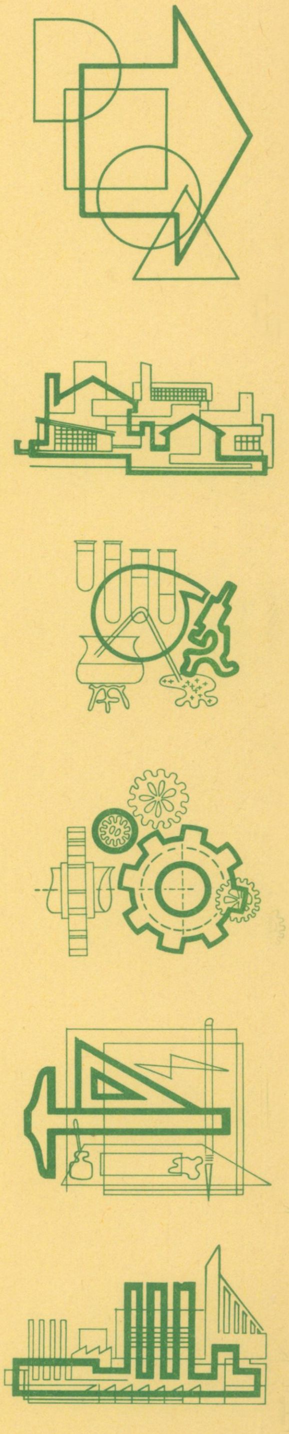
PROCEEDINGS

SEVENTH ANNUAL INDUSTRIAL ENGINEERING INSTITUTE



UNIVERSITY OF CALIFORNIA

BERKELEY January 31, February 1 1955 January 28, 29 LOS ANGELES

PROCEEDINGS

SEVENTH ANNUAL

INDUSTRIAL ENGINEERING INSTITUTE

BRUCE G. McCAULEY
EDITOR
Assistant Professor of Mechanical Engineering
University of California
Berkeley, California

UNIVERSITY OF CALIFORNIA

BERKELEY

Monday and Tuesday
January 31 and February 1, 1955

Presented by:

DIVISION OF MECHANICAL ENGINEERING

SCHOOL OF BUSINESS ADMINISTRATION

INSTITUTE OF INDUSTRIAL RELATIONS

UNIVERSITY EXTENSION

In cooperation with:

AMERICAN INSTITUTE
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SOCIETY

LOS ANGELES

Friday and Saturday
January 28 and 29, 1955

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PREFACE

If the growing interest in the Proceedings of these Industrial Engineering Institutes is a valid criterion, the field of industrial engineering is expanding rapidly both in geographical scope and in the variety of organizations utilizing its principles. That such is truly the case is evidenced by the increasing number of requests for these Proceedings that are continually being received from all over the world.

Requests for copies have come from all over the United States, as well as many foreign nations, including England, the countries of Western Europe, and the Allied zone of Berlin. Among the Asian nations, requests for copies of the Proceedings have been received from Japan, India, Australia, New Zealand and Israel. In addition, numerous copies have been ordered from Western Hemisphere countries, such as Canada, Hawaii, Alaska, Mexico and the South American nations.

Likewise, there is a growing expansion in the types of organizations showing an interest in the industrial engineering field. Proceedings have been requested by the governmental agencies of several foreign countries, as well as many of our own federal, state and municipal government offices. Service industries, such as laundries, transportation companies, department stores and hotels, have shown an increasing interest in the possibility of utilizing industrial engineering principles; and so have several financial institutions, including insurance companies and banks. Of course, the greatest interest in industrial engineering has been and probably always will be vested in manufacturing industries of all types.

The wide variety of industries which sent participants to attend this year's Institute is further evidence of a growing awareness of the applicability of industrial engineering principles, techniques and practices in the solution of an endless variety of management problems. It is in line with this expansion of thought that the newer areas of present interest, such as automation and operations research, are herein given greater emphasis.

The Proceedings of the first of these Institutes have never been published and only a very limited number of copies of the second year's conference were distributed. In view of the increasing demand for copies of these earlier sessions, arrangements have been made to publish in one volume the papers presented at the First and Second Institutes. It is expected that this publication will be available directly from the publisher, The Elliott Printing Company, the latter part of this year.

Needless to say, the growing interest shown in these Industrial Engineering Institutes is indeed gratifying. One has only to hear the exoellent papers presented and the high caliber of the questions from the audience which they generate to realize that the profession of industrial engineering is currently making vigorous, forward strides.

BRUCE G. McCAULEY
Editor

Standing: E.P. DeGarmo, R.C. Grassi, C. Alvin
Seated: Mrs. Campbell, W.G. Campbell, E.T. Grether

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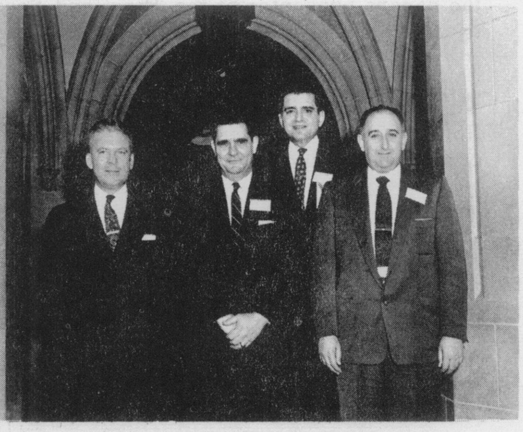

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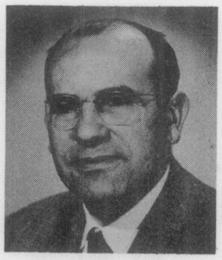

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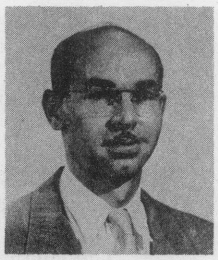

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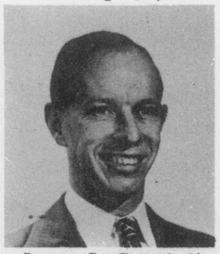

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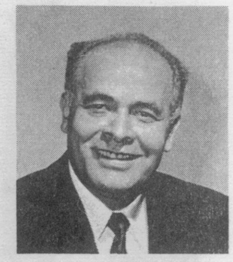

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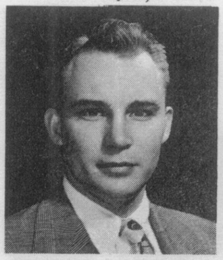

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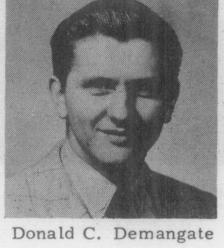

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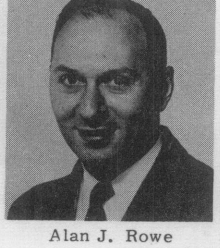

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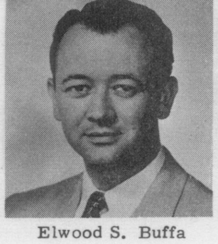

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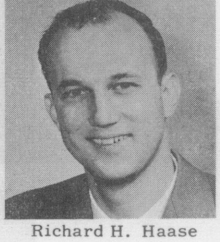

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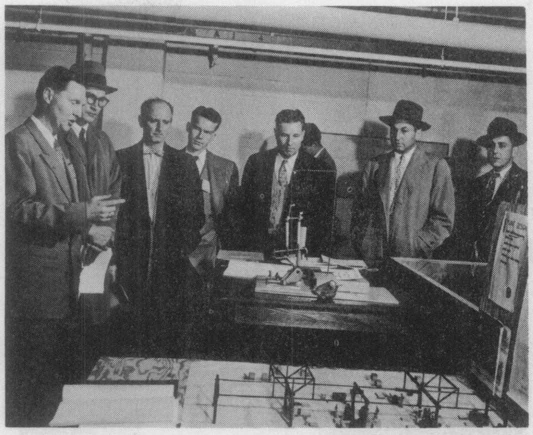

Plant layout and methods improvement demonstration
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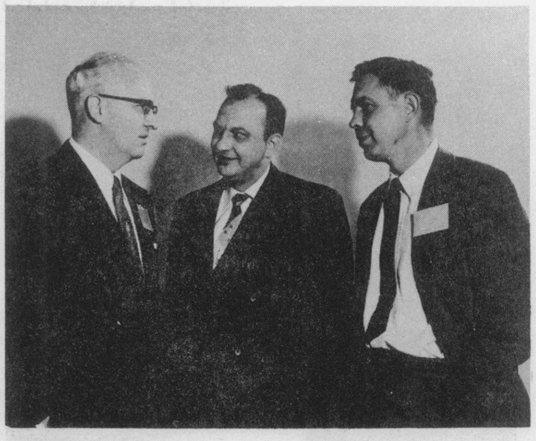

E. P. DeGarmo, C. Alvin, T. Gordon

Standing: B.G. McCauley, R.C. Grassi, E.D. Howe
Seated: F.V. Gardner, T.A. Fante

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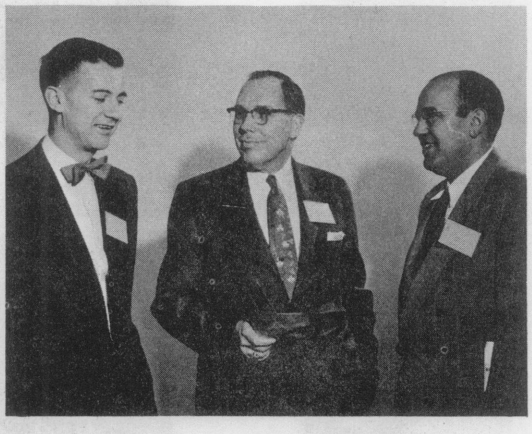

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FOREWORD

The Industrial Engineering Institutes held each year on the Los Angeles and Berkeley Campuses of the University of California have become outstanding annual national attractions in industrial engineering and management. Approximately seven hundred people from throughout the United States and several foreign countries participated in the Seventh Institute. This level of support is most encouraging and gratifying to those of us who enjoy the annual responsibility and privilege of staging this event.

A program of this kind is the product of the efforts of many people. The beginning point in the design of a program is the interest questionnaires filled out by all the participants at the last Institute. Early in the Spring, meetings of the Planning Committees on the Los Angeles and Berkeley Campuses are held. These Committees comprise members of the faculty and administration on each Campus and representatives from each of the sponsoring professional societies. As a result of the interest questionnaires and the meetings of the Planning Committees, a list of the desired subjects and speakers is prepared and the General Chairman is authorized to commence sending out invitations.

By operating on a joint program and budget between the two Campuses it is possible for us to "reach out" to distant parts of the country for speakers whom local professional societies could not otherwise invite because of budgetary limitations. All activities and session chairmen and speakers donate their services to the Institutes. Travel expenses are offered to speakers, although in many instances their companies graciously defray these expenses. The Institutes are operated on a non-profit basis thereby minimizing the registration fee to the participants.

The frontiers of industrial engineering appear to be expanding rapidly and traditional techniques are being challenged. The impact of the need for using more effective new quantitative techniques for decision making purposes is being felt more and more in business enterprises. This is the result of the impetus given to the successful use of such techniques by the American and British Defense Establishments during the Second World War. The papers in these Proceedings on such subjects as automation, linear programming, operations research, and job enlargement are illustrative of the expanding frontiers or of what some people call the "new look" in industrial engineering. The principles of industrial engineering are also being applied more universally so that non-manufacturing personnel as well as non-industrial enterprises are being brought within the purview of these principles. The heterogeneous makeup of the participants at the Institutes attests to this statement. It is one of the prime objectives of these Institutes to present such new and important practical developments and applications. Because of the limited time in a two-day program it is not possible to cover all the subject matter in industrial engineering each year. However, an attempt is made to rotate subjects from year to year.

The speakers who presented the papers in these Proceedings are men with outstanding and unique accomplishments. Their presentations were most stimulating and inspiring. Our deepest appreciation goes to them for generously taking time from their busy schedules to share with us their ideas and experiences and thereby disseminating a better understanding of the best practices in industrial engineering and management.

Presentations such as these made at the Seventh Institute help to define the ever-growing profession of industrial engineering. Gradually, and in some instances immediately, they have an impact on the level of sophistication of the science and art of management practiced in different business enterprises. It is also significant to note that more and more management is drawing from industrial engineering groups for operating line executives.

My sincerest appreciation goes to all the good people who volunteered their efforts to make the Seventh Annual Industrial Engineering Institute another outstanding success. Their satisfaction as well as mine came from the continuing interest, support, and appreciation evidenced by the large audiences on both the Los Angeles and Berkeley Campuses. It is this continuing interest which makes these Institutes possible. We thank all of you who participated in the Seventh Institute and hope you will tell your friends about it. We shall look forward to seeing you and your friends at the Eighth Institute, the plans for which are already under way.

JOSEPH D. CARRABINO
General Chairman

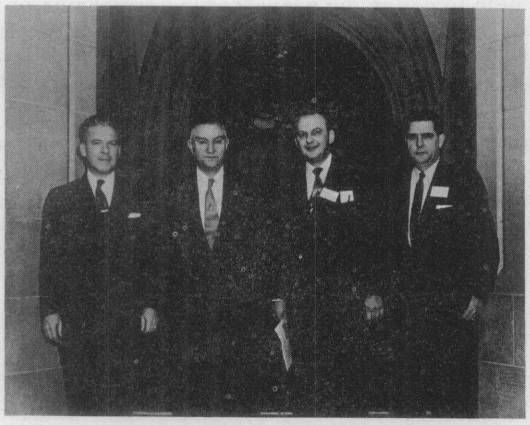
SCENES AT LOS ANGELES

R. M. Barnes, D.B. Hertz, J.J. Barry
J. D. Carrabino

Production plant demonstration
in Engineering Laboratory

View of part of Los Angeles audience

R.B. Allen, N.H. Jacoby, G.W. Robbins



· A.O. Mann, L.M.K. Boelter, C. Alvin, F.V. Gardner

Line production demonstration
in Production Management Laboratory

WELCOMING REMARKS

Paul H. Sheats
Associate Director
University Extension
University of California
Los Angeles, California

I have always had a slight suspicion that these welcoming remarks have an undisclosed purpose, namely that of giving the latecomers a change to settle down without missing anything really important, but even if that hypothesis were correct, I would still count it a privilege to be able on behalf of the University of California to welcome you to this Seventh Annual Industrial Engineering Institute and to assure you that we shall do everything without our power to make your stay here these next few days profitable and pleasant. I think that the large number of you who have attended one or more previous Institutes and are returning for this one gives more eloquent testimony than anything I could give to the high standards of excellence which were established in these previous meetings, and as I look at the program and the list of outstanding speakers who have been invited to participate in this event, there is no reason why this particular Institute should not write an outstanding record also -- equal to or surpassing that of the previous meetings.

I would like to take special note of the numbers of departments and cooperating professional societies. These are all listed on your program on the annoucement. I'm not going to mention them, but I think this is no mean achievement in itself to get this kind of collaborative planning on a single event such as we have here today. And I want to take this occasion to express particular appreciation to the officers and members of these cooperating associations and societies for the help that you have given us in planning this program. I think this kind of collaboration is perhaps characteristic of the teamwork which we're going to need between the University and practicing professionals if we are to achieve increased productivity in our industrial society without sacrificing human values.

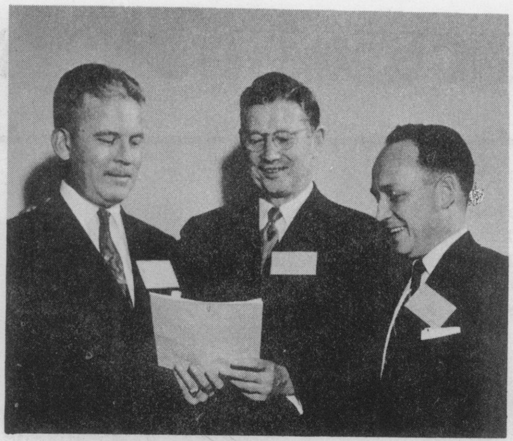
In these days no great university, I think, should rest content with the creation of new knowledge through research or even with the transmission of knowledge to a resident student body. It should, and I know it certainly does in the case of the University of California, concern itself with the extention of knowledge, the application of research by means in the state and in the community which it was created to serve. In the current year at UCLA, while we will have approximately 14,000 resident students on campus, we will have 28,000 adults who will be participating in graduate and undergraduate courses and in postgraduate activities off campus through the facilities of the University Extension. Many of these will be in the fields of Business Administration and Engineering. Probably another 20,000 beyond these 28 in formal class activities will be participating in conferences of the type we're holding here today.

Now, impressive as these statistics may be, and proud as we are of the record of achievement in this program of off-campus service, this is only a drop in the bucket because last year the most accurate estimate we could get indicated that something over 49,000,000 adults in the United States are participating in some kind of organized adult education activity. Now I mention these facts to the members of an Industrial Engineering Institute because I think they indicate in some measure the extent of the committments which we in this country have to the practice of life-long learning. There is no country in the world today which was so generally accepted as self-evident the necessity for the continuing wider discovery of new knowledge. In my judgment, it is a secret weapon in the democracy which may in the long pull equal the importance of a stockpile of hydrogen bombs.

A few days ago I noticed in The Los Angeles Times, what Clarence Francis said in an address before the American Management Association, and I expect that some of you were there and heard this address which he took a fifty-year view of the road ahead and predicted an era in which there will be, in his words, stupendous and undreamed-of developments on the economic front. As I learned from last-year's proceedings and a bit of research of my own, industrial engineering seeks to affect an optimum combination of men, materials, and money for the purpose of reducing and controlling costs in conjunction with increasing productivity and human satisfaction. You who are here today will be on the front lines in the effort to make Clarence Francis' dreams come true. This line of thought makes what you do here socially as well as professionally important. Speaking then, for your lay colleagues in other fields, and in the larger communities, may I be forgiven if I pray fervently and somewhat selfishly that your labors here may be productive and that your life-long learning may proceed.

I have a story that I heard in the East a few weeks ago which I will tell only on condition that you realize I am not applying this to the School of Business Administration on this campus. This concerned a graduate of a College or School of Business Administration who, after five years of successful practice happened to be on a business trip in the city where the campus was located and thought it would be fun to stop and visit with his favorite professors in the School of Business Administration, which he did. It was about this time of year and the professor had a stack of blue books on his desk and they talked and visited for a little while and then somewhat idly the visitor picked up one of the examination books and leafed through it casually and he said, "My God, Prof, these are the same questions you were asking five years ago!" "Every Frat house on campus has probably got a set of these by now." The Prof said, "Oh, we know that. What you don't realize is that we change the answers every year." I suspect that one of the reasons that we get such consistent turnouts at these Institutes is because the answers are changing pretty fast. I hope you will find some of the new answers while you're here, and more than that, I hope you'll keep coming back as they change them on you every year.

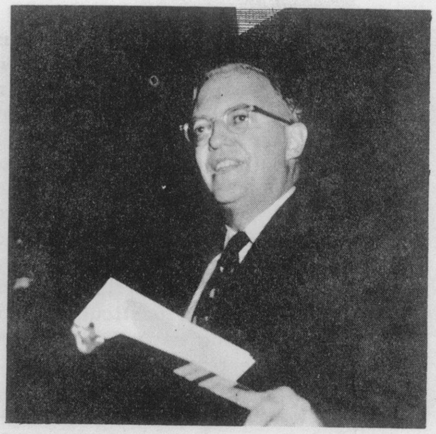
Industrial Engineering Laboratory
at Berkeley



A.O. Mann, G.S. Drysdale, J. McDougall

Speaker introduction by
G. W. Robbins

C. Alvin presenting address
for D. J. McDonald



Speaker introduction by
R. B. Allen

Standing: R.C. Grassi, F.V. Gardner, W.R. Willard
Seated: D.B. Hertz, Mrs. M. Folsom

THE EIGHTH ANNUAL INDUSTRIAL ENGINEERING INSTITUTE WILL BE HELD CONCURRENTLY ON THE FOLLOWING DATES

BERKELEY - January 27, 28, 1955 - LOS ANGELES

INDIVIDUAL PRODUCTIVITY SESSION

Session Chairmen: At Berkeley - ROBERT C. SISCO, Production Control Supervisor, East Bay Municipal Utilitity District, Oakland, California; President, The American Institute of Industrial Engineers, San Francisco-Oakland Bay Chapter.

At Los Angeles - RALPH M. BARNES, Professor of Engineering and Production Management, University of California, Los Angeles, California.

