result of changes in the subsystem. An illustrative model of respiratory gases interacting with an aqueous phase is constructed. 137 pp. Refs. (EB)

RM-5774-NYC The New York City Health Budget in Program Terms. C. Teng. February 1969.
A description of how health appropriations in the conventional line budget of the City of New York can be reformulated in terms of a program budget structure. Extended examples involving recent line budgets of the Department of Hospitals and the Department of Health (both in the Health Services Administration) and the Department of Social Services (in the Human Resources Administration) illustrate the process of reformulation. Major problems are considered in detail: the design of the program structure, the availability and the adequacy of relevant data, and the development of specific methods for translating the conventional budget into the program structure. The examples were selected to highlight the techniques developed in the course of preliminary effort for the Health Services Administration to reformulate all health service allocations in several City-wide budgets, including the Proposed Executive Expense Budget for 1968-1969. Results for three such City-wide budgets are also presented. 71 pp. (MJP)

RM-5809-NIH Ionic Interactions between Neural and Nonneural Membranes in the Mammalian Central Nervous System.

R. M. Lebovitz. December 1969.
In this study, it is shown that the hypotheses of (1) the ionic basis of neural electrical activity and (2) a restricted extracellular space, imply transient, local depolarization of otherwise resting membranes by spike activity in a nearby active neural membrane. The depolarization is mediated by variations in the extracellular concentration of potassium ion, which leads it to be called an "ionic interaction." A model describes the dynamics of a limited extracellular volume, and derives flux equations for the electrochemical movement of potassium ion to and from the extracellular space. The calculated magnitudes for the postulated interaction are impressive; in particular configurations, the interaction may exceed firing level and communicate an action potential across the extracellular space. Although this interaction has not yet been experimentally verified, sufficient data suggest its existence. It should help to understand such phenomena as presynaptic control of information and membrane noise, and could relate to more permanent information storage, as well as certain pathological states. 63 pp. Bibliog. (CC)

RM-5893-RC Analytic Hospital Planning: A Pilot Study of Resource Allocation Using Mathematical Programming in a Cardiac Unit. R. M. Gurfield, J. C. Clayton. April 1969.
A description of RAPS (Resource Allocation for Patient Services), a new technique for planning medical facilities. RAPS applies input-output analysis of patient flow and uses standard linear programming algorithms to match clinical facilities against demand. Conventional hospital planning techniques take no account of the fact that different kinds of patients use different amounts and mixes of services, so that overcrowding and inadequacies commonly result, while some facilities may be underutilized. RAPS is based on the principles that (1) all patients can be classified into a finite number of functional groups, based on diagnosis; (2) each procedure that uses a different mix of space, personnel, and equipment is a functional facility; (3) different groups of patients follow different paths through the facilities and require different mixes of services; (4) all services to patients can be expressed in terms of the flow of patients through facilities; (5) within each patient group, the average utilization of each service constitutes the patient-service vectors of that group for computing purposes. The bulk of the memorandum consists of a sample RAPS analysis of the inpatient cardiac care service at UCLA Medical Center. 92 pp. Ref. (MW)

RM-5925-NIH An Interactive Graphics Program for Studying Models of Kinetic Chemical Systems. G. F. Groner, R. A. Berman, R. M. Heirschfeldt. June 1969.
This interactive computer graphics system permits biologists to study models of kinetic chemical systems and computer scientists to investigate interactive modeling. The program runs on an IBM 360/40 computer and is intended to provide a convenient means of (1) describing a model via chemical equations; (2) observing the behavior of a model during simulation; (3) editing output formats and modifying the model. The user communicates with the computer via the RAND Tablet used in conjunction with a 2250/Model 1 CRT display device. The program has several desirable features: (1) It simulates multiphase chemical systems having both fast and slow reactions. (2) The user may enter chemical equations by printing them, as on a piece of paper, and the program displays its interpretation as a check. (3) The user can intervene in the simulation at any time, examine any reactant plotted on any linear scale against any other reactant or time, rescale curves, or delete them. (4) A reset capability permits backtrack for correction or to return a graph to a previous state. 62 pp. (MW)

RM-5944-RC Summary of Coronary-Care-Unit Literature. M. A. Rockwell. April 1969.
A summary of the medical literature published through June 10, 1968, describing coronary care units (CCUs), and a synthesis of the data on which past decisions to acquire CCUs have been based. A total of 102 papers, books, and pamphlets were reviewed. The conclusions were based primarily on information published in 16 papers that contained acceptable criteria for diagnosis of myocardial infarction (MI). Valid comparisons of the gross mortality rates cannot be made between CCUs because of variations in the age and sex distribution of patients, in the incidence of complicating factors, in the mean time from onset of symptoms until admission, and in admission and length-of-stay policies. Although the data are insufficient to identify all factors (e.g., personnel training) that influence the effectiveness of a CCU, they indicate that CCUs offer better care than regular wards in the treatment of MI and that one-third of MI deaths could, potentially, be prevented by CCUs. 67 pp. Bibliog. (MJP)

RM-5952-PR Chemical Equilibrium Problems with Unbounded Constraint Sets. J. H. Bigelow, J. C. DeHaven, N. Z. Shapiro. February 1970.

An investigation of the use of mathematical models to explore the chemical aspects of physiological systems; this deals with the theoretical and computational aspects of understanding the chemistry of human physiological function. The question of existence of solutions to problems having unbounded constraint sets is investigated by relating their existence (or nonexistence) to a property of a solution to an auxiliary chemical equilibrium problem with a bounded constraint set. An example system is selected consisting of gases in contact with an aqueous buffer solution at a uniform total hydrostatic pressure and temperature. The numerical problem of determining the amount of CO2 to be added to achieve a specified partial pressure of CO2 in the gas phase, and its effects on the composition of the total system, is solved by using a procedure suggested by the concept of unbounded constraint sets, requiring 2.8 seconds on an IBM 7044 using a FORTRAN IV program. Findings may apply to design of artificial life-support systems needed in extraterrestrial environments related to Air Force missions. 25 pp. Ref. (KB)

RM-5955-NIH Theoretical Evaluation of a Patient-Artificial Kidney System Using the Kiil Dialyzer. M. B. Wolf, P. D. Watson, B. H. Barbour. April 1969.

A mathematical model of hemodialysis (artificial kidney treatment) that can accurately predict the changes in distribution of urea and creatinine in the patient's body during dialysis, for a wide range of system parameters. The model was validated using considerable clinical data from two patients, plus one-time data from 10 randomly chosen patients on the Kiil Dialyzer. The predicted fraction removed during dialysis was plotted as a function of blood-flow rate, length of dialysis, initial blood concentrations, and patient weight. Results suggest that in most dialysis patients, material removal during dialysis and blood concentrations afterward can be accurately predicted from just the patient's weight and his rate of blood flow into the dialyzer. The computer-generated results can be valuable to the clinician by showing the time needed to dialyze a given patient to achieve a desired result. 46 pp. Refs. (KB)

RM-6047-RC Biosciences at Rand. Edited by E. C. DeLand, C. Gazley, Jr., L. L. Colbert. April 1970.

Describes Rand's current programs and potential new projects in the biosciences --biochemistry, biomathematics, and bioengineering--which apply the physical, mathematical, engineering, and computer sciences to biological and medical problems. These applications can clarify complex physiological mechanisms and develop better diagnostic and clinical procedures. Current studies may be grouped in 3 general categories: (1) physiological models and computational techniques to analyze and quantify the biochemistry of human physiological systems and phenomena; (2) analyses of the mechanics and neurophysiology of human vision, pattern recognition, and image enhancement to facilitate information transmittal; and (3) clinical applications and diagnostic techniques. Potential future projects include additional fundamental research in all the biosciences, investigations of complex biological and health care systems, and development of computer support for bioscience programs. This memorandum does not address studies centered in experimental laboratories or those primarily concerned with the economics, sociology, or administration of health care systems. 77 pp. Bibliog. (LC)

RM-6057/1 Improving Budgeting Procedures and Outpatient Operations in Nonprofit Hospitals. V. D. Taylor, J. P. Newhouse. January 1970.

An analysis of the budget of a nonprofit hospital and the costs and operations of its outpatient department. The problem addressed is: How can the hospital use the funds available to it to provide maximum benefit to the community? A methodology is developed to answer that question. The methodology shows what parts of the operation are inefficient, what parts should be expanded, what contracted, what the net cost of the teaching program is, and what an appropriate pricing policy is. A revised budget format focusing upon social benefit and social cost, rather than profit and loss, is also presented. 57 pp. (Author)

RM-6073-PR Simulation of the Renal Effects of Antidiuretic Hormone (ADH) in Man. J. C. DeHaven, N. Z. Shapiro. November 1969.

A biomathematical model incorporating the actions of antidiuretic hormone on urine flow and composition. Body compartments representing intracellular and interstitial fluid, as well as plasma, red cells, and respiratory volume, are simulated. Urine formation, including concentration ratios produced by the kidney through glomerular and tabular functions, is treated via a compartment separated from the body by an active membrane. The composition and rate of urine flow are influenced both by the level of antidiuretic hormone in plasma and by the chemical

reactions within and between body compartments, including urine. During dynamic response to stress, the current antidiuretic hormone level in the model is established by the previous history of hormone production, by excretion and destruction, and by the current plasma volume. The validity of the model was tested by simulating rapid ingestion of water. A previous model is described in RM-4609. 69 pp. Refs. (Authors)

RM-6108-1-RC A Normative Model of Medical Research Resource Allocation. E. B. Keeler, J. P. Newhouse. June 1970.
This memorandum is concerned with the allocation of resources to biomedical research. In particular, it asks the question: How much should the country spend on such research? A simple mathematical model of individuals' preferences is proposed that gives reasonable predictions to qualitative questions posed. In lieu of obtaining sample data about consumer preferences, the model is used to determine what biomedical research is worth to consumers. The answer is that the probability of achieving future advances appears to be sufficiently low to warrant the conjecture that the nation is already spending more for biomedical research than it is worth to consumers. This revision expands the original by explicitly treating uncertainty rather than assuming it away. In addition, the first version assumed, incorrectly, that the important parameter a could not be greater than one. This revision corrects that assumption. Certain other less important errors also have been corrected. 23 pp. (Author)

RM-6129-NLM Biomedical Information Dissemination: Alternative Systems. J. A. Farquhar. March 1970.
An exercise toward determining how technology might assist the provision of biomedical information. Three present services are scrutinized as to current demand, responsiveness, and quality. The three chosen were MEDLARS (Medical Literature Analysis and Retrieval System), the interlibrary loan (ILL) service, and the network of Poison Control Centers. The author proposes an alternative that would provide for the automation of present services. This system could be implemented at a cost comparable with that of the current system, utilize existing and well-proven technology, and increase the quality of services previously described. Configurations are given to provide services from a single national center, three regional centers, and seven regional centers. Although use of the seven-center system represents a considerable increase in cost, it may offer an increased capability and opportunity for provision of additional biomedical information services. 54 pp. Ref. (RG)

RM-6149-AID The Philippine Family Planning Program: Some Suggestions for Dealing with Uncertainties. J. E. Koehler. February 1970.
Some tentative conclusions about family planning in the Philippines. Using data from National Demographic Survey (NDS), the study investigated knowledge and use of birth control procedures among Philippine women by language, income, age, rate of use, information source, and use or nonuse. The study offers the following suggestions to designers of the AID family planning program in the Philippines: (1) to avoid explicit reference to some population growth rate as a formal program goal; (2) to examine the complex relationship between knowledge and use of contraceptive techniques; (3) to gather information from across the country rather than in depth from any single area or ethnic group; and (4) to use its leverage over the various agencies concerned to record experiences of individual women and to standardize recordkeeping. 36 pp. (SM)

RM-6180-NLM Applications of Advanced Technology to Undergraduate Medical Education. J. A. Farquhar, R. Bretz, A. S. Ginsberg, T. L. Lincoln, R. J. Melone, G. F. Mills. April 1970.
Discussion of the nature, benefits, and capabilities of advanced technological systems that evidence indicates can speed up medical education and boost the quality of instruction without straining the capacity of medical schools to expand or driving costs to unreasonable levels. Some key applications: (1) Instruction can be individualized and learning self-paced, especially in the pre-clinical sciences, by means of electronic video recording (EVR) and computer-assisted instruction (CAI). (2) Actual clinical experience can be supplemented by computer simulation, including simulation of rare maladies. Learning would not depend alone on random patient admissions. (3) A portable "med-file" library can enable students as well as physicians to tap a central medical information source with the latest findings. 94 pp. (TC)

RM-6203-PR Whole Body Base Excess: Acute Response to Acid-Base Stress in the Dog. C. D. Russell, H. D. Roeher, M. M. Illickal, E. C. DeLand, J. V. Maloney. May 1970.
Derives the correlation between the arterial blood composition and the acid-base status of the whole body subjected to si-

multaneous respiratory and metabolic changes. To improve diagnosis and therapy, the biochemical status of a patient is often predicted from commonly measured parameters of a sample of blood *in vitro*. This method gives a rough index of the body status. This memorandum constructs a nomogram for more exactly estimating whole body base excess from the pH and the partial pressure of carbon dioxide of arterial blood in vitro. It is based on experimental data obtained from 54 nephrectomized dogs subjected to hyperventilation, carbon dioxide breathing, and infusion of acid and base. The experimental results validated a mathematical, computer-based model of whole body fluid and electrolyte distribution. Because of the similarity between the acid-base responses of dog and man, the model should permit more accurate determination of human whole body base excess from a blood specimen. 40 pp. Ref. (LC)

RM-6204-NLM A Cost Analysis of Minimum Distance TV Networking for Broadcasting Medical Information. J. A. DeiRossi, R. S. Heiser, N. S. King. February 1970.

A cost analysis of the most economical AT&T common-carrier, land-line networks for broadcasting biomedical information to the U.S. biomedical community, via ETV, and to medical schools, via closed circuit TV. The cost estimates are based on standard AT&T rates. The "minimal weighted spanning tree" algorithm was programmed on JOSS to calculate the least-cost network. A 106-station ETV network to serve over 97% of all active U.S. physicians living in Standard Metropolitan Statistical Areas would require 12,000 miles of intercity line. The total cost per hour would be $80,000 for a 1-hour and $27,000 for a 5-hour broadcast; costs per potential viewer-hour would be 30 and 11 cents, respectively. All 97 medical schools could be served by 72 local AT&T Program Operating Centers using 10,000 miles of intercity line. To broadcast 160 hours a month to 85,000 students and staff in 97 medical schools, the cost is $6000 per school, $7 per potential viewer, and 5 cents per potential viewer-hour. 88 pp. Ref. (MW)

RM-6205-NLM A Telephone Access Biomedical Information Center. J. A. DeiRossi, C. R. Lindholm, G. F. Mills, G. C. Sumner. April 1970.

Examines the costs of information centers using voice-grade telephone lines to access recorded messages for biomedical personnel. Projected utilization is estimated as a function of physician population, number of messages available, and advertising promotion. The demand estimates, ranging from 464,600 to 884,400 calls per year, are national extrapolations from the University of Wisconsin Dial Access Center experience. Telephone line rental charges are a major portion of costs. Sufficient lines must be available so that no more than 5 percent of the calls at peak usage hours will be blocked. The total annual operating cost for a single national center ranges from $673,000 to $936,000, with cost per call between $1.06 and $1.45. This includes personnel, supplies, line charges, facilities rental, and promotion and evaluation costs. Single centers are generally more economical than multiple centers. 65 pp. (See also RM-6204.) (LC)

RM-6214-NIH Convection and Diffusion in the Microcirculation. J. Aroesty, J. F. Gross. June 1970.

A study using the ideas and analytical techniques of fluid mechanics to investigate the role of plasma motion in the transport of species between erythrocytes and surrounding tissue in rather narrow capillaries. It has been widely believed that the plasma circulatory motion in the region between the red blood cells and capillary wall is sufficiently vigorous to augment the low rates of species transport by diffusion alone. This study makes a detailed theoretical and numerical examination of the bolus model of capillary flow. It shows that for this highly idealized situation, the convective motions of the plasma and the enhanced mixing due to these motions do not appreciably augment diffusional species-transport rates for dissolved gases. The results of the equations of motion and the equations of species transport indicate that plasma mixing is important only in the transfer of materials such as macromolecules, which may diffuse more slowly than dissolved gases. 55 pp. Ref. (DGS)

RM-6246-RC A Functional Classification System of the Visually Impaired to Replace the Legal Definition of Blindness. S. Genensky. April 1970.

The capacity of the visually impaired to perform normal tasks is the basis of a new classification system proposed to supplant the current legal definition of blindness, now based on arbitrary numerical values used to measure visual acuity and angular field. The problem: the law in effect lumps all Americans into two groups--those who can see and those who can't, thus denying essential services to some visually impaired persons and imposing needless, burdensome disciplines on others. For example, many are taught and strongly urged to read braille although they could be taught to read and write as the normally

sighted do. Adoption of the new system would establish the fact that the visually impaired population is not homogeneous, and vastly reduce the number of people automatically classed as "functionally blind." Coupled with relevant, high-quality education and vocational training programs, it would enhance the financial and emotional independence of literally thousands of the visually impaired. 36 pp. (TC)

RM-6327-NIH BIOMOD: A User's View of an Interactive Computer System for Biological Modeling (A Preliminary Report). G. F. Groner, R. A. Berman, R. L. Clark, E. C. DeLand. August 1970.

An example of the current version of BIOMOD, an interactive computer-graphics system for biological modeling. The example models water and solute distribution between the intravascular and extravascular spaces of the body. BIOMOD operates on a graphic console comprising a CRT screen, RAND Tablet, and keyboard. BIOMOD allows the user to draw block diagrams, handprint or type text, push displayed buttons, and drag labels, while providing immediate interpretation and validity reports. A user may represent a model by a block diagram, each component of which may be defined by another block diagram, by CSMP statements, or--when BIOMOD is completed --by chemical equations, differential equations, or data curves. Hierarchy facilitates devising complex models a portion at a time. All modeling languages used are internally translated to IBM's CSMP/360 simulation modeling language. During the simulation, the user may display curves for different variables, rescale, alter simulation parameters, and immediately rerun or continue the simulation. 46 pp. Ref. (MW)

RM-6339-NYC Planning Public Expenditures on Mental Health Service Delivery. F. A. Sloan. February 1971.

An economic analysis of mental health services, expecially community centers, prepared for NYC policymakers' use. Delivery of mental health services may be improved by refining existing market mechanisms. More effort can be made to improve consumer knowledge by means of publications describing service alternatives, without major use of public funds. Cost-benefit analysis can demonstrate the relative worth of programs, but efficiency analysis based on production-function analysis, even evaluation of output effectiveness, is for the future, because prerequisite data are lacking. A pilot study was conducted at two community mental health centers. It demonstrates that persons with widely different educational background perform the same function; inputs are highly substitutable; diseconomies of scale exist; reduction in the several sources of inefficient production unrelated to scale would mean operational cost savings; personnel-patient ratios must change markedly to alter direct patient care; and patient contact costs more in some community mental health centers than in private psychiatric practice. 131 pp. Bibliog. (SM)

RM-6342-GS Ambulatory Care in the Good Samaritan Medical Center. V. D. Taylor, J. P. Newhouse. November 1970.

A recommendation that Good Samaritan Hospital provide nonemergency outpatient care without clinics by intermixing the nonprivate patients with the private patients of physicians in the planned Medical Center. New patients would be assigned to available doctors by a centralized referral service keeping track of all appointments. Interns and residents would provide care under supervision of senior physicians in the latter's offices. This plan eliminates the normal defects of outpatient clinics --long waiting, unpleasant atmosphere, lack of continuity of care, and overhead costs three times those of physicians in private practice--and frees the emergency room of the large and increasing load of nonemergency cases. Of 30 Good Samaritan staff physicians, 80% expressed willingness to participate. Many, especially internists, insist on retaining control over laboratory procedures if they join the Medical Center. 37 pp. (MW)

RM-6347-PR A Methodology for Quantitative Evaluation of Health Care, with Application to Postsurgical Care in U.S. Air Force Hospitals. J. E. Eckles, J. G. Root. July 1970.

Evaluates the quality of postsurgical care provided by 20 AF hospitals. Information is provided for patients treated in AF facilities during calendar years 1966 and 1967--approximately 50,000 surgical cases. The records provide each patient's postsurgical length of stay, complication record, and a detailed medical description. The 20 hospitals are compared with respect to length of stay and incidence of complications. Attention is given to variation in patient characteristics from hospital to hospital so that evaluative measures developed reflect the activities of the health-care delivery unit and not the underlying differences in the patients. A finding of the study is that among the hospitals there exist differences that cannot be accounted for by variation in patient mix or by statistical error. The analysis shows that explanations normally given to account for apparent institutional dif-

ferences are inadequate. 92 pp. Ref. (KB)

RM-6352-APC The Health Delivery System for the Poor in the State of Arkansas. L. A. Dougharty. August 1970.
A description of what medical services are provided, who receives them, and who pays for them that will serve as a base case for an Arkansas Planning Commission study of alternative delivery systems. Of $28 million spent on medical services for the poor in 1968, the counties contributed 4%, the State 36%, and the Federal Government 60%. Health service is principally provided through local clinics and the University of Arkansas Medical Center. The State has several programs for specific health problems. Private medicine serves welfare patients through State purchases of medical service. Welfare recipients receive medical services under Medicaid, but those making slightly more than maximum allowable income are not eligible. If one of the State's primary objectives is to serve as a balance wheel in the distribution of health services, it is not only not achieving this objective but is contributing to the variance in terms of money, availability, and groups of the poor to whom services are available. 50 pp. (See also RM-6365.) (Author)

RM-6365-APC The Supply of Physicians in the State of Arkansas. L. A. Dougharty. August 1970.
Four models are used to estimate the future supply and distribution of physicians in Arkansas in 1970-1980 and to illustrate forecasting techniques that will be helpful to the Arkansas Planning Commission in long-range planning. The form of the models was dictated by their purpose--to predict rather than to explain the supply of physicians--by the data limitations, and by the different assumptions on which each model is based. The results were as follows: Model I estimates a 29% increase in the supply of Arkansas physicians over the next decade; Model II, a 16.7% increase in total supply but only a 7.4% increase per capita; Model III, a 14% increase; and Model IV shows that physicians discriminate against low-income counties. Approximately 65% of all physicians practicing in the State graduated from the University of Arkansas School of Medicine. 44 pp. (See also RM-6352.) (Author)

PAPERS

P-311 An Application of Markov Processes to the Study of the Epidemiology of Mental Disease. A. W. Marshall, H. Goldhamer. September 1954.
A presentation of several methods (developed in studies of mental disease) for determining certain epidemiological parameters that are not directly observable or that can be secured only by expensive and time-consuming field surveys. The simple models of the process involved in the passage from sanity to insanity, hospitalization and death provide some picture of the underlying process that generates a given incidence rate. 51 pp.

P-1550 Some Mathematical Aspects of Chemotherapy--I: One-Organ Models. R. E. Bellman, J. A. Jacquez, R. E. Kalaba. June 1959.
A discussion of models designed to study concentrations of a reagent injected into the blood stream of a relatively simple system consisting of the heart and one organ. Even at this level, there are formidable mathematical problems involving systems of linear and nonlinear parabolic differential equations with time lags in the boundary condition. 27 pp.

