ABSTRACT

THE SAWMILL MANAGER:
HIS NATURE AND HIS TIME

By

Antone Cornelis Van Vliet

An investigation was made of 11 managers of small sawmills in Michigan concerning their nature and their use of time. The time these managers devoted to decision making, communication, and other characteristic activities was studied. The study is divided into three parts.

Part I involved the choice of work sampling as a technique used to collect data. A self observational variation of work sampling was made possible by the invention of a new Random Interval Timer. This compact device emitted random signals at a rate that could be pre-set by the researcher. The Poisson process was chosen as best fulfilling the technical requirements. The 11 managers carried their instruments an average of 25 days, spanning four months. They produced 2215 total observations in 11 activities, each recorded by time of occurrence, type of activity, and duration of event.

Part II involved in-depth interviews with each manager to see if different types of managers existed. Generally, these men could be

best described as exhibiting an entrepreneurial behavior. This discovery led to using a method of separating the managers into the Craftsman-Entrepreneur (C-E) or Opportunistic-Entrepreneur (O-E) classifications. If these classifications were valid, then a series of hypotheses could be tested using time-use data. The findings were discussed in three forms: 1) profile of the entire group, 2) three High O-E vs. the three High C-E managers, and 3) three High O-E vs. all the C-E managers.

Hypothesis: The Opportunistic-Entrepreneur spends more time in the decision making process than the Craftsman-Entrepreneur.

Result: The three High O-E's spent 114% more time in the decision making process than the three High C-E's. This proved significant at the 5% and 1% levels only for the pure types, not for the O-E's vs. all C-E's.

Hypothesis: The Opportunistic-Entrepreneur spends more time in the communication process than the Craftsman-Entrepreneur.

Result: The three High O-E's were involved in 2.4 times as many communication interactions as the three High C-E's.

Hypothesis: The Craftsman-Entrepreneur engages in more manual labor in his firm than the Opportunistic-Entrepreneur.

Result: The three High C-E's spent 309% more time doing manual labor than the three High O-E's.

Hypothesis: The Opportunistic-Entrepreneur participates in more training programs than the Craftsman-Entrepreneur.

Result: Out of a total of 2215 observations, only two events involved training.

An activity profile of the 11 sawmill managers revealed that they spent almost one third of their time doing routine work. Manual work accounted for 10.88% and the decision making process (four segments) occupied 27.47% of their time. Duration time for each activity was also calculated.

Part III involved looking at the communication networks and organizational structure. The entire group of managers were communicating in 35.45% of the total observations. In these instances, the manager was the sender over 80% of the time. The object or source of the communication contacts were listed by groups, such as employees, foreman, and equipment suppliers. Six organization charts are shown to understand how the sawmill manager views his firm.

Conclusion. The self observation form of work sampling, coupled with the use of the new Random Interval Timer proved an effective method for collecting data. Their use could save large sums of money in studies that require accurately measuring a variety of tasks.

The activity that was lacking--training--is a cause for concern. The possibility of discovering the right "wave-bands" for reaching the managers involves the communication networks.

The entrepreneur is a vital part of the free enterprise system.

He exhibits innovation, courageous risk taking and energy. These values should not be lost for the sake of the large firm's efficiency.

APPROVED:

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To Louise, Dan, Sue, Mary, Bill
and
Tom

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I. INTRODUCTION

The Purpose of the Study

This is a study of the managers of 11 small hardwood sawmills in Michigan.[1] The purpose is to investigate how these managers spend their time, how they communicate on the job, and how they view their organizations.

Many people familiar with the lumber industry have long suspected that there may be characteristic differences among sawmill operator's approach to management. These differences, if they exist, could provide a valuable base of information about this segment of the Forest Products industry.

The process of narrowing the area of concern to this representative managerial group is in response to what has been taking place in the small sawmill business across the country. Is the high mortality rate among small sawmills an inescapable consequence of the times or a condition that can be halted through a better understanding of these managers? The national picture is mirrored in many ways by the Michigan sample.

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[1]This research was carried out in Michigan with funds made available by the McIntire-Stennis Cooperative Forestry Research Program.

This chapter will briefly acquaint the reader with the Forest Products industry in general, and small sawmills in particular.

The Forest Products Industry in General

The Forest Products industry today is involved in a crucial period in its history--a period that will see many firms fail to survive. The coroner's report will probably give numerous reasons for the deaths of those who finally close their doors or are absorbed by other companies. It may list among the causes the difficulty of acquiring raw materials, the growing obsolescence of men's skills and his machines, the keen intra-industry competition between the various wood products, the growing competition from outside industries (non-wood substitutes like plastics), the rising cost of labor, and the scarcity of capital or capital sources.

Most managers agree that running today's firm is a complex and bewildering task. In a short span of time many new kinds of demands have been placed upon the modern executive. He must be more efficient, make decisions faster, possess or have access to greater knowledge, communicate with clarity and ease, and be willing to initiate and accept change--all at the same time.

The Forest Products industry possesses some interesting characteristics different from many other major industries. Its common base is a renewable resource, timber, and the spectrum of industrial integration is unusually wide--from rough lumber to

engineered laminates; from chips to high grade paper; from thin veneer to attractive furniture.

Segments of the industry, like lumber and plywood manufacturing, are tied closely to the monetary restrictions or seasonal fluctuations of the building industry.

Lumber has been called one of the last true "market administered" price commodities in the United States economy. Some operators are extremely proud to be identified as one of these "last bastions of free enterprise." In economic terms, Mead (30) refers to the lumber industry as an excellent example of a real world approximation to the economic model of pure competition.

Technological innovation in general has been slow when compared to such rapid growth industries as electronics, chemicals or plastics. This fact alone may have lulled some operators into thinking that "change" was an unnecessary ingredient for survival or growth.

Small[1] Sawmills

Not only is there a wide diversity between segments of the Forest Products industry, but also within each basic commodity group. Sawmills, as a group, are no exception. There are so many sizes and

[1] For the purposes of this study, the term 'small' will indicate mills producing up to 5 million board feet annually; terminology indicating size of mills is not standardized nationwide.

kinds that it was necessary to concentrate upon one sub-group. Small sawmills have been singled out for this study because:

1. This group for many years has constituted a majority of the mills in the United States.
2. The number of small mills has been sharply decreasing over the years. In 1964 they contributed less than 30% of the national output of lumber.

Some background information

From the first sawmills established at Jamestown and later in New England, there has been a steady migration of mills following the westward movement and the development of the United States. On the heels of the pioneers, the mills came with the waves of goods and services that built the towns and made life bearable. These mills were established near the source of accessible virgin timber. Today the largest concentrations of mills are found in the west and south, close to the remaining resources.

Lumber is a primary product; this is simply another way of saying that it is recognizable in its final form after it has gone through the mill. The resulting basic product has not changed substantially since the first mills were established. It was basically a good product with a variety of uses, and the sawmiller has been content to allow other craftsmen to capitalize upon its versatility.

The majority of studies about the lumber industry have been

done by economists. This is not surprising as the economist is well equipped to view an industry in terms of resource allocation, price systems and the market place. Economic studies provide some useful statistics and theories concerning the behavior of firms comprising an industry.

In a general industry description, Keppler (20) states that in the period from 1929 to 1954 sawmills more than doubled in number in the United States while total lumber production was showing a slight decline. Acknowledging the difficulty of accurately determining mill numbers, he disclosed the existence of over 50,000 sawmills in the United States according to the 1947 census of manufacturers. Since the early fifties production has remained fairly constant nationwide (between 32 and 37 billion board feet annually), but the number of producing mills has declined sharply. The large mills and the efficient medium-sized mills have increased in number and production. At the same time some of the small mills have moved into the next size class by improving their efficiency through modernization and expansion.

The most current figures available concerning size classification of mills are for 1969 as reported in the May 29, 1970 issue of Forest Industries (22). While these figures are too incomplete to be useful here (only 64% of the production was accounted for), the trend is definitely continuing with a sharp decline for small mills. The

following table illustrates this decline from 1947 to 1964.[1]

Table 1. U.S. sawmill size classification.

Mill Class Annual Cut	Mill Data	1947[1]	1964[2]
LARGE:	Number of Mills	165	287
25 million board	% of total number	0.3	2.5
feet and over	% of total production	23.0	42.6
MEDIUM:	Number of mills	939	1,008
5 to 25 million	% of total number	1.8	8.6
board feet	% of total production	25.9	29.0
SMALL:	Number of mills	52,005	10,386
under 5 million	% of total number	97.9	88.9
board feet	% of total production	51.1	28.4
	Total number of mills	53,099	11,681

[1]Keppler (20).

[2]U.S. Bureau of Census (41).

Loss of mills

The loss of mills is a concern to many students of the industry. Why are so many of these mills now silent? Should we be concerned? Or should we simply tally these lost businesses to changing times?

Many observers claim that the loss of small mills is inevitable and predict a continuance until the manufacture of lumber is in the hands of relatively few manufactures, an oligopoly.

The economic "facts of life" faced by small firms seems

[1]1964 represents the most recent complete data available at the time of this writing.

formidable. In addition to what has been mentioned the small mill manager, striving to survive, must deal with:

1. The growing competition for raw material at reasonable prices. This does not necessarily mean that there is not enough timber in the locality to support the mills. But if the small mill manager does not have access to his own raw material he must face the high cost of acquiring non-owned timber from public or private sources.
2. The relatively low entry cost into the lumber business by others. The purchase of a "belly-up" operation or second-hand equipment can be made with limited capital resources. Mead (30, p. 123) notes that,

   > When demand conditions improve significantly lumber prices increase and milling profits temporarily improve thereby inviting entry into the industry. Small mills enter in response to the invitation, and the favorable operating profit position is quickly erroded away.

3. The availability of adequate skilled labor. While the number of skilled workers required is not exceedingly high, they often cannot be replaced. An example is the current shortage of head sawyers and millwrights (maintenance men).
4. Limited sources of capital. Complicated equity or debt financing normally is not available to the small operator. Local bankers and friends are usually the prime sources of funds.
5. A complicated marketing structure. This includes many

different avenues for disposing of the product, each taking a share of the selling price, usually in the form of discounts.

6. The lack of improved managerial techniques. Even when the manager recognizes the need for improvement, additional training and help are often not available to him, or will not fit into his busy schedule.

It would be easy to continue the list of difficulties of these businesses in today's world. Even if the manager does cope with these factors, he is forced to ponder the increasing technological gap between his company and his large corporate counterpart. His sporadic and limited excess capital often must go into maintenance, or if he is lucky, into minor production improvements. Bigger firms routinely allocate funds for process sophistication, market expansion and some research and development. And so the gap grows larger and larger between the two.

On the surface it is anything but an optimistic picture, and yet many of these small managers are succeeding. Why? Is it the unspoken optimism and nature of the leadership? Is it the character of the organization? Do small mills possess advantages of size that offset the power of the larger firm? No group would more appreciate the answers than the managers of the small sawmills themselves.

Managerial Time-Use

In the search for published studies dealing with how managers use their time, a relatively small number of references could be found. This is not hard to understand. It has only been in recent years that concepts developed by behavioral or management sciences have experienced recognition, testing and success in industry. Carlson's study of Swedish managing directors, Brisley's (6) study of a group of Detroit executives, and Stogdill and Shartle's (39) study of wholesale executives and Navy officers are examples of research that produced data showing percentages of time spent by managers in different activities. In addition some quasi-managerial studies, ranging from engineers to office personnel, are available.

No time studies concerning sawmill managers in the United States could be found. Moreover, no comparable published research on managerial behavior in any aspect of the Forest Products industry was located. One Swedish study (1) was found concerning supervisory personnel in Forest Units, and one proposal by Battelle Institute (3) to investigate the decision making process of forest managers.

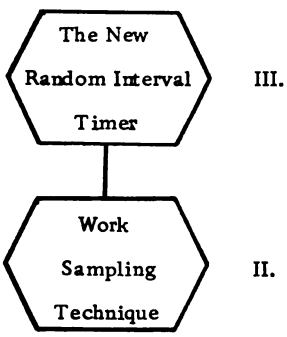
Time plays an important role in this research. It was used to measure behavior periods and to search for commonness and differences between managers. An effort will be made to tie empirical behavior data concerning time-use and communication channels to theoretical role requirements of previously established types of

leadership.

The individual analyzed in this study will be the manager or the owner-manager of the mill, who therefore has the sole responsibility for the direction of his company. No attempt will be made to establish who "should not" or "will not" be in business in the future, but rather to explore the characteristics of a few of those who are surviving with varying degrees of success. The analysis should enable the manager to judge his own activities in light of his own goals.

While the temptation is indeed great to draw conclusions about the status of all managers operating small sawmills, it must be remembered that the results apply only to the Michigan group. Further regional studies will be necessary to prove the suspicion that the types of managers described in the Michigan sample are also running sawmills in North Carolina, Oregon or Maine.

PART I. METHODOLOGY



II. THE SAMPLING PLANS

Two distinctly different sampling techniques were used in this research. The first, used to select the managers for the study, was a one-time-only process. The second, used to sample the activities of the mangers, was a continuous process, carried on for a specified period of time.

Selection of Managers and Their Mills

A list of all the sawmills located within a 100 mile radius of Lansing, Michigan, was compiled using the newly published Michigan Directory of Primary Wood Using Plants (31). The size of the mill, precise location, county, and ownership were verified with assistance from the Michigan Department of Conservation and the Cooperative Extension Service.

Mills beyond the 100 mile radius were not considered for the study because of the practical constraints of driving time, and because there were enough mills within that area to provide an adequate sample. Although the study was limited to mills producing five million board feet or less per year, there were 140 mills within the radius from which to select the sample. After further investigation,

mills producing less than one million board feet per year were eliminated from the study. They do not operate on a regular basis, they usually are low manpower operations, and often these mills are not permanent.[1] In fact, some could not even be found!

The mills remaining for consideration then fell into Michigan classifications C and D (see Legend, Figure 1). Over 30 telephone calls were made to mills scattered throughout the 100 mile radius, and each manager who showed any interest in participation was visited. In the final analysis, the list was randomly thinned by the managers themselves; those who were willing to make a commitment to a considerable amount of work, with the hope of learning more about themselves as managers.

The vital statistics of the 11 companies to be studied were as follows:

5 owner - managers
5 co-owner - managers
1 manager (absentee owner)
11 total participating managers (or key decision makers)

4 Class C mills out of a state total of 14
7 Class D mills out of a state total of 74
11 Total mills out of a state total of 88 Class C and D mills

The sample was 12.5% of the managers operating plants within the state in the one to five million board feet per year production

[1] A permanent mill usually exhibits a concrete foundation, a planned site near road and/or rail, and a pattern of regular operation. In contrast, many small mills are portable, skid or tire mounted, and run according to the immediate needs of the operator and his local market.

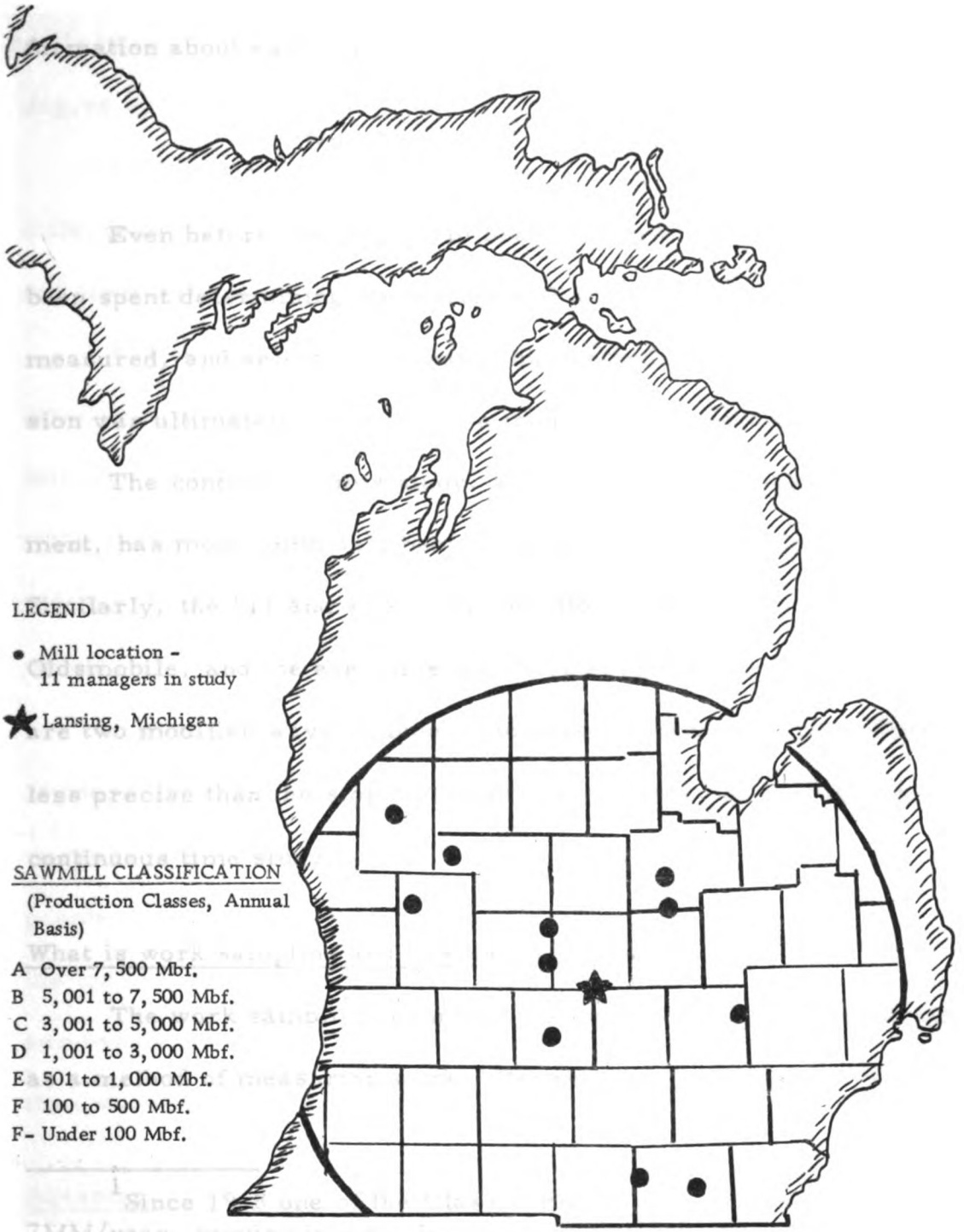


Figure 1. Location of 11 sawmills in Michigan study.

range.[1] The map in Figure 1 locates the 11 sawmills. Standard information about each plant can be found in Appendix A.

Work Sampling[2] as a Technique

Even before the plants had been selected, considerable time had been spent determining the managerial activities that were to be measured, and selecting the sampling methods to be used. The decision was ultimately made to use a modified form of work sampling.

The continuous time study, another method of work measurement, has most commonly been used with production line workers. Similarly, the "11 and 4" system[3] employed by supervisory people at Oldsmobile, and the executive-time-log advocated by Drucker (16), are two modified ways to account for every minute of time. While less precise than the stop-watch analysis, these are still forms of continuous time study.

What is work sampling and how can it be used?

The work sampling technique has been employed for some time as a method of measuring work. Barnes (2, p. 11) states, "Work

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[1] Since 1968 one of the Class C mills has increased production to 7MM/year, moving into the lower range of the Medium sized mills.

[2] The development of work sampling is attributed to L. H. C. Tripplet in his 1927 study of lost time in weaving.

[3] At 11 o'clock and at 4 o'clock, the participant records from memory his activities for the day.

sampling is based upon the laws of probability." The statistician calls it random sampling: the larger the sample, the greater the degree of accuracy in the predictions.

The application of this method seems to be in three distinctly different areas. One use concentrates on forecasting, maintaining, and improving the quality of products, or quality control.

Another use establishes or sets work standards, or time standards, for a job. One of the earliest and simplest examples of this was called the "ratio-delay" method; it measured the ratio of work-time to delay-time of machines or workers. Conway (12) provides a recent forestry application, pinpointing delays in logging operations.

A third use is an increasing tendency to analyze different groups of people, such as school teachers (2), engineers (40), and missile workers (36). When used in this way, concentration is more on what people do and less on machines and production schedules. Gradually the idea of research on managers is being accepted, although the total number of managerial time studies is small, even when methods other than work sampling are included.

Advantages and limitations of work sampling

Traditional work sampling, where an outside observer makes random observations of his subject at work, possesses several key advantages over the continuous time study (2). Some advantages

which apply to this study are:

1. Work sampling may be preferred by those who are being studied; some people do not like being continuously observed.
2. Work sampling is less likely to cause the observed to change his routine or alter his behavior.
3. Little observer training is required and the fatigue factor of the observer is much less.
4. Observations can be spread over days, weeks, or months, thereby giving a fairer view of activity.
5. The study can be interrupted, stopped and restarted without seriously affecting the results.
6. The degree of accuracy can be chosen in advance by predetermining the sample size.
7. It usually requires less time to calculate the results of work sampling, especially with the use of computers.

Some limitations of traditional work sampling, in terms of this study are:

1. In situations requiring one observer for one operator, it is uneconomical.
2. The operator may change his work pattern when being watched; the results would then have little value.
3. Sample size has to be quite large if a high precision estimate is required.
4. Work sampling is difficult to explain to the participants.

Since this study is concerned with managerial behavior, two more limitations of the traditional work sampling method must be considered. A manager's job is both versatile and mobile. An observer has a difficult time evaluating activities such as talking, reading or thinking (7) and he has the problem of following the manager to a variety of locations.

An alternative: self observation system

Faced with the limitations of the traditional work sampling approach, an alternative method was suggested by Dr. Miles Martin,[1] Department of Communications, Michigan State University. A self observation system incorporating a novel Random Alarm Mechanism had been tried with success by Martin (26). Its major advantage: the observer and the observed were the same person.

Recently, several other work sampling studies have been conducted using some form of the self observational technique. White (40), in a pilot study of engineers, used a low power, centrally located radio transmitter which emitted a tone and then a voice message to each participant carrying a vest pocket receiver. The tones arrived randomly.

Carroll and Taylor (7) tested the validity of the self observational central signalling method against traditional work sampling with clerks in an office. Overhead lights were flicked on and off at random

[1] Currently at Syracuse University, Syracuse, New York.

times as a signal for the workers to check an activity sheet. An outside observer made another set of observations. The differences between the methods ranged from .1 to 3.3%, depending upon the activity. While this variation would not be accurate enough for setting job standards, they felt that a self observational technique would be the most realistic approach to studying time allocations of personnel in managerial positions.

Even with its own set of limitations, for this study the self observation system could overcome most of the disadvantages of traditional work sampling, and still retain the advantages that work sampling has over the continuous time study.

1. The cost of conducting the study would be substantially reduced. Either of the other methods would have required 276 man days devoted to gathering data alone by an outside observer.
2. Although the possibility of behavior change cannot be ruled out, the participant would not be influenced to change his work pattern in the same way he might if he were being watched. Some self-reporting bias could occur, however, unless he was guaranteed anonymity of his recording.
3. The sample size could be adequately large because outside observers would not be required to gather the data.
4. Activities such as "think time" and "getting information about a problem" could be self-evaluated if meaningful categories

of activity were provided for the participant.

5. Freedom of movement would be possible. Because of the location of sawmills, a random signal transmitted by radio or by telephone would have been prohibitive in terms of distance and cost. The compact individualized Random Alarm Mechanism could overcome this obstacle.

Pilot studies

Twelve Random Alarm Mechanisms were obtained on loan from Merck, Sharp and Dohme on a trial basis. At the time of their acquisition, they were the only devices being manufactured in the United States with a set average signal rate[1] considered acceptable to managers. Several people in the Forest Products Department at Michigan State University carried a unit for two weeks, recording alarm times and activities. The units performed according to their specifications, but several shortcomings were evident in light of the intended use. These will be discussed in Chapter III.

Perhaps one of the most important aspects of this study was the design and building of the new random alarm instrument to meet the specific needs of sawmill managers and their surroundings. Twelve new devices were built by Thomas H. Charters, an electrical engineer, according to desired specifications. A bench test conducted on

[1] One of the tested Random Alarm Mechanisms had an average rate of one signal every 151 minutes.

instrument Serial Number 81 constituted the second pilot study. Chapter III is devoted entirely to the new Random Interval Timer.

Before enough of the new instruments were available to begin the general study, one manager agreed to use the first device on a trial basis. It was set to emit an average of one signal every 60 minutes. This manager's response to the trial period indicated that such a large number of signals per day would irritate many managers and the rate should be reduced. As the rest of the Random Interval Timers arrived and were put into the field, they were set to signal an average of once every 80 minutes (or ±8 signals per day), which seemed to be an acceptable rate for this group of men.

General Work Sampling Procedures and Coverage

If interest was shown by a mill manager during the initial telephone contact, a standard procedure of explanation developed by the writer was followed. This involved traveling to the mill, explaining the project and, if the manager was still interested, leaving an instruction sheet, Random Interval Timer and data cards. The complete instruction sheet is shown in Appendix B.

A minimum of four trips was made to each participant to gather extensive interview information, replenish data cards, and service instruments if needed. It was stressed throughout the study that individual time-use results would remain anonymous, and therefore numbers were used to designate each participant and his firm.

Data Card design

Key activities as they pertain to managers were listed on the Data Card, utilizing the few previous studies available. The first devised form was too detailed and the second was confusing. The sample card shown in Figure 2 represents the final product. The work classifications had to be meaningful to a sawmill manager and easy to record.

Four of the listed activities attempted to uncover the amount of time spent in the decision making process. This decision making group included:

Receiving a problem:	any kind of problem, from broken equipment to a dissatisfied customer.
Getting information about a problem:	consultation with others, reading and writing for available information.
Deciding action about a problem:	consultation with others, "think time" and "creative time"; includes weighing alternatives.
Giving instructions about a problem:	communicating how and what shall be done after the decision has been reached.

The rest of the activities were self-explanatory. Each card was designed to be used for one day (up to 15 signals), and when folded would fit into a shirt pocket. Space was provided to record START time (turning on the instrument) and OFF time; this information was

Mill No. S-8
Month May
Day 25 M (T) W TH F S
Card No. 2

		RIT Time	Time Spent Prior RIT
	Start	7:45	
Training	1	8:10	5
2 Receiving a problem	2	8:37	2
4 Getting info about problem	3	9:03	15
3 Deciding action about problem (think time too)	4	10:17	10
9 Giving instructions about a problem	5	12:11	3
1,8 Routine work	6	12:40	25
Job interviews	7	3:30	0
Correspondence	8	3:45	7
5 Travel	9	9:15	2
7 Break time (personal also)	10		
6 Other (describe)	11		
	12		
	13		
	14		
	15		
	Off	9:30	

EVENT 1 - Opening mail at my desk - talking to Sally (Secretary)

EVENT 2 - Received call from customer that order had not been received

EVENT 3 - I've been thinking for 15 minutes about I'm put to go about my absent lumber grader

EVENT 4- Talking with a salesman about a new band-saw. He contacted me.

(Front side)

(Back side)

EVENT 5- Traveling with my log buyer to lunch

EVENT 6- Eating lunch with my log buyer

EVENT 7- Having coffee with my Sales Manager, Edsall, T

EVENT 8- Making daily tour of mill

EVENT 9- I contacted the mill foreman to tell him what to run tomorrow

EVENT 10-

EVENT 11-

EVENT 12-

EVENT 13-

EVENT 14-

EVENT 15-

Figure 2. Example of Data Card.

important in establishing interval times between signals.

Each time the Random Interval Timer emitted a tone, the manager would record the time under RIT Time and then write down, under EVENT, what he was doing and with whom he was communicating, if applicable. A special column was provided for recording the length of time he had been engaged in that particular activity prior to the signal. Finally, the user was to classify by event number the activity designation which best described the event; TRAINING, ROUTINE WORK, etc.

Proposed vs. actual pattern of coverage

Four sampling plans had been designed in the early planning stages, each with a different number of total observations. In all experiments the researcher is caught between the perfect design and the minimum acceptable to provide useful data. This study was no different; the final group of participants, the available time, arrival of new Random Interval Timers and travel cost contributed to a feasible compromise plan. Table 2 shows the best proposed plan and the actual coverage as it occurred. Numbers 1 through 12 correspond to the mill manager's code designation.

Each manager's observations included different weeks in different months to avoid any bias due to a concentration of unusual circumstances. No data was collected at any mills during the first week in July; traditionally sawmills are closed that week for repairs and the

Table 2. Proposed plan and actual coverage of managers by months and weeks.

Proposed Plan 12 Managers N = 2400 observations					
Week / Month	1	2	3	4	Comments
	Manager				
May	1, 2, 3	4, 5, 6	7, 8, 9	10, 11, 12	Each manager sampled in a different week each month.
June	10, 11, 12	1, 2, 3	4, 5, 6	7, 8, 9	
July	7, 8, 9	10, 11, 12	1, 2, 3	4, 5, 6	4 weeks = 20 working days = 20 x 10 obser/day/mgr = 200 obser/man
August	4, 5, 6	7, 8, 9	10, 11, 12	1, 2, 3	12 mgrs x 200 obser = 2400 total

Actual Coverage 11 Managers N = 2215 observations						
Week / Month	1	2	3	4	5	Comments
				Managers		
May				1, 2, 3	2, 3	Each manager Averaged: 25 working days 8+ obser/day 201+ obser/mgr
June	1, 2, 3, 4, 5, 6	1	2, 4, 5	5, 6	N/A	
July	Mill vacations	1, 4, 6, 7, 9, 10, 11	1, 4, 6, 10, 11	1, 2, 6, 7, 8, 9, 10, 11	1, 2, 6, 8, 9, 10	11 mgrs x 201 + = 2215 total
August	4, 5, 8, 10, 11	3, 5, 7, 9, 10, 11	3, 8, 9, 10, 11	N/A	N/A	

July Fourth holiday.

A composite comparison of monthly, weekly and daily observations is shown in Table 3. The observations become more evenly distributed as the units become smaller, progressing from months to weeks to days. The first five days show a relatively even coverage. If, for instance, the entire group of managers spent Thursday afternoons buying timber, there were approximately as many observations (427) occurring on Thurdays to capture this behavior as there were on any other days of the week.

Table 3. Total distribution of observations (N) by months, weeks and days.

Months	N	Weeks of All Months	N	Days of All Weeks	N
May	189	1st	392	Mon	404
June	465	2nd	561	Tue	429
July	913	3rd	531	Wed	435
Aug	648	4th	496	Thur	427
		5th	235	Fri	420
				Sat	100[1]
Total N	2215		2215		2215

[1]Observations for Saturday are low because some managers operated only half a day.

The coverage by hours of the day was also important. The distribution of observations should be nearly equal for each hour of the day if the managers have not turned the Random Interval Timer off during the day or missed any signals.

In Figure 3 the total distribution of signals is shown for each hour of the day. Different START and OFF times of the managers explains the lower number of observations for the early morning and late evening hours. They had been instructed to switch on when they left their homes and to leave the instrument on until 9:30 p.m. if any company business was being conducted. However, after 4 p.m. a few of the early starters turned off their devices, and the rest of the managers continued to turn off at various times up to 10 p.m.

The hours between the dotted lines represent the average 10 hour day for most of these managers. The upper bold line (and upper figure) represents the total of all observations recorded during each hour. The lower checkered line (and lower figure) represents the remaining total after Saturdays have been subtracted, because some managers did not work a full day.

It is not possible to explain with any certainty the higher than normal deviation in the 12 and 1 o'clock hours. Some operators may have turned the devices off after being annoyed during lunch and forgotten to turn them on again until later.

Examples of the distribution of signals (or observations) for three of the instruments is shown in Figure 4. Here, as in Figure 3, the lower line and numbers indicate the subtraction of Saturdays. While it is felt that any error occurring was most likely human, the instruments would have to be run under varying conditions of movement and temperature to prove that some error was not caused by the

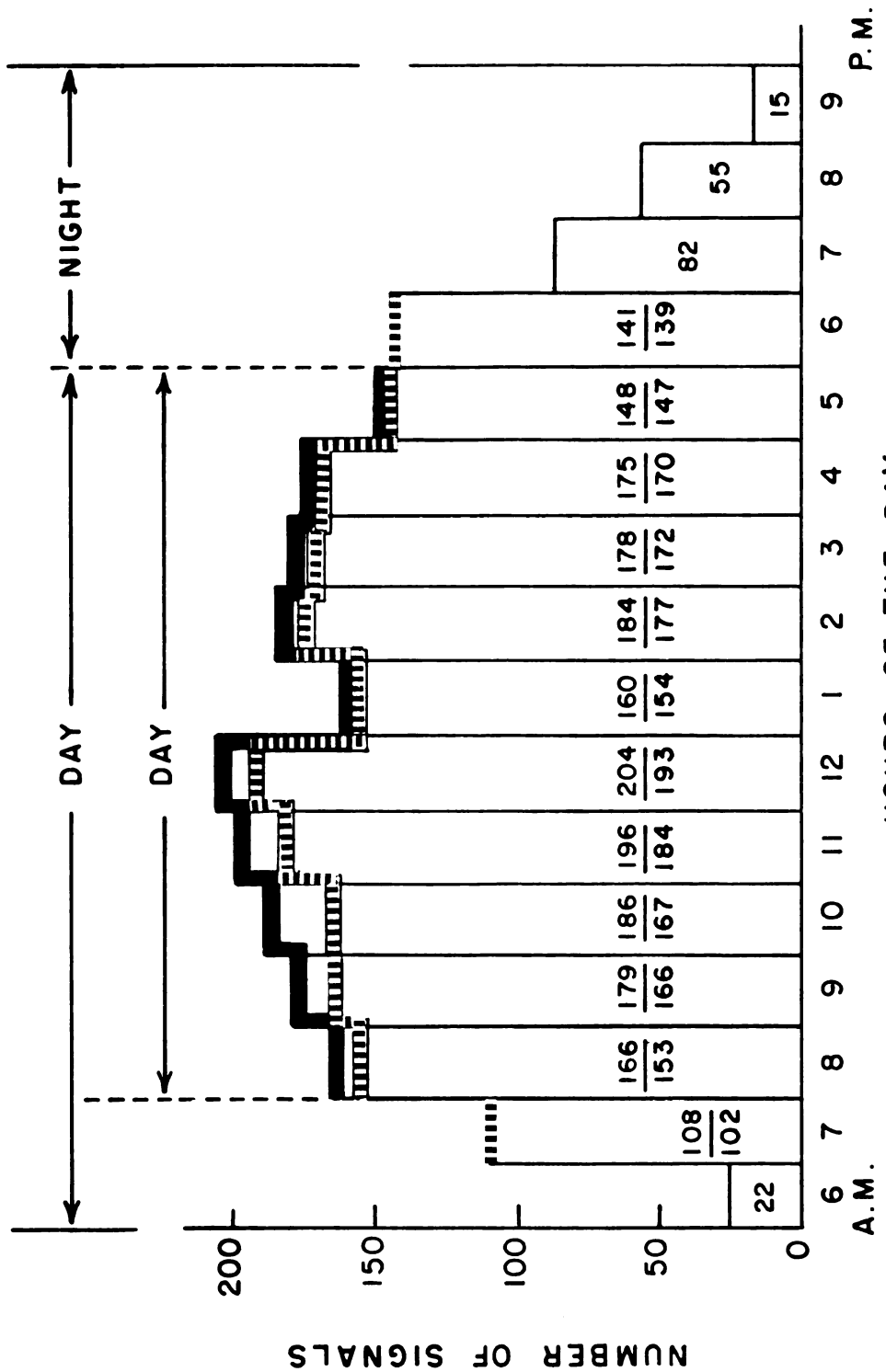


Figure 3. Time signals recorded during each hour of the day (11 managers).