HOWARD M. DICKASON, President, Los Angeles Chapter, American Institute of Industrial Engineers.

INSTALLATION AND MAINTENANCE OF WAGE INCENTIVES FOR MANUFACTURING AND NON-MANUFACTURING PERSONNEL

John J. Barry
Incentives Administrator
Kwikset Locks, Inc.
Anaheim, California

About ten or fifteen years ago, as a student at the University of California, I was a great admirer of our football coach Stub Allison. After each home game in the Memorial Stadium, Stub Allison would come out on the balcony to be cheered or not to be cheered by the student body. This was quite a tradition at Cal, and on the days that Cal won a football game, Coach Allison would call the members out one by one and congratulate them, and introduce them to the crowd. On the days that Cal had not won the game, he would come out on the balcony using a very famous statement, "Back to Fundamentals." This became quite a popular slogan in the days when Cal didn't win too many football games.

And that, ladies and gentlemen, is what I would like to do today. I would like to go back to fundamentals. To the fundamentals or the basic reasons for American business. If we are going to supply jobs to our people, we must show a profit. If we are going to create steady employment for our people, our unit cost must be low enough to allow for a profit. The program that we are talking about today is designed for two purposes. First, to reduce this unit cost; and second, to give the individual employee an opportunity to be in business for himself. This approach that we have used is certainly not new, and by no means do we have a patent on the approach. As a matter of fact, as we talk, we will see that we have gone to various plants in the Los Angeles area, and have borrowed pages from their books. This, put together, makes up the incentive program as we will describe it.

TERMINOLOGY

Before going into the development of the incentive program, I would like to talk about terminology. Most of you are acquainted with the terms that we will use. We may use them in a little different way, so I thought it would be well to review some of the basic terms. First, we will talk about incentives and work measurement. What we mean by incentive and work measurement is extra pay for extra production, with a guarantee that the person will make a regular weekly or monthly rate. Again, it is extra pay for extra work above normal. If a person turns out more than a normal person would, then he is given extra pay. Conversely, no extra pay is given unless a person turns out extra work.

We will talk about standard hour plans for individual incentive. Individual incentive is the approach that we are using. Here, each individual is on his own. Extra pieces that a person turns out are to his credit. All of the extra pieces that are good work are given to him for his credit. The standard hours plan is one that is a one for one plan. That is, if a person turned out 1,000 pieces a day and the standard is 100 pieces per hour, then he will receive 1,000 divided by 100 or 10 hours of pay.

Another term is daily clearing. This means that each day a person has a fresh start. Each day is a new leaf in his incentive record. Certainly a key word is our time study. As we will discuss later, it is the key to our incentive plan. Time study is the observation by an engineer of a person that is working. To use it means determining how long that person is taking to do a given job. A time study also includes allowances for coffee breaks, for personal needs, instruction, etc. And most all of the time studies include pace rating whereby the person is given extra credit or less credit depending upon the pace at which they are working.

A term that we will use is direct labor. Again, it is true of direct labor, you get those people that work on the line; those people that are in direct production, contributing to the final product.

DEVELOPMENT

Now, in getting back to our story, some years ago, our company had a cost savings and sharing plan. This plan worked where any savings that the production group brought about were given to them. As long as the company was small this worked out very well.

But, as the company grew and as other costs, over which production had no control were included in this, apparently it lost some of its punch. It was found that the cost of raw material, the cost of labor and the fluctuation of materials over which the individual laborers or production people had no control. As this cost of material varied the cost savings plan was wiped out. Yet, the management of the company wanted the individual employees to have the opportunity to be in business for themselves. And, being in an extremely competitive market, it was decided to reduce to a minimum the cost of operation.

With this in mind, we went looking for some type of incentive. We did, what many of you would do, we went to other plants in the Los Angeles area, and other parts of the country. We took the advice of such people as Charlie Bogenrief at Grayson Controls, and Bob Blattenberger at General Controls -- they were very helpful. They have had successful incentive plans for many years and the advice and direction that they gave us was of immeasurable value as the incentive plan progressed.

From our examination of other plants and from our examination of our own plant, it was decided to use the individual incentive. A standard hour type of incentive-- a one for one plan was the answer for us. That this was best suited for our operation, does not mean that it would be best suited for yours. But we make pretty much of a standard product for this type of approach, where each individual could go out and do his best, this appeared to be the best solution.

TIME STUDIES

The next step was to start making the time studies. We spent over two man years making time studies before the first person was put on incentive. Actually, we were delayed because of the Wage Stabilization Board, but this gave us a chance to consolidate our standards and at the same time, gave us a chance to analyze our methods. Standardizing methods and improving these methods before you set the standards is of utmost importance. We made many changes in the methods before we set the standards, and as we look back now we feel that, perhaps, we could have spent more time. Two man years before the first department went on standard, and a total of seven man years before the last department went on standard is a lot of time. And, at the present time, we have less than 350 basic standards that we check each day. We have spent a great deal of money in time studies. We have used MTM and standard data, ratio delay studies and films. But we feel that it is more important that we spend a great deal of time in making time studies and at the same time selling the people on the incentive plan. We think of time study men as salesmen, not only selling the incentive before it is applied, but continuing to sell it as they are checking or auditing the standards. We don't believe in the ivory tower approach. We believe the engineer should be with the people, and should make every effort to understand their problems. As an example of this, I have personally studied every employee in the Kwikset Lock Company. Not that my studies are any better or are as good as the other engineers, but in administering the program, we have felt that all of us should be with the people, finding out what their problems are. Working directly from the President's office, we have felt that this is a way to keep management fully informed regarding any problems that might come up.

As we mentioned, we used MTM, (method time measurement) as well as standard data. With these MTM standards, we have checked our basic standards so that we know they are in line with national standards. We have not used standard data to a great extent as yet, but a number of the engineers are combining our standards in form standard data to be used for estimating, and for checking the standards. All standards must be set from time studies.

We mentioned ratio delays. We use ratio delay studies in with the time studies to set standards for material handling or department helpers.

We also use ratio delay studies to set standards for the leadmen and foremen to determine how much of their time is utilized on different types of work. We have taken a great deal of film. We have done this to record the operations so that we know if there is a methods change and we have done it as a training method so that our engineers can all look at the same operation and can determine what the pace should be. Naturally we use the film for checking the pace rating of the engineers.

After all of these time studies were made, after two man years, the first department was ready to go.

PROCEDURES

Yet, before the incentive could start, we also had to consider accounting. We started by calculating the incentive manually, approximately one clerk is required per 100 people on the floor. Also, for a typical operation, we require one time study engineer per 150 people on the floor. Perhaps here we should figure one per 100. This is for the direct labor incentive.

The foreman is responsible for the accuracy of the reports in his department. We have counters on most of the machines. We have a number of line operations, of five or six girls sitting in a row so that if these girls do not report the same number of parts, there then is quite an obvious error. I point these things out to show some of the cross checking that we use to insure accuracy in our reports. I will go into this further later on.

So, actually, the procedure is that the individual employee reports, the foreman checks, accounting extends and records, and this report comes back to the floor on large sheets which show what each person in a department has done the day before.

Since the inception of the incentive plan, IBM has been leased for our use. We now run these reports on IBM. This is not a time saver, nor does not save money, but the machinery was purchased for other reasons and it is now being used for this because time is available.

We keep a record to show the output of each individual for each day of the year. The purpose of this is to help those who are unable to perform at standard the majority of the time.

We have trained the foremen in a formal training program to read the incentive reports, to understand the incentive reports, and to help the people out. This is also a cross check to see that the individual employee is getting his chance to earn incentive. When we have a person who is not earning incentive, we go to the foreman and we try to teach the person or the foreman to earn incentive. We firmly believe that those people that earn incentive are more happy.

Each month we also audit the count. Here we again check to see if a certain number of parts were diecast, were sent through the punch press department, were buffed and plated and lacquered, etc. If more parts were sent through a given operation, then we know that something is in error. We have detected three cases of false records in the last two years. These are a couple of cross checks that we have along with others to keep the program in balance. We are continuously checking the methods at each work station. We have posted a card that shows the standard methods. We have taken film; we are constantly checking accuracy of our records to be sure that method changes have been incorporated in the standards.

TRAINING

We have had a formal training program for our foremen. They have had sixteen formal classes. About two sessions were taken to teach them to make time studies. Not that we wanted our foremen to be time study engineers, but we felt that they should know how a time study is made. We went over with the foremen in detail the method used in accounting for calculating this incentive, so that they can explain this to their people. The foremen also have been trained in reading the other accounting reports showing how the departmental costs are made up. In addition to the formal training program for the foremen, we have had extensive on-the-job training.

For the direct personnel we had a meeting together with the time study engineers in the conference room and explained the rules of the incentive. Explaining to them the detailed time studies that had been made, and asking their co-operation in giving the incentive plan a fair trial. It would seem that if you were to ask a group of people to come to work the next day to be measured on standards that had been quite thoroughly engineered, and that the next day they would receive the regular rated pay, and that they would have an opportunity to be in business for themselves; if people were told these things, you would think that they would come to work the next day with anxiety and with some eagerness. That they would come and do, in the majority of cases, a good days' work. But this was not the case. In many departments we had more women in the nurses office than we had at the machines. I point this out to you to emphasize the transition that you go through when you go from daywork to a measured type of incentive.

Certainly, you are playing with dollars and cents, but more than that, you are playing with people's feelings, with their pride, and everything that you can do to get their confidence and get their understanding, will make the installation that much easier. We have had from four to six people who left of their own accord because they couldn't earn 100%.

But, again, we must emphasize the importance of the transition and the importance of getting down and making detailed time studies on people for yourself, if you are going to administer such a program.

One of the departments that we put on incentive, the polishing department, had had incentive before. In this department the foreman had set the standards the best he could, incidentally, he had done a very good job. But, methods changes, raw material changes and other creeping changes, had come into the picture. We spent 1-1/2 man years setting engineered standards in this department, and then came the day when they were on their own -- not on the foreman's standards, but on the engineer's standards. This was a very difficult transition to make. This certainly was a sales program as much as an engineering program. As it is, out of this department, we had gained more friends for the industrial engineering department. They are more friendly with us today, a year later, than any other department, and there is more understanding in that department. One person left, but is back today and is working steady. This, I point out, as some of our growing pains and the solution to these problems must be on an individual basis. But I emphasize, the more confidence you have and the more understanding that you have, the easier will the installation be.

DIRECT LABOR INCENTIVES

The incentive for the direct labor groups are illustrated in Figure 1. As you can see, about two years ago the overall performance of the direct labor

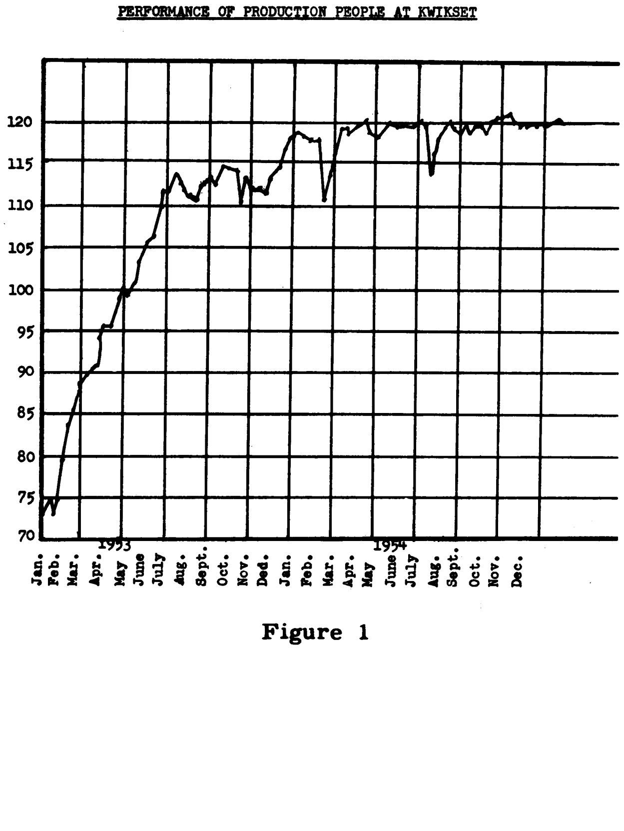


Figure 1

group was about 75%. This, from what Dr. Barnes says, is about average. Then, as more time went by, and more people were on incentive and standards were installed, then the average was increased. Until now it runs pretty steady at 120%. This is not unusually dramatic. We have heard of other plans that have an average performance of 125% to 130%. We are very pleased with the results that we have been able to bring about in this manner. It means that 10 people that were turning out 7 pieces are now turning out 14. We did turn out 14,000 parts per day with 7 people in the department. After the incentive had been installed the same people, same equipment, the same foreman, the same 7 people, instead of turning out 14,000 parts, were turning out 28,000 parts. Another example, in a department where we had 40 people, these 40 people were turning out 4,000 parts per day. Then in one year these same 40 people with the same material and same parts, were now turning out 10,000 parts per day. These I point out, are the outstanding examples. This change was brought about by helping the people utilize their time fully. Some of the people are working a little faster, but the noticeable change is the utilization of time. You can come to our plant any morning before 7 and find people already working. We have had people working through their lunch hour. It is this change that has brought about this increased production.

It has cost a lot of money, in administration, clerical, and of more importance, in incentive pay to the people. The people in the last two years have taken home several hundred thousand dollars in total pay. Along with this, we have made a noticeable reduction in unit cost. We have made a marked reduction in our selling price. It is not difficult to calculate how the savings were brought about by 400 people producing above 100% rather than 70%.

OTHER INCENTIVES

I plan now to briefly go through some of the other incentives and work measurements that we have had in the past year or so. Our approach has been to solve the direct labor problem. Then to solve the incentive for the indirect groups such as the toolmakers, the maintenance groups, the foremen and other people who are directly connected with the manufacturing section. Some months ago we put the janitors on incentive. Here time studies were made to determine how long it took to sweep a square foot in an area, to wash windows, how long it took to clean desks, to empty waste baskets, etc. This was set at nine hours work. For each eight hours work they received nine hours pay. Eight hours pay is guaranteed. Where there had been five janitors in the offices, now there are three. Some savings were brought in the changes of the janitor force, in the tool room and in the maintenance sections.

The approach that has been used is one of making a series of time studies. There were three men making time studies in the maintenance and tool room sections for about 1-1/2 years. We did again, what we had done for direct labor, we had to examine other programs, that had been successful as a part of the ground work. Again taking the pages from their book, we tailored work measurement based on time studies to measure and pay for extra skill and effort.

In the case of the toolmakers, we count the time that they have taken, weighted for pace rating. We base the time study on this and on standards which we have taken from other companies. In the maintenance department, little work can be measured beforehand, therefore, our engineer goes out after the job and checks to see what work was performed. What we do is give credit for the work that has been or will be performed.

In the offices about a year and a half ago, we started incentive. The results were very gratifying. We made time studies on some basic methods. Some of the basic methods were changed because of the time study. We had each individual report each day the amount of work that he performed. How many invoices they had typed, or how many letters they had typed, how many pieces they had filed, how many letters they had opened, etc. It takes about two man weeks to put each individual in the office on incentive; after these time studies, after a standard is set, and again reset, and in turn explained. Since the installation of the incentive with the same work load, where we had previously 16 people, we now have 8.

KWIKSET LOCKS, INC. CONTROL ANALYSIS Foreman ______

Manufacturing Labor Department ______

Third Quarter 1954

Weekly Report

WEEK No.	WEEK Ending	DIRECT HOURS Std.	DIRECT HOURS Act.	Oper. Perf.	LOST TIME Wait for Work	Wait for Mat'l	Wait for Rpr.	Train Meet	Take Inv.	Rework Sal. Lbr	TOTAL	Total Actual Hours	Dir. Perf.	Sub Std. Hrs.	DAY WORK Reg.	Out of Dept.	Total	% Meas. Work
1	7-10	1014	862	118						5	5	867	117	18	2		2	100
2	7-17	1452	1171	124						8	8	1179	123	0	2		2	100
3	7-24	1527	1184	129				12			12	1196	128	0	8		8	99
4	7-31	1535	1203	128							0	1203	128	0	0		0	100
5	8-7	1552	1169	133					25		25	1194	130	0	6		6	99
6	8-14	1551	1187	131							0	1187	131	0	8		8	99
7	8-21	1499	1141	131				31			31	1172	128	9	11	16	27	98
8	8-28	1470	1116	132				20			20	1136	129	19	0		0	100
9	9-4	1504	1145	131				27	23		50	1195	126	0	2		2	100
10	9-11	1223	923	132				27			27	950	129	6	0		0	100
11	9-18	1516	1159	131				13			13	1172	129	0	1		1	100
12	9-25	1537	1166	132				3			3	1169	131	0	2	1	3	100
13	10-2	1560	1184	132				2			2	1186	132	0	1		1	100

No.	INDIRECT HOURS Foreman S	Leadman T 05	Set up U 09	Mat'l Handling V 02	Misc. Labor W 01,03	Inter Dept. Rpr. X 14	Purch. Lab. Mach. Rpr. Y 141	Tool Die Rpr Z 130	Indirect Hrs Act. AA	Indirect Hrs Std. BB (STD. 14%)	IND. PERF. CC	OVERALL PER Total Std. DD	OVERALL PER Total Act. EE	DEPT. PERF. FF	$2.21 86% PREV. Excess Hours GG	% HH	EQUIV. NO. Direct Emp. II	Indirect Emp. JJ
1	32	32	3	19	16		12	8	122	142	116	1156	989	117	122	14	21.7	3.0
2	40	39	4	1	51		1	53	189	233	123	1685	1368	123	104	8	29.5	4.7
3	40	38	1	1	8		1	22	111	246	222	1773	1307	136	0	0	30.1	2.7
4	40	23	1	2			1	20	87	246	283	1781	1290	138	0	0	30.0	2.1
5	40	38	1				6	13	98	249	254	1801	1292	139	0	0	30.0	2.4
6	40	37			2		17	1	97	249	257	1800	1284	140	0	0	29.8	2.4
7	40	30	2	2			15	1	90	244	271	1743	1262	138	0	0	29.9	2.2
8	40	35	2	2			11	11	101	235	233	1705	1237	138	0	0	28.4	2.5
9	40	29	1	1	1		4	2	78	241	309	1745	1273	137	0	0	29.9	1.9
10	32	22		1			3	14	72	196	272	1419	1022	139	0	0	29.6	2.2
11	40	29	1	1			9	34	114	182	160	1698	1286	132	12	1	29.3	2.8
12	40	31	1	1				22	95	185	195	1722	1264	136	0	0	29.3	2.3
13	40	35	1	1	1		5	64	147	187	127	1747	1333	131	23	2	29.6	3.6

Figure 2

Figure 2 is a brief report that summarizes the direct and indirect hours and shows who is responsible for the costs. You will notice in the upper left hand corner the number of hours on standard and the number of hours which are actual hours, then the number of lost time hours and the number of hours that are turned out. In this case, let's use 1,000 hours in the department, and say, 1,300 standard hours were turned out. This means that the performance is 130%. Now the incentive is based on a department's performance of 100%. All the foreman must do is get all of his people to operate at 100%. A foreman must learn to control the indirect labor. He is allowed a certain percent for repair as shown here -- 12 or 14%. If the foreman has all of his people working at 100%, there are no substandard hours; the answer in column N, he makes a 35% bonus. If he controls his indirect hours, and if he has no lost time and no waiting for work, no repair hours and no excess expenses.