P-1560 The Distribution of a Drug in the Body. J. A. Jacquez, R. E. Bellman, R. E. Kalaba. December 1958.
An extension of the model discussed in P-1550, to include the effects of the major tissues of the body and circulation. An attempt is made to show the relationship of this general problem to feedback problems, input-output analysis, and transportation problems arising in economic and engineering control processes. 22 pp.

P-2300 Mathematical Experimentation and Biological Research. R. E. Bellman. May 1961.
A discussion of the contributions experienced mathematicians can make in biomedical research. The skills of the mathematician combined with the experience and intuition of biomedical research personnel can result in significant mathematical models of biological processes. 15 pp.

P-2307 Simulation of a Biological System on an Analog Computer. E. C. DeLand. May 1961.
Demonstration of a method for simulating complex chemical equilibria, using the respiratory function of the blood at the lung surface as an example. The analog computer is used because its characteristic parallel computation and its fast solution-time enable the simulation of dynamic systems in real time. The results obtained for a small model indicate that the accu-

racy and stability are sufficient for analysis within the laboratory experimental error. The method is flexible, and basic models may be expanded to incorporate more complex phenomena. 34 pp.

P-2328 Mathematical Aspects of Adaptive Control. R. E. Kalaba. May 1961.
A mathematical treatment of adaptive control processes based on the use of the functional equation technique of dynamic programming. The Paper discusses (1) the nature of adaptive control, (2) processes in which the results of decisions are not known precisely, (3) processes in which decisions must be made with incomplete information concerning the state of a system, (4) processes with the objective only partially known, and (5) other problems of current interest. 33 pp.

P-2523 Some Effects of Radiation on Man. H. Laitin. November 1961.
A review of certain aspects of radiation and of its effects on man. Such topics are discussed as: (1) the effects of radiation at the cellular level; (2) the somatic or total body effects resulting from injury at the biochemical and cellular level, with emphasis on the early effects of whole body exposure to penetrating ionizing radiation; and (3) recovery and long-term effects. 18 pp. Illus.

P-2565-1 Physiochemical Characteristics of Placental Transfer. J. C. DeHaven, E. C. DeLand, N. S. Assali, W. Manson. February 1965.
A study of the physiochemical characteristics of placental transfer, using a biophysiochemical model of maternal-fetal circulatory and metabolic relations simulating the composition and transfer of respiratory gases and other elements across the placental membrane. 26 pp. Bibliog.

P-2596 Analysis by Migration in the Presence of Chemical Reaction. N. Z. Shapiro. June 1962.
A mathematical framework that will allow, under certain circumstances, a quantitative analysis of the migration of several species of molecules, even in the presence of nonnegligible chemical reactions. The methods described may apply to systems other than those of analytical chemistry. 18 pp.

P-2724 A Study of Blood by Chemical Analysis and by Digital Computer: A Comparative Evaluation. J. C. DeHaven, E. C. DeLand, G. B. Bradham, J. V. Maloney. April 1963.
A description of an experiment designed to compare the results of an analysis of blood in the laboratory and on a model. It was found that the laboratory and model results agree well. The blood model is of primary advantage in correlating the chemical structure of blood, in quantitating clinically significant chemical alterations, and in directing attention to areas of investigative interest. 14 pp.

P-3057 A Defense of Neural Modelling. D. H. Perkel, G. P. Moore. January 1965.
A discussion of specific instances in which neural models have proved useful to research workers in neurophysiology. The examples are presented as a response to a commentary questioning the usefulness of such models to the experimental research worker. 11 pp.

P-3128 Mathematical Problems Arising in Biomedical Research. R. E. Bellman. May 1965.
An examination of mathematical problems in biomedical research. Discussed are: (1) analytic problems originating in chemotherapy; (2) aspects of the heart-lung complex; (3) questions initiated by cardiology; and (4) problems stimulated by current research in neurophysiology. 11 pp. Bibliog.

P-3194 Example of a Large-Model Simulation of the Blood Biochemical System. J. V. Maloney, J. C. DeHaven, E. C. DeLand, G. B. Bradham. August 1965.
A mathematical model of a viable blood system, outlined to demonstrate the plausibility of constructing detailed models of large biochemical systems. 32 pp. Bibliog.

P-3196-1 A Documentary on Weight, Diet and Exercise. R. C. Drebelbis. May 1966.
A compilation of scientific data on the relationship of weight, diet, exercise, and longevity. It gives a table of desirable weights, caloric charts, and a set of simple exercises. 92 pp.

P-3228 Education in Bioengineering. T. W. Murphy. September 1965.
A proposal for a systematic educational program for bioengineering, a study that has arisen as a separate discipline because of educational deficiencies in biology and engineering. The bioengineering student should receive the best

possible foundation in the primarily mathematical tools of system analysis, in engineering material currently in use in biological work, and a theoretical and practical study of mathematical models in physiology. 8 pp.

P-3230-1 Rainer Rohler, Some Relationships Between the Average Energy of Quanta in a Visual Stimulus and the Color Response, (Einige Zusammenhange zwischen der mittleren Grosse der Quanten in einem Lichtreiz und der Farbempfindung), Vision Research, Vol. 5, 1965, pp. 361-377. J. J. Sheppard, Jr., J. F. Gross, Translators. September 1965.
The title of this paper describes its contents. 27 pp.

P-3254 On the Control of Urine Formation. J. C. DeHaven, N. Z. Shapiro. November 1965.
A presentation of mathematical and physicochemical models of the intrinsic renal control of body water and electrolytes. On the basis of these models, Jacobian matrices are prepared, which assist in predicting local, qualitative changes in body water and electrolytes in response to various forms of chemical stress. The results obtained in specific examples compare favorably with those of reported physiological experiments. The Paper discusses the usefulness and limitations of these models, and describes various methods for introducing time into them--the most useful being the one in which the flux of metabolites is derived from the composition and flow of urine. 109 pp. Illus. Bibliog.

P-3300 A Mathematical Model of the Respiratory Controller. T. W. Murphy. January 1966.
Presentation of a mathematical model of the respiratory controller, one of the mechanisms whereby the body attempts to maintain a constant concentration of carbon dioxide. The model stresses information transport in blood and attempts to test the widely held hypothesis that the respiratory controller is a proportional controller, whose error signal is the difference between the tissue carbon dioxide concentration in the respiratory center and some reference level. Although the model simulates some experimentally observed phenomena, it becomes unstable under other circumstances. The reasons for this are discussed. 58 pp.

P-3368-1 Preventive Medicine Policies. J. J. McCall. May 1969.
Some potential applications to health care of current methods used to schedule equipment repairs. It is difficult to transfer scheduling policies from physical equipment to human beings, since there are many problems involved in assessing a human being's economic value and in adapting maintenance policies to health care. However, many of the standard equipment models used for scheduling repairs on stochastically failing physical equipment may be modified for use on humans, particularly in the scheduling of dental checkups. A dental scheduling problem is outlined that is applicable to more serious health problems, such as cancer detection. 9 pp. Refs. (EB)

P-3496 Consideration of the Contributions of Engineering Analysis in the Study of Living Systems. E. C. DeLand. December 1966.
A symposium paper with discussion. Biological problems arising from modern research techniques are too complex to be solved without the most powerful techniques of mathematics and engineering analysis. Compared with the usual engineering problems, however, biological problems are ill-defined and immensely complex. The cooperation of specialists from each side is required. A problem in fetal blood flow, from the work of Professor George Bekey of USC, is used as illustration of the point that first-order simulations are inadequate. A biological system seems always to have closed-loop communication lines, so that a change in one variable affects every other variable. (Presented at the Symposium on the Impact of Bioengineering on Engineering Education, sponsored by Oak Ridge Associated University, August 1966.) 16 pp.

P-3523 Remarks on the Question of Privacy Raised by the Automation of Mental Health Records. P. Baran. April 1967.
It is necessary to face issues of the individual's right to privacy raised by the future automation of information systems. Systems will be interconnected for both economy and performance, but time-shared computer file systems will not at first have adequate safeguards commensurate with the sensitivity of the information they contain. The problem is thus how to obtain the greatest benefits from such systems with the least danger to privacy. (Presented to the American Orthopsychiatric Association Workshop, Washington, D.C., March 21-23, 1967.) 10 pp.

P-3524 Neuroelectric Activity Displayed by Computer-Produced Films. D. H. Perkel. February 1967.
Introduction and commentary accompanying two films of neuroelectric activity shown at the 1966 Annual Meeting of UAIDE (Users of Automatic Information Display Equipment), San Diego. The two films were produced by computer and automatic plotting techniques. The first film shows the firing of nerve cells and the transmission of nerve impulses along axonal pathways in a small interconnected group of neurons. The second film is a phase-plane representation of the fluctuations of membrane potential in a single nerve cell as measured with a microelectrode. The computer used is the IBM 7044 and the plotting device is the SC-4020. 8 pp. Refs.

P-3584 A Theoretical Model of the Cornea for Use in Studies of Tonometry. C. C. Mow. April 1967.
A presentation of the "sandwich-shell" model of the cornea, which should be sufficiently flexible to contain many parameters of the cornea while remaining amenable to analysis. The author discusses the mechanical properties and typical dimensions of the cornea and the parameters normally used to characterize a shell structure, in order to show that Reissner's sandwich-shell theory can be used to develop a satisfactory model. A set of equilibrium equations based on Reissner's theory is presented. Effects of corneal parameters on the stress resultants due to intraocular pressure are shown by numerical examples. 25 pp. Refs.

P-3588 Social Cost of Peptic Ulcer. I. S. Blumenthal. April 1967.
An updating of the data on the social cost of peptic ulcer presented in an earlier RAND study, R-336-RC. The previous study focused on the years 1954-1956; the present study focuses on 1963. Three indicators of the economic cost of peptic ulcer are examined: deaths due to ulcer, its prevalence in the population, and economic loss. The concept of economic loss as developed in the previous study has three components: (1) direct cost of resources diverted to medical care of the disease; (2) indirect cost resulting from the loss of individual productivity; and (3) indirect cost resulting from the loss of future productivity of individuals whose death is attributed to the disease. Total deaths ascribed to peptic ulcer in 1954 were 9,610. The number for 1963 was 11,900. If the 1963 rate is projected to the 1965 population, the total deaths are then estimated to be 12,500. The updated estimate of the economic cost of peptic ulcer approximates $1.0 billion. 25 pp. Refs.

P-3613 A Bibliography on Nerve Conduction and Nerve Impulses (RAND Library Literature Search No. 127). E. McKeldin, L. Newman, J. Wallach. July 1967.
A bibliography of works published between 1952 and June 1, 1967 on the behavior of networks of nerve cells. The bibliography includes items on the theory and simulations that apply closely to the behavior of living nervous tissues and networks; items on automata or bionic devices are not included. Results of machine searches requested from the Defense Documentation Center, NASA, and the National Library of Medicine have been incorporated in the bibliography. 33 pp.

P-3659 Comentarios Acerca del Uso de la Computadora en la Investigacion del Sistema Nervioso.' D. H. Perkel. Diciembre 1967.
Transcript of an address in Spanish before the symposium on "Computacion en el Sistema Nervioso," VIII Congreso de la Asociacion Latinoamericana de Ciencias Fisiologicas, Mexico, D.F., 1967. Four levels of the use of the computer in investigating the nervous system are distinguished: (1) as a data-reduction device; (2) as a participant in neurophysiological or behavior experiments (e.g., in on-line control of stimulus presentations); (3) as a vehicle for realizing and observing models of neural action and interaction; and (4) as a model itself for interpreting nervous system operation. The author points out that the use of the computer is a natural extension of other tools and logical methods of accepted use in neurophysiology; he warns of facile comparisons between the human brain and the computer. 6 pp.

P-3672 Input-Output Relations for Axo-Somatic Activation in a Neuron Model. R. J. MacGregor. November 1967.
Experimental findings have suggested that axodendritic activation is the primary source of nonlinear integration among input pulses, while axosomatic activation mediates a relatively inflexible driving action on the cell. A theoretical basis for this distinction was previously examined and a model was presented to account for the nonlinear properties of axodendritic activation. The present study addresses the properties of axosomatic activation with a digital computer simulation of the elicitation of spikes by postsynaptic potentials. Input-output rela-

tions for regular and irregular temporal patterns of excitatory activation, and for combined excitatory and inhibitory activation, are presented. The results corroborate the hypothesis. 28 pp. Ref. (See also RM-4877.)

P-3682 "The Chromaticities of Subjective Colors Elicited by Rotation of the Fechner-Benham Disc," by Guy Verriest and Ryo Seki. Translated by R. J. MacGregor. October 1967.
A translation of an article in the Revue d'optique theorique et instrumentale (1964) describing an experiment made to quantitatively evaluate artificially induced colors in terms of Munsell samples and to determine the effect of unequal speed on their development. The results indicate that the colors elicited do not depend on the trichromatic components of the illumination, but on the spectral distribution. Since the data were obtained from a single individual thirty-eight years of age, and in most cases represent single unrepeated measurements, this work does not preempt that proposed by Hubert Moshin, who will perform repeated measurements on a large number of younger subjects. 16 pp. Refs.

P-3743 Pseudo-Color Processing of Electronic Photographs. J. E. Rieber, C. Gazley, Jr., R. H. Stratton. January 1968.
A description of the processing method used on Mariner IV test photos to transform shades of gray into shades of color to enhance their visibility. The tape came coded line by line with digits, from 0 for white to 63 for black. An IBM 7044 computer with S-C 4020 graphical plotter converted each frame of the tape to 64 separate frames, each corresponding to one shade of gray. The 64 frames were then copied successively onto one frame of Kodachrome, using color filters from red for 0 to blue for 63. The Paper is illustrated with 9 photographs. The FORTRAN program and control cards are appended. (Prepared for presentation at the October 1967 annual meeting of UAIDE, Users of Automatic Information Display Equipment.) 28 pp. Ref.

P-3747 A Model for Continuous Neuroelectric Activity: The Encoding of Stimulus Intensity. R. J. MacGregor. February 1968.
Applies the idea of large-amplitude depolarizations in dendritic regions to the intensity dependence of graded potentials in the vertebrate retina. The model assumes that membrane in dendritic regions of primary afferents is linear, that receptors excite primary afferents by a synaptic mechanism that is continuously active during stimulation, and that the magnitude of the permeability change depends linearly on stimulus intensity. Comparison of the results with electrical data suggests that such a synaptic mechanism might represent the source of logarithmic intensity encoding. Psychological intensity data and possible applicability to other sensory modes are briefly discussed. 36 pp. Refs.

P-3786 An Application of Decision Theory to a Medical Diagnosis-Treatment Problem. A. S. Ginsberg, F. L. Offensend. February 1968.
A specific medical diagnostic-treatment problem, characterized as a sequential decision under uncertainty, is solved by decision-theoretic techniques. The basic assumption in the construction of the model is that the doctor wishes to choose the course of action that will maximize his and/or the patient's "satisfaction," i.e., to maximize expected utility of all possible actions and outcomes. Despite shortcomings of this particular analysis, especially in problems encountered in a more general setting, further research is encouraged in decision-theoretic techniques as an effective means of solving complex diagnostic-treatment problems facing physicians today. 27 pp.

P-3799 Problems of Disease Classification in Machine Processible Format. T. L. Lincoln. February 1968.
A discussion of the problems involved in establishing an information processing system for the medical profession. The effective management of medical and health data is complicated by the three diagnostic categories that presently prevail: the clinical, which requires information focused on the individual; the scientific, which deals with the development of appropriate models that define disease processes; and the epidemiological, which considers the effect of medical and health efforts on populations of people. The most effective approach to solving the problem of information processing is to concentrate on elements that show stability in the face of rapid change, that focus on the patient, and that directly describe his problems. It should then be possible to relate the data that result from the separate activities, interests, and goals of health professionals. 9 pp. Refs.

P-3827 Some Comments on Urban Research. S. Genensky. April 1968.
A discussion of RAND research efforts for the City of New York, with some pros and cons of involvement in an urban program.

Contracts with the City's Fire Department, Health Services Administration, Housing Development Administration and Police Department form the basis of continuing research efforts for RAND. However, research within the urban sphere can be difficult due to (1) the political structure's demand for immediate results; (2) unfavorable criticism from premature public exposure; (3) possible subpoena of confidential materials; (4) divided authority; and (5) multiple-source funding problems. The advantages, centering in the opportunity to solve major urban problems and implement solutions, are seen as outweighing the disadvantages. 14 pp.

P-3862-1 An Economic Model of Family Planning and Fertility. T. P. Schultz. July 1968.
A description of an economic model of family planning and its application to explain differences among municipalities and over time in birth rates in Puerto Rico. Beginning with the preferences of parents for children, the model seeks the determinants of birth rates among environmental factors that influence the goals and planning of parents. The hypothesis is set forth that the frequency of births in a population can be understood in terms of three groups of factors: (1) the family size goal, (2) the incidence of death, and (3) uncertainty in the family formation process where births, deaths, and remarriage are unpredictable. Pooling a time series of cross-sections for 75 municipalities in Puerto Rico, strong support is obtained for this hypothesis and its approach to population growth study. 52 pp. Refs.

P-3868 Contributions to the Analysis of Urban Problems: A Selection of Papers from the Rand Workshop on Urban Programs, December 18, 1967-January 12, 1968. Edited by A. H. Pascal. August 1968.
A compilation of fourteen papers analyzing U.S. urban problems. Co-sponsored by the Ford Foundation, the three-week Rand workshop was intended to define and initiate a long-term research program on urban policy issues and to interest other organizations in undertaking related work. Participants included scientists, scholars, Federal and NYC officials, and Rand staff members. They were invited to prepare preliminary papers recommending program initiatives, research, and experiments in the program areas of education, health services, welfare/public assistance, jobs and manpower training, housing and urban planning, police services and public order, and municipal finance and administration. Papers were also invited on nonprogram issues, such as race relations and bureaucracy. The selected papers included in this compilation are grouped under four headings: (1) urban perspectives, (2) municipal objectives and organization, (3) urban poverty, (4) urban violence and public order. 190 pp. (See also RM-5603-RC.) (EB)

P-3872 Are Evolutionary Concepts Needed? J. E. Cohen. June 1968.
A demonstration of the applicability of the method of Padoa to the question of whether all laws of the secondary science (say, evolutionary biology) are derivable in the theory of the primary science (say, molecular genetics), once the appropriate concepts in each have been linked. In deciding the question of logical dependence and independence, Padoa's method is basically one of finding two interpretations of the axioms of the theory such that "a" (a given primitive) has two different interpretations, while the remaining primitives, in set B, have the same interpretation. An example of the method is applied to an elementary theory of fitness; however, in order to use the method nontrivially, one must have a nontrivial theory, with a nontrivial set of axioms and concepts. At present these do not exist in the fields of genetics or molecular biology, partly because the theories do not cohere, and partly because the concepts in use are changing rapidly. The method will be a useful tool, if the passage of time and developing concepts promote reducibility. 9 pp. Refs.

P-3898 Coronary Care Unit Bibliography. M. A. Rockwell. July 1968.
A comprehensive unannotated bibliographic listing of 5 books and pamphlets and 92 journal articles on hospital facilities for the intensive care and monitoring of patients with acute coronary disease. The journal articles are listed in chronological order of publication under these headings: Coronary Care Unit Performance; CCU Design, Operation and Construction; and General Articles on the CCU. The etiology, epidemiology, pathology, prognosis, and medical treatment of coronary artery disease and myocardial infarction are excluded. Entries were drawn from a National Library of Medicine literature search of the years 1962-1967, with follow-up review of the bibliography appended to each of the articles, plus review of Index Medicus for January-June 1968 and the tables of contents of all relevant journals during that period on the shelves of the UCLA Biomedical Library. Further references are invited. 10 pp.

P-3906 A Framework for Planning Social Services. A. H. Pascal. August 1968.
An outline of a planning process for social services, prepared for the Task Force on the Organization of Social Services, Department of Health, Education, and Welfare. The first step is to adopt a classification scheme indicating where resource-allocation decisions must be made politically and where they ought to be made technically. Functions could be distinguished by major classes, by target groups, by societal objectives, or by a combination of these classifications. Once resources have been allocated, standards to measure achievement and a method for attaining the goal can be determined. There are four general institutional arrangements for furthering a social purpose: (1) The government distributes generalized purchasing power. (2) The government provides a particular social service. (3) An outside institution provides a given service under government contract. (4) The government provides scrip or identification cards that are used to purchase goods or services from competing offerors. Each delivery system has advantages, but the last method, where applicable, goes farthest toward increasing efficiency through competition while maintaining individual freedom. Although each system will have its own criteria for evaluation, sufficient feedback must be provided to allow for self-criticism and adaptive behavior. 11 pp.

P-3931 Medical Care Cost Incentives: Some Questions and Approaches for Research. I. Leveson. September 1968.
A discussion of the problems and range of alternatives available for developing incentives for medical care cost reduction. The major problems will be to develop adequate definitions of the output of medical care and measurements for the value of the attributes of alternatives. Incentives to control costs can vary by type, object, stage in the production process, or level of operations. An understanding of these differences and their possible combinations clarifies the range of alternatives. Some suggestions for specific areas for research include cost studies, productivity analysis, organizational structure analysis, capital allocation studies, alternative methods of production, and the effect of pricing policies. 21 pp. Refs. (MJP)

P-3945 How Much Is Good Health Worth? V. D. Taylor. July 1969.
A consumer demand or subjective value approach to government-provided or -subsidized medical services. The usual cost/benefit or human capital approach is irrelevant to human preferences and actions of decisionmakers. For the nonpoor, government action should generally be restricted to what consumers cannot obtain elsewhere: regulatory actions, control of infectious diseases and pollution, aid to biomedical research. Government activities are worth what people would be willing to pay for them. Services to those who could not pay are justified by the willingness of the nonpoor to pay for them. Giving the poor what they want instead of what some index says they need would better serve the total perceived well-being, since present programs arouse hostility. Direct money transfers to the poor cost far less to deliver than medical services and would probably contribute more to improving health through better living conditions. 38 pp. Refs. (MW)

P-3947 Technological Opportunities for the Delivery of Health Care. E. C. DeLand, B. D. Waxman. October 1968.
An examination of the efforts of the National Center for Health Services Research and Development to identify areas for the application of modern technology, particularly computer technology, to critical health care problems. Focus is on those solutions applicable to problems of hospitals and clinics; applications to biological research and development are not considered. Included are brief descriptions of (1) patient-monitoring systems; (2) permanent automated patient clinical record files that can store and retrieve data in both narrative and numerical form; (3) an automated system whereby drugs ordered at the nursing terminal can be delivered and accounted for in the inventory of the pharmacy and in the cost records of the hospital; (4) automated clinical chemistry laboratories, with computer-based analysis and display of data; (5) population multiphasic health screening; (6) patient interviewing techniques that could be used in preventive medicine as well as in rudimentary diagnosis and therapy; (7) pattern recognition devices for tissue typing, etc. 15 pp. (CC)

P-3952 The Effects of Improved Health on Productivity Through Education. I. Leveson, D. Ullman, G. Wassall. September 1968.
An examination of the relationships between health status and educational attainment, achievement, and absenteeism. Earlier materials on absenteeism, school dropouts, and armed forces rejectees are examined, and new data from a study of school health records and armed forces rejection are presented. Some rough, overall calculations are made of the effects of health on productivity through

education, such as: (1) A minimum estimate of productivity losses through dropping out of school for health reasons is $3 to $4 billion for employed persons. (2) Absenteeism from school results in a loss of output of $2 billion. Much needs to be done in this area of research, since omission of productivity effects in estimates of the value of improved health biases our thinking about resource allocation away from medical care toward other investments. 19 pp. Refs. (MJP)

P-3969 The Anomalous Distribution of Body Water Under Alkaline Osmotic Stress in Hypothyroid Dogs. D. Dorr, M. B. Wolf, J. V. Maloney, E. C. DeLand. December 1968.