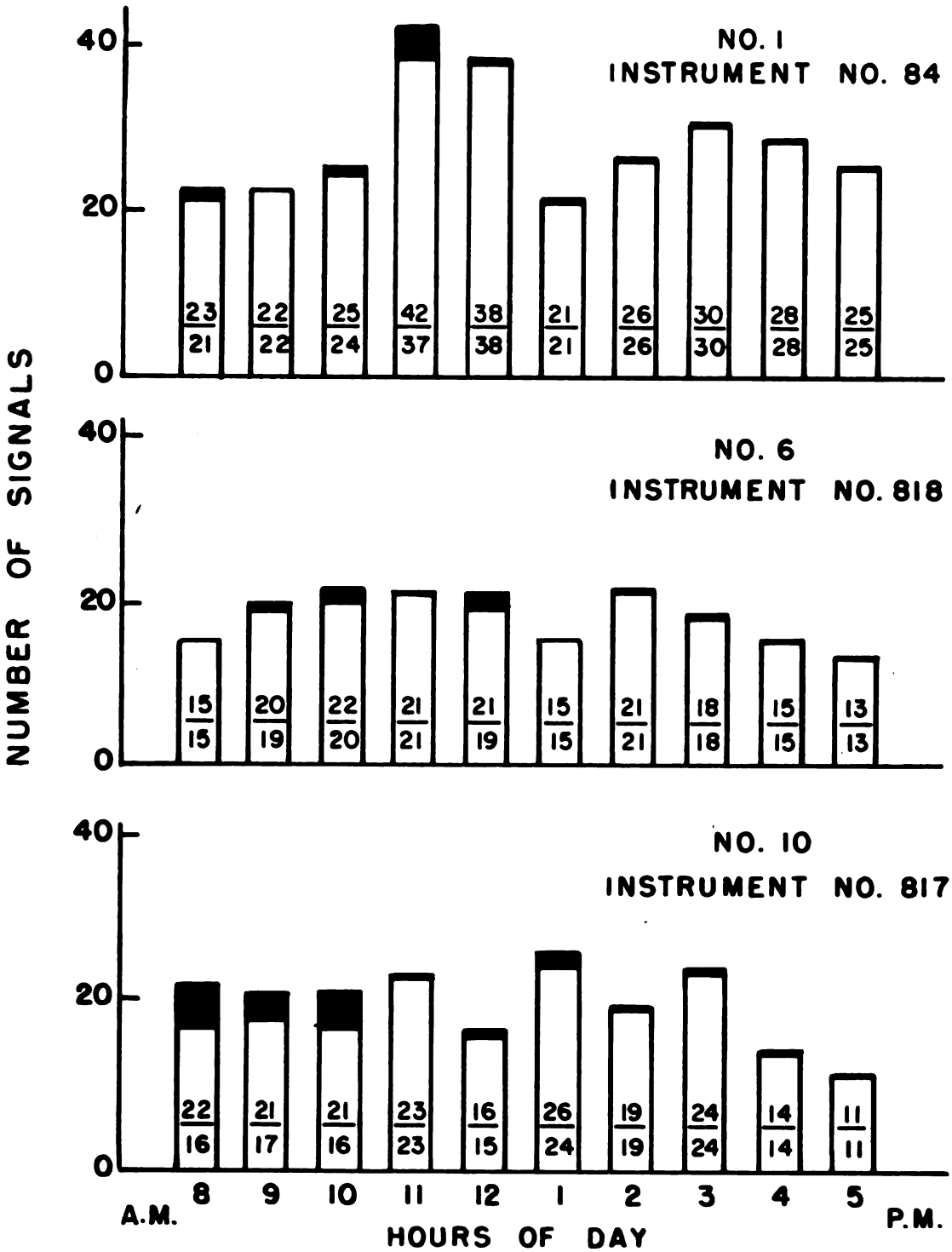


Figure 4. Examples of the distribution of signals per hour of three managers.

instrument. A larger individual manager sample would improve the distribution if the possibility of human and instrument error was eliminated. However, the prime concern in this study is the behavior of the entire group, and of the sub-groups, and therefore utilizes pooled data.

Accuracy of Work Sampling Measurement

One of the difficulties any researcher faces is that of determining a satisfactory number of observations. For sawmill managers, there were no previous studies to indicate the percentage of occurrence each activity would occupy out of the total observations. The decision was made in the beginning to use a confidence level of 95%; in work sampling this is the most widely used. Barnes (2, p. 13), explaining the meaning in simple terms says, "This means that one is confident that 95% of the time the random observations will represent the facts, and 5% of the time they will not." Based upon the 95% confidence level, the expression for determining the accuracy for a given number of observations out of the total is:

$$S(p) = \pm 1.96 \sqrt{\frac{p(1-p)}{N}}$$

where

S- the degree of accuracy[1]

[1] Degree of accuracy is the work sampling term comparable to the statistical Standard Error of the Mean.

p- the percentage occurrence of the activity being measured; p is the percentage of the total number, N.

N- the total number of occurrences (signals) in the sample.

1.96- establishes the left and right critical regions of the normal curve, under which 95% of the area is represented (or the 95% confidence level).

The relationship between the desired degree of accuracy and percentage occurrence of an activity can be seen in Table 4. The higher the percentage an activity occupies of the total sample, the greater the degree of accuracy. As an example, ROUTINE WORK occupied 30.33% of the total observations. Using the above formula, the accuracy is ±6.81% of 30.33%. Down the list, JOB INTERVIEWS made up 0.98 (or 1%) of the total observations and the degree of accuracy slips to 44.40% of 1%.

By multiplying the percentage of occurrence by the degree of accuracy the Absolute Error and True Value range can be found. The accuracy of ±6.81% of 30.33% equals the Absolute Error of ±2.04%. This is another way of saying that for ROUTINE WORK the True Value lies between 28.29% and 32.37% (30.33% ± 2.04%) and there is the probability that 95% of the time (confidence level) this is a true representation.

The practical question arises: Is it better to have a high degree of accuracy for activities that represent from 1% to 10% of the total

Table 4. Accuracy table for the daytime activities of 11 sawmill managers.

Activity	No. of Obs.	% of Total	S (%) Degree of Accuracy	(%) Absolute Error	% True Value Range
ROUTINE WORK	585	30.33%	± 6.81%	±2.04%	28.29-32.37
MANUAL WORK	225	11.67	12.26	1.43	10.24-13.10
GETTING INFO ABOUT A PROBLEM	202	10.47	13.03	1.37	9.10-11.84
MEAL, BREAK TIME	199	10.32	13.17	1.36	8.96-11.68
TRAVEL	191	9.90	13.46	1.33	8.57-11.23
DECIDING ACTION	165	8.55	14.55	1.25	7.30- 9.80
GIVING INSTRUCTIONS	128	6.64	16.79	1.11	5.53- 7.75
HOME, PERSONAL	104	5.39	18.68	1.01	4.38- 6.40
CORRESPONDENCE	74	3.84	22.45	0.85	2.99- 4.69
RECEIVING A PROBLEM	35	1.81	32.96	0.59	1.22- 2.40
JOB INTERVIEWS	19	0.98	44.40	0.44	0.54- 1.42
TRAINING	2	0.10	141.05	0.14	0- 0.24
TOTAL DAYTIME OBSERVATIONS	1929	100.00%	---		

(for which a tremendously large sample size would be necessary), or is it better to keep the Absolute Error below a reasonable minimum for the entire study?

The answer lies in the type of research. For a managerial study, a variation of ±2.5% Absolute Error is acceptable. To lower the Absolute Error to ±1% for ROUTINE WORK, thereby narrowing the True Value range slightly, would have required approximately 8200 observations. The additional cost of expanding the study to four times its size is not warranted for the sake of saying that 30.33% could have been 29.33% or 31.33% instead of 28.29% or 32.37%!

III. THE RANDOM INTERVAL TIMER

History of the Instrument

In a developmental sense, the history of the Random Interval Timer or Random Alarm Mechanism is most fascinating. The complexities of developing a small electronic device that will produce an audible signal at random moments in time cannot be underestimated.

The first prototype was developed by Stuart Cooke of Case Institute of Technology in 1960 for use by their Operations Research Group in conducting a nationwide study involving chemists and physicists (26). The basic design was simple and ingenious, but required some skill on the part of the carrier in the "re-set" operation by counting ten flashes on two small neon lights and returning the switch to the "run" position. Its major drawbacks were: (1) it would not signal until a lag period of two or three hours had elapsed after it was initially started, and (2) its output was dependent on the position of two mercury tilt-switches induced by motion.

A commercially built unit called RAM-1[1] came on the market in the mid-nineteen sixties and offers some improvements over the

[1] RAM-1, Random Sampler, Electronic Ideas, Inc., Wyncote, Pennsylvania.

original design. It is compact and has only one small fiber wheel for the operator to manipulate. Since the instrument is built to produce one specified average number of signals, its lack of versatility limits its possible applications. There is also a more serious problem; the device could cease to be a truely random timer if the operator forgets to turn the fiber wheel, which is the heart of its unpredictability.

With these shortcomings in mind, Mr. Thomas H. Charters, a consulting electrical engineer, was asked to design a new instrument.

General Requirements for Design of the Instrument

It was suggested that for this study involving sawmill managers the desirable features of the new device should include:

1. Self-contained circuitry that did not require the operator to turn wheels or switches after each audible alarm.
2. A choice of several average signal rates so that the annoyance factor could be accommodated to the user.
3. A built-in speaker and external earphone jack with a volume control. This would allow the user to adapt the device to various noise levels found around heavy machinery without being embarrassing in quiet environments.
4. A reasonable size and weight.
5. Belt straps for concealed and convenient carrying.

Technical Requirements for Design of the Instrument

The technical objective was to produce a sampling device which would sample uniformly in time but in such a manner that the user could not anticipate the signal.

The uniformity in time specification arose from the logic that each hour of the day should be sampled with an approximately equal number of observations. Satisfaction of this requirement could have been achieved by selecting a reading every 30 minutes and asking the manager to record what he was doing at 8:00 a.m., 8:30 a.m., 9:00 a.m. and so on. Three difficulties arise with this technique. (1) It requires the manager to remember to look at his watch and write down his observations. (2) If he forgets an observation and his memory is unreliable, the results could be biased as he tries to recall his actions. (3) His normal behavior pattern could be changed if he began to anticipate the established times.

Another way to achieve uniformity could have been the use of a random time table. By taking a large number of observations, each hour of the day would be fairly represented. This technique would produce all the difficulties mentioned in the previous paragraph since the random times would have to be written down, carried and referred to.

The Random Interval Timer solves these three difficulties and also satisfies the second portion of the technical objective. The user

cannot anticipate the signal. Uniformity over time should be achieved if the number of observations is large enough and the user does not turn the Random Interval Timer off and on during the period of study.

The theoretical model

The requirements mentioned in the preceding paragraphs are best fulfilled by the Poisson Model or Poisson process.

The approach toward choosing a mathematical model for this study is reversed from most real-world situations. Normally the researcher is confronted with a collection of data that he believes behaves according to a particular model such as arrivals of autos at toll booths or coal mining disasters. If, by analysis, the historical evidence compares well with that model, he can make good approximations about the future from that model, such as the maximum back up of vehicles or time between mining accidents (35).

In the case of the Random Interval Timer, a theoretical model was chosen whose behavior best fulfilled the technical requirements without neglecting the realities of design. It can be used to collect data for a wide range of studies if the conditions are thought to be the same as the model. The Random Interval Timer generates events (signals) according to a model rather than the researcher recording events as they occur and then finding the best-fit model. Finally, the instrument can be tested against its own theoretical model to see if it is operating according to design specifications.

The main features incorporated in the definition (35) of the Poisson process are:

1. The process is stable. The mean rate of occurrence, μ,[1] must be constant if the series is to be random.
2. The probability of a signal occurring in the interval of time t to $t + \Delta t$ is always $\mu\Delta t$.
3. Any chance of a signal (event) occurring in the interval of time t to $t + \Delta t$ is independent of all prior signals (14).
4. Two or more signals cannot occur simultaneously. There will always be some measurable interval between any pair of signals.
5. The signals are seemingly uncontrolled and unpredictable, but over a long period of time the total number of events are predictable (equal to μT, where μ = the mean rate of occurrence and T = total elapsed time).

The above five features make up the main definition of the process. Three additional characteristics are included because of their graphical application.

6. The signals have a Poisson distribution. The probability (chance of occurrence) for a given number of signals in a given period of time may be calculated from the expression:

---

[1] Also called the "average arrival rate," "rate of occurrence," "a reciprocal of time" depending on the source of reference. μ is not to be confused with M, the mean of the Poisson distribution; $M = \mu t$.

$$P(k) = \frac{e^{-\mu t}(\mu t)^k}{k!}$$

where:

P(k) = the probability of obtaining exactly k signals (events)

μ = mean rate of occurrence

k = number of signals (events)

t = time

7. Distribution of time intervals, Δt, between signals will have an exponential distribution with the mean interval equal to $1/\mu$ and defined by the expressions:

$$P(t) = \mu(e^{-\mu t})$$

where: P(t) is the probability of obtaining an interval length of value t, a point on the smooth exponential curve.

A more useful expression is to construct a grouped frequency distribution, or histogram, with Δt wide bars:

$$\Delta t P(t) = \mu \Delta t(e^{-\mu t})$$

where: $\Delta t P(t)$ is the probability that an interval of time, Δt, is centered upon mid-point value t.

It is this characteristic exponential distribution of the time intervals that reassured the researcher that the users of the

instrument would be prevented from anticipating the next signal.

8. Using a large enough sample size, the distribution of signals over time (hours of the day in this study) are uniform.

With the theoretical Poisson model in mind, it was possible to design a new type of random alarm mechanism.

The new Random Interval Timer

Mr. Thomas H. Charters, operating within the general and technical constraints, invented and applied for a patent (9) on the instrument shown in Figure 5 and Figure 6. In Figure 5, the numbers apply to circuitry and the letters to wave-forms.

There are two pulse inputs into a coincidence detector, 14. When these pulses coincide, an audible output is produced.

The source of one of the pulse inputs, and a critical feature of this device, is a random noise generator, 10, producing a noise signal A that modulates the output of the rectangular wave generator, 12. The rectangular wave generator is capable of producing a train of rectangular waves, B, itself, if it is not affected by the A input. The noise input is effective for either advancing or retarding the occurrence of each pulse output. As a result, an output signal, B, is produced comprising negative-going pulses occurring at substantially random times into the coincidence detector, 14. In designing the circuit, the duration of each negative-going pulse, B, was

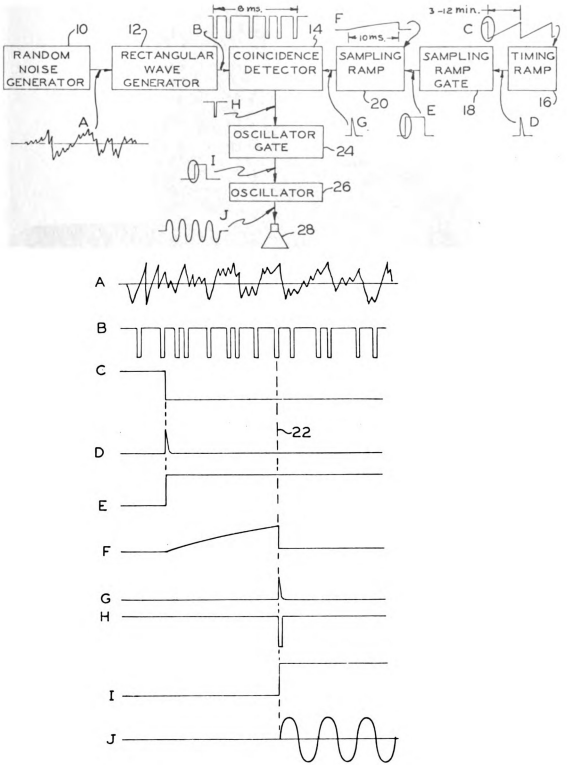


Figure 5. Block diagram of new Random Interval Timer[1] and waveforms.

[1] From U. S. Patent Office Application Serial No. 805-339.

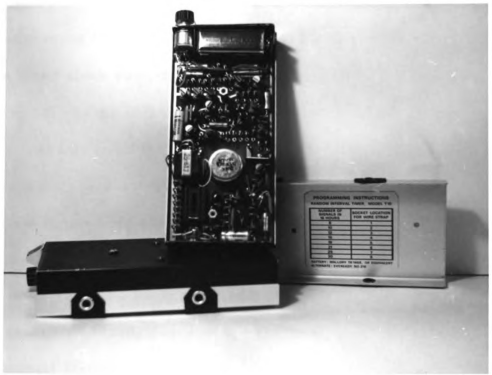


Figure 6. Photograph of the Random Interval Timer.

established at approximately ten percent of the period between pulse occurrences (9). Therefore, there is about a ten percent chance that the other given wave-form, output G, will coincide with wave-form B in the coincidence detector, 14.

At this point the device can best be described as a systematic Bernoulli process. The sampling principle is analogous to flipping a coin with one head and nine tails. On the average, one out of ten tosses will produce a head, or signal in this case. If a large number of these repeated Bernoulli trials were plotted with the established probability of coincidence of approximately 0.1 at each sampling, the binomial distribution shown in Figure 7 would result from calculations in Table 5.

> Where the Bernoulli process is characterized by the probability of success (signal) on any trial, the Poisson process is characterized by the expected number of successes (signals) per unit of space (time) (35, p. 212).

The second pulse input with two time delay circuits provides a signal period on the order of minutes. The second input is provided from a pulse generator comprising a timing ramp, 16, a sampling ramp gate, 18, and a sampling ramp, 20. The timing ramp allows the user to select a sample period in advance. There are eight choices, or strap settings, ranging from 3 to 12 minutes. Since wave-form G will coincide with wave-form B on the average of once every 10 samples, it becomes a matter of multiplying by ten to find the average signal period.

Example: Strap setting No. 3 has an 8.0 minute sample period. A probability of coincidence of approximately 0.1 at each sampling will yield an average of one alarm every 80 minutes (10 x 8.0 minutes).

The sampling ramp gate, 18, and the sampling ramp, 20, merely take the relatively long duration wave-form C (several minutes) and generates a pulse for input into the coincidence detector. In other words, the second time delay circuit, 20, takes the output of 18 and produces a pulse, G, in a very short period of time. This prevents pulse G from being influenced by wave-form B. The dotted line, 22, in Figure 5 shows all the wave-forms generated in the instrument and the instance of a coincidence between pulses B and G. Pulse H then triggers the oscillator gate, 24, which allows the oscillator, 26, to operate, generating an output signal tone J in the speaker, 28.

The relationship between the binomial probability law to reduce approximately to the Poisson probability law is seen in Figure 7 and Table 5. These curves will remain the same regardless of the time setting because even though the average signal rates may change, the probability of coincidence remains 0.1. Therefore, the probability of obtaining exactly one signal is greatest when the elapsed time is equal to ten times the sampling period of the timing ramp, 16.

There are three innovations in this instrument:

1. The detection of coincidence between two separate pulses,

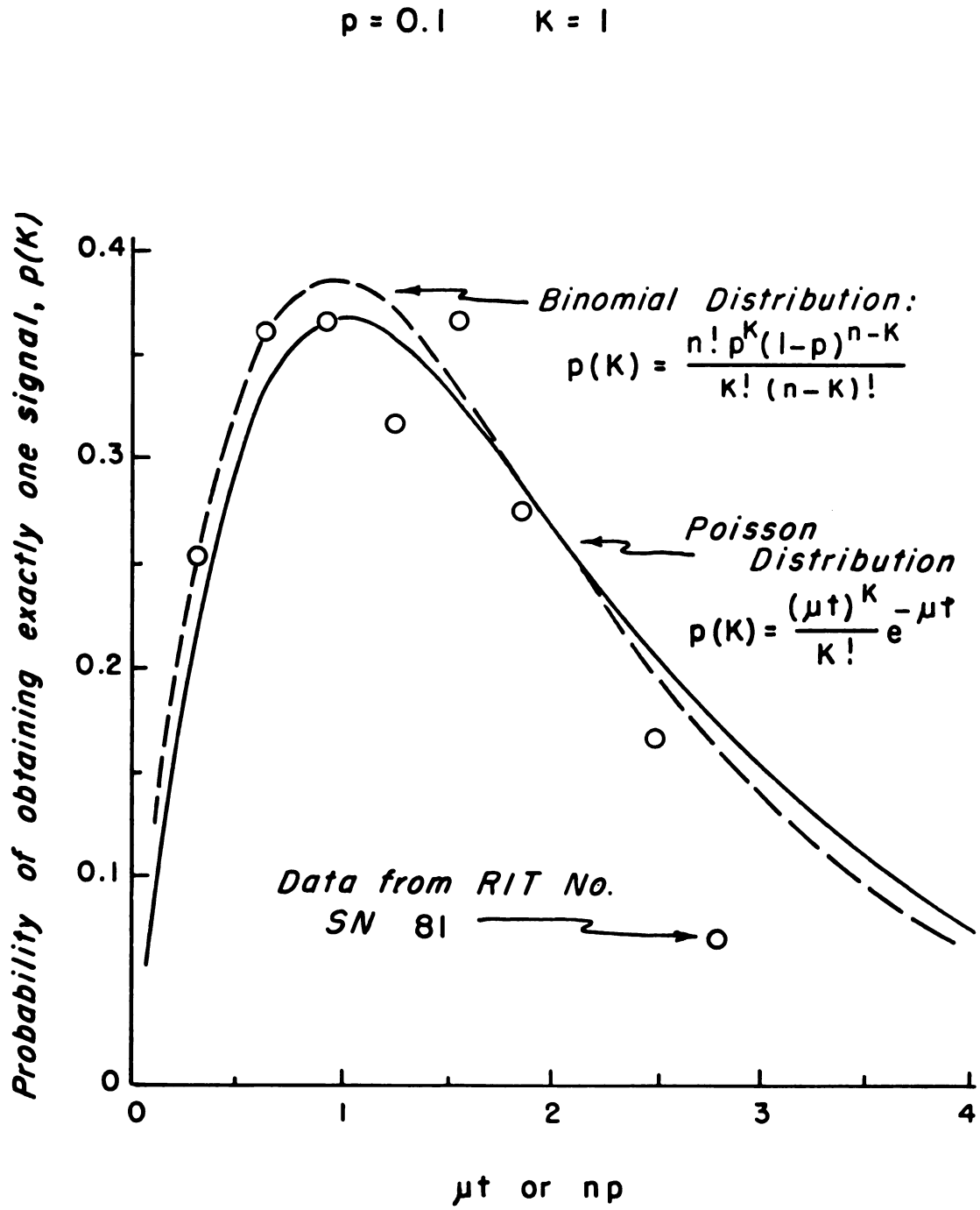


Figure 7. Poisson, binomial probability distributions of the Random Interval Timer.

Table 5. The mathematical comparison of the binomial and Poisson probability distributions.

Binomial	Poisson
n = number of samples	μ = mean rate of occurrence or average signal rate
k = number of successes, signals or events	k = number of successes, signals or events
P = probability of success at each sample	P = probability of success
(1-P) = probability of failure at each sample	t = time

If k = 1, then P(k) = the probability that one signal, and one only, will occur in time t. The following table was constructed and the results plotted in Figure 7. Both expressions are simplified when k = 1.

μt or nP $\mu t = nP$	n when P = 0.1	n-1	$(0.9)^{n-1}$	$n(0.9)^{n-1}$	$e^{-\mu t}$	Poisson P(k) $e^{-\mu t}(\mu t)$	Binomial P(k) $\frac{n(0.9)^{n-1}}{10}$
0.20	2	1	0.900	1.80	0.819	0.164	0.180
0.50	5	4	0.656	3.28	0.607	0.303	0.328
0.70	7	6	0.531	3.71	0.497	0.348	0.371
1.00	10	9	0.387	3.87	0.368	0.368	0.387
1.20	12	11	0.314	3.77	0.301	0.361	0.377
1.50	15	14	0.229	3.44	0.223	0.334	0.344
2.00	20	19	0.135	2.70	0.135	0.270	0.270
3.00	30	29	0.047	1.41	0.050	0.150	0.141
4.00	40	39	0.016	0.66	0.018	0.073	0.066

Note: This curve is universal--it will apply for all signal rates selected in the Random Interval Timer. The peak occurs at $\mu t = nP = 1$

$\mu t = 1$ when $nP = 1$ where

$P = 0.1$

$\therefore n = \frac{1}{P} = \frac{1}{0.1} = 10$ which means that the probability of getting one signal is greatest when circuit takes 10 samples.

one random and one periodic.

2. The use of the two ramps to insure the independence of pulses in the coincidence detector.
3. The controlled probability of coincidence, in this case small enough so that the output signals substantially satisfy the definitions of the Poisson process.

The present circuit is automatic and continues to produce output signals having a Poisson distribution without resetting or other human intervention, thereby rendering the output distribution substantially free of error.

Testing the Instrument

The output of this device can easily be tested against the Poisson distribution. All of the tests referred to in this section were made on the first production model, Serial Number 81. The instrument was programmed for an average of one signal every 25 minutes.

Three characteristic curves of the Poisson process are shown in Figure 8.

1. Figure 8a: The Probability of Obtaining Exactly One Occurrence (signal). Other curves for $k = 2$, $k = 3$, $k = n$ have been omitted.
2. Figure 8b: Percentage of Occurrences. This distribution shows the percentage of waiting times or intervals between signals, and is exponential for a Poisson process. This

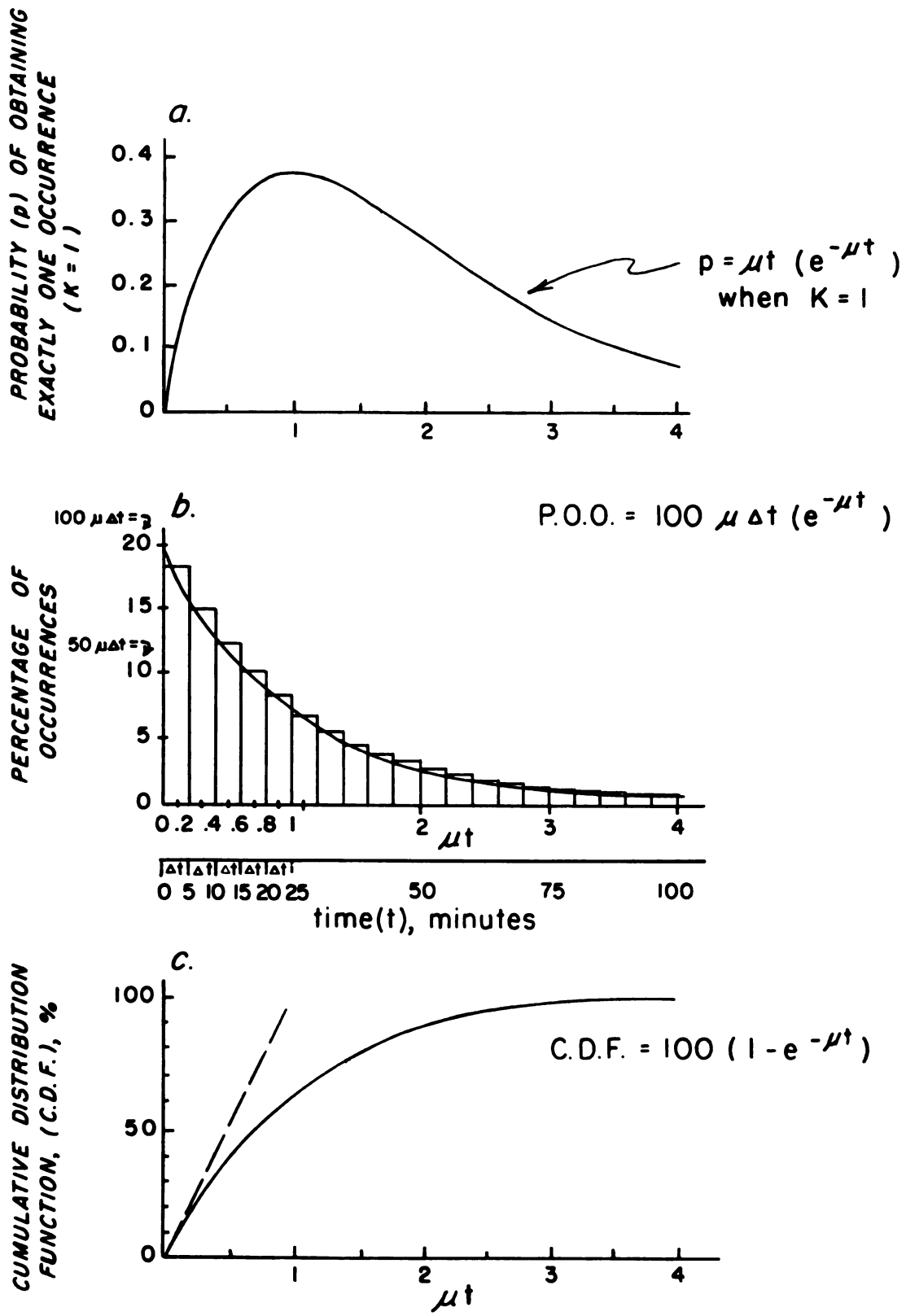


Figure 8. Three characteristic curves of the Poisson process.

histogram is helpful in detecting deviations of the observed data. The theoretical curve is also shown.

3. Figure 8c: Cumulative Distribution Function. This theoretical curve was the most useful of the three in this study as the empirical data could be compared to it using a computer program of a one-sample Kolmogorov-Smirnov test of fit (32).

With the three curves of Figure 8 as a base of comparison, a closer look was taken at test instrument Serial Number 81. The results already plotted from Table 5 in Figure 7 produce an accurate representation of Figure 8a.

Still another method of plotting is shown in Figure 9 using Table 6 for the data. By actually counting the number of signals that occurred in every 24 minute period along the continuum of total time the instrument ran, the percentage distribution of signals per set time period can be plotted.

An example in Table 6 shows that one signal occurred in 34 out of 89 of the 24 minute time periods. In Figure 9, the observed data is plotted against the theoretical values. A good correlation exists for such a short bench test. The fit shows that the actual signal occurrences have a Poisson distribution.

If the operating device is performing as designed, then given the Poisson process, the distribution of time intervals between signals is exponential. Figure 8b shows the theoretical distribution of the time intervals with the mean rate of occurrence set in the instrument

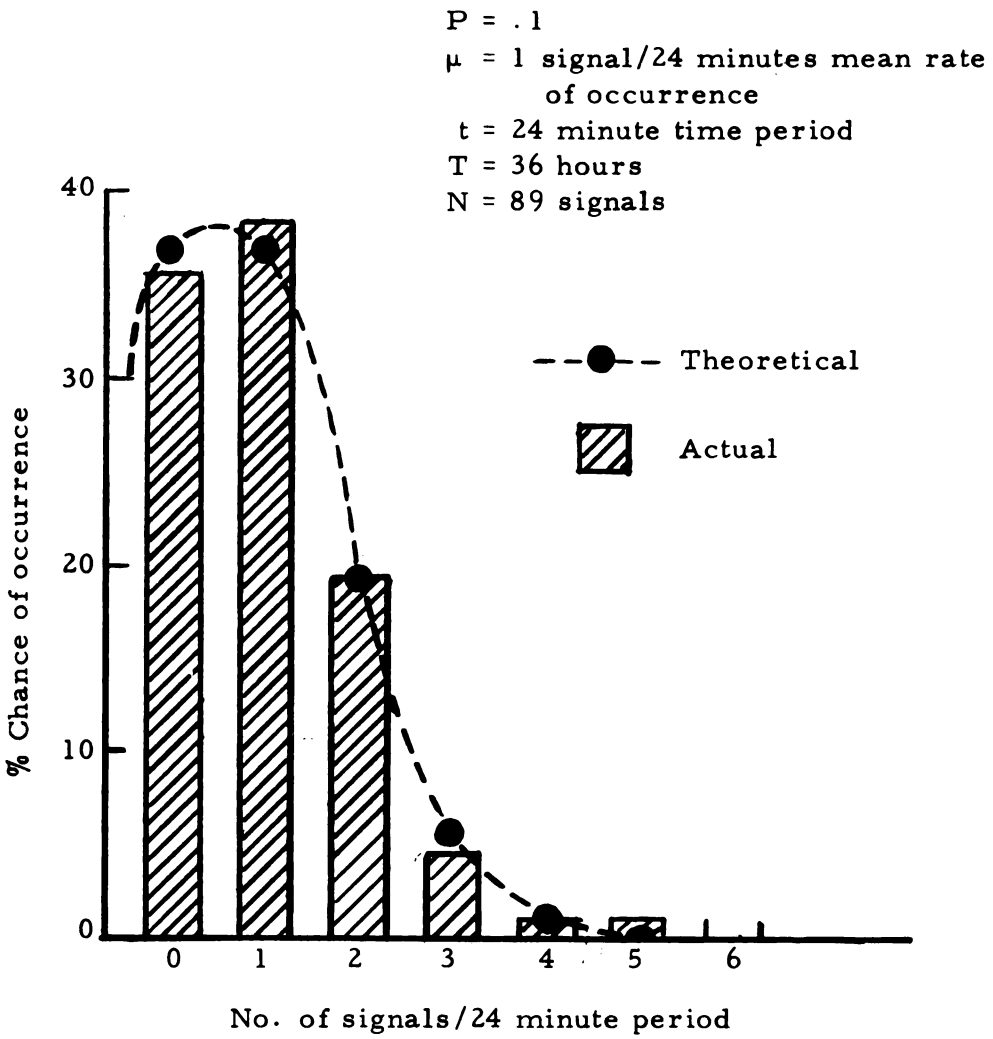


Figure 9. Distribution of signals per time period--actual vs. theoretical for SN 81.