KWIKSET LOCKS, INC. CONTROL ANALYSIS Foreman ______

Third Quarter 19 54 Department ______

(Manufacturing Expense)

MO.	MO. END	O.T. PREMIUM (007) .04			FACTORY SUPPLIES (002) .20			EXPEND. TOOLS (005) .21			COMP. & LIAB. INS. (018) .28			MACH & EQUIP RPR. (002) .41			TOOL & DIE (002) .43			SALVAGE & REWORK (01)		
		STD.	ACT.	PERF	STD.	ACT.	EFF	STD	ACT	EFF	STD	ACT	EFF	STD	ACT	EFF	STD	ACT	EFF	STD	ACT	EFF
-	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
7	July 31	115	72	160	33	105	31	82	0	1000	295	300	98	33	20	165	33	26	127	164	96	171
8	Aug. 31	152	76	200	44	139	32	109	14	778	392	296	132	44	29	152	44	24	183	218	228	96
9	Sept 30	121	0	1000	35	230	15	87	153	57	311	240	130	35	20	175	35	30	117	173	102	170

	Sub-St Cover	Real Indirect Cost			Calculations for real cost of labor			SUMMARY — TOTAL CONTROLLABLE COST				EXCESS			
		STD	ACT	EFF	STD	ACT	EFF	CLASSIFICATION	STD	ACT	EFF	COST	%	B	P %
		W	X	Y	Z			AA	BB	CC	DD	EE	FF.	GG	HH
S	18		1273		12217	12217	125	DIRECT LABOR	16,375	12,312	133	31	0		
C	12		- 95		+ 95	- 9		INDIRECT LABOR	1,590	1,178	135	0	0		
L	25		1178		12312	12208	99	EXPENSE	755	619	122	53	9		
								TOTAL	18,720	14,109	133	69	0		33
S	28		1160		16743	16743	132	DIRECT LABOR	21,766	16,743	130	418	3		
C	43		-340		+ 340	- 31		INDIRECT LABOR	2,140	1,160	184	0	0		
L	126		820		17083	16712	98	EXPENSE	1,003	806	124	54	7		
								TOTAL	24,909	18,709	133	27	0		33
S	6		1070		12898	12898	132	DIRECT LABOR	17,305	13,011	133	32	0		
C	5		-113		+ 113	- 4		INDIRECT LABOR	1,675	957	175	0	0		
L	45		957		13011	12894	99	EXPENSE	937	775	121	72	10		
								TOTAL	19,917	14,743	135	0	0		35

Figure 3

Figure 3 is the monthly report. It shows data in dollars -- how many dollars of work, how many dollars in production, and dollars in expense. It shows how you can get back many pennies for each dollar that you spend. For lost time hours, you get zero pennies for extra dollars spent. For shift premium you get zero pennies for dollars spent. For daywork hours, you make 66¢ for each of the dollars spent -- these are examples of the costs. Expenses are measured against the parts that are turned out. This means that the more parts that are made, the more allowance the foreman is given for supplies, for gloves and lubricating oil, for buff and compound, for overtime premium or shift premium, and scrap. They are only paid for good parts. If a person makes 100 good parts and 100 bad parts, they will get paid for the 100 good parts only. These bad parts are charged back to the individual.

In going back to fundamentals, we must find out what goes into making up the production costs. We have found that these fundamentals show that direct labor, the manufacturing expenses are a relatively small percent of the total. Figure 4 shows the over-all cost and the method of control that we use. It again is another broader application of the approach outlined above.

This broader approach is an attempt to control about 85% of the operating expenses. The 15% is the cost of manufacturing, direct labor, indirect labor and expenses. The 85% includes raw materials, taxes, engineering, accounting, personnel, cost of sales, etc. Standards have been set on these expenses. These standards have been set using the same approach that was used for the foreman expense standards. These standards are all based on a given set of circumstances, so that as these circumstances change, the standards may be changed.

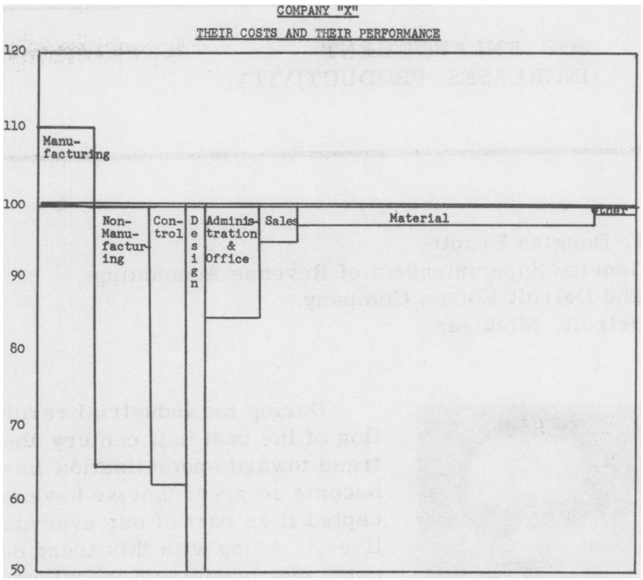


Figure 4

To determine what the standards should be for a department such as production control, we have listed five points. First, we made a survey of twelve local companies that have similar operations. We found from them what the cost of production control has been running. We contacted national organizations such as NAM, Dun & Bradstreet, Bureau of Labor Statistics, etc. From these people we were able to get standard costs for production control. Third, we made a detailed study of the operations to determine how much lost time, repetition, and the value of the basic methods used for controlling production. Fourth, we made an historic study of our company to determine what the best rating of production control costs has been to over-all manufacturing costs. Last, we set up goals for the production control department. These goals were the criterions set up by management for the production control department. The criterion is that adequate materials shall always be available, that there shall not be more than three months supply of raw materials, etc.

This has been a brief description of our control program. Our fundamental problem has been to eliminate unnecessary costs and reduce other costs. We have had to find out first, where unnecessary costs are or where the excess costs are. The above approach has been a help in determining where to look to eliminate costs. We are a long way still from bringing all those things into proper control.

As we mentioned earlier, other companies have been very helpful in setting up and administering our incentive program. If this presentation has been of help to any of you who have heard it, then we appreciate the chance to help others.

JOB ENLARGEMENT INCREASES PRODUCTIVITY

J. Douglas Elliott
General Superintendent of Revenue Accounting
The Detroit Edison Company
Detroit, Michigan

During the industrial revolution of the past half century the trend toward specialization has become so great that we have accepted it as part of our everyday lives. Along with this trend has come new production techniques, the assembly lines and new specialized machines. Specialization has now found its place in the office too.

This has been necessary to keep pace with business expansion, mechanization, greater technological know-how and the ever-increasing complexity of our economy. It has proven advantageous as well. We are experiencing a higher standard of living with more pay and shorter working hours. We have greater output of goods and better products. New tools and machines have made less physical effort necessary to produce these gains.

What has all this evolution done to the average job?

We have specialized many jobs to the extent that they are monotonous and uninteresting. We have proceeded to make our jobs fit machines available, assembly-line methods or other mass-production operations without much regard for the employee. As a result, we have more and more jobs that require very little thinking on the part of the worker, no initiative and less responsibility for quantity and quality -- quantity being controlled by the speed of the assembly line or a production standard or schedule, and quality being checked by another group of specialists such as inspectors or examiners. While we have eliminated many jobs that require physical effort, we have created more jobs that depend upon the individual's rhythmic body movement or jobs that require a thinking process so repetitious that it is done automatically without much brain power utilization.

So, must monotonous jobs be accepted as necessary evils of our modern age? We haven't been accepting them. We've recognized the problem and are doing something about it. To relieve job fatigue -- a result of monotonous and uninteresting work -- many of us have resorted to music, scheduled rest periods, color dynamics, competition and the like. We are taking many other steps to raise the morale of our people, knowing very well that this is necessary to maintain or improve the quality and quantity of production. However, rarely do we attack the problem squarely by changing the job itself, by enriching or enlarging it to include a greater variety of operations; nor do we lessen the monotony and utilize more fully the potential skills and intellectual abilities of the individual and give him an opportunity of doing work of which he is capable. Nor must such changes -- and let's call them job enlargement -- be made purely for emotional reasons, as job enlargement brings about economies not easily recognized.

Monotonous and uninteresting work tends to increase costs as high fatigue and lack of job interest mean less productivity and higher costs. The bored, uninterested employee has more absences, more grievances and more frustrations, all of which adversely affect the quantity and quality of his work. When we add the cost of these extra absences, extra grievances and extra poor quantity and quality of work to the cost of relief periods, music, color dynamics and the like, we become increasingly aware of the fact that the monotonous, uninteresting job can be costly. Yet how often do we take these indirect costs into account when we make a change to reduce costs which increase job monotony?

Recently a comparison of absences was made in 78 different work groups in our Company. These work groups were divided into three classifications: groups whose work is highly repetitive, moderately repetitive and non-repetitive. The absence rate of employees in the groups whose work was classified as highly repetitive was 20 per cent higher than in the other two groupings, between which there was no significant difference. This can be reduced to mathematical formulas of the A + B = C type. Here is one: "A headache plus lack of job interest equals an absence". And here is another for comparison: "The same headache plus job interest equals attendance". Similar formulas could be used to demonstrate the relationship between low morale, grievances, tardiness, poor production and the like.

The poor utilization of the potential capabilities of the average worker is costly too. We spend a great deal of time and effort in determining the capability of various types of mechanical equipment both in the plant and in the office in order to use them fully, but we are not prone to extend ourselves in evaluating and fully utilizing the capabilities of our people. It is recognized that we have extensive training and development programs, but we too frequently try to simplify the worker's job to reduce training requirements or just assume that the worker isn't capable of doing much more than he is already doing. There are many employees who are at the limit of their capabilities on their present jobs, just as there are some employees who like repetitive work; but, I can cite many men and women under my jurisdiction who, after years on simple, unchallenging jobs, have blossomed forth when given broader responsibilities. We don't actually know an individual's ability until he is given an opportunity. My boss says his men do their best work when under pressure -- but only when done voluntarily because of interest in their job, not when keeping pace with a machine or a tight production schedule. Maybe this is the area in which we need a little more faith in our fellow human beings, in which we need to invest a little more energy in their development and capitalize on their talents and abilities. They, too, profit by increased job satisfaction and better wage opportunities.

Doctor Catarinich, while Director of Mental Hygience in Victoria, Australia, found that there were very few industrial occupations beyond the ability of subnormals. Experiments in Australia and in our own country indicated that subnormal individuals placed on certain production-line jobs actually did better work than their normal counterpart. They were more content with their simple repetitive tasks.

We can enlarge the job of the worker, therefore, not only to make his job less monotonous and more interesting, but also to give him a variety of tasks that require a broader knowledge and to increase the element of judgment in his job to give him more opportunity to do some creative thinking of his own.

During this era of mechanization and mass-production methods, we have become imbued with the thinking that a high degree of specialization brings about economy of operation. As a result, we have persistently specialized many jobs without looking thoroughly into the cost of specialization, failing to realize that a less-specialized operation may well be more economical or that duplication of operations is perhaps being created.

EXAMPLES OF JOB ENLARGEMENT IN THE OFFICE

A few examples of actual cases in which job enlargement has been put in use will be helpful to demonstrate its true value. My background has been in office work rather than the factory, so I cannot give you examples of enlarging the job of industrial workers as a result of my own experience. However, I do have a couple of examples to give you about some job changes being made in our power plants.

We have experimented with job enlargement in our Customers Billing Department at Detroit Edison with rather convincing results. The work in this department has been highly specialized with a fair amount of mechanization on standard punched card equipment. Certain customer cards for our 1,100,000 customers are maintained in this department in addition to the actual billing of over 35,000 accounts per day. Tabulating cards flow from machine to machine, gradually accumulating information much like a product in a factory moves down a production line. We even considered putting a conveyor belt in to transport the records from machine to machine and clerk to clerk.

We gradually became aware of the possibilities of job enlargement in such a setup. We became aware of the indirect costs related to the many monotonous jobs we had and of the fact that many of our people were capable of performing tasks beyond those on which they were employed. The rudest awakening came when we were made aware of the fact that, to reduce costs, we had overspecialized some of our tasks to the extent that we had actually increased costs by creating needless or duplicate operations.

Probably the most elementary job change we made was the combination of two very repetitive bill-examining jobs. One required the checking of completed bills with other records to verify the accuracy of billing information. Five employees were assigned to this job, each checking about 5,000 bills per day. The other job consisted of a quick examination of about 30,000 bills for one type of discrepancy. To make the job more varied, we finally got around to rotating the employees, giving all six a turn at two different jobs. This was a poor substitute for job enlargement, as all we did was to give the six employees a different repetitive job to work on every sixth working day. We then tried job enlargement in its truest sense by combining the two jobs into one so that each employee would perform the duties of both jobs intermittently all day long on her own group of bills. About all this accomplished, however, was to establish one monotonous job to replace two, although we were going in the right direction. No direct savings resulted from this change.

As improvements in mechanical equipment and procedures were made, the need for such a detailed check of our bills was no longer necessary, although some check was still desirable. The further simplifying of this operation, however, would have increased the monotony of the job considerably. We then decided to discontinue this specialized checking operation at the end of our production line, except for a quality-control check, and give it to the machine operators who were printing the bills. It is normally the responsibility of machine operators to check their work, anyway; so they were given more to watch for and the final responsibility for the general appearance of the bill. The operators were also given the task of balancing the bills they prepared to a predetermined total. This, too, had been done at the end of the line. The machine operators have renewed interest in their work and are doing a better job of printing their bills now that it is their responsibility. This further reduces the need for a final examination. In addition, because the operators balanced their own work rather than it being done later in the routine, time and money was saved in materially fewer re-runs due to errors being detected immediately. Because of the added duties, it was necessary to assign an operator to each machine instead of one operator to two machines. Also, the rate and pay of the machine operators was higher than that of the bill checkers. Nevertheless, there was a net saving in labor costs because more bill checkers were saved than machine operators added.

We have three machine work groups in this department. The work flows from machine to machine within and between these groups in a traditional production-line fashion. As a result, we had many specialized machine jobs within each of the work groups. Such a high degree of specialization began to take its toll in low employee morale and in lack of flexibility of operations. So, we established one machine-job classification in each work group, requiring each operator to be able to perform any job in the group. These operators are now assigned by their supervisors to any task necessary to produce an even flow of work when disrupted by absences, machine breakdowns and the like. In fact, formal "assignment" to tasks by the supervisor is not always necessary as the employees themselves know where they are needed the most. Such free movement of employees promotes teamwork not formerly prevalent. When work is running smoothly, the operators rotate between machines according to their own collective choosing. I must confess that this job rotation came about a few years ago not because of our awareness of job enlargement, but just because it worked better that way.

Here is an example involving first-line supervision. There was a machine specialist in the IBM machine room of the Billing Department whose main duty was to set up the machines for new jobs, to assist in making minor repairs, to run down and study the cause of machine errors and to coordinate the servicing of the machines with the repairmen. The first-line supervisors of the three work groups performing the machine operations referred machine problems to this specialist for his follow-up. They were relieved of the necessity of knowing the intricacies of the machines and the time necessary to wire plugboards, studying machine changes, "arguing" with the repairmen, etc.

We discontinued this specialist's job and added his responsibilities to those of the three affected supervisors. Today, after a certain amount of training, these three supervisors are operating their groups more efficiently than every before. They understand more fully the components of the machines under their jurisdiction. Being more familiar with their own work than the specialist, they began coming up with many good ideas to improve their operations. They have new interest in their jobs. No longer must they wait for the specialist to wire a new plugboard for them. They also save valuable production time by coordinating the servicing of their machines directly with the servicemen rather than having to work through a third, "disinterested" party.

The pay of the three supervisors was increased to compensate for the additional technical skills and responsibilities required of them; but the machine setup job was eliminated, resulting as so often happens when the jobs are enlarged and combined, in a net saving to the Company in direct labor as well as more pay for the participants.

Our Company has been delegating more and more responsibility to first-line supervisors along with authority commensurate to their added responsibilities. Here again, this was not done because of job enlargement but it carried all the attitudes of it. The supervisor's job has been enlarged over a period of years from a mere leader or "policeman" status to that of manager within his own right.

I have gone into some detail in giving a few examples of job enlargement at the worker level and at the supervisory level. I should like now to describe a job-enlargement undertaking involving two entire work groups.

We had one work group which maintained a voluminous file containing over 1,700,000 tabulating cards. It was the duty of the people in this group to perform certain clerical functions by making reference to the cards in the file, as well as the many other tasks normally performed in relation to maintaining such a file. We had another group which set up new tabulating cards for this and other files. This group consisted primarily of key-punch operators and checkers. This group and the file group worked closely together.

We decided to combine the activities of these two specialized groups; but, because the combined groups would have had too many employees for one supervisor to properly supervise, it was divided into two new identical work groups. Each of the two new groups was to be responsible for all the functions performed by both the old groups.

Before the change was made, one group in particular was consistently behind schedule. The people in this group were being pushed all the time and were working a considerable amount of overtime. There seemed to be a greater number of discrepancies than there should have been. We had reached the point where it was quite obvious that additional help was needed. However, it was decided to defer the hiring of additional help until the new groups were established, so that we might determine how the help should be distributed. We anticipated some confusion at the time of rearrangement because many of the employees would be working for a different supervisor and because a physical rearrangement of desks and files would be necessary. The expected confusion was practically non-existent.

Immediately after the change, the two supervisors discovered that much duplication had existed in the two former groups. They had been making certain checks on each other's work and performing many other operations required by the constant flow of work between the two groups. This was no longer necessary because each group was fully responsible for the operations within its sphere of activities. With the discontinuance of these fringe jobs, the work groups were practically on schedule within a week after the change was made.

With the establishing of these two new identical groups, the supervisor's job was enlarged automatically. Each supervisor, while having about half the number of accounts to work with, had his responsibilities broadened to cover a wider range of activities. The same thing was true of their assistants. Once the new groups were well established, we began to tackle the enlargement of other jobs within the groups. Each new group had nine clerical job classifications. We could see some problems in enlarging the jobs of two of these classifications, so we deferred action on these and tackled the remaining seven. After study and review with the employees themselves, we came up with three job classifications to replace seven. These new jobs were duly established through our normal company procedure of job evaluation and have been installed, each of the new jobs containing the duties of two or more of the former jobs.

Even the employees in the two job classifications which were not changed have a better understanding of their work because they can see the over-all picture of operations better and because, during peak periods and absences, they assist on a wider variety of work. I am sure they, too, now find their jobs more interesting.

Here are some of the results of these changes in work groups. First, under our Company's job-evaluation plan, all the enlarged jobs, both supervisory and non-supervisory, came out with a higher point value upon re-evaluation than did the job they replaced. As a result, some employees were thrown into a higher pay-rate classification. This is of benefit to the employees, but how about management? Disregarding such indirect benefits to management as increased morale and increased job interest when an employee receives higher pay, we still saved money on this change because we didn't add the additional help we were going to add before the change was made. That was over two years ago and we haven't had to increase the force yet in spite of an increase of 10% in volume. The higher pay rates costs the Company less than half the pay of just one new employee. In addition, overtime during the first year after the change ran well under half of what it was the previous year, although the volume of work in these two groups had increased 5% during that period. Furthermore, we were able to cut one day off our schedule for setting up new accounts by consolidating the two work groups. A comparison of absences in the two groups during the first year after the change with absences for one year prior to the change in the two former groups showed that the number had dropped between 10 and 15 per cent. While a comparison of this nature is not too conclusive, it is an indication to me, nevertheless, that the decrease in absences may well have been due to the greater interest these employees now have in their work.

EXAMPLES OF JOB ENLARGEMENT IN THE POWER PLANTS

I have two examples of job enlargement in our Production Department; one is now in effect and the other is being considered. The first example has to do with the maintenance of our power plant equipment. Our maintenance crews were made up of 1st, 2nd, and 3rd class Electrical, Mechanical, Pipe, Boiler and Stocker Repairmen and Welder Mechanics. A new Plant Service Group consisting of two grades of General Mechanics was created -- each general mechanic having two of the skills mentioned. Now, when repairs are needed, a self-sustaining crew is sent to complete the job. No longer is it necessary to have one tradesman wait for another to complete his task. This greater flexibility of repairmen is bringing about considerable savings to the Company in the form of fewer workmen and speedier repairs, in spite of an increase of pay to the job incumbents. I must say, however, that some of the men affected resented the change as they like to be recognized as specialists. This is particularly true of the older men.

The second job-enlargement change in our power plants is being proposed because of the higher types of jobs being needed due to the technological improvements made in our newer plants. Many of our present men do not have opportunities now to get these better jobs. Assistant Switchboard Operators must have steam experience to get their licenses to operate some of the advanced equipment now being installed. Our Production Department is, therefore, proposing to rotate the switchboard operators with men on three other jobs to get the necessary experience. Besides the additional opportunities for the men, this is expected to make the jobs more varied and interesting -- and provide higher pay. The Company will get a new source of men for promotion to better jobs as well.

STREAMLINING OFFICE AND FIELD OPERATIONS

Now I want to tell you about some changes we are planning to make in a broad area of activity in our Company. I will not go into as much detail as I have in the examples already given. It is the entire customer accounting area consisting of meter reading, billing, maintaining customers' records including the posting of payments, collecting current and delinquent bills, handling customer inquiries and complaints, maintaining customer offices, etc. At Detroit Edison this is a large activity which costs us about $7, 000, 000 annually. Although many operations are highly mechanized, about 1, 000 persons are employed on these activities. We have over 1, 100, 000 customers in our service area of 7, 500 square miles. We read 35, 000 meters per day, bill 35, 000 accounts a day and collect 35, 000 payments a day. About 250, 000 accounts are closed each year and final bills rendered. Nearly 300, 000 accounts are opened each year.

