Section 1
INTRODUCTION

This proposal describes an automatic Monitoring and Control System for the Die Casting Department of the Guide Lamp Division of General Motors. This proposal describes what the system will do and how the system will be used by the Guide Lamp management and supervision. The proposal describes what the system is and how it will be installed. A discussion of how the system may be expanded to include other activities within the Guide Lamp Division is presented, concluding with a description of Beckman's DEXTIR*line (the heart of your system).

SYSTEM DESCRIPTION

The system performs four basic functions.

- Reads all plant variables of interest and transmits them to the central processor
- Converts all plant data to a common format for transmission to the computer
- In the computer, the information is processed to determine conditions that require attention; selected data is stored for report preparation
- The information of interest is disseminated to the remote recording devices for the attention of the plant forman.

Each of these four functions will be discussed separately in light of the Guide Lamp Die Casting Department requirements as they were determined during a visit on January 13th.

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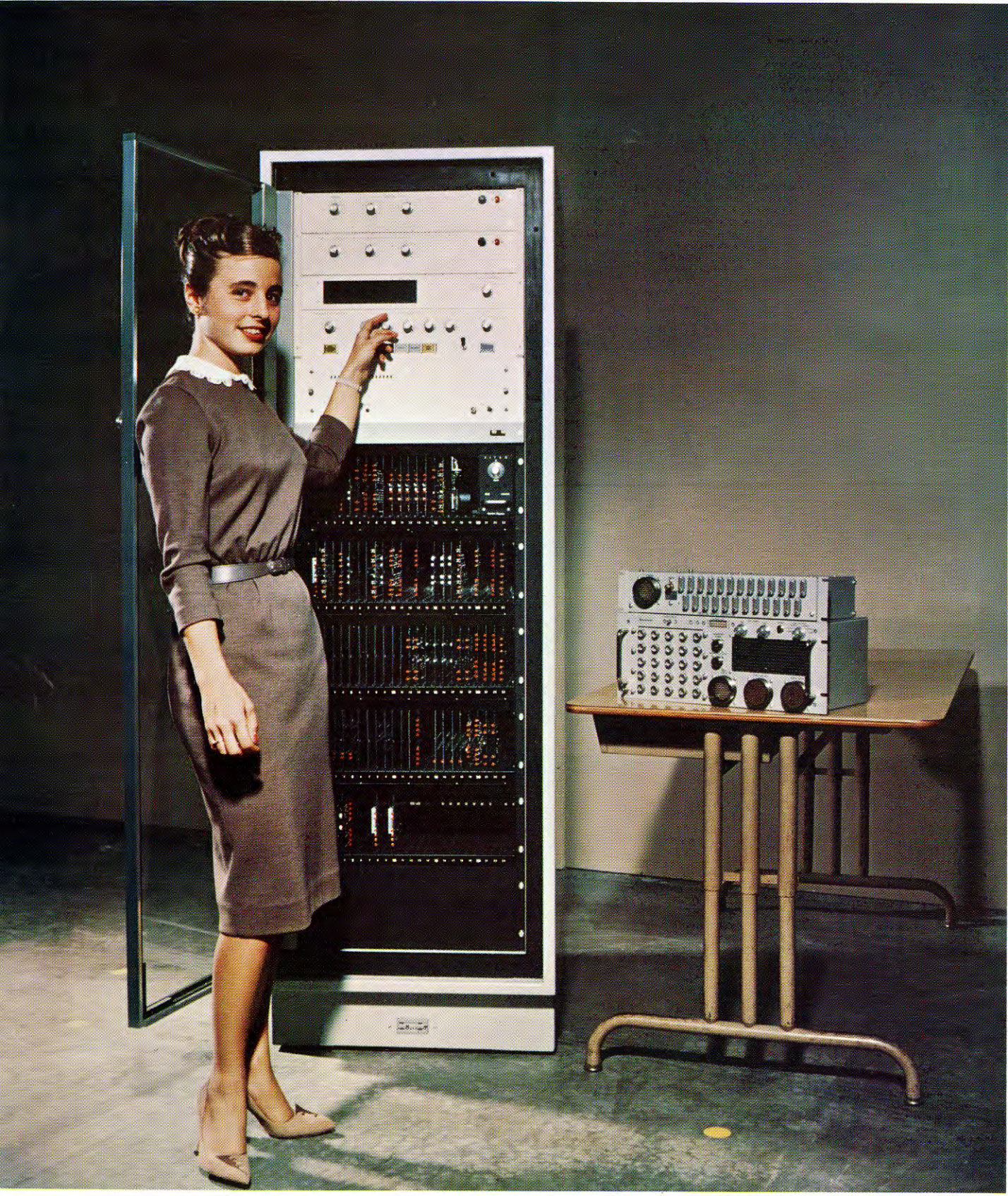
* A trademark of Beckman Instruments, Inc.