Table 6. Distribution of signals per time period actual vs. theoretical for SN 81.

Signals (k)	No. /24 min period No. /t	Actual No. of Periods Occurring	Actual No. of Signals	Actual % Chance of Occurrence
	0	32	0	35.8
	1	34	34	38.3
	2	17	34	19.2
	3	4	12	4.5
	4	1	4	1.1
	5	1	5	1.1
	6	0	0	0
		89	89	100.0

k	$\frac{e^{-\mu t}(\mu t)^k}{k!}$	% Chance of Occurring	Theoretical No. of Periods Occurring	Theoretical No. of Signals	Theoretical Chance of Occurrence
0	.368	36.8	33	0	37.0
1	.368	36.8	33	33	37.0
2	.184	18.4	17	34	19.2
3	.061	6.1	5	15	5.7
4	.015	1.5	1	4	1.1
5	.003	0.3	0	0	0.0
6	.001	0.1	0	0	0.0
	1.000	100.0	89	86	100.0%

at $\mu = \frac{1}{25}$. The Percentage of Occurrences column of Table 7 was used to plot the theoretical curve with a grouping time interval of five minutes.

If the actual number of signal periods (interval in minutes between signals) is plotted against the theoretical number expected, any serious lack of fit should be detected. Figure 10 represents a histogram of SN 81 in exponential form. Notice the slight oversampling in the short times and under sampling in the log times (except for 30 and 60 minutes). The best explanation possible is that the total time the instrument was run was too short for such an extensive statistical comparison. In the actual study these devices were run for weeks so that the total number of signals was substantial.

Still another way to look at the distribution of interval times, given the Poisson process, is to plot the curve of the exponential function $P(t) = \mu e^{-\mu t}$. Then for a particular μ ($\frac{1}{25}$ or 0.04), one can determine $t_1, t_2, t_3, \ldots, t_{10}$, so that the area under the curve is divided into equal parts.

Using $\mu = 0.04$ we solve for $\bar{t}$ from the basic expression:

$$\int_0^{\bar{t}} \mu e^{-\mu t} dt = -e^{-\mu t} \Big|_0^{\bar{t}} = -e^{-\mu \bar{t}} + 1$$

If the number of occurrences within these time intervals is recorded, a visual evaluation can be made on the goodness-of-fit. The

Table 7. The calculated percentage of occurrences for time intervals (between signals) in the Poisson process--actual vs. theoretical for test instrument SN 81.

Total elapsed time (T) SN 81 was run = 36 hours
Total signals N = 89
Mean rate of occurrence $\mu = 1/24$ .... set $\mu = 1/25$
Mean interval $1/\mu = 24$ minutes ..... set $1/\mu = 25$ minutes

Time Interval Δt in 5 Minute Brackets[1]	μt of Δt Midpoints	$e^{-\mu t}$	$\mu \Delta t$	Percentage of Occurrences (P.O.O) $100(\mu \Delta t)e^{-\mu t}$	Theoretical No. of Occurrences N x P.O.O.	Actual No. of Occurences	Cum. Distr. Function %
0-5	0.100	.905	.2	18.10%	16.1	20	9.5
5-10	0.300	.741	.2	14.82	13.2	14	25.9
10-15	0.500	.607	.2	12.14	10.8	12	39.3
15-20	0.700	.497	.2	9.94	8.4	9	50.3
20-25	0.900	.407	.2	8.14	7.2	6	59.3
25-30	1.100	.333	.2	6.66	5.9	1	66.6
30-35	1.300	.273	.2	5.46	4.9	6	72.7
35-40	1.500	.223	.2	4.46	3.9	3	77.7
40-45	1.700	.183	.2	3.66	3.2	2	81.7
45-50	1.900	.150	.2	3.00	2.7	3	85.0
50-55	2.100	.122	.2	2.44	2.1	2	87.8
55-60	2.300	.100	.2	2.00	1.8	1	90.0
60-65	2.500	.082	.2	1.64	1.5	4	91.8
65-70	2.700	.067	.2	1.34	1.2	1	93.3
70-75	2.900	.055	.2	1.10	1.0	1	94.5
75-80	3.100	.045	.2	.90	.8	1	95.5
80-85	3.300	.037	.2	.74	.7	2	96.3
85-90	3.500	.030	.2	.60	.5	0	97.0
90-95	3.700	.025	.2	.50	.5	0	.
95-100	3.900	.020	.2	.40	.4	0	.
100-105	4.100	.017	.2	.34	.3	0	.
105-110	4.300	.014	.2	.28	.3	0	.
110-115	4.500	.011	.2	.22	.2	1	.
		Approaches 0		98.88% Approaches 100.00%	87.7 Approaches 89	89	Approaches 100.00%

[1] Bracket used to capture the length of time interval between signals. Example: Elapsed time of 77 minutes between signals falls into the 75-80 bracket (a fixed 5 minute wide Δt bar) for histogram purposes.

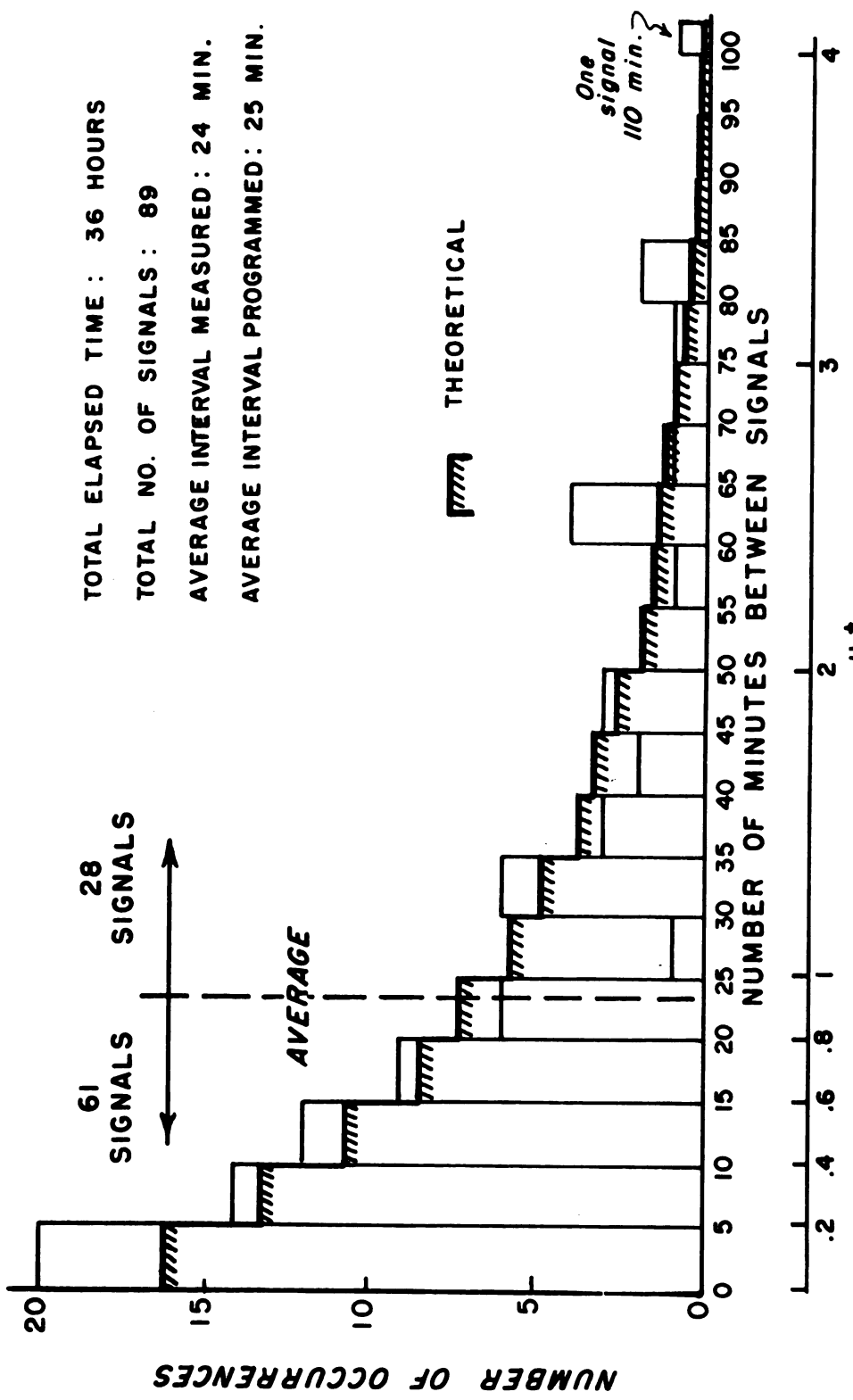


Figure 10. Distribution of signal intervals for the Random Interval Timer--actual vs. theoretical.

advantage is that the expected number of signals is the same for all panels; it is the observed signals that vary.

Table 8. Calculations of $\bar{t}$ in minutes.

Area	$\bar{t}$	(Minutes)	E = N/10 = 89/10 = 8.9
.1	t_1	2.62	8.9
.2	t_2	5.57	8.9
.3	t_3	8.88	8.9
.4	t_4	12.74	8.9
.5	t_5	17.40	8.9
.6	t_6	22.85	8.9
.7	t_7	29.70	8.9
.8	t_8	40.20	8.9
.9	t_9	57.50	8.9
1.0	t_{10}	∞	8.9

Figure 11 shows the plotting of $\bar{t}$ and the actual number of signals versus the expected number of signals, E. Considering the same shortcomings as before, the instrument over performed slightly on the short times except between t_2, t_3, and t_3, t_4 where it was three signals low. The instrument performed better on the longer times. This graphical representation and mathematical method is also included for the purpose of testing an instrument. A longer period of time for testing would have been advantageous to the results.

The final curve is the Cumulative Distribution Function shown in Figure 8c. While it is the integral of the exponential curve of

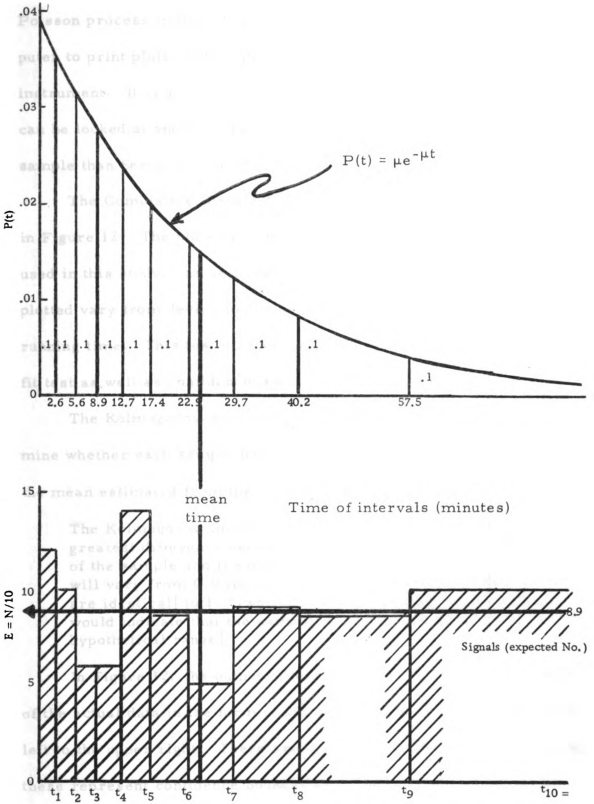


Figure 11. Expected vs. actual number of signals of SN 81.

Figure 8b, it provides an accurate method of analyzing the entire Poisson process in this study. This was achieved by using the computer to print plots of the cumulative distributions of outputs on each instrument. It is at this point that the data from 11 field instruments can be looked at and their performance analyzed in terms of a larger sample than Serial Number 81.

The Cumulative Distribution Plot for Manager Number 1 is seen in Figure 12. The plots for the other 10 instruments, as they were used in this study, can be found in Appendix D. The number of signals plotted vary from device to device because of different lengths of total running time. This test provided an excellent graphical goodness-of-fit test as well as confidence intervals for each instrument.

The Kolmogorov-Smirnov One-sample Test was used to determine whether each sample had come from a Poisson distribution with the mean estimated from the sample. As stated by Morris (32, p. 2),

> The Kolmogorov-Smirnov statistic D, is a measure of the greatest difference between the cumulative distributions of the sample and the hypothetical population. . . . It will vary from 0.0 [in which case the two distributions are identical] to 1.0 [which, if there has been no error, would indicate that the sample is wholly outside the hypothetical range].

In Figure 12, the output of this program shows the distribution of the actual data in the form of printed stars running from the lower left to the upper right. There are three other pairs of curves shown; these represent confidence boundaries. The x's correspond to ten percent confidence bounds, the 5's for five percent, and the 1's for

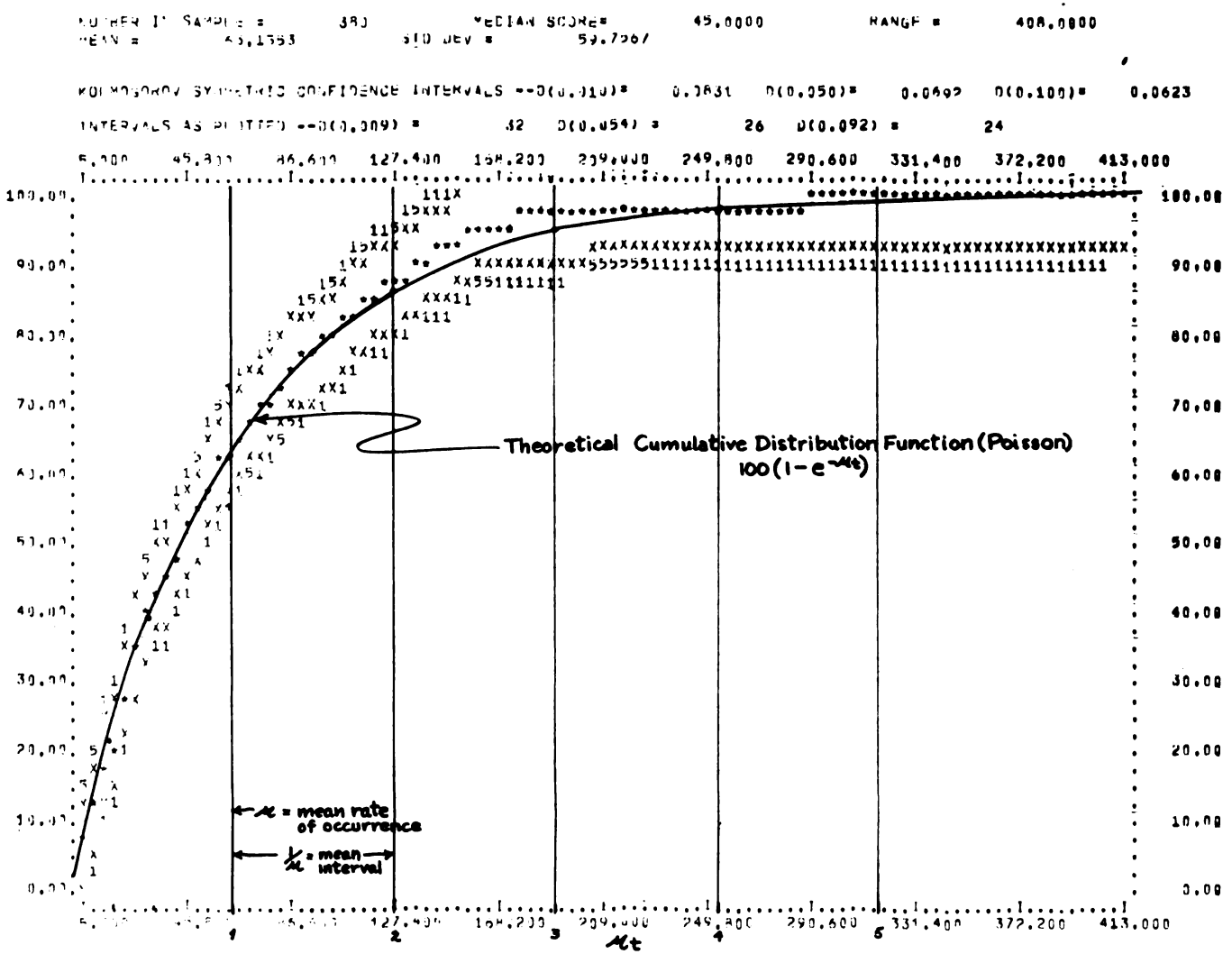


Figure 12. Cumulative distribution plot of signals for manager (No. 1) actual vs. theoretical).

one percent.

The author (33, p. 2) of this program states,

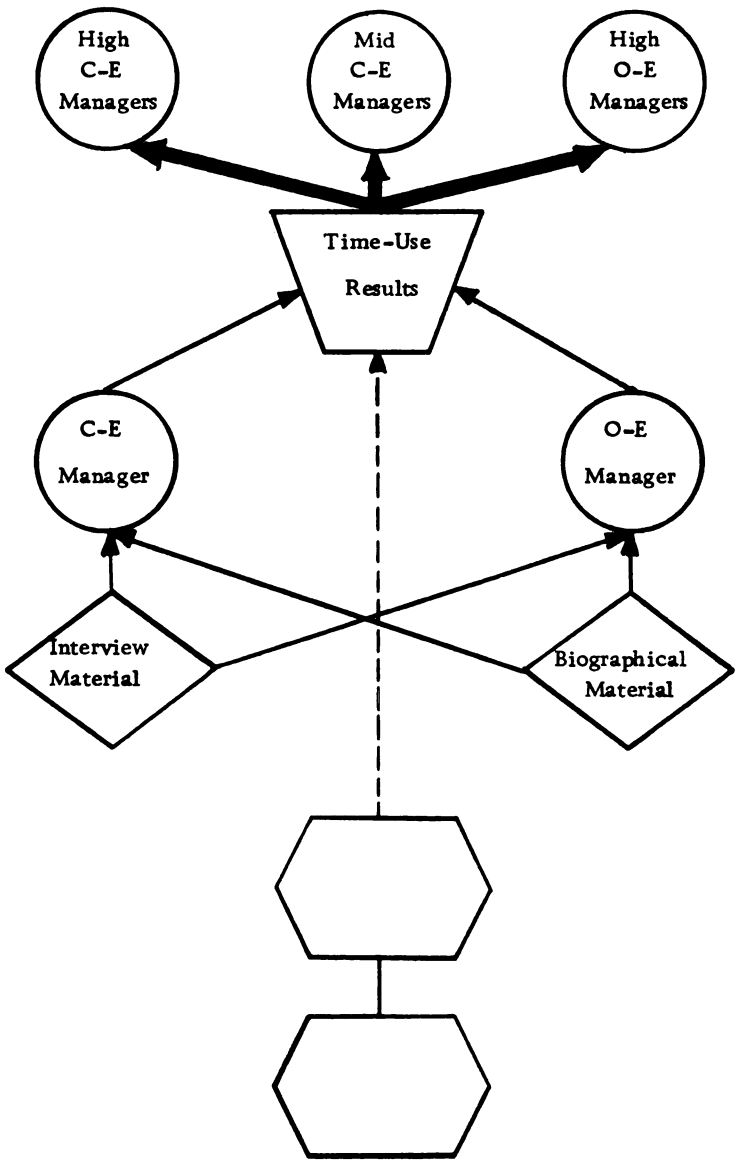
> The meaning of these bounds may be understood as follows: The probability is 10 percent that the cumulative distribution function of the parent population from which this sample is drawn lies [at least partially] outside the 10 percent confidence bounds.

The same holds true for the other boundaries.

The attempt to provide a uniform distribution of signals in each hour of the day was shown in Figures 3 and 4 of Chapter II.

Considering the human error that can be introduced in any self observational technique, the investigator (Van Vliet) and the inventor (Charters) were pleased with the performance of the Random Interval Timer. It surpassed any instrument on the market at that time and probably still does today. The devices were well-built, rugged and performed within the inventor's quality control standards.

PART II. TYPES OF MANAGERS AND THEIR TIME-USE



IV. TYPING THE MANAGER

Introduction

Whether man enters this world stripped of any inherent behavior patterns or whether he enters possessing some cognitive awareness called "born knowing" will continue to be debated in the behavioral sciences[1] for years to come.

The argument is not over the goals of the science, (one of which is the ability to build theories that possess reliable predictability), but over the ways to accurately measure man's behavior. Still the behavioral sciences are maturing with innovative contributions coming from many directions. While the search to isolate the cognitive mysteries of the mind continues, behavioral research also continues to measure the observables, admitting the existence of the unknown variables.

When the sawmill manager is asked, "Who are you?", or, "Why do you behave this way?", a twofold answer is required. There is a great deal of inconsistency between expressed images and actual

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[1] This includes the behaviorists, who believe man's observable actions can be measured as inputs and outputs, as well as certain cognitive psychologists who worry about the phenomenal aspect of man's mind.

behavior; actions often do speak louder than words.

The role theorists (15) may attempt to explain behavior deviations in terms of "role conflict," but man simply does not fit neatly into "role type" boxes. He is a confusing mixture of evoked behaviors and expressed attitudes. Despite these difficulties, the character of an individual does follow some general pattern. His past experiences and current thoughts help shape the image, and with enough probing a fairly realistic picture emerges.

In this study, the major emphasis was placed upon the measurable actions of the 11 managers in the belief that a man tells something about who he is by what he does. But it was also important to understand what each man believed--how he saw himself and his organization--in the search for evidence of the differences and similarities existing in the small mill manager group.

The Entrepreneurial Manager

Many thoughtful analyses have been written by economists, business historians, and behaviorists concerning the entrepreneurial role. McClelland (27) warns that the theoretical analysis of role requirements must preceed any empirical study of actual behavior. This is placing considerable faith in the theory builder to establish the "right" characteristics of the role, or the "ideal" type to be tested.

The researcher first constructs a role from his experience and

insight. This yields in a normative sense to value judgments. The theory then can be sharpened by measuring the observables. Using those dependent variables that explain the greatest amount of variability, the unimportant can be separated from the important.

The difference between the typical entrepreneur and the big business executive has been established. The evidence is impressive in The Enterprising Man (11) through the application of the Thematic Apperception Test, and in The Achieving Society (27) using "need for Achievement" scores.

Research by McClelland (27), and by Collins, Moore and Unwalla (11) contributed to confirming that the 11 managers in this study were more typically entrepreneurs than their managerial counterparts in big business. They identify the major characteristics of the entrepreneur as an individual who:

1. Possesses the major decision making function in directing the firm; a managerial keystone.
2. Exhibits risk-taking qualities, but not in a gambling sense.
3. Is innovative by nature and thrives on solving a problem with his own resources.
4. ". . . trades away his present for his anticipation of the future" (11, p. 162).
5. Uses money only as a scorecard of success and not as an important motive in itself.

The Craftsman-Entrepreneur and the Opportunistic-Entrepreneur

Through extensive research into typology literature, Norman R. Smith (38) provided an analytical tool for dividing the entrepreneur into two meaningful sub-groups. The hypothesis derived from Smith's (38, p. 95) study that was used in the initial separation of the Michigan sawmill managers, states:

> There are at least two types of entrepreneurs which can be differentiated on the basis of their orientation and characteristic behavior patterns. These are the polar types Craftsman-Entrepreneur and Opportunistic-Entrepreneur.

In abbreviated form, Smith (38) believes that the Craftsman-Entrepreneur exhibits a narrowness in education and training, a low social awareness and involvement, a lack of flexibility and confidence in dealing with his environment, and a time orientation centered in the present and the past. In contrast, the Opportunistic-Entrepreneur exhibits a broader education and training, a higher social awareness and involvement, a greater flexibility and confidence in dealing with his environment, and an orientation toward the future.

Smith recognized that most managers are a mixture of the "ideal" types. He supported their existence through matching them with the types of firms they build and invited further research.

This study of sawmill managers followed Smith's (38) pattern for classifying the managers and then statistically tested their use of time.

Gathering the Information

In addition to collecting the Random Interval Timer data, information was gathered through written and oral interviews.

Oral interview

Four or five personal interviews, lasting from one to two hours, were held with each manager. These were unstructured and informal, usually conducted over lunch. The managers were extremely cooperative on these occasions. The interviewer was familiar with both the business and technical aspects of sawmilling and could be accepted by the managers as appreciative of their aspirations and difficulties.

To maintain informality during the interview, only a few notes were taken. The key points of each interview were captured on a tape recorder kept in the car. Dictation could begin immediately upon leaving the mill site. Most of the mills were far enough apart that information from one manager could be recorded before the next interview began.

Although these interviews were unstructured, and ordered by conversation, an attempt was made to cover the following areas.

1. Training, experience and background.
    a. What kind of family background do you come from?
    b. What kind of schooling have you had?
    c. What has been the pattern of your work experience?

d. What aspects of your job do you like best--mechanical or organizational?

e. Did you always think about running your own firm?

2. Community involvement and social awareness.

a. What kind of groups do you belong to?

b. Do you have social events that include the workers?

3. Organizational structure and business.

a. If you had to describe your company how would you do it?

b. From where do you get decision making information?

c. Who are your most valued information sources?

d. What types of communication do you rely on the most--written or oral?

e. Where do you look for capital if you need it?

f. What seem to be the most important factors in staying competitive?

4. Future orientation.

a. Do you have long range plans for the firm?

b. Do you have ideas about how much you want to grow?

Written interview

The written SAWMILL MANAGER INTERVIEW FORM can be found in Appendix C. This written form provided much of the routine data and also served to cross check some of the oral interview information.

In addition to the routine information, Question 12 provided an opportunity for the manager to view the structure of his organization. Question 13 required him to think about his communication pattern both inside and outside the firm. These areas will be analyzed in Chapter VI.

Analyzing the Interview Material

Smith's outline (38, p. 59-63), provided the working definitions for handling the more subjective interview data gathered from the 11 sawmill managers. Table 9 is a summary of this outline of definitions. The sub-type classifications of sawmill managers were based upon the interview information, and the actual recorded behavior was then compared with these established groups (see Chapter V).

Smith's (38) simple scoring system was used to analyze the data from both the oral and written interviews. Each manager was given a (+1) for each characteristic he exhibited similar to the "ideal" Opportunistic type, and a (-1) for each characteristic similar to the "ideal" Craftsman type. A blank was left when there was conflicting or incomplete evidence in the interview transcripts or the written forms.

The maximum possible score was (+13) for the Opportunistic-Entrepreneur (O-E) and (-13) for the Craftsman-Entrepreneur (C-E). A manager who was given one blank, seven (+)'s and five (-)'s would receive a (+2) as his total score. Table 9 shows the final scoring

Table 9. Sub-type analysis of 11 sawmill managers.

Sub-type Definitions			Distribution of Attributes by Manager Number										
			1	2	3	4	5	6	7	8	9	10	11
Breadth in Education and Training	Formal Education	C-E: Tech				-	-		-				-
		O-E: Tech +	+	+	+			+		+	+	+	
	Work Experience	C-E: Tech	-	-		-	-	-	-				-
		O-E: Tech +			+					+		+	
	Reference Group	C-E: Not Mgt.											
		O-E: Mgt.	+	+	+					+	+	+	
	Mgt. Sponsorship	C-E: No					-	-	-	-			-
		O-E: Yes	+	+	+	+						+	
Social Awareness and Involvement	Social Involvement	C-E: Professional Groups only			-		-				-		
		O-E: High Community Involvement	+	+		+		+	+	+		+	+
	Communication Ability	C-E: Limited				-	-		-				
		O-E: Many Forms	+	+	+			+		+	+	+	+
Ability to Deal With Economic and Social Environment	Delegates Authority	C-E: No	-		-	-		-	-	-	-	-	-
		O-E: Yes		+			+						
	Hiring	C-E: Particularistic	-		-	-		-	-			-	
		O-E: Universalistic		+						+			+
	Capital Sources	C-E: 2 or less				-	-	-	-		-		-
		O-E: Over Two	+	+	+					+		+	
	Sales Promotion	C-E: Personal Contact	-		-	-	-	-	-		-		
		O-E: Variety		+						+		+	+
	Competitive Strategies	C-E: Limited	-		-	-		-	-		-		
		O-E: Various		+			+			+		+	+
Time Orientation	Future Plans	C-E: No Plans	-		-	-		-	-		-		-
		O-E: Planned Growth		+			+			+		+	
	Employee Relations	C-E: Paternalistic	-		-	-		-	-			-	-
		O-E: Not Paternalistic		+			+			+	+		
	Total Sub-type scores		-1	+11	-1	-8	-3	-6	-10	+9	-2	+7	-2

based upon Smith's (38) sub-type definitions.

The following examples show how the actual interview material was used in the (+) and (-) scoring procedure. In some instances the decisions had to be made through the subjective evaluations of the interviewer more than through the answers given during the interviews.

Formal education

The formal education level ranged from the eighth grade through completion of college. Seven managers had some exposure to business or social science training beyond their high school educations, allowing them to fall into the "technical plus," or O-E category. The four remaining managers more closely fit the C-E definition of "technical only."

Work experience

The two types of managers were divided in this area on the basis of previous jobs held as well as the attitudes they expressed. C-E's tended toward jobs that provided technical skills, especially along mechanical lines. Mr. X believed that a small mill manager had to be mechanically inclined so that he could do almost any kind of job on the mill site. Mr. V attributed his knowledge of steam engines and mechanics to his earlier experiences. During the off season for lumbering he and his brothers had earned considerable money running steam threshers on a contractual basis. He also had worked as a

truck driver prior to World War II. The seven managers who had background experiences similar to these were placed in the C-E type. In contrast, the backgrounds of the other four managers included non-mechanical experiences such as buying and selling timber and learning about real estate law, placing them in the O-E type.

Social involvement

According to Smith (38), one of the identifying characteristics of the C-E sub-type is a lack of social involvement. Only three of the 11 managers in this study were scored as C-E's in this category. Several managers who were rated as C-E's in many other areas were very involved in civic and social affairs. The difference between this mill manager group and the standards set by Smith (38) may be the fact that the mills were associated with small communities and the managers prided themselves in taking an active part in their communities. Mr. Q had been chairman of the School Board for eight years along with an impressive list of other activities. Other managers served on hospital boards and were active in the Chamber of Commerce. They worked with Boy Scouts and 4-H groups, Lions and Kiwanis Clubs. Many held positions of responsibility within their churches, as well as more socially oriented groups, such as Country Clubs and fraternal organizations. These were indications of the depth of involvement the mill managers had within their communities.

Communication ability

In this category, scoring was subjectively based on the flow of conversation and all communication between the manager and others (such as telephone calls, written work, and directions) observed during the interviews. This characteristic was considered to be of such importance that it will be discussed in detail in Chapter VI.

Delegation of authority

This characteristic had to be determined more by the interviewer's observations than by the manager's statements. As an example, Mr. P, who repeatedly stated his strong belief in the concept of delegating authority, continually watched to see that trucks were loaded correctly, and checked on many details that other workers were responsible for. Another manager, Mr. L, was running the head rig, repairing a truck or involved in similar activities each time he was called upon for an interview. These characteristics indicated the C-E orientation. In contrast, Mr. W felt that his four key men carried the entire burden of the plant, and he therefore had nothing to do but manage. He was rated O-E.

Hiring of employees

Six managers indicated that they wanted to hire a man who could step in and do the job. Some stated specifically that they could not take time for training programs. They emphasized their desires for hard working honest men and expressed disappointment in workers

who fell short of these expectations. They were rated C-E. In contrast to this, the three O-E oriented managers seemed to think in terms of contributions and training, and the need to fit the worker to the job. These were attitudes defined by Smith (38) as universalistic and fitting the O-E characteristic. These men were more willing to take the workers as they came. Mr. A was developing a program for training high school fellows during the summer, and planning to continue this on a part time schedule during the winter.

Capital sources

In this cateogry, Smith's (38) scoring was altered to include the local banker as a capital source within the C-E definition. In the sawmilling business, the entrepreneur breaks with tradition not when he patronizes his friendly banker, but when he goes beyond him for his capital resources. With this interpretation, six managers were classified as C-E and the other five, who looked to sources beyond the banking community for capital, fell into the O-E definition. Mr. Z represented this O-E approach. He was negotiating a loan with a large private credit association. Obtaining this loan was further complicated by the need for interim financing which would have to come from a big city bank.