About a year ago, it was decided to make a thorough study of our customers accounting and closely related activities to see what could be done to reduce costs in this area and to maintain or improve our already good customer relations. We also wanted to take a look at the most recent office machines being developed. Job enlargement did not motivate this study; in fact, no specific attention was given to it at the start although we were aware of its benefits. We did wonder, however, if we had over-specialized our activities. When our Company was organized fifty years ago, all customer accounting activities were handled by but a handful of people. As our Company experienced a rather rapid growth and as our service area became larger, our customers accounting activities became more involved. The activities became highly specialized and departmentalized to the point where they were scattered, cumbersome and less efficient than they should be.

We had built up eight different basic records for each customer. They are located in seven different files in five different departments or locations in the Company and maintained in four different sequences. We have over 9, 000, 000 individual records for over 1, 100, 000 customers. We have four different groups of field men talking to our customers at their premises about their accounts -- meter reading investigators, bill collectors and two different groups of bill adjustors. We have four different telephone boards set up for rendering information of some sort or another -- some talking to customers about their accounts without the account information being readily available. We have two groups writing different types of letters to customers. These are some of the most noticeable examples of what resulted due to a high degree of specialization. Because specialization in itself had been the accepted practice for many years, these scattered and duplicated operations existed without challenge.

After a year of objective study it was determined that considerable economies could be made and service to our customers improved by:

1. Consolidating similar functions formerly specialized, and
2. Further mechanizing our operations by the use of large-scale electronic data processing equipment.

The use of the electronic data processing equipment in an office is, in effect, a tool which brings about the consolidation of many functions. So for the purpose of this presentation, I believe I am justified in saying that consolidation of activities either manually or on machine was the only factor bringing about the desired results.

We propose to consolidate over 9,000,000 scattered customer records on less than 150 reels of magnetic tape. Periodic account information registers run from these tapes will be provided to clerks answering customer telephone contacts and to customer account clerks. Each customers accounts clerk will be responsible for all work pertaining to a specific number of accounts. Many public utilities have similar so-called "unit bookkeepers" but the complete consolidation of all customers records into one spot, as we propose, is unique. All inquiries from customers will, therefore, come to one group of telephone clerks, instead of three, from which any type of telephone transaction can be handled. The premise contact personnel are to be consolidated so the same individual can take care of different types of contact whether it be to collect a delinquent bill, investigate a questionable current bill or to discuss a bill adjustment problem.

It is recognized that certain types of activity will not be completely consolidated. For example, we do not expect the clerks responsible for the maintenance of customer records (this is primarily an accounting function) to answer inquiries directly from customers. While we propose to consolidate all types of customer telephone contacts, our Company feels it is not desirable to go so far as to merge customer contacts, which often become time consuming and controversial, with the primarily clerical function of maintaining customers records.

So you see, here is a major change about to be made in a fairly large segment of our business in which specialization is giving way to consolidation. Although I have not mentioned job enlargement specifically in talking to you about our plans, it is quite obvious that job enlargement will naturally result as we consolidate the many activities mentioned. After having become familiar with job enlargement and having favorable experience with it, we were not hesitant in accepting and getting approval of the new consolidated procedures. Had we originally set out at the start of our study to enlarge jobs, we would probably have come up with activities consolidated in much the same manner -- and the same expected economies.

In evaluating the economies to be made from these changes we did not overlook the affect job enlargement would have on pay rates. In this particular study, $75,000 was deducted from the total annual savings estimate to allow for additional pay to the large number of employees whose jobs will be broadened enough to place them in a higher pay bracket. In addition to higher pay for some, many more will wind up on jobs much more interesting and challenging than the monotonous jobs they formerly had.

JOB ENLARGEMENT AND WORK SIMPLIFICATION

Much is being said about a conflict existing between job enlargement and work simplification. What I want to point out in this regard can best be illustrated by again referring to the study and contemplated changes I have just mentioned. With the consolidation of many activities and with the use of electronic machines, our routines are being tremendously simplified. Our current billing routine for residence accounts, for example, is being reduced from seventeen key steps to seven. The final bill routine is being reduced from nineteen steps to five. When a correction or change is to be made to an account, such as a new meter being installed, a care of address being added and the like, the change to the accounts can be initiated by a single employee for posting to customers records automatically rather than having the change go from file to file necessitating many different clerks making changes to many different types of customers records. This is not only going to greatly simplify the making of changes or corrections to our records but will also greatly speed up the work.

Has our work been simplified? Of course it has. Routines and procedures cannot help but be simplified upon the consolidation of similar activities. But I have already pointed out that consolidation of activities resulted in the enlargement of jobs and, conversely, that the enlargement of jobs results in the consolidation of activities. How can we say job enlargement and work simplification are not compatible when they both result from consolidation. So, whether the change is motivated by activity consolidation or by job enlargement, a natural result to expect is work simplification. If this is correct, then cannot the reverse also be expected -- that as indicated in Figure 1, work simplification results in consolidation of activities and job enlargement?

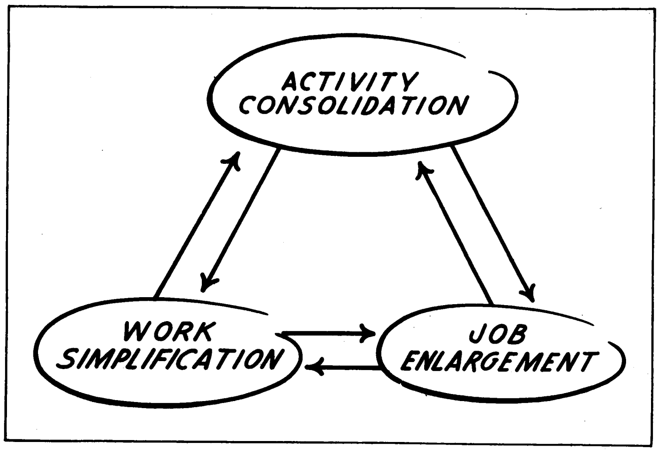


Figure 1

This must be remembered: Job enlargement is intended to enlarge jobs -- not work; and work simplification is intended to simplify work -- not jobs. It is only when we get away from these basic intentions that any incompatability seems to be prevalent. It is when we mistakenly try to simplify jobs that we run into this human factor of productivity -- when cost of boredom and lack of job interest may well offset expected savings from job simplification which has taken place under the disguise of work simplification.

The best example of this is one I have used before. That is when a study points out that a clerk is required to leave her desk a few times a day to walk twenty feet to place an item in file, we are inclined to put the file and desk together, or let this work accumulate and make one trip a day, or let a messenger boy do it. But the walk may be the break in monotony the clerk needs to make the job less repetitious and more relaxing. If the trips made to the file are eliminated, the time saved may well be spent by the employee in added relief periods or day dreaming, or may be offset by decreased production or quality because of job fatigue.

ELECTRONICS AND JOB ENLARGEMENT

The completely automatic factory and office are being looked on with fear and trepidation by the average working man. Technological improvements are being fairly well accepted as necessary in our ever-expanding economy but many see the machine as the monster which is going to reduce the workman to a mere robot-- a slave to automation. As I have already pointed out at the start of this paper, specialization together with the past mechanization trend and its mass-production and assembly-line methods have brought about the reverse of job enlargement.

I am not in a position to make predictions on the future effect of factory automation on the factory worker's job -- but I do have some convictions about what effect electronic "brains", and the so-called completely automatic office, will have on the office worker's job of the future.

In the first place the so-called electronic brains are played up as having tremendous memories and the capacity to think. Actually the most advanced electronic data processing machines available for office use today -- and what I have to say goes for the scientific computer as well -- are complete morons. They actually need someone else, a human being, to think for them and tell them what to do in the minutest of detail and in the simplest of terms. These machines are capable of performing a tremendous volume of simple, well-programmed operations at terrific speed.

The office jobs these new electronic machines are going to replace are the simple repetitious jobs. The more complex jobs requiring thinking and judgment by people will still remain, and new more involved jobs will be created. Therefore, I foresee a reversal of the trend to specialized and simplified jobs in the electronic office of the future. With the simple, lower-pay jobs being taken over by the machines, we can expect a higher average pay for white-collar workers.

A recent newspaper article in a Detroit paper mentioned that a labor movement is taking place to unionize large segments of white-collar workers who were not unionized. It was felt that the time was right for such a movement because the white-collar workers were losing their individualistic feelings due to mechanization and specialization of the office activities. The article also said that office wages had not kept pace with those of the blue-collar worker. This has certainly been the trend, but the electronic offices on the way and, I hope, with an increasing application of job enlargement, this trend will be revised.

MAKING JOB ENLARGEMENT WORK

Job enlargement is a new philosophy in management which we are just beginning to hear about and about which we will be hearing more in the future. But many businessmen I talk to on this subject can think of jobs in their organizations they have combined in the past without ever hearing of job enlargement. They have been enlarging jobs simply because it seems to work better. However, because we are so imbued with the philosophy of specilization, and are inclined to overlook the human factors of productivity, job enlargement has been slow in making headway.

I can see no better place to talk about this new philosophy than before a group of industrial engineers and businessmen on a campus of a great educational institution. Certainly a group of this caliber is capable of analyzing its true value, even if it is against an accepted principle. An exposure to those who have seen it work, together with an appreciation and understanding of the human side of our jobs, should reveal to those willing to accept this philosophy the indirect costs of overspecialization -- and I don't just mean dollars and cents costs either -- but the cost of wasted human know-how.

It would be folly for me or anyone else to even imply that we should give up all the gains attained through specialization. But, we can minimize the disadvantages to overspecialized jobs once we become aware of them. We can pursue lower costs and higher efficiency so singlemindedly that we don't realize when we have reached the point of diminishing return. We must also guard against making jobs too complex or enlarging them without full consideration of all the factors involved.

In one change of jobs we were considering in our Company, we found, after discussing it with the employees affected, that it would not be beneficial to make the change. The employees liked the two jobs being proposed for consolidation as they were. This particular change would not have resulted in higher pay for the individuals concerned, not direct savings to the Company -- except that expected to be gained by increasing job interest and satisfaction. But the incumbent employees were not going to be satisfied, so the project was abandoned. There is little to be gained for the company or employee, and sometimes something to be lost, by forcing an employee who likes repetitive work to perform a more varied task, or by requiring an individual to do something definitely known to be beyond his capabilities.

It is also unwise to mix certain skilled crafts like plumbing with bricklaying or steamfitting with carpentering. Men who have taken pride in learning and developing a skilled trade are not likely to appreciate being made a jack-of-all-trades. One example I gave demonstrated this. There are opportunities to practice job enlargement within certain trades, however.

THE HUMAN FACTOR

Along with specialization, we have accepted the machine as a necessary part of our business. But we have been forgetting the most important "machine" ever to be conceived -- God's machine, the human being. We are actually ignoring these human beings in designing many of our jobs. We expect them to adjust to their jobs even when it is psychologically impossible for them to do so. I mentioned earlier in this paper about experiments in which subnormal individuals actually increased production over normal persons on certain simple, repetitive jobs. It is a terrible thing to find that morons do the best work on the jobs conceived by the best brains of our country to fit into the technological improvements of the day.

Top management men, with all the present day problems of competition, governmental regulations, taxes and so forth, are busier than they ever have been in the past. Their ingenuity and intelligence are seemingly being taxed to the limit. Yet at the other end of the economic leader, there are still many workers whose jobs are being made simple and unchallenging. So what are we doing? In our quest for efficiency, we are widening the gap between top management and the worker at a time when there is a great need for bringing about better understanding of each other's problems.

CONCLUSIONS

All I have had to say today appears to boil down to three basic areas of concern. All three are closely related. All three can help us increase productivity to the benefit of both management and worker. Here are the three, stated as objectives to guide us!

1. Become aware of the human factor of productivity in designing jobs and its adverse effect on costs -- monotony, lack of job interest, fatigue, seeing a job through to completion, feeling of accomplishment, etc.

2. Become aware of the potential of employees by fully utilizing their capabilities to a greater extent.

3. Become aware of the disadvantages of overspecialization where it has created duplication of activities.

I would like to close this presentation with a story. A couple of months ago, a young lady - 65 years young - retired from our Company. Her name was Dorothy. In wishing her well, I asked Dorothy where she started working and what she did when she came to the Company 41 years before. She said she was one of a handful of bookkeepers who worked on customers' accounts. She said she received the meter readers and then she figured the bills manually, wrote the bills in longhand and saw that they were mailed. She assembled revenue data, received payments and posted them to a single ledger sheet. She answered customer inquiries, initiated collection action and opened new accounts. Dorothy said, "That job was really interesting". When she retired, she was supervising a group of girls running adding machines balancing 20,000 payment coupons daily to predetermined totals. That was about all -- eight hours a day, five days a week.

I knew Dorothy was familiar with some of the changes we have proposed for our customers accounting activities through the use of electronic machines and the consolidation of similar activities. I asked her what she thought of it. She said, "Why it's similar to what I used to do when the Company was small. I wish I could be around the next three years and see this change take place."

So there you are, as George Gobel would say. With the help of electronic equipment to take over the simple and repetitive tasks and the consolidation of activities, we are almost right back to where we started from 41 years ago; a single clerk, equivalent to the old-time bookkeeper, having complete control of all the records for a fixed group of customers and performing all necessary clerical tasks pertaining to them; one clerk, working from a "single ledger sheet", handling all types of telephone contacts; and, each customers' representative in the field handling all types of customer transactions and problems.

GROUP PARTICIPATION: THE GAP BETWEEN PRINCIPLE AND PRACTICE

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Recently, I was attempting to describe to the president of a young and growing industrial firm what a consulting psychologist might do to help his executives become more effective as a group and as individuals. When he learned from our discussion that I had recently been on the faculty of a university, he made a remark that has since provoked a lot of thinking on my part - a remark to the effect that his organization certainly did not want anything theoretical or academic but rather it needed practical solutions to practical problems. This industrial leader's understandable distrust of anything "theoretical and academic" is a manifestation of a broader and deeper problem which has a timely significance for psychology as a science and a profession and, I think, for the field of industrial management, too.

In the decade now almost ending, since World War II, through both research and professional practice, psychologists as scientists probably have learned more about groups and leadership than had been learned in the previous 50 or 60 years of psychology's history. Granted it is only a start and there is much yet to be learned, some of the principles that have emerged from experiments and social studies of psychologists and other closely related behavioral scientists may become as significant to the behavioral sciences as the release of atomic energy has been to the physical sciences.

These principles have already been, and are now being, communicated in one form or another to thousands of industrial leaders via the medium of books, management and personnel journals, executive and supervisory conferences and training programs, and, of course, via the growing number of psychologists serving as professional consultants to management. An industrial leader today, unless he is the type who limits his reading to newspapers, mystery novels and his golf score-card, is being bombarded from all sides with ideas from the social scientists about leadership and management. Here are only a few of the ideas he hears:

> The industrial leader must add to his technical skills the new skills of human relations.
>
> Executives and administrators in industry must now learn new patterns of leadership.
>
> Industry must find ways of implementing the basic principles of a democracy.

In addition to these rather abstract broadsides, industrial leaders are also the targets for much lighter artillery in the form of such notions as "participative supervision", "consultative leadership", "upside down management", "employee-centered supervision", "conference leadership", "non-directive counseling", "group dynamics", "role-playing methods" - and I could list many more. The tenor of the times is aptly illustrated by a remark made by an industrial executive attending an university-sponsored workshop on leadership. He exclaimed, "It's getting to the place where those of us in management feel that 'authoritarian leadership' is some kind of a nasty word, and if we use it we are automatically in the same class as Hitler, Huey Long or Joe Stalin." While this remark was intended to be humorous, it also indicated rather clearly the confusion felt by this industrial leader. In a sense he was asking the psychologists, "What in the world are you guys trying to tell us about our leadership?" His was a legitimate question, and one that strikes at the heart of the problem I wish to examine here.

THE PROBLEM

There is an amazingly wide gap between the principles of leadership being discovered by psychologists and the successful application or utilization of these principles by industrial and business leaders. In my experience both as an academic psychologist and now as an applied psychologist consulting for management, I have seen ample evidence that there is many a slip between the cup of knowledge and the lip of application.

The attitude of some executives, though certainly a small percentage, is out-and-out rejection of any and all of psychologists' findings about leadership because of a fear that these ideas are too radical, socialistic and perhaps even communistic. An illustration of this attitude, and incidentally an example of the semantic confusion that still pervades discussions of leadership, is contained in the following statement made to me by an executive: "All this talk about the need for more democratic leadership in industry is plain communism."

Another kind of response of industrial leaders to psychological principles of leadership might be described as an uneasy guilt feeling. It is as if at one level they feel that as forward-looking industrial leaders they <u>ought</u> to examine critically their style of leadership, but at another level (wherein lie the basic feelings and attitudes that determine one's actual behavior) these leaders strongly resist any change. I recall my contacts with a well-meaning executive who sincerely wanted others in his management group to learn more effective methods of leadership, yet he felt that for him it would be too difficult and upsetting at his age to make any changes in his own leadership behavior.

Another indication of the gap between knowledge and application is found in the many unsuccessful and abortive attempts of industrial leaders to try-out new methods of leadership. Fresh from some executive training program and inspired to become more "democratic" in his leadership role, many an industrial leader has returned to his organization only to have some kind of failure experience, either when he first tried to apply his new learnings to a group or when he encountered strong opposition to his ideas from top-management.

Still another indication that the psychologist's newly-discovered principles are not "coming through clearly" into the earphones of the industrial leader is the extent to which industry has been eager to buy certain techniques and packages, using them as mere psychological gimmicks without adopting the psychological principles upon which the success of the techniques depends. One example of this is industry's adoption of certain techniques that they hope will foster participation among employees -- such as suggestion systems, counseling programs, group discussion methods, role-playing, buzz-groups, rotating chairmen in conferences, and so on. But many industrial leaders already have discovered for themselves that these techniques fail miserably in the absence of the fundamental principle underlying the techniques - namely, that people will continue to participate creatively and constructively in a group only if they feel they have a real voice in making decisions about the problems on which their contributions are being solicited. In other words, if a group knows its leader is always going to make the final decision anyway, the members soon begin to lose interest in trying to reach a solution to problems for which they feel no ultimate responsibility.

One final symptom of the gap between principles and practice is the attitude of some industrial leaders that these new ideas about leadership are a kind of necessary evil, because times have changed and employees unfortunately now have to be treated with kid gloves. These industrial leaders long for the return of the good old days when management did not have to be soft or be concerned so much about human relations. Here again, there has been a failure of communication between the social scientists and the industrial leaders. If industrial leaders get the feeling that they are being forced into trying out a different kind of leadership role and that this new role is only a necessary compromise to efficient, aggressive and productive management, they have failed to understand what the social scientists have tried to communicate.

A DIAGNOSIS

Where can we look for answers to this problem? How can we explain the difficulty industrial leaders have with the application of some of the principles of leadership derived from social science research? Why the misunderstandings and misapplications, why the resistances and fears?

It would be tempting for psychologists to put the blame on industrial leaders - to say it is they who are too short-sighted to see the value of the psychologist's research findings. But I have come to believe that we must place the burden of responsibility primarily on the psychologists themselves. Granted there are many other reasons for the lag between discovery and application - for example, the high walls that traditionally stand between different departments in our universities (as between psychology and engineering), or the tendency of our universities to be somewhat detached and dissociated from the everyday problems of the world around them. Undoubtedly communication of new ideas is seriously retarded by such factors as these. Nevertheless, I cannot escape the conclusion that we psychologists have to examine critically our own behavior to see how we have contributed to the gap between the discovery of principles of leadership and their application in the industrial setting.

My present diagnosis is that we psychologists have ourselves to blame, on two counts. First, we have at times done a rather poor job of communicating our ideas, principles and research findings. Sometimes we have been far too abstract, as when we talk about "democratic" leadership. At other times we bury our principles in complicated statistical tables or disguise them in theoretical jargon. More frequently we neglect to point out the possible applications of our research findings.

Secondly, we have mistakenly assumed that all that was needed for industrial leaders to apply our findings and our principles was for us to state them or write about them in books and journal articles - we have stopped too short, neglecting to help industrial leaders interpret our facts and findings and neglecting to help them learn the skills of applying and utilizing them effectively in the industrial setting. For example, we have conducted many large scale research studies in industrial organizations, but too often have neglected to feed-back the findings from our studies to the leaders in those organizations in such a manner that they can understand what the findings mean and how they can effectively utilize them. We have published many research findings to the effect that high morale and productivity are related to the type of supervision employees work under, yet there have been too few psychologists around who could actually give industrial leaders the intensive personal counseling and skill-training that we now know most leaders need in order to change their style of leadership.