Investigation describing a disease state in physiochemical terms. To test the hypothesis that the hypothyroid (low-energy) person must respond differently from the normal person to physiologic stress, body compositional studies were performed on 19 randomly selected mongrel dogs (including euthyroid and hypothyroid cases). Using the multiple-isotope dilution technique, studies were performed both before and after the infusion of a hypertonic sodium bicarbonate solution. It is suggested that the significant increase in transfer of water to the extracellular space in hypothyroid dogs might be due to altered metabolic pumps, presence of abnormal mucopolysaccharide in the extracellular space, or possibly altered chemical activity of water across cell boundaries. The results of the investigation invite further study in the formulation of a specific chemical thermodynamic model of the hypothyroid state. 12 pp. Refs. (KB)

P-3980 The Demand for Neighborhood Medical Care. I. Leveson. December 1968.

A study of the demand for medical care. The roles of the factors most affecting this demand in general, and the demand for urban neighborhood ambulatory medical care in particular, are hypothesized and then analyzed statistically in terms of the Queensbridge Health Maintenance Service, a clinic set up in November 1961 for residents of a housing project for the elderly. The sample consists of 1219 of the approximately 1400 residents. Health status, income, education, and price variables (especially travel distance) are the most powerful determinants of patterns of medical care. Education and income are positively correlated. When income and other variables are held constant, education encourages use of clinic services, and color is not important. On the whole, there are substantial social and economic barriers to the receipt of ambulatory care even when it is provided without charge at a convenient location. 42 pp. (LC)

P-3984 Some Comments on a Closed Circuit TV System for the Visually Handicapped. S. Genensky. December 1968.

Text of a presentation to the annual meeting of the American Academy of Optometry in December 1968, outlining Rand efforts to design and construct a closed circuit TV (CCTV) system to aid the visually handicapped. Defined as those with poor vision even with the aid of eyeglasses, the visually handicapped could be helped toward more productive lives by an increase in image magnification and light intensity or brightness. Rand's prototype CCTV system is simple and inexpensive, consisting mainly of a TV monitor on an adjustable shelf, a TV camera capable of rotating on a fixed horizontal axis, and a working surface to support the materials used. This system has been tested and found valuable to individuals in a wide age span for many uses. Several desirable prototype devices are yet to be designed and built, for which financial support is being solicited. 16 pp. (See also RM-5672-RC). (EB)

P-3988 Pseudocolor as a Means of Image Enhancement. J. J. Sheppard, Jr., R. H. Stratton, C. Gazley, Jr. January 1969.

A description of two methods for enhancing perception of detail in black-and-white images. Image enhancement by pseudocolor involves the problem of specification of chromaticities and luminances. Two techniques of producing color by three-primary mixtures are discussed: a computer-based approach (with considerable versatility) and a relatively simple process of photographic transformation. The first technique is limited only by the sophistication of the image-processing program and the data handling capacity of the computer. It is a costly approach requiring appropriate scanning of the original black-and-white image for input. Attractions of the photographic technique include the low cost factor, flexibility in type of color renditions possible, and the availability of processing equipment to medical personnel for clinical tasks. Pseudocolor techniques are being used to design psychophysical experiments in pattern recognition and may be applied to chromosome photomicrographs, X-ray films, and pathological specimens. 33 pp. Refs. (KB)

P-4011-2 A Model of Physician Pricing: Comment and Reply. J. P. Newhouse, P. A. Sloan. February 1971.
Two econometric models are devised to judge the market for physicians' services: one, monopolistic, with factors of consumer price ignorance and inability to judge quality of product received; the other, with set price from intersection of supply and demand curves, as in a competitive market. The authors determine that market pricing for physicians' services is monopolistic rather than competitive. Critics complained that the models were in error, were inconsistent, and that price was positively related to demand whether physician pricing is monopolistic or competitive. In reply, the authors state that, while it may be difficult to distinguish among these hypotheses empirically, the general thrust of the evidence shows that the amount of price dispersion, the low price elasticities, the apparent unresponsiveness of price to insurance coverage, and the age composition of the population all point to a noncompetitive market. 38 pp. Ref. (SM)

P-4016 A New Approach to Hospital Insurance. J. P. Newhouse, V. D. Taylor. January 1969.
A proposal for a new type of hospital insurance that would re-establish consumer concern with price: Variable Cost Insurance (VCI). Major features of VCI are: (1) The insurance premiums vary directly with the "expense class" of coverage chosen by the subscriber. (2) In the event of hospitalization, the proportion of the hospital bill covered by insurance varies directly with "expense class" of the hospital used. In addition to making the consumer an active seeker of economical care, VCI would give hospitals an incentive to be efficient; it can be introduced without substantial prior research; it avoids quality-comparison problems and the bureaucratic complexities of central planning and franchising; and it is adaptable to all types of insurance programs including Medicare and Medicaid. While not a total solution to spiraling hospital costs, VCI appears sufficiently superior to current plans that every effort should be made to introduce it quickly. 12 pp. (MJP)

P-4019 Computers and the Delivery of Medical Care. E. C. DeLand, W. F. Raub, R. W. Stacy, B. D. Waxman. February 1969.
The Introduction to Computers in Biomedical Research, Vol. III, evaluating accomplishments over a 3-year period and predicting areas for future emphasis. Characteristics distinguishing recent computer systems from those in the past include increased complexity, flexibility, and capacity for improving health-care services. Work is being done to implement present image processing techniques and, in addition, to promote computer-aided instruction in regard to biomedicine. In the future, mathematical models combined with graphic and flexible forms of data presentation could become an integral part of research hospitals, monitored patient wards and clinics, and basic research laboratories. Interactive computer terminals and the attendant central processor software will be useful for hospital communications, for model building and hypothesis testing, for patient autointerview, for perusing files of data and for other tasks requiring the transfer or analysis of data. 20 pp. (KB)

P-4022 Toward a Theory of Non-Profit Institutions: An Economic Model of a Hospital. J. P. Newhouse. January 1969.
Development and implications of the economic model of a hospital applicable to other nonprofit institutions. The assertion is made that the voluntary hospital with nonprofit status may result in economic inefficiency and cause some misallocation of resources. A bias exists against producing lower quality products in the sense that a profit-maximizing firm would produce such qualities. There is little reason to think that a nonprofit hospital will enter in response to a profitable opportunity (either because the consumer demands are not being satisfied or because inefficient hospitals are providing the product). On the other hand, philanthropy gives the nonprofit hospital some latitude for inefficiency, and this, among other things, tends to forestall entry by profit-making firms. An additional problem exists if the hospital is simply reimbursed by a third party for its costs. By removing the budget constraint, incentives for least-cost production are weakened. 22 pp. (KB)

P-4056-1 Population Growth: Investigation of a Hypothesis. T. P. Schultz. August 1969.
An empirical examination of a family planning model built around three factors that are assumed to exert a systematic effect on birth rate: (1) a family-size goal or the number of surviving children that parents want; (2) the death rate, mainly among offspring, which necessitates a compensating adjustment in birth rates to achieve any particular family-size goal; and (3) uncertainty in the family formation process, in which deaths, births, and remarriage are unpredictable. The

model also allows examination of the phenomenon of the substantially lower birth rate among urban women when compared with that among rural women. Data from Colombia, supplemented by data from Puerto Rico and Taiwan, give general support to the working hypothesis that variations in reproductive behavior are the outcome of parent behavioral responses to the opportunities and constraints of their environment. The selective expansion of health, education, and welfare programs may do much to encourage parents to seek fewer children. 58 pp. (MJP)

P-4068-1 Lifetime Earnings and Physicians' Choice of Specialty. F. A. Sloan. December 1969.

A study to determine whether lifetime earnings in various specialties influence physicians' choice of field. Although income payments to practicing physicians in certain specialties felt to be "shortage" fields may be a politically infeasible policy instrument for influencing specialty choice, increases in residents' salaries could have some appeal for legislators. The effectiveness of both policies is evaluated. Estimates of lifetime earnings differentials between specialties and general practice are presented. The income differentials do not explain why virtually all medical school graduates enter residency programs. However, choices among particular specialties may reflect interspecialty income differences. Regression equations measuring the supply response to income in several specialties are presented. The results indicate that income payments to practicing physicians and stipends to residents would have only a small effect on choice of field. The author suggests other factors that may influence specialty choice: vacancies in a particular specialty, intellectual stimulation, and prestige. 22 pp. Ref. (RG)

P-4069 The Effectiveness of Family Planning in Taiwan: A Proposal for a New Evaluation Methodology. T. P. Schultz. April 1969.

A new approach to evaluating the effectiveness of family planning programs in reducing birth rates. A predictive model incorporates demographic and economic statistics to analyze the relationships between birth rate and various environmental determinants: the number of surviving children that parents want, the death rate for children, and inputs to the family planning program that reduce unwanted births. Examination of the time dimensions of these relations reveals a two- or three-year behavioral-biological lag in determination of birth rates and a similar lag in empirical confirmation of program input variables. Health workers, doctors, and especially village nurses make significant contributions to the success of the program through the dissemination of services and information concerning traditional forms of contraception. 67 pp. Refs. (KB)

P-4074 Innovations and Experiments in Uses of Health Manpower--A Study of Selected Programs and Problems in the United Kingdom and the Soviet Union. E. H. Forgotson, J. H. Forgotson. April 1969.

A study of British and Soviet health care programs that might be applied in U.S. health services in order to develop new categories of medical manpower. The currently inadequate geographical distribution of medical care in the United States might be alleviated through the development and use of intermediate health professionals and high-level auxiliaries. Existing state regulations, however, impede the development and training of such medical manpower, and these regulations must be revised. Midwifery and coronary intensive care programs in Britain and feldsherism in Russia were examined to determine their suitability as models for a revised regulatory program in the United States. Although none was completely applicable, guidelines for regulatory revision were apparent. U.S. developments are not lagging behind the United Kingdom or USSR, but research must be pursued, along with the development of a regulatory program that will foster innovations and concurrently protect the patients. 22 pp. (EB)

P-4075 The Demand for Medical Education--A Study of Medical School Applicant Behavior. F. A. Sloan. April 1969.

An analysis of medical school applicants to provide government planners with policy instruments that may be used to affect production levels of the medical education system. Potential medical students are responsive to recent earnings developments in alternative occupations. Direct medical education cost increases have decreased student interest in medicine, and stipends in Ph.D. fields have lured them away. The government should reappraise its loan and scholarship policies, as well as its manpower objectives in the scientific fields in which its control can influence earnings. The public sector may stimulate demand for medical education by implementing policies, such as health insurance schemes that effect a rise in physician earnings. It is also possible that the supply of medical

education has a positive impact on the demand. 40 pp. Refs. (EB)

P-4080-1 The Economics of Moral Hazard: Further Comment. J. P. Newhouse, V. D. Taylor. August 1969.
A commentary on an article in the June 1968 American Economic Review pointing out that medical insurance reduces medical care price below marginal cost and thus acts as a subsidy. Hospital insurance has contributed to the overall inflation in medical costs by making the consumer responsible for only a small portion of the cost differences between hospitals, thus encouraging him to opt for more expensive care. A remedy would be to provide Variable Cost Insurance (VCI) that pays a hospitalized individual a lump sum for a predetermined quality level, which may be applied either to more or less expensive care. Insurance subsidization of the quantity of hospital services provided would still exist, but by removing the distortion in the consumer's choice of a hospital, VCI could importantly reduce the escalation of hospital costs. This scheme is relevant to the current policy debate over medicare and medicaid. 11 pp. (EB)

P-4087 Priorities in Funding Health Research. V. D. Taylor. May 1969.
Improved methods of delivering medical and dental care will have little effect until doctors and hospitals are motivated to adopt them. The most important research task is to find levers to change the system. Among the needs is an institutional framework in which nonprofit hospitals become concerned with efficiency. Consumers need tools for evaluating the service they receive, and motivation to avoid extravagance. The medical insurance system should reward quality and efficiency. The licensing system should be changed to eliminate restrictions that serve mainly to keep needed health personnel scarce. 9 pp. (MW)

P-4090 The Price of Hospital Care. V. D. Taylor. May 1969.
Derivation and application of a new hospital price index constructed for the National Advisory Commission on Health Manpower. Based on a weighted average of the prices of the factors used as inputs in producing hospital care, it distinguishes the effects of price inflation from the progressive increase in the amount of labor and supplies consumed per patient-day. Of the 92 percent rise in costs per patient-day during 1955-1965, only 37 percent was due to price increases. Since 1966, doctors and hospitals have been progressively slowing down the increase in resource inputs (the difference between price increase and cost increase) --a fact completely obscured by the normally cited indicators of hospital cost. 6 pp. (MW)

P-4104 Pseudocolor Enhancement of Biomedical Images. J. J. Sheppard, Jr., R. H. Stratton, C. Gazley, Jr. September 1969.
For human observers, the number of distinguishably different colors is much larger than the number of distinguishably different shades of gray. Therefore, if the scale of grays in a complex black-and-white image is transformed into some suitable scale of colors, perception of the details in that image will be greatly enhanced. In one versatile but expensive method of producing such pseudocolor images, the black-and-white image is photoelectrically scanned and a computer is used to produce three pseudocolor separations on 35-mm film. A simpler and more inexpensive method uses purely photographic procedures. Examples of pseudocolor enhancements are presented. (Prepared for presentation at the First International Colour Congress, Stockholm, Sweden, June 1969.) 11 pp. (Authors).

P-4136 Erythrocyte Composition in Cirrhotic Patients with Secondary Hyperaldosteronism. J. Swedenborg, J. V. Maloney, E. C. DeLand. July 1969.
Erythrocyte sodium, chloride, and water were significantly different when a group of eight patients with cirrhosis of the liver was compared to a group of normal subjects, but plasma levels were not different. This study demonstrated that patients with cirrhosis can be identified by the analysis of erythrocytes. 9 pp. Refs. (Author)

P-4147 A Closed Circuit TV System for the Visually Handicapped and Prospects for Future Research. S. Genensky, H. L. Moshin, H. Steingold. July 1969.
Description of a prototype closed-circuit TV system, developed at Rand, for helping the visually handicapped to read and write. The CCTV system, which consists of a TV monitor and camera, camera-positioning equipment, and a working surface, increases image magnification (from 1.4x to 31.7x), amplifies light, and heightens contrasts. It permits the user to track printed or handwritten material across a line, to adjust the position of the monitor, and to change the vertical plane of the camera to accommodate his individual writing habits. Among the major benefits provided by CCTV would be those of restoring pri-

vacy and independence, as well as the ability to compete for jobs. Modifications are planned to improve the usefulness of the device, such as more compact construction. 20 pp. (CC)

P-4200 Water Distribution Abnormalities in Hypothyroid Dogs Due to Acid-Base Disturbances. M. B. Wolf, E. C. DeLand, J. V. Maloney. December 1969.

Experiments to measure the changes in water and electrolyte distribution in euthyroid and hypothyroid dogs as a result of an infusion of HCl. This paper hypothesizes that the physico-chemical state of the connective tissue ground substance is altered by changes in the hydrogen ion concentration of the interstitial fluid. Since a base infusion increased the extracellular water and the interstitial water in the hypothyroid, as compared to the euthyroid, an acid infusion should yield comparative changes in the opposite direction. Of all the data taken, only the plasma water and interstitial water volumes showed a significantly different change between the two groups of animals. When these results are compared to those presented by Dorr for NaHCO sub 3, it is found that the volume of interstitial water in the hypothyroids increases relative to the euthyroids after NaHCO sub 3 is administered, and decreases relative to the euthyroids after the infusion of HCl. 8 pp. Ref. (MT)

P-4207 The Use of Information in Clinical Problem-Solving: A Framework for Analysis. L. G. Chesler, A. M. Hershdorfer, T. L. Lincoln. October 1969.

A systems-analysis framework for the organization of information in a biomedical communication network. Formal structures need to be developed to improve information handling in medicine. Tutorial constructs show relationships between present practice and medical information. Decisions under physician control are initial work-up (history, examination, and lab reports), diagnosis, and therapy. Depending on the kind of information known, the physician may use supportive, patient-specific, or disease-specific therapy, or may adopt a multiple-problem policy. Each approach emphasizes a different aspect of clinical problem-solving. Further, any decision process will be subject to the factors of environment, time, uncertainty, goals, and constraints. The domination of each of these will vary the set of decisionmaking rules. Each set of variables has different dimensions. The observables may be considered as data per patient; the conceptual state variables, data per problem; the decision variable, time per problem; and control variables, data per time problem. 42 pp. Ref. (SM)

P-4218 Spatial Organization Implied by Horizontal Cell Chains in the Vertebrate Retina. R. J. MacGregor. October 1969.

The locus of the receptive endings of horizontal cells whose activation eventually influences a given reference point in the retina is explored. For simplicity, it is supposed that all the horizontal cells have the same length and that the spread of their dendritic trees is ignored. Each axon in the chain can be oriented at any angle and all orientations are equally likely. This problem is a two-dimensional isotropic random walk problem which can be solved. Probability densities for nth-order endings in a horizontal cell chain are graphed. The implications of the horizontal cell-chain concept are that its significance in the coding of visual information is probably great but that pursuit of its ramifications is far from straightforward. This random-walk-like organization should be applicable to other subsystems of nerve cells, as well as to many questions outside the realm of neural networks. 10 pp. Refs. (MT)

P-4253 Effectiveness of Family Planning in Taiwan: A Methodology for Program Evaluation. T. P. Schultz. November 1969.

This paper proposes a method for answering the question: For a given level of effort, which of the many alternative family planning programs appears preferable? The approach here is to develop a predictive model of human fertility, from which one may statistically infer from cross-sectional associations the effectiveness of family planning programs. The author presents some tentative statistical evidence on the association between regional birth rates and family planning program activity in Taiwan to illustrate a different approach in evaluating program effectiveness. The overall effects of the program as well as the mix of personnel are evaluated in terms of cost-effectiveness. This study confirms the central importance of a behavioral model, even where this model can only take account of a few of the characteristics of the parents' environment which might be responsible for differences in desired birth rates. 73 pp. Refs. (RG)

P-4254 A Technique for Producing Color Pictures from Black-and-White Negatives. J. V. Lamar. November 1969.

The method of transforming an original

image in tones of gray into a chromatic reproduction is discussed. The S-C 4060 was coded to produce a series of plots, on 35 mm film, varying the number of spots and their sizes per unit area. The film was read on a densitometer to establish the correlation between the transmittance and the plot patterns. A 21-step gray scale was designed and a FORTRAN program, using calls to the IGS Subroutines, was written to produce two separation negatives. These were subsequently printed in register successively through red and blue filters on a negative color material. 10 pp. (Author)

P-4267-1 Interrelationships between Procreation and Other Family Decision-making. A. J. Harman. March 1970.
Discusses the determinants of and interrelationships between fertility and four other factors that affect family size--employment, income, length of marriage, and migration. A model is developed characterizing relevant behavior of individual families. Fertility (a process of first reaching a family size goal and then maintaining that level) is analyzed empirically using a formulation based on the model derived from data for the Republic of the Philippines. The goal is related to alternative uses of the wife's time--child rearing or labor force participation--as well as the parents' education. Both employment of the wife and education affect fertility negatively. Population control requires both eliminating unwanted births and reducing the number of desired births. The most cost-effective strategy for curtailing the population growth rate should include not only direct control policies, but also programs not directly aimed at population reduction, such as increased education for the female. 34 pp. (LC)

P-4272 Alternative Technologies for Information Networks. J. A. Farquhar, J. A. DeiRossi. December 1969.
A discussion of the economic considerations inherent in designing user services that incorporate various communication systems. Three such services for the biomedical community are described: (1) land-circuit television networks such as ETV; (2) telephone access via INWATS to a library of recorded messages; (3) a single center responsible for the dissemination of copies of 1,000,000 documents a year utilizing a general purpose computer, microfiche devices and either U.S. mail or facsimile transmission. Because of the complex character of library operations, particular user needs must be determined before designing a system. Effective support of information systems is now available in large scale digital storage, laser recording, eraseable holographic memories and rapidly developing communications hardware. Unfortunately, much of the implementing software has been unsuccessful. Future success may lie in abandoning attempted solution of general problems and concentrating on specific areas. 8 pp. (MT)

P-4274-1 Medical Costs, Health Insurance, and Public Policy. J. P. Newhouse, V. D. Taylor. March 1970.
Spiraling medical costs are partly the result of price subsidy health insurance plans that prompt neither hospitals nor the insured to economize. Most regulatory approaches don't directly address the problem. A new kind of insurance might. The authors propose variable cost insurance (VCI). Under its terms, applicable to all types of health insurance, hospitals would be rated according to their expensiveness and a portion of costs, reflected in variable premium plans, would be passed on to subscribers. Many might still choose more costly (which may often be only more "luxurious" or wasteful) treatment. But economy-minded patients and their physicians would use more efficient hospitals, in turn providing rewards for good management. Expected results: a slowdown in the hospital cost spiral and the return of the consumer as a force in the market place. 38 pp. (TC)

P-4279-1 The Diagnosis of Cerebrovascular Disease by Ophthalmic and Thermographic Means. I. M. Kalb, H. L. Karpman, J. J. Sheppard, Jr. January 1970.
Describes the current development of a Potential-Stroke Screening Unit to detect persons with high risk of stroke before symptoms develop. Statistics indicate that about 3 out of 4 strokes are due to occlusive lesions usually of the carotid system, particularly in the age group 40 to 60. The pilot screening unit (PSU) combines several diagnostic methods that do not involve any tissue damage, each of which has been proved separately in a research environment. Ophthalmodynamometry (comparing the blood pressure in the ophthalmic artery with systemic and intraocular pressure) detects stenotic and occlusive lesions with 85 to 90% reliability, as does thermography, which measures the infrared emission of the forehead. Cervical auscultation (stethoscopy of the neck area) has 85 to 88% reliability in detecting the lesions that are both commonest and most amenable to therapy. Flowcharts of the PSU and patient care systems are appended. (Prepared for the XXI International Ophthalmological Congress.) 9 pp. Ref. (MW)

P-4280 Physiologic Monitoring in the Operating Room. E. C. DeLand, J. V. Maloney. February 1970.
An evaluation of monitoring techniques that range from "gadgets" to potential lifesavers, but are, in general, simply new ways of displaying old information much of which the surgeon can detect or deduce by more direct means. Their value has been in establishing physiologic principles that, once established, make the electronic equipment less important. Advances may be expected in three areas: (1) in theoretical analysis, where computational techniques enable the surgeon to make multiple correlations to identify significant variables, and to use continuous "trend analysis"; (2) in technical hardware, such as needle transducers and improved non-invasive techniques for recording arterial blood pressure; and (3) in system design, where the monitoring device will not only detect abnormalities but will initiate corrective therapy through preprogrammed logic. As new and beneficial monitoring aids are provided, the surgeon must separate in his own mind the equipment used for monitoring from the physiologic principles that regulate patient condition during surgery. 11 pp. (MT)

P-4298 Privacy and Information Systems: An Argument and an Implementation. J. J. Hellman. May 1970.
Examines the social and technical implications of information systems in relation to the individual's ability to control the dissemination of information about himself. It is argued here that information systems must incorporate in their initial design safeguards to man's individuality while still providing society the information it needs to function effectively. These properties are: control of access by the individual, accuracy and completeness of information, audit trail, and potent legislative support. The second part of this paper applies these properties of safe information systems to problems currently encountered in the medical environment. A toxicological information system, a drug information system, and patient's medical record information system are each analyzed in relation to society's right to learn and the individual's right of privacy. Suggestions are then presented for using available techniques to safeguard society's attempts at using the new information handling technologies. 76 pp. Biblioq. (Author)

P-4304 The University of Texas Dental Branch Independent-Access Television System. R. Bretz. February 1970.
A description of a very advanced electronic instructional system which is at the time of writing in the late stages of construction. Designed for dental laboratory courses, the system will include 100 student stations, each with three-dimensional video, both motion and still, and live 3-D camera equipment of a unique design. Instruction may be programmed in multiple-track or branching formats, and an electronic tablet collects students' constructed responses. Any student may access any of the materials available entirely independently of all other students who are using the same system. The system is unique not only in technical sophistication but in the fact that the designer is both engineer and dental school instructor. 21 pp. (Author)

P-4312 Does an Increase in the Price of a Necessity Reduce Welfare More than an Equivalent Increase in the Price of a Luxury? J. P. Newhouse. February 1970.
This paper develops an argument to suggest that the price increase that causes the greater decrease in welfare is independent of which good is a "necessity," if necessity is interpreted as low-income or low-price elasticity. A simple two-commodity model expresses utility as a function of medical care and a composite bundle of other goods. Conclusions that hold for the model are assumed to apply to a multicommodity world. An illustration shows the proportion of a city worker's family budget for a moderate living standard allocated to various commodities in 1966. According to this index, shelter, food, and medical care price increases cause a noticeably greater decrease in welfare than other commodity groups. Thus, there may be some reason for concern over recent behavior of medical care prices, but the reason is not that medical care is a "necessity." 8 pp. (KB)

P-4325 A Report on the Role of Economic Motivation in the Performance of Medical School Faculty. J. V. Maloney. April 1970.
Analysis of a 1969 survey of physician involvement in clinical medicine, based on data from interviews with 94 faculty members from 9 top medical schools in the nation. Results showed a high degree of involvement in teaching and other activities contributing to better health care by those academic physicians required to earn a portion of their salary in clinical practice as opposed to those paid a straight salary. The study also indicates that the ability of the modern medical school to instruct in the care of the sick is improved by professors who practice clinical medicine as well as teach. Fiscal crises

and chronic shortages of patients appear to be directly related to the unwillingness of faculty to give personal medical care. A persuasive case is made for reversal of the trend toward developing medical scientists with little interest in clinical medicine. 44 pp. Ref. (TC)

P-4337 Review of Hospital Information Systems. E. C. DeLand, B. D. Waxman. June 1970.

A survey of attempts to solve the critical hospital information flow problem, emphasizing PHS-funded computerization projects. No total hospital information system exists, although, since 1962, the VA has spent $6 million and PHS $10 million to develop them. Hospital business functions and diagnostic laboratories are automated successfully, often with hospitals' own funds, apart from the respective $2 million and $5 million from PHS. (A descriptive list of 41 computerized clinical laboratories is given.) Other PHS-funded hospital automation projects include: patient medical records, $4.5 million; logistics, $4.25 million; physiological monitoring (intensive care, operating room, cardiac catheterization), $6.5 million, apart from monitoring within cardiovascular care and research programs. This ignores DOD and private inputs. Since hospitals are conglomerations of minimally related subsystems, success may be in networking discrete information subsystems that are not immediately compatible, rather than trying for a single overall system. (Prepared for the Handbook of Biomedical Information Systems.) 40 pp. Ref. (MW)

P-4343 Closed Circuit TV and the Education of the Partially Sighted. S. Genensky. March 1970.

Description of Rand-sponsored research resulting in a closed circuit TV system designed to help the legally blind and others with severe visual impairments read and write with near normal proficiency. CCTV can dramatically amplify light and heighten contrast, has a proven capacity to aid the visually handicapped where most optical aids fail, and exhibits great potential for systematic use in educating the partially sighted. It is anticipated that CCTV could also open up many jobs requiring manual precision that are now closed to the visually handicapped. Current components of a prototype model and modifications that will permit a variety of applications are discussed. 18 pp. Ref. (TC)

P-4388 The Use of Thermography in the Detection of Extracranial Carotid Arterial Insufficiency--Description of a Provocative Cooling Technique. H. L. Karpman, J. C. Clayton, I. M. Kalb, H. L. Moshin, J. J. Sheppard, Jr. June 1970.

The majority of strokes are due to occlusive lesions, most often in the extracranial carotid arterial system. A method is proposed in which a provocative cooling technique is employed utilizing time-sequenced thermograms of the supraorbital regions of the forehead in order to provide a functional test of internal carotid arterial blood flow. The thermographic procedure is presented as one of several atraumatic diagnostic modalities which are being adapted for performance by paramedical personnel in a specialized, semiautomated, screening, clinical laboratory environment using computer data processing. 16 pp. Ref. (Author)

P-4390 Prevention of Hypokalemic Cardiac Arrhythmias Associated with Cardiopulmonary Bypass and Hemodilution. E. C. DeLand, R. P. Henney, T. A. Riemenschneider, J. V. Maloney. December 1970.

An application of the Rand computer model of fluid balance and electrolyte distribution in the human body (RM-4347) to solve a common problem of open-heart surgery: depletion of potassium in the blood serum interfering with the normal heartbeat. The potassium loss, or hypokalemia, has been attributed to preoperative diuretic therapy, digitalis, and hemodilution. The effects of extracorporeal hemodilution circulation, involving an extremely complex set of chemical thermodynamic relationships, were simulated, and the results checked against experiments with 16 dogs and observations of 5 patients undergoing heart-lung bypass. Hypokalemia is not prevented by simply adding potassium ion to the hemodiluent, nor by adding protein, but is prevented by adding both. (Presented at the Surgical Forum session of the American College of Surgeons, October 1970; to be published in Surgical Forum.) 4 pp. Ref. (MW)

P-4397 A Brief Survey of Literature Relating to the Influence of Low Intensity Microwaves on Nervous Function. R. J. MacGregor. September 1970.

Reviews recent reports, mostly from the Soviet Union, indicating that microwaves of intensity far below U.S. safety limits may produce many deleterious effects on organisms. Insomnia, irritability, loss of memory, fatigue, headache, tremor, hallucinations, and autonomic disorders are among reported symptoms. The radiation considered is in the 10 (exp 8) to 10 (exp 11) cps range, with intensity less than about 10 mw per sq cm. Outside the

Soviet Union, there has been little experimentation concerning the influence of microwaves on neuroelectric events. The reported swelling of nerve cells is in itself sufficient to account for all the anomalies reported; it is also likely to be accompanied by changes in electrolyte concentrations that could have even more seriously disruptive effects. Various neurophysiological mechanisms that might produce these results are suggested for research. 13 pp. Ref. (MW)

P-4398 A Direct Mechanism for the Influence of Microwave Radiation on Neuroelectric Potentials. R. J. MacGregor. June 1970.
An exploration of the idea that the electrical component of applied microwave radiation might induce transmembrane potentials in nerve cells and thereby disturb nervous function and behavior. The paper estimates the transmembrane currents and potentials induced in nerve cells by applied electrical fields and currents. Estimates are made for steady and for oscillating stimulation. The primary conclusion is that intracranial electrical fields associated with low intensity microwave irradiation may induce transmembrane potentials of tenths of millivolts or more, and that, therefore, such externally applied fields may disturb normal nervous function through this mechanism. The paper also presents an analysis which indicates that the induced transmembrane potential should exhibit a maximum in the microwave range of electromagnetic radiation. 32 pp. Ref. (Author)

P-4406 Allocation of Public Sector Resources in Medical Care: An Economist Looks at Health Planning. J. P. Newhouse. July 1970.
Discusses the problem of determining the appropriate allocation of resources within health; such is the usual problem of health planning. The paper points out why the market may not lead to a theoretical optimum; that is, why health planning may be necessary. Health planning, as it is often conceived, attempts to determine the best allocation of medical resources, where best is defined as that allocation which is most efficacious for health. This approach makes two errors: first, the effect of non-medical inputs on health is ignored; second, the effect of medical inputs on things the consumer desires other than health status is ignored. 12 pp. Ref. (Author)

P-4410 Modeling Continuous Systems with BIOMOD--A Preliminary Report. R. L. Clark, G. F. Groner, R. A. Berman. August 1970.
Models a fluid reservoir system using the current version of BIOMOD, an interactive computer-graphics system for biological modeling. The BIOMOD system features interaction with immediate feedback, hierarchical model structuring, and user-oriented model-definition languages. It operates on an interactive graphics console comprising a CRT screen, a RAND Tablet, and keyboard. The user may draw block diagrams, handprint or type text, push displayed "buttons" to initiate certain actions, and move labels. He may represent a model by a block diagram, each component of which may be defined by another block diagram. This facilitates devising complex models one portion at a time. When BIOMOD is completed, the user may define model components by chemical equations, differential equations, or data curves, rather than having to translate his model description into a conventional simulation language. During model simulation, the user may display curves for different variables, change scales, or alter simulation parameters. 41 pp. Ref. (LC)

P-4414 The Health-Related Budget of Los Angeles County, FY1970. S. N. Blumenfeld. July 1970.
Details Los Angeles County's health-related expenditures for FY 1970. In a government budget, funds are usually allocated to the agencies that are authorized to disburse them in a particular service area. However, one unit may have significant inputs to an area that is the primary responsibility of another agency. Thus, to determine the actual budget for a service area, both primary and secondary expenditures must be aggregated. The category "Health and Sanitation" in the FY 1970 Los Angeles County budget accounts for only $56 million of the $479.3 million actually spent on health-related services and facilities. Other expenditures include public assistance, $399.6 million; capital projects, principal and interest payments on bonds, $15.6 million; medical insurance for county employees, $3.6 million; and payments for state services, $1.25 million. Funds for these expenditures are derived from direct charges for hospital services, federal and state subsidies (Medicare and Medi-Cal), and property taxes. 10 pp. (LC)

P-4458-1 Induced Fields and Heating within a Cranial Structure Irradiated by an Electromagnetic Plane Wave. A. R. Shapiro, R. F. Lutomirski, H. T. Yura. November 1970.
The induced fields and the static heating patterns within a multilayered spherical model that approximates the primate cranial structure irradiated by plane waves

in the microwave spectrum are calculated. The relation of the model to the biological structure and the sensitivity of the results to the uncertainties in the dimensions and electrical properties of biological material are investigated. A method of solution for both the scattered and interior fields for a sphere with an arbitrary number of electrically different concentric layers is developed in a form readily amenable to machine computation. It is shown that the semi-infinite slab model is inappropriate for calculating the microwave radiation dosage to the human head and similar structures. 32 pp. Ref. (Author)

P-4463 Pseudocolor Image Enhancement by a Two-Separation Photographic Process. R. H. Stratton, C. Gazley, Jr. September 1970.

A black-and-white photograph contains, in its varying intensities of gray, much more information than can be extracted by the human eye, which can distinguish only 15 to 20 gray shades. Transforming the gray scale into a chromatic scale in which each intensity level is presented as a different color makes it possible to transmit more of the image information--a possibility being investigated for use in medicine, criminology, and aerial reconnaissance. This paper describes a method that requires only two separation steps (red and blue) and can be handled by a modestly equipped photo laboratory. This pseudocolor process produces a continuous line through color space from adjacent densities in the original. If desired, it can be transformed in various ways by changes in photographic materials, filters, and exposures. (Presented at the 15th Annual Symposium of the Society of Photo-Optical Instrumentation Engineers, Anaheim, September 1970.) 6 pp. Ref. (MW)

P-4465 Use of SC4060-Produced Microfilm Output in Pseudocolor Transformations. J. V. Lamar. September 1970.

A pseudocolor transformation is produced when each discrete density level in an original, continuous-tone, black-and-white image is represented as a different spectral hue in the transformation. The SC4060 has been employed to produce microfilm output for use in 2 pseudocolor processes that have been developed at Rand. This paper discusses the computer programs and techniques for producing specific density levels in the film and the pseudocolor processes using the film. 10 pp. Ref. (Author)

P-4469 The Pupil--Importance in the Optics of the Visual System: Part I. Clinical Data. E. Goodlaw, H. L. Moshin. October 1970.

Closeup photographs were taken of each eye of 163 patients who had obtained and were wearing contact lenses. These photographs were taken in both an illuminated and a dark environment. Twenty-three variables were recorded. Seven of these that were relative to the pupil diameter were analyzed. These data were then evaluated against the findings of other investigators. 25 pp. Ref. (Author)

P-4478/2 The Economics of Group Practice. J. P. Newhouse. May 1971.

Group medical practice is often urged, to lower health care costs and improve quality; but the claimed advantages do not apply to fee-for-service, single-specialty physician groups that share costs without prepayment plans. In a sample of 20 such groups and solo practitioners, the groups spent more for rent, and their salary costs for nonmedical services such as appointments, records, and billing averaged $2.55 more per patient visit. Hospital outpatient clinics are still less efficient, judging from 3 with and without teaching functions. Clinic overhead costs per visit (excluding rent) averaged $14.24, compared with $4.54 for private doctors. The economic theory of groups predicts just such lack of motivation to improve efficiency and control costs when the physician does not bear the financial effects. Revenue-sharing doctors also saw fewer patients, but the difference was not statistically significant. It does suggest that encouraging formation of more groups might decrease the supply of medical services while increasing costs. 27 pp. Bibliog. (MW)

P-4485 A New Type of Hospital Insurance: A Proposal for an Experiment. J. P. Newhouse, V. D. Taylor. October 1970.

Proposes variable cost hospitalization insurance to give consumers more choice of cost and quality, give doctors and hospitals an incentive to cut waste, and stop insured users of lower-cost hospitals from subsidizing users of expensive ones. Under Variable Cost Insurance, the insured's premium depends on the relative costliness of the hospital he selects. Higher quality or greater economy would be chosen according to tastes and income. Physicians would be encouraged to consider hospital cost. At least some doctors and patients would switch from high-cost, low-quality hospitals to others, giving hospitals a motivation for improving their management practices. VCI is completely compatible with major risk insurance, and straightforwardly applicable to compreheh-

sive prepaid medical care. Costs for the latter might be calculated as the Clakamas County (Oregon) Physicians Association has done for 30 years. Cost index calculations are appended. 27 pp. Biblioq. (MW)

P-4503 Interactive Simulation of Continuous Systems: Progress and Prospects. J. A. Bekey, E. C. Deland. January 1971.
The development of a simulation system that would provide both the interactive, user-oriented features of analog computers and the precision, memory, and computing power of the digital computer has been a design objective for many years. This paper reviews the background of present-day continuous systems simulation techniques, with emphasis on interactive, graphic-oriented systems. The state of the art is discussed, particularly as it concerns user convenience, interactive features, the use of block diagram descriptions, and graphic displays. BIOMOD, a system recently developed for simulation of biological systems, is used as an example. Limitations of present-day systems and prospects for near-future development are discussed. 21 pp. Ref. (Author)

P-4516 On Pulsatile, Non-Newtonian Flow in the Microcirculation. J. Aroesty, C. Gazlev, Jr., J. F. Gross. December 1970.
In small blood vessels, such as venules, arterioles, and the smaller arteries, the blood flow exhibits solid-like behavior in regions where the shear stress is less than the yield value. The Casson flow equation, originally designed to represent the movement of pigment/oil suspensions such as printing ink, is a fairly realistic model for the flow of blood in venules and arterioles. For such vessels, the frequency parameter is very small, of the order of 10 (exp -2) for a 0.4mm-diameter arteriole. To determine the flow of a Casson fluid under periodic pressure gradient, asymptotic expansions were applied in the square of the frequency parameter, and the simplified equations were then solved numerically. First-order inertial corrections were found to be negligible. The quasi-steady theory is a good approximation of reality, if the yield plane shifts as the pressure changes. (Presented at the 6th Conference of the European Microcirculation Society, Aalborg, Denmark, June 1970.) 13 pp. Ref. (MW)

P-4537 Models of Disease Costs and Their Use in Medical Research Resource Allocations. E. B. Keeler. December 1970.
Biomedical research today is selected on the basis of its "scientific merit" as panels of experts see it; instead, it should be judged by its probable effects on American health. Two cost models to help judge those effects--and allocate medical research funds--are introduced. One treats health and life as an investment and measures the costs of a disease in terms of its medical costs and work days lost to illness and death. The other treats health as a consumption good and measures the costs of a disease by how much people would be willing to pay to avoid it. Discussion is focused on using the models to evaluate the potential payoff of specific research proposals, thus improving the process by which scientific study groups rate them for selection. 52 pp. Ref. (TC)

P-4538 Determinants of the Flow of Physicians to the United States. H. S. Luft. December 1970.
In 1969 over 2300 foreign medical school graduates obtained a license to practice in the U.S. In 1968, 15,582 interns and residents among the 47,494 in U.S. hospitals were foreign educated. The flow of foreign physicians to the U.S. has escalated dramatically in recent years, and today more come from the underdeveloped countries than ever before. This paper probes reasons for the influx, providing detailed statistical backup such as income differentials and other factors affecting migration. Among the conclusions: Prospects for developing nations look dim, as the lure of more money plus an emphasis here and abroad on specialized training exercises its influence to siphon off needed physicians. But, with respect to medical trainees, the situation may not be as bad as it looks: The U.S. receives the physician's services for a number of years, and his home country eventually receives a more highly trained doctor. 118 pp. Ref. (TC)

P-4560 Plasma Volume Dynamics after Hypertonic Fluid Infusions in Nephrectomized Dogs. M. B. Wolf. January 1971.
Plasma volume (PV) and red cell volume (RCV) transient changes due to rapid (1 min) infusion of 12 ml/kg of 0.833 M NaHCO3 solution were measured in dogs. The PV transient was measured using the "indirect" method with 125I-albumin dilution and measurement of RCV with 51Cr tagged red cell dilution, large vessel hematocrit, and F cell ratio. Both methods gave results of an 80% peak overshoot of PV immediately following the infusion and then a fall over the next 120 min to a new steady state. The RCV fell 5% immediately after infusion and then returned in 20 min to slightly lower than control. The PV

transient indicates an initial rapid absorption of water due to an increase in plasma osmolality; then a balance of forces at the peak PV, possibly through increased capillary hydrostatic pressure, decreased tissue pressure, and decreased capillary osmotic pressure due to dilution of plasma proteins. This was followed by a gradual filtration of water out of the vascular system. 27 pp. Ref. (Author)

P-4575 The Changing Balance of Births and Deaths: A Comment. T. P. Schultz. February 1971.
Commenting on Kinsley Davis' paper, the author discusses the problem of rapid population growth in the low-income countries. Research strategy should focus on the family or small community to trace environmental constraints and opportunities influencing desired and achieved fertility, and possibly to isolate the additional contribution family planning programs make to the decline of fertility. In disagreement with Davis, the author finds that fertility and child mortality rates are related. Parents frame their family goals on numbers of surviving children. Once these goals have been reached, parents exercise birth control. In developing countries, improvements in child nutrition and local health facilities might reduce infant and child mortality, and therefore birth rates, within a decade. Modification of education, employment, and welfare policies might further change parental demands toward smaller surviving family size goals. 11 pp. Ref. (SM)

P-4617 Acute Response to Acid-Base Stress in the Dog. C. D. Russell, M. M. Illickal, J. V. Maloney, H. D. Roeher, E. C. DeLand. April 1971.
A crucial problem in the clinical treatment of many pathological states is determining the acid-base status of the patient from a sample of his blood. This study derives such a correlation from experimental data. Since the acid-base reactions of man and dog are similar, experimental data were obtained on 54 dogs subjected to various combinations of stresses corresponding to mixed respiratory and metabolic disorders. The data were introduced into the Rand computer model of fluid balance and electrolyte distribution in the human body. A nomogram was obtained for use in estimating whole-body base excess from the pH and pCO2 of arterial blood samples. 39 pp. Ref. (See also RM-6203.) (MW)

P-4619 Clinical Applications of Dynamic Electrocardiography--The Frequency of Ventricular Tachyarrhythmias and Ventricular Premature Beats in Asymptomatic Patients. H. L. Karpman, J. J. Sheppard, Jr., S. B. Bleifer, D. J. Bleifer. April 1971.
A study of the association of ventricular arrhythmias with the presence or absence of significant symptomatology in a predominantly ambulatory patient population. Dynamic electrocardiograms of 10-hr length were recorded, on 1421 occasions, from 1108 patients, a majority of whom were men and women aged 40 to 80 years. Detailed statistical analysis of the ventricular arrhythmias encountered in these recordings is presented. Paroxysmal ventricular tachycardia (PVT), an extremely hazardous arrhythmia, occurred in 50 patients (4.5%); the incidence increased with increasing age. PVT increased where unifocal ventricular premature contractions were demonstrated at a frequency of more than 12 per minute, or multifocal ventricular premature contractions of any frequency. PVT increased where patients demonstrated unifocal or multifocal paired ventricular premature complexes of any frequency, but did not occur with supraventricular arrhythmias alone. Only 4 of the 50 patients demonstrating PVT were symptomatic. 26 pp. Bibliog. (SM)

P-4623 Simulating PHYSBE with BIOMOD. G. F. Groner. March 1972.
Description of simulating PHYSBE (Physiological Simulation Benchmark Experiment) with BIOMOD, an interactive computer graphics system specifically designed for unsophisticated computer users. Programming was simple because PHYSBE's original description is mostly in terms of a block diagram and integral equations, which BIOMOD provides for, and because BIOMOD's diagnostic messages and quick response aid in discovering and correcting errors. Elapsed programming time was five hours, including studying the definition of PHYSBE and debugging. BIOMOD made exploring PHYSBE's behavior easy by providing complete control of both simulation and display of output curves. The CSMP/360 program that BIOMOD produced for PHYSBE was run in batch-mode to determine the cost of BIOMOD's facilities. BIOMOD required twice as much storage as the batch-mode program, but only about 10 percent more CPU utilization when running and simulating and formating the results. BIOMOD's provisions for easy programming and model exploration justify this cost. 16 pp. Ref. (See also R-617, R-746, R-747.) (Author)

P-4635 The Importance of Plasma Mixing in Bolus Flow. J. Aroesty, J. F. Gross. April 1971.
Examines the relative importance of convection and diffusion in blood plasma in

transporting oxygen into the red blood cells. The bolus flow model of Prothero and Burton is questioned. The role of convection in the mass transfer process is expressed by the Peclet number, UL/D, where U is the velocity of the red cells, L is the distance between them, and D the diffusion coefficient. Convection will play a significant role only when the Peclet number is 10 or higher. That can occur in capillary flows only with material of high molecular weight, such as protein, that diffuses very slowly. For oxygen and other dissolved gases, therefore, diffusion is the dominant mechanism of oxygen transfer. 9 pp. Ref. (MW)

P-4636 Pulsatile Flow in the Microvessels. J. Aroesty, J. F. Gross, C. Gazley, Jr. April 1971.
A simple conceptual model of blood flow in the microcirculation, including small arteries, arterioles, capillaries, venules, and small veins, with linearized equations of motion and simplifying assumptions. The pulsatility of the imposed blood pressure and the importance of the inertial terms are expressed by the Wormersley frequency parameter alpha. In large arteries, alpha is greater than 1. For microvessels, alpha is near zero, viscous forces predominate, and the pressure gradient is balanced by shear. Using transmission line nomenclature, with large alpha, the wave propagation equation results. When viscous forces dominate, the diffusion equation results, and pulsatile flow is highly attenuated and dispersive. Decrease in the pressure amplitude and change in the wave form are characteristic. The numerical values obtained are in qualitative agreement with experimental measurements. The model is being extended to include non-Newtonian effects and tissue compliance. 24 pp. Ref. (MW)

P-4646 Analysis of Pre-CCU Time Interval in Acute Myocardial Infarction. M. A. Rockwell, A. P. Klaus, J. K. Cooper. May 1971.
Analysis of the time from onset of symptoms to admission to a Coronary Care Unit for 2122 patients with acute myocardial infarction treated in the CCUs of 9 hospitals. These data were studied to determine the factors that affect the speed with which patients seek treatment. The median for all patients was 5.8 hours, with a mean of 16.9 hours; 84% arrived within 24 hours. Stepwise regression analysis on age, sex, previous medical history, clinical status at the time of admission, and symptom severity was performed for the 1202 patients for whom all the data were recorded. When factors were considered individually, shorter median times occurred with males, young persons, congestive heart failure patients, cases with shock or fainting, and those who considered their symptoms severe. In the stepwise regression, significant variables were shorter intervals for patients with much sweating and longer intervals for angina cases and for one particular hospital. In the aggregate, all the variables together explained only 9% of the variance. 14 pp. Ref. (MW)

P-4688 Toward a Natural Simulation Language. E. C. DeLand, G. A. Bekey, G. P. Moore. August 1971.
Discusses the state of the art of computer languages for simulation of biological systems, and describes BIOMOD as a step toward enabling a researcher to communicate with a computer in the natural semi-technical language of his discipline. The computer should test his hunches against established scientific and mathematical criteria, identify structures from data, point out unusual or unexpected behavior, and investigate those aspects of the behavior of large systems that are not predictable from knowledge of the subunits. BIOMOD is still elementary in that the user must be able to specify appropriate mathematical operations. Compared with engineering problems, which can be handled well by existing continuous system modeling languages, biological problems are far subtler and more complex, and do not have sets of well-defined primitive functions. We do not yet know whether entirely new mathematical operations are needed for biological modeling or whether life systems are amenable to current engineering/mathematical analysis. 11 pp. Ref. (See also R-617.) (MW)

P-4698 Some Radical New Approaches to Dealing with the Physician Shortage. W. B. Schwartz. September 1971.
Proposal for developing new approaches and a wider mix of programs to deal with critical health manpower shortages. Many tasks now performed by physicians could be delegated to physicians' assistants or nonphysician health care specialists. These specialists, most of whom would function under physician supervision, could free the doctor for a considerable amount of time and allow him to make best use of his professional skills. To improve health services in areas where physicians are not available, new independent physicians' associates have been proposed and experimental programs are now in progress. It should be possible to develop computer programs to guide the physician substitute in the management of both minor and complex clinical problems. The discussion briefly touches on fiscal, man-

agerial, and educational aspects of the proposed changes. 12 pp. (KB)

P-4704 Interactive Biochemical Modeling and Analysis. E. C. DeLand. September 1971.

BIOMOD is a user-oriented, interactive computer graphics system using a terminal composed of a RAND Tablet, CRT, and keyboard. The background computer is currently an IBM 360/65; the system uses a 228K partition of high-speed core with overlay from disc. The system was designed so that a user untrained in computer programming could have direct access to the computer to design a model of a biochemical or physiological system and subsequently simulate his problem. He constructs his model using semiformal simulation languages, insofar as possible from his own discipline. After construction, the model is automatically compiled for simulation. Programs in the computer translate each detail of the model into Continuous Systems Modeling Program (CSMP) language, an IBM program that in turn compiles it into FORTRAN and finally machine language. CSMP also organizes the problem for solution. 10 pp. Ref. (LC)

P-4718 Biomedical Data Processing. E. C. Deland. October 1971.

Description of medical information systems at various levels of organization. This paper traces the history of biomedical data processing and outlines primary sources of difficulty for R&D, including technological design and instrumentation, cross-disciplinary communication, clear task formulation, and modeling problems. The challenge for information system technology, in a patient-management decision problem, for example, is to convert data to functional, on-line information having utility in a medical context. Although it may be sufficient, perhaps, simply to move the data from place to place and list it at the output, copying the manual methods, this would not exploit the real value and potential of the computer system. There are many other cases in which the computer can be used to support the decision process: sophisticated patient monitoring, image processing and pattern recognition (as in EKG analysis), prediction of drug effects, fully automated mass screening, and lay education. 68 pp. Biblioq. (KB)

P-4731 Blood Bank Inventory Control. J. B. Jennings. October 1971.

Essentially, blood banks are facilities which procure, store, process, and dispense blood. To operate effectively in the face of both random supply and random demand, sizable buffer stocks of blood are maintained. The resulting inventory control problem is an extremely complex one for several reasons: (1) both supply and demand are random; (2) approximately 50 percent of all bloods demanded, "cross-matched," and held for a particular patient are eventually found not to be required for that patient; (3) blood is perishable, the present legal lifetime being 21 days in most areas; and (4) each blood bank typically interacts with a number of other banks. This paper presents a framework for the analysis of the whole blood inventory problem at the individual hospital as well as at the regional level; presents a realistic model of blood inventories for both the individual and regional cases; and analyzes the effects of several alternative inventory policies. 23 pp. Ref. (Author)

P-4736 Nine Current Problems in the Theory of Electrolyte and Water Balance. E. C. DeLand. November 1971.

List and discussion of problem areas that appear to be critical obstacles to modeling electrolyte and fluid balance in the body. Current modeling difficulties result from (1) inadequate analysis of the so-called membrane process--the biochemical structure and functional properties of membranes separating various fluid compartments of the body, (2) insufficient design and measurement of critical variables, (3) unsatisfactory statistical design of experiments, (4) the use of imprecise biological jargon, (5) the lack of appropriate functional models of the kidney and muscle cells, (6) poor descriptions of hormone function, (7) inconvenient and expensive methods of incorporating equilibrium and kinetic equations, (8) the absence of stochastic processes and parameter sensitivity analyses, and (9) incomplete understanding of the effects of neural functioning on electrolyte control. 13 pp. Ref. (KB)

P-4766 Predicting Progress, Recognizing Breakthroughs, and Evaluating Performance in the Treatment of Leukemia. T. L. Lincoln, R. E. Wells. March 1972.

Graphical tools are valuable for the prediction of future achievements and in the early recognition of breakthroughs in leukemia research and for the comparative evaluation of results. Predictions of future ALL (acute lymphocytic leukemia) trends indicate that the median life expectancy of patients is increasing 14 percent per year and that the hazard rate is decreasing 9 percent. If the present trend persists, the disease will not be controlled until the end of the century. Chemotherapy has been the only breakthrough

in the last 21 years. New drugs, multiple drugs, and sophisticated maintenance regimens have steadily improved the control of the disease but have not yet produced a sudden advance. Of the two methods examined for evaluating performance, one based on median survival and the other on hazard rate, the second is recommended because it provides more rapid feedback. 27 pp. Ref. (ETG)

P-4771 Cancer Chemotherapy--An Example of Physician Decisionmaking. T. L. Lincoln, J. Aroesty, N. Z. Shapiro. March 1972.
Describes a planned, computer-implemented decision-aiding system to help in patient management during leukemia chemotherapy. Key variables in leukemia chemotherapy are compact and essentially quantitative; the system will provide an explicitly quantitative method for aiding those components of physician decisionmaking that are quantified and structured, while leaving to physician judgment, intuition, and clinical experience the more contextual elements. The paper describes plans for a series of five nested computer programs interacting with a physician through interactive graphics. These programs, which will be based on mathematical models of biological processes that incorporate aspects of the biology and pharmacology of leukemia and its therapy, should help to guide the querying and use of the clinical data base. Each module will concentrate on a different aspect of the treatment problem. The modular construction will permit clinical use of the individual components as they are developed, and prior to their ultimate integration into a complete system. 16 pp. (Author)

P-4773 Biological Primitives. E. C. DeLand. March 1972.
Discusses the concept, and proposes a list, of basic biological functions to aid biologists (as contrasted with mathematicians and chemists) in building models by means of Rand's BIOMOD interactive graphics computer system. These "biological primitives" are characterized as having unambiguous definitions and the capacity to be parameterized clearly and directly. Among the primitives identified are diffusion, equa-osmolarity, pressure gradient, compartment, binding and metabolism (as of a drug), and phosphate, bicarbonate, or protein buffer. The intention is to furnish the biologist modeler with building blocks that are uniquely meaningful to him and that do not require detailed knowledge of their underlying mathematics or chemistry to be used. 9 pp. (CD)

P-4774 Cell Kinetics Simulation in the Treatment of Acute Granulocytic Leukemia. T. L. Lincoln. March 1972.
Describes systems of models simulating patient response to cancer chemotherapy and various mechanisms of blood and blood forming tissues. Such models will make it possible to choose a drug-dosage strategy favoring destruction of tumor cells and minimizing the effect on healthy cell systems. The simulations use the BIOMOD system, developed at Rand, with on-line interactive graphic capability including data tablet and 1024 x 1024 screen. The ability to explore the implications of a simulation during its course makes the system a powerful tool. The inputs to the leukemia program include patient history and a hypothetical future schedule of drug dosage. The outputs are the daily predicted future values of circulating bloodcell and platelet concentrations as affected only by the leukemia, ignoring changes due to complications. Thus, as new drugs and insight develop, hypotheses may be tested without undue risk to the patient. 10 pp. Ref. (HT)

P-4775 The Clinical Significance of Simulation and Modeling in Leukemia Chemotherapy. T. L. Lincoln. March 1972.
Describes the use of mathematical modeling and computer simulation in the management of leukemia through chemotherapy. Treatment of leukemia is quantitative and offers a spectrum of options. The objective of chemotherapy is to kill encroaching leukemic cells without injuring normal ones. Computer programs have been written that incorporate rules of thumb as well as objective measures. The BIOMOD system can enter models in mathematical formats and can keep track of evolving output curves. The simulation can be stopped, changed, then proceed. Ultimately the models must incorporate a variety of information on blood and blood-forming tissue through the organized analysis of experimental and clinical data. Present efforts are aimed primarily at a teaching model. Each patient must now be considered as an average case of the teaching model. A patient-specific model will require that parameters be modified to account for individual biological differences. 14 pp. Ref. (To be presented at the Spring Joint Computer Conference, New Jersey, May 18, 1972.) (HT)

P-4785 The Fluid Mechanics of Pulsatile Flow in the Microcirculation. J. F. Gross, J. Aroesty. March 1972.
Discusses pulsatile fluid flow in small blood vessels and presents a non-Newtonian model for pulsatile blood flow and a pre-

liminary network model for a composite microcirculatory bed. Pulsatile flow in the microvessels is shown to be quasi-steady, a theoretical result that agrees with *in vitro* experiments in tubes under 100 microns diameter. A cell-deficient layer of plasma along the vessel wall appears to act as a lubricating layer increasing the flow rate; for a fixed blood yield stress, the role of the plasma layer decreases as the flow pressure gradient increases. A five-layer model of the microcirculation--small artery, arteriole, capillary, venule, small vein--gave results in general agreement with observation. Amplified to seven levels, with vasodilation and vasoconstriction, the network model was in qualitative agreement with results of *in vivo* experiments on rabbit omentum. (To appear in Fluid Dynamics Transactions, Vol. 6, Part 2, 1972). 12 pp. Ref. (MW)

P-4788 Report on a Survey of CCU Design, Staffing, and Operating Policies. M. A. Rockwell. December 1970.
Summary statistics on the design, staffing, and operating policies of coronary care units at 91 West Coast hospitals. The data were collected as part of a CCU-effectiveness study for the California Committees on Regional Medical Programs. A 6-page questionnaire was sent to each participating hospital in August 1970. The questionnaire data will be compared with the patient data collected using a system developed at Rand in 1968-70 for collecting and analyzing data on CCU patients. The objective is to better understand the interrelationships between CCU operating and staffing characteristics and unit effectiveness. 14 pp. (MW)

P-4790 FLUIDMOD: A Versatile CAI System for Medical Students. E. C. DeLand, R. W. Winters, R. B. Dell, A. E. Zuckerman. March 1972.
FLUIDMOD is an interactive program for student practice and instruction in the medical treatment of fluid and electrolyte problems in human patients. Previous instructional programs in this field have been based on teaching numerous rules applicable to particular problems, which must then be applied by the student to actual patients, who supply the feedback response to the therapy. The FLUIDMOD program uses a mathematical model of the patient so that a student at a graphics console may work completely through the sequence of steps of a given therapeutic problem. Thus, he is actively involved in simulated patient management. FLUIDMOD also contains interactive programs to simulate the clinical patient-management environment: doctor's orders, nursing notes, the patient chart and record, etc., are provided. Eventually, FLUIDMOD will contain instructional programs to which the student may branch as required. The utility of using such a system in teaching-hospital environments is now being evaluated. 16 pp. Ref. (Author)

P-4796 Small-Scale Phenomena in the Flow of Dispersions. C. Gazley, Jr. March 1972.
Exploration of non-Newtonian flow phenomena encountered in biological fluids, with particular attention to changes that occur close to a solid surface in the flow. This phenomenon is presumed responsible for the appreciable changes in the apparent viscosity when the scale of the flow is not large compared to the particle size. To provide a better understanding of the phenomenon and to predict its effects, an analytic model is developed, which comprises a wall layer and a core whose viscosities are dependent on the respective concentration of particles. Experimental data for the effects of feed concentration and tube diameter on the dynamic tube concentration and on the effective viscosity are used to evaluate the parameters of the analysis. 28 pp. Ref. (ETG)

P-4799 FLUIDMOD: A Program for Computer-Based Instruction in Clinical Fluid Therapy. A. E. Zuckerman, E. C. DeLand, R. B. Dell, R. W. Winters. July 1972.
Description of, and instructions for using, a Rand-devised computer program to simulate fluid, electrolyte, and acid-base balance in simulated human patients. The program is intended for use primarily by physicians to study the medical management of hydration disorders and electrolyte imbalances. Written in Fortran IV for use on the IBM system 360, the program goes beyond analysis of steady-state fluid balance to show the effects of continuous stress and homeostatic regulation. The clinical environment is simulated so as to permit physicians and medical students to deal with simulated disease states without special knowledge of computer technology or physical chemistry. 107 pp. (CD)

P-4804 What Color is Gray? J. V. Lamar, J. J. Simac, G. D. Haas. March 1972.
If a black-and-white image is converted to a chromatic image, each shade of gray in the original becomes a different color in the pseudocolor transformation. The color in which gray is shown in the final image is a function of the densities of corresponding locations in the separations, the spectral content of the exposure light

sources, and the exposures used during successive printing, in register, of the separations on color material. This paper describes the problems encountered and the techniques developed for generating separations on the Stromberg Datagraphix 4060. 11 pp. Ref. (Author)

P-4812-1 A CSMP/360 Precompiler for Kinetic Chemical Equations. R. L. Clark, G. F. Groner. March 1973.
CHEMCSMP is designed to bring both a convenient problem-oriented language and the power of CSMP/360 to those who solve problems in kinetic chemical equations, where the primary interest is in the transient states of chemical systems. Language and computational techniques are based on those of BIOMOD, but whereas BIOMOD requires a sophisticated graphics terminal and a large amount of computer storage, CHEMCSMP can be used at more conventional facilities. Chemical equations are written in a format resembling conventional chemical notation and can be combined with other CSMP statements. A precompiler translates the chemical equations into pure CSMP. CHEMCSMP will operate at any installation that can use CSMP/360 if sufficient core storage is available. The core required to run a simulation depends on the problem; execution times are also problem-dependent. Rand will distribute CHEMCSMP to any installation. A nominal charge will be made for copying and shipping the distribution tape. (Prepared for publication in Simulation, the monthly journal of Simulation Councils, Inc.) 27 pp. Ref. (DGS)

P-4846-1 Compulsory Health Planning Laws and National Health Insurance. J. P. Newhouse, J. P. Acton. September 1972.
Examines the relationship between health insurance and the demand for regulation or compulsory planning for hospitals. Reimbursement insurance has caused an increase in the demand for and price of medical services, resulting in concern about efficiency in production of health services. The history of attempts at regulation suggests, however, that such regulation is ineffective, when not actually counterproductive. Improvement is more likely to be produced by a change from reimbursement insurance to major risk insurance, variable cost insurance, or prepaid health maintenance organizations. It is often argued that proprietary hospitals would skim off the profitable patients and ignore the unprofitable ones; but charity medicine constituted only 1.5% of hospitals' activities in 1970, suggesting that this objection is not valid. Moreover, there is no sound reason why some categories of patients should be forced to subsidize others. Compulsory regulation is undesirable, but the collection and dissemination of health care statistics are much needed. 24 pp. Bibliog. (MW)

P-4849 Interactive Computer Elucidation of a Biological System. E. C. DeLand, M. B. Wolf. June 1972.
Examines the process of perceiving and predicting the behavior of complex systems. BIOMOD, an interactive, graphical digital computer system with a remote terminal, has software designed specifically for use by biologists untrained in computer programming. During model construction, the user draws a flow chart and defines the model. During model simulation, he adjusts parameters and observes the output variable plots, comparing them with desired or laboratory results. The user can modify the model and go again to simulation. The key to the system's power is the facile, biologically oriented interface language that places the burden for language translation and problem organization on the software. An osmotic balance problem is given as an example. The actual iterative process could be done by batch processing in a month. Using BIOMOD the biologist can solve it in an afternoon and simultaneously gain a sound, intuitive understanding of the mechanisms, sharpening his perception of the basic problem. 6 pp. Ref. (HT)

P-4864 Organization of and Allocation of Resources to Biomedical Research and Development. J. P. Newhouse. July 1972.
Analytically, research and development are distinguished as follows: (1) Development involves improvement of a technology whose dimensions are known; in research, unknown. (2) Development generally involves the ultimate production of a marketable product; research does not. Development generally takes place in and is financed by the private sector; research, by the public sector. The institutional arrangements in the private sector may not lead to a sufficient amount of development in total or a proper mix of projects, but satisfactory remedies are hard to find. Also to what extent is the rate of development a function of the rate of spending? Rand's methodology has determined this for jet engines and it may be applicable to biomedical development. Since research is publicly financed on a cost-reimbursement basis, methods are necessary to ensure efficiency, but no easy solutions exist. Finally, the links between R&D, widely presumed to exist, are only beginning to be estimated empirically. 25 pp. Bibliog. (MJP)

P-4892 Thoughts on the Experimental Design for the Health Insurance Experiment. A. A. Afifi. August 1972.
An outline of some statistical considerations relevant to the health insurance experiment. The work was done a year ago and as a result is based on a preliminary conception of the experimental design. 12 pp. Ref. (PB)

P-4941 Remarks at Conference on Directions in Health Economics Regarding Research on Health Insurance and Biomedical Research and Development. J. P. Newhouse. January 1973.
Comments on significant research opportunities for economists: (1) Why does health insurance cover minor costs better than major ones--why comparatively low upper limits? (2) What is the effect of methods of reimbursing providers of medical care? (3) market structure problems, (4) difficulties in measuring elasticity of demand, (5) understanding health stock loss, (6) effects of price schedules, (7) marginal prices. Turning to R&D, development is defined as improving a product along existing quantifiable dimensions, and research as introducing new products (new dimensions). (8) Has reimbursement insurance reduced development in cost reduction? (9) What is the tradeoff between expenditure and speed of development? (10) What is optimal patent policy? (11) Optimal size and distribution of research firms and researchers? (12) Incentives for efficiency? (13) Optimal length of support--what is the trade-off between the greater responsiveness and control obtained with shorter periods, vs. greater insecurity and nonproductive times writing proposals? 6 pp. Ref. (MW)

P-4943 Performance of Partially Sighted with RANDSIGHT I Equipped with an X-Y Platform. S. Genensky, H. L. Moshin, H. E. Petersen. January 1973.
A test is described which has been used to determine how well a partially sighted subject can read and write with the help of the closed circuit TV system, RANDSIGHT I. The procedure is designed to build up the subject's confidence in himself by emphasizing how much he can see and how much he can accomplish with his residual vision. Over 120 subjects have been tested and the results are given for 81 of them. 35 pp. Ref. (Author)

P-4954 Activity Analysis and Cost Analysis in Medical Schools. J. E. Koehler, R. L. Slighton. February 1973.
In circumstances of joint production, there is no unique answer to the question of what an ongoing program costs. One can only speak of "pure" and "joint" program costs, the sum of pure costs being less than the total cost and the sum of pure and joint costs being more than total cost. However, if the policy question is whether a new program is worth doing, the appropriate cost concept is the sum of pure and joint costs. If the policy question is whether an ongoing program is paying for itself, the appropriate cost concept is pure cost. Whether the institution is paying for itself, however, is not implied in the answers to the questions concerning individual program costs. A major modification of classical cost accounting procedures is required to obtain appropriate cost estimates. Activity analysis models could provide the basis for such estimates if constructed to capture the phenomenon of joint production. The input-output model does not. 39 pp. Ref. (Author)

P-4965 Medical Computing--Cons and Pros. T. L. Lincoln. February 1973.
This paper examines some of the pitfalls encountered in introducing computing technology into the health care system. At present each institution entering the field rediscovers the same problems, and many of the same solutions. Although there is both a major centralized source of funds for medical computing work and a master plan, a key function is lacking--a medical computer design center. Such a center would be concerned with standards and specification of system performance. It would identify systems now in operation and analyze their reasons for success or failure. Also, it would increase the effectiveness of proposals for investigating and developing grants by establishing formalities and specifications for proposals. By setting up a proposal system based on engineering design specification, the center should be able to separate feasible from infeasible proposals and also, through the proposal process itself, give further substance to proposals. 39 pp. Ref. (DGS)

P-4969 BIOMOD Simulation of Pharmacokinetics for Leukemia Chemotherapy. T. L. Lincoln, P. A. Harris, J. F. Gross. March 1973.
Describes how the Bischoff and Dedrick compartment model of the blood and body organ systems, programmed in BIOMOD (R-747-NIH), predicts the distribution of drugs within the body as a function of time. This is crucial in leukemia chemotherapy, where the aim is to kill the cancer cells in the bone marrow with minimal injury to the patient's normal cell types. The model parameters are blood flow through the body compartments, tissue volumes, and

drug metabolism within the compartments. The only programming required, using BIOMOD, is to enter the appropriate differential equations and parameter values representing the animal in question (including man) and the drug characteristics of metabolism. Drug concentrations in blood plasma and organs can be graphically displayed. Changes in dosage, method of administration, and parameter values can be explored interactively. The model has accurately predicted concentrations of drugs other than those used in model design, in animals on which it was not calibrated. Such models offer a useful tool for predicting drug levels in man and in designing therapeutic strategies. 21 pp. Ref. (MW)

P-5000 Effects of Morphology and Structural Properties on Microvascular Hemodynamics. J. F. Gross, M. Intaglietta. April 1973.

Uses detailed microvascular data for certain animal tissues to specify the components of the network model of the blood microcirculation presented in P-4636. Quantitative morphological information on the rabbit omentum, cat mesentery, cat tenuissimus muscle, bat wing, and rat cremaster muscle was used to calculate the hydraulic resistance and compliance of the microvessels, to determine the decay of pulsatile pressure. Results are presented graphically. In most capillary networks, the pulsatile pressure amplitude is shown to be highly damped before it reaches the mid-capillaries. (Presented at the Seventh International Conference on Microcirculation, Aberdeen, Scotland, August 1972.) 11 pp. Ref. (MW)

P-5021-2 Non-Monetary Factors in the Demand for Medical Services: Some Empirical Evidence. J. P. Acton. November 1974.

A discussion of the effects of travel time (as measured by distance) in determining demand for medical care as money-cost-to-patient falls because of increasing insurance coverage or availability of subsidized care. A model of demand for medical services is developed that includes a payment in money and time for private care. Predictions are then tested on a cross-sectional survey of about 2600 users of out-patient departments in New York City. The study supports the prediction that travel time functions as a price in determining demand for free medical services, and that free-care demand is more sensitive to time-price changes than non-free-care demand. Two important policy implications emerge: (1) Improving transportation, locating clinics closer, or establishing satellite clinics around central facilities are viable means of increasing access to care. (2) If it is desirable to increase health consumption of target groups, income subsidies may be as effective as direct provision of services in achieving the goal. (For the Journal of Political Economy.) 31 pp. Bibliog. (GDS)

P-5024 Modeling and Evaluation of the Health Care Delivery System. M. A. Dade. May 1973.

A master's thesis in management, presenting a methodology for evaluating existing and possible future modes of delivery of health care in the U.S. A systems approach is taken, in contrast to the usual fragmented studies. Health is defined as "a state of complete physical, mental, and social well-being." The study describes the present health care delivery system, defining the key elements and their interactions and identifying inherent problems; defines a methodology for evaluating alternatives by conceptualizing the objectives and formulating effectiveness criteria; and applies this methodology to evaluate the traditional fee-for-service system and a prepaid Health Maintenance Organization mode. Methods of reducing measurement errors are given. In constructing indices, each alternative is described by a vector of independent measures, and certain techniques of Raiffa are described for reducing this vector and assessing a value index for each alternative. Practical problems of data collection are discussed, with suggestions for future research. 94 pp. Ref. (MW)

P-5082 Tables for Calculation of Nominal Standard Dose for Complex Treatment Schedules. H. M. Phelps, C. E. Phelps. April 1974.

Tables with instructions and examples are presented which allow calculation of NSD values for complex treatment schedules with gaps or changes in fractionation pattern. These are based on a previously derived formula and eliminate the need for a computer. 15 pp. Ref. (Author)

P-5150 Economic Implications of Changes in Financing Medical Education. J. E. Koehler, A. P. Williams, Jr. December 1973.

To increase the supply of doctors, the government has become directly involved in physician education. Of the $673 million appropriated for health manpower programs in 1972, 55 percent was for medical schools. Legislation to date has emphasized expansion of medical education output in the aggregate, but increasing attention has been directed to the composition of the output with regard to the

type and location of practice and to the equality of educational opportunity for ethnic minorities and women. This paper examines changes that have occurred in the medical education system concurrently with the growth of federal programs designed to influence that system's output. The data indicate that the system has responded very favorably. Capacity is expanding rapidly, discrimination against women has apparently disappeared, medical schools are seeking out and admitting qualified individuals from minority groups, and financial barriers to medical education have been lowered. 19 pp. (ETS)

P-5181 A Data Management System Evaluation for the Health Insurance Study. B. Yormark, D. H. Stewart. November 1973.

In this paper, the authors encapsulate and formalize the thinking and processes involved in selecting a data management system for the Health Insurance Study. The types of information processed, its sources and quantities are discussed, together with a number of key decisions affecting the decision to employ general-purpose commercially available software. The HIS design philosophy is described relative to several general categories of systems on the market. Other areas covered are: the problems of reviewing software packages; the development of data management analysis; the actual process of collecting information on data management systems; and the analysis performed to determine a classification and a functional usefulness score for each system. Candidate systems that the evaluation process showed to be of interest were subjected to a final evaluation that resulted in a recommended software acquisition. The configuration and purpose of the proposed software are presented. 60 pp. Biblioq. (See also R-965.) (DGS)

P-5185 Applications of Computers in Health Care Delivery: An Overview and Research Agenda. G. F. Groner, N. A. Talley, M. A. Rockwell, D. H. Stewart. February 1974.

This paper hypothesizes that computer technology has not yet been widely applied in health care delivery even though it could favorably influence the cost, accessibility and quality of health care. It summarizes the current status of computer applications in physiological monitoring, diagnostic aids, medical record data systems, clinical laboratory automation systems, multiphasic screening systems and hospital information systems; reviews current research on automated aids for clinical decisionmaking; and summarizes critiques dealing with attempts to use computers in health care. It concludes by outlining some important areas of research that might facilitate the rate and extent to which computer technology will be applied in health care. They deal with economic issues (evidence of cost-effectiveness; large facility and equipment investments; issues posed by regional computer systems); public policy issues (information privacy, security and integrity; standards for health care information systems) and technologic issues (medical data bases; automated aids for medical decisionmaking). (Written for a proposal to the Bureau of Health Resources Development, DHEW.) 53 pp. Ref. (Author)

P-5229 A Design for Information Processing in the Health Insurance Study. D. H. Stewart. September 1974.

The Health Insurance Study is a complex multi-year longitudinal study of the role of health insurance in the utilization of health care services. The information system being developed to facilitate this research is reviewed. A number of key design considerations are discussed and outstanding information science problems are outlined. (Accepted for presentation at the Annual Conference of the American Society for Information Processing in October 1974.) 24 pp. Ref. (Author)

P-5232 The Service Syndrome: A Book Review of Mental Health on the Campus: A Field Study. R. K. Yin. April 1974.

Discussion of mental health services offered by seven college campuses during the period 1971-1972. The colleges included a variety of institutions in terms of geographic location, enrollment, curriculum, and financial resources. Each program studied generally had a formal mental health service, a less formal counseling service, student-operated services, and special programs on topics such as sex education. Part I describes contemporary student populations and general characteristics of the seven programs; Part II is comprised of individual presentations of the seven programs. Although the cataloging effort gives the reader a sense of the range and nature of services, utilization rates for one year, and type of professional personnel engaged in the services, the book does not analyze the success of these seven exemplary cases. (Paper prepared for publication in Contemporary Sociology.) 3 pp. (KB)

P-5238 Serving the Deaf-Blind Population: Planning for 1980. J. D. Brewer, J. S. Kakalik. May 1974.

The rubella epidemic of the mid-1960's

has contributed to a much larger than average cohort of deaf-blind children. As they progress upward in age, some very major problems will occur in responding to their needs. Today's fragmented service system suffers from underdeveloped prevention services; lack of information on effective planning; and failure to mobilize far enough in advance to meet known future needs of the deaf-blind handicapped population. In this paper, the authors discuss (1) the planning required to meet the needs of young deaf-blind persons in 1980; (2) the need for information about and control of the service system; (3) the need to improve identification programs, especially for older deaf-blind persons; (4) the humanitarian and economic desirability of prevention; (5) the probable size of the young deaf-blind population in 1980 and the cost of serving it. 19 pp. (See also R-1220, R-1420.) (DGS)

P-5281 The Numerical Solution of Exponential Equations. T. A. Brown. August 1974.
A procedure for finding the least positive root of exponential equations of a form arising in Don Perkel's study of neuron firing subject to inhibitory and excitatory stimulation. Because the solution would be a small part of a Monte Carlo routine, it had to be fast and not fail even in rare circumstances. The chosen method involves fitting a certain curve with a cubic and another with a parabola. The well-annotated JOSS program is appended. 13 pp. (Author)

P-5304 Serving Handicapped Children: The Road Ahead. G. D. Brewer, J. S. Kakalik. August 1974.
A brief overview of Rand's findings and recommendations. Over 50 major Federal programs and hundreds of state and local programs spend $4.7 billion annually serving mentally and physically handicapped Americans aged 0 to 21, yet only 3% goes for prevention, identification, and direction, which have the highest social payoff. Many of the 9 million eligibles receive no services, others an unpredictable melange, due to complete lack of coordination. Many handicapping conditions can be cured if treated in the child's first years. Yet there is no system for screening children for potentially handicapping conditions; over half the children do not even receive a hearing or vision test upon entering school. Half the children who need sensory aids lack them, while some are fitted with sensory aids without a prior medical examination. While early identification and treatment would greatly reduce the handicapped population, there remains a need for vocational habilitation, and the most unfortunate subset will require income maintenance. (Presented at Child Welfare League Executives Conference, August 1974; based on R-1220 and R-1420.) 13 pp. (MW)

P-5309 On Becoming Partially Sighted: A Personal Account of Loss of Sight. W. D. Putnam. October 1974.
As the title indicates, this is the personal history of a Rand researcher's partial loss of vision--below the level of legal blindness--caused by histoplasmosis and retinal hemorrhaging. It describes the adjustments he has made to drastic loss of vision, including the use of RANDSIGHT for reading. Although able to read at only some 100 words per minute instead of his former 5-600, Putnam can read for up to two hours at a time with RANDSIGHT. It is extremely difficult for the partially sighted to convey to the sighted exactly what they can and cannot see; this paper may be of some help to those who deal with the partially sighted, as well as to those confronted with a drastic loss of vision. 29 pp. (MW)

P-5348 Face Perception: A Review of Experiments with Infants, Normal Adults, and Brain-Injured Persons. R. K. Yin. February 1975.
A chapter for the Perception volume of the Handbook of Sensory Physiology, reviewing experimental literature relevant to the question of whether people recognize human faces differently from the method of recognizing other meaningful objects. Research on infants' perception suggests the possibility of a special face recognition ability, but is not yet conclusive. The few studies comparing face with object recognition in adults and children suggest that a holistic strategy may be used for recognizing faces. Recognition of normally oriented faces is superior to recognition of other meaningful objects, but recognition under distorted conditions is inferior. When denied the opportunity to use a holistic/social coding strategy, as by schematic or artificial reproductions, subjects may fall back on the feature analysis strategy they use for other objects. A special deficit in face recognition (prosopagnosia) is found among some brain-injured patients; persons with injuries to the right hemisphere of the brain have special difficulty recognizing faces. Suggestions for future research are given. 30 pp. Ref. (MW)

P-5376 The University of Texas Dental Branch Clinical Encounter System. R. Bretz. February 1975.

Describes and explains the independent-access Clinical Encounter Simulator used at the innovative University of Texas Dental Branch in Houston. Based upon a unique three-dimensional intraoral camera and still-picture storage on video disc, it gives individualized practice in clinical decisionmaking by showing stereo images of a step in a dental process, letting the student judge whether it has been correctly executed, and if not, what revision is required before the next step can be taken. The student is then shown on split-screen the original picture and a view of the appearance when the work has been properly done. The student compares and revises his judgment, if indicated. This is repeated throughout the exercise, giving the student 60 times as many decisions to make, with immediate feedback, as conventional laboratory work provides in the same length of time. The advanced student is also given information about the patient's needs and condition; tactile and olfactory information is described. For each procedure, the system generates many programs, each with 50% random errors. Flowcharts are included. 13 pp. (Invited article for A Systems Approach to Learning Environments, edited by Philip D. Sleeman and Suleiman D. Zalatino.) (MW)

P-5387 Health Manpower: California Trends and Policy Issues. A. J. Lipson. February 1975.

Discusses major Rand findings and recommendations concerning health personnel (R-1572). No consensus exists on how to measure health personnel requirements, since we lack adequate measures of how health care services affect health. Unlike other states, California uses few foreign medical graduates--it retains its own and attracts those of other states. However, three areas are "physician poor": Bakersfield, Imperial Valley, and San Joaquin Valley. The numbers of RNs and LVNs have increased substantially, but the supply/demand ratio fluctuates erratically. California's Nurse Practitioner training programs were undermined by the Board of Medical Examiners, which telegraphed the medical school deans to stop training nurse practitioners. Licensure issues are discussed. Implementing a Rand recommendation, the Office of Planning and Intergovernmental Relations was established under the State Health Director. Rand also recommended appointing public representatives to develop and updata a unified health sciences education plan responsive to societal needs. (Presented at Regional Health Manpower Conference, Los Angeles, January 1975.) 12 pp. (MW)

P-5398 CCU Design, Staffing, and Operating Policies. H. E. Blumen. March 1975.

Describes the equipment, staffing, and operating policies of 96 Coronary Care Units (CCUs) in California that participated in a study for the California Committee on Regional Medical Programs (CCRMP) on the effect of CCUs on the treatment of patients with acute myocardial infarction. Elaborate equipment for patient monitoring and resuscitation accounts in part for the fact that the average daily charge for care in a CCU is over twice the average daily charge for care in a semi-private room. In 64 percent of the hospitals in the study, there is always a physician on call, but in only 8 percent is there always a physician in the CCU. The nursing staff consists predominantly of RNs, with LVNs and Nurses' Aides on duty in some CCUs. Responsibility for administering drugs and performing emergency procedures has been delegated to the nursing staff in most CCUs. 14 pp. (JR)

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	P-3057	610 580	1.50	
	P-3128	615 168	1.50	
	P-3194	619 704	3.00	
	P-3196-1	633 860	5.00	
	P-3228	621 318	1.50	
	P-3230-1	626 436	3.00	
	P-3254	623 671	7.00	
	P-3300	627 312	5.00	

Quantity	Publication	AD Number*	Cost**	Total Cost
	P-3368-1	688 542	1.50	
	P-3496	645 317	1.50	
	P-3523	651 417	1.50	
	P-3524	646 966	1.50	
	P-3584	651 107	1.50	
	P-3588	651 766	1.50	
	P-3613	654 637	3.00	
	P-3659	662 006	1.50	
	P-3672	662 334	3.00	
	P-3682	660 102	1.50	
	P-3743	664 543	3.00	
	P-3747	665 453	3.00	
	P-3786	665 962	3.00	
	P-3799	666 017	1.50	
	P-3827	668 070	1.50	
	P-3862-1	670 259	5.00	
	P-3868	673 916	7.00	
	P-3872	671 646	1.50	
	P-3898	673 334	1.50	
	P-3906	673 338	1.50	
	P-3931	676 965	1.50	
	P-3945	690 838	3.00	
	P-3947	676 638	1.50	
	P-3952	676 966	1.50	
	P-3969		1.50	
	P-3980	679 984	3.00	
	P-3984	679 526	1.50	
	P-3988	681 492	3.00	
	P-4011-2	684 031	3.00	
	P-4016	681 110	1.50	
	P-4019	682 952	1.50	
	P-4022	682 499	1.50	
	P-4056-1	694 381	5.00	
	P-4068-1	PB 188 302	1.50	

Quantity	Publication	AD Number*	Cost**	Total Cost
	P-4069	686 724	5.00	
	P-4074	687 399	1.50	
	P-4075	687 213	3.00	
	P-4080-1	694 577	1.50	
	P-4087	687 834	1.50	
	P-4090	687 615	1.50	
	P-4104	693 922	1.50	
	P-4136	690 274	1.50	
	P-4147		1.50	
	P-4200	699 581	1.50	
	P-4207	695 283	3.00	
	P-4218	696 803	1.50	
	P-4253	698 146	5.00	
	P-4254	698 186	1.50	
	P-4267-1	704 723	3.00	
	P-4272	699 537	1.50	
	P-4274-1	703 165	3.00	
	P-4279-1	701 616	1.50	
	P-4280	701 997	1.50	
	P-4298	706 963	5.00	
	P-4304	702 671	1.50	
	P-4312	702 620	1.50	
	P-4325	704 348	3.00	
	P-4337	708 427	3.00	
	P-4343	704 236	1.50	
	P-4388	708 307	1.50	
	P-4390		1.50	
	P-4397	712 694	1.50	
	P-4398	708 815	3.00	
	P-4406	709 308	1.50	
	P-4410	711 034	3.00	
	P-4414	710 586	1.50	
	P-4458-1	712 845	3.00	
	P-4463	712 850	1.50	

Quantity	Publication	AD Number*	Cost**	Total Cost
	P-4465	713 901	1.50	
	P-4469	713 427	1.50	
	P-4478-2	(basic) 713 943	3.00	
	P-4485	713 945	3.00	
	P-4503		1.50	
	P-4516		1.50	
	P-4537		5.00	
	P-4538		7.00	
	P-4560		1.50	
	P-4575		1.50	
	P-4617		3.00	
	P-4619		3.00	
	P-4623		1.50	
	P-4635		1.50	
	P-4636		1.50	
	P-4646		1.50	
	P-4688		1.50	
	P-4698		1.50	
	P-4704		1.50	
	P-4718		5.00	
	P-4731		1.50	
	P-4736		1.50	
	P-4766		3.00	
	P-4771		1.50	
	P-4773		1.50	
	P-4774		1.50	
	P-4775		1.50	
	P-4785		1.50	
	P-4788		1.50	
	P-4790		1.50	
	P-4796		3.00	
	P-4799		7.00	
	P-4804		1.50	
	P-4812-1		3.00	

Quantity	Publication	AD Number*	Cost**	Total Cost
	P-4846-1		1.50	
	P-4849		1.50	
	P-4864		1.50	
	P-4892		1.50	
	P-4941		1.50	
	P-4943		3.00	
	P-4954		3.00	
	P-4969		1.50	
	P-5000		1.50	
	P-5021-2		3.00	
	P-5024		5.00	
	P-5082		1.50	
	P-5150		1.50	
	P-5181		5.00	
	P-5185		5.00	
	P-5229		1.50	
	P-5232		1.50	
	P-5238		1.50	
	P-5281		1.50	
	P-5304		1.50	
	P-5309		3.00	
	P-5348		3.00	
	P-537[illegible]		1.50	
	P-5387		1.50	
	P-5398		1.50	

Cobe

Second Quarter Report June 30, 1975

To Our Stockholders and Employees:

Our growth at Cobe Laboratories has continued this year with sharply higher sales and earnings for both the first six months and second quarter over a year ago.

Consolidated sales for the six months ended June 30 were $10,409,000 compared to $7,607,000 last year, an increase of 36.8 percent. Net earnings advanced 42 percent to $707,000, or 72 cents a share, from $498,000, or 53 cents a share.

Second quarter consolidated sales increased 39.7 percent to $5,580,000 from $3,994,000 a year ago. Net earnings rose 53.9 percent to $391,000, or 39 cents a share, from $254,000, or 27 cents a share.

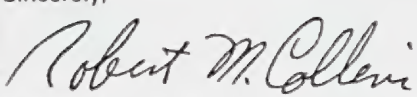
During the second quarter, ground was broken for a 50,000-square foot addition to our Lakewood, Colorado, headquarters facility to accommodate increased volume. The Company also started shipments of the new Centry® 2 dialysis machine, and was heartened by the excellent reception accorded the new unit.

As previously reported, introduction of the Cobe hollow fiber dialyzer has been limited to selected patients and dialysis centers due to adverse reactions sustained by three patients with histories of asthma. We have continued investigations of the dialyzer since then, and clinical efficacy validation studies have been completed. We are now adding carefully screened patients with no history of asthma to expand dialyzer usage.

We have continued to make good progress in increasing our share of the cardiopulmonary market both here in the U.S. and abroad through our Optiflo® oxygenator.

Randall F. Bellows, Vice President of the firm, is moving to Brussels in August to lead our foreign marketing thrust and build Cobe's organization to serve the Common Market.

Sincerely,



Robert M. Collins
President

Consolidated Statements of Net Earnings (Unaudited)

	Three Months Ended June 30		Six Months Ended June 30	
	1975	1974	1975	1974
Net Sales	$5,580,000	$3,994,000	$10,409,000	$7,607,000
Cost of Sales	3,055,000	2,108,000	5,786,000	4,079,000
Gross Profit	2,525,000	1,886,000	4,623,000	3,528,000
Expenses				
Research & Development	352,000	365,000	652,000	717,000
Selling	831,000	632,000	1,547,000	1,108,000
General & Administrative	557,000	400,000	1,005,000	753,000
Interest	32,000	22,000	60,000	51,000
	1,772,000	1,419,000	3,264,000	2,629,000
Operating Earnings	753,000	467,000	1,359,000	899,000
Other Income	7,000	8,000	15,000	36,000
Earnings Before Income Taxes	760,000	475,000	1,374,000	935,000
Provision for Federal & State Income Taxes	369,000	221,000	667,000	437,000
Net Earnings	391,000	254,000	707,000	498,000
Earnings Per Common & Common Equivalent Share	$.39	$.27	$.72	$.53
Weighted Average Common & Common Equivalent Shares Outstanding	991,000	957,000	986,000	944,000

Consolidated Balance Sheet

(Unaudited) JUNE 30, 1975

Assets	
Current Assets:	
Cash	$ 662,000
Accounts receivable - net	4,198,000
Inventories	4,264,000
Prepaid expenses	107,000
Total Current Assets	9,231,000
Property, Plant and Equipment - net	2,849,000
Other Assets	702,000
	$12,782,000

Liabilities and Stockholders' Investment	
Current Liabilities:	
Current maturities on long-term debt and short-term notes payable	$ 1,520,000
Trade accounts payable	927,000
Accrued salaries, wages and commissions	353,000
Other accrued expenses	330,000
Federal and State income taxes	172,000
Total Current Liabilities	3,302,000
Long-term Debt	563,000
Stockholders' Investment:	
Common stock	4,889,000
Retained earnings	4,028,000
	8,917,000
	$12,782,000

Cobe Laboratories maintains three Domestic Distribution Centers in addition to the Lakewood facility. Shown here is the new Cobe Central facility in Chicago. The other centers are located in Fremont, California and Glen Burnie, Maryland.

Cobe Laboratories, Inc.
1201 Oak Street, Lakewood, Colorado 80215
(303) 232-6800

Box 38
Keystone, Colorado 80435
303 468-5822

Keystone Center for Continuing Education

December 10, 1975

Dr. Clay T. Whitehead
1250 28th St., N.W.
Washington, D.C. 20007

Dear Tom:

I believe I said I'd send you the Cobe material. I'll be glad to get more data if you are interested.

As ever,

Bob

RWC/plb
Encl.

P.S. You may want to visit (from the capital resources point of view) my friend Robert Richards who is former Sr. V.P. Fremont-McKesson and Pres. F-M Int'l Drug Div. Bob is very interested in developing an integrated medical (small) company framework, including the likes of Cobe!

Cobe

First Quarter Report March 31, 1975

To Our Stockholders and Employees:

Cobe's growth continued during the first quarter of 1975. Consolidated sales and net earnings for the period ended March 31 were $4,829,000 and $316,000, respectively, compared to $3,613,000 and $244,000 in 1974. This represents an increase of 33 percent in sales and 30 percent in earnings. Earnings per share were 32 cents compared to 26 cents last year.

In late March, we initiated the controlled market introduction of our Centry® 2 machine and hollow fiber dialyzer. During the second quarter, we will gradually expand the number of customers served as clinical validation is completed and production is scaled up. The Centry® 2 System was introduced at the American Society of Artificial Internal Organs convention in mid-April and received an enthusiastic reception. We believe this second generation hemodialysis system will have a favorable impact on Cobe's market position.

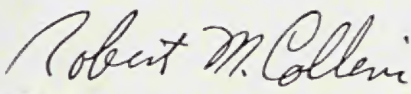
As previously reported, Cobe and Abcor, Inc., brought suit on March 10 in the United States District Court for Delaware against Dow Chemical Company, Cordis-Dow Corporation, and the Regents of University of Minnesota, seeking a declaratory judgment that certain patents relating to the use of hollow fiber dialyzer units as artificial kidneys, among other things, are invalid and not infringed by Cobe's HF 130 dialyzer. This action was filed to seek a judicial declaration to that effect.

We continued to make excellent sales progress in the cardiopulmonary field, gaining additional market share with our Optiflo® oxygenator.

During the first quarter, we upgraded our cardiopulmonary manufacturing team and added a Systems Development Manager and Accounts Receivable Manager. The team approach to planning our two market areas was further refined through establishment of therapy management committees.

The balance of 1975 promises to be very exciting for Cobe. Strong emphasis will be placed on developing manufacturing capacity for the Centry® 2 System products, maintaining product quality, and continued building of our international organization. We are confident that our Management will deal effectively with these challenges.

Sincerely,



Robert M. Collins
President

Consolidated Statements of Net Earnings (Unaudited)

	Three Months Ended March 31	
	1975	1974
Net Sales	$4,829,000	$3,613,000
Cost of Sales	2,731,000	1,971,000
Gross Profit	2,098,000	1,642,000
Expenses:		
Research & Development	300,000	352,000
Selling	716,000	476,000
General & Administrative	448,000	353,000
Interest	28,000	29,000
	1,492,000	1,210,000
Operating Earnings	606,000	432,000
Other Income	8,000	28,000
Earnings Before Income Taxes	614,000	460,000
Provision for Federal & State Income Taxes	298,000	216,000
Net Earnings	$ 316,000	$ 244,000
Earnings Per Common & Common Equivalent Share	$ .32	$ .26
Weighted Average Common & Common Equivalent Shares Outstanding	980,000	928,000

Consolidated Balance Sheet

(Unaudited) March 31, 1975

Assets	
Current Assets:	
Cash	$ 555,000
Accounts receivable - net	3,928,000
Inventories	3,807,000
Prepaid expenses	53,000
Total Current Assets	8,343,000
Property, Plant and Equipment - Net	2,762,000
Other Assets	769,000
	$11,874,000

Liabilities and Stockholders' Investment	
Current Liabilities:	
Current maturities on long-term debt and short-term notes payable	$ 620,000
Trade accounts payable	1,031,000
Accrued salaries, wages and commissions	390,000
Other accrued expenses	242,000
Federal and State income taxes	487,000
Total Current Liabilities	2,770,000
Long-Term Debt	630,000
Stockholders' Investment:	
Common Stock	4,838,000
Retained earnings	3,636,000
	8,474,000
	$11,874,000

The fully integrated Centry® 2 System with blood pump, heparin pump, air bubble detector, HF 130 hollow fiber dialyzer and specially designed blood tubing set. The system has the advantage of a direct read-out for fluid rate removal, among other benefits.

Cobe Laboratories, Inc.
1201 Oak Street, Lakewood, Colorado 80215
(303) 232-6800

Cobe/1974

Annual Report

The Company

Cobe Laboratories, Inc., develops, manufactures and markets therapeutic systems, devices, instruments and supplies for use in the treatment of kidney disease (hemodialysis) and products for use in open heart surgery (cardiopulmonary). Both therapy markets involve a similar technology of transporting and treating blood in the extracorporeal circuit.

The Company's principal hemodialysis product is the Centry® system, which is comprised of an electronic monitoring and dialysate control unit, pumps, blood lines, chemical and related supplies. Cardiopulmonary products include the OptiFlo® oxygenator, cardiotomy reservoir, disposable tubing packs, filters and accessory products used as a life support system during open heart surgery.

The Company sells directly to customers in the U.S., Canada and certain Western European countries through its own sales personnel, and through distributors in other parts of the world. Cobe products are distributed from the main facility in Lakewood, Colorado, distribution facilities in California, Illinois and Maryland, and through distribution subsidiaries in Belgium and West Germany.

Contents

1 Financial Highlights

	1974	1973	PERCENT INCREASE	FOURTH QUARTER 1974	FOURTH QUARTER 1973
Net Sales	$16,755,000	$11,261,000	48	$4,765,000	$3,098,000
Gross Profit	7,445,000	5,204,000	43	2,057,000	1,397,000
Operating Earnings	1,952,000	1,274,000	53	588,000	315,000
Earnings Before Income Taxes	1,991,000	1,404,000	42	590,000	348,000
Net Earnings	1,006,000	747,000	35	285,000	187,000
Earnings Per Share	$1.06	$.80	33	$.30	$.20
Weighted Average Common and Common Equivalent Shares Outstanding	952,000	936,000	2	963,000	933,000

See complete financial information and related notes on pages 18 through 28.

FORM 10-K

The Company's complete Form 10-K (excluding exhibits) for the fiscal year ended December 31, 1974, filed with the Securities and Exchange Commission, is available to stockholders without charge upon written request. Please direct your request to Wendell J, Gardner, Treasurer, Cobe Laboratories, Inc., 1201 Oak Street, Lakewood, Colorado 80215.

Annual Meeting

The annual meeting of stockholders will be held on Wednesday, April 30, 1975 at 10 a.m. at the United Bank of Denver, Forum Room, 17th and Broadway, Denver, Colorado. Proxy materials and a notice of the meeting are included in the mailing of this report addressed to stockholders of record.

Trading

The common stock of Cobe Laboratories, Inc. is traded Over-the-Counter and quoted on NASDAQ as "COBE." See page 28 for common stock bid prices.

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President's Letter

To Our Stockholders and Employees:

Your Company's 10th anniversary was another year of progress. In 1974 we achieved a 48 percent sales increase to $16,755,000 from $11,261,000 in 1973. Net earnings were $1,006,000 compared to $747,000 in 1973, a rise of 35 percent, and earnings per share advanced to $1.06 from $.80.

The logic of our therapy marketing specialization concept was supported by the 112 percent increase in cardiopulmonary product line sales over 1973. During 1974, we moved significantly forward in the development of our cardiopulmonary product line by adding the Galen OptiFlo® oxygenator and Cobe-developed new products.

Hemodialysis product line sales increased 34 percent last year over 1973. Strong sales of our established hemodialysis products enabled us to push forward development of a hollow fiber dialyzer and second generation hemodialyzer control unit (Centry®). Both of these products, which combine to form the Centry® 2 System, began clinical validation tests in the last half of the year. Cobe committed heavily in Research and Development resources to these products.

Considerable achievements were made in expanding services to our two world growth markets. Although covered in detail in the report that follows, the highlights are:

STAFF DEVELOPMENT - We added a number of experienced managers and professionals, among them Hillard P. Tavrow, Director of Manufacturing complementing our capable team.

ORGANIZATIONAL DEVELOPMENT - During the year we developed more fully the organization to bring a sharp focus on the two markets we serve, restructuring our manufacturing and marketing groups.

CUSTOMER SERVICE - To improve services to customers in the midwest, we laid plans for a new distribution center in the Chicago area which opened in February 1975. Also, a subsidiary was established in Munich, Germany to provide direct distribution and sales service to the German market.

MANUFACTURING - Acquiring Galen Laboratories, Inc., not only provided us with a product but gave us additional manufacturing capability. We also obtained under a license agreement with Abcor, Inc., hollow fiber dialyzer manufacturing expertise and rights.

PRODUCTIVITY IMPROVEMENTS-Higher overall productivity was demonstrated by a sales volume increase of 48 percent while total employees rose only 24 percent to 435 from 350 in 1973. This success was shared with employees through deferred and cash profit sharing programs with $235,000 being contributed in 1974 compared to $12,000 in 1973.

Coping with inflation turned out to be more difficult than anticipated. Labor, material and other costs rose faster than could be offset by productivity gains combined with increased prices. As a result, our gross profit slipped to 44.4 percent from 46.2 percent in 1973. A fourth-quarter price increase aided a gross profit improvement in that quarter from the third quarter.

Cobe's future appears most encouraging. We anticipate that 1975 will be a year of continued building in our two therapy markets. We face the challenge of launching the hollow fiber dialyzer and Centry® 2 during the first half of the year. This will incur start-up costs which will impact on earnings, but will provide a very sound product line in the world hemodialysis market. With the success of these products, we believe 1975 will be another year of significant growth in sales and earnings.

Robert M Collins

Robert M. Collins,
President

4/5

Research and Development Expenditures Increased to $1.4 Million or by 72 percent.

During the past year, Cobe's research and development expenditures were increased to $1,414,000 from $823,000 in 1973, or 72 percent. We presently are conducting research on dialyzers (artificial kidneys), hemodialysis equipment and supplies and cardiopulmonary products.

HEMODIALYSIS

We have been developing a hollow fiber dialyzer since 1971 and last year acquired certain manufacturing expertise and marketing rights from Abcor, Inc. to speed the development process. The Abcor dialyzer, developed further by Cobe, has undergone extensive clinical use. The configuration of our dialyzer utilizes the Abcor manufacturing process with cuprophan hollow fiber membrane. Cuprophan, in sheet form, is used in nearly all coil and flat sheet dialyzers and only recently became available in the form of a hollow fiber from its West German manufacturer.

We believe our dialyzer offers significant advantages to the user. They include gas sterilization offering reduced set-up time, low blood volume, performance characteristics competitive with other dialyzers, plus a wide range of ultrafiltration capabilities for meeting individual therapy needs.

A competitor has notified Cobe that he has patents in the hollow fiber dialyzer field. We and our patent counsel have studied this situation carefully and are of the opinion that we do not infringe these patents.

Patient (left) adjusts Centry® 2 system in use at Artificial Kidney Foundation, Garden Grove, California.

(Center) The Cobe hollow fiber dialyzer to be introduced in April, 1975.

Reviewing features (right) of Centry® 2 system are Brian Morgan, Hollow Fiber Research Manager, Robert L. White, Centry® 2 Research Manager; and Ted A. Dale, Product Manager.

The dialyzer is being produced at our headquarters in Lakewood, Colorado and the production level is increasing on a continuing basis.

A second generation monitoring and delivery machine (Centry®) for hemodialysis has been in the developmental stage during the past three years. Our objective has been to integrate up to five pieces of hardware used in an operating unit into one. This objective has been achieved. The new Centry® 2 machine has completed clinical trials and the first production units are being validated in a number of clinics around the U.S.

Because it is an integrated unit, the Centry® 2 machine offers a much shorter set-up and clean-up time than competitive machines thereby reducing the total time that the patient and medical staff are involved with the dialysis procedure and reduces the training time required for the medical staff and patients. The Centry® 2 machine is compatible with all competitive enclosed single pass dialyzers. When used with the Cobe hollow fiber dialyzer and specially designed tubing sets (Centry 2 system) it permits fluid removal control by utilizing the machine's ultrafiltration control system and the wide range ultrafiltration capabilities of the Cobe hollow fiber dialyzer. This permits accurate and uniform removal of a predetermined amount of fluid over the dialysis period.

The Centry® 2 and hollow fiber dialyzer will be introduced to the hemodialysis market at the American Society of Artificial Internal Organs Convention in Washington, D.C. in April, 1975.

CARDIOPULMONARY

The cardiopulmonary research team devoted much of its time last year to refinements in the Galen OptiFlo® oxygenator and development of the cardiotomy reservoir. Further research is being performed on product improvements and the development of new products which we hope will enable Cobe to become a leader in providing products for use in open heart surgery.

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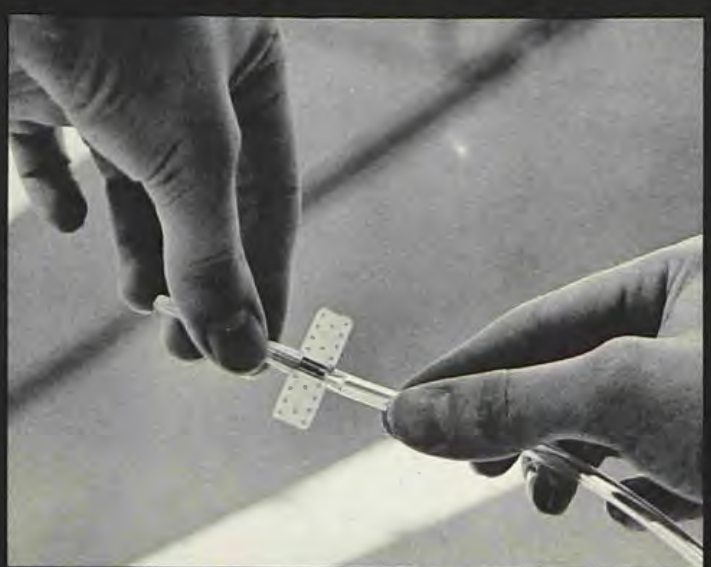
OptiFlo® Blood Oxygenator Most Significant New Product

CARDIOPULMONARY

The most significant new product introduced during 1974 was the OptiFlo® blood oxygenator used in open heart surgery. This product was obtained through the acquisition of Galen Laboratories. The oxygenator serves as an artificial lung to sustain the gas exchange processes during the period of time the heart and lungs are bypassed for surgical repair of the heart.

Cobe believes that the OptiFlo® oxygenator offers many significant advantages to the open heart surgery team, including convenience by reduced set-up time, a lower blood prime volume than many competitive oxygenators, and superior heat exchanger permitting lowering and raising of body temperature more rapidly than other disposable oxygenators.

We also completed development and introduced a cardiotomy reservoir used during open heart surgery. This product is the first cardiotomy reservoir to incorporate a small particle blood filter. The cardiotomy reservoir is used to recover and filter the patient's blood from the wound during the surgical procedure. Our cardiotomy system offers convenience in set-up and control together with superior filtration with the built-in Swank® dacron blood filter.



HEMODIALYSIS

We continued development and upgrading of Cobe disposable products used for hemodialysis. The Safeport℗ sample site introduced and incorporated into most of Cobe's kidney blood sets during 1974, replaces the rubber sleeve used for drawing blood samples. It is designed with a soft target for the needle stick which is mounted in a hard plastic case. This eliminates the possibility of puncturing one's hand and contracting hepatitis as can happen with the rubber sleeve.

Another new hemodialysis product is the VenaFlo℗ AVF access needle. This product is an extension of the Cobe line of arterial/venous access needles and offers both patient and nurse a wider choice of bevel and sharpness for ease of access to the patient's vascular system.

New Cobe disposable products used in hemodialysis (left to right) . . . VenaFlo™ AVF access needle and the Safeport™ sample site.

Cobe's new OptiFlo® (right) blood oxygenator employed in open heart surgery shown in inspection and during a surgical procedure.

8/9

Two Separate Marketing Forces Serve Hemodialysis, Cardiopulmonary Markets

SERVING THE CUSTOMER

To develop a high level of competence in a single therapy area, Cobe began in 1973 and completed last year the development of separate domestic sales and marketing forces to service hemodialysis and cardiopulmonary markets. Our Cobe market managers also began assuming marketing and product management responsibility on a world-wide basis.

We believe our sales personnel must possess a high level of technical knowledge and competence to service customer needs. Accordingly, the Company each year conducts three to four training seminars for salesmen. New sales representatives also receive in-house training prior to servicing customers.

In February 1975, a third U.S. distribution facility was opened in the Chicago area. Inventories of all products are maintained at all distribution centers in the U.S. to provide prompt deliveries to our customers. Each facility has its own order processing capability and is supported by the home office Customer Service and Distribution departments to insure a steady flow of products. We have continued to expand our equipment service capabilities and currently have five regional equipment servicemen supported by home office service personnel.

HEMODIALYSIS

The hemodialysis market continued its rapid growth last year. According to Social Security Administration figures at the end of 1974, 18,400 artificial kidney patients

Domestic customers are serviced from the home office and facilities in California, Illinois and Maryland.

Discussing performance characteristics of the OptiFlo® oxygenator are (left to right) Robert Steg, Cardiopulmonary technical representative; Donn D. Lobdell, PhD, Research Director; and William J. O'Connor, Cardiopulmonary Sales/Marketing Manager.

Hemodialysis marketing group includes (left to right) Edward J. Giachetti, Marketing Manager; Randall F. Bellows, Vice President/Marketing; and Lawrence J. Byrne, National Sales Manager.

were receiving medicare benefits under the program begun July 1, 1973 compared to 12,000 a year earlier. We estimate there are now approximately 19,500 patients in the United States and Canada, and the current market for equipment and supplies is $100 million annually. Our estimates indicate that this could double by 1978.

We believe our domestic market share is now about 10 percent. Lack of a disposable dialyzer has excluded Cobe from approximately 45 percent of the total market. If our new Centry® system, composed of the Centry® 2 machine, hollow fiber dialyzer and integrated blood sets (see Research and Development section), achieves the success we anticipate, we believe it will be possible to increase our market share beginning in 1976. With a dialyzer, Cobe's potential sales of supplies will be approximately $30-$40 per dialysis treatment which is performed three times weekly for most patients.

During the past three years, Cobe has provided its Hompac service to patients performing hemodialysis treatments at home. Hompac, operated from each of the regional distribution facilities, provides the patient with all supplies (including those not manufactured by Cobe) needed for hemodialysis.

To better serve these patients, we began accepting assignment of medicare payments in 1974. This has resulted in a larger number of home patients being served by Cobe. We believe these sales generally produce a lower profit margin because there is a greater exposure to bad debts on the portion not paid by Medicare and Medicare does not allow price increases on a current basis.

CARDIOPULMONARY

The cardiopulmonary market continued to expand last year and, according to Company estimates, there are presently about 100,000 open heart procedures performed annually in the United States and Canada. With the addition of the oxygenator and cardiotomy reservoir, Cobe now has a complete disposable therapy system for open heart surgery, and its potential sales per procedure is approximately $250-$300—nearly double the potential without these products.

Cobe estimates that the cardiopulmonary market advanced at a 15 percent rate in 1974 and will continue at this rate during 1975. We believe that our present share of the domestic cardiopulmonary market is about 15 percent.

INTERNATIONAL

Cobe international sales are achieved through its own direct sales force in Canada and certain European countries and the use of independent distributors.

Hemodialysis and cardiopulmonary products are sold in Germany, Netherlands, Belgium and France by employees of two foreign subsidiaries. The Belgian subsidiary was opened in 1973 and serves the Benelux countries and France, utilizing a public warehouse for storage and shipment of inventories.

Eugene S. Szollosi, International Director, meets with Teresa Shearer, administrative assistant.

(Far right) Cardiopulmonary sales training session for new representatives at Cobe's home office.

The German subsidiary, started last year, utilizes its own warehouse in Munich for warehousing, shipping and order processing. Both subsidiaries are supported by home office marketing, finance and research.

We now have 32 independent distributors selling hemodialysis and cardiopulmonary products on all continents. The distributor buys from Cobe at a price that is usually lower than the domestic hospital price and resells to hospitals, kidney centers and patients.

During 1974, Cobe's international sales grew at a 68 percent rate compared to an overall 48 percent and made up about 19 percent of total sales compared to 17 percent in 1973.

Sales By Therapy Markets

	1974	1973	1972	1971	1970
Hemodialysis	73%	81%	82%	82%	80%
Cardiopulmonary	27%	19%	18%	18%	20%
Total	100%	100%	100%	100%	100%

Restructured Manufacturing Better Serves Customer Needs

Cobe made considerable progress during 1974 in strengthening its manufacturing capabilities. Hillard P. Tavrow joined us last May as Director of Manufacturing. He brings to Cobe 20 years of experience in high technology manufacturing.

To better serve the needs of the customer and shorten the time required to move a new product from research to manufacturing, the manufacturing organization was restructured along therapy lines similar to marketing and research and development. This new structure is proving very successful and ecourages a team approach made up of manufacturing, marketing and research.

We had our share of problems during 1974. Material shortages and price increases had to be coped with. At the beginning of the year, petrochemical base materials were in short supply, and to insure a steady materials flow, we began stockpiling many items. Currently most materials seem to be available in adequate quantities and our stockpiles have been reduced, although certain items such as electromechanical parts continue to have very long lead times.

(Left) Thomas E. Jones, Quality Control Manager, reviews pyrogen test procedures in laboratory with Peggy J. Walline, manager of biological testing.

(Center) Robert B. Smith, left, General Manager of Galen Laboratories, checks finished OptiFlo® oxygenators with Production Manager George P. Messing at Galen's Santa Ana, California manufacturing facility.

(Far right) Hillard P. Tavrow, left, Director of Manufacturing, meets with Edward C. Wood, Jr., Hemodialysis Disposables Production Manager and Theodore Weaver, Electromechanical Production Manager.

The prices of nearly all raw materials increased significantly last year, and we expect this trend will continue in 1975.

We continue to place strong emphasis on the productivity of our workforce. In this regard, significant progress was clearly demonstrated by a 48 percent increase in volume last year compared to a 21 percent advance in the number of manufacturing and quality control personnel.

With the acquisition of Galen Laboratories in March, we began to integrate their activities and functions with those of Cobe. The Galen subsidiary, although operating as a completely separate entity, is now following many of Cobe's standards and procedures to insure high quality and reliable products.

Directors

Randall F. Bellows
Vice President of the Company

Robert M. Collins
President of the Company

Ted A. Dale
Product and Field Service Manager of the Company

Donald A. Faber
Senior Vice President of Charter Resources Corporation, engaged in Management Recruiting

H. Earl Ginn, M.D.
Chief, Nephrology Division, Vanderbilt Medical Center

Cobe Management (Left to right) Robert M. Collins, Randall F. Bellows, Wendell J. Gardner, Eugene S. Szollosi, Hillard P. Tavrow, Donn D. Lobdell.

Belmont Towbin
Partner of
C.E. Unterberg, Towbin Co.,
an Investment Banking firm

Charles P. Waite
General Partner of
Greylock & Company,
a Venture Capital firm

Management

Robert M. Collins
President

Randall F. Bellows
Vice President

Wendell J. Gardner
Treasurer

Hardin Holmes
Secretary

Eugene S. Szollosi
International Director

Hillard P. Tavrow
Director of Manufacturing

Donn D. Lobdell, PhD
Research Director

Kenneth R. Hoar
Controller

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Corporate Data

Corporate Offices and Main Manufacturing Facility
Lakewood, Colorado 80215
(303) 232-6800

Domestic Distribution Centers
Fremont, California
Glen Burnie, Maryland
Chicago, Illinois

Subsidiaries
Galen Laboratories, Inc.
Santa Ana, California

Cobe Laboratories GmbH
Munich, Germany

N.V. Cobe Laboratories-Europe S.A.
Brussels, Belgium.

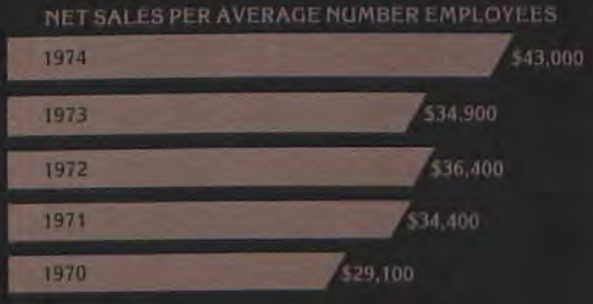
Auditors
Arthur Andersen & Co.

Legal Counsel
Ireland, Stapleton, Pryor & Holmes
Professional Corporation

Co-transfer Agents
Colorado National Bank
Denver, Colorado

General Stock Transfer Company
Jersey City, New Jersey

Karen A. Kalina (right), Personnel Manager, and Patricia Haebe, benefits coordinator, discuss benefit plan with consultant.



Financial Review

Our financial management objectives have included growth with profitability, maintaining a strong balance sheet, arranging for financing from six months to two years in advance of need, and effective asset management. From the time that Cobe became a public company in 1972, we have been in the fortunate position of financing growth from the proceeds of that offering and increasing earnings. Beginning in mid-1974, however, we began drawing on our short-term lines of credit to meet our financing needs and were indebted for $350,000 at year-end.

During 1974 we expanded our lines of credit from $750,000 to $2,000,000 and are developing sources for long-term capital. We expect during 1975 to enter into a long-term debt agreement with a large insurance company that will meet our financing needs for approximately the next two years. The amount of debt required will depend heavily on our facilities needs, which we are now defining, and the level of accounts receivable and inventories.

We may expand our facilities late in 1975, and are hiring key personnel and developing systems to enable us to better manage accounts receivable and inventories.

Although Cobe has had a relatively low interest expense the past two years, this will increase in 1975 as debt increases.

With the uncertain world economic conditions prevalent today, we believe our financial objectives are now even more important than they have been in the past and will be receiving our close attention.

Wendell J. Gardner, Treasurer (right), reviews financial data with Kenneth R. Hoar, Controller.

Cobe Laboratories, Inc.

Summary of Operations

(In thousands) (Not covered by Auditors' Report)

YEAR ENDED DECEMBER 31	1970	1971	1972	1973	1974
NET SALES	$3,579	$5,466	$8,705	$11,261	$16,755
COST OF SALES	1,803	2,875	4,463	6,057	9,310
GROSS PROFIT	1,776	2,591	4,242	5,204	7,445
EXPENSES:					
Research & Development	174	278	515	823	1,414
Selling	616	881	1,296	1,721	2,336
General & Administrative	443	647	1,170	1,277	1,633
Interest	28	36	79	109	110
Total Expenses	1,261	1,842	3,060	3,930	5,493
OPERATING EARNINGS	515	749	1,182	1,274	1,952
OTHER INCOME (EXPENSE)	2	(2)	51	130	39
EARNINGS BEFORE INCOME TAXES	517	747	1,233	1,404	1,991
PROVISION FOR FEDERAL AND STATE INCOME TAXES	264	376	592	657	985
NET EARNINGS	$ 253	$ 371	$ 641	$ 747	$ 1,006
EARNINGS PER COMMON AND COMMON EQUIVALENT SHARE	$ .34	$ .49	$ .77	$ .80	$ 1.06
WEIGHTED AVERAGE SHARES OUTSTANDING	752	754	830	936	952

Management Discussion and Analysis of the Summary of Operations

ACCOUNTING POLICIES have been applied on a consistent basis for the past five years.

SALES growth has come from existing products and new products including the Hompac supplies added in 1972, blood filters in 1973, OptiFlo® oxygenator and cardiotomy reservoir in 1974, plus many product improvements.

COST OF SALES as a percent of sales has been increasing and is attributed to adding certain distributed products that carry a lower gross profit than manufactured products, increased costs of material and labor that have not been fully offset by price increases and some changes in product mix.

RESEARCH AND DEVELOPMENT expenditures, which are expensed as incurred, have increased faster than sales in order to develop more complete therapy systems. Heavy costs were incurred on the Centry® 2 machine and hollow fiber dialyzer.

SELLING EXPENSE increases have generally followed sales trends.

GENERAL AND ADMINISTRATIVE expenses generally increased at a slower rate than sales but include profit sharing contributions during the last three years which were $175,000 in 1972, $12,000 in 1973, and $235,000 in 1974

INTEREST EXPENSE has been primarily the cost of carrying long-term debt incurred in 1972, and short-term borrowings were required to finance growth beginning in mid-1974.

INCOME TAXES were determined using statutory rates adjusted for investment tax credits, benefits from a Domestic International Sales Corporation (DISC) and considering that losses of foreign subsidiaries cannot be offset against domestic earnings.

Consolidated Balance Sheets

December 31, 1974 and 1973

ASSETS	1974	1973
CURRENT ASSETS:		
Cash	$ 663,000	$ 239,000
Short-term cash investments	—	1,050,000
Trade accounts receivable, less reserve of $91,000 in 1974 and $61,000 in 1973	3,848,000	2,360,000
Inventories (Note 1)	3,156,000	2,498,000
Prepaid expenses (Note 1)	23,000	17,000
Total current assets	7,690,000	6,164,000
PROPERTY, PLANT AND EQUIPMENT AT COST (Notes 1 and 4):		
Land	356,000	351,000
Buildings and improvements	1,544,000	1,474,000
Machinery, equipment and molds	1,187,000	827,000
Office furniture and equipment	330,000	264,000
Automobiles	53,000	36,000
	3,470,000	2,952,000
Less accumulated depreciation	763,000	462,000
	2,707,000	2,490,000
OTHER ASSETS (Notes 2 and 3)	767,000	284,000
	$11,164,000	$8,938,000

The accompanying notes to consolidated financial statements are an integral part of these statements.

Note 1 (Continued)

Inventories, valued at the lower of first-in, first-out cost (material, labor and overhead) or market, used in the determination of cost of sales were as follows:

December 31	Raw Materials and Work-in-Process	Finished Goods	Total
1974	$1,678,000	$1,478,000	$3,156,000
1973	$1,730,000	$ 768,000	$2,498,000
1972	$1,167,000	$ 524,000	$1,691,000

Depreciation is computed using the straight-line method for buildings, building improvements and molds, and the declining balance method for machinery, equipment, furniture and automobiles. Estimated service lives used are as follows:

Buildings	40 years
Building improvements	5-10 years
Machinery, equipment and furniture	5-10 years
Molds	3 years
Automobiles	3-4 years

Consolidated Statements of Operations

For the Years Ended December 31, 1974 and 1973

	1974	1973
NET SALES	$16,755,000	$11,261,000
COST OF SALES	9,310,000	6,057,000
GROSS PROFIT	7,445,000	5,204,000
EXPENSES:		
Research & Development (Notes 1 and 2)	1,414,000	823,000
Selling	2,336,000	1,721,000
General & Administrative (Note 6)	1,633,000	1,277,000
Interest (Note 4)	110,000	109,000
Total Expenses	5,493,000	3,930,000
OPERATING EARNINGS	1,952,000	1,274,000
OTHER INCOME (primarily interest income)	39,000	130,000
EARNINGS BEFORE INCOME TAXES	1,991,000	1,404,000
PROVISION FOR FEDERAL AND STATE INCOME TAXES (Note 1)	985,000	657,000
NET EARNINGS	$ 1,006,000	$ 747,000
EARNINGS PER COMMON AND COMMON EQUIVALENT SHARE	$1.06	$.80
WEIGHTED AVERAGE COMMON AND COMMON EQUIVALENT SHARES OUTSTANDING (Note 5)	952,000	936,000

The accompanying notes to consolidated financial statements are an integral part of these statements.

Cobe Laboratories, Inc. and Subsidiaries
Notes to Consolidated Financial Statements
December 31, 1974 and 1973

(1) MAJOR ACCOUNTING POLICIES

Principles of consolidation—The consolidated financial statements include the accounts of Cobe Laboratories, Inc. (Cobe) and foreign and domestic subsidiaries. All intercompany accounts and transactions have been eliminated in consolidation. All accounts with the foreign subsidiaries have been translated at exchange standards which approximate the respective year-end exchange rates for current assets, and at the average rates for the statements of operations.

Foreign currency exchange gains are recorded when realized. Unrealized gains of $44,000 existed at December 31, 1974. Realized exchange variances were insignificant in 1974 and 1973.

Research and development costs are charged to operations during the period incurred.

LIABILITIES AND STOCKHOLDERS' INVESTMENT	1974	1973
CURRENT LIABILITIES:		
Notes payable and current maturities of long-term debt (Note 4)	$ 620,000	$ 270,000
Trade accounts payable	889,000	683,000
Accrued salaries, wages and commissions	276,000	170,000
Reserve for warranties (Note 1)	35,000	34,000
Other accrued expenses	166,000	68,000
Federal and state income taxes (Note 1)	402,000	157,000
Total current liabilities	2,388,000	1,382,000
LONG-TERM DEBT, less current maturities included above (Note 4)	697,000	967,000
Total Liabilities	3,085,000	2,349,000
STOCKHOLDERS' INVESTMENT:		
Common stock, no par value; authorized 1,500,000 shares; issued and outstanding, 965,585 shares in 1974 and 915,876 in 1973 (Notes 2, 3 and 5)	4,760,000	4,276,000
Retained earnings (Note 4)	3,319,000	2,313,000
Total Stockholders' Investment	8,079,000	6,589,000
	$11,164,000	$8,938,000

Note 1 (Continued)

Maintenance and repairs are charged to operations as incurred and property replacements and betterments are capitalized. Property and related depreciation accounts are relieved of the cost and accumulated depreciation on assets retired or otherwise disposed of and the resulting gain or loss is included in operations.

Investment tax credits are used to reduce the tax provision charged to operations in the year in which the related assets are acquired.

Income taxes payable are stated at the estimated amount payable after considering that the reserve for warranties is not deductible until such costs are actually incurred. As a result, at December 31, 1974 and 1973, the Company had paid $17,000 and $16,000, respectively, more in income taxes than amounts charged to operations. These amounts are included in prepaid expenses. Cobe's Domestic International Sales Corporation (DISC) subsidiary (formed in 1973), intends to permanently invest all of its undistributed earnings in "qualified export assets," so Federal income taxes have been provided on such earnings at an effective tax rate of 24% rate rather than 48%.

Consolidated Statements of Changes in Financial Position

FOR THE YEARS ENDED DECEMBER 31, 1974 and 1973	1974	1973
WORKING CAPITAL PROVIDED BY:		
Operations—		
Net earnings	$1,006,000	$ 747,000
Expenses not requiring working capital:		
Depreciation	293,000	190,000
Amortization of Galen Product Cost (Note 2)	83,000	—
Funds provided by operations	1,382,000	937,000
Net proceeds from issuance of common stock—		
Galen acquisition (Note 2)	158,000	—
Abcor license agreement (Note 3)	228,000	—
Stock options (Note 5)	16,000	3,000
Stock purchase plan (Note 5)	82,000	33,000
Other	7,000	—
	1,873,000	973,000
WORKING CAPITAL USED FOR:		
Purchase of—		
Land	5,000	15,000
Equipment—net	505,000	435,000
Reduction of long-term debt	270,000	292,000
Advances to Galen Laboratories, Inc. (Note 2)	(268,000)	268,000
Purchase of dialyzer rights and oxygenator investment (Notes 2 and 3)	841,000	—
Other	—	8,000
	1,353,000	1,018,000
Increase (Decrease) in Working Capital	$ 520,000	$ (45,000)

Note 1 (Continued)

A reconciliation of income taxes for the years ended December 31, 1974 and 1973 is as follows:

	1974	1973
Earnings before income taxes	$1,991,000	$1,404,000
Less State income taxes	108,000	69,000
Earnings subject to Federal income taxes	$1,883,000	$1,335,000
Federal income tax at statutory rates	$ 898,000	$ 634,000
Deduct:		
Investment tax credits	(23,000)	(42,000)
Tax benefit of DISC operations	(54,000)	(10,000)
Add:		
Tax effect of intercompany profits in inventories of foreign subsidiary	23,000	—
Tax effect of losses of foreign subsidiaries not deductible for Federal income tax purposes	33,000	6,000
Provision for Federal income taxes	$ 877,000	$ 588,000

	1974	1973
INCREASE (DECREASE) IN WORKING CAPITAL REPRESENTED BY:		
Increases (Decreases) in Current Assets—		
Cash	$ 424,000	$ 33,000
Short-term cash investments	(1,050,000)	(1,225,000)
Accounts receivable	1,488,000	577,000
Inventories	658,000	807,000
Prepaid expenses	6,000	(19,000)
	1,526,000	173,000
(Increases) Decreases in Current Liabilities—		
Current maturities of long-term debt	—	(180,000)
Short-term notes payable	(350,000)	—
Trade accounts payable	(206,000)	(185,000)
Accrued salaries, wages and commissions	(106,000)	(39,000)
Reserve for warranties	(1,000)	31,000
Other accrued expenses	(98,000)	62,000
Income taxes payable	(245,000)	93,000
Increase (Decrease) in working capital	$ 520,000	$ (45,000)

The accompanying notes to consolidated financial statements are an integral part of these statements.

Note 1 (Continued)

Warranty liability is recorded when equipment is sold, using an estimate determined from historical information. At the end of each reporting period the warranty liability is reviewed for adequacy, and is adjusted based on the remaining number of months that equipment will be under warranty.

Bad debts are accounted for using the reserve method. The reserve is reviewed and adjusted at the end of each accounting period using historical information and current evaluations of accounts.

Obsolete inventory is determined by identifying specific items at the end of each accounting period and writing off the cost of items known to be obsolete or unusable.

Vacations for all employees are accrued as earned and the related liability shown in the balance sheet.

Consolidated Statements of Stockholders' Investment

FOR THE YEARS ENDED DECEMBER 31, 1974 and 1973

	COMMON STOCK		
	NUMBER OF SHARES	AMOUNT	RETAINED EARNINGS (Note 4)
Balances at December 31, 1972	913,830	$4,240,000	$1,566,000
Proceeds from sale of common stock—			
Stock options and employee stock purchase plan (Note 5)	2,046	36,000	
Net earnings			747,000
Balances at December 31, 1973	915,876	4,276,000	2,313,000
Common stock issued for—			
Stock options and employee stock purchase plan (Note 5)	10,709	98,000	
Acquisition of Galen Laboratories (Note 2)	14,000	158,000	
Abcor Dialyzer rights (Note 3)	25,000	228,000	
Net earnings			1,006,000
Balances at December 31, 1974	965,585	$4,760,000	$3,319,000

The accompanying notes to consolidated financial statements are an integral part of these statements.

(2) ACQUISITION

In March 1974, Cobe acquired all of the outstanding stock of Galen Laboratories, Inc. in exchange for 14,000 of Cobe common stock, valued at $157,000. Cobe had previously advanced $268,000 to Galen. This acquisition, which has been accounted for as a purchase, was made primarily to obtain Galen's OptiFlo® blood oxygenator to round out Cobe's line of cardiopulmonary products. The value of the Cobe stock issued exceeded the tangible net assets of Galen by $468,000 excluding product development cost. This amount has been assigned as the cost of the blood oxygenator acquired and is included in other assets in the accompanying balance sheet. It is being amortized ratably against operations over five years, the anticipated economic life of the oxygenator; $83,000 was charged to operations in 1974. The results of Galen's operations since its acquisition are included in the accompanying financial statements.

Galen was founded in 1971, and from mid-1972 to its acquisition by Cobe, was primarily involved in research and development of the OptiFlo® oxygenator. The results of the combined operations of Galen and Cobe, had Galen been acquired as of January 1, 1973, would have been as follows (unaudited):

	1974	1973
Net Sales	$16,817,000	$11,366,000
Net Earnings	1,022,000	407,000
Earnings per Share	$1.07	$.43

Note 2 (Continued)

The Galen acquisition agreement provided that additional shares of Cobe stock would be issued under certain circumstances. In satisfaction of the agreement, in January 1975, Cobe's Board of Directors authorized issuing 10,000 shares of stock (valued at $64,000) to the former Galen stockholders. This additional cost will be amortized ratably over the remaining anticipated life of the oxygenator (four years) beginning January 1, 1975.

(3) LICENSE AGREEMENT

In April 1974, Cobe entered into a license agreement with Abcor, Inc., to acquire certain manufacturing rights and exclusive marketing rights for a hollow fiber dialyzer (artificial kidney) in exchange for 25,000 shares of Cobe common stock (valued at $228,000) and $145,000 cash (total of $373,000). This amount is included in other assets in the accompanying balance sheet and will be amortized against operations over future sales of the product but not to extend beyond December 31, 1977. There were no sales of this product in 1974.

In addition, the license agreement provides for the payment of royalties to Abcor at decreasing rates on sales through December 31, 1977 beginning when cumulative sales exceed a specified level.

(4) NOTES PAYABLE

Interest on long-term debt is payable monthly at the prime rate in effect at the beginning of the month plus 2%, with a maximum of 8% and a minimum of 7%. The debt matures at the rate of $270,000 in the years 1975, 1976 and 1977, and $157,000 in 1978. Under the loan agreement, Cobe agreed, among other things, not to pay cash dividends, to maintain a current ratio of 1.5 to 1, and not to change certain management personnel. Certain land, all buildings and improvements, and machinery and equipment are pledged as collateral for this loan.

Cobe has available a $2,000,000 unsecured short-term bank line of credit subject to annual review. Interest is at the prime rate on the first $1,000,000 and prime plus 1% on the next $1,000,000. At December 31, 1974, $350,000 had been borrowed under this line; there were no borrowings at December 31, 1973. The maximum borrowed under this line of credit was $350,000 in 1974 and $150,000 in 1973. The average interest rate in 1974 was 11.5%. There are no compensating cash balances required by this line of credit.

(5) COMMON STOCK

At December 31, 1974, Cobe had 57,250 shares of common stock reserved for issuance under its qualified stock option plan adopted in 1970, including 25,000 shares authorized in 1974 by the Board of Directors, subject to stockholders' approval. Option prices represent market values at their respective grant dates. Options are exercisable 25% two years after grant, 50% after three years, and 100% after four years, and expire five years after grant or May 7, 1979, whichever occurs first. Options issued after August 9, 1974 are subject to additional conditions which will require a charge to operations should the market price exceed the exercise price. Option activity has been as follows:

Note 5 (Continued)

GRANTS:

	OPTIONS GRANTED			OPTION PRICES	
YEAR	NUMBER OF SHARES	SHARES FORFEITED	NET SHARES	PER SHARE	TOTAL
1970	4,800	1,500	3,300	$4.33	$ 14,300
1971	600	—	600	$8.33	5,000
1972	26,640	7,260	19,380	$8.33 and $12.50	181,000
1973	2,055	275	1,780	$26.00 and $37.00	49,580
1974	14,860	325	14,535	$10.75 and $11.75	162,590
	48,955	9,360	39,595		412,470

OPTIONS EXERCISED:

	MARKET VALUE ON EXERCISE DATE				
	PER SHARE	TOTAL			
1972	$38.25	$40,163	1,050	$4.33	4,550
1973	$22.25 and $24.25	10,313	450	$4.33 and $8.33	2,550
1974	$10.75	24,188	2,250	$4.33 and $8.33	15,762
		$74,664	3,750		22,862
OPTIONS OUTSTANDING AT DECEMBER 31, 1974			35,845	$4.33 to $37.00	$389,608

OPTIONS BECOMING EXERCISABLE IN 1974 AND 1973:

		OPTION PRICES		MARKET PRICES ON EXERCISABLE DATES	
YEAR	NUMBER OF SHARES	PER SHARE	TOTAL	PER SHARE	TOTAL
1973	1,350	$4.33 and $8.33	$ 6,450	$26.25 and $33.75	$ 36,563
1974	7,020	$4.33 to $12.50	52,400	$10.00 to $14.50	94,875
	8,370		$58,850		$131,438

Cobe has an employee stock purchase plan for the issuance of up to 30,000 shares of common stock. The plan provides for 10 six-month option periods whereby eligible employees may utilize up to 10% of their regular earnings to purchase stock. The price is 85% of the lower of the fair market value at the beginning or end of each option period. Stock issued under the plan is summarized as follows:

OPTION PERIOD ENDED	NUMBER OF SHARES	PRICE PER SHARE
November 30, 1973	1,596	$21.00
May 31, 1974	2,193	$ 9.00
November 30, 1974	6,266	$10.00
	10,055	

Note 5 (Continued)

The fourth option period began on December 1, 1974 and options have been granted for 6,111 shares at a maximum price of $9.00 per share. There are 13,834 shares available under the plan for subsequent option periods.

The proceeds received from all sales of common stock are credited to the common stock account.

(6) PROFIT SHARING PLAN

Cobe has a profit sharing plan covering all employees meeting certain age and service requirements. Contributions under the plan are determined by the Board of Directors and were $235,000 for 1974 and $12,000 for 1973. These amounts are included in general and administrative expense.

(7) LEASE COMMITMENTS

Cobe and its subsidiaries lease facilities in a number of locations outside of Colorado and charged operations $54,000 in 1974 and $13,000 in 1973 under terms of the lease agreements. The leases (all non-financing leases) call for Cobe to pay insurance and maintenance costs plus property tax increases, if any. The leases expire from March 1976 to January 1980. Future minimum annual rentals are as follows:

YEAR	AMOUNT
1975	$83,000
1976	75,000
1977	68,000
1978	68,000
1979	58,000
1980	5,000

Auditors' Report

To the Stockholders and Board of Directors of Cobe Laboratories, Inc.:

We have examined the consolidated balance sheets of COBE LABORATORIES, INC. (a Colorado corporation) and subsidiaries as of December 31, 1974 and 1973, and the related consolidated statements of operations, stockholders' investment and changes in financial position for the years then ended. Our examination was made in accordance with generally accepted auditing standards, and accordingly included such tests of the accounting records and such other auditing procedures as we considered necessary in the circumstances.

In our opinion, the accompanying consolidated financial statements referred to above present fairly the financial position of Cobe Laboratories, Inc. and subsidiaries as of December 31, 1974 and 1973, and the results of their operations and the changes in their financial position for the years then ended, in conformity with generally accepted accounting principles consistently applied during the years.

Denver, Colorado
February 3, 1975

Arthur Andersen & Co.

Cobe Common Stock Bid Prices by Quarters for 1973 and 1974

	High	Low
1973		
1st Quarter	40-1/4	29
2nd Quarter	36	21-1/2
3rd Quarter	30-1/2	24
4th Quarter	28-1/2	13
1974		
1st Quarter	16-1/2	10
2nd Quarter	14-3/4	9-1/2
3rd Quarter	13-1/2	8
4th Quarter	12-1/2	6-3/4

Cobe paid no dividends in 1973 or 1974 and has no present plans to commence dividend payments.

Five Year Financial Position Summary

	1970	1971	1972	1973	1974
Current assets	$1,558,000	$2,300,000	$5,990,000	$6,164,000	$ 7,690,000
Current liabilities	488,000	1,024,000	1,162,000	1,382,000	2,388,000
Working capital	1,070,000	1,276,000	4,828,000	4,782,000	5,302,000
Current ratio	3.2 to 1	2.2 to 1	5.2 to 1	4.5 to 1	3.2 to 1
Property, plant and equipment—net	611,000	800,000	2,230,000	2,490,000	2,707,000
Total assets	2,176,000	3,105,000	8,228,000	8,938,000	11,164,000
Long-term debt	331,000	353,000	1,260,000	967,000	697,000
Stockholders' investment	1,357,000	1,729,000	5,806,000	6,589,000	8,079,000
Return on average stockholders' investment	20.6%	24.1%	17.0%	12.1%	13.7%
Return on average assets	12.6%	14.1%	11.3%	8.7%	10.0%

Cobe Laboratories, Inc.

Equal Employment Opportunity Policy

In recognition of the essential rights of our employees and job applicants as individuals, it is the policy of Cobe Laboratories to recruit, hire and promote in all executive and employee job classifications without regard to race, color, religion, sex or national origin.

The Company's policy includes affirmative action to insure that all personnel action, such as compensation, benefits, transfer, lay-offs, Company-supported training, recreation and social programs and promotions, all shall be administered in accordance with this policy.

Our officers, managers and supervisors are committed to insure that this policy is carried out at all levels of the Company.

Cobe Laboratories, Inc.
1201 Oak Street, Lakewood, Colorado 80215
(303) 232-6800