Sales promotion

The nature of the lumber business implies a variety of sales outlets. The marketing system has become so entangled that the

sawmill manager (or his sales manager) needs great skill in choosing his outlets. The separation point for this attribute was clearly between those who relied on a select group of customers, the C-E's, and those who tried many channels to contact new customers, the O-E's. Mr. Q, a typical C-E, did not carry on any sales promotion. He maintained his old established customers and preferred not to change them.

Competitive strategies

There seemed to be a strong correlation between Sales Promotion and Competitive Strategies. A manager who used a variety of methods to contact customers often was one who searched for different channels of distribution and who diversified product lines. Mr. N and Mr. O were good examples of managers in the O-E group. Mr. N had been instrumental in getting several local mill owners together to investigate a joint chipping facility. When this idea failed to generate interest, he installed his own chipper. In addition, he had established new outlets for his sawdust and bark. Mr. O had a complete fabrication table for laying-up house components and trusses to be used in building homes in his real estate venture. Those managers who indicated a limited interest in competing and diversifying were judged to be C-E's in this category.

Future plans

Seven managers did not express any concrete long range plans for growth. Mr. Z was typical of this C-E characteristic, stating that he would like to retire within ten years. He hoped that someone would buy his firm and allow him to work for awhile on a part time basis. Four managers were future oriented and rated as O-E's. Mr. E had built a scale model of a new mill and was investigating financing. Mr. F was formulating long range plans built on sound objectives, but felt that they would have to correct 20 years of deficiencies before they could begin.

Amount of planning prior to initiation of the company

The generally accepted definition of an entrepreneur is a person who initiates, maintains or aggrandizes a profit oriented business (10). Many definitions of the entrepreneur emphasize the initiating--the starting of a business where none before existed--more than the maintenance or growth phases of the company. This study departed from the strict interpretation of the initiation stage of this definition because of the nature of the sawmill business.

In the history of sawmilling, the family has played a strong role. Father to son, and brother to brother relationships abound to such an extent that "passing the torch" is considered traditional. The other most common entry into the small sawmill industry is purchasing a business casualty. In either of these circumstances, the manager

has not initiated a business according to the more strict definition of an entrepreneur. But buying a business failure or taking over a family firm would constitute the "beginning" of the company in the eyes of these 11 men.

The author believes that this is an industry variance that should not eliminate the sawmill manager from fulfilling the definition of an entrepreneur. Because of this disagreement (as it applies to the sawmill industry), the initiation category from Smith's (38) outline was not used in this study and is not included in Table 9.

Plotting the Sub-Types

Figure 13 illustrates the distribution of managers along a continuum, with the "ideal" types, Craftsman-Entrepreneur (C-E) and Opportunistic-Entrepreneur (O-E), polarized at each end.

Three clusters are evident. In the middle group, five managers are closely arranged from (-1) to (-3). They do not fit well into either O-E or C-E, but are a blend of the two with a tendency to the Craftsman side. The two remaining clusters fall closer to either end of the scale and show that Smith's (38) sub-types do exist on the basis of interview information. The three managers in each of these clusters (shaded areas) exhibited more of the attributes of the "ideal" types than did the middle group of five.

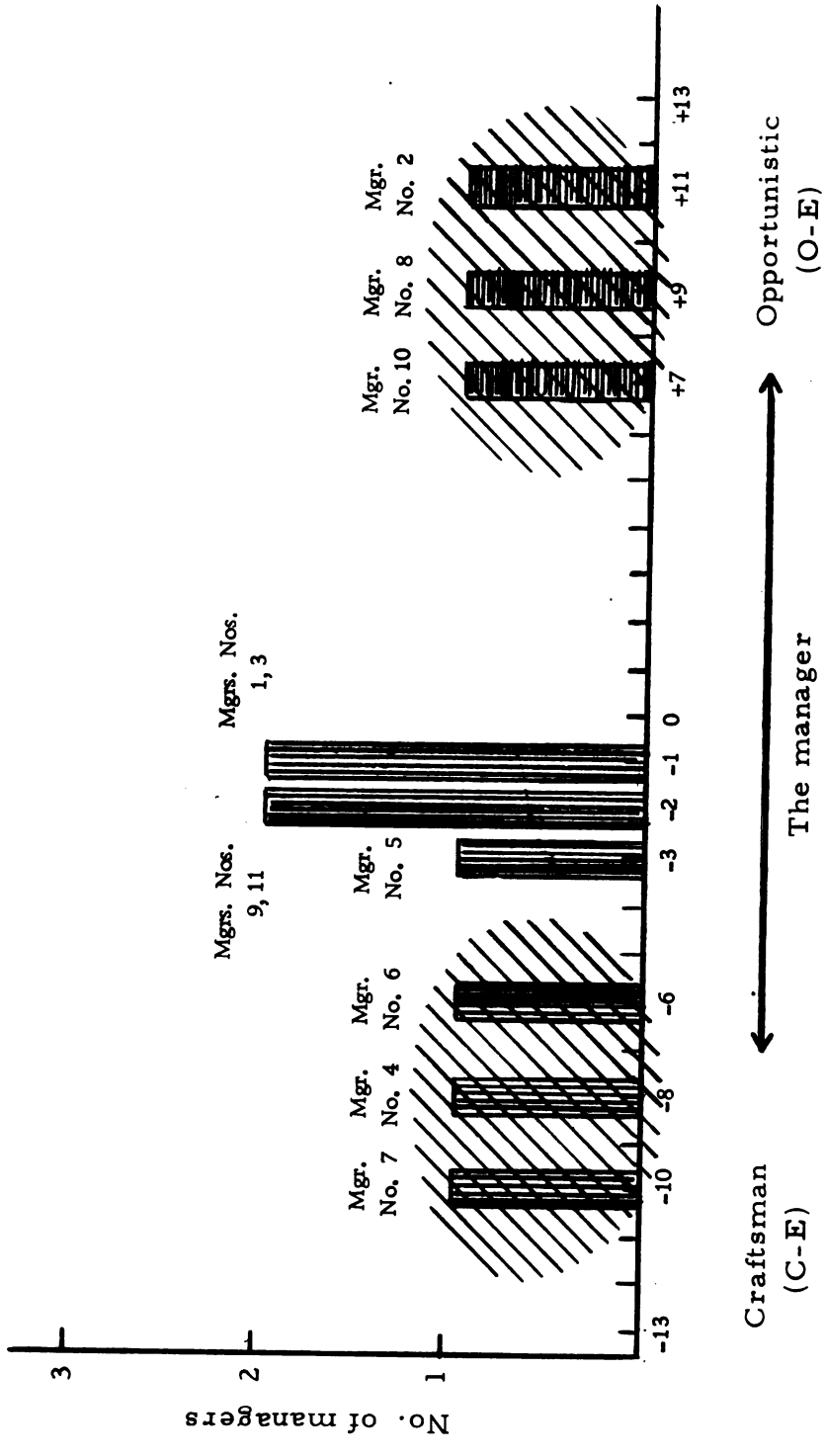

Figure 13. Distribution of entrepreneurial types.

V. RESULTS OF TIME-USE STUDY

"Zeit ist Geld"[1]

Since the turn of the century ushered in the beginning of the "Scientific Management Movement," industry has spent considerable time, talent, and money producing analytical studies about its workers. Countless hours have been devoted to measuring, interviewing and studying workers' activities in stop-watch dimensions. This research was prompted by the desire for increased efficiency.

Yet, as Brisley (6) points out, the executive...or manager...or entrepreneur... has escaped this close-up analyzing. This is not surprising when one studies man's attitudes relative to the times. Until the depression, the division of labor was clear-cut. Rank (especially ownership) had its privileges, and labor was just beginning to flex its muscles. At the same time, a gradual shift was taking place in management's view of the worker. Management had traditionally treated the worker as the mechanistic means to achieve the the production goals; it now began to recognize him as a person with many complex needs. A major turning point in industrial relations

[1] "Time is Money."

could well have been the famous Hawthorne Study[1] (34) at Western Electric Company in the late 1920's.

During the 1930's contributors to the business fields from the social science disciplines were gathering under the "human relations" umbrella.

The war and post war years saw periods of increased technology, a rapidly expanding economy, and the courting of the worker by management. At the same time management was also learning more and more about automation. Eventually the inevitable happened: in the name of efficiency and costs, entire operations as well as individual operators were replaced by machines. It seemed that while the intent had been to take the engineering out of "human engineering," the human had been engineered out instead!

Inevitably, the cost-cutting or examining finger had to point to the managers themselves. Suddenly, the boring of six holes instead of five, with its $100,000 annual savings in labor and material, became less serious than a managerial faux pas in decision making, which could cost the business many times that amount.

Thus as industry becomes more highly sophisticated, much more must be known about managerial behavior and effectiveness.

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[1] This study showed that in addition to the formal organizational structure, informal networks that have great influence also exist. It dealt with motivation, productivity and quality of work as they relate to social relations among workers and between workers and their superiors.

This knowledge is as basic to the success of small managers as it is to those in big business.

The time-use data collected with the Random Interval Timer recorded a total of 2215 observations. Less than 300 of these occurred after 6:00 p.m. and will not be included in the tabulations. These night time observations were irregular because the managers turned their devices off at different times toward the end of the day. Although these observations were too incomplete for calculating percentages of total time, they do illustrate that the men continued to be engaged in business activities during the evening hours. Some managers returned to the plants to do maintenance, problem solving and routine work. The actual number of night time observations for each activity can be found in Appendix E, Table E2.

Hypotheses Tested in This Study

The hypotheses stated were formulated in the planning stages of this research based upon knowledge of the industry.

1. Hypothesis: The Opportunistic-Entrepreneur spends more time in the decision making process than the Craftsman-Entrepreneur.
2. Hypothesis: The Opportunistic-Entrepreneur spends more time in the communication processes than the Craftsman-Entrepreneur.
3. Hypothesis: The Craftsman-Entrepreneur engages in more

manual labor in his firm than the Opportunistic-Entrepreneur.

4. Hypothesis: The Opportunistic-Entrepreneur participates in more training programs than the Craftsman-Entrepreneur.

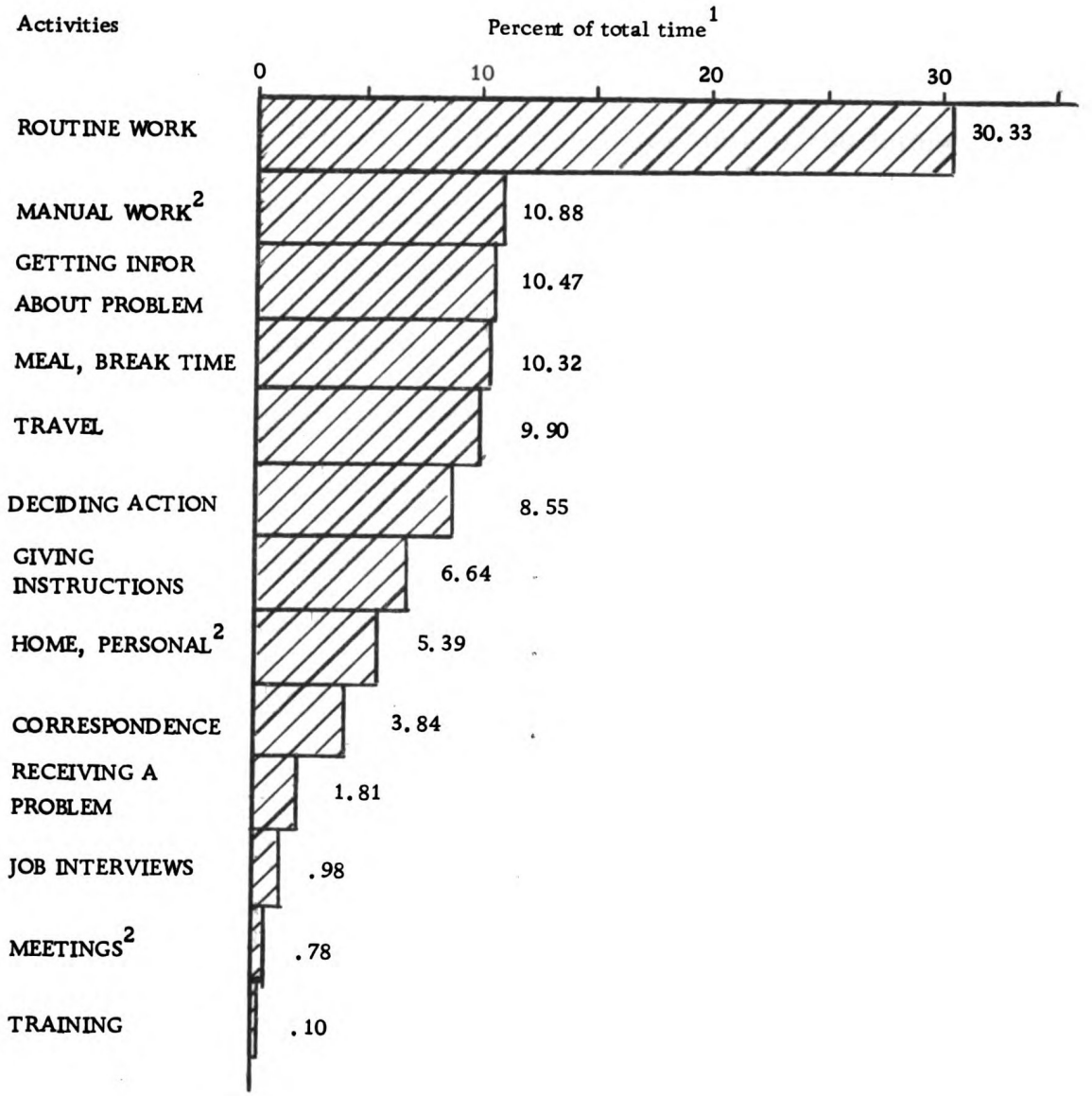
Smith's (38) method for identifying the Craftsman-Entrepreneur and the Opportunistic-Entrepreneur was basic to proceeding with this time-use research. If these hypotheses could be verified by the time-use results of the sawmill managers, then the work sampling approach might provide a useful tool in identifying these managerial sub-types without the need for subjective analysis.

Percent Time-Use

This portion of the time-use data results analyzes the percentage occupied by each activity of the total time sampled. The data is assembled in an order that progresses from a profile of the entire group to an examination of the sub-group comparisons in order to accept or reject the previous hypotheses.

All eleven managers

One of the purposes of this research was to view the managers of small sawmills as a characteristic group of the Forest Products industry. Figure 14 illustrates the percentage of the total daytime observations devoted to 13 activities, as listed on the Data Card. In Figure 14, the category OTHER on the Data Card was divided into Manual Work, Home and Personal, and Meetings, to more clearly



[1] Based on 1929 daytime observations.

[2] Part of category "Other."

Figure 14. Activity profile of all 11 sawmill managers.

define the managers' activities.

The managers spent the largest segment of time, 30.33% of the total daytime hours, doing ROUTINE WORK. This area had been divided into four sub-activities. Examples of the information gathered show that managers used this Routine Work time in the following ways.

1. Consultation with subordinates; usually guiding someone through a routine assignment such as instructing office help in form-keeping or a yard man in placing finished lumber.
2. Consultation with the outside; could be talking to an equipment salesman or a potential log supplier.
3. Scaling logs or grading lumber; a technical function often performed by the manager.
4. Office work; calculating log scale, lumber footages, accounts, payrolls, etc., indicating that the manager functioned as an accountant, or salesman, or personnel manager.

MANUAL WORK accounted for 10.88% of the managers' time. Since this was a managerial study, a percentage this high may surprise those unfamiliar with small sawmills.

The time devoted to the problem solving or decision making process (RECEIVING A PROBLEM, GETTING INFORMATION ABOUT A PROBLEM, DECIDING A COURSE OF ACTION, and GIVING INSTRUCTIONS) accounted for 27.47% of the managers' total time. This included both oral and written aspects of the problem solving process. These were listed individually in order to identify and analyze the

time spent in each step.

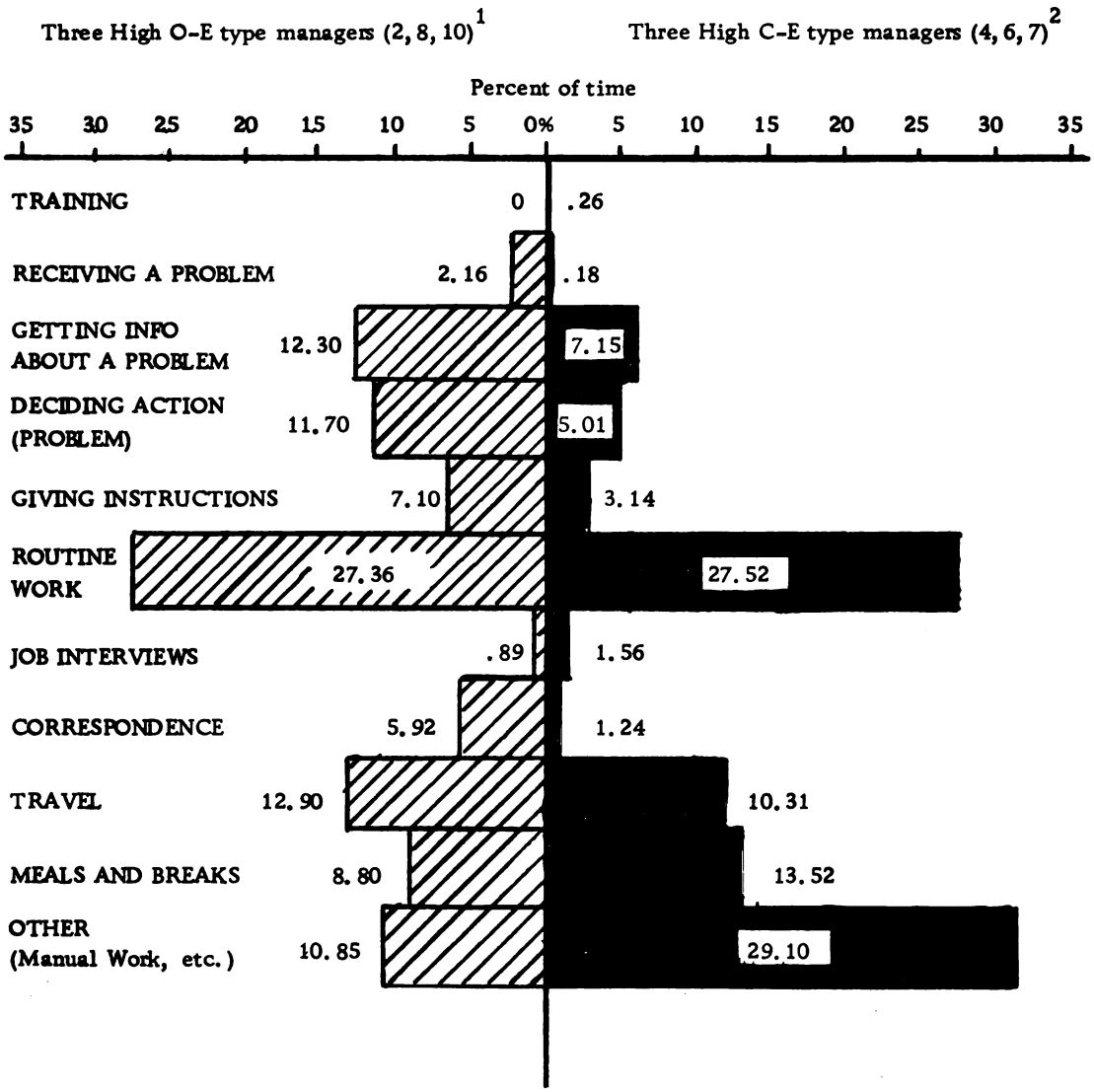
The discovery that only .10% of the managers' time was spent in TRAINING shows that this was an almost non-existent activity.

High Opportunistic-Entrepreneur vs. High Craftsman-Entrepreneur

In Figure 13, Chapter IV, a cluster of three managers was polarized at each end of the continuum. These two clusters represented the more "ideal" entrepreneurial types, the High Craftsman-Entrepreneur and the High Opportunistic-Entrepreneur. These subjectively divided clusters were tested statistically to see if there was truly a difference between the two pure managerial types on the basis of their use of time.

Figure 15 illustrates the percentage of time spent in the 11 major activities noted on the Data Card by the High O-E and High C-E types of managers.

The decision making sequence was noticeably different between the two pure types. The O-E's spent 33.26% of their time in problem solving activities as contrasted to 15.48% spent by the High C-E's. This study did not provide information to show why the O-E's spent 114% more time making decisions. Perhaps more problems were brought to them, or they were more inclined to seek out the problems. Or perhaps they had a greater desire to deal with these things. But the fact remains that the Opportunistic-Entrepreneur did spend considerably more time receiving, getting information, deciding a course



[1] Based upon 511 daytime observations and pooled averages.

[2] Based upon 521 daytime observations and pooled averages.

Figure 15. Percent of time spent in 11 major activities by High O-E's vs. High C-E's.

of action, and giving instructions about problems.

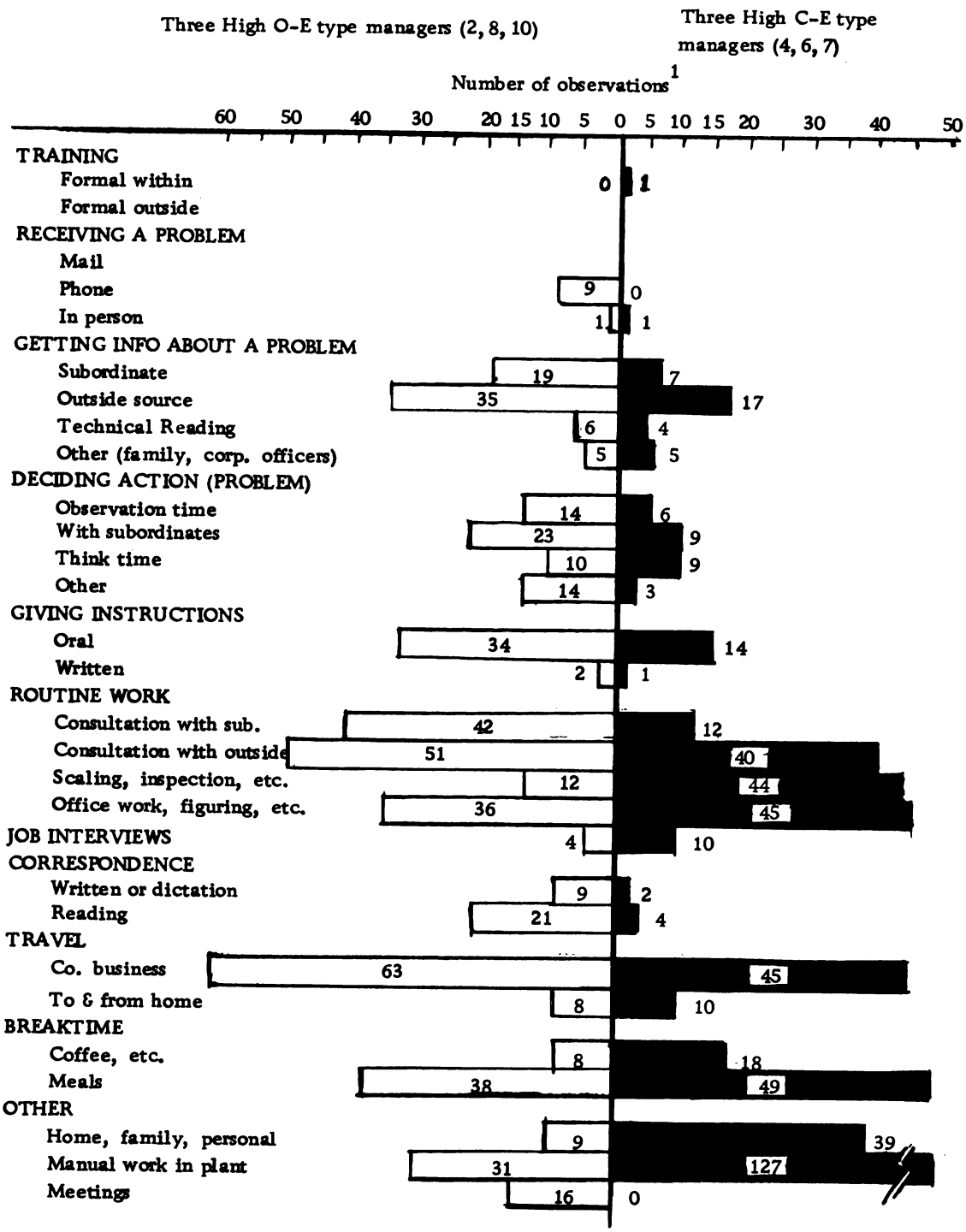
The overall proportion of time expanded in ROUTINE WORK was almost identical for the two "ideal" types. This category, which used 27% of the managers' day, illustrated the variety of job roles performed by the small mill manager in both sub-groups.

The larger CORRESPONDENCE time of the Opportunistic-Entrepreneur coincides with the hypothetical view that the flow of communications should be increased with this type of person.

The large percentage of time spent in OTHER by the High Craftsman-Entrepreneurs represents the most striking single time-use difference. This category included manual work, home time and meetings. Because these were not listed individually, the Event statements on the Data Card provided the means for sorting out the numbers of observations in these sub-categories.

A more detailed analysis of all observations for the High O-E's and the High C-E's is shown in Figure 16. The actual number of observations when used to compare the sub-groups, reveal that:

1. The Opportunistic-Entrepreneur spent more time communicating in the decision making process. When GETTING INFORMATION ABOUT A PROBLEM he turned to outside sources and subordinates more often. Consultation with subordinates was also evident when DECIDING A COURSE OF ACTION, and he was more verbal when GIVING INSTRUCTIONS.



[1] O-E No. has been adjusted to C-E's 521 from 511 for the purpose of this chart only.

Figure 16. Actual number of observations recorded by High O-E's vs. High C-E's.

2. The Opportunistic-Entrepreneur spent more time in CORRESPONDENCE, and he used the largest part of this time in reading the correspondence rather than in writing or dictating.
3. While the total time spent in ROUTINE WORK was nearly equal for both groups, the Opportunistic-Entrepreneur spent more time communicating in this category and less time in those activities that resembled other work roles. Apparently scaling, grading and office work were activities that the O-E would rather delegate to others.
4. Company business accounted for almost the entire TRAVEL category for both groups and a great deal of this time was devoted to looking for raw material.
5. The High Craftsman-Entrepreneur spent a larger percentage of time in coffee breaks and meals.
6. The High Craftsman-Entrepreneur spent more time doing manual work around the plant.

Average time allocated to activities

In Figures 17 and 18, the average 10 hour (600 minute) day shows the average total time spent in each activity. This was determined by multiplying the 600 minute day by the pooled percentage of time each group spent in each activity. The results for the three High Opportunistic-Entrepreneurs are shown in Figure 17 and for the three

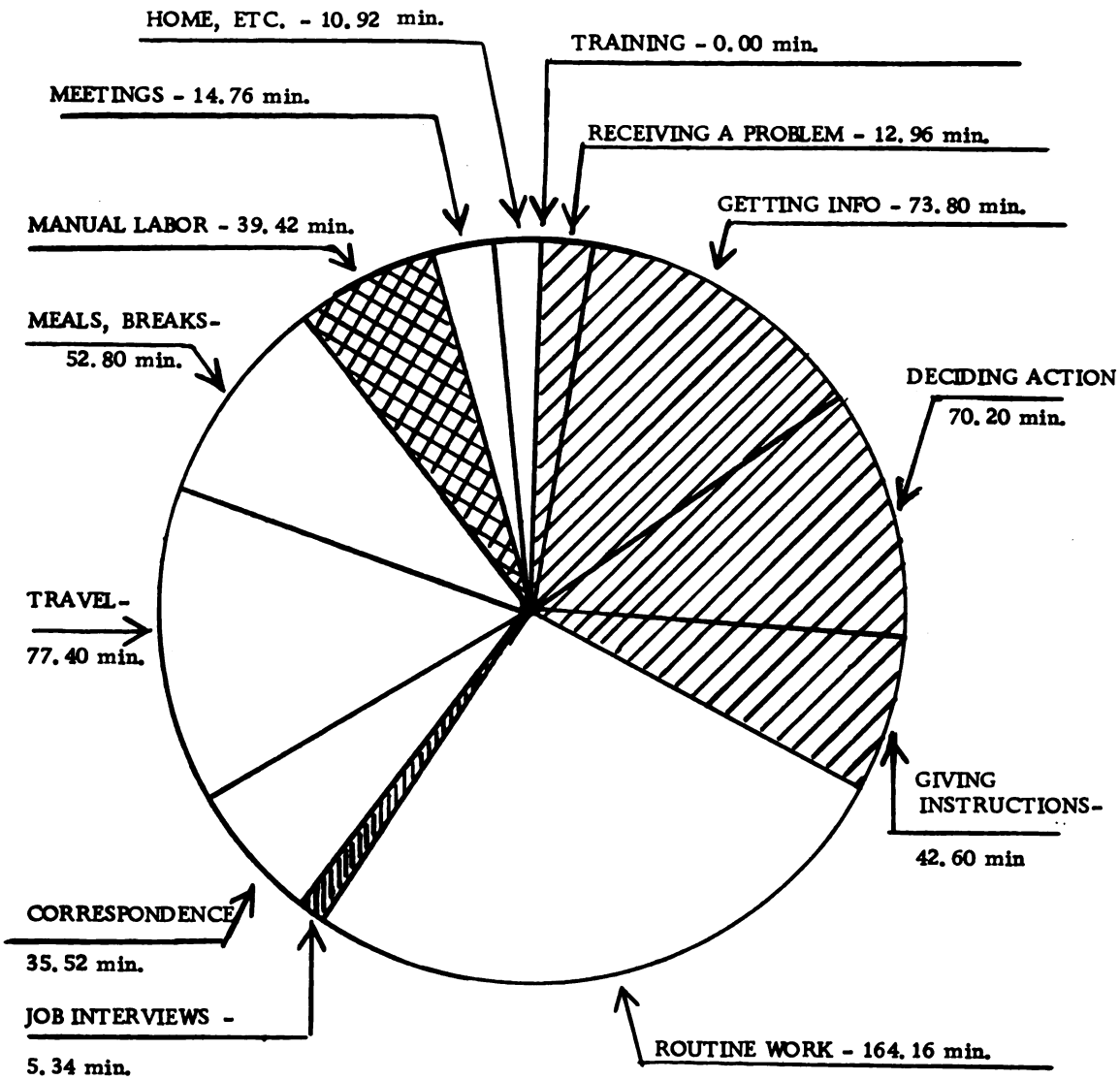


Figure 17. Total number of minutes per day[1] devoted to key activities by three High O-E managers.

[1] Based upon average 10 hour day or 600 minutes. Divide by 10 if per hour estimate is desired.

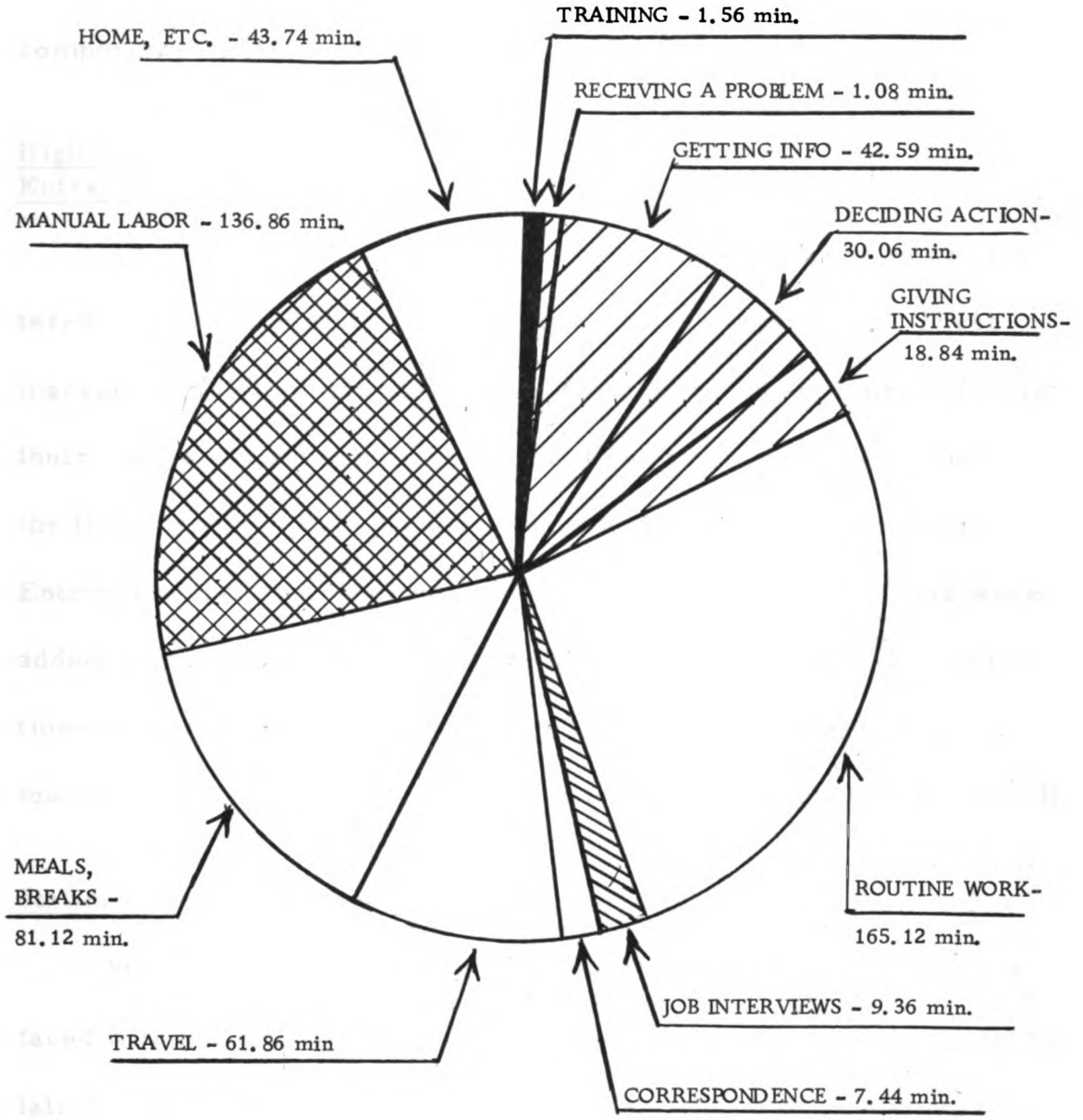


Figure 18. Total number of minutes per day[1] devoted to key activities by three High C-E managers.