ARE PSYCHOLOGISTS LEARNING FROM THEIR MISTAKES?

Is there any hope that we psychologists can do a better job of communicating our research findings and principles and can now give more substantial help to industrial leaders as they try to apply this knowledge? I think there is hope, and in fact we already are profiting by some of our past mistakes. Perhaps this can be demonstrated in this paper by considering just one principle of leadership, pointing out some of the objections and resistances of industrial leaders, trying to correct some of the misunderstandings about the principle, and finally describing what some psychologists are doing to help industrial leaders successfully apply the principle.

THE PARTICIPATION PRINCIPLE

Perhaps no other principle has emerged so clearly from recent research on groups and leadership than the one we shall call the "participation principle".

If a group is continuously given the opportunity to participate in making decisions about courses of action that ultimately have to be carried out by the group, its members (1) will be more satisfied with the decisions, (2) will carry out the decisions more effectively and (3) will become more responsible and productive group members than the members of a group that is continuously denied this opportunity.

We shall not attempt here to review all of the research studies from whose findings this principle has been derived. It should be pointed out, however, that the participation principle has emerged from many independent research studies, carried out in different organizational settings: business and industrial organizations, educational institutions, community groups, hospitals, and so on. We might also emphasize that the principle itself is not exactly a new one - it is very much the same as the principle upon which our democratic form of government was firmly based almost 200 years ago. Psychologists have merely tried to derive the principle empirically - that is, through experimentation.

It will be immediately apparent to anyone with experience in business and industry that this simple principle is seldom applied vigorously or utilized extensively by industrial leaders. In fact, it can be said with considerable certainty that industrial organizations traditionally follow a practice quite at variance with this one - namely, that decisions are made for groups by individuals in positions of authority over them.

Why has the participation principle not been applied or utilized very extensively? Is it not a sound principle? Does it not apply to industrial groups? Or, following our original thesis, is it more because the principle has not been communicated clearly and because industrial leaders have not been given sufficient help in learning how to apply it?

THE GROUP VS. LEADER ARGUMENT

First, a look at how the principle has been misunderstood. As a consultant to management, I frequently hear industrial leaders argue against the participation principle on the grounds that a group's leader usually can make a better decision than the members - he usually has more training, more knowledge, more judgment, and so on, or else he would not be their boss! Actually they are right. It is true that a group's leader frequently has more training; he also has exclusive access to certain pertinent facts because of his formal position as the communications center for the group and the gatekeeper of communications from above. It is only natural to expect that he will often make better decisions than his subordinates. However, this is not an argument against the participation principle. It is a misunderstanding of the principle. The psychologist has not communicated adequately, for the participation principle certainly does not require a separation of the leader from his group and then pit the other members against him with respect to who can make the wisest decisions. The principle needs to be stated more explicitly, however, in order not to leave the poor leader out of the decision-making process, as some incorrectly want to do in arguing against the wisdom of group decisions. The question to ask is: can a group leader without the members' resources (their facts, ideas, judgments) make better decisions than the total group including the leader (with his special facts, training, judgment)? Stated in this way, the question about the quality of decisions breaks down to whether the total group is able to make a better decision than any part of itself. Though research has not conclusively confirmed this, I will put my money on the wisdom of decisions made by the total group including the leader.

THE PROBLEM OF LIMITS

There is another common resistance to the participation principle, and this, too, seems to be based upon some misunderstanding of the principle. This resistance arises out of certain attitudes toward power, authority, and responsibility. Sometimes it can be observed as a kind of fear on the part of industrial leaders that, if you give a group an inch of decision-making authority, it will want a mile of power. The attitude as expressed by some executives or supervisors is that there are some things you just cannot give a group power to decide. Sometimes this resistance appears in the form of a conviction that an industrial leader cannot possibly delegate decision-making authority to his group because he himself is held responsible by his own superiors. Other argue that to allow groups to participate in making decisions might result in their taking over the business themselves. These are understandable arguments against the participation principle, from the point of view of some industrial leaders. But let us take a closer look at this problem of the group's authority and power. Again the social scientists have not communicated as clearly as they might.

In all human relationships and in all human institutions and organizations there are always limits set upon the power of individuals and groups. Take the family as an example. As parents we set certain limits upon the power of our children, or upon their area of freedom, to put it more clearly. They are told they cannot fool with matches, play in the street, hit the neighbors' baby over the head or play house with mother's best china. The existence of such limits, however, does not mean that we cannot effectively utilize the principle of participation in the family unit, allowing children to participate in family decision-making within the area of freedom they are allowed by the parents. All of us who are parents foster participation on the part of our children every day; and some families I know actually have institutionalized regular family decision-making conferences in which they decide as a group on such problems as where to go on vacations, how to divide up the family chores, how to redecorate the house and so on.

Similarly there are limits set by a community upon each of its citizens. If you choose to live in that community you must accept those limits upon your area of freedom - paying taxes, respecting the property of others, driving within the speed limit, and, if you live in a city like mine, stopping at every traffic light because they have not been properly synchronized. Again this does not mean the principle of citizen participation cannot be utilized by a government. It means only that there are limits upon everyone's freedom in a group.

In an industrial organization, too, there are limits beyond which individuals or groups cannot exercise their power, their freedom or their decision-making authority, and this is usually true for the president as well as the employees. If, for example, the president is responsible to a board representing the stockholders, he has limits set upon him and there he has to set certain limits upon the area of freedom for those below him, one of which will be that they must operate to produce a certain profit, another that they respect the stockholders' property. Now, assuming he sets these limits upon the area of decision-making freedom of his second-level management group, he still may if he chooses delegate to this top group a wide area of freedom, including himself, of course, as a member of that decision-making group.

This example is over-simplified, of course. Yet it may serve to communicate that the decision-making function may be delegated by an industrial leader to his subordinates within the limits of the authority that has been delegated to him by his own superiors. What this means, then, is that any supervisor or leader can, if he so chooses, allow his group (including himself) to participate in decision-making within whatever limits he feels are set upon the group's power by higher authority.

This can be illustrated by a simple diagram, as shown in Figure 1.

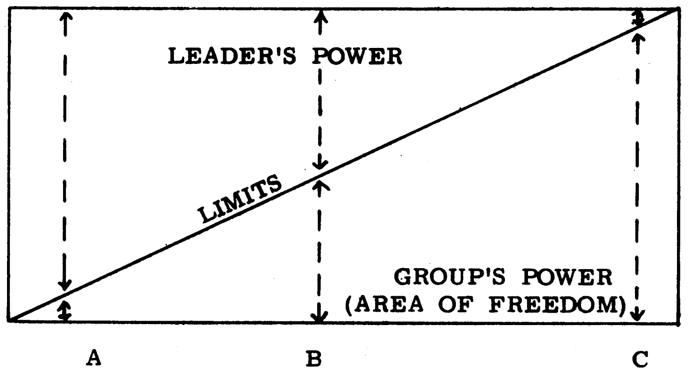

Figure 1

Represented in the diagram is the relationship between the leader's power and the group's area of freedom - the fewer his limits, the larger the group's area of freedom. One leader may be at Point A with maximum limits upon the group's power; another leader may be at Point C, where the group has maximum power and the leader but a few limits.

Just where a leader chooses to be on the diagonal line - that is, how many limits he feels he has to set upon his group's area of freedom or power - is not determined entirely by situational factors outside of himself. To a great extent he determines for himself what limits he will set. True there are always some situational limits, like the need for a company to make a certain profit, or the amount of money a department is allowed by the company's budget to spend for new equipment, or company rules about working hours, and so on. Experience tells us, however, that most leaders set far more limits than those dictated by the situation alone. In the same organization, two supervisors working under the same boss and in charge of similar departments may differ greatly with respect to how much they allow their subordinates to participate in decisions. This can happen because the number of limits a leader sets is related to many factors within his own personality such as how much he trusts people in general to act wisely and constructively, the degree to which he is secure enough as a person to have his ideas challenged, how much he likes personal power over others, how dependent he is upon the approval of his own superiors, and how much personal satisfaction he gets from seeing others grow and become self-responsible and independent.

What we have been leading up to is that somehow in the process of communicating the participation principle, we psychologists have not emphasized this matter of limits - the fact that leaders are seldom free to extend to their groups the authority to make all decisions, simply because they do not have unlimited authority in the first place. However, any leader may, if he is willing to trust his group enough, delegate to the group that amount of decision-making authority that he has actually been given by his superiors, provided he personally and emotionally feels that he can best carry out his responsibility by doing just that. This would be just like a father who decided he could best carry out his responsibilities as a father by allowing his children to participate in many decisions affecting the family. We need not discard the participation principle on the strength of an argument that subordinates cannot make decisions on everything.

THE PROBLEM OF WHETHER GROUP DECISIONS TAKE TOO MUCH TIME

A third possible misunderstanding of the participation principle is found in the argument that is heard so frequently: in industry decisions have to be made quickly, group decisions take much more time than individual decisions, and consequently, it is too inefficient and costly to let groups participate in decision-making.

On the matter of whether groups take longer to make decisions than individuals, psychologists have very little experimental evidence. But we do have some experience in observing both groups and individuals operating in organizations where decisions supposedly need to be made quickly. We know from our clinical and developmental work with individual executives that some of them take excessively long times in making important decisions, either because they are denied the essential facts by their subordinates or because of the executive's own insecurity or emotional make-up. We have also observed groups make very rapid decisions on extremely complex issues. True, we have observed the exact reverse of this, yet our observations make us wary about drawing any conclusions about the relative speeds with which groups and individuals make decisions.

A separate issue, of course, is the quality of decisions. This factor cannot be overlooked, because no industrial leader would claim that industry needs decisions that are made rapidly regardless of whether they are good or bad decisions. Consequently, the question of whether it takes groups more time to make decisions is irrelevant unless we evaluate the quality of each decision. Psychologists have recently come up with some research findings that demonstrate that on certain problems requiring novel and creative solutions the quality of group decisions is usually better than the quality of decisions made by individuals alone. Although not conclusive, at least there is some evidence that group decisions may be better on some kinds of problems.

Forgetting for the moment the matter of quality of decisions, let us examine the question of whether group decisions inevitably take too much time in an industrial organization. Once again psychologists have not been as helpful to industrial leaders as they might, for we have often failed to help them learn how to adapt the participation principle to situations in which often there are severe time pressures. Recently in one industrial firm I had the opportunity to work with the Plant Superintendent long enough to help him better understand the meaning of the participation principle and learn how to utilize it effectively. He adopted the practice of always telling his group of nine supervisors what time limits his superiors required whenever a problem came up for group decision. Some problems had to be decided within the hour, others before the end of the working day; still others were long-range problems with no time limits. His experience demonstrated that his group could be just as sensitive to time limits as he had been as their leader. When his group knew they had to operate under a time limit, it usually arrived at a decision well within the limit. The group used several methods to accomplish this - limiting its own discussion, putting pressing problems first on the agenda, forcing an early vote, or delegating the decision-making responsibility to one of its members, frequently the Plant Superintendent. I learned three lessons from observing this group: (1) a group can read time as well as a leader, (2) a group can adapt its decision-making procedures to fit the situational requirements, (3) if a leader delegates authority <u>down</u> to a group, the group often delegates it back <u>up</u> to <u>him</u> if they feel he is better qualified than the total group.

SOME COMMON MISAPPLICATIONS OF THE PARTICIPATION PRINCIPLE

The many misapplications and abortive try-outs of the participation principle observed in industrial organizations have further convinced me that we psychologists have not done our best in translating principle to practice.

Some industrial leaders have tried to apply the principle by encouraging subordinates to participate in the decision-making process yet retaining for themselves the authority to veto or countermand the group's decision if they do not like it. The long-range outcomes of this practice are usually quite predictable - the group members begin to see through the sham and resent giving their time and effort to making decisions that might be rejected; and the quality of their contributions begins to change from creative thinking to trying to figure out how the boss is thinking so their contributions will please him. I am reminded of a particular executive whose practice was to consult foremen when he needed their help but seldom respect their judgment when it differed with his own. One foreman's remark when he saw this executive approaching one day was, "Don't bring your problems to us, buddy, us peasants aren't paid to think".

Psychologists need to help industrial leaders see the difference between this executive's approach, which should be labelled as <u>consultative leadership</u>, and an approach in which subordinates have a real voice in making decisions, for which the term <u>participative leadership</u> might be used.

A second common misapplication has occured when industrial leaders become so enthusiastic about the idea of fostering participation that they go back to their groups and put strong pressure upon subordinates to participate, then later become disallusioned when the group members do not immediately become self-responsible, creative, and productive participants. Psychologists, along with stating the participation principle, need to communicate more clearly to industrial leaders that you seldom can use authoritarian methods to make people become democratic - this obviously is a paradox in itself. Secondly, we have not interpreted our research findings in such a way that industrial leaders have learned that it takes time for people to change from dependent and submissive subordinates to self-responsible, self-directing and creative group members. Just as it takes time and training for a leader to change his leadership behavior, so it takes time for subordinates to change their membership behavior. My personal experience in helping groups learn for the first time to participate responsibly and constructively has been that they almost inevitably go through an initial period of expressing gripes, hostility, and resentment toward people in authority or people who have previously kept them dependent. This may last for several group meetings before they start to operate constructively. It is this initial period of catharsis or release of feelings that so often frightens the recently converted industrial leader, and, of course, causes him to reject the participation principle on the grounds that subordinates do not want to participate or that participative leadership merely "stirs up trouble" and "breaks down discipline".

HELPING LEADERS APPLY THE PARTICIPATION PRINCIPLE

Up to this point we have been considering ways of reducing misunderstandings and misapplications of the participation principle through improved communication to industrial leaders. As suggested earlier, however, psychologists may also narrow the gap between principle and practice by helping industrial leaders learn the skills of applying and utilizing the principle in their own organization. Until very recently this kind of help for industrial leaders was almost non-existent. There were but a few applied psychologists working in industrial organizations and most of them were concentrating on helping industry select and train employees, evaluate job performance, reduce accidents, and increase worker incentives. Since World War II, however, the number of applied psychologists has greatly increased and even the academic psychologists in our universities are offering excellent training opportunities for industrial leaders who are interested in trying out new approaches to leadership. We have much yet to learn about how to be most effective in helping these leaders apply new principles and methods, but we have come a long way from where we were when we expected industrial leaders to seize upon our research findings and eagerly and easily apply them in their organizations.

First, psychologists have learned that leadership training is primarily attitude training. A person is not likely to make any significant changes in his leadership style unless he can be helped to change some of his own basic attitudes about self, about others, and about groups. Consequently, we have learned to rely less and less upon teaching leaders psychological principles or giving them facts, findings and figures and to rely more upon methods that facilitate basic changes in their deeper attitudes and values.

For a leader to be successful in helping group members learn how to participate creatively in decision-making he must believe that people have something to contribute over and above what he, their leader, can contribute. Another way of putting this attitude is that he must believe in the uniqueness of each individual - that each person is different from everyone else and thus has the potentiality for making some unique contribution to a problem, one that no one else could make because no one else is quite like him. To hold such an attitude as this, the participative leader needs to feel fairly secure himself. This is not to say he needs to be perfectly "well-adjusted". Rather he must be secure enough to tolerate others having opinions different from his own. A strong desire to pattern others in our own image is usually rooted in a deep sense of insecurity, inferiority and powerlessness. On the other hand, a willingness for others to have their own unique thoughts and ideas and to see the world through their own eyes requires of any leader that he have considerable inner security and strength.

To this end psychologists working with organizations are now trying to help each executive from the top on down better understand himself through individual counseling and developmental interviews in which he explores his attitudes and feelings and discusses his personal problems. The psychologist, of course, rigorously maintains the confidentiality of these interviews, just as he would in counseling with a private client. Group therapy, too, is being successfully used in industry to help executives both understand themselves and learn to relate more effectively with each other.

A second new approach in leadership training is to gather together a group of people who are leaders in different organizations and hence do not know each other, and put them in a kind of laboratory situation where, stripped of their usual power, they go through the sometimes painful experience of learning how to become an effective group themselves. In this process, with the help of an experienced trainer, group members learn valuable new insights about how they typically relate to others in a group situation and what the impact of their personality is upon others. This kind of understanding of oneself as a group member is a prerequisite for understanding one's own leadership behavior.

Many industrial leaders also are finding that one of the most valuable skills of leadership is the ability to conduct successful coaching and counseling interviews with their own subordinates, helping them discover their own strengths and weaknesses, solve their personal problems and make more effective use of their abilities. Consequently, psychologists are now giving training in counseling methods to industrial leaders, assisting them to develop skills of listening and skills of creating a therapeutic atmosphere in which their subordinates feel free to discuss their limitations and problems openly and constructively, instead of hiding them from their superior as usually happens.

Psychologists have recently begun to help top-management groups learn how to think creatively together through utilizing a unique technique for encouraging each member of the group to contribute off the top of his head any idea that comes to his mind for solving some complex problem. No one is allowed to evaluate or criticize any idea tossed out until the group runs out of ideas. The outcomes of this group participation technique are often amazing to everyone involved with respect to the number of truly novel and creative solutions that come forth.

These are but a few of the newer methods some psychologists are using to help industrial leaders learn how to implement the participation principle. Meanwhile other psychologists are continuing their researches to test more rigorously the principle itself or to discover extensions of the principle. Both as social scientists, and social practioners, perhaps we are making progress in narrowing the gap between psychological principles and their application by industrial leaders.

OPERATIONS RESEARCH SESSION

Session Chairmen: At Berkeley - WILLIAM R. WILLARD, Director of Organization Planning, Columbia-Geneva Division, United States Steel Corporation, San Francisco, California; Chairman, Society for Advancement of Management, San Francisco Chapter.

At Los Angeles - EDWARD CARTOTTO, Chairman, Los Angeles Section, American Society for Quality Control; Group Leader, Instrumentation and Equipment, Propulsion Field Laboratory, North American Aviation, Inc., Chatsworth.

TOP MANAGEMENT'S APPRAISAL OF OPERATIONS RESEARCH, LINEAR PROGRAMMING, AND OTHER NEW QUANTITATIVE TECHNIQUES

Alan O. Mann
Commercial Coordinator
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Philadelphia, Pennsylvania

It was interesting to review the advance program of this Seventh Annual Institute and observe the topics of discussion. You, too, may have noted that the subjects broke down into two on costs, three on technical subjects of a cold, impersonal nature, and then six on people.

I was pleased with this distribution for an industrial engineering institute - gratified by such an emphasis to accompany my assigned subject. Any top management appraisal must be founded first and foremost on human values - on the people who are industry. I therefore will feel better as we cover mathematical and technical matters this afternoon, for these have now been whittled down to proper proportion by the number and quality of presentations you have already heard on the most important element of industrial management. As I stick with the technical subject, please keep in mind the fact that this all plays second fiddle to the administration of people in an organization.

On the other hand the quantitative techniques will have a real impact on people in industry - for the good. As the new techniques become more extensively used they will beneficially affect us all, socially and economically. We will not have time today to give our full reasoning for this prediction, but I am sure you will pick it up by inference and suggestion.

Before we being our discussion of top management's appraisal it might be well to briefly describe the subjects of appraisal - "operations research, linear programming and other new quantitative techniques."

During World War II a number of outstanding mathematicians and scientists were enlisted to tackle some of our rather staggering problems of strategy and logistics. They were chiefly men with backgrounds in pure sciences seemingly unrelated to new and strange problems of war. They naturally attempted to seek out of strange stituations any basic fundamentals that were in the tradition of their own pure scientific field.

Amazingly, as they narrowed down random, complex, disordered situations into orderly models they found themselves able to employ the methods and logic that they had used in their original fields of chemistry, physics, mathematics and the like. Solutions of many of their problems had been previously thought to require experience, judgment and intuition. They were now found answerable by mathematical logic, when thoroughly boiled down into simple, orderly fundamentals, studied in a fundamental way. Many problems of "decision-making" became possible of mathematical or quantitative solution. Many matters of military supply and strategy began to move over from haphazard emotional areas of thought into orderly scientific areas.

The techniques of simplification and study, together with the use of existing logical structures from the pure sciences, showed possibilities of application in increasingly complex fields. Naturally, the many fields of our industrial organization became ripe candidates.