ESSO RESEARCH LABORATORIES

HUMBLE OIL AND REFINING CO., BATON ROUGE, LOUISIANA

DEXTIR is a medium speed, low cost per channel system designed for industrial and research applications where data must be gathered from a great number of processes and experiments taking place at random locations. The small components on the right are analog and digital input boxes providing access to the main cabinet which accepts 2,500 digital channels. Delivered, July, 1961.

DATA GATHERING

The data from the 55 die casting and trimming stations will be brought by appropriate cabling to six remote centers that will be located at places in the plant where efficient machine grouping can be accomplished. These six remote centers will be connected together by a shared party line cable that will run to the computer room.

At each machine, the die cast count and trim count will be monitored by a contact closure that already exists in the present machine control equipment. Also, at each machine, mold temperature and casting metal temperature will be monitored at appropriate places in the troughs and reverberation furnaces.

At the central processor, all of the analog inputs (temperatures and pressures) will be converted to a numerical value and transmitted to the computer. Interlaced with the analog data will be the data from the counters associated with each machine. This count data will also be transmitted to the computer.

The computer will contain in its memory all of the information required to convert the measurements taken in the plant into meaningful data. All of the temperatures and pressures will be compared against alarm limits. If any of these variables are found to be outside of alarm limits which have been set by the plant operating supervisors, this fact will be transmitted to the teleprinter in the supervisor's office responsible for the machine in question. An audible alarm will be provided to announce in the shop area that an abnormal condition has been detected. At the output display, a bell will ring to attract attention whenever data is to be transmitted from the computer.

The count data from the die casting machine and from the trimming machine will be used to compute an efficiency for each station. Whenever the number of trim operations drops below a certain percentage of the die casting operations, the computer will consider this an alarm condition and will announce this by teleprinter to the shop location responsible for that machine.

The monitoring system described above will allow the complete die casting machine area to be examined every thirty seconds. When a problem arises, it will never be more than thirty seconds before this is detected and announced. For example, level in the cooling water reservoir goes outside of safe limits, it will be announced before damage can be done to the dies or other equipment due to lack of cooling water. If some shop condition on a specific machine or group of machines causes the trimming operation to fall behind, this will be detected within 30 seconds.

In any system of control that involves personnel, attention must be given to the man-machine interface so that proper communication exists in the control loop. To most effectively use the information generated by the computer system, a teleprinter is located at each of the supervisor's offices in the die casting area. Any information of interest that is detected by the computer will be transmitted to the office responsible for the machine involved. The information will appear in typewritten form so it may be retained for records, if desired. A bell on the teleprinter rings in advance of each transmission to call attention to the message.

It is conceivable that communication between the individual machines and the supervisor's office may be desirable in the event of difficulty or during start-up procedures. Also, in cases where the process is spread over a large area as in the case of the Guide Lamp Division, it is quite possible that messages could be transmitted into the supervisor's office while the interested parties are not in attendance. Therefore, it is recommended that an audible signal be sounded in the plant to announce that a message is being transmitted from the central computer unit. This audible signal will then allow the interested supervisor to contact his office or the central processing room to determine the nature of the message. We would like to recommend, rather than a wired system with a jack at each machine, the consideration of an in-plant radio system similar to that used in hospitals for paging doctors or similar to that often used by plant security personnel. Such a system would allow supervisors on the floor to be paged on an individual basis from the central system or would allow them to communicate with their offices or with the computer room. This method of providing communication would eliminate the need for additional plant wiring and phone jack installations at each machine. The radio system would also allow supervisors to answer calls from their offices immediately without having to go to the nearest machine and plug in a hand set.

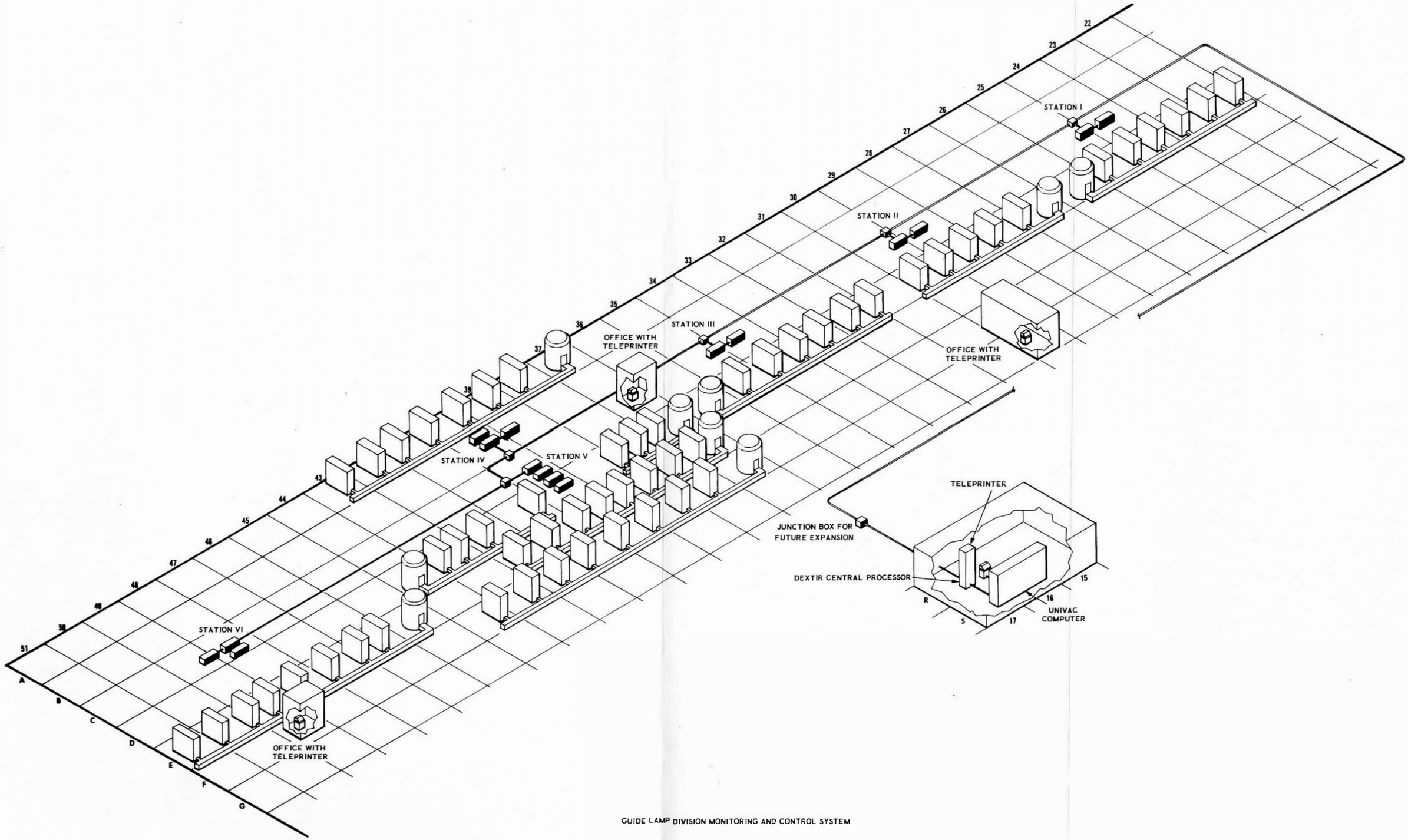
The data gathering portion of the system consists of a Beckman/DEXTIR* data gathering system specially configured to serve the die casting department of the Guide Lamp Division. DEXTIR is a standard product of the Systems Division of Beckman Instruments Inc. and is described in detail in the following section.

The specific configuration designed for this application consists of six remote stations containing elevendata gathering boxes and seven digital input boxes. The inputs to these six stations come from thermocouples, pressure transducers and counters associated with the individual die casting and trimming units. Data is also obtained from thermocouples in the reverberation furnaces and in the holding furnaces and channels which serve the die casting machines. These six stations all share a common party line which leads to the computer room. The drawing on the fold-out sheet immediately following this page shows the DEXTIR configuration for this application. From this drawing, and from the table of instrumentation points, an estimate can be made of the installation costs.

INSTALLATION

It is proposed that the installation of cabling and instruments between machines and the six remote stations be carried out by the Guide Lamp Division of General Motors using their own plant engineering staff. Beckman will provide consultation and will have an engineer on site during the installation of the DEXTIR equipment and cabling. This engineer will also conduct performance and acceptance tests when the installation is complete. This procedure for installing the equipment is proposed since plants' wiring and electrical requirements vary from state to state and from company to company. By working jointly on the installation, we thereby insure that all electrical equipment is installed to acceptable General Motors standards. A table showing estimated cable length for the different types of transducers is shown on the next two pages.

* A registered trademark of Beckman Instruments, Inc.



GUIDE LAMP DIVISION MONITORING AND CONTROL SYSTEM

Mach #	Descript. of Point	T/C	Distance	Pressure	Distance	Contact	Distance
Sta #1							
Mach # 1		3	360	1	120	2	240
2		3	240	1	80	2	160
3		3	120	1	40	2	80
4		3	120	1	40	2	80
5		3	240	1	80	2	160
6		3	300	1	100	2	200
	Reverb #1	1	140				
Sta #2							
	Reverb #2	1	120				
Mach # 7		3	240	1	80	2	160
8		3	180	1	60	2	120
9		3	180	1	60	2	120
10		3	300	1	100	2	200
11		3	360	1	120	2	240
Sta #3							
Mach#12		3	420	1	140	2	280
13		3	300	1	100	2	200
14		3	180	1	60	2	120
15		3	120	1	40		80
16		3	240	1	80		160
17		3	270	1	90		180
	Reverb #3	1	150				
Sta #4							
Mach#43		3	480	1	160	2	320
44		3	360	1	120	2	240
45		3	240	1	80	2	160
46		3	120	1	40	2	80
47		3	210	1	70	2	140
48		3	300	1	100	2	100
49		3	420	1	140	2	140
	Reverb #9	1	200				
Sta #5							
	Reverb #4	1	180				
7Z		3	450	1	150	2	300
125		3	390	1	130	2	260
250		3	360	1	120	2	
	Reverb #5	1	210				
30		3	180	1	60	2	240
32		3	360	1	120	2	240
33		3	450	1	150	2	150
34		3	540	1	180	2	180

Mach #	Descript. of Point	T/C	Distance	Pressure	Distance	Contact	Distance
	Reverb #7	1	180				
21B		3	450	1	150	2	300
22B		3	360	1	120	2	240
23B		3	300	1	100	2	100
24B		3	210	1	70	2	140
25B		3	180	1	60	2	120
26B		3	300	1	100	2	200
27B		3	390	1	130	2	260
28B		3	480	1	160	2	320
	Reverb #10	1	250				
51		3	450	1	150	2	300
52		3	330	1	110	2	220
53		3	210	1	70	2	140
54		3	270	1	90	2	180
55		3	390	1	130	2	260
56		3	480	1	160	2	320
57		3	570	1	190	2	380
58		3	690	1	230	2	460
Sta #6 Mach# 35		3	330	1	110	2	220
36		3	240	1	80	2	160
37		3	180	1	60	2	120
38		3	105	1	35	2	70
39		3	235	1	75	2	150
40		3	330	1	110	2	220
41		3	420	1	140	2	280
42		3	510	1	170	2	340
	Revert #8	1	150				
TOTALS		174	18,830	55	5,750	110	11,500

PROGRAMMING

The effectiveness of any computer control system is directly determined by the design of the computer program. This program must be carefully organized to operate on the available data in a manner that provides the necessary information to the right people at the right time. The programs must be written so that it is easy for the users of the system to communicate with the computer. Beckman Systems Division has had considerable experience in writing programs which allow non-computer trained personnel to communicate with the system in common every-day shop language. Working closely with Univac a "Human Engineered" operating program will be provided with the system. We would propose that such a program be written for this control system so that the computer, in producing its reports, would refer to the shop areas, machines and departments by their regular names that are now in use in the factories rather than introduce some new vocabulary peculiar to the system. The program will be written so that information can be requested of the system in the same language that it is requested now of accounting or production control or other record-keeping services.

To insure that the system is programmed to truly fit in with the manner to which Guide Lamp would like to manage their shop, a team of two Systems Consultants will work with Guide Lamp people interviewing the supervisors and managers involved and, together with these Guide Lamp Division personnel will establish the criteria and flow charts for the program. These programs will then be written concurrently with the construction and installation of the hardware and will be checked out on Univac computers so that they will be ready to run by the time the installation of the hardware is complete.

The Beckman DEXTIR system is designed solely for the purpose of entering data into computers. The computer may be a small machine devoted solely to the process control problem, performing no other function than to operate on the DEXTIR outputs, or it may be a time-shared portion of a much larger computer installation. The DEXTIR produces data at a rate that can be easily assimilated by a large, high-speed computer such as the Univac 1108. Such a computer also has sufficient capacity to perform all of the other plant functions such as payroll, production control, inventory control,etc.

BACK-UP

While the Beckman DEXTIR System is designed primarily to prepare data for computer entry, it can perform recordings and alarming functions outside of the computer. It may be desirable to add these features to your DEXTIR System to provide back-up in situations where the computer is not available full-time, or in situations where the computer service must be interrupted for maintenance. A proposal for a magnetic tape recorder and alarm capabilities is proposed as a separate item on the Financial Quotation accompanying this proposal. These features would allow the DEXTIR to make a recording of all data generated which could be later played into the computer for the preparation of reports and the computation of efficiencies. Also, in the "independent operation" mode, the DEXTIR System would check up to 150 alarm limits on critical points in the plant and would sound an audible alarm and give an indication of the unit which caused the alarm.

EXPANSION

The DEXTIR party-line system was particularly designed to permit easy and inexpensive expansion of the data acquisition function. The present financial quotation includes a junction box to be located at the intersection of line M and 21 on the drawing used for system layout. A piece of party-line cable 1200 feet long would serve the seven large plating tanks which are located throughout the area boardered by lines J and N. An additional 300 feet of party-line cable would reach the plating tank in the corner of the plant near the intersection of line A and 49. An additional 500 feet of party-line cable would extend to serve the plastics area located between lines U and W. A section of party-line cable 600 feet long would be required to incorporate the punch press area between lines V and W at stations 101 and 102 and an additional 500 feet to include the punch press area at lines D and C stations 8 and 9.

The financial quotation includes an estimate of the equipment required to instrument the plating areas. No estimate is offered for plastics or punch press operations since these areas were not discussed in detail during our meeting on the thirteenth of January. However, I think it can be seen from the estimate for the plating area that the expansion of the Univac/Beckman to include the entire Guide Lamp facility can be accomplished with a minimum of additional investment.