[1] Based upon average 10 hour day or 600 minutes. Divide by 10 if per hour estimate is desired.

High Craftsman-Entrepreneurs in Figure 18. By shading and cross-hatching, the differences between the sub-types is shown more dramatically. The most noticeable differences are the decision making components and manual labor.

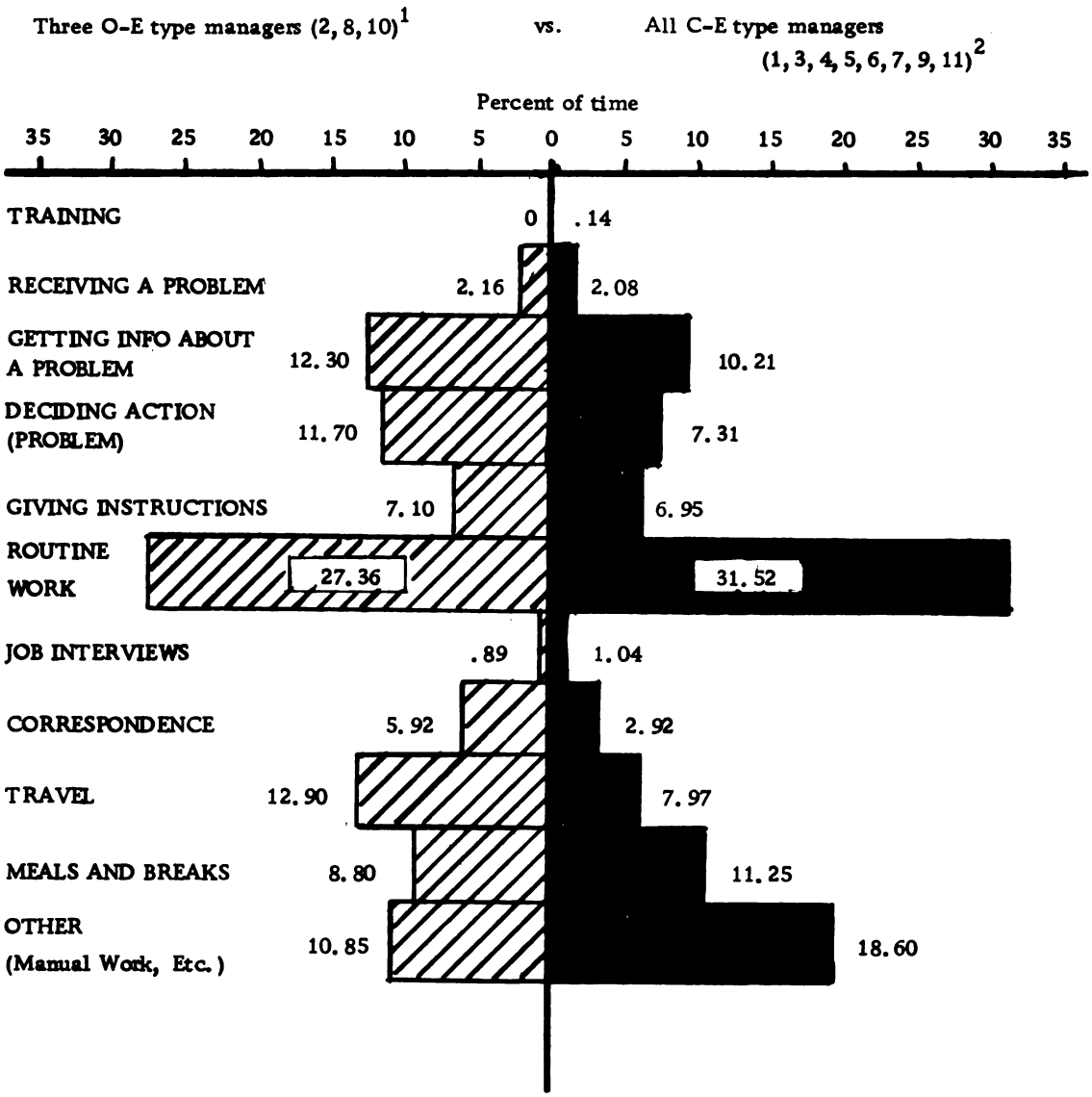
High Opportunistic-Entrepreneurs vs. all Craftsman-Entrepreneurs

As shown in Figure 13, Chapter IV, five managers were clustered near the center, from (0) to (-3), on the continuum. These managers exhibited characteristics from both "ideal" types, although their final scores placed them on the Craftsman side. To compare the High Opportunistic-Entrepreneurs with all of the Craftsman-Entrepreneurs, the observations for the middle cluster of five were added to those of the High C-E group. When all of the C-E observations are grouped together they tend to move the entire C-E group toward the O-E group, making the differences less obvious (Figure 19).

Statistics used in comparisons

Since anything can be proved by statistics, the researcher is faced with a dilemma. He must use the collected data without manipulation. Sample sizes were uneven in this study making it especially necessary to select methods of handling the data that would provide a fair analysis.

The activity profile (Figure 14) of all of the 11 managers is based upon the number of daytime observations recorded by the



[1] Based upon 511 daytime observations and pooled averages.

[2] Based upon 1418 daytime observations and pooled averages.

Figure 19. Percent of time spent in 11 major activities by O-E vs. all C-E managers.

participants. The percentage of the day that each manager was engaged in each activity was the ratio of the number of observations of that activity to the total number of observations. Work sampling is represented in the standard "ratio-delay" form in this application. In this statistical group comparison the role of the individual manager was secondary to the entire group. The time-use percentages for each individual manager can be found in Appendix E, Table E3.

The problem arose when the Opportunistic-Entrepreneur was compared statistically with the Craftsman-Entrepreneur. The number of observations for each manager were not the same. A manager with more observations would influence those with less, and thereby change the averages of the group in which his data was pooled.

Figures 15 and 19 reflect the pooled averages and help correct this problem of uneven sample size. Table 10 compares the ratio of actual observations with the pooled averages of each sub-group. The figures do not change a great deal when the two methods of calculating the time-use percentages are compared.

A procedure for statistically testing whether two samples, differing in size, come from different populations is described by Snedecor (37, Section 4.9). His variation of the Student's t test went one step further than pooling the averages. Using this method, each day's percentages were tabulated by computer for each man. The expression used to calculate the t values was:

Table 10. Comparison of ratio-delay method[1] vs. pooled averages[2] for each activity.

Activity	3 High O-E Managers		3 High C-E Managers		All C-E Managers		All Managers	
	Ratio of Actual Obser.	Pooled Ave.	Ratio of Actual Obser.	Pooled Ave.	Ratio of Actual Obser.	Pooled Ave.	Ratio of Actual Obser.	Pooled Ave.
	%	%	%	%	%	%	%	%
TRAINING	---	---	.19	.26	.14	.14	.10	.10
RECEIVING A PROBLEM	1.96	2.16	.19	.18	1.76	2.08	1.81	2.10
GETTING INFORMATION	12.52	12.30	6.33	7.15	9.73	10.21	10.47	10.78
DECIDING ACTION	11.74	11.70	5.18	5.01	7.40	7.31	8.55	8.51
GIVING INSTRUCTIONS	6.85	7.10	2.88	3.14	6.56	6.95	6.64	6.99
ROUTINE WORK	27.01	27.36	27.06	27.52	31.52	31.52	30.33	30.39
JOB INTERVIEWS	.78	.89	1.73	1.56	1.06	1.04	.98	1.00
CORRESPONDENCE	5.87	5.92	1.15	1.24	3.10	2.92	3.84	3.74
TRAVEL	13.70	12.90	10.56	10.31	8.53	7.97	9.90	9.32
MEALS and BREAKS	8.81	8.80	12.86	13.52	10.86	11.25	10.32	10.58
OTHER (Manual, etc.)	10.76	10.85	31.86	29.10	19.32	18.60	17.06	16.48
Total %	100.00	99.98	100.00	99.99	100.00	99.99	100.00	99.99

[1]Number of actual observations per activity ÷ total number of observations. [2]Activity average per manager ÷ number of managers.

$$t_{cal} = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}} \quad \text{and} \quad t_{table} = \frac{\frac{s_1^2}{n_1} t_1 + \frac{s_2^2}{n_2} t_2}{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}$$

where:

$\bar{x}_1, \bar{x}_2$ = the means of samples 1 and 2

s_1^2, s_2^2 = the variance of samples 1 and 2

n_1, n_2 = the number of observations in samples 1 and 2

t_1, t_2 = the table value of t at (n-1) degrees of freedom for samples 1 and 2.

Snedecor's (37, p. 98) modification of the Student's t test was to be used for testing, "Two samples, differing in size, from populations with different standard deviations $(\sigma_1 \neq \sigma_2)$, together with the test of $H_0 : \mu_1 = \mu_2 \ldots .$", meaning that both samples come from the same population. Results for each activity are shown in Table 11. The calculated t and t_{table} values can be found in Appendix F.

The statistical interpretation from Table 11 is that in the majority of their activities the High Opportunistic-Entrepreneur and High Craftsman-Entrepreneur represent two distinct and separate subtypes (H_0 is rejected or $\mu_1 \neq \mu_2$). Thus the modified Student's t test helped add credibility to the already discussed visual differences of Figure 15.

Table 11. Tests for significance by activity.

Activities	t Calculated: Three High O-E vs. Three High C-E Type Managers	t Calculated: Three High O-E vs. All C-E Type Managers
TRAINING	-- N.S.	-- N.S.
RECEIVING A PROBLEM	2.5791 *	-- N.S.
GETTING INFO	3.4962 **	-- N.S.
DECIDING ACTION	3.3737 **	2.5678 *
GIVING INSTRUCTIONS	3.1431 **	-- N.S.
ROUTINE WORK	-- N.S.	-- N.S.
JOB INTERVIEWS	-- N.S.	-- N.S.
CORRESPONDENCE	3.3354 **	2.1134 *
TRAVEL	2.1650 *	3.2536 **
MEALS and BREAKTIME	-- N.S.	-- N.S.
OTHER	7.9296 **	4.3343 **

N.S. = not significant.
* Probably significant--5% level.
** Highly significant--1% level.

When all the Craftsman-Entrepreneurs are included, the "ideal" types are less distinguishable and it became difficult to test for sub-types.

The Results and the Hypotheses

The hypotheses stated early in the chapter can now be examined in terms of the time-use results.

Hypothesis: The Opportunistic-Entrepreneur spends more time in the decision making process than the Craftsman-Entrepreneur.

The percentages shown in Figure 15 indicate that the three High O-E's spent 114% more time in the decision making, or problem

solving, process than did the three High C-E's. A further breakdown, comparing the two pure types of managers according to each event shows that the O-E's spent 12 times as much time RECEIVING A PROBLEM, almost twice as much time GETTING INFORMATION ABOUT A PROBLEM, and over twice as much time DECIDING AN ACTION and GIVING INSTRUCTIONS ABOUT A PROBLEM. Further evidence is found in Figure 16, comparing the actual number of observations. The problem solving group of activities shown in the shaded areas of Figure 17 and 18 provide a clear visual picture of these differences based on the 10 hour day. In view of this evidence, the hypothesis is accepted when considering the two pure managerial types.

Hypothesis: The Opportunistic-Entrepreneur spends more time in the communication process than the Craftsman-Entrepreneur.

When observing the communication process strictly on the basis of numbers of observations, a definite contrast can be seen in Figure 16. In all of the categories that would involve the communication process (with the exception of JOB INTERVIEWS and TRAINING), the number of observations for the High O-E's is greater than those for the High C-E's. These categories included the four factions of the problem solving process, some portions of ROUTINE WORK, and CORRESPONDENCE. While a more complete analysis of the communication process will be made in Chapter VI, the hypothesis is accepted when considering the two pure managerial types.

Hypothesis: The Craftsman-Entrepreneur engages in more manual labor in his firm than the Opportunistic-Entrepreneur.

Manual work was not listed as a major category on the Data Card but was one of the activities recorded as a part of OTHER. Figure 16 shows the finer breakdown of the categories and indicates that the High C-E spent 309% more time doing manual work in his firm. The crosshatched areas in Figures 17 and 18 give a good visual picture of the manual labor comparison for the two groups. Based on these findings, the hypothesis is accepted when comparing the two pure managerial types.

Hypothesis: The Opportunistic-Entrepreneur participates in more training programs than the Craftsman-Entrepreneur.

Out of the total of 2215 observations, there were only two events recorded for TRAINING. The hypothesis is therefore rejected.

When comparing the Opportunistic-Entrepreneur with the total group of eight Craftsman-Entrepreneurs, it becomes difficult to draw significant conclusions relative to the hypotheses. Figure 19 indicates a slightly higher percentage for the O-E's in the problem solving area than for all of the C-E's. However, this was not sufficient for accepting the entire decision making hypothesis.

In Table 11, the statistical significance of OTHER (which is predominantly Manual Work) indicates that if the O-E's were compared to the total C-E group, the hypothesis concerning manual work would still be accepted.

The existence of a middle group of managers, not consistantly aligned with either of the pure types, cannot be ignored. Work sampling alone could separate the polar types Craftsman-Entrepreneur and Opportunistic-Entrepreneur, but would not provide a reliable approach for separation when considering this clearly existing middle group. Therefore, if a definition of managerial types is needed, some form of subjective evaluation will continue to be necessary until further work sampling research has been done.

Average Duration of Each Event

The average time spent on each occurrence of an activity by the managers was determined by an entirely new concept. Several intricate systems have been used successfully to establish job length (36) or time frames (26); each requires a high rate of sampling and/or a low number of tasks to record. The data collected in this study showed that the managers were involved in 27 types of activities, making the existing systems unusable.

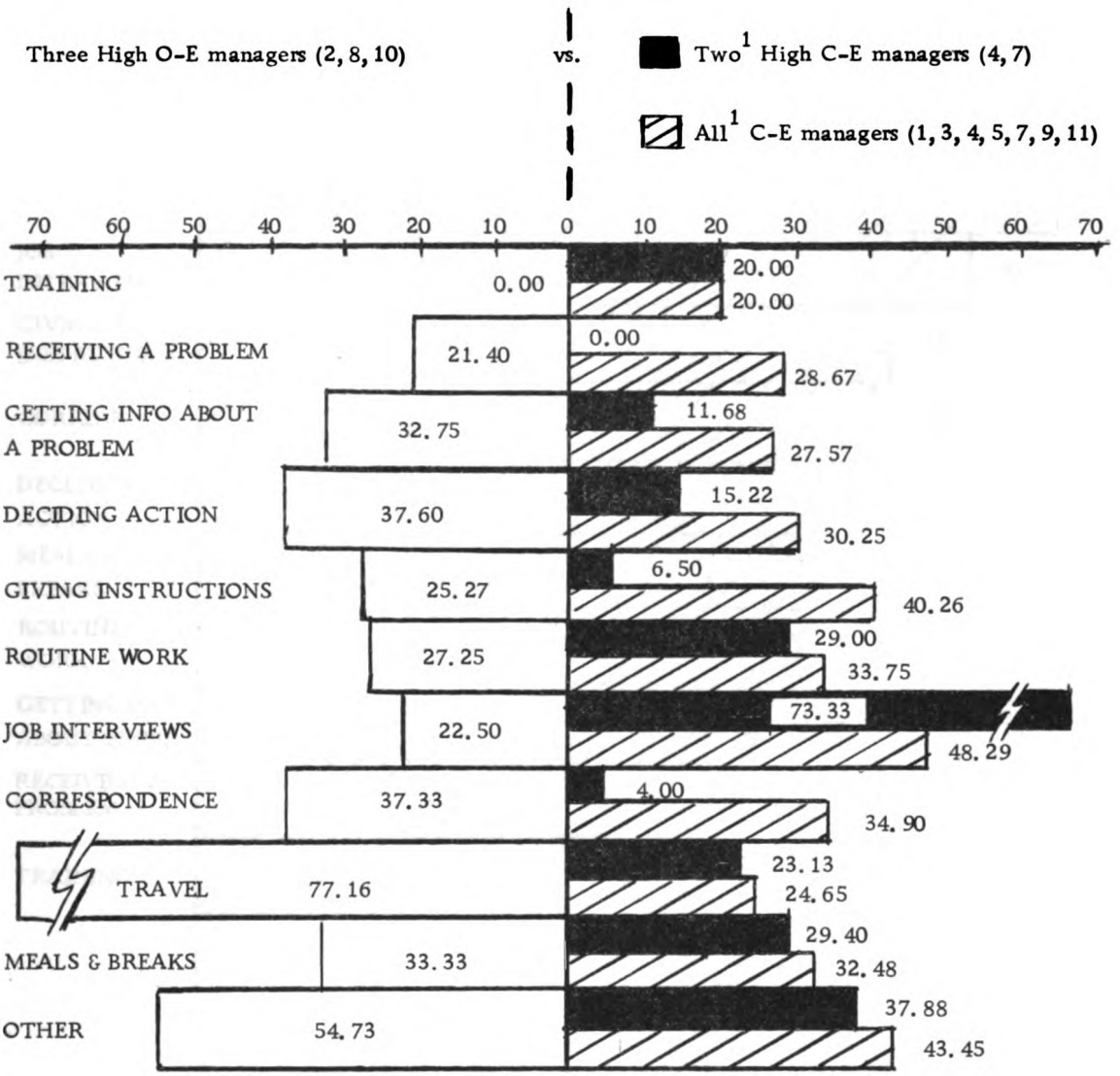
To test the duration of an event, each mill manager was asked to record the amount of time he had spent in the activity caught by the random signal. This was not to be the total time spent, but the amount of time involved in that event prior to the alarm. As an example, if he was talking on the telephone when the Random Interval Timer sounded, he not only recorded the clock time of the signal, but the time in minutes he had already been talking on the telephone. If

he had been receiving a complaint (RECEIVING A PROBLEM) for three minutes, it was considered the "half life" for that activity. The three minutes were then doubled to estimate a six minute activity length. The average duration of time spent performing each type of activity could then be calculated. The author felt that the long and short times would average out if a substantial sample was taken.

No statistical tests were run on this data. To arrive at the averages shown in Figures 20 and 21, the total of all durations recorded for each activity was divided by the number of observations for that activity. The amount of time spent when the event occurred was the important factor: not how many managers performed the activity, but the average time it took him if he did. This way the non-participants in any particular activity could not affect the averages for those who did participate.

Figure 20 compares the Opportunistic-Entrepreneur with both groups of Craftsman-Entrepreneurs. An abundance of observations by one operator could have influenced the duration averages. The calculated average remains a truthful representation of the facts for each group of managers because non-participants were not included.

What catches the eye of the analyzer is the longer times spent per activity by the Opportunistic-Entrepreneurs with the exceptions of TRAINING, ROUTINE WORK and JOB INTERVIEWS. Does the O-E take more time, is he provided more time by his organization, or has he delegated responsibility well enough to provide himself more time?



[1] Manager 6 did not record this portion--data not included.

Figure 20. Average duration of each activity in minutes, comparing High O-E's vs. High C-E's and all C-E's.

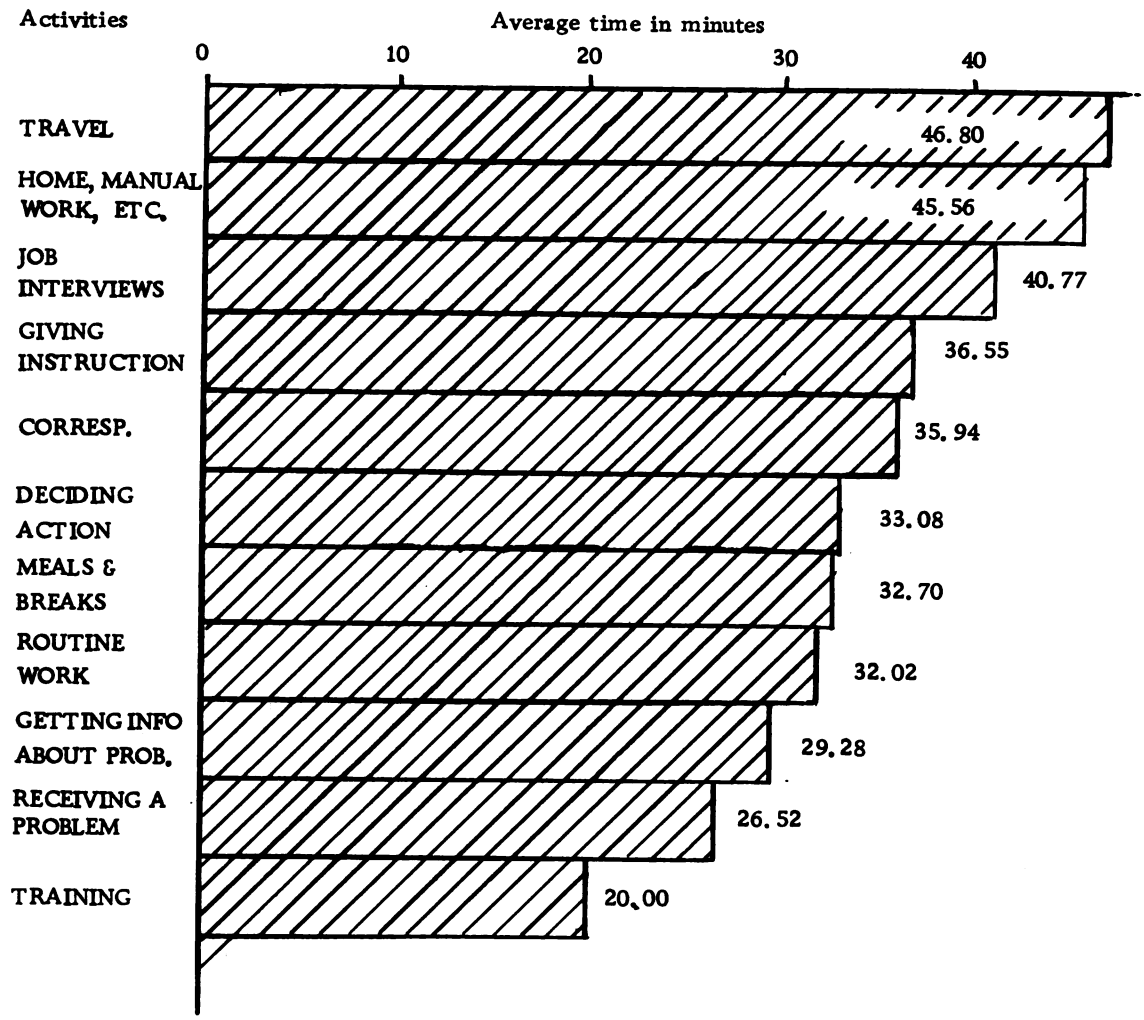


Figure 21. Average duration of each activity in minutes for 10[1] managers.

[1] Data for manager No. 6 not included.

In contrast, does the shorter duration of events for the High C-E indicate a greater degree of efficiency, or is he racing from "brush fire" to "brush fire"? The research is not conclusive, but offers an interesting avenue for further study as the efficiency of managers gains interest.

When all of the Craftsman-Entrepreneurs were grouped together, their resulting duration of events was closer to that of the Opportunistic-Entrepreneurs. In many activities the middle cluster of five managers had slightly longer average times which offset the shorter averages of the three High C-E's.

Figure 21 is a profile for the entire group of managers and represents 1744 observation-duration times. All but one of the decision making components fall into the lower portion of the chart, indicating shorter times spent in these events. At the bottom of the chart is TRAINING, the most neglected activity for all of the 11 managers.

While focusing upon the duration of an event, the frequency of each activity must not be neglected. A manager spends an average of 32.02 minutes per ROUTINE WORK task, but he also performs this task more often than any of the other activities (Figure 14). In the same way, the 20 minute duration of TRAINING must be kept in perspective by observing the rare occurrence of the event.

Comparison With Existing Studies

A time-use comparison of the sawmill managers with other groups of executives was considered worthwhile, even though very little other research was available.

Seven studies from four sources are compiled in Table 12 according to the percentage of time spent in various activities. The four columns on the left side of the table are the author's attempt to classify similar categories from these studies. Some broad interpretations were necessary, since term definitions differed from one study to another. The percentages of the three High Opportunistic-Entrepreneurs are shown in addition to the totals for the 11 mill managers. The data collected in this study relates them more closely to big business than are other managers in the small sawmill group.

The decision making component is the single area that allows some measure of comparison. However, the variance in category definitions makes it impossible to form definite conclusions. Referring to the three studies in the Social Science Approaches to Business Behavior, Dubin (17) states,

> If these studies are at all representative of what executives do, it would seem that making decisions, which is often considered their cardinal function, occupies a remarkably small share of their total working time.

This statement would also seem to apply to the Brisley and sawmill manager studies, in view of their percentages of time in decision making categories.

Table 12. Percent of executive time spent by activity--7 studies.

Common Terms Describing Areas (Activities) of Functional Behavior				Chapple/ Sayles (1)		Social Science Approaches To Business Behavior (2)						
Chapple/ Sayles (1)	Social Science Approaches To Business Behavior (2)	Brisley (3)	Sawmill Mgrs.	Ind. Rel. Mgr.	Prod. Plan. Mgr.	470 Navy Off.	66 Whole-sale Exe.	Carlson (4) Managing Directors		Brisley (3) Detroit Exe.	All 11 Saw-Mill Mgrs.	3 Hi O-E Mgr.
Anal. Data & Reading Reports	Getting Information		GETTING INFORMATION	5.25	32.20	18.00	18.00	37.90	39.60	13.20	10.47	12.30
Trouble Shooting			RECEIVING PROBLEM	12.90	1.24							
Consultation, Advise, Interview	Advising & Explaining	Discussion	Consultation w/subs	9.58	1.24	13.00	12.00	15.90	14.60	6.20	6.68	10.29
Anal. & Initiate Action	Making Decisions	Deciding a Course of action	DECIDING ACTION	8.35	62.84	28.00	26.00	14.60	6.30	12.10	8.55	11.70
	Giving Orders		GIVING INSTRUCTION			15.00	15.00	13.80	6.80		6.64	7.10
			ROUTINE WORK								16.21	9.53
		Consultation	Consul. w/outside							10.50	9.25	9.72
		Interv. Visitors	JOB INTERVIEWS							3.00	.98	.89
			CORRESPONDENCE									
		Dictation	Dictation & Writing							7.80	3.84	5.92
			TRAVEL								2.28	2.02
		Visiting Office	Co. Business							14.70	7.62	10.90
		Luncheon Disc.	BREAKTIME-MEALS							14.30		8.80
Meetings		Meetings	Meetings	5.00	2.48					9.40	.78	2.46
Run a Meeting	Other	Telephone	OTHER	.62		26.00	29.00	17.80	32.70	8.80	5.39	1.82
Negotiate				58.30								
			Manual Work								10.88	6.57
			TRAINING								.10	0.00

(1) Chapple and Sayles (8, p. 60).

(2) Dubin (17, p. 17) adapted from Stogdill and Shartle (39, p. 49) and Carlson.

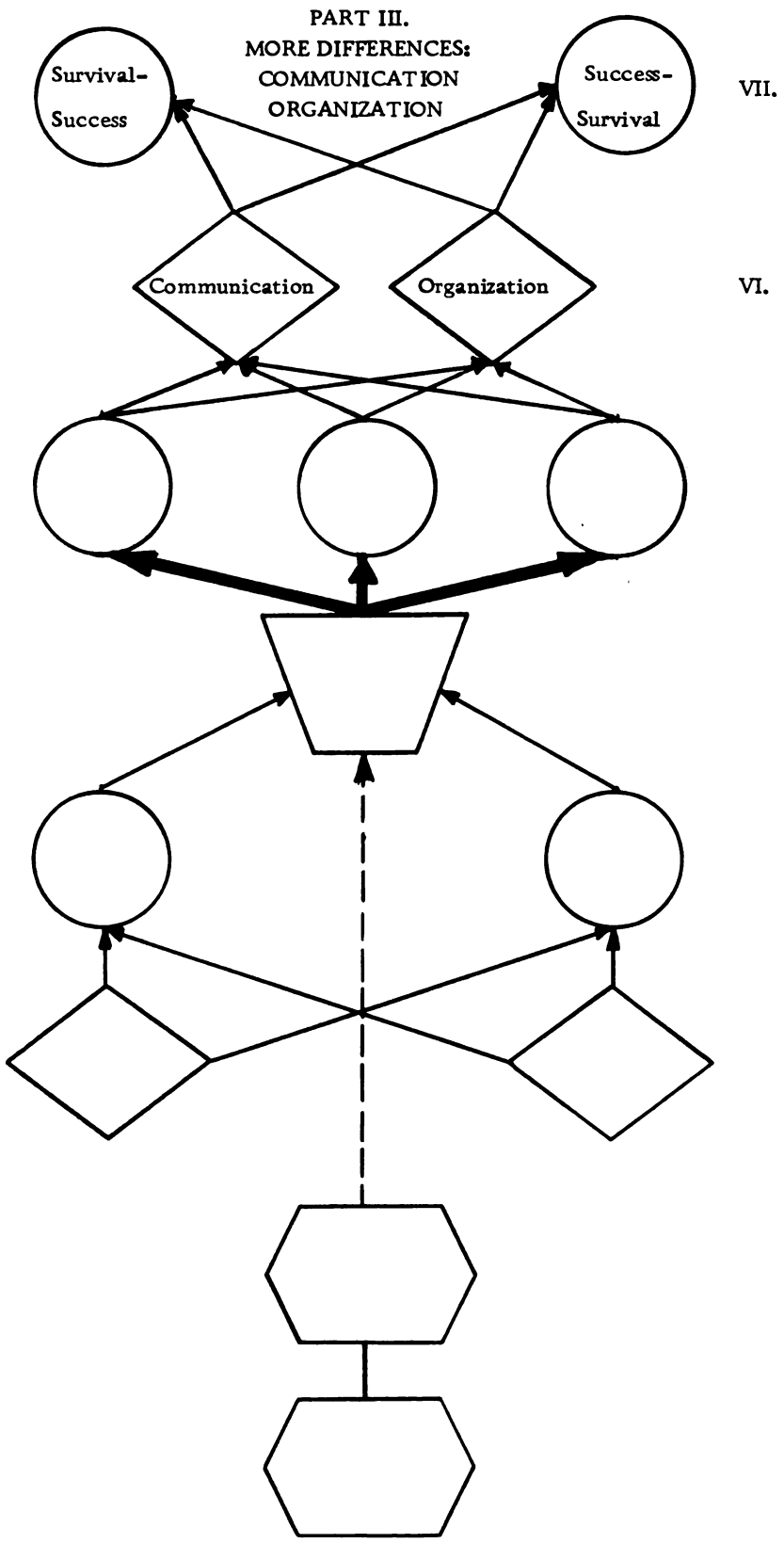
(3) Brisley (6, p. 60).

(4) Swedish Managing Directors, Centralized and Decentralized Organizations.

Brisley's study of Detroit Executives can be compared more closely with the mill managers because the category divisions were more similar. Brisley's study did not have any activity corresponding to Routine or Manual Work.

The complete omission of training in all of the studies, except the .10% for the sawmill managers, is interesting. When does the manager keep up on the new tools of his trade?

Another obstacle to a realistic comparison was the two different types of executives. Those in the comparison studies were big business executives, or more like them. No time-use research could be found concerning entrepreneurial executives.


PART III.
MORE DIFFERENCES:
COMMUNICATION
ORGANIZATION
Survival-
Success
Success-
Survival
VII.
Communication
Organization
VI.

VI. TYPE OF MANAGER: HIS COMMUNICATION AND ORGANIZATION PATTERNS

Integration of Communication and Organization Theory

Two students, one studying Organization Theory and the other studying interpersonal communication theory, would eventually find themselves searching and reading the same literature. How man organizes himself for accomplishing tasks relies so heavily upon how he communicates that the areas become inseparable.

The traditional approach

The role of communications has been treated very differently by the traditional and modern theorists. Organization Theory is not old; it started in the early 1900's with contributions from Taylor, Gannt, and the Gilbreths. In the early years it was called Scientific Management and later writers have used the term Administrative Design Theory.

Originally these theories were built upon the concept of a clear division of labor. From this point of view, maximum efficiency or productivity could be attained only when a division of work was achieved at all levels of the organization. Men were looked upon as adjuncts to machines and as occupants of job descriptions in

structured organizations. Management was the rational element (according to management), enjoyed rigid control, and communicated from the top down with little feedback.

Evolution of modern theory

Meaningful consideration of the patterns of human relationships began to change the emphasis in the 1930's. Studies of communication networks also gained attention. The discovery of feedback channels, or bottom-to-top communications, demonstrated the sensitivity that was developing to this vital part of organizational life.

After World War II, modern Organization Theory began to evolve. One of its main concepts is the importance of each member to the formal and informal structure of the organization, and his contribution to these structures. The new decision making processes and management-by-objectives generated interest from both researchers and practitioners. The organization was viewed as an "open system" rather than a "closed system."

Finally some recognition

Today the term communication is overworked, underpracticed, and confusing, even to those trained to teach its wide spectrum of intrepretation. While the management scientists were enlarging their theories to include communications, the social scientists were directly linking communications to human behavior. A few of the outstanding organization theorists show a wide range of views that run from

information acquisition systems, to the effect of networks and their communication flow, to change agents (and why they change opinions), and to interpersonal communications (and behavior change).

March and Simon (25) list channel usage, content of the "in group" communication, efficiency of communication, and instruction of communication among a series of variables in their theory. Likert (24) treats communication as an intervening variable and introduces the idea of linking key people and their groups together in organization networks.