Since the war, these techniques have been carried over into industry by many of the mathematicians and scientists, looking for peacetime fields of research. Problems of wartime decision-making, successfully solved, naturally led to similar work on peacetime problems of decision-making. The techniques have gradually developed into Operations Research, a growing activity for confirming existing method and system or for developing system and methods in situations previously considered too complex for such. Actually, it is merely a modified version of Industrial Engineering pointed a little more specifically in the direction of an integrated, unified science of management.

Among the mathematical methods that have gained ascendency in this brief period of operational research is Linear Programming. Mathematically, it is described as a method of minimizing or maximizing a linear function subject to linear restrictions or inequalities. In industrial application it is a mathematical means of analyzing a large number of variables in a complex situation to arrive at first, second, third most desirable answers for accomplishing a single, most-desired goal. The computations deal with large numbers of equations and inequations. In a problem of relatively few variables the required series of computations, though quite numerous and complicated, can be made manually. In a problem of broad scope, with many variables, restrictions and conditions, the series of computations can become so numerous and complex that the use of electronic equipment may be required and justified. However, recent research and experimentation have developed mathematical short-cuts on some industrial applications. These improve former decision-making with less than complete mathematical exactitude but with nonetheless gratifying results. Some of these short-cuts are still termed "Linear Programming" although they do not precisely follow the mathematical definition. Rather, they satisfactorily fulfill the purposes of Linear Programming; the organizing of numerous facts, analysis of possible alternative choices, and selection of the best course to a desired goal.

The technique naturally has application only where there are problems of decision in a large number of possible choices. For example, Linear Programming can be used in scheduling numerous production orders on a large group of alternative, interchangeable machines for maximum production at least cost, provided the machines must run at or near capacity. In a slack period of low machine utilization, decision-making consists simply of running orders on the most ideal machines. This of course involves no such elaborate computations as those of Linear Programming.

Thus far, a number of problems have been satisfactorily solved in industry by this method - determination of product mix for greatest profit; machine loading for least cost; warehouse distribution for least cost; most profitable sales programming; inventory planning; most equable salary classifications; most economic gasoline blending and so forth. So much for Linear Programming.

Now on to "other new quantitative techniques." Here we can scarcely take time to define the many logical structures that have been and are being worked on by the scientists and mathematicians: dynamic programming, concave programming, game theory, statistical decision theory, search theory, theory of teams, probability distribution, theory of servo-mechanisms.

Nor can we take time or provide wherewithal for evaluating or predicting their varying degrees of applicability toward one composite science of management. We can only register the conviction that their logical processes in general appear to possess more fruitful potential for the industrial enterprise than do our present haphazard, intuitive thought processes. To one who has grown up in the latter school it has been impressive to sense (intuitively) the existence of patterns, cycles, repetitive consistencies in all industrial situations he has encountered. Further it has been impressive to observe the inconsistencies of managerial decision in the presence of such consistent situations. There must at least be improvement available from among all the new quantitative techniques and we're always seeking improvement.

These, then, are the areas of top management's appraisal which we are to appraise today; operations research, linear programming and other new quantitative techniques. You may have noted by now that I evaluate them highly. But I am not representing top management today. I am here to present my views on how top management evaluates them. My views are objective views, I hope, although arrived at by intuitive rather than quantitative process.

Quite frankly I question the extent to which top management is attempting appraisals of these techniques today. I question whether, with generally limited attempts, the evaluations are very high. It would seem not.

It is in the nature of man that, aside from his God-given graces, he is what he is from training and experience. It is in the nature of industry that a top manager becomes a member of top management because he has excelled in his particular training and experience over a period of many years. The many years up 'til now have included little experience and scarcely any training in the new quantitative techniques. This is particularly true since the low levels of the scattered research have not yet begun integration into general administration where top management has been doing its most recent learning.

To put it more bluntly, today's top manager has grown up on a concentrated background of intuitive decision-making on what he considers major company matters. He may sense values in the detailed elements of so-called scientific management that are carried on daily under his view. He may wholeheartedly appreciate statistical quality control, time and motion study, his incentive system, market research and automation. But they are internal details which, while invaluable, do not fill his personal requirements for decision-making and policy-setting. They do not tell him what to do with a recalcitrant board of directors, how to settle a dispute between several division heads over a general company problem, where to go for more capital, whether to reduce inventory or how to reduce inventory under conflicting philosophies of sales and manufacture, how to keep the operation both legal and ethical, whom to hire and whom to fire, what charities to support, what speeches to make and when to grant an interview. Through the years, and increasingly of late, these are but a small sample of his personal concerns, acted upon out of his training and experience. I repeat again, that training has not included quantitative techniques. Therefore, he considers the quantitative techniques as but a variation of the detailed, invaluable elements of scientific management carried on daily under his view. How can he consider them an over-all, general-company, administrative tool for top management's personal use?

The member of top management who has a thirst for knowledge can go after it. He can find information in books, periodicals, research tracts, and institutes, among other sources. But to get thorough understanding he'll find it only in detailed technical tracts. His background, generally, is that of a financial man, or a lawyer, or a production man, or a salesman. Has he, in all fairness, had sufficient training to accept readily, or to be able to understand easily the mathematics and the logical structures? What does he do with pages of mathematical symbolism interspersed only with descriptive phraseology such as this?

"Minimization of non-linear convex functionals subject to linear inequalities."

"Maximization of concave functionals."

"Optimizing points that are usually interior points rather than extreme points."

"Separable convex functionals."

"Bounded variables."

"Least squares regression subject to linear inequality restraints."

"Dual formulation."

"Reduction in the computational tableau."

"Structure of the uncompressed matrix of the problem."

These are but a sample from two explanatory paragraphs of a technical paper. Unquestionably the semantics cannot inspire or appeal to top management. There is nothing here that indicates to the layman even a slight bearing on matters of production, sales, inventory or finance. As a matter of fact there is little here for most laymen to indicate that the language is English. Yet it is from an outstanding work on the computational theory of linear programming.

So the member of top management who thirsts for knowledge in these areas must go to the so-called "popularized" versions to learn. He must cull, out of masses of such materials, that which he can understand and absorb. However, ever present is the danger that some popularized versions distort the basic concept or do not properly put it across. This is a danger for you today, for I am not a properly trained person in the theories and the research about which I am speaking. I have only one possible saving grace that, in discussing my intuitive concepts with the computational technicians, we seem most always to be on common ground of understanding and agreement.

A lack of favorable appraisal from top management has possibly rested in insufficient editing of popularized versions by those capable of doing so. This is a job that has been taken on by the Institute of Management Sciences, ORSA, this Institute and other groups of leaders in the field. We are beginning to make progress towards not only clearer concepts, but clearer explanations of them. Computational techniques will be gotten across to top management as rapidly as their explanation can be phrased in understandable terms.

That top management does not favorably appraise the new concepts is evidences in several ways today. Let's review some of the indications.

1. Financial domination of industrial data processing. We believe this is a strong indication because it holds to an accounting view of data rather than an economic view. Accountancy has developed general acceptance as a predictor and a controller for industry. But its views are based largely on three assumptions; that the dollar is the primary unit to be used in the measurement of industrial operations, that the making of operational decisions consists largely of projecting dollar history into the future, and that measurements and decisions must be applied to arbitrarily fixed periods of time.

Hency, the present or accounting techniques depart from the new concepts. In the new, other factors than the dollar also are used as units of measurement, chief among them being quantity and time. The new techniques consider time as dynamic, moving, flowing, not as a rigid dimension, arbitrarily fixed. They treat decision-making as a flow process; one which constantly receives quantitative data from the flow process of industrial operation, evaluates the data and in turn feeds it back to control the operations. The two views of controllership still seem substantially opposed. Top management, understandably enough, still generally holds to the former view.

2. Another indicator of top management's unfavorable appraisal is evidenced by the fact that systems, procedural and operations research activities are largely being carried on under the financial division of industry. It seems apparent that this has occurred because of financial domination of data processing. Here, as in top management's case, training and experience have been a prime factor. Accountants have learned to handle data, figures, facts better by past standards than any other division of the industrial organization. Why, then, shouldn't they continue to handle the data when new concepts come up? Why shouldn't they continue to operate the equipments that have been developed for handling data? Thus reason both the accountants and top management.

The significant differences in the two philosophies do not seem to have been realized yet. The accountant's training and experience have not encompassed the new philosophy. Data processing is still just what it was before, the gathering, storage and summarization of dead figures for subsequent submittal to the decision-makers as a check on their past performance. Data processing is not yet considered a living, vibrant part of day-to-day decision-making in the production and sales divisions of industry. That is why the data handlers continue to hold sway under accountancy and why those who develop systems, procedures and logical structures based on data are largely carrying on their work under the supervision of the financial branch.

Because accountancy is one of the strongest single conceptual models applied to date in industry, its philosophy holds great power in industry. Its training and experience in that philosophy is formidable. Yet the philosophy of the new techniques will require active participation of production and sales in the processing and interpretation of data. The new concepts threaten to go beyond accounting philosophies and take away from the accountants those areas which they assume to be solely their responsibilities and prerogatives under their unique capabilities. Can financial leadership change its philosophy with all the altruism that would be required to give up some of its present powers? Will it? If not, operations research may continue under its auspices and the philosophy of the new computational techniques may struggle long and hard in its ascendency. Top management shows general evidence of reluctance to force the new philosophy at the expense of the old. This would indicate to me, a less than favorable understanding and appraisal of the new techniques.

3. A third indicator of top management's appraisal is that few of those active in operations research and computational concepts are actively included in the company policy-making at top level. They are not invited to participate in the over-all strategy of sales planning, production planning, financial planning. They are treated as tacticians, not strategists. They are not given the opportunity even to observe closely the daily decision-making at top level so that they can adapt their tactical concepts into strategic tools. Rather, the technicians still have to operate at lower level, in a specialized branch of the organization, under a fundamentally opposing philosophy. It hardly indicates a strong desire on the part of top management to find fuller uses for the new techniques or the capabilities of the new school for technicians.

Of course, part of the responsibility for this limitation of computational techniques to machine loading, traffic routing and other detailed activities rests with the short life of the concept. It was only recently born. The research into applications is still in the infant stage. So top management still questions the infant's ability to ever do man's work. Of course, much responsibility of winning management's acceptance also rests in the child himself.

Fortunately, there are some administrators of vision who see beyond the infant who creeps, to the striding man of tomorrow. There are presidents and vice presidents today who are training the growing infant - who are letting him stretch his muscles - who are letting him exercise his mind. And I believe that they will be joined by many, many more as the benefits of this new philosophy gain a wider understanding.

In this connection, I am happy and proud to report that Richard H. DeMott, chairman and president of SKF Industries, my own company, was among the first to see and accept the advantages which these new computational techniques will bring.

Mr. DeMott has brought his great powers of patience, insight and creative vision to bear on this matter. His acceptance followed days and weeks of the most intensive consideration of the problems involved. His decision has been most gratifying to me, and an invaluable incentive in my own enthusiasm in furthering the use of these techniques.

I repeat, with some scattered exceptions, top management is not including operations research and computational personnel in policy-making at top level. This is an indication of still limited and less than favorable appraisal.

4. The fourth and last indicator we shall cover today lies in a lack of top-level coordination. Three programs are sweeping industry these days with feverish intensity. You will agree, I'm sure, as I speak of electronic computers, communications and "integrated data processing." I think you will further agree that work on all three of these programs is not being carried on simultaneously in most industrial concerns. We can find large numbers who are working on one or two of these programs but few who are pressing all three. Based on this we aver that there is a lack of coordination at top level. For we believe that all three programs are inherently requisite to the philosophy of the new computational techniques.

As we develop ultimate concepts of computational decision-making we will be fighting time. We will need to communicate transactional data to our computers with speed. With speed we will make our computations and decisions. With speed we will need to communicate our decisions back to the operations where transactions occur.

Industrial transactions occur continually and speedily in all areas of sales, manufacturing and procurement. We cannot control such transactions well on dead data, tardy decisions and late corrective instructions. Much of the industrial chain of control runs in a steady, pulsating sequence from action, through communications, to computation, then decisions of adjustment, back through communications to the point of action, for modification of the action. Time lapses, time lags in this chain, in this control process, are practically paralytic in effect. Our industrial organism still displays too many spastic symptoms. The three popular programs just mentioned are being directed at various points in the control chain to diminish the paralytic effects of each point. But the spasms will continue, although abated, until all corrective measures are coordinated along the entire chain. Top management is not yet effectively concentrating on the entire chain.

Take the case of the electronic computer. Some very expensive computers have been purchased or leased in advance of thorough plans for their use. The machines have been financially justified by potential savings in clerical and computational personnel. They are being considered as glorified adding machines or calculators. They can do a previous day's work in a fraction of a day - the same work. They can make the same calculations, on the same forms, with the same periodicity, so that management can make the same kinds of decisions a little sooner.

In how many cases is a computer being put into this kind of operation without companion work on communications? A computer handles data with great speed. But with what speed is data being fed to and from it? Isn't the job being tackled backwards when we collate and compute in micro-seconds, using data that required hours or days to reach the computer? It would seem that speed of computation must be accompanied by speed of communication.

On the other hand, there are many companies that are concentrating only on speed of communications. These include exponents of "integrated data processing", using "common language" paper tapes. Boiled down to simple terms, the common language is five-channel punched paper tape used in wire transmission of alphamerical information. Simpler yet, it means "teletypewriter communications."

The integration of "integrated data processing" arises out of the fact that great numbers of office machine companies have developed "common language" machines. They include typewriters, cash registers, calculators, bookkeeping machines, printers and "what not", to operate from five hole paper tapes and to produce them. They all work with and from a common language of holes.

But somehow lost from this program is the realization that a conglomeration of varied machines to perform varied functions under scattered auspices is more segregation than integration. The paper forms on many, varied machines run in wide varieties of shape and size, again less integration than segregation.

Yet, here we are with the electronic computer at long last available. Here, at last, can be true integration. It can read from all kinds of input, including five-channel punched paper tape. It sorts, it files, it stores, it collates, it adds, subtracts, multiplies, divides, it prints, it can make five hole punched paper tape, it can be made to transmit over wire circuits and it can even be made to speak. It would seem that herein rests the true potential for actual "integrated data processing", based on coordinated application of both the computer and taped wire communications. Top management is still not effectively providing such coordination, our final indicator of their appraisal.

In review, then, here are the main points we have covered. Top management is still making only limited appraisals of operations research, linear programming and other new quantitative techniques. In general its evaluations are not very high. The reason is that top management has had little experience or training in such techniques. The evidence supporting these opinions is four-fold:

1. That financial techniques still dominate industrial data processing.
2. That systems, procedures and operations research continue to come under the financial arm of industry.
3. That the new technicians are not yet being drawn into participation in top management.
4. That activities which should be companion to the new techniques are neither being thoroughly coordinated among themselves nor with the computational concepts.

I regret the negative tone in the summaries I have given. However, I hope that you carry out of it the positive note intended. I think it was Lecomte du Nouy who said, "All simplications are arbitrary and lead us to drift insensibly away from reality." The reality behind what I have said is that all these tones and overtones of divergent opinion constitute progress. Some of the points I have inferred as weaknesses are actually strengths for they make us think in this age when too much of man's labor is machine work done by man.

The most serious criticism that we can level at some present administrative methods is that they do injustice to the dignity of man. It is intolerable that people with souls, with intellect, judgment, vision, initiative, still spend all their working hours in mechanical repetition. The work of sorting, filing, copying, matching, belongs to the tools man can contrive, not to man himself. Even at managerial level, a major portion of our time is spent in making what we glorify with the term "decisions", but which, in reality, are repetitive arithmetical calculations at eighth grade level, performed mentally.

So our positive note today is one of challenge. Our challenge is to mold the new philosophies and the old towards better life for all who live and work.

I cannot express it better than Professor Churchman of Case Institute. His keynote for the new journal, "Management Science", might well be our keynote as industrial engineers. Here is what he says:

"In what ways will our science today be the historically naive forerunner of tomorrow's discoveries? Not with respect to the future revolutions in the physical sciences, but in our taking seriously the Socratic 'know thyself!' "

"To a future age, we are naive on the subject of the way men act and react among themselves. What is good administration? What is a decision? What is a risk? What is a utility? What is a profit? What is an optimum? We do know the answers to all these questions in our present conceit of accomplishment; we do not know any of these answers in the perspective of another age to come."

"Our objective is dedicated to a science of management, and this means that we must do whatever we can to guarantee a more sophisticated future. This, in turn, means that we must keep alive all present philosophies of management science that have promise for a better future science."

"(We are) committed to the conviction that all these conflicting philosophies should be encouraged, because in a free, open, and scientific discussion there will emerge the discoveries which will absorb and make naive the conflicts of today, and generate the more sophisticated conflicts of tomorrow."

MODERN INDUSTRIAL ORGANIZATION

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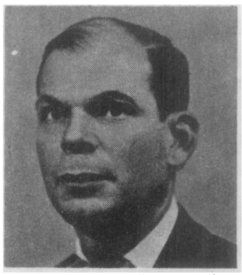

The problem of modern industrial organization is fundamentally the problem of understanding the administrator. What is his job? What can he do? What is he like - the man? What is his environment - the social and industrial matrix? Any organized industrial operation is a system, including and controlled by administrators, which changes some set of elements (that is, things or commodities) into some other set.

In general, the administrator's job consists of a fundamental group of problems and processes, of tasks and responsibilities which vary from time to time, and in importance. The job requires a wide variety of abilities, skills, knowledges, concepts and attitudes.

The man responds in a great many ways to the total universe in which he finds himself. Some of these responses are made to the unique factors and forces which are directly connected with his job. The responses he makes depend upon his physical, intellectual and emotional capacities -- upon his experiences, his past history, his values, his beliefs. In other words, what he is affects his reaction to any given situation in his job and in his industrial or social setting.

The social and industrial matrix encompasses the people and their institutions in the industrial and social community in which he operates. It is a complex of relationships and inter-relationships, of factors which act and interact upon man; these constantly change and change man. The social and institutional pressures often shape the image of the fundamental tasks in the mind and perception of the administrator. The social setting, then, affects the man and the job, and they, in turn, influence each other and the social setting; the three are inextricably interrelated. (1)

Our goal here is to understand industrial "operations" of all kinds, and their relationships. In this sense we are considering both the "operations" of administrators, and the "operations" of those who operate machines. We should like to be able to: (a) visualize the objectives of any industrial organization in common terms, (b) conceptualize the kinds of alternative operations which are available to meet chosen strategic objectives, and (c) logically develop meaningful and operational components of objectives. (2)

In undertaking this kind of abstract and fundamental analysis of industrial organization, I am reminded of the well known Boston story of the Back Bay Lady who daringly planned to have her chauffeur drive her all the way to Santa Barbara.

"What route will you take," she was asked.

"I have decided," she grandly replied, "to go by way of Worcester." (Massachusetts, that is).

I sometimes feel that we who try to solve organizational problems in industry all too often take this approach in reaching for solutions.

Thus, "I have decided to reorganize our entire sales activity, to improve its efficiency," I may say.

"How will you do this?" I will undoubtedly be asked.

And my reply may very well be, "I have decided to go by way of the Coordinative Principle!"

Whether we can do any better than that is, of course, open to question, but it certainly should prove useful in the long run to examine the nature of the terrain over which we will have to travel and to look at the country through which the alternative routes available are likely to take us. We might do what the man in the famous Lincoln story did when he came to a stream. He took off his shoes and socks and his pants, carefully rolled them up, cut a willow pole, made a bundle of his belongings and his clothes, and set out to ford the stream. At no place when he crossed it, did he find it to be deeper than his ankles. This, I guess, is the other extreme.

In this paper, we shall attempt to examine the general notion of organization in industry, and then give specific meaning to the terms involved in the organization relationship in respect to the behavior of administrators.

In industry, we have things (or commodities) which we wish to (or uncontrollably do) change into other things or commodities. We characterize or measure these commodities by some method, as: Labor-man hours; Material-pieces, pounds; Money-dollars; Time-hours; Information-bits; etc. An industrial operation is precisely the process of transformation. The input into an operation is expressed during some time interval. The output from an operation may similarly be expressed as a set of measures of the commodities produced by the operation during some time interval.

We, of course, implicitly assume in our examinations of industrial organization that what goes into an operation has a cost and that what comes out of an operation has a value. Being completely general, we need only specify that each input has some function associated with it which gives us some (real) number as a measure of the cost of the input elements. We all recognize that this is essential to proper administration, but it is less often expressed as part of the organization process. Similarly, the outputs have a function associated with them, providing a (real) number as a measure of their value. Sometimes these functions are not easy to find, as we all know. I should like to note that both the cost and the value can be negative as well as positive (that is, someone could pay me to use an input, or a given output may actually cost me something to dispose of, etc.).

Any industrial operation is characterized by the way in which it changes the inputs into outputs, or in other words, by a transformation function. This function defines the outputs available from any inputs. Now, this set of abstract definitions is sufficient to describe any industrial operation. However, it is not in this descriptive possibility that our interest now lies. Can we, from further consideration of the nature of these elements and functions, provide additional insight into organizational relationships and problems? First, let us note that we consider the objective of an operation as some desired relationship between the costs of the inputs and the values of the outputs over some sequence of time intervals. For example, we may wish to set as an objective the maximization of the difference between the value of outputs and the costs of the inputs over a given time. This you will recognize as ordinary profit maximization. However, the number of possible relationships that might be employed is unbounded.

Let us now sketch the way in which these concepts may be used to describe industrial organization. We see that an objective has four operational components: inputs, cost functions, transformation functions, and value functions. Outputs, of course, are determined by the inputs and the transformations. We recognize that individuals in industry attempt to select and modify these four components (which are not necessarily independent). The structure of an industrial organization is established so that specific selections and modifications may be achieved. To put it another way, administrators "operate" within the system to do the selection and modification.

The goal of such administrators is the achievement or maintenance of some objective or relationship between costs, inputs, transformations and values. At a higher executive level may lie the selection of the objectives themselves. We may outline some of the things that administrators do to achieve their goals (not the way in which they do these things). The administrator may select and/or modify:

(a) the inputs (allocation)
(b) the costs (bargaining)
(c) the transformations (research, engineering, methods studies
(d) the values (salesmanship or promotion)

He also may take action with respect to each of these to maintain some selected set of values, or to correct deviations; in other words, he may engage in control activities. He must provide, in various ways, for the measurement of these components in order to quantify the various attributes associated with inputs and outputs.

The administrator and the executive may compare results of the organization in terms of variously selected objective functions. The manner in which he does this may range, obviously, from vague and undefined comparisons to very precise development of measures of performance. Contrary to many notions, there is no necessary requirement in industry that the administrator be consistent or efficient in his selection of objectives or components of the objective function. It is possible to demonstrate that the stability of a specific operation will reflect the consistency of the administrator in this respect.

In these terms we may now define industrial organization as a structure of administrators (organization operators) who function (efficiently or inefficiently) with respect to selection, modification, and/or control of inputs, costs functions, transformation functions, and value functions in terms of specific objectives. More often than not, as we examine organization problems in industry, we find that most of the information required by such a formulation is not available, even for the simpler operations. No real measure of the effectiveness of the operation of the operator is possible without an explicit statement of the objective, and even when this is available, descriptions of inputs and outputs, costs and values are required before it can be made operational. I think you all know this, but the fact that it is so intimately related to the organization structure is sometimes overlooked. Of course, it is sometimes extremely difficult to obtain insights into objective functions, particularly for individual operations. It may be possible, by means of an analysis based upon these concepts, to obtain some notion of the objective, even if not stated, by examining the statistical stability of the input-cost-value-transformation relationships. Certainly, we can test for this consistency in terms of our own choice of objectives; without some selection of objective, no contribution to organization improvement is possible in the long run.

Within this structure, what does the administrator do to select and/or modify the components of his objective function? Let us first treat his processes as individual and then see how they relate to the other operators in the organization.

One process which all administrators much engage in is the gathering of information, which means scanning the areas available to his perception, retaining in storage (memory) those perceptions which have meaning to him in his understanding of his objectives. These perceptions serve as a basis for action. He asks questions of others, and then of himself. As he accumulates facts and information essential to his task, he records and stores systematically the information which he has gathered (files, record-keeping systems, etc.).

The second process of administration is the drawing of inferences: evaluating information and recognizing significant relationships in a concrete manner. Note that the clearer the understanding of the objective the more likely are the inferences to be meaningful.

Third is the process of relating to people. In this process the administrator needs to realize when he is interacting within the total system and when with a particular person. He must be able to infer the desires, objectives and operating characteristics of the individual, group, and culture with which he interacts. As we shall see subsequently, this is vital to both himself and the organization. He must be clearly aware of and skilled in the process of change: in himself, in the job, and in the industrial setting.

The fourth process involves predicting and deciding. Included in this process are three major steps. First is the evaluation of possible inputs, costs, transformations, and values (which may be also stated as evaluation of possible means and ends). This of course signifies the capacity of the administrator to determine the values and costs which should be implicit, as well as explicit, in all of the goals, operations, and procedures of his area of industrial operations. Second is his ability to predict the probable values, costs, and acceptances (personal and organizational) of the procedures and goals implied by the evidence. Finally, on the basis of the evidence he has collected and evaluated, he must be able to select and/or modify the elements of his objective function which are appropriate to the immediate or long-term responsibilities in achieving and maintaining that objective.

The final process is that of implementation. The implementation of decisions includes first of all the ability to communicate clearly to others the preferred means and ends and to demonstrate their importance with evidence. In order to implement any objective, method or procedure, it is necessary for the people involved to understand clearly the means and ends for the task. Implementation also implies the action with which the administrator, the group, or the organization structure chooses to carry out the selected objectives with the available resources; further, it is carrying out these choices in terms of behavior.

Let us now apply this analysis to the overall enterprise before examining specific functions of a firm. Any firm may be considered as an operation which transforms the owners' capital into input commodities, transforms these inputs into various output commodities and transforms these outputs into money. On a very simple basis, then, the enterprise is an operation which transforms invested capital into gross earnings. The transformation function here defines the expected gross earnings for any given input. Note that the transformation function is spoken of in probabilistic terms which will be true in all cases and which one would expect in a realistic sense. The costs attached to the inputs may be considered to be a function of the alternative uses to which the money may be put. The value of the gross earnings is a measure of the utility of these earnings to the owner or administrators (in a simple case, this value may be the same as the dollar measure of the gross earnings themselves).

Under these conditions a possible objective function is the maximization of the difference between gross earnings and the cost of the input capital (as a simple equation: $F_T[X^T] - C[X^T]$) in time T. Or, maintain this difference equal to or greater than some specific value.

In this case the problem of meeting either of these objectives resides in the administrator's ability to allocate his funds, and to control or improve the transformation function; he must take into account predicted changes in the cost function, and any change which might occur in the value function selected in the particular case.

In this look at modern industrial organization, we represent the administrator, who operates to make the allocation decisions, as a sub-operation within the overall operation. We have indicated the nature of the administrative process. Clearly, in a given firm, one may make proportionately higher or lower allocations of inputs of administrative activity. Each of the elements of the process, might involve the hiring or assignment of staff members (to gather information, to systematically record and store information, to draw inferences, make predictions, etc.). Such a program, intended to develop the maximums indicated above requires the allocation of additional administrative inputs, which would reduce those available to the remainder of the enterprise. I suggest that the problem of dividing the total available resources between the administrator and the actual transformation function is a major part of the allocation activity.

In a very real sense, the allocation activity of the administrator determines, among other things, how much of the resources will be devoted to the allocation activity. From this concept the allocation activity emerges as the critical determinant of the nature of an enterprise, determining the extent to which any of the activities of the administrators may be carried out, the net resources available to the transformation function, and how optimally they may be allocated. All too often, administrators make the assumption that additional staff applied to allocation problems will automatically improve overall results.

Maintenance of the transformation function in operating order, and selection and change of this function in an advantageous manner are both problems facing the administrator. The maintenance activity may be described as an attempt to counteract the inevitable progressive deterioration of the technological resources used to produce the desired transformations. Organization tends to disorganization, processes tend to get out of control. We may deal in this sense, with either human elements of the function (human relations, among other things), or with mechanical elements (engineering and quality control, for example).

It is incumbent upon the administrator to continuously evaluate possible alternative transformation functions, with respect to the results to be expected by their use in the objective function. As we all know, methods activity, research and development, purchase of patents, etc., can yield profitable changes in the meeting of objectives. Allocation of resources to this selection, improvement, and evaluation activity will have a direct affect upon the resources available for other administrative tasks. In this sense allocation activities and the general class of "methods" activities are closely related.

We have said that allocation activity is the critical determinant of the nature of an enterprise. What does this mean in terms of modern industrial organization? It seems to me to point the way to a creative and meaningful approach to the control and organization of a group of operations into a coherent whole. In the first place, a mere operational description of organization obviously implies a great deal more than organization charts and the usual organization manual indicating functional authority and responsibility.(3) The inputs and outputs and the transformation functions involved must be assigned to each operation center (an organization outline, in other words) or administrator. The objective functions must be explicitly stated (objectives program), and the administrative process involved should be spelled out (administrative outline) and scheduled (administrative schedule). The objectives program will provide the values to be attached to the outputs, but the costs of the inputs must be available as well (functional budgets). Then, these must be hierarchally related in the same manner right up to the top or chief executive. Modern industrial organization requires the provisions of each of these elements through a descending cascade of allocation activity. Let us now turn to some of the component functions of a firm and briefly examine their inputs, outputs and allocation functions. In this brief appraisal, we shall not attempt to exhaust the inputs or outputs, frequently ignoring labor and capital goods, but rather discuss specific differentiating characteristics.

Purchasing, for example, may be viewed as part of the administrator configuration. This operation has a direct part in determining the modification of the input cost functions (bargaining). As a functional center, inputs into purchasing are primarily requests for material and specifications regarding the material. Specifications include not only requirements of quality, quantity, but also requirements as to the time materials must be on hand. Outputs from the purchasing operation are prices of needed materials, and the actual delivery of materials.

Control of the purchasing activity includes the problems of determining and maintaining in an adequate manner the timing involved between the input of a request for materials and outputs of vendors' bids and the delivery of material. Delineation of the administrative process includes the methods of determining the number of bids to be received on a particular item, the choice of vendors to bid, and the timing of purchases. It should be clear that the objectives function and program will indicate whether a larger or smaller number of bidders should be required. The more bids received, the larger the chance of obtaining the item at the lowest possible price, but the higher the cost of this part of the activity. The allocation of personnel to search out new vendors and to expedite delivery will be a function of the value placed on low prices and on-time deliveries.

The production control and scheduling operation, on the other hand, does allocation almost entirely. Inputs to this activity are primarily informational, and include orders for output, requirement dates, and measures of actual outputs. The output delivered by the operation includes activity assignments associated with particular equipment over time, and orders to the purchasing department for raw materials. The administrator must determine how much of the available production control resources should be used for scheduling per se and how much should be used for expediting the performance according to schedule. These, of course, react on each other. The more and better the scheduling the less the expediting; the better the expediting, the less the requirement for accurate scheduling.

Similarly, quality control supplies an informational output concerning the stability of the essential parameters of the various transformations involved in the enterprise. Inputs to the quality control function are specifications of outputs and inputs of the various operations. The quality control function must determine how much of its resources will be devoted to measurement, and how much to the analysis of measurement, another pair of "coupled" variables.

The major task of measurement for the enterprise and for most of the component operations is usually performed by the accounting activity. Essentially, its objective is the quantification of the various elements of the respective objective functions throughout the firm. Characteristic inputs to the accounting operation are recordings of observations of actual output and input commodities exchanged by the various component operations. The transformation performed by the accounting activity is to associate (real) numbers with the rates of flow or absolute quantities exchanged. These real numbers constitute the output of the accounting operation, to be used by the administrators. In allocating its resources through the requirement of meeting its objectives program, the accounting activity must decide questions as to the reliability and accuracy of its output. An increase of accuracy will require an increased allocation of labor and equipment or a decrease in the quantity of output numbers. The desireability of a given approach, will be reflected in the consistency of the accounting objective function with respect to the objectives of the other component operations of the firm.

Typical of another kind of activity - promotional - is the advertising operation whose job it is to modify the parameters of the values of the firms outputs. Characteristic inputs into the advertising operation are data concerning the nature of the customer and the nature of the firm's existing output commodities. What the customer wants and how he wants it must be fed into the advertising operation so that it may produce information directed to the customer emphasizing areas where a correspondence exists between the characteristics of the enterprise's output commodities and the requirements. The allocation of advertising resources among alternative channels of communication with the customer, the relative allocation to various outputs, and the extent of use of outside services are among the administrative problems to be settled by competent organization.

As we all know, the relationship of operations such as these to each other form the structure of the organization, and clearly must be meaningfully operational if the firm is to be successful. Flow of information is characteristic of all component operations.

From the point of view of the purchasing operation, for example, a requisition from the production control operation, would represent not only an input to be transformed into an output of materials at a price, but also an indication that a value would be associated with this particular output. We may suggest, that tying all the component operations together, the cost of an input commodity exchanged internally will be identical to its value as an output commodity. That is, the cost to the production control activity of the purchasing service (as an input) will be identical to the value to the purchasing operation of the purchasing service (as an output).

From our previous visualization of each administrator of an operation attempting to achieve or maintain some objective function, in part determined by his input costs and output values, we can see the importance of this concept from a structural or organizational point of view. The administrators have some measure of control over the costs of their inputs, and a major problem for them involves decisions as the amount that will be "paid" for commodities (information and others) produced internally by other operations. The transmission of such decisions and their stability represents a measure of the integrated nature of the organization structure of the firm. For example, if the advertising department refuses to use the output of the market research department, or depreciates its value, or has no consistent policy as to its use, it is clear that a kind of internal instability must exist.

The administrators, by allocation activities and by establishing internal prices exercise a major degree of control over the stability of the production operations of the firm. The attempt on the part of such administrators to optimize their respective objective functions is influenced by the prices they must pay for their inputs from other operations and the value of their outputs to other operators. These "prices" are not entirely subject to their own selection and promotion bargaining activity with the other operations, but to their bargaining and promotion activity with respect to the chief executive and his staff and to the latter's own decisions. In the modern sense, control over the production function is not only controlled by actual direct change of operations, but also by modification of the internal "price" structure.

Thus, a highly centralized firm would be characterized by tight control of the internal price structure by the chief executive; decentralized firms, on the other hand, would have this structure determined by the sub-operators.

The chief executive and his staff, in this framework, become the administrator of the component administrators, and this in itself is a specific operation with organization outline, objectives program, administrative outline and schedule, and functional budget. The chief executive, tries to maximize the firm's administrative operation through the various means mentioned earlier. He operates, not on the firm as a whole, but on its organization operators.

The output of the operation of the chief executive is entirely informational and is primarily directed at the values which the various administrators may place upon the output of their own operations. In a sense, he is either setting or agreeing with already set prices of their outputs. The chief executive's analysis of the structure and basic parameters of the firm's objective function will affect his administrative process - his relative allocation of resources to administrator and producer operations, as well as the degree of autonomy he allows in internal pricing. The extent to which his analysis of the firm's objective function is operationally meaningful is a critical aspect of the long-run successful operation of the firm.

We suggest that it is necessary for the executive and his administrators to establish a framework of (a) organization outlines, specifying input-output, transformation responsibilities, (b) objectives programs, stating the objective function, (c) administrative outlines and schedules, describing the specific administrative process, and (d) functional budget, outlining the cost input functions and limits. In addition to these, the firm must program its operations through time. The choice of a strategic interval (i.e., the time over which the objective function for the whole firm or a given operation will remain unchanged), as opposed to the decisions required within tactical intervals (e.g., maintaining objective function parameters within control) is a decision problem for the chief executive. The answer to this question is not necessarily simple, and may determine the degree of total optimization of the firm's activities which is achievable. Thus, too short an interval will result in high planning allocations, too long an interval in sub-optimal programming, the amount of which will depend upon the uncertainty of future estimates of critical parameters.

It will be necessary for administrators to associate a "risk of ruin" to any realistic objective function, whether of the overall firm, or of a sub-operation. Displacement of an administrator (an organization operator) might be construed, for example, to represent the "ruin" of the replaced operator. Obviously, there are penalties attached to such "ruin", since the administrators administer the means whereby the firm's objective function is achieved.

This analysis of modern industrial organization in terms of the network of administrators, culminating in the chief executive who "operates" the administrative net, implies a communication system operating continuously with an automatic set of feedbacks affecting the control of each component operation. As in any feedback mechanism, there is no necessity that the servo be either stable or efficient with respect to its objectives. It seems to me that the task of organization analysis is to improve both the efficiency and stability of the operational organization structure, and that these are the kinds of tools with which he may be able to do so.

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LABOR RELATIONS SESSION

Session Chairmen: At Berkeley - E. PAUL DeGARMO, Assistant Dean, College of Engineering, Professor of Industrial Engineering, University of California, Berkeley, California.
EWALD T. GRETHER, Dean, School of Business Administration, University of California, Berkeley, California.

At Los Angeles - L. M. K. BOELTER, Dean of the College of Engineering, University of California, Los Angeles, California.
GEORGE W. ROBBINS, Acting Dean of the School of Business Administration, University of California, Los Angeles, California.

MAN IS NOT OUT-MODED

David J.. McDonald[1]
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Pittsburgh, Pennsylvania

It is with extreme regret that I have found it impossible to address in person this highly important conference. Had it not been for the most strict orders of my physician, I would have, in spite of two most recent and grueling trans-continental round trips between the east and west coast, been with you today.

Your deliberations and decisions cannot but have a profound effect upon our society and the world. Many of you are men skilled in the techniques of the sciences and are using your great knowledge to forward with ever increasing rapidity the productivity out-put of our industrial plant, and insure an ever-rising standard of living for our people.

My own position in life has always been on the side of the working man and I have devoted my life to the cause of American labor. I think it important always to remember that in every form of society it is man who builds the society in whick he lives and works, and it is man and not the machine, for whom the society was established.

[1]In Mr. McDonald's absence, his paper was presented by Mr. Cass D. Alvin, Educational Director, Western District, United Steelworkers of America, C.I.O., Huntington Park, California.

It is said that we are on the threshold of the second, and some have even said the third, industrial revolution. I need hardly recall for you that it was the harnessing of coal for steam engines that introduced the first industrial revolution, and in a sense, though it liberated man from the ages of back breaking toil, it also created a machine which challenged his very existence. From this sprang the beginning of modern industrial unionism. Today, as in the opening of the machine age some 180 years ago, the problem re-presents itself and in much the same way.

But, now the problem is two-fold -- not only has man found how to capture the secret of the atom and by harnessing it to the machine produce unlimited good, evil, or both -- but also man has learned how to develop a continuous flow of products through a battery of precision machines without the aid of his labor or mental direction. This latter is now rather broadly called automation.

There is no denying that our age through the proper use of these two great advancements can achieve results as yet undreamed of. The economic and social changes which can be wrought world-wide are fascinating matters on which to speculate. Nothing that man does can be accomplished without energy and, as energy becomes more abundant the fruits of properly directed energies can create products and services in incalculable proportions.

Just as the use of man power and horse power greatly determined the type of civilization in by-gone years and as coal, gas, and oil determine it today, so will the wide-spread use of the atom in the years ahead condition the society that will harness, control, and use it. It has been estimated that at the rate we are currently using our dwindling resources of coal, gas, and oil, within 400 years all will have been consumed, but the Atomic Energy Commission reports that as of today there is sufficient uranium and thorium in sight to provide the energy required for the worlds work for the next 1,700 years. For the first time in history there is an unlimited supply of energy available for man's work and in most parts of the world, it can be produced at a cost undreamed of a few years ago. Those countries where power is in short supply may now have it in abundance once the financing of the relatively costly reactors is achieved. Those countries which have power but need more of it can see atomic power as a most attractice solution once the cost of producing it has been brought into line.

In my own State of Pennsylvania where there is an abundance of coal, oil, and gas the Atomic Energy Commission has started construction of an atomic electrical generating plant which will be producing currents to satisfy a city of 100,000 by 1957. Think what this can mean to the underdeveloped nations of the world that have lacked material resources and consequently have suffered frightfully low living standards and the accompanying envy of the American people that goes with it. We, with but 6% of the population of the world have produced 50% of the world's energy and industrial out-put.

There is no sense denying that the use of this new energy from the atom, linked with the ever-expanding automatic factory, will cause serious problems for our industrial economy. Releasing man from physical labor threatens the immediate economic security of all men who want to work. There can be but two answers to this threat: To find new jobs for those who will be released from the old ones; or by drastically reducing the number of hours of work that man must give in return for the ever-increasing products; and, at the same time provide sufficient earnings so that he can purchase the manifold new products being made for his consumption.

As stated before, that if the great strides in increased productivity do not require labor on a full time basis for all who are willing and able to work, then we have reached the point where it is necessary to institute the six-hour day or less with maintenance of wage income. Machines are tools to be used for good if we are wise and courageous. As has often been said, and rightly, machines are for man, not man for machines. New machines can create new work, greater work opportunities, if put to the proper use for the good of all men. To state it in a slightly different way, I believe that the machine instead of becoming a monster can be used for the production for people with profit -- spiritual as well as material -- for all of us. I confess that the projection of this into every-day reality does shock one in the consciousness and into the realization that displacement of people is not something that the future will bring in plant after plant but rather that it is something that is here now. And that problem is something which labor and management, and specifically its leadership, must face and rationally solve. Consider for a moment what I know must be familiar to all of you. In two plants, one electrical and the other steel, there are now installed and in operation automatic machines that are used in payroll calculation. These machines in less than six hours each, do the following: for 12,000 employees compute the incentive pay in addition to the base pay; subtract the great number of deductions; allocate to the proper cost accounts; and then, write the check, post the entry, and finally, print all of this on its own printer at the rate of 600 lines a minute.

People in great numbers are displaced in these operations and I know that in several areas, because of an already aggravating economic decline, they have been unable to find jobs and are currently listed among the unemployed and many have exhausted their meager unemployment benefits. Too much of this without proper consideration for the individual will create out of potential consumers a block of unemployed who are unable to purchase the goods made by the automatic Frankenstein which displaced them.

Ways will be found to circumvent these malpractices as ways have been found in the past when the machine threatened man, or when the owner of the machine placed his faith in the machine rather than in man himself. And I would caution those who are undoubtedly in this group -- who have at times be over-whelmed by their own vision of what this portends for the years ahead. There are among us those who are perhaps a little too press conscious and who are inclined to fill the newspapers and periodicals with premature rumors that man will no longer be needed in the operations of our plants and factories. Man is not out-moded and no machine, clever though it may be, will ever replace him. The best of machines is able to spew out what man has put into it and no more.

A machine recently was able to translate in the twinkling of an eye, 250 words of Russian into English. But it is incomprehensible to think that any machine would be able to translate "The Brothers Karamazov". An electronic brain is only a dream though, within limits, an approximation can be made.

I am sometimes concerned about those who control the curricula of our great engineering schools and those who graduate from them. I hear it said on all sides that while there has been a remarkable job done in training youth in the physical sciences, there has been an ever increasing void developed in the understanding of the social sciences. Is this really so? Is the charge true that many of our most learned and gifted technicians, scientists, and engineers lack a true appreciation of man, his origin, his society, and his appreciation? I am afraid that it is.

It was only recently that one of our most gifted scientists confessed that at one time he had shut himself apart from his work, his people and his problems and that naively as a consequence, he had done things which became of serious question to our government. I am certain that this is an extreme case, but isn't it true that pure science and its pursuit often spell pure isolation from the living realities of our times?

However, man cannot be displaced within the factories and I am certain that no one really believes that he will be -- and if his demands in a changing social and economic climate are to be understood, does it not merit consideration that his viewpoint be permitted expression, if not acceptance, in the classroom? I believe that leaders of labor, just as leaders of industry and the professions, should be invited and encouraged to participate in the give and take on the American university campus. This can lead to a better appreciation of the inter-relationships of human beings and how changes can be effected without serious misunderstanding and disruptions. Man is an intelligent animal and if he understands those changes which will affect him, he can better accept them.

In all this relatively mad scramble of some to make bigger and better and faster machines (and the semi-idolatry which at times seems to surround them) it must be remembered that man alone can acquire true dignity and that all efforts of man in the mean must be directed toward the ennobling of man himself.

In conclusion, let me state that in the steel industry automation or the automatic process is not new. It is further advanced than in any other industry and it made its tremendous strides not yesterday but slowly over the years. It was unheralded but nevertheless very real. It has brought changes and will continue to bring more. Plants have been displaced, men have been reduced in great number in some facilities and employed in greater number in others. We have tried to keep pace with these changes, and our efforts in the future will be directed along these lines.

The problem, however, is really not one of productivity and we should welcome all increases without limit. The real problem is solving the antiquated means of distribution of what is now being produced in ever larger numbers. The needs of our own people are so great -- not to speak of the needs of the rest of the world whose living standards are so incredibly low -- that both atomic power and automation can be the twin gift from science that may rid the world of loathsome war, killing disease, and ravishing famine.

THE GUARANTEED ANNUAL WAGE -- A CHALLENGE TO INDUSTRIAL STATESMANSHIP

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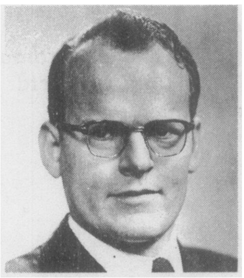

The guaranteed annual wage is certain to be one of the major collective bargaining issues in 1955 and 1956. Mr. Walter Reuther, President of the CIO, has announced that the United Automobile Workers will strike if necessary to obtain such a plan. Two other CIO unions, the United Steelworkers and The International Union of Electrical, Radio and Machine Workers, were successful in obtaining annual wage guarantees in 1954 but are expected to renew their demands in 1955 and 1956 respectively. The A. F. of L unions seem likely to take a wait and see attitude.

The emotional appeal of the phrase "guaranteed annual wage" is, of course, very high. In modern industrial societies, in which some three-fourths of the labor force work as employees and are dependent on wages or salaries for income, there are few catastrophies that can compare with the stopping of a paycheck. The guaranteed annual wage conjures up a picture of continuous income whether one works or not. Because of this there has been some tendency among proponents to trade on the appeal of the phrase and to define it in terms of a utopia with no unemployment. Mr. Ted Silvey of the CIO writing in the Manufacturing and Industrial Engineering magazine (1) has stated that "Our conception of the guaranteed annual wage is to assure continuous, full employment for all who are able and willing to work."

The term "guaranteed annual wage" has been and is used to describe a variety of plans which may guarantee little or which are not concerned with income over a period as long as one year. For example, under the well known Procter and Gamble plan, the Company reserves the right to modify, withdraw or terminate the guarantee at any time.

A 1952 report of the Bureau of Labor Statistics(2) indicated the limited extent of current coverage under guaranteed wage programs. Out of some 2,500 trade union agreements, only 184 provided some form of guarantee. Of these only 20, covering about 12,000 workers, guaranteed wages or employment for a substantial part of a year or throughout the year. Many shorter guarantees, often of only one week's work, are frequently lumped under the heading of annual wage guarantees. Even the United Automobile Workers' proposal titled "Guaranteed Employment Plan" contains both a one week guarantee for workers with little seniority and a fifty-two week guarantee for workers with two or more years' seniority.

THE CURRENT TRADE UNION DEMANDS

The current demands by trade unions further illustrate the variety of guarantees which may be found under the annual wage guarantee label. The United Steelworkers' proposal of May, 1954, contains an annual guarantee of weekly income equal to 32 times an employee's regular hourly wage. The Electrical Workers' proposal would guarantee weekly income equal to 40 times the regular hourly wage rate. The Automobile Workers' proposal would guarantee weekly wages sifficient to maintain the same living standards as when a worker is fully employed.

The Steelworkers' guarantee would apply only to employees with three or more years of service and the IUE's to employees with three months of service. Under the UAW's plan, fifty-two weeks of pay would be guaranteed only to employees with two or more years of service.

The current demands have one new and important feature -- the integration of employer guaranteed income with unemployment compensation benefits. The unions propose that unemployment compensation benefits received by an individual be deductible from the amount guaranteed by the employer. In this connection it should be noted that most state laws do not permit payment of unemployment benefits to individuals receiving supplementary allowances from former employers because these supplementary payments are considered deferred wages. Unless methods can be devised for circumventing state laws, the unions' proposals, therefore, would seem to require substantial change in state unemployment compensation laws.

Actually, all employees covered by unemployment compensation already have a wage guarantee. In fact, it is probably more accurate to refer to the current demands as private supplementation of unemployment compensation or simply as private unemployment compensation rather than as guaranteed annual wages.

While it is difficult to be exact because of state-by-state variation in unemployment compensation programs, it is probably accurate to say that the more typical programs pay benefits for from 5 to 6 months at a weekly benefit rate varying between 30% to 50% of take-home pay. Pressures to extend benefit duration and to raise weekly benefits have been continuous since the inception of the program in the 1930's and state legislatures have on several occasions raised both benefits and duration of benefits.

State unemployment compensation systems are financed by a payroll tax levied on employers. Proceeds from this tax go into a trust fund out of which benefit claims are paid. In general the tax varies according to the employment record of the employer and the degree of solvency of the overall state fund. Typically the rate varies from about .3% to 3% of payroll.

The current supplementation proposal implies a basic change in the philosophy of unemployment compensation. This can best be illustrated by a quotation from a publication of the Bureau of Employment Security of the U. S. Department of Labor entitled "Proposals for Coordinating Guaranteed Annual Wages and Unemployment Insurance."

> "A basic principle of our existing system of unemployment insurance is that the benefit recipient must not only be without work but must also have suffered a wage loss. It is a system for compensating wage loss. The Supplementation proposal seems to conflict with this principle . . .
>
> "In recognition of the wage-loss principle, the State laws all relate the weekly benefit amount to the individual's previous wages. The level of the benefit amount represents a compromise between two contradictory purposes. The most obvious of these purposes is to compensate the individual for his wage loss due to unemployment. The other is to preserve the incentive to take work in preference to benefits. These contradictory purposes are resolved in the provision of a differential between benefits and wages . . . The effect (of supplementation) would be to eliminate the effectiveness of the wage-loss differential in preserving the individual's incentive to seek work."

The three current proposals discussed above do have several features in common:

1. All three specify a maximum duration of guarantee payments of 52 weeks with eligibility of workers to be determined by seniority.

2. All three contemplate that the employer's guarantee obligation would represent a large percentage of weekly pay (in two cases, the full amount). The employer's guarantee obligation would, of course, be reduced by the amount of unemployment compensation received.

3. Some form of trust fund financing is used with limits placed on the employer's liability.

4. All require that laid-off workers register at state employment service offices and "accept" suitable alternative employment.

5. All three plans would establish less restrictive standards of suitable employment through collective bargaining and they would be applied independently of the more restrictive state unemployment compensation standards.

There are a few other characteristics of wage guarantees which should be noted before we proceed to a discussion of the pros and cons. Frequently, the impression is given that an annual employment guarantee is feasible for all workmen in a plant, for all plants in an industry and for all industry. This is not the case. Trade unions readily negotiate plans which set forth strict eligibility requirements within a plant, the most common being a minimum number of months or years of service for receipt of benefits. The Steelworkers' proposal of May, 1954, we have already seen, would guarantee annual wages only for those employees with three years' seniority.

On this point, the UAW has stated (3) that otherwise "The employer would be reluctant to hire new workers if he were not sure he had a full year's work for them. He might prefer to schedule excessive overtime, or even turn down orders." The UAW takes the position that any incentive for the employer to limit job opportunities is eliminated in their plan "by graduating the number of weeks a worker can receive payments for full-week layoffs in accordance with the number of weeks he has worked since acquiring seniority."

From the employer's point of view, the higher the level of seniority requirement, the lower the potential cost of the guarantee. Also, it should be noted, if the seniority patterns of the work forces differs, a plan which is similar in all details would have a different cost impact on different companies. The Steelworker unions studied the seniority pattern for twenty basic steel companies. In one company they found that 94% of the workers would have been included under their guarantee proposal since they had more than three years' seniority, while in another company only 51% of the workers would have been covered.

Although one company within an industry may with little actual cost guarantee employment, that does not mean that other firms in the same industry can do likewise. Not only may seniority patterns differ, but also slight variations of product, production techniques and supply factors within the same industry may create wholly different problems. The Nunn-Bush Shoe Company has a guaranteed wage plan. However, a firm which manufactures a standard man's shoe as does the Nunn-Bush Company will not have the same problems of seasonal demand and consumer taste changes as does the manufacturer of a highly stylized woman's shoe. In fact, the adoption of an annual wage guarantee by one firm in an industry may result in other firms in that industry bearing in greater degree than previously the effects of fluctuation in demand for the products of that industry.

REASONS WHY UNIONS DESIRE A GUARANTEED ANNUAL WAGE

The CIO unions are of the opinion that their guaranteed wage proposals would bring important benefits not only to the employees covered but also to workers generally and to the whole economy. They point out that covered employees would be able, even when on layoff, to maintain the living standards they enjoyed while fully employed. Given the level of benefits proposed, this point is, of course, obvious and requires no further discussion.

Their second claim is that the proposals would stimulate management to take steps in its plants to end the instability for which it is directly responsible. The main types of instability placed in this category are seasonal layoffs and dismissals resulting from the introduction of labor saving machinery and methods.

The contention is also made that the current supplementation plan would have two desirable results with respect to workers generally and the company as a whole. (1) Guaranteed wage payments to workers in periods of business recession would help to maintain purchasing power and thus contribute to halting the down turn. (2) The supplementation plan would stimulate management to press for changes in state unemployment compensation laws to provide higher benefits and thereby assure that the laws would be liberalized.

On the point that the plans will stimulate management to eliminate instability, the claim is made that adoption of guaranteed wage plans will discourage the kind of recruitment of temporary workers that later leads to layoffs of regular workers. On the other hand, it is felt that employers will not be discouraged from hiring new workers when there is a genuine increase in the amount of work available as new workers' rights to guarantee payments are only gradually built up under the UAW plan. The recruitment of thousands of workers by the auto industry during the early months of 1953 when there was only three to six months' work for them is cited as an example of a policy which would not likely be repeated once an industry has their guaranteed employment plan. It is further their view that the employment given these workers was of little help to them since, in the words of the UAW, "they were soon dumped out on the streets far from their home communities, and it meant that the regular workers of the auto corporations were deprived of work later in the year that they otherwise would have had."

However, a few questions might be raised on this point. How does the UAW know that "the employment given these workers was of little help to them"? How does the UAW know to what extent production could have been scheduled differently in 1953 without advance knowledge of changes in demand and competitors' plans so that the regular workers of the auto companies would not have been deprived of work later in the year? It will be recalled that most of the unemployment in the auto industry in the second half of 1953 was occasioned by the fall off in consumer demand for the products produced by Chrysler and the independent companies.

The question might also be raised whether or not widespread adoption of guaranteed employment plans will bring about some restriction of job opportunities by closing doors to the new worker -- the very young, the middle aged widow, etc.? The UAW's proposal is geared so that, in their own words, "the employment manager of any company, faced with two workers applying for the same job, will be more apt to hire the man who has the right to guaranteed payments from some other plant in case he is laid off."

Unions have long argued that the guaranteed annual wage is a proper method for forcing other groups to share the costs of technological unemployment with employees. Many unions recognize that the community, as a whole, benefits from technological change over the long run in the form of more and better goods at lower prices, but point out that under existing conditions the short run burdens are frequently borne almost exclusively by displaced workers. Automation has given this argument a new and even more prominent place in the thinking of many union people.

The subject of automation is being discussed at this institute by several much better qualified speakers. Therefore, I shall confine myself strictly to its connection with the guaranteed annual wage.

I am sure that there is no need to point out here that the displacement of men by machines is not new. In all cases of technological change, there is likely to be some immediate unemployment of individuals. The question that must be answered here is whether an annual wage guarantee is the proper method of handling this problem. The additional fixed labor costs of a wage guarantee would, of course, be likely to slow down the introduction of automation. It is also possible to argue that the U. S. standard of living is generally high enough so that it is desirable to have a more gradual introduction of automation than would otherwise take place and as a result, less temporary dislocation and displacement. The increase in output and the accompanying increase in the leisure time of American workmen would still eventually occur.

However, it is my firm belief that if we take the position that it is advisable to slow down the introduction of automation and that this should be accomplished by a monetary penalty on the employer, a simple severance pay plan would accomplish this purpose without the additional complicating features of annual wage guarantees.

The idea that a guaranteed annual wage will maintain consumer purchasing power and thus prevent depressions has long been a familiar argument. In fact, some unions go so far as to claim that the widespread adoption of guarantee plans would so stabilize employment and production that the guarantee reserve funds might not have to be used. Apparently, it is felt that guaranteed wages will create a market large enough to buy all production. If this were the case, it would indeed be a simple solution to the most pressing economic and social problem of our times. Any drawbacks which guaranteed wage plans may possess would be a small price to pay for such resounding results.

Unfortunately, as virtually all economists know, there is an essential fallacy in this theory. A guarantee of worker income does not mean that markets would also be guaranteed. This is not the place to enter into a learned analysis of all the causes of economic instability. For our purposes it is sufficient to recognize that a dynamic free economy like the American economy is subject to constant change. Interruptions of employment may be due to abrupt shifts in consumer choice, new inventions and technological changes, dislocations caused by differential rates of growth, waves of pessimism following periods of optimism, war, defense mobilization and other factors.

The natural human tendency is for the individual worker sometimes to forget that his income security is interdependent on the health of the whole economy and that if there is a depression, his employer may have little choice but to retrench even though, for obvious reasons, he also would like to maintain production and employment at a high level. Many people see only the more obvious causes of unemployment such as seasonal fluctuations, managerial misjudgment and argue that a guaranteed wage would act as a monetary spur on the employer to correct such situations. Unquestionably, there is some validity in this argument in certain cases, but it must be remembered that not all seasonal production can be eliminated nor can human judgment always be infallible.

Instead of a guaranteed annual wage bringing stability to unstable industries, many responsible experts hold the opposite opinion -- that cyclical movements in business activity constitute the greatest obstacle to the successful adoption of guaranteed wage plans. The 1952 report of the Bureau of Labor Statistics, to which we have referred earlier, contains the following findings:

> "Cyclical movements in business activity are considered to be the greatest obstacle to successful operation of a guaranteed wage program (especially in the durable goods industries). Thus far, wage guarantees have been confined largely to the service, distributive, and nondurable consumer-goods industries which are less affected by cyclical fluctuations in employment than are the durable goods industries."

There is one way, however, in which wage guarantees may tend to reduce instability. The unemployment compensation system is frequently referred to as an automatic stabilizer on the economy because more is paid out in benefits than is collected in taxes during periods of depression, thereby exercising a net stimulating effect on the economy. Private supplementation of unemployment compensation would have the same effect on the economy.

Worker and union dissatisfaction with existing state unemployment compensation laws and their administration account for much of the strength of the current annual wage guarantee drive. The UAW's proposal is especially designed to encourage management to work for higher and longer duration of benefits under unemployment compensation and for less strict interpretation of state eligibility clauses. The union feels that its plan would encourage employers to work for removal of what are termed "unreasonable" disqualification provisions. Payment by the employer of the amount of state unemployment compensation benefit would be required whenever the employee is ruled ineligible under state law because of refusal of "suitable" work, providing such work is held to be "unsuitable" under the guaranteed employment plan. Under such conditions the annual wage guarantee becomes a means to an end and not just an end in itself.

It has also been claimed that employers with guaranteed employment plans can expect lower costs from an increase in the level of unemployment compensation benefits. This is questionable. Except in two states, unemployment compensation benefits are financed solely by employer taxes and many employers may consider it a moot question as to which payment route they choose. Certainly those firms which are opposed to and without guaranteed employment plans will not favor higher unemployment compensation taxes to pay what, from their point of view, are obligations of other companies.

THE POSITION OF MANAGEMENT

Why has management not accepted the annual wage guarantee plans currently proposed? Certainly it cannot be said that management personnel are opposed to a higher degree of work and income security for employees. Thus it must mean that management in general believes that annual wage guarantees either will not increase work and income security or that they will increase security but only at the expense of other more desirable aims.

In general, management believes and most economists agree, that an annual wage guarantee will not appreciably reduce unemployment caused by the business cycle. Thus individual income security via this route is still incomplete.

Annual wage guarantee plans are sometimes opposed because they mean making labor costs fixed and rigid over a fairly long period of time. This increased cost rigidity makes planning for future markets, expansion of factory facilities, etc., more difficult and more risky.

Many companies fear that the ultimate cost of wage guarantee plans may be excessively high. Historically most wage guarantees have been much more limited than the current proposals both in respect to eligibility requirements and the level and duration of benefits. Despite this fact they have never been widely adopted. Less than one-tenth of 1% of employees have ever at any one time had an annual wage guarantee.

Although the current union demands propose more generous benefits, they do at the same time contain limitations on the employer's liability for benefits. The Steelworkers propose that the employer contribute 4% of payroll to a trust fund and the IUE proposes that the employer contribute 5% of payroll. In both cases employer liability would be limited to the amount in the trust fund. However, there appears to be no actuarial cost studies of what the rate of contribution should be and what size the trust fund must be in order to meet proposed benefits. Because of different seniority patterns and market conditions and other such factors, each firm would need an extensive study in order even to approximate an answer.

In fact, there is serious question whether in view of the uncertainties involved, it would be possