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TECHNICAL EVALUATION OF THE PLANS  
OF NATIONAL DATA COMMUNICATIONS INC.  
FOR THE "REACH" SYSTEM

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Prepared for:

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## PREFACE

This report has been prepared exclusively for Drexel Harriman Ripley Inc., 60 Broad Street, New York, New York. In addition, Bolt Beranek and Newman Inc. agrees to the report's dissemination to the Securities and Exchange Commission and to those firms which may engage in the underwriting of a National Data Communications, Inc. securities offering. BBN requests, however, that Drexel Harriman Ripley exert its best efforts to insure that each of the recipients respects the confidentiality of this report. In no event is it to be construed as an endorsement by Bolt Beranek and Newman Inc. of the services to be offered by National Data Communications, Inc. Furthermore, the name of Bolt Beranek and Newman Inc. may not be used in any way which might imply such endorsement.

This report assesses the relevant technical issues which may affect the REACH Project of National Data Communications and, insofar as possible, attempts to answer other non-technical questions posed by Drexel Harriman Ripley. We believe that we have considered all of the aspects of the REACH Project which are of major technical significance. However, it should be understood that a technical review of a project of the scale proposed by National Data Communications, Inc. is a difficult and time-consuming task and that in this particular case, constraints of time have precluded a thorough examination of all the details of the REACH Project.

## 1. INTRODUCTION

Bolt Beranek and Newman Inc. (BBN) is a research, development, and consulting organization with extensive experience in computer science and technology. In particular, during the past six years BBN has conducted research and development in the application of computer technology to the information-handling problems of hospital patient-care activities. In addition to the specific experience of designing and building a hospital information system, BBN has closely followed other efforts in the hospital/computer field. It is with this experience that we have prepared a technical evaluation of the National Data Communications Inc.'s (NDC) plans and activities.

This evaluation was conducted by three senior members of the BBN staff — Paul A. Castleman, Director of Medical Information Technology; Alexander A. McKenzie, Senior Software Specialist; and Stephen R. Levy, Director of Computer Systems Marketing. These three staff members visited the NDC facilities in Dallas on August sixth and seventh for an on-site evaluation and interviews with the NDC staff. Prior to this trip, several telephone discussions were held with the NDC staff and with three members of the marketing organization of Honeywell Inc., which is providing the computer equipment to NDC. (The Honeywell personnel were Edward Kirby, who is directly responsible for coordinating Honeywell's involvement with NDC; Paul Tucker, who is Mr. Kirby's direct supervisor; and Richard Adams, who is Mr. Tucker's direct supervisor.) In addition, a number of technical documents were obtained and studied; we also reviewed our information about other commercial activities in the hospital/computer field.

During the visit to Dallas, NDC was extremely cooperative and helpful. Although the staff was highly optimistic and tended somewhat to minimize certain problem areas, when pressed on individual points, they displayed technical and intellectual integrity. (However, in our discussions with Honeywell employees, we found considerably less optimism with regard to software completion schedules, and specific differences regarding the nature of the equipment and the hardware delivery schedule as discussed on pages 10 and 20 respectively.) At NDC no restrictions were placed on our access to either personnel or technical documents, and the staff members were quite candid in their discussion.

While in Dallas, interviews were held with the following employees:

Thomas Butler	President of NDC
Byron Stuckey	Project Manager of REACH System
Clark Pritchard	Assistant Project Manager
Raymond Simons	Group Leader for Hospital Applications
Michael Rabenaldt	Group Leader for Hospital Executive Programming
James Clark	Display System Programmer
Morris Burns	Hospital Applications Programmer
Frederick Pryor	Group Leader for Conversion and Education
Lee Malone	Hospital Executive Programmer (Honeywell employee)
Shirley Malone	Hospital Applications Programmer (Honeywell employee)

Following the visit to Dallas, we visited the Honeywell and Raytheon facilities where the REACH System equipment is manufactured. Because some of the equipment is being specially designed for the REACH System, Mr. John C. Henry, a BBN electronics engineer, was also included in these visits. Finally, during the preparation of this report, several telephone conversations were held with NDC to verify some observations and to pose further questions.

## 2. OVERVIEW OF THE REACH SYSTEM

The over-all nature of the REACH System has been presented in a document prepared by NDC ("The REACH System," revised 7/23/68, BWS). Briefly, the REACH System is a set of electronic computers, data storage devices, printers, and terminals, which are to be assembled and programmed to handle much of the paperwork now involved in hospital activities. Terminals, each of which may include a television-like screen, a badge reader, a typewriter-like keyboard, and a teleprinter, will be located at various points throughout each hospital using the REACH System. Using these terminals, hospital staff (e.g., doctors, nurses, technicians, administrators) will enter information into the system and receive reports, schedules, reminders, and other information required for their particular activities.

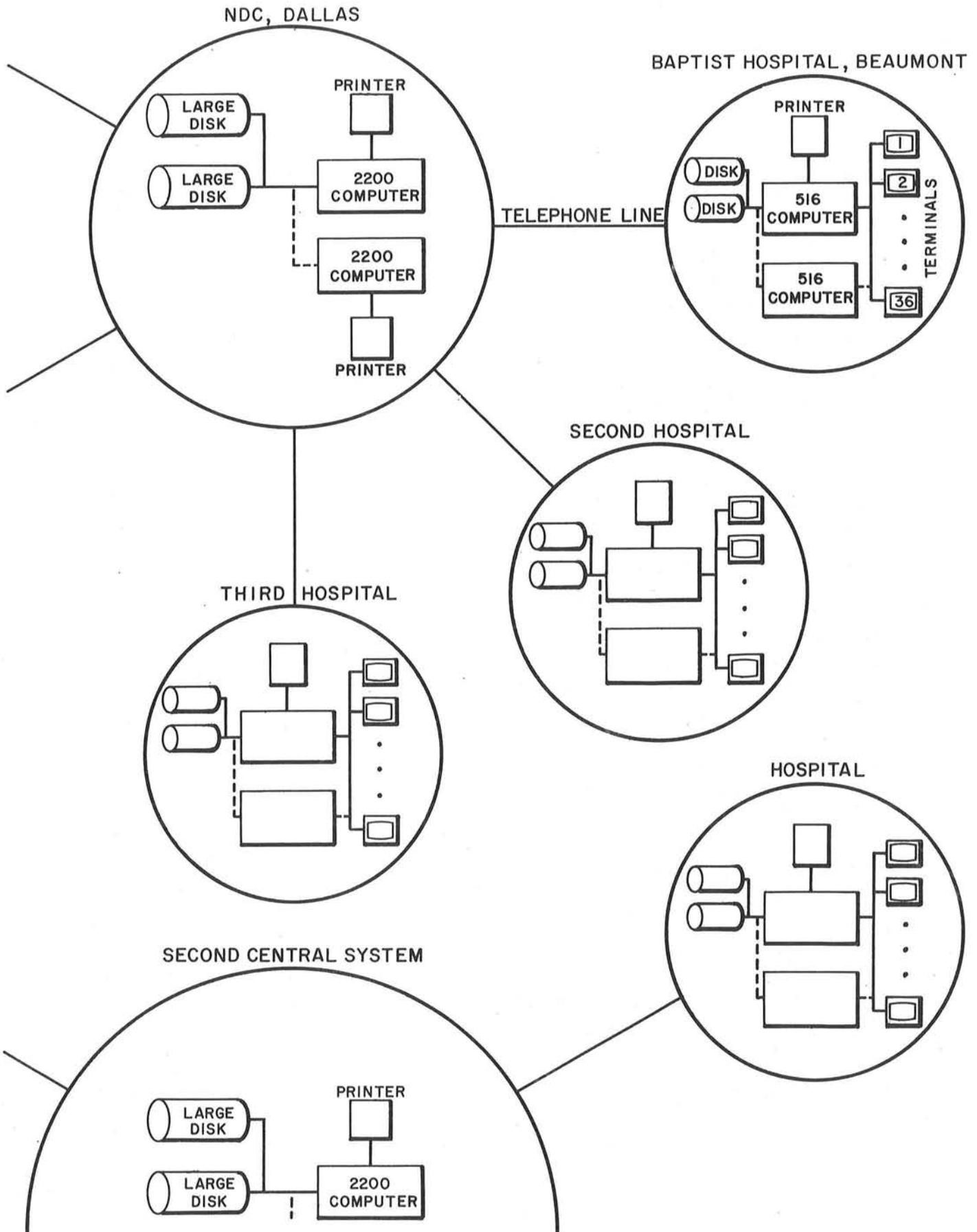
NDC plans to rent this information-handling service to hospitals on a monthly-charge basis. NDC will be responsible for all aspects of the system operation and will assign several people to each hospital on a full-time basis. All equipment will be provided and maintained by Honeywell. At present, a staff of about

25 technical people, including several on loan from Honeywell, are working on the development of this system. The first hospital in which the system is to be installed is Baptist Hospital of Southeast Texas, a 250-bed acute hospital in Beaumont, Texas. (This hospital is not scheduled to pay rental for the REACH System until it is operating to the complete satisfaction of the hospital.) This hospital, and a number of other hospitals scheduled for installation, have been subscribers to a patient credit system marketed by the Professional Men's Association (PMA), an organization closely associated with NDC.

The REACH System will consist of a computer including "memory" for program storage (516) and a data storage device (disk) in each hospital, connected by telephone line to a larger computer (2200) and a larger disk at a central site (initially NDC headquarters in Dallas). As protection against equipment failure, each computer and each data storage device will have a duplicate device, ready to be turned on when needed. Thus, the initial test configuration at Beaumont, Texas will require four computers — two in the hospital at Beaumont and two in Dallas. The central site computer complex, however, is designed to accommodate connection to several hospitals (NDC's estimates range from 5 to 25) so that a configuration of, say, three hospitals would require eight computer units, not twelve. High-speed printers will be connected to the central site and in-hospital computers. Also, a number of terminals will be connected to the in-hospital computer. The figure on the following page outlines the equipment configuration for the REACH System.

The design of the executive software (that is, the set of computer instructions that controls the operation of the entire

OUTLINE OF THE REACH SYSTEM EQUIPMENT



system without human intervention) is much more straightforward than that of many other information system designs. Most of the programs that will be required for normal operation will reside directly in their own area of computer memory at all times, rather than on the data storage device. This design eliminates the need for what is called "program swapping" and the complicated executive programs to control it. Although this design eases the programming task, it places stringent (not necessarily debilitating) restrictions on the amount of computer memory that can be used for each separate task as discussed on page 9.

The description of the REACH System prepared by NDC ("The REACH System," revised 7/23/68, BWS) might leave the reader with the feeling that the system will attempt to solve all the paperwork problems of a hospital. This is somewhat at variance with the system actually being implemented. For example, the section dealing with hospital Dietary Service implies that the system might handle food inventory and ordering or that it might perform menu planning, but a later section (System Explanation II C9) explains that the system will merely compile totals of patients requiring each type of available diet (e.g., soft, regular, salt free). Similarly, the section dealing with Electrodiagnostics might leave the reader with the impression that EEG or EKG equipment could be connected directly to the computer system, while, in fact, clinicians must still interpret the output from this equipment and enter some sort of textual abstract into the computer from a terminal.

The REACH System, therefore, is currently being implemented as a somewhat limited aid to the hospitals, and not as a panacea

for all paperwork problems. This is not to say that the system being planned for implementation will not be useful in Baptist Hospital and in other hospitals. In fact, developing a limited but dependable system is probably not an unreasonable approach to take at this time. However, it seems necessary to point out that the system NDC is building, and the one on which we will comment in this report, is not as grandiose and all-inclusive as the NDC descriptive material suggests. Consequently, it should be remembered that the remainder of this report comments only on what is actually being planned for installation in Beaumont.

### 3. GENERAL EVALUATION

This section gives a general evaluation of the REACH Project in the technical, application, management, and marketing areas.

#### a. Technical

The technical design of the REACH System seems to be well planned and adequate to accomplish the project objectives. As mentioned in Section 2, the "executive" programs are straightforward and should prove relatively easy to implement. The decision to have back-up equipment at every installation is, from a technical point of view, an extremely wise plan, even though it will considerably increase the cost of the system. The choice of screens, or cathode ray tubes (CRT's), again an expensive choice, is also desirable for both speed of output and ease of use.

The NDC staff members who are implementing the system all seem competent and experienced. Many of them have worked together previously, so the key members of the group are, in general,

familiar with each other's strengths and weaknesses. This is an important consideration in a project of this size and complexity. On the other hand, at least one high-level system designer has recently left NDC and his departure appears to have created a sizable gap in the technical staff. It is not unreasonable to suppose that the portions of the system for which he was responsible will experience some problems and delays.

The majority of computer equipment that has been chosen for the project is standard product line equipment with a history of successful operation for many customers. This equipment is generally selected from the middle range of a family of compatible hardware, so if unforeseen problems of computer or data storage space or speed requirements develop, a more powerful member of the family can be substituted. This substitution will be extremely easy because of the family compatibility provided by the manufacturer. The one exception to this rule is the computer chosen for installation at the hospital. This computer, the Honeywell DDP-516, was originally planned as a "communications concentrator", that is, as an electronic switchboard between the central site computer and the terminal devices. As such, the 516 was an excellent choice for the size category it represented. As the system design evolved, however, the 516 acquired more and more of the hospital functions and is now expected to perform most of the hospital information-handling functions of the REACH System. We feel that at this point the choice of the 516 should have been reevaluated and a computer with a larger memory capability chosen, for the reasons detailed below.

The 516 is the largest member of its family, and has already been equipped with the largest amount of memory commercially available. (Honeywell has done preliminary design of a method for increasing the memory size, but the method is awkward and would require a considerable amount of reprogramming if it were added as an option to an established 516 system.) Although a small amount of the available memory is currently not allocated to any program, any major system difficulty or unforeseen requirement that necessitates more programs could cause severe problems. Similarly, space has been allocated for programs to control 64 terminal devices, but if a hospital required a significantly larger number of terminals, the memory size restriction would also cause severe problems. In fact, either of these problems would almost certainly force NDC to discard the DDP-516 and select some other computer. Honeywell manufactures a number of other computers which might use the same data storage devices and other peripheral equipment, but even if one of these were chosen, a major reprogramming effort (e.g., at least three programmers for at least six months) would be required. Thus, although the DDP-516 may prove to be adequate, we feel its selection is certainly a design weakness.

In addition to standard product line items, Honeywell and Raytheon have contracted to develop a small amount of special-purpose electronic equipment for the REACH System. The design of this specially-built equipment is well within the state of the art and consequently should not present serious time delay problems. We feel that the most critical of these items (from a scheduling point of view) is the modification to the Raytheon CRT units; Raytheon expects to deliver 36 of these modified units by the third week of April, 1969. It should be noted that Honeywell

(the prime contractor for all equipment development) has considerable interest in the success of the REACH Project; this interest is not only due to anticipated equipment rental but also due to the fact that Honeywell is purchasing all terminal equipment and then leasing it to NDC. For this reason, Honeywell can be expected to minimize hardware delays and be as generally helpful as possible.

As previously described, much of the equipment will be installed in duplicate to provide continuity of service in the event of equipment failure. The NDC personnel stated that the switching between equipment pairs will be performed by computer-controlled switches operating in fractions of a second. At this time, Honeywell plans to provide only manual switches requiring a time measured in minutes to operate. This switching delay, however, does not seem to be a serious design weakness.

We have not studied the physical layout of Baptist Hospital or any other hospital which has expressed an interest in the REACH System. Hospital layout will, however, have a definite effect on the installation of the system since hardware constraints require that all terminals be connected to the computer by not more than 1000 feet of cable. This would, for example, rule out installation in a multiple-building hospital complex. Raytheon is doing some preliminary investigation aimed at extending cable lengths to 2000 feet, but NDC does not expect this effort to yield any results until at least September, 1969, and probably much later.

## b. Applications

In spite of NDC's close association with the PMA patient-credit organization and in contrast to NDC's reasonably strong technical activities, their hospital applications area seems weak. Automating a hospital is a much more complex and difficult task than automating, say, an airline reservation system. It appears that insufficient attention has been paid to all the subtleties and details of hospital operation, as illustrated in the following examples. There seem to be two general categories of potential problems in the applications aspect of the REACH System — difficulties in particular application areas and general user annoyance when interacting with the system.

One particular application area in which difficulties may occur is medication scheduling and charting. In the initial installation at Baptist Hospital, the REACH System will print medication schedules once each shift (the time interval requested by the hospital). The schedules will be printed on the high-speed printer and distributed to the various nursing stations by messenger. It would seem that the printed schedule may be cumbersome to update as changes are required and will provide reminder notices only in a very limited way.

The REACH System is designed to provide the ability for printing medication schedules at any desired interval, and hospitals which now prepare hourly schedules may choose hourly intervals in order to avoid the problems mentioned above. Hourly schedule printing, however, will introduce a new set of problems. For example, it may be desirable to have hourly schedules printed directly at the nursing station terminals; but, if this method is chosen,

the terminals may be occupied in printing schedules for a considerable percentage of the day. Also, there may be problems if acknowledgments for all the scheduled drug administrations (see below) are not entered within the hour. For example, it is not clear what should be printed on the next hour's schedule if a scheduled drug administration is not acknowledged.

The REACH System requires either positive or negative acknowledgment, or charting, for each scheduled drug administration. It has been estimated that the total amount of time spent at a nursing station terminal dealing just with charting medications will exceed five hours per day. Some other method of charting might have been chosen which would save the nurses a considerable amount of time.

Each nursing station terminal of the REACH System, in addition to the CRT visual display, will have a badge reader, a teleprinter, and a keyboard similar to a typewriter keyboard. The normal mode of user interaction will be as follows:

1. The user's badge is inserted into the badge reader, identifying the user.
2. The computer will cause a display to appear on the CRT. This display will give the user a choice of functions which he is entitled to perform; for example, a doctor's functions might include ordering medication, examining a medical record, scheduling a surgical procedure, and so on. The user selects the desired function by pushing a button next to the line of the display which

describes the function. This will cause the computer to produce a new display, giving specific choices related to that function. He again pushes the appropriate button and more choices are displayed, continuing until all the information has been entered or retrieved.

3. The user may be required to enter some information via the keyboard. For example, laboratory test results will probably be entered in this way.
4. When the user has completed his work at the terminal, he will remove his badge from the reader.
5. If hard copy is desired, the system can be instructed, either from the terminal or the computer, to produce it on the teleprinter.

There are a number of difficulties inherent in this system, which will not destroy its usefulness, but which may prove annoying to the people who use it. Some of these are listed below.

1. The use of a coded badge is an excellent device from the point of view of file security, but it might prove somewhat rigid and punitive. For example, if a doctor forgets his badge, or if he finds it necessary to examine the record of some other doctor's patient, it may be inconvenient for him to gain the appropriate access to the system.
2. Personnel using the system may become annoyed by the number of displays required for each function. The number of displays will range from three to fourteen, with an average of about seven.

3. Hard copy, when required, will slow down the terminal tremendously. Each display can consist of up to 1040 characters, which can be placed on the CRT in less than a second. Printing them on the Teletype, however, can require more than 1 1/2 minutes.
4. There are a large number of unsolicited messages which the system will transmit to a terminal. Messages include medication reminders, schedule changes, and the like. These messages will all produce hard copy to insure that they are received. If the destination terminal is in use, the system will store the messages and wait for it to become available. As soon as the user removes his badge, however, the system will begin printing hard copy of all messages which have been stored. Other users, who may have been waiting to use the system, will be prevented from using the terminal at least until the message being printed is completed.

In these areas of potential problems, it seems that either simplifying assumptions have been imposed, that the problem is to be solved by after-the-fact patching, or that the possible difficulties have not been considered. This is not to say that the system will not work in a hospital; it will work — after special fixing of the system and tailoring to hospital procedures — but then it will work only in a somewhat rigid form.

There are several reasons for the apparent weakness in the area of hospital applications. First, although PMA has had experience with hospitals, this experience has been limited to the hospital's financial activities and has not included the medical area.

Second, neither the President of NDC, the Project Manager for the REACH System, nor even the Group Leader in charge of hospital applications has had significant direct experience in the medical aspects of hospital operations such as a doctor or nurse would have. And, finally, hospital operations are often so diverse and irrational, and computer systems in general tend to be so structured and uncompromising, that the integration of the two is a very difficult task.

c. Management and Marketing

In addition to hardware and software considerations, the technical success or failure of a project of this scale can be affected by the quality and philosophies of NDC's management as well as the nature of its marketing plans. Thus, it seems appropriate for us to comment on the management and marketing of the REACH System where these aspects may affect the technical evaluation.

Most of the management authority seems concentrated in one man, Mr. Thomas Butler, President of NDC. Mr. Butler appears to be a hard-driving and competent businessman who believes in establishing a schedule and finding capable people who are well motivated to carry out his plans in accordance with that schedule. He indicates, for example, that one of his principal interests in a public offering is to create a marketable security to be used for motivating the employees and recruiting other qualified technical, marketing, and management personnel. He believes that each of his key employees should receive a "piece of the action" and that the public market will allow them readily to appraise the value of their holdings and, in general, to gauge the success of their efforts.

Mr. Butler maintains absolute authority over all aspects of the operation, but in the technical areas has delegated reasonable line authority to Mr. Byron Stucky, Project Manager, and Mr. Clark Pritchard, Assistant Project Manager. In the marketing and financial areas, he has himself, at least temporarily, assumed line responsibilities. He has shown considerable management talent in driving the manufacturers, in preparing facilities, and in recruiting and motivating his staff. However, his apparent lack of direct experience in the management of the more specialized technical aspects of the REACH Project or with internal hospital operations, coupled with a rigid time schedule, might lead him to accept design compromises which could very quickly "box in" the REACH System and make it inflexible.

Mr. Butler demonstrates considerable flair for marketing, as evidenced by his apparent success in PMA, marketing that organization's services to thirty-five hospitals. One of these PMA hospitals is Baptist Hospital of Southeast Texas, where the first REACH System is to be installed. Mr. Butler feels that his influence at Baptist Hospital, as well as the hospital's strong administration, will maximize the probability of success there. He intends to establish that installation as the showplace for potential customers from other hospitals. Mr. Butler claims to have a list of 54 hospitals which have already expressed a desire to purchase the REACH System.

Very conscious of the training requirements inherent in the installation of any new system, Mr. Butler has engaged educational consultants to assist NDC in this regard, and has constructed educational facilities at the main computer center in Dallas.

Although a firm price for the REACH services has not yet been established, Mr. Butler reasons that if hospitals want the system, adequate funding should not present any major problems. This attitude must be considered somewhat optimistic since it is likely that the REACH System would represent a major on-going cost to most hospitals. It is suggested, however, that NDC's marketing approach will emphasize that the REACH System will assist considerably in recovering what NDC claims to be \$3 per patient-day now being lost because many proper charges go unrecorded, and that additional savings of the same amount will result from decreased staff requirements. Mr. Butler feels that this will be a very persuasive argument in countering any objections to the high cost of the REACH System. However, some simple and reliable charge-collection systems (e.g., Medelco System) can be expected to offer substantial price competition in this area.

While it is impossible to evaluate the marketing potential of the competition accurately (technical comparisons are made in the next section), it should be noted that several companies have been developing similar systems during the past several years. Each has encountered exceptionally long delays but each expects to have a marketable product within a year or two. It is, therefore, difficult to evaluate the effect NDC's competition might have in the hospital market. However, the expected concurrent introduction of several such services will surely awaken that market to the general availability and desirability of hospital information systems and will inevitably lead to a period of hospital evaluation. Thus the existence of competition and the resulting hospital evaluations and comparisons will force careful pricing and product design, or redesign. If the

REACH System's general design is too rigid to allow much change, one can reasonably expect the competition to exploit that weakness.

In summary, while Mr. Butler is an extremely capable manager and evidences considerable marketing talent, the problems of technical management, the rather ambitious schedule, and the probable high price (cost effectiveness from the hospital standpoint) relative to expected competition, may force NDC to offer a service more tailored to individual hospital requirements than is currently contemplated. NDC might then find that its original design criteria (prepared under rigorous time schedules) are, as a result, too rigid to allow such tailoring without major redesign.

#### 4. COMPARISON WITH SIMILAR ENTERPRISES

Several companies have made major commitments to the development of a computer system as an aid to the information-handling activities involved in hospital patient care. IBM, Lockheed, General Electric, and Sanders have all made substantial efforts in this area and plan to market their products in the near future. Although the over-all approach of each of these competing systems is similar to that of the REACH System, it is an exceedingly difficult, if not impossible, task to ascertain their exact nature for the following reasons: none exists in service in any hospital; much of the relevant information is proprietary; and the claims of each of the companies have proved to be unrealistically optimistic in the past. But because of the strong similarity of these efforts to the REACH System and because of

the difficulties that these other companies have encountered, it seems appropriate to compare NDC's approach to these other enterprises.

There are a number of areas in which NDC seems to have avoided some of the problems of other attempts. (1) Instead of trying to build a highly complex system to handle each idiosyncrasy of hospital activities, NDC has taken a relatively simple, straightforward approach to the design of their system. This build-a-simple-system-now philosophy is certain to increase the possibility that NDC will have a product ready for use within a reasonable time. (2) As discussed in Section 3a, the technical design of the REACH System seems sound. The use of CRT's with buttons and the use of duplicate equipment seem to us an extremely wise decision. (3) NDC also seems to have made a very shrewd choice of a test hospital. Rather than choosing a large, complex, atypical hospital, NDC has picked a somewhat "typical" hospital in which — and this is very important — the administration appears to have strong control over hospital operations. (4) Another area in which NDC can be favorably compared to other efforts is in their extensive contacts and working experience with hospital administrators. This experience, through PMA, will prove advantageous not only in marketing but also in the very difficult area of education and conversion of hospital staff to a wholly new and somewhat rigid system. (5) One final advantage is NDC's small, highly motivated organization. Each worker appears to have a personal, and perhaps financial, stake in the success of the project; morale is very high, and management seems demanding but benevolent.

There are, however, several areas in which NDC seems weak. One such area, which also seems to be a problem with the other attempts in this field, is a failure to appreciate the subtleties of hospital operations. This problem, discussed in Section 3b, is partly the result of the inexperience of the personnel and partly their simple-approach philosophy. One result of this over-simplified viewpoint is the plan to implement the system in all areas of the hospital at the same time. Reluctance to phase the introduction of such a radical change may prove to be a problem. Another negative factor, already discussed in Section 3c, is the expense to hospitals. This problem is partly the result of equipment decisions — e.g., CRT's and duplication. One final way in which NDC appears at a disadvantage to some of its competitors is its lack of experience as a company with computer systems development. Each of the competitors mentioned has had a long and successful history of designing, building, and implementing complex "state-of-the-art" computer systems. Neither PMA, NDC's President, nor the REACH Project Manager has any experience in this area.

## 5. TIME SCHEDULES

One of NDC's weakest areas is the estimation of the amount of time it will take to get the REACH System working in the initial test site in Beaumont, Texas. Even in the scheduling area that should be easiest to predict, namely the schedule of equipment delivery, we found differences among the three organizations concerned. NDC expects to have the system in full operation in Beaumont by April 1, 1969, and to begin installation in two additional hospitals by August of that year. During our visits (in late August, 1968) to Honeywell and Raytheon, however, we

learned that Honeywell is not scheduled to deliver the first CRT terminal device until March first, and feels it will require the rest of March to deliver the remainder of the terminals destined for Beaumont. Furthermore, Raytheon, the terminal supplier, does not even expect to complete manufacturing these terminals until the third week of April. While these differences are not critically important in themselves, they illustrate the delays which we feel may appear throughout the system development and installation period.

It is the general experience of the computer industry that large, complex hardware systems, especially those incorporating hardware of unique design, require at least several months to become operational due to a host of minor technical problems. We feel that this system is unlikely to escape such difficulties, especially because of the last-minute delivery schedule for the CRT's.

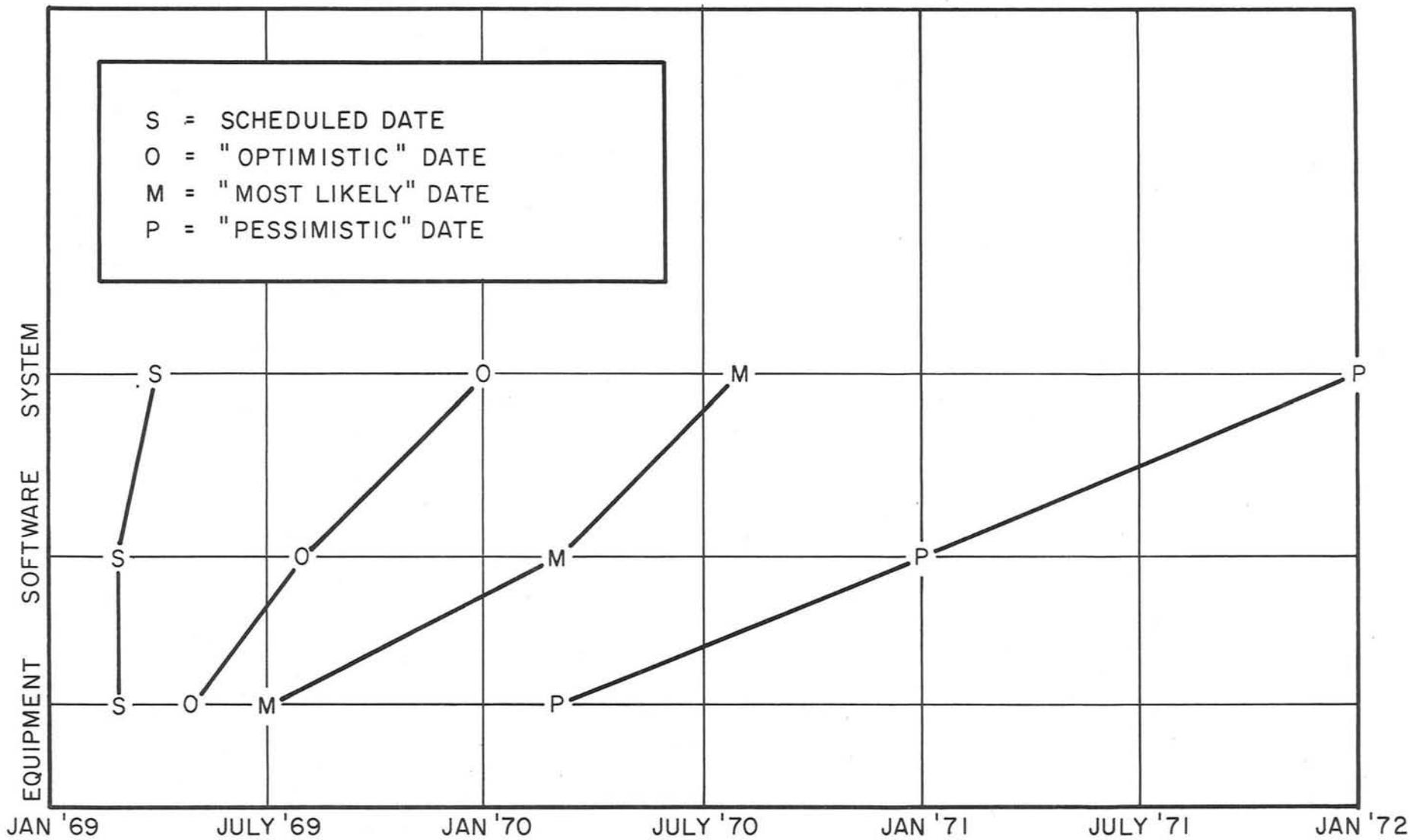
Similarly, the computer industry has typically experienced long delays between scheduled software (i.e., program) delivery dates and actual software operation. Mr. Clark Pritchard, the REACH Assistant Project Manager and technical director of software development, classified himself as an "optimist" with regard to setting software development schedules. Furthermore, several other outside personnel, who work directly with NDC, seemed rather skeptical about NDC's tight time schedule for software development. Thus, in spite of the apparent high morale and motivation of the NDC staff, we feel that the operational date of the REACH System software is likely to encounter a significant delay.

Finally, after the hardware and software systems are performing according to their design criteria, the system as a whole must be adapted to actual hospital operation. Because of the lack of familiarity with hospital operations on the part of the NDC staff, we feel that this will be a relatively long and painful process. (Even with considerable experience this would be a difficult task.) The NDC staff frequently admitted that they anticipated problems which could only be solved when the hospital staff had a chance to interact with the system; for example, it may become apparent that more than one terminal device is required at each nursing station. Nevertheless, NDC expects their system to be in full operation, without any parallel manual operation, within a month of their installation date.

The accompanying graph presents our view of the time scales involved. We have provided estimates for three "milestones" in the development of the system — hardware completion, software completion (according to the design criteria), and actual operational capability for the entire system, without parallel manual backup, in a manner entirely satisfactory to the test hospital in Beaumont. We have taken a very hard view of these milestones; for example, if the computer systems work individually, but could not be switched in the event of a breakdown, we would not consider the hardware completed. (Computer systems are typically described as "almost completed" for several months, or even years. By our standards, such a system is not completed in the commercial sense.) We have, in addition, shown four dates for each of these milestones as follows:

1. The scheduled date according to NDC; denoted by "S".
2. Our optimistic estimate of the completion date, based on the assumption of minimal problems of a technical nature, denoted by "O".

# ESTIMATES OF COMPLETION DATES FOR THE REACH SYSTEM



3. Our estimate of the most likely date of completion; denoted by "M".
4. Our pessimistic estimate of the completion date, assuming major problems in equipment, programming, and hospital satisfaction with the system; denoted by "P".

It should be noted that our time estimates refer only to the first installation of the REACH System. Once the entire system is performing satisfactorily in Baptist Hospital, we would expect that subsequent installations will not experience as significant differences between the scheduled and actual completion dates for the hardware and software.

## 6. EXPENDITURES

Although this report is the result of a technical investigation, which did not include a detailed study of NDC's budget plans and policies, there is one financial aspect that seems important to discuss — namely the increased expenditures resulting from any schedule slippage.

It would seem that a delay in the completion of the development would necessitate maintaining the same personnel, equipment rentals, and other running expenses over a longer period of time. It was our understanding that NDC's rate of spending during the final few months of the REACH System development is budgeted to be \$186,000 per month. If the development period were extended by 16 months, as suggested in Section 5 to be most likely, then this delay would cost NDC an additional \$3 million

(\$186,000 x 16). (Using our pessimistic estimate of an outside date of completion, the additional cost would be \$6 million.) These numbers should not, however, seem so extreme when one considers the many tens of millions of dollars already spent on development in this area.

## 7. QUESTIONS AND ANSWERS

As a guide to the highlights of this evaluation, a set of questions was submitted by Drexel Harriman Ripley Inc. This section restates these questions and, insofar as possible, presents answers based on the evaluation discussed above.

- Q. Will the equipment ordered by the company produce the performance stated in the material describing the REACH System?
- A. As discussed in Section 2, all of our comments concern the system as actually planned for implementation, which is somewhat less "total" than the impression a reader of the REACH material might receive. In general, the equipment choices appear well matched to the requirements. As discussed in Section 3a, there is ample room for expansion to upward compatible equipment in all cases except the DDP-516. While it appears that the 516 will probably do the job, it is possible that this limitation might preclude the tailoring of the system to certain special needs and therefore render the system somewhat more rigid and less useful than it might have been.

- Q. What is the outside date at which the equipment necessary to produce the performance stated in the material describing the REACH System will be in successful and marketable operation at Beaumont, Texas?
- A. Section 5 gives our best estimate of the various completion dates. While our pessimistic estimate for the completion of the equipment is March, 1970, and the most likely date is estimated to be July, 1969, it should be noted that until the software has been completed and until the system is functioning usefully in Beaumont, the equipment may not be marketable.
- Q. Will the software developed and proposed to be developed by the company for use in conjunction with the equipment ordered by the company produce the performance stated in the material describing the REACH System?
- A. As discussed in Section 2, all our comments concern the system as actually planned for implementation, which is somewhat less "total" than the impression a reader of the REACH material might receive. As discussed in Section 3a, the software developed and proposed appears adequate to produce the performance intended for the planned system, but it is not likely to have the power or flexibility to handle all the hospital paperwork.
- Q. Does the company have the capability with its present staff and resources to develop this software?

- A. As discussed in Section 3a, the technical staff seems competent and sufficiently large (with, perhaps, the addition of two or three more senior programmers) so that no single individual is overburdened, but there are not so many people that internal communication becomes a major problem. However, as discussed in Section 3b, the staff concerned with the design of the hospital-application software has had no significant direct experience in the medical aspects of hospital operations, such as a doctor or nurse might have.
- Q. What is the outside date (with the present staff situation) at which the company will have this software developed and in successful and marketable operation with the REACH System at Beaumont, Texas?
- A. Section 5 gives our best estimate of the various completion dates. While our pessimistic estimate for the completion of the software is January, 1971, and the most likely date is estimated to be March, 1970, it should be noted that, until the entire system is functioning usefully in Beaumont, the system (including its software) may not be marketable.
- Q. What specific communication problems could develop in installations of the terminal systems that could lead to delays of the beginning of the system operation?
- A. We do not anticipate any technical problems in the telecommunication link between the hospital computer and the central-side facilities. As discussed in Section 3a, there is a limitation to the communication distance between the terminals and the hospital computer; this limitation could prove to be a problem.

- Q. Is the REACH System medically desirable to hospitals and will hospitals realize that it is medically desirable?
- A. The system is designed to be useful as an aid in solving hospitals' paperwork problems. Studies have shown, and most hospitals are aware of, the high number of medically significant clerical errors and the large amount of time the medical and paramedical staff must spend doing clerical chores. The system may relieve both of these situations to a certain degree. Also, the REACH System is designed to present medical information in a clear and concise form.
- Q. Is the REACH System economically desirable to hospitals and will hospitals realize that it is economically desirable?
- A. As discussed in Section 3c, NDC has not established a definite price for the REACH System. However, it is our impression that the likely high price would far outweigh any economic gains that could not be attained with much less expensive systems. This is not to say that the economic advantages will not contribute to the system's marketability, but the REACH System could probably not be justified solely on economic grounds.
- Q. If an important method of marketing the REACH System to hospitals will be on a cost saving comparison basis, are the costs which use of the System will replace or eliminate readily ascertainable from hospital records for the purpose of accurate and convincing comparison?

- A. NDC claims that some hospital administrators realize the extent of the cost savings a system like REACH would provide. This is probably true, but many other administrators probably do not realize it, and the facts are not usually ascertainable from hospital records.
- Q. Does the company have the necessary staff and resources to successfully and quickly market the REACH System?
- A. Although it was not possible to make a comprehensive study of the marketing requirements, our technical investigation did consider some of the possible marketing issues relevant to the technical evaluation. As discussed in Section 3c, Mr. Butler has assumed direct responsibility for marketing. Because of his competence in this area, because of his hospital contacts through PMA, and because the REACH System is not yet working, NDC has not, it appears, found it necessary to mount a major marketing effort at this time. However, NDC claims to have a list of 54 hospitals which already have expressed a desire to purchase the REACH System.
- Q. How many REACH Systems can be expected to be on a revenue producing basis in hospitals by December 31, 1969?
- A. As indicated in the graph in Section 5, our estimate of the most likely date the system will be fully operational, and therefore perhaps producing revenue from one hospital, is August 1970.
- Q. How will the pricing policy of the REACH System affect the potential penetration into the various hospital markets both by hospital site and geographical location?

- A. As discussed in Section 3c, NDC has not released a firm pricing policy. (The technical design of the system seems to be oriented toward medium-size, acute, non-teaching hospitals.) It is our impression that high price could be a marketing problem, but that medical, economic, and prestige factors could be a persuasive counterforce.
- Q. The potential impact of union control of individual markets will be evaluated to assess potentials of interference by strikes and similar unfavorable acceptance of the system by unions.
- A. Although it was not possible to study the union issue in depth, it might be argued that one potential problem area is the reduction of clerical staff requirements. However, in many hospitals the number of purely clerical workers, outside of the financial offices, is small. Where they do exist (e.g., ward clerks), the REACH System seems as likely to increase the work load as to decrease it. Therefore, the REACH System may not represent a direct challenge to union interests in this particular area.
- Q. Evaluate the state-of-the-art of the equipment in the REACH System and the skill and experience required to design, develop, engineer and market the system. Other such systems being pre-marketed by other companies will be compared with REACH to determine what lead time, if any, will the REACH System have over similar systems which may be offered competitively by other companies.

- A. We feel that the REACH System hardware configuration is well within the state-of-the-art of computer technology, and that the NDC staff has sufficient skill and experience to develop the system successfully as presently designed, although not within their scheduled time frame and not as the "total" hospital information system which might be inferred from NDC's literature. Furthermore, NDC may have a marketing advantage over other hospital information system developers because of their close affiliation with several hospitals through the PMA activities. As indicated in Section 4, however, we feel that NDC's lack of knowledge of internal hospital operations has handicapped their design of the hospital applications aspects of the system. Also, in an effort to meet their tight development schedules, the REACH System programmers may make design and development compromises that could prohibit later expansion or tailoring of the application functions.

Currently, Medelco Inc. of Skokie, Illinois, is marketing an automated charge-collection system at a price substantially lower than that which NDC may be able to offer. The availability of the Medelco System may tend to undercut NDC's economic justifications for the REACH System on the basis of cost effectiveness. The REACH System, however, is proposed to be far more extensive in its treatment of hospital operations. There are no widely publicized data systems of the scale of REACH currently available to hospitals, although several are under development or field test. As discussed in Section 4, the competition plans to market their products in the near future. Therefore, it is likely that the REACH System will enter the market at approximately the same time as other systems.