McGregor (29) and Herzberg (19) leave no doubt that as we progress toward participative management, the value of being a good communicator is an essential part of a total managerial philosophy.

Communication and the Sawmill Manager

The need to know about the sawmill manager's communication pattern stems from the concern for the high mortality rate in the small sawmill business.

By virtue of his position, it was assumed that the manager was at the apex of the communication network in his firm; that he was in the position to affect those who work for and with him. Knowing about his communication habits should show one dimension of his effectiveness as a manager.

But knowing who he talked to and listened to would provide another, even more important, kind of information: what avenues are

available for reaching the manager with any form of help or information?

In the rapidly changing business and industrial environment, new ideas and techniques are constantly appearing. These come in the form of education and training, product innovations, quality control improvements, and technical advances in equipment and utilization. These advances are virtually useless unless they are received. The combined time-use, organization, and communication information could provide knowledge about available channels for reaching the manager.

The communication data was collected with the Random Interval Timer. If there was some form of communication going on at the time of the signal, this was recorded on the Data Card.

Several important aspects of the communication process could not be captured by a form of data collection that observed only the dyadic communication network of the manager. It could not be shown if the verbal communications involved a one-way or two-way system. Leavitt (23) states that while the one-way system is faster, looks orderly, tends to hide the sender's mistakes, and protects his power, the two-way system is more accurate. It is also more demanding of the participants.

Thus it was impossible to measure the effectiveness of messages in these interpersonal communications. The importance of the listener or receiver, and the percentage of listening or receiving

required for a manager to be effective, cannot be overlooked. Still the volume of oral communication flowing to and from the manager, and the channels he used inside and outside the organization, provided an important view of his communication pattern.

Total time spent in communication

Berlo (4, p. 1) cites that ". . . the average American spends about 70% of his active hours communicating verbally--listening, speaking, reading and writing--in that order." Dubin (17) summarized two industrial studies conducted on foremen of two large companies. The figures for time spent in communication by these foremen ranged from 46.6% to 57.3%, depending on whether the observer was counting actual conversation or all "interaction" contacts. Brisley (6) recorded that the managers in his Detroit study spent 80% of their time in oral communication.

Table 13 shows that five of the sawmill managers fall in the 40% to 60% range. The average for the total group of 11 managers was 35.46%. The average communication time for the three High Opportunistic-Entrepreneurs was 48.53% and falls at the lower edge of the industrial range when compared with Dubin's findings. The three High Craftsman-Entrepreneurs spent only 19.70% of their time in communication.

The time-use and interview information provided a possible explanation for the difference in communication patterns for the two

groups of managers. In general, the Craftsman-Entrepreneurs operated smaller firms which demanded that they fill more job roles, such as manual labor and maintenance. This would leave them less time for typical managerial tasks. In contrast, the Opportunistic-Entrepreneurs spent more time in their larger firms doing managerial type activities, and therefore spent more time in some form of communication. The fact that the High O-E's engaged in some form of communication 2.4 times as often as the High C-E's further supports the hypothesis stated in Chapter V.

Table 13. Percent time spent in communication.

Group	Percent of Total Obser. Activities Involving Communication	Percent of Communication Observations: Manager is Originator	Percent of Communication Observations: Manager is Receiver
All Managers	35.46%	81.29%	18.71%
3 High O-E type Mgrs.	48.53%	82.47%	17.43%
3 High C-E type Mgrs.	19.70%	88.35%	11.65%
Manager			
1	36.73	78.70	21.30
2	40.88	76.92	23.08
3	55.26	66.67	33.33
4	15.38	81.25	18.75
5	20.47	88.46	11.54
6	22.70	88.10	11.90
7	22.66	96.55	3.45
8	54.36	81.48	18.52
9	31.31	91.94	8.06
10	50.25	87.25	12.75
11	45.24	75.44	24.56

Direction of flow

A total number of 1929 observations were recorded by the Random Interval Timer for the 11 mill managers; 684 of these caught the managers in some form of communication. These 684 observations provide the base for examining the communication percentages.

When a communication activity was recorded, each manager was asked to state on the Data Card whether he had originated the contact or acted as the receiver. Table 13 shows that the managers acted as the sender, or originator, in more than 80% of the communications. The actual tabular record is shown in Table 14. Illustrations of the communication flow are provided in Figures 22, 23, and 24.

Comparable research about managers reported by Dubin (17) showed that when managers initiated contacts inside the firm, the figures ranged from 57% to 74% of his communication time. The variability depended upon which subordinate group was involved. Figure 22 shows that the total group of sawmill managers initiated communication inside the firm 48% of the time. Manager initiated communications were directed outside the firm 33% of the time. Only 19% of all the managers' communication contacts were directed toward him.

It is interesting to note that when the manager was the receiver of information (or communication), the contacts made from outside the firm accounted for almost three times as many as those made from inside the firm.

Table 14. Tabular recording of communication flow.

COMMUNICATIONS TO:

COMMUNICATIONS FROM: SAWMILL MANAGER NO.:	INSIDE FIRM: Relative, friend	Salesman	Mill foreman	Other foreman	Mill employee	Shop employee	Secretary	Timber buyer	Own logger	OUTSIDE FIRM: Contract logger	Lumber mill	Broker	Customer	Equipment supplier	Banker	CPA-Attorney	Insurance agent	Job applicant	Civic & other
2	15		2	3		2	2	6		9			7				3		1
8	3		5	9	20			2					12	8	3	3	1		
10	5	10	10		19			4	5			3	8	18	4		2		1
1	1		5	13	8		8	5	3		6	7	12			8			9
3	6		4	7	14		6	3				4	1	10		1			
9	1		8		15		2	3	10		2		12	4					
11	1				11		5	5	7				9			1	2	2	
5					3			3	1		3			7	1				
6	2				6		2	3	6				11	3				4	
4	1			1	5				1				4	8	1				5
7	5				10			3	5				4	1					

COMMUNICATIONS FROM: SAWMILL MANAGER NO.:	2	8	10	1	3	9	11	5	6	4	7
INSIDE FIRM: Relative, friend				1	6						
Salesman											
Mill foreman				1							
Other foreman											
Mill employee	1	2			4		4				
Shop employee											
Secretary					2						
Timber buyer	3		2	1	2		3		2		
Own logger											
OUTSIDE FIRM: Contract logger	1										
Lumber mill	1										
Broker				8							
Customer	6	9	2	5	6	2		2	3	1	1
Equipment supplier	1			2		1	1	1		3	
Banker						1					
CPA-Attorney				2							
Insurance agent						1					
Job applicant		4		1	6		6			2	
Civic & other	2		9	2	2						

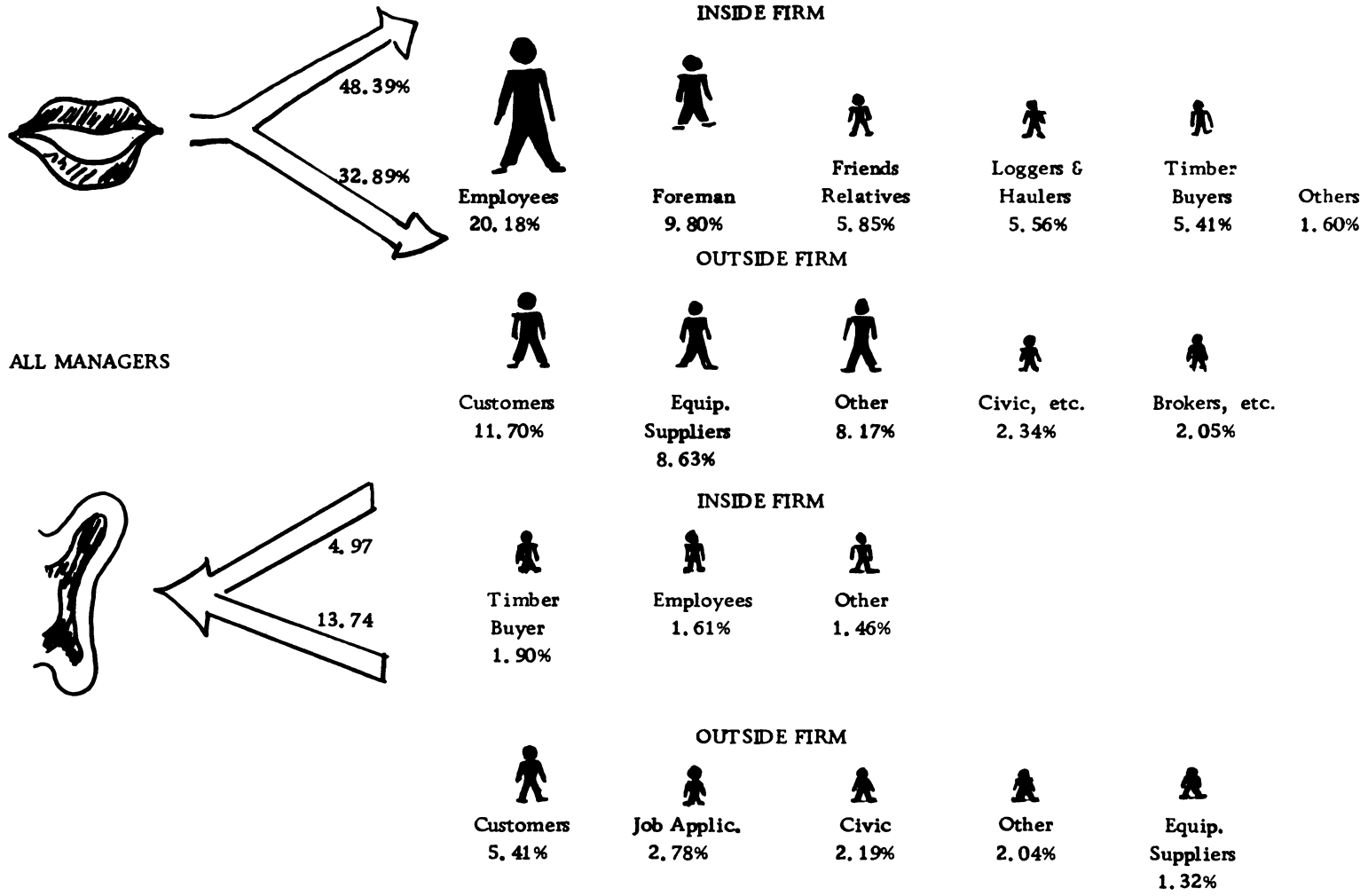


Figure 22. Communication flow for all managers--shown as a percentage of 684 total observations.

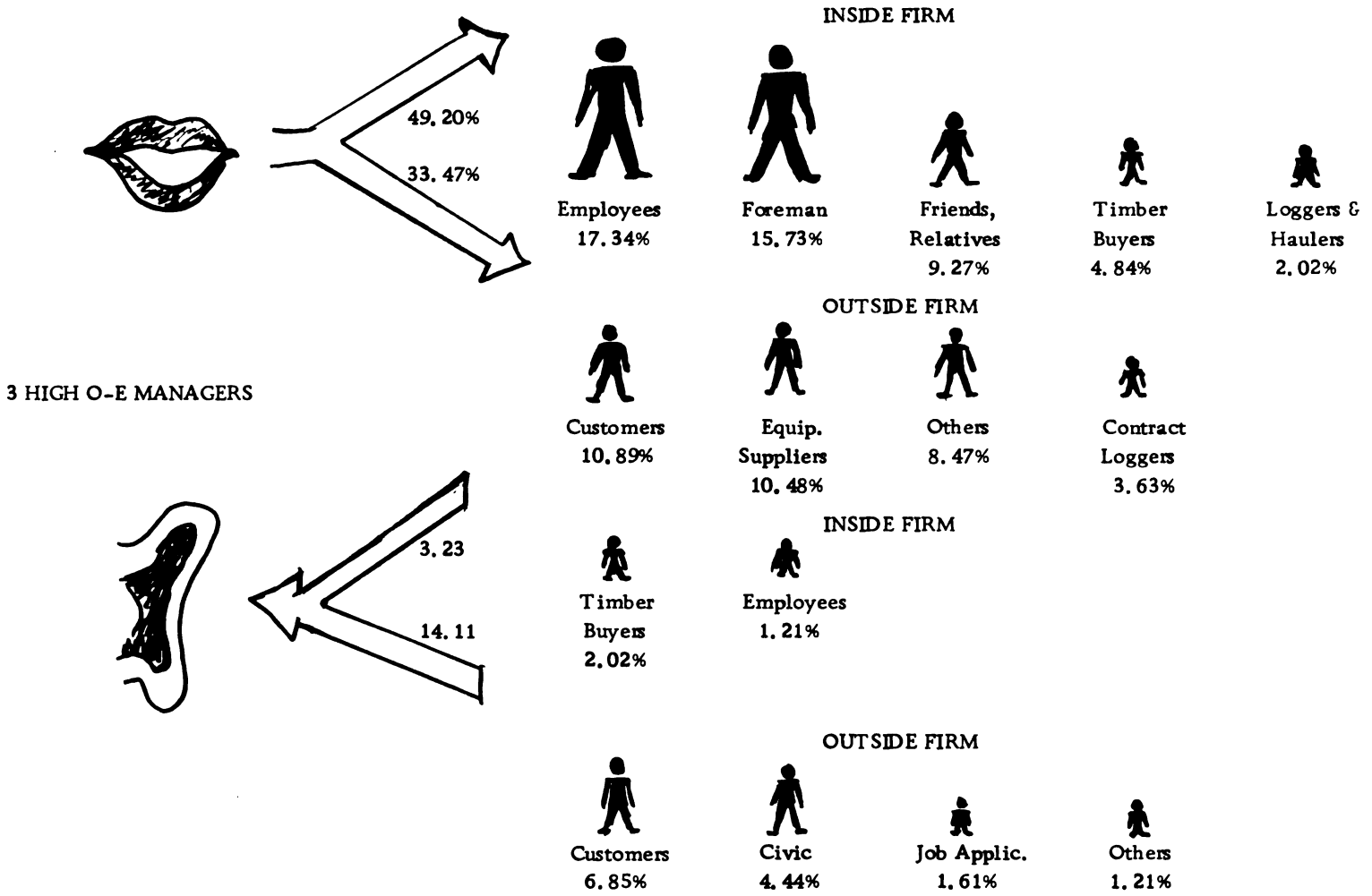


Figure 23. Communication flow for three High O-E type managers--shown as a percentage of 248 total observations.

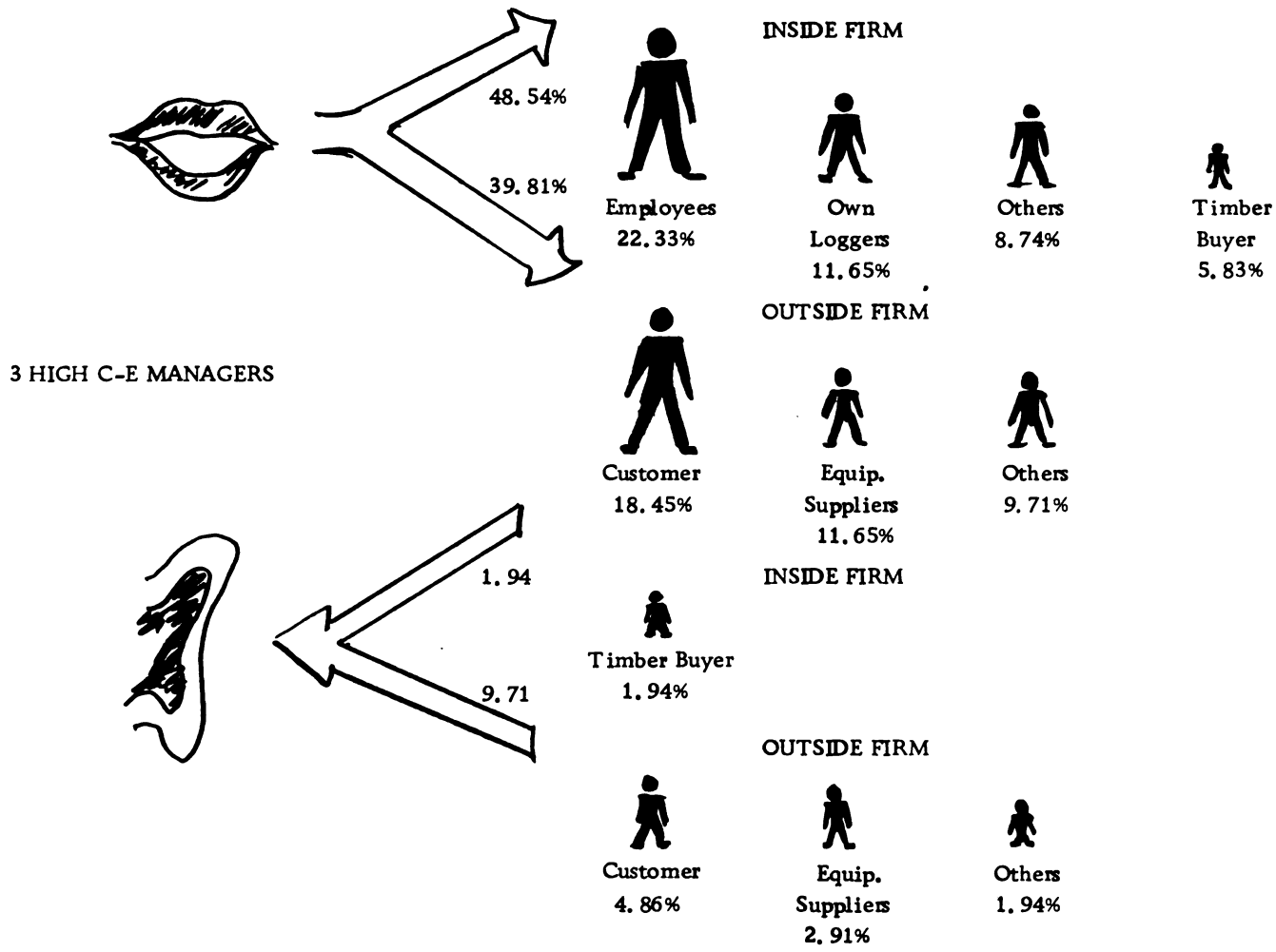


Figure 24. Communication flow for three High C-E type managers--shown as a percentage of 103 total observations.

Favorite information sources--work sampling

Communication is the means for sending and receiving information. In addition to finding the volume of communication and the direction of its flow, it was important to investigate who was involved in these interactions.

All managers. Figure 22 shows that the highest percentage of all the contacts (54%) were with people inside the firm. Millsite employees and foremen accounted for 30% of all communication. Contacts concerned with timber acquisition within the organization accounted for 13%. Customers and equipment suppliers were the managers' favorite contacts outside of the firm.

High O-E vs. High C-E. Figures 23 and 24 compare the communication patterns of the two "ideal" types of managers. It is important to observe the difference in the volume of the contacts. The three High O-E's had 248 communication observations as compared to 103 for the three High C-E's.

Dealing in percentages, the two groups were almost equal in their contacts with their employees. One noticeable difference is the O-E's 15.73% for contacts with foremen. The C-E's had no comparable observations recorded. The relative sizes of the firms could account for at least a part of this difference.

Timber acquisition involved a much larger percentage of the C-E's communication (19.42%) when compared to his O-E counterpart (12.51%). These contacts include talking with timber buyers or

sellers, company loggers and haulers, contract loggers, independent loggers and haulers, and an occasional inspector or scaler.

The C-E's used a greater percentage of their communication time contacting customers (18.45%) than did the O-E's (10.89%). This difference could also reflect the size of the firm since the C-E often plays the role of the sales manager. The O-E's showed a slightly larger percentage of contacts receiving customer calls.

Equipment suppliers held the esteemed position of being the second most contacted group outside the firm for both the High C-E's and the High O-E's.

Favorite information sources--interview data

Each manager was asked to list his key sources of information, both inside and outside the firm, on the Written Interview Form. This information was added to the interview transcript data for a composite listing shown in Table 15. It was then possible to make some comparison of their expressed feelings and their actual behavior.

The table shows that the three High C-E's listed fewer favorite information sources than did the O-E's. There was, however, a strong similarity between their expressed favorites and who they actually contacted, with the exception of customers.

When all of the C-E's were grouped together, their list of sources was greater than that of the three High O-E's. This indicated that the middle group of managers were more similar to the

Table 15. Favorite information sources listed by managers.

Location	Sources	3 Hi C-E	All C-E	3 Hi O-E
Inside Firm	Brother/s		x	x
	Wife	x	x	
	Board of Directors	x	x	x
	Foreman	x	x	x
	Head Sawyer	x	x	
	Timber (Log) Buyer	x	x	
	Maintenance Man		x	
	Secretary		x	
	Forester		x	
	"Younger Fellows"	x	x	
	Employees			
Outside Firm	Lawyer		x	x
	C.P.A.	x	x	x
	Banker		x	x
	Equipment Suppliers (Mfg.)		x	
	Technical Salesman	x	x	
	Other Mills (competitors)		x	x
	Lumber Brokers (wholesalers)		x	
	Michigan State University			x
	University of Michigan			x
	Cooperative Extension (M.S.U.)		x	x
	Michigan State Dept. of Conservation	x	x	x
	Michigan Forest Products Coop		x	
Trade Magazines	Forest Industries		x	x
	Wood and Wood Products			x
	Southern Lumberman	x	x	x
	Wood Working Digest			x
	Industrial Woodworking			x
	Northern Hardwood		x	
	Northern Logger	x	x	
	Plywood and Panel		x	
	Modern Material Handling			x
	The Timber Producer			x
	Industrial Equipment News		x	
Price and Credit	Wisconsins Forest Marketing Bulletin			x
	Dun and Bradstreet			x
	Green Book		x	x
	Memphis Hardwood Price Lists		x	x

Opportunistic-Entrepreneur in this category.

Trade magazines subscribed to by the managers are also included in Table 15. There was no determination of how much actual reading was done, but even glancing at the advertising and a few articles would constitute a degree of contact with a form of written information.

Organization and the Sawmill Manager

To complete the picture of the sawmill manager, it was important to understand how he viewed his organization. Each manager was asked to diagram the formal structure of his firm as part of the Written Interview Form.

The small sawmill organization appeared to be a patchwork, incorporating many concepts of Organization Theory. The entrepreneur provided a strange paradox in the application of these concepts. The manager often viewed his authority in the more classical terms of early managerial thinking--authority is assigned, the place of the worker is clearly defined, and boss is boss. On the other hand, he often exhibited attitudes strongly akin to the human relations movement--paying attention to the interaction of people, their needs and expectations. Perhaps unknowingly, he has built into his organization many attributes of modern Organization Theory--a flexible organization, a close and informal social structure, stable goals, and simple communication networks.

It was not surprising to find inconsistencies in managerial thought. Most of the managers were not familiar with the terminology explaining newer communication and organizational concepts.

In addition to viewing the sawmill firms as a group, the search was made for evidence of the entrepreneurial sub-types in the managers' views of their organizations. Only the two "ideal" groups are compared here to illustrate the kinds of differences that existed.

The three High Craftsman-Entrepreneurs

The three High C-E managers were hesitant when asked to draw their company structures (Figure 25). They did not want to look at their "families" that formally.

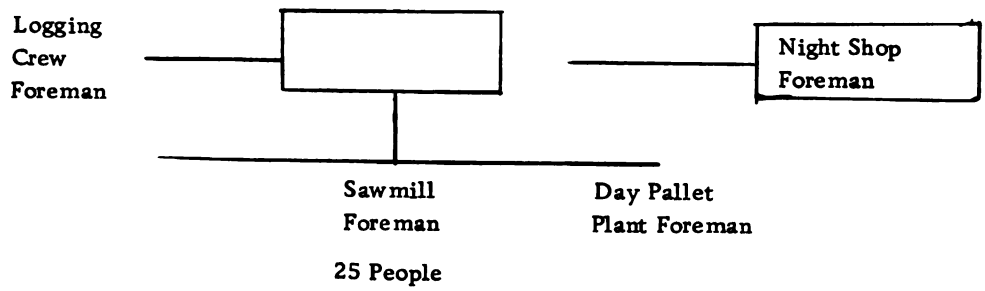
The High C-E structures had only two levels, and the managers did not title themselves. Manager Number 4 did not even include his own name. There was also some confusion as to what constituted a staff function in contrast to a line position.

Their perception of themselves and their employees resembled Smith's (38) paternalistic description of the typical C-E.

The three High Opportunistic-Entrepreneurs

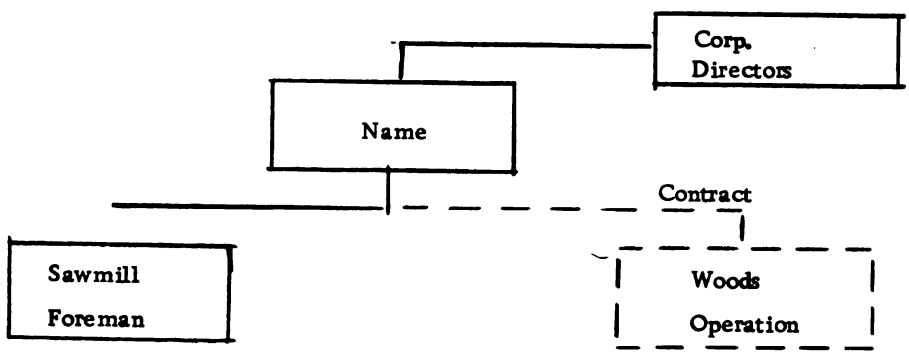
Diagrams of the O-E company structures are shown in Figure 26. These drawings indicate a greater number of levels and the use of formal titles. It was not clear whether the managers understood the meaning of a staff position even though they used it. The diagrams could not indicate whether the more formal O-E structures resulted

MILL MANAGER 4



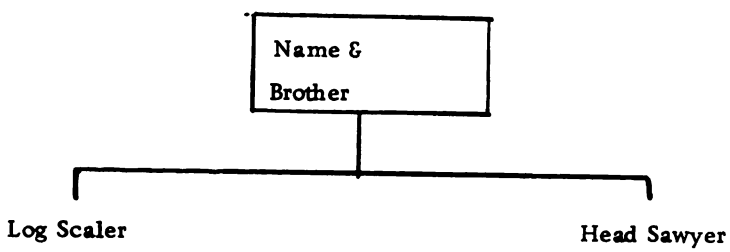
25 People

MILL MANAGER 6



8 People

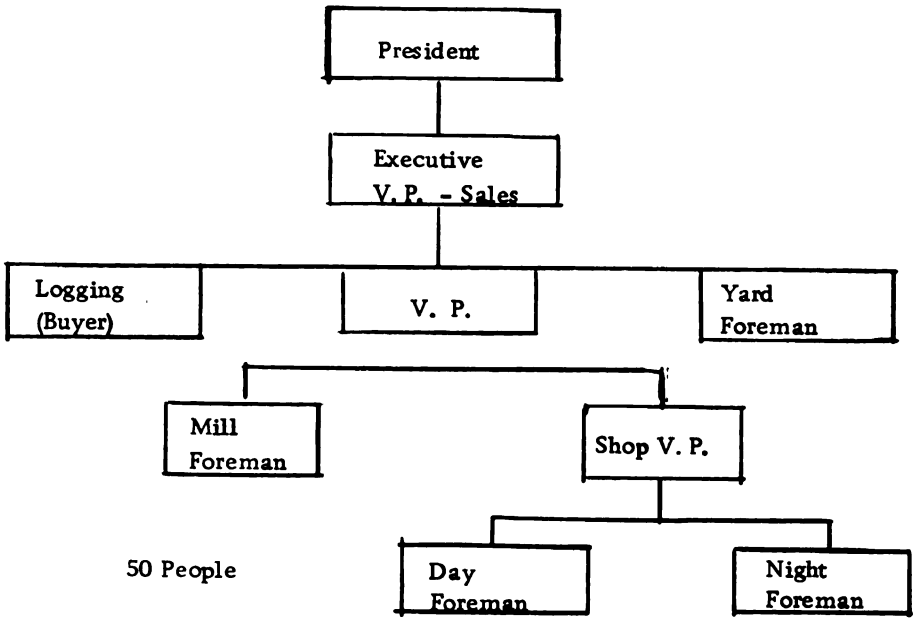
MILL MANAGER 7



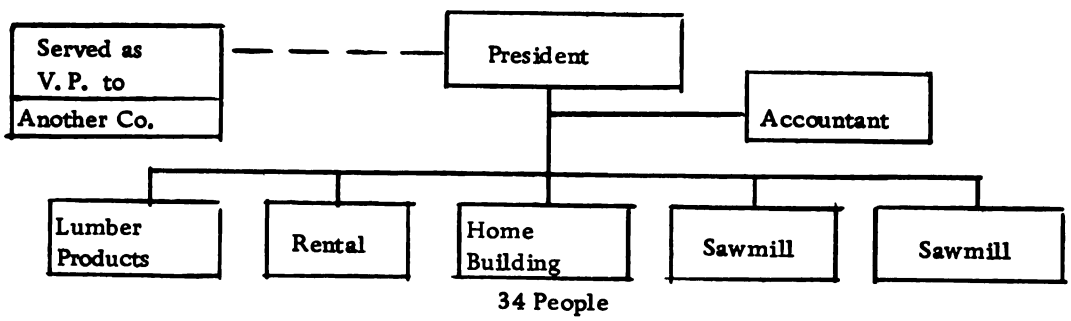
10 People

Figure 25. Organization charts--3 High C-E type managers.

MILL MANAGER 2



MILL MANAGER 8



MILL MANAGER 10

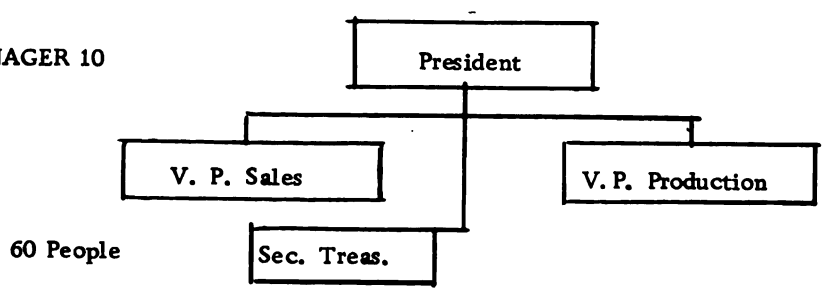


Figure 26. Organization charts--3 High O-E type managers.

from a greater understanding of organizational concepts, or were simply the result of a larger number of employees.

With this brief look at the structure, it is impossible to reach many conclusions about the small sawmill organization. The diagrams do illustrate, however, that the O-E constructs his firm in a manner more resembling his big business counterpart.

A cents-ible comparison

One measure of the effectiveness of management is in terms of sales and the number of employees. Figure 27 illustrates the average gross sales per firm and per employee for the High O-E's and the High C-E's. The tremendous difference in the average sales per firms is misleading until this figure is divided by the average number of employees. Still, the High Opportunistic-Entrepreneur generates 48% more sales per employee than the High Craftsman-Entrepreneur. Even if the entrepreneur looks at money merely as a scorecard (28), he cannot escape this form of measurement when others are judging his performance.

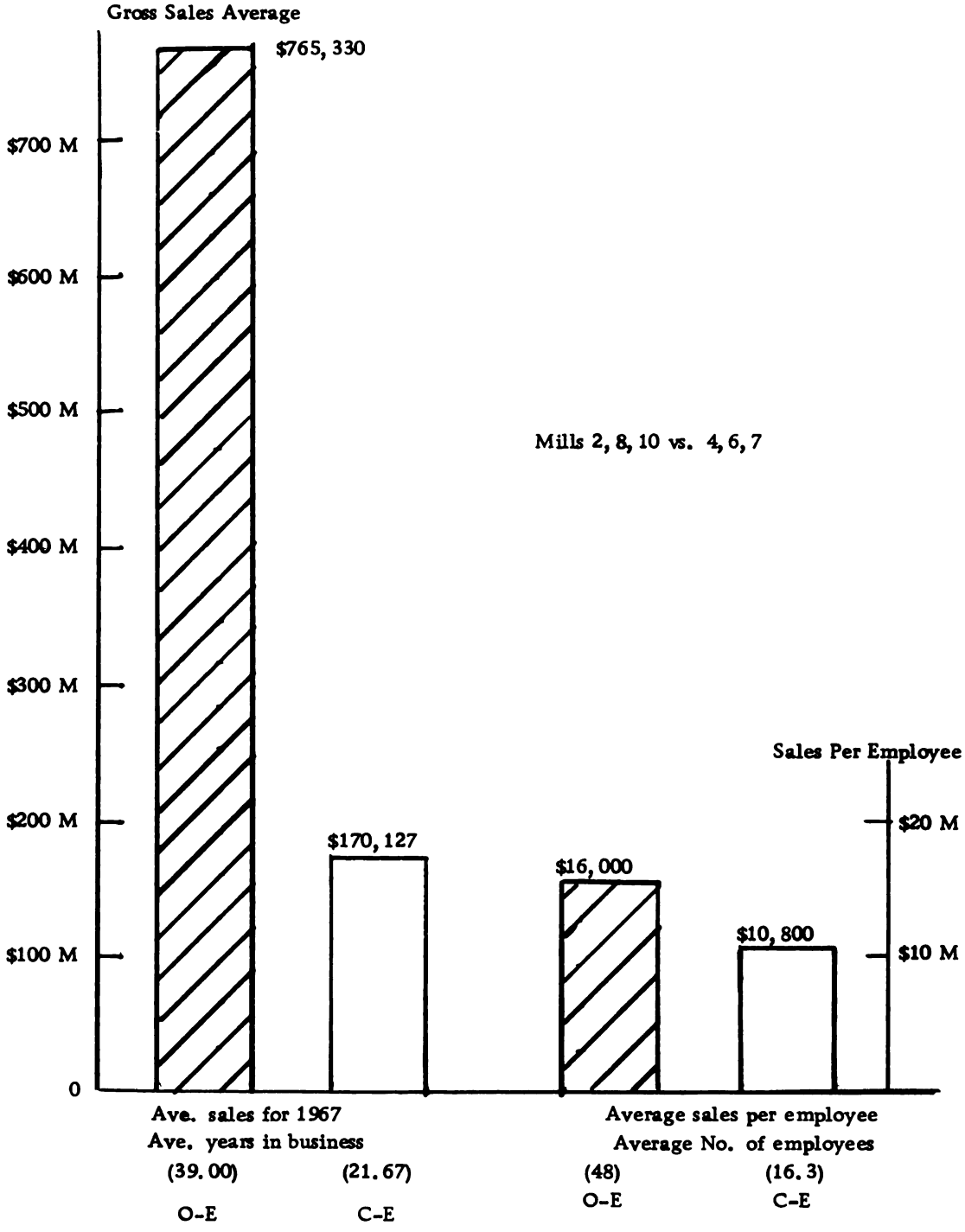


Figure 27. Sales comparison of selected firms (mills 2, 8, 10 vs. 4, 6, 7).

VII. CONCLUSIONS

> Time is the scarcest resource, and unless it is managed, nothing else can be managed. The analysis of one's time, moreover, is the one easily accessible and yet systematic way to analyze one's work and to think through what really matters in it.
>
> Peter F. Drucker (16, p. 51).

The purpose of this exporatory research was to study the nature of the small sawmill manager in terms of how he used his time, his communication networks, and viewed his organization.

One could not be exposed to the hours of friendly conversation with each of these 11 managers without developing a sensitivity to them, their leadership styles, and their problems in a very competitive industry.

This study provided both a technical contribution and a behavioral contribution. It is the first research conducted using the new Random Interval Timer, and the first research about small sawmill managers.

Technical Contributions of the Study

Although the primary goal of this research was to produce basic data about a group of managers, the importance of the method of

collection should not be overlooked. Work sampling is a well established technique but the self observation approach has not been widely used. Because of the Random Interval Timer, the self observation system worked well for this study. It could be used effectively in many situations if the research is properly constructed and analyzed. This method offers researchers an exciting measurement tool for assessing the human resources of organizations. It could be especially valuable in managerial studies.

The successful use of the self observation system showed that large sums of money need not be spent to gather data, even when measuring a wide variety of tasks. This study also indicates that the method of observation does not appear to cause altered behavior. In order to confirm this, a statistical check was made to discover if carrying the Random Interval Timer resulted in an initial behavior change by the manager. The first weeks' observations for all of the managers were statistically compared against all of the remaining observations (Appendix F). There were no significant changes in behavior at either the 5% or 1% level, using the modified Student's t test previously described. When the traditional observer system is used, behavior recorded early in the study has often not been consistant with later observations.

A group of researchers have begun a search for ways to place dollar values on the human assets of firms. They need accurate ways to measure such an asset.

A large department in Government recently generated much unhappiness when employees were asked to account for every minute of their time. This irritating and time consuming task might have been accomplished with considerably less annoyance and bias by using the Random Interval Timer and the work sampling approach.

The Behavioral Contributions of the Study

The small sawmill group has been experiencing a high mortality rate. The loss of the inefficient operator, and the normal attrition rate common in the small business world, must be accepted. The concern is for the efficient manager who is responsible for the destinies of thousands of small sawmills. These managers represent an unstudied and complex group.

Generally, these man could be best described as exhibiting an entrepreneurial behavior. Entrepreneur is a descriptive term, indicating a characteristic set of values, a particular approach to life. The men studied in this research were managers by job description and entrepreneurs by the way they thought and the way they performed their tasks.

Further evaluation of the 11 mill managers identified two specific or pure types of entrepreneurs, the Craftsman-Entrepreneur and the Opportunistic-Entrepreneur. A third or middle group also existed. While not identifying consistently with either of the pure types, this group was closer to the Craftsman orientation.

The differences in their investment of time in certain activities was statistically measurable for the two pure types.

The three High Opportunistic-Entrepreneurs

In terms of their use of time, these managers spent:

1. More time in the decision making process.
2. More time in the communication process, both written and oral.
3. Nearly 30% of their time doing routine work; more of this was allocated to consulting with employees and those outside the firm.
4. A greater duration of time in most of the activities measured. This represented a new method of calculating the duration of an event.
5. No time in any type of training.

In differences not captured by the use of time, the research showed that the O-E generated more sales per employee in a more structured organization.

The three High Craftsman-Entrepreneurs

In terms of their use of time, these managers spent:

1. More time doing manual work.
2. Nearly 30% of their time doing routine work; more of this was allocated to technical activities.
3. More time interviewing job applicants.

4. Almost no time in any type of training.

When the study of the manager is based on the use of time, many important aspects of his approach to management cannot be analyzed. This method of data collection could not indicate the manager's sequential steps in the decision making process, his effectiveness in his communications, or his need to do the manual work in his plant.

This research simply shows what is happening, not how or why it is happening. Basic to this approach is the belief that before analyzing any situation it is essential to know first what actually is going on. This does not, in any sense, deny the importance of other approaches, but offers researchers from various disciplines a place to begin.

While only some simple and obvious facts are shown in this account of manager activities, these facts raise important questions.

The percentage of time devoted to routine work by all of the managers seemed excessive when routine work is the very thing a manager should be minimizing. The C-E's manual work level is unlike any other managerial comparison, and possibly is being done at the expense of the decision making functions. The lack of training is a cause for concern when the gap of advantage is already wide between the manager of the small firm and his counterpart in larger firms.

If the results of the time-use study provide an opportunity for

the manager of the small sawmill to take a thoughtful look at his time, then the value of behavioral research is justified.

Training--The Missing Activity

"Today's fast changing business methods are spawning a new breed of executive--the obsolete executive" (5). If this statement is coupled with a concern for the training or retraining of skilled workers, then the obsolescence and shortage of trained personnel at all levels becomes one of the most important problems facing our society.

Operating and managing a firm in today's environment is complex and bewildering to the executive unable to adjust to rapid business changes. "When a man in a responsible position fails to do his job efficiently, no crew of mechanics can rush to the scene, repair kits in hand, to restore his efficiency" (18). Failure may be easier to detect than obsolescence. Both cost industry untold sums, and while the latter bleeds more slowly, it will eventually be a greater volume.

The sawmill manager and training

Since there were only two training events out of 2215 total observations in this study, this information could not be used except to indicate the void.

Where does the entrepreneur receive his training? The answer provided in this research, the same as other writers have reported (11), is on the job in the "School of Hard Knocks." If the sawmill

manager works ten hours or more each day, and often six days a week, he is not likely to choose night courses or all day programs that call for a high amount of energy and time. The willingness to make that kind of commitment was not evident among the participants in this study.

A possibility: the "change agent"

It appears that past efforts for training programs have been exactly backward. First, the programs have been established, and second, the information about them has been disseminated on the assumption that this would provide the motivation for training. Whether or not the message is received has come last, and has been essentially ignored.

In view of the obvious lack of commitment to training, it is evident that the order of events must be reversed. First, the right "wavebands" must be found for reaching the manager in order to provide the second, which is the motivation. Last in the order of priority would be the establishment of the program.

The possibility of discovering the right "wavebands" for reaching the manager may require further research concerning communication networks. This study provided an initial look at the communication networks used by the manager, but there was no real way to place a value on the sources. The "waveband" may have to be a "change agent." He is the valued and skillful opinion maker that tends

the gates of information. The "change agent" would be the acceptable "waveband," and because of his trusted position would motivate the manager.

One possibility for instigating change might be through the manager's relationship to the equipment manufacturer. Companies with technical salesmen who are an accepted contact with the manager could provide educational packages based on needs other than new equipment. Technological changes and maintenance programs could be produced in short take-home form with diagrams and illustrations similar to a small correspondence course. Video tapes, short tape-slide sets, and other new information systems could be reused by many managers. Universities and Extension could provide the research and educational coordination for such programs.

But the greatest need for training is in the area of managerial techniques which could help keep the firm healthy and competitive. It is well known that technical information is passed on in the industry through one manager's influence upon another. The most likely approach would be to reach the O-E manager first, since he is already more motivated toward change. If he would accept and benefit from some form of managerial training he might well become the "change agent" for other managers in his local area.

Assuming that commitment and motivation are present, are Extension, University and private short courses providing acceptable programs? For the small entrepreneur, the answer is probably no.

Little attention has been paid to the wide variety of backgrounds, experience, and education of those attending. Most programs have been directed toward managers of large and middle-sized firms. It is unlikely that the needs of the corporate manager and the Craftsman-Entrepreneur can be served by the same program.

A short course or continuing education series must be based on the needs of those attending. For the manager of the small firm, it could include a cluster of six to twelve managers, chosen because of similar backgrounds, and be held in the locality of the mills.

Survival : Success or Success : Survival

The managers in this study basically fulfill the entrepreneurial definition in their desire to have their own business, to be their own boss, and to take the necessary risks involved in such a venture. But as several researchers have found, at some point in time there are those who choose not to grow. They want to stay small and see no virtue in biggness. In all probability they would not be happy if their firms became too large.

Subjectively, the managers of the sawmills seemed to rank order their future priorities in two ways, "Survival : Success," or Success : Survival." Society today equates success with growth, status and money. The "Survival : Success" manager does not necessarily see the importance of these symbols. He may have encountered

circumstances that do not allow him to devote his attention to the future; or he may simply be content to make a living with his small business. The order of concern for the "Success : Survival" manager pushes him constantly toward continued growth. For him, making a living happens as part of the process of aggrandizement.

The Need for the Entrepreneur

Concern for the survival of the small sawmill business is not based on sentiment. There is no useful purpose served by maintaining a business simply for the sake of tradition. Nor is there concern for the product. Large corporations could amply provide the economy with necessary quantities of lumber.

The concern is for the survival of the entrepreneur and the kind of firm he builds. This is best exemplified in the Forest Products industry by the operator of the efficient small sawmill.

Economists may debate whether or not the free enterprise system can economically survive without the entrepreneur, but his addition to our culture through his system of values cannot be denied. He is a source of creativity and innovation. His courage in risk-taking, his desire to assume responsibility, his energy to tackle the job are characteristics basic to the individuality that is the backbone of the free enterprise system.

And he offers these advantages to others in the businesses he creates. The variety of tasks, the flexibility of organization, and the

enjoyment of "belonging" are a fulfillment of human needs not readily available in many large and structured bureaucratic organizations. These values should not be lost for the sake of the large firm's efficiency.

Future Research

A Theory of Entrepreneurial Behavior seems possible in the foreseeable future. It will require a team effort. Several valuable concepts have already been contributed, role characteristics being the best tested. More research will be required particularly on managerial style (time-use is a possible measure), communication networks, organizational patterns, and economic behavior. Sound analytical procedures coupled with empirical data should provide a theory capable of predicting the future of entrepreneurial groups.

The author feels that we do not have to settle for a high rate of business failures or the total elimination of this vital segment of society.

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APPENDICES

APPENDIX A

List of Sawmill Managers in Study

APPENDIX A

Table A1. List of sawmill managers in study.

Plant Name and Address	County	Production Class	Principle Products Sold
Bauer Lumber Co. 615 Detroit Avenue Portland 48875 Joseph L. Bauer, Owner-Manager	Ionia	Sawmill - D	Lumber, pallets, sawdust
Russ Bradish Veneer and Hardwood, Inc. Route #2, East U.S. 223 Adrian 49221 Russ Bradish, Owner-Manager	Lenawee	Sawmill - D	Lumber
O. J. Briggs Lumber Co. 37 Benson Street White Cloud 49349 Ellroy Richardson, Owner-Manager	Newaygo	Sawmill - C	Lumber, pallets, crating
Custom Woodworking, Inc. Howard City 49329 Ken Thomas, Co-Owner, Manager	Montcalm	Sawmill - D	Lumber, pallets, furniture parts, furniture, chips, sawdust
Devereaux Sawmill, Inc. Pewamo 48873 James Devereaux, Co-Owner, Manager	Ionia	Sawmill - D	Lumber, chips, sawdust
Devereaux Brothers 18885 Sharon Road Oakley 49649 Ralph Devereaux, Co-Owner, Manager	Saginaw	Sawmill - D	Lumber, timbers, pallets, chips, sawdust, bark
Dimension Hardwood Lumber Company 10925 Highland Rd. (M-59) Milford 48042 George Reneand, Manager	Livingston	Sawmill - D	Lumber, chips, sawdust
Hawkins Lumber Co. Rollin 49278 John H. Hawkins, Owner-Manager	Lenawee	Sawmill - D	Lumber

(Continued)

Table A1. Continued.

Plant Name and Address	County	Production Class	Principle Products Sold
L. L. Johnson Lumber Manufacturing Company 563 N. Cochran Street Charlotte 48813 Robert Johnson, Co-Owner, Manager	Easton	Sawmill - C	Lumber, dimension, pallets, chips, glued up panels
Schneider Lumber Co., Inc. 325 Martindale Sparta 49345 Marvin Schneider, Co-Owner, Manager	Kent	Sawmill - C	Lumber, dimension, chips
Szepanski Sawmill, Inc. 1225 Saginaw St. St. Charles 48655 Cecil Szepanski, Owner-Manager	Saginaw	Sawmill - C	Lumber, pallets, chips, sawdust, bark

(Information in this table taken from Directry of Primary Wood Using Plants in Michigan. 1968.)

APPENDIX B

Sawmill Manager Information and Instruction Sheet

APPENDIX B

Sawmill Manager Information and Instruction Sheet

GENERAL INFORMATION:

First, we of the Forest Products Department of Michigan State University would like to express our thanks for your cooperation in this study. We feel that the results will provide a new insight into a very important segment of the forest products industry. Remember, all information will remain anonymous, but if you desire to identify yourself in the finished report--your code number will be S-_____.

INSTRUCTIONS:

1. You will be supplied with a Random Interval Timer (RIT) and a series of Daily Check Cards.
2. The RIT attaches to your belt or can be carried in a jacket coat pocket (however, it is too bulky for shirt pockets). By wearing it on your belt slightly to the side, you will hardly know that it is there.
3. Turn the RIT switch to ON when you leave your home (front door) each morning and record that starting time on your daily card. (RIT time-start)
4. The Daily Cards are designed for rapid use.
   a) Mark the month, data and day as you use them. If you need more than one card for a particular day, feel free to use another but number it #2.
5. Each time the timer sounds, follow this routine:
   a) Mark the time the device went off (upper right hand corner RIT Time).
   b) Mark the number of minutes you have been doing the activity you are engaged in (upper right hand corner--Time Prior to RIT).
   c) Mark the activity with the signal number.
   d) Describe briefly the activity under the Event number that coincides with the signal number.

6. See attached card as a typical example of a Daily Card.
7. Since most managers put in long days and much business is still transacted in the evening hours, please run the device until 9:30 P.M. Clarify your evening times the same as the day ones. TURN OFF THE TIMER and record the Off Time.
8. Accuracy plays a very important role in good research.

WORDS OF CAUTION IN USING THE RIT:

1. The RIT is very unique--there are no others like them in the U.S. --they were developed for this study! This is the first such study with business executives in our industry.
2. They cost over $100--so your care with them will be very much appreciated. While not fragile, they still cannot take dropping or submersing in water.
3. These devices will be picked up between scheculed use periods so that other managers can use them.

Your scheduled periods are:

_____ to _____.

_____ to _____.

_____ to _____.

In case your RIT fails to signal in an eight hour period, please notify me.

TONY VAN VLIET
MSU Office 517-355-3500
Home 517-339-8041

APPENDIX C

Sawmill Manager Interview Form

APPENDIX C

Sawmill Manager Interview Form

DATE:_____ MILL CODE NO._____

1. Name:_____ Age:_____

2. Title/s (General Mgr., President, etc.):_____

3. No. of people in charge of:_____

4. Firm founded in:_____ Family owned: YES NO

   Partnership ☐ Corporation ☐

5. No. of years you have been with firm:_____

6. No. of years in your present position:_____

7. Previous Positions held:

   a) Company_____ Title:_____
   from_____ to _____.

   b) Company_____ Title:_____
   from_____ to _____.

   c) Company_____ Title:_____
   from_____ to _____.

   d) Company_____ Title:_____
   from_____ to _____.

   e) Company_____ Title:_____
   from_____ to _____.

8. Education

   a) High School:_____
   b) College:_____
   Major:_____ Minor/s:_____

9. Training courses attended last 2 years:

   a) Name:_____ Location:_____
   Duration:_____

   b) Name:_____ Location:_____
   Duration:_____

   c) Name:_____ Location:_____
   Duration:_____

   d) Name:_____ Location:_____
   Duration:_____

10. Community activities & organizations you belong to (offices held too):

_____

_____

_____

_____

11. Professional or trade organizations you belong to (plus offices held):

_____

_____

_____

_____

12. Draw your organization's chart showing (a) persons you are responsible to, (b) persons responsible to you.

13. Key sources of information (all kinds) from

inside firm:

_____

_____

_____

_____

outside firm:

_____

_____

_____

_____

14. Gross Company Sales (last 8 years or most recent since starting operations).

1967 -

1966 -

1965 -

1964 -

1963 -

1962 -

1961 -

1960 -

APPENDIX D

Cumulative Distribution Plots of Signals
for Managers
(Actual vs. Theoretical)

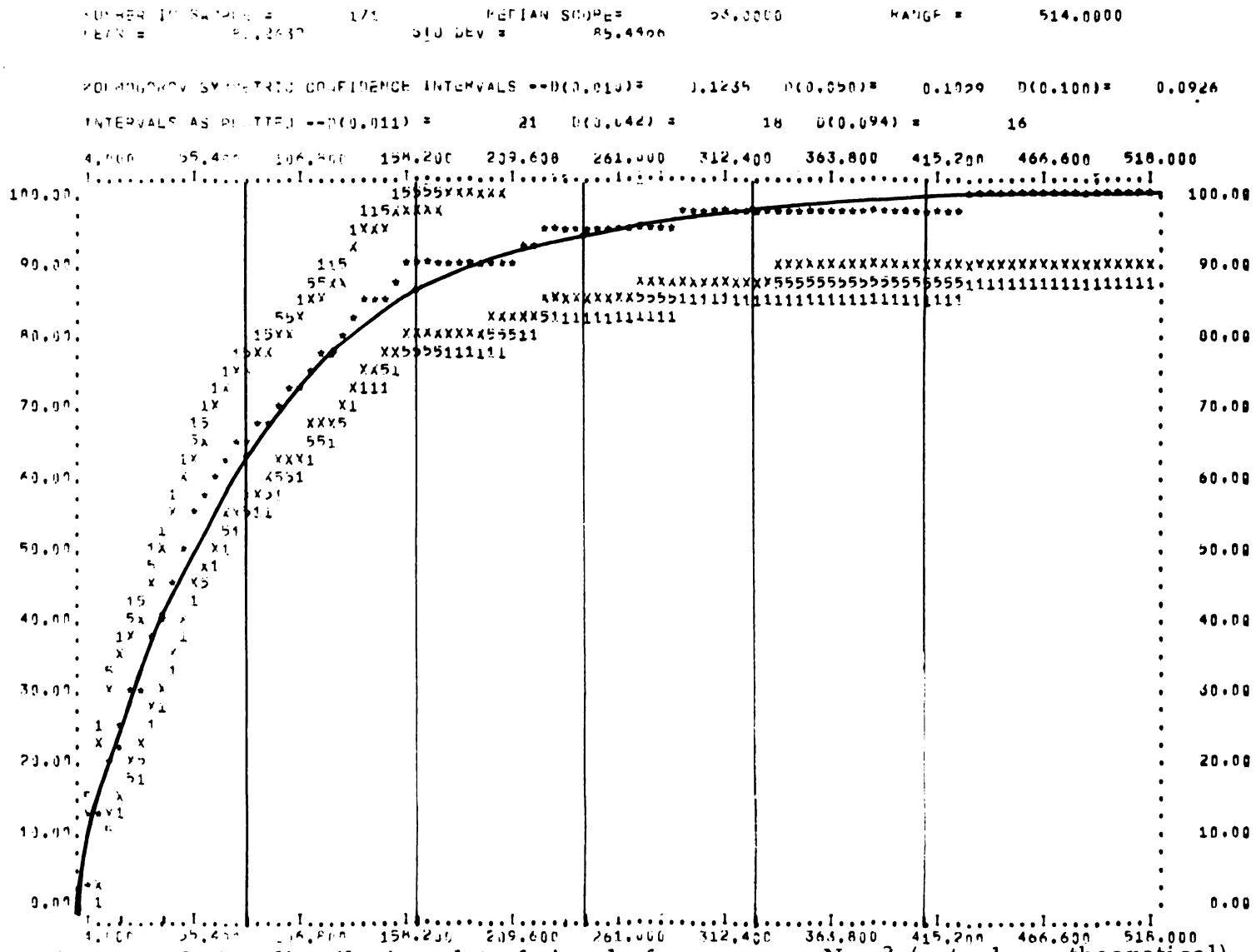

Figure D1. Cumulative distribution plot of signals for manager No. 2 (actual vs. theoretical).

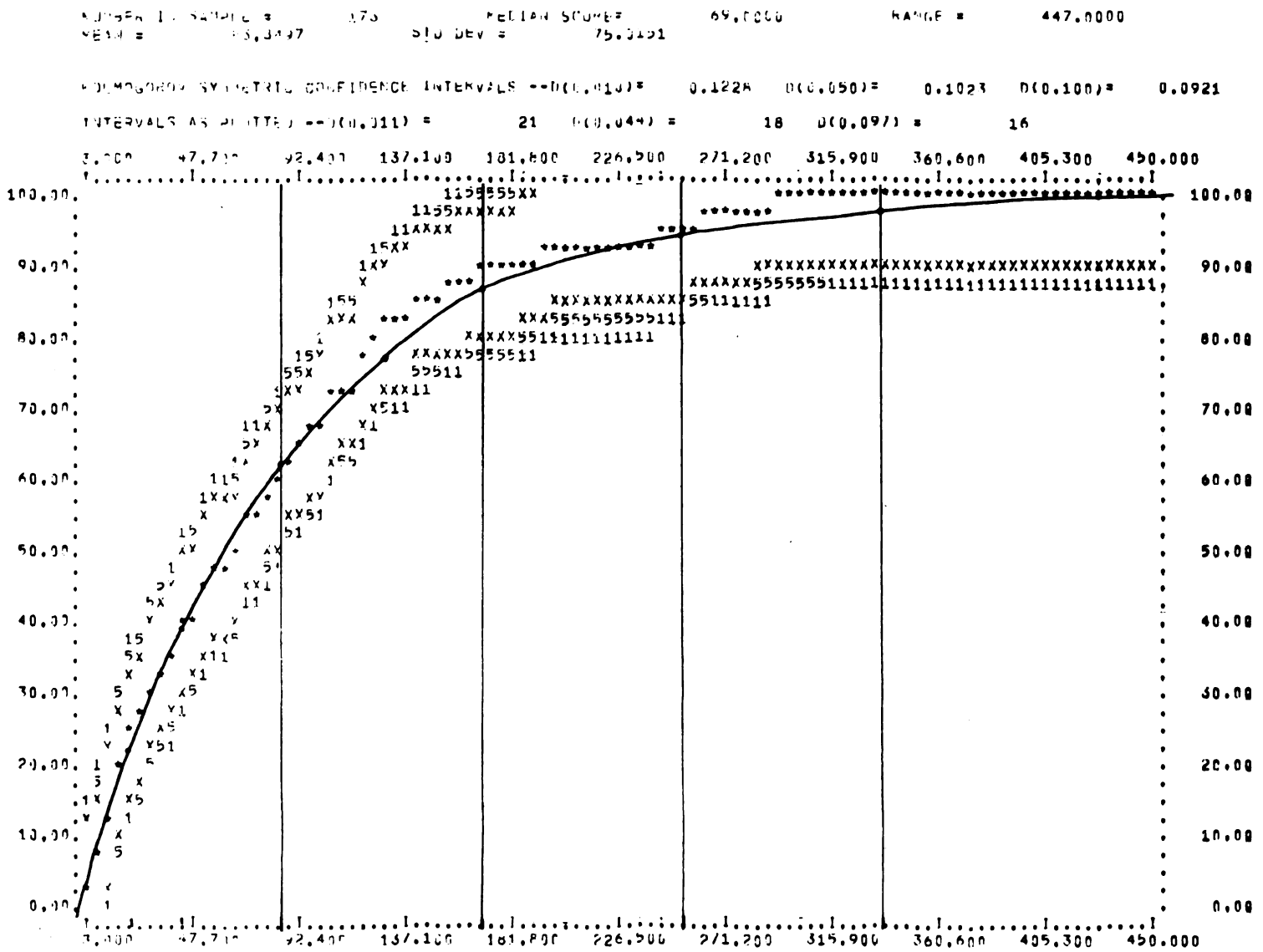

Figure D2. Cumulative distribution plot of signals for manager No. 3 (actual vs. theoretical).

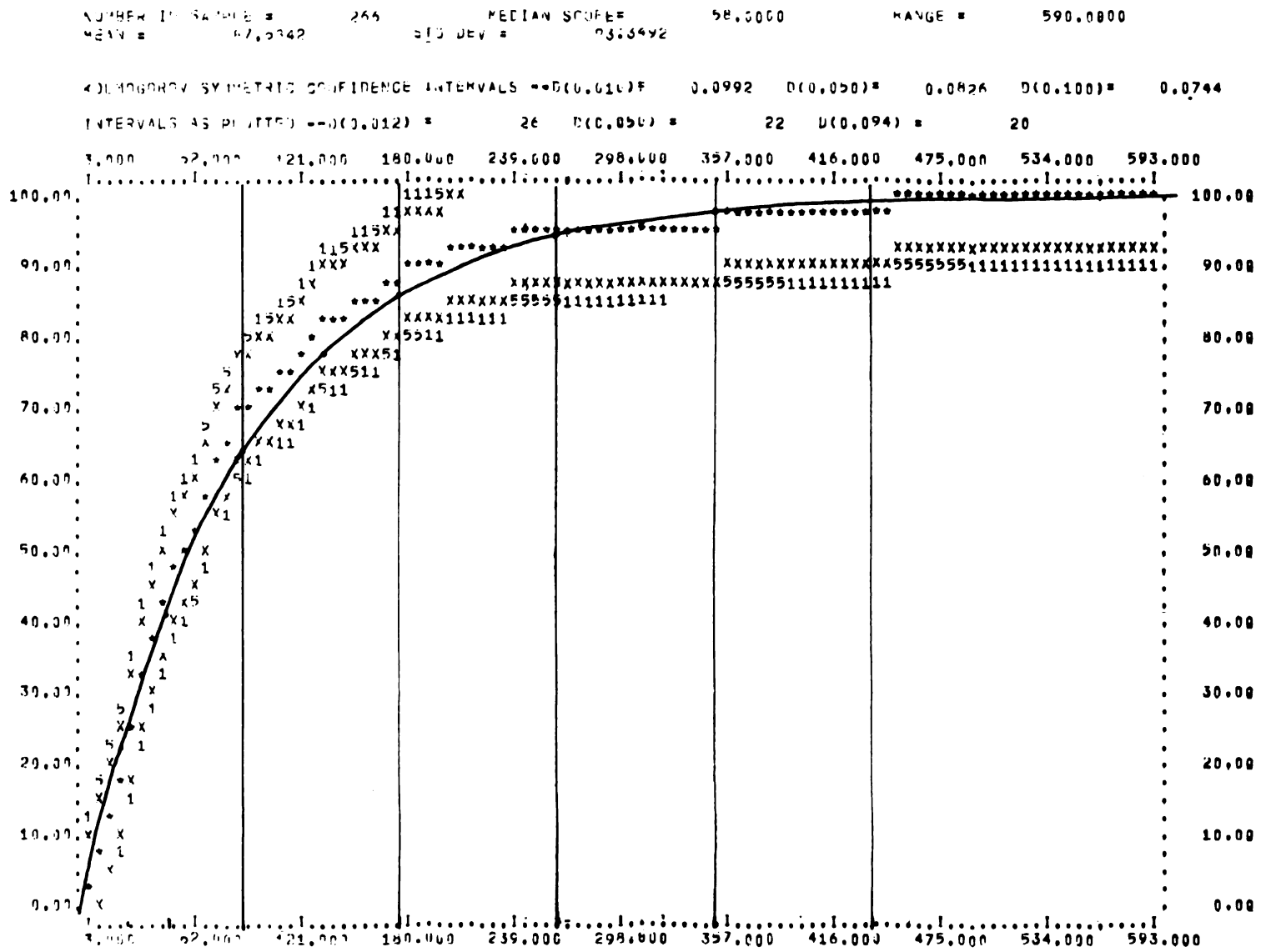

Figure D3. Cumulative distribution plot of signals for manager No. 4 (actual vs. theoretical).

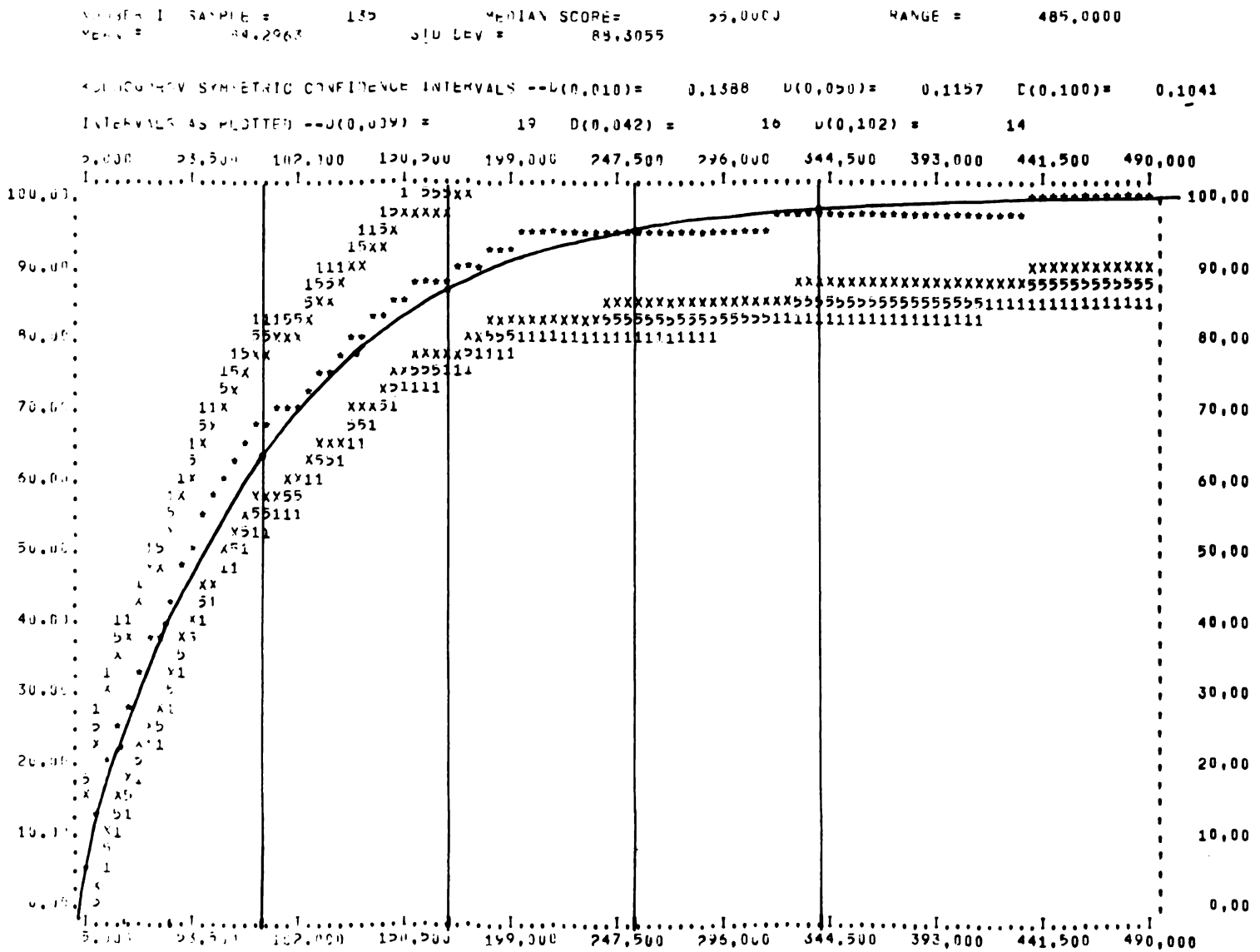

Figure D4. Cumulative distribution plot of signals for manager No. 5 (actual vs. theoretical).

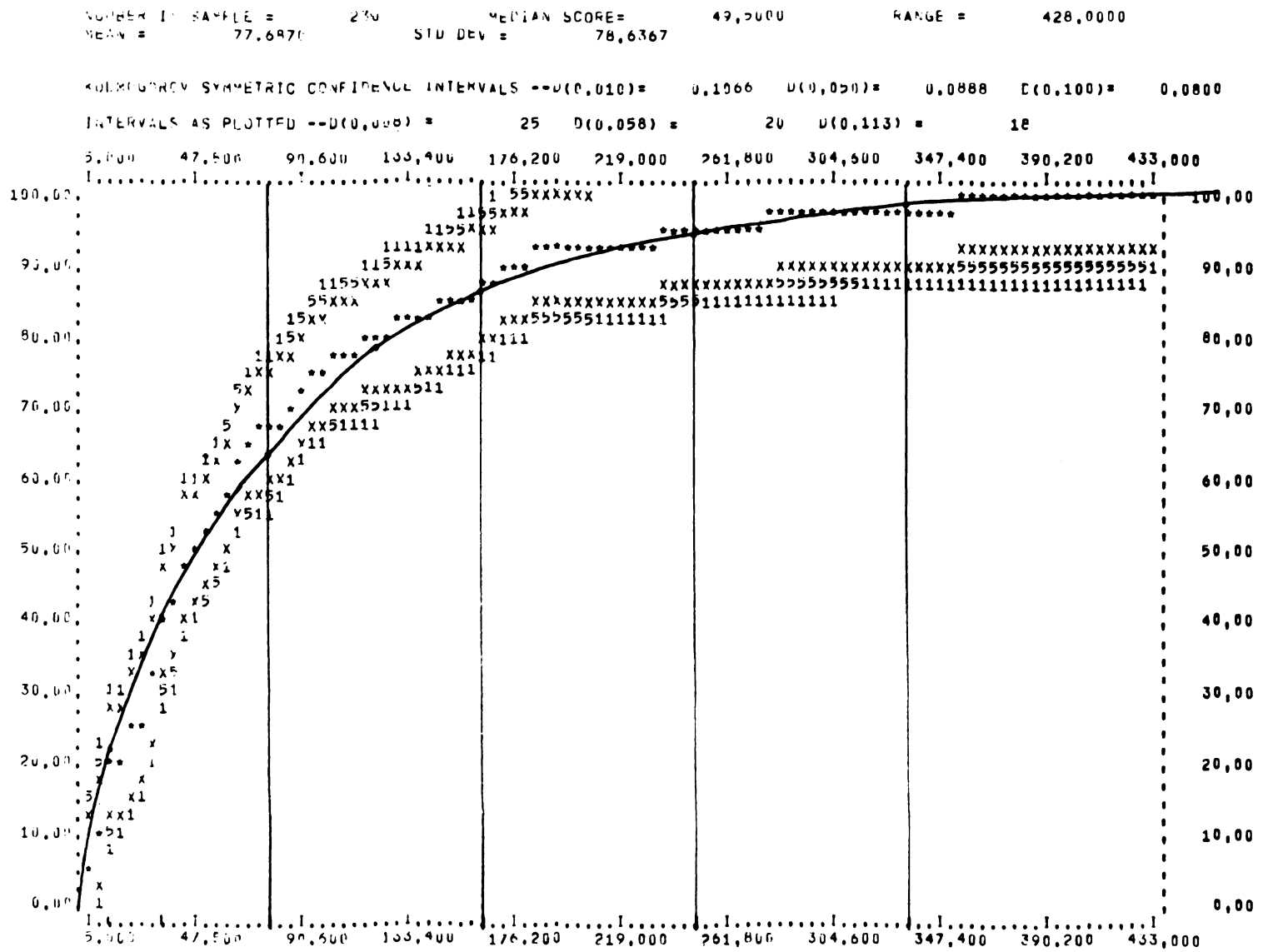

Figure D5. Cumulative distribution plot of signals for manager No. 6 (actual vs. theoretical).

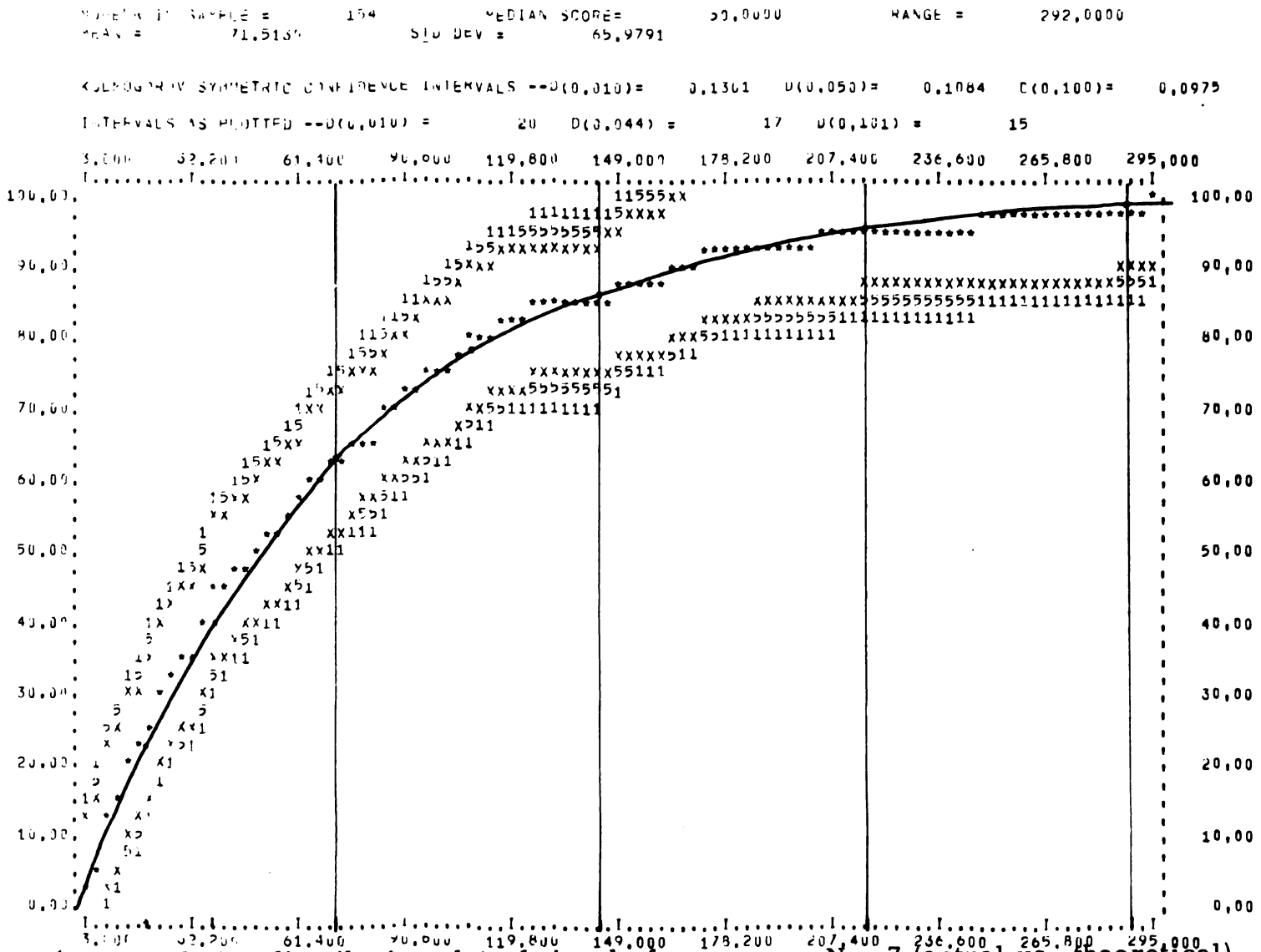

Figure D6. Cumulative distribution plot of signals for manager No. 7 (actual vs. theoretical).

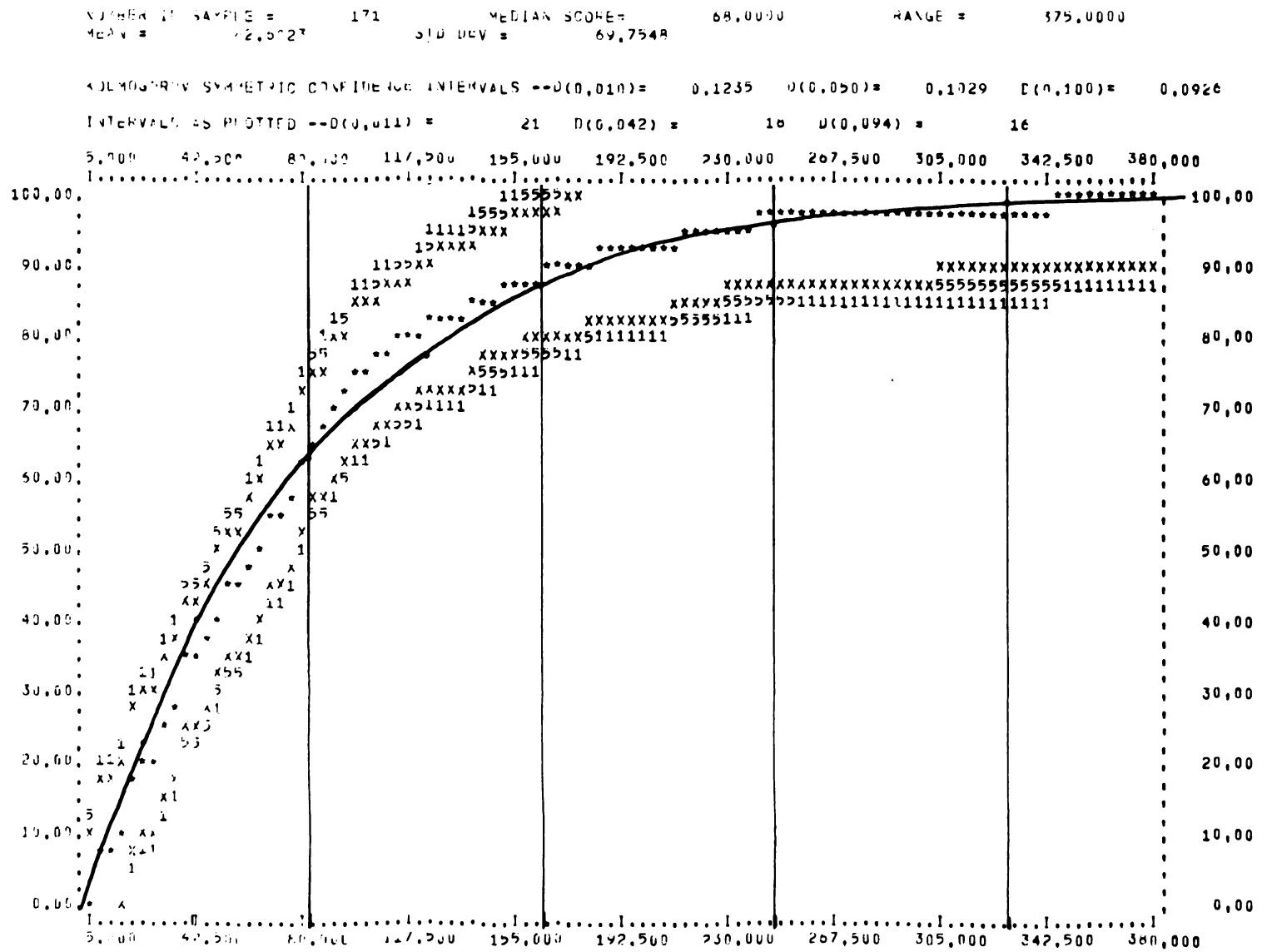

Figure D7. Cumulative distribution plot of signals for manager No. 8 (actual vs. theoretical).

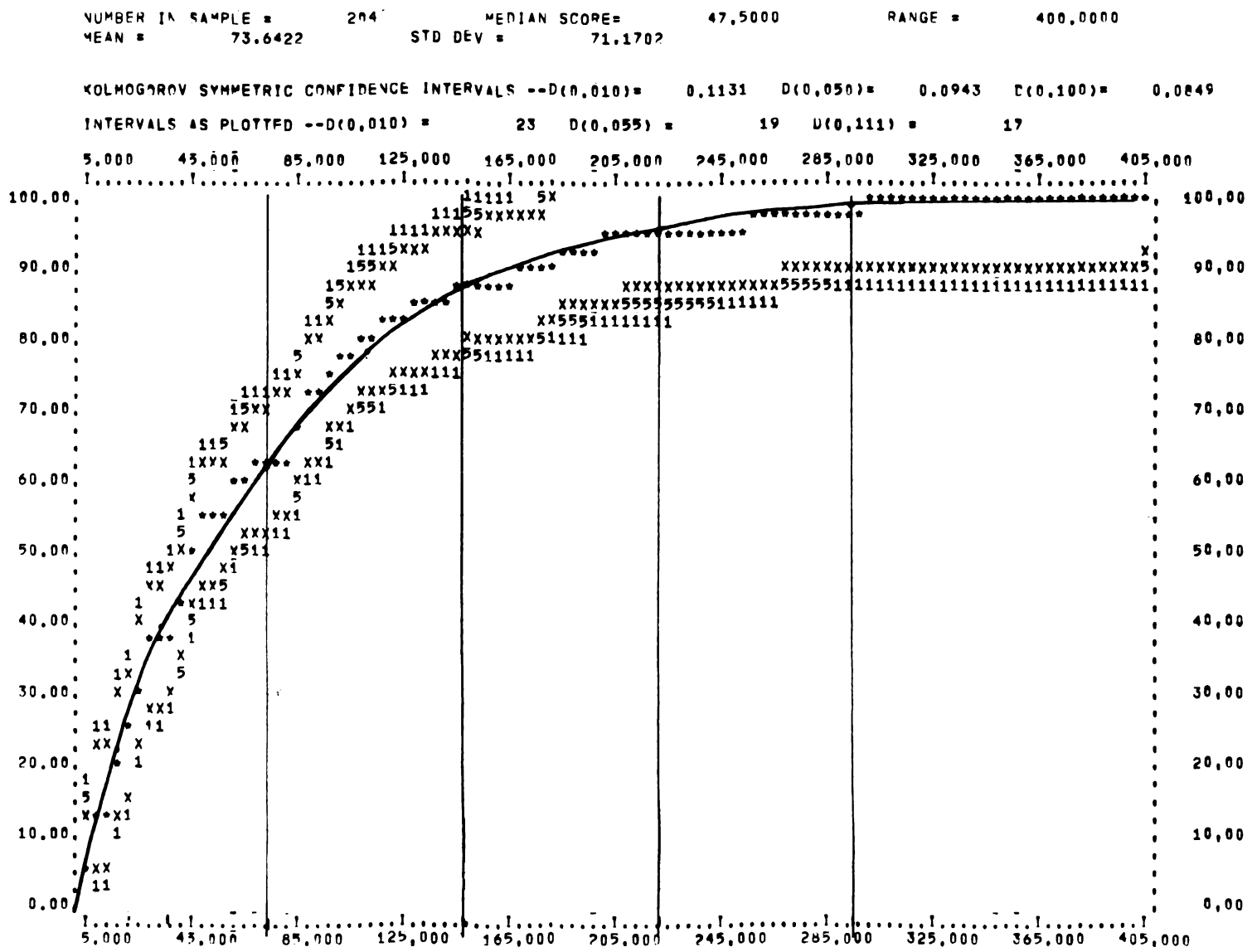

Figure D8. Cumulative distribution plot of signals for manager No. 9 (actual vs. theoretical).

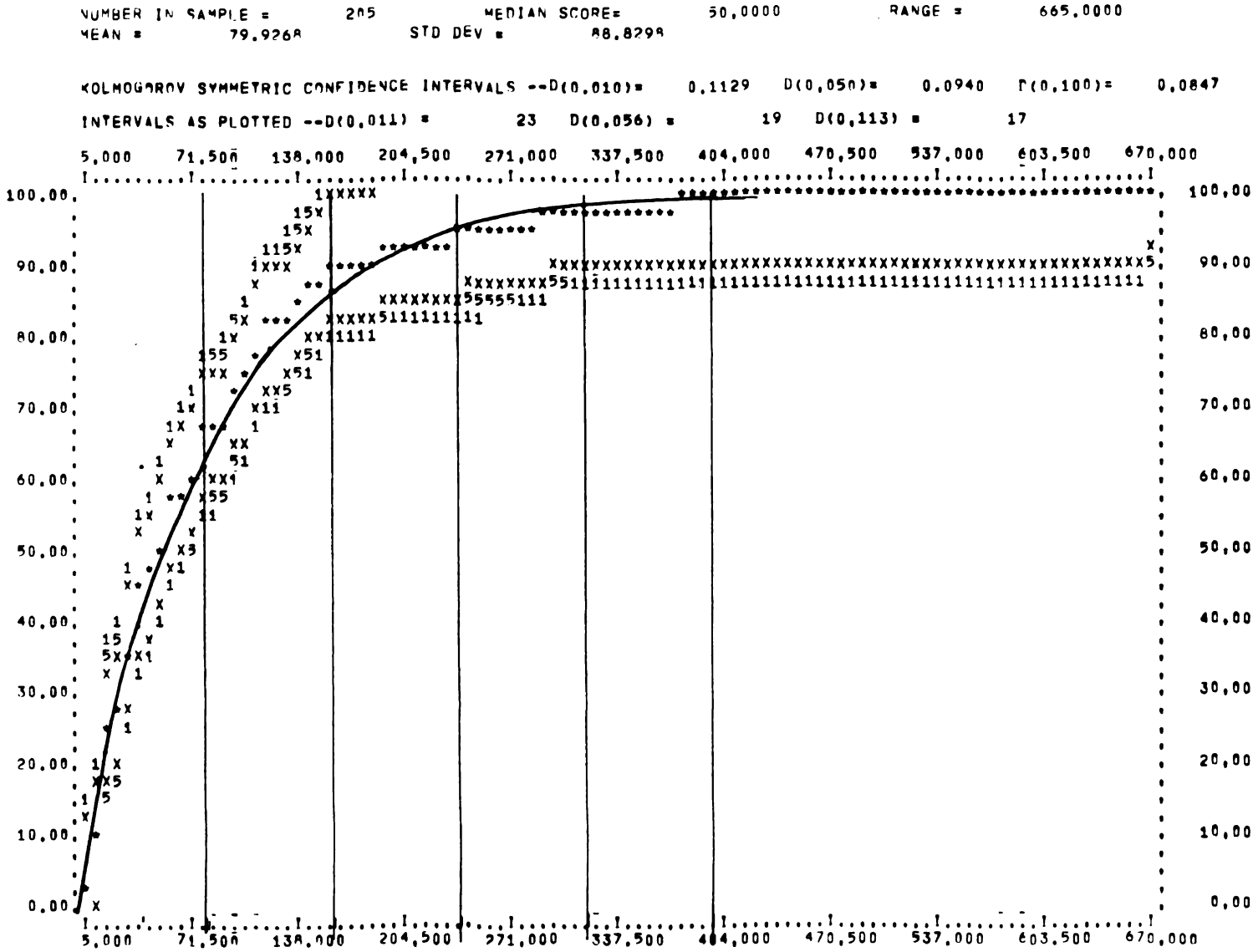

Figure D9. Cumulative distribution plot of signals for manager No. 10 (actual vs. theoretical).

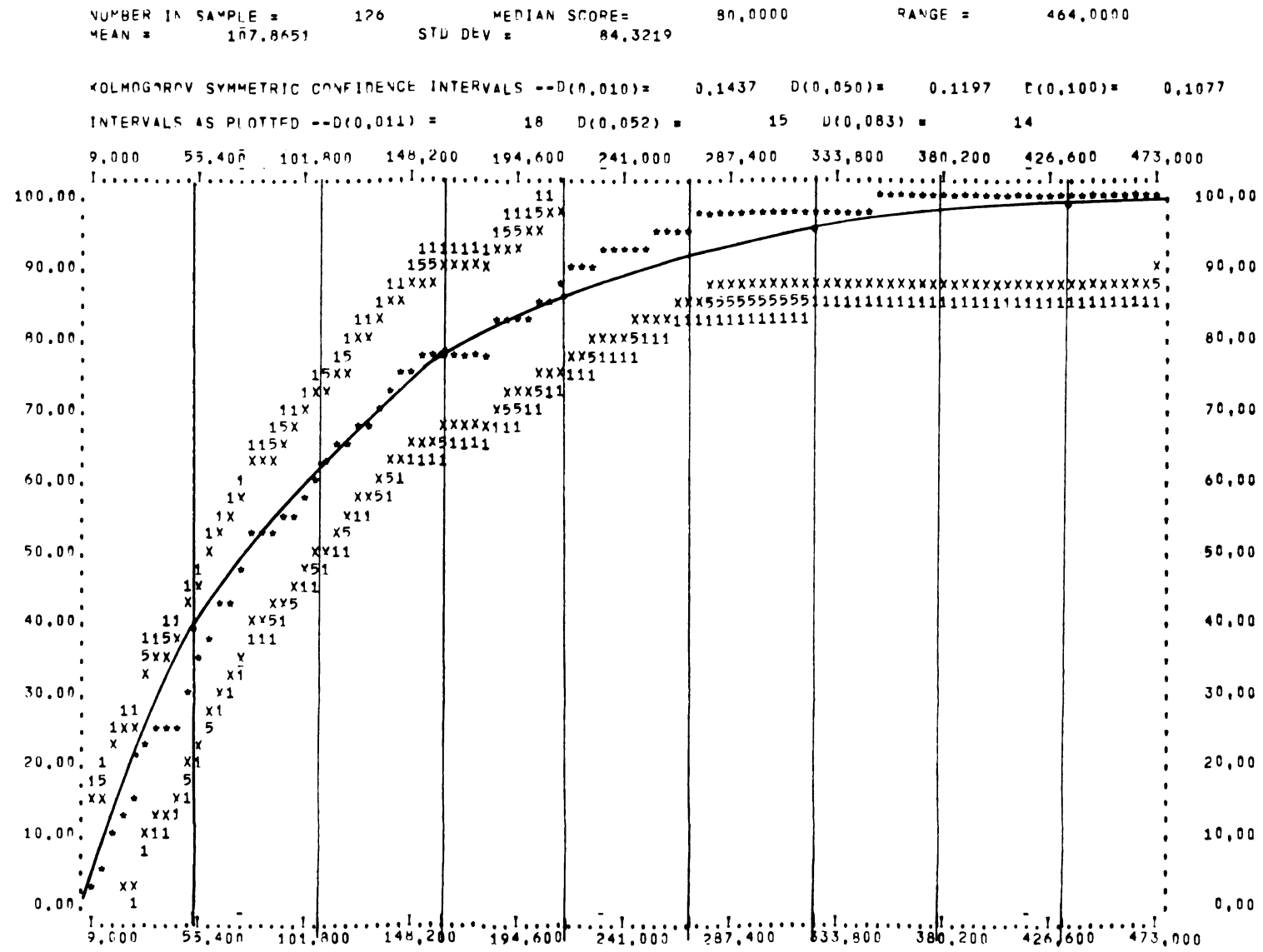

Figure D10. Cumulative distribution plot of signals for manager No. 11 (actual vs. theoretical).

APPENDIX E

Managerial Activity Tables

APPENDIX E

Table E1. Number of daytime observations per activity per manager.

Activity	Manager No. 1	2	3	4	5	6	7	8	9	10	11	Act. Total No.	Act. %
TRAINING	1						1					2	.10
Formal Within							1						
Formal Outside	1												
RECEIVING A PROBLEM	4	1	8		5	1		8		1	7	35	1.81
Mail													
Phone	2	1	2		5			8			1		
In Person	2		6			1				1	6		
GETTING INFO ABOUT A PROBLEM	34	21	22	8	9	8	17	14	16	29	24	202	10.47
Subordinate	6	8	2	1		1	5	2	6	9	8		
Outside Source	25	3	6	6	8	7	4	11	8	20	16		
Tech Reading	3	6		1	1		3		1				
Other		4	14				5	1	1				
DECIDING ACTION (PROBLEM)	32	17	18	13	6	9	5	18	5	25	17	165	8.55
Observation Time	3	1	3	6	5			2		11	3		
With Subordinates	9	10	3	2		4	3	8	3	4	7		
Think Time	5	4	7	5	1	2	2	6			3		
Other	15	2	5			3		2	2	10	4		
GIVING INSTRUCTIONS	15	5	21	2	3	7	6	19	21	11	18	128	6.44
Oral	15	4	21	2	2	7	5	18	21	11	18		
Written		1			1		1	1					

(Continued)

Table E1. Continued.

Activity	Manager No. 1	2	3	4	5	6	7	8	9	10	11	Act. Total No.	Act. %
ROUTINE WORK	96	55	50	39	61	66	36	37	78	46	21	585	30.33
Consultation with Subs	13	16	5	3	2	4	5	11	18	14	3		
Consultation with Outside	29	15	9	8	19	22	10	14	22	21	7		
Other (Scaling, Grading, etc)	36	5	17	16	28	23	5	7	21		1		
Other (Office Work, etc.)	18	19	19	12	12	17	16	5	17	11	10		
JOB INTERVIEWS	1		5	3		6		4				19	.98
CORRESPONDENCE	21	14	3			4	2	6	2	10	12	74	3.84
Written or Dictation	12	5	3			1	1	2		2	3		
Reading	9	9				3	1	4	2	8	9		
TRAVEL	31	14	6	20	7	25	10	13	16	43	6	191	9.90
Co. Business	18	8	2	18	7	19	8	13	8	41	5		
To and From Home	13	6	4	2		6	2		8	2	1		
BREAKTIME	27	5	9	20	12	24	23	20	21	20	18	199	10.32
Coffee		1	2	1	4	11	6	3	5	4	6		
Meal	27	4	7	19	8	13	17	17	16	16	12		
OTHER	32	27	10	103	24	35	28	10	39	18	3	329	
Home, Personal	19	5		19	7	12	8	2	27	2	3	104	5.39
Manual Work in Mill	13	22	10	84	17	23	20	8	12	1		210	10.88
Meetings										15		15	.78
GRAND TOTALS	294	159	152	208	127	185	128	149	198	203	126	1929	99.99%

Table E2. Number of nighttime observations per activity per manager.

Activity	Manager No. 1	2	3	4	5	6	7	8	9	10	11	Act. Total No.	Act. %
TRAINING												0	0
Formal Within													
Formal Outside													
RECEIVING A PROBLEM								1				1	.35
Mail													
Phone								1					
In Person													
GETTING INFO ABOUT A PROBLEM			2	1				1				4	1.40
Subordinate													
Outside Source			2					1					
Tech Reading				1									
Other													
DECIDING ACTION (PROBLEM)				1		2		6				9	3.15
Observation Time				1				1					
With Subordinates								4					
Think Time													
Other						2		1					
GIVING INSTRUCTIONS			1					3				4	1.40
Oral			1					2					
Written								1					

(Continued)

Table E2. Continued.

Activity	Manager No. 1	2	3	4	5	6	7	8	9	10	11	Act. Total No.	Act. %
ROUTINE WORK		1	4	5	4			7		1		22	7.69
Consultation with Subs								2					
Consultation with Outside			1		1			3					
Other (Scaling, Grading, etc.)			2		1								
Other (Office Work, etc.)		1	1	5	2			2		1			
JOB INTERVIEWS			2									2	.70
CORRESPONDENCE		1		1								2	.70
Written or Dictation		1		1									
Reading													
TRAVEL	5	1	3	3	2	2	3			1		20	6.99
Co. Business	1		1		2		2			1			
To and From Home	4	1	2	3		2	1						
BREAKTIME	30	3	5	2	1	7	2	1				51	17.83
Coffee								1					
Meal	30	3	5	2	1	7	2						
OTHER	51	6	4	45	1	34	21	3	6				
Home, Personal	48	6	3	24	1	34	18		6			140	48.95
Manual Work in Mill	3		1	21			3	3				31	10.84
GRAND TOTALS	86	12	21	58	8	45	26	22	6	8	0	286	100 %

Table E3. Percent of daytime observations per activity per manager.

Activity	Manager No. 1	2	3	4	5	6	7	8	9	10	11
TRAINING	0.34						0.78				
RECIEVING A PROBLEM	1.36	0.63	5.26		3.94	0.54		5.37		0.49	5.56
GETTING INFO ABOUT A PROBLEM	11.56	13.21	14.47	3.85	7.09	4.32	13.28	9.40	8.08	14.29	19.05
DECIDING ACTION	10.88	10.69	11.84	6.25	4.72	4.86	3.91	12.08	2.53	12.32	13.49
GIVING INSTRUCTIONS	5.10	3.14	13.82	0.96	2.36	3.78	4.69	12.75	10.61	5.42	14.29
ROUTINE WORK	32.65	34.59	32.89	18.75	48.03	35.68	28.13	24.83	39.39	22.66	16.67
JOB INTERVIEWS	0.34		3.29	1.44		3.24		2.68			
CORRESPONDENCE	7.14	8.81	1.97			2.16	1.56	4.03	1.01	4.93	9.52
TRAVEL	10.54	8.81	3.95	9.62	5.51	13.51	7.81	8.72	8.08	21.18	4.76
BREAKTIME	9.18	3.14	5.92	9.62	9.45	12.97	17.97	13.42	10.61	9.85	14.29
OTHER	10.88	16.98	6.58	49.52	18.90	18.92	21.88	6.71	19.70	8.87	2.38
TOTAL	100 % of Daytime Observations										

Table E4. Average duration time (in minutes) spent per activity per manager--daytime observations.

Activity	Manager No. 1	2	3	4	5	6*	7	8	9	10	11
TRAINING	20.0						20.0				
RECEIVING A PROBLEM	28.0	4.0	48.3		4.4			21.3		40.0	24.0
GETTING INFO ABOUT A PROBLEM	20.8	10.8	35.6	24.5	44.4		5.6	18.6	37.1	55.5	33.7
DECIDING ACTION	21.1	16.8	52.3	14.5	87.3		17.2	29.4	30.8	57.6	19.8
GIVING INSTRUCTIONS	16.5	5.2	62.3	8.0	2.6		6.0	19.7	50.3	50.9	43.9
ROUTINE WORK	31.8	9.8	55.6	40.4	37.1		16.6	20.8	26.5	53.3	24.9
JOB INTERVIEWS	20.0		40.0	73.3				22.5			
CORRESPONDENCE	46.5	30.7	70.0				4.0	20.0	10.0	57.0	15.2
TRAVEL	18.6	8.6	17.7	30.1	27.1		9.2	23.0	18.8	115.8	83.3
BREAKTIME	42.0	17.6	39.8	36.0	37.0		23.9	25.1	22.6	45.5	30.1
OTHER	45.3	65.9	40.2	37.7	62.8		38.5	30.0	50.4	51.7	32.0
TOTAL	100 % of Daytime Observations										

* Data not usable.

APPENDIX F

Table of Student's t Test Values

APPENDIX F

Table F1. Table of Student's t test values.

Activity	High O-E vs. High C-E Mgrs.			High O-E vs. All C-E Mgrs.			First Five Days (All Mgrs.) vs. Remaining Days (All Mgrs.)		
	$t_{cal.}$	$t_{.05}$	$t_{.01}$	$t_{cal.}$	$t_{.05}$	$t_{.01}$	$t_{cal.}$	$t_{.05}$	$t_{.01}$
TRAINING	n.s.[1]	n.s.	n.s.	0.8634	n.s.	n.s.	0.8146	n.s.	n.s.
RECEIVING A PROBLEM	2.5791	1.9896*	2.6392	0.2818	n.s.	n.s.	1.5391	n.s.	n.s.
GETTING INFORMATION ABOUT A PROBLEM	3.4962	1.9901	2.6403**	0.2189	n.s.	n.s.	0.0564	n.s.	n.s.
DECIDING ACTION	3.3737	1.9897	2.6394**	2.5678	1.9856*	2.6306	0.2727	n.s.	n.s.
GIVING INSTRUCTIONS	3.1431	1.9896	2.6393**	0.1647	n.s.	n.s.	1.7824	n.s.	n.s.
ROUTINE WORK	n.s.	n.s.	n.s.	1.3372	n.s.	n.s.	1.6639	n.s.	n.s.
JOB INTERVIEWS	n.s.	n.s.	n.s.	0.3787	n.s.	n.s.	0.6072	n.s.	n.s.
CORRESPONDENCE	3.3354	1.9890	2.6381**	2.1134	1.9862*	2.6321	0.8161	n.s.	n.s.
TRAVEL	2.1650	1.9906*	2.6413	3.2536	1.9856	2.6301**	0.1852	n.s.	n.s.
BREAKTIME AND MEALS	n.s.	n.s.	n.s.	0.8087	n.s.	n.s.	1.9098	n.s.	n.s.
OTHER	7.9296	1.9925	2.6451**	4.3343	1.9780	2.6096**	1.0935	n.s.	n.s.

[1] n.s. = not significant.
* = probably significant—5% level.
** = highly significant--1% level.

APPENDIX G

Tabulation of Data from Prototype
Instrument Serial No. 81

APPENDIX G

Table G1. Tabulation of data from prototype instrument Serial No. 81.

Mean Interval $= \frac{T}{N}$ (Total Elapsed Time)

$= \frac{2114 \text{ minutes}}{89}$

= 23.75 or 24 minutes

Mean Rate of Occurrence equal to 1 sigmal/24 min.

Signal No.	Time (ΔT) Interval Between Signals	Total Elapsed Time (T)	Signal No.	Time (ΔT) Interval Between Signals	Total Elapsed Time (T)	Signal No.	Time (ΔT) Interval Between Signals	Total Elapsed Time (T)
1	16	16	31	20	768.6	61	5	1331
2	49	65	32	28	796.6	62	7.5	1338.5
3	13	78	33	56	852.6	63	33	1371.5
4	61	139	34	18	870.6	64	2.5	1374
5	20	159	35	2.4	873.	65	21	1395
6	10	169	36	2.4	875.4	66	15	1410
7	82	251	37	7.6	883.	67	15	1425
8	16	267	38	10	893.	68	23	1448
9	2.4	269.4	39	31	924.	69	46	1494
10	7.5	276.9	40	8	932.	70	21	1515
11	78	354.9	41	33	965.	71	41	1556
12	2.4	357.3	42	33	998.	72	5	1561
13	25	382.3	43	11	1009.	73	64	1625
14	13	395.3	44	10	1019.	74	44	1669
15	5.4	400.7	45	2.5	1021.5	75	110	1779
16	7.8	408.5	46	2.5	1024.	76	2.5	1781.5
17	51	459.5	47	2.5	1026.5	77	2.5	1784
18	5.4	464.9	48	10	1036.5	78	5	1789
19	13	477.9	49	13	1049.5	79	62	1851
20	70	547.9	50	10	1059.5	80	81	1932
21	7.5	555.4	51	5	1064.5	81	5	1937
22	64	619.4	52	20	1084.5	82	20	1957
23	5.4	624.8	53	36	1120.5	83	31	1988
24	38	662.8	54	5	1125.5	84	13	2001
25	2.4	665.2	55	74	1199.5	85	5	2006
26	15	680.2	56	2.5	1202	86	13	2019
27	2.4	682.6	57	15	1217	87	31	2050
28	23	705.6	58	39	1256	88	15	2065
29	23	728.6	59	16	1272	89	49	2114
30	20	748.6	60	54	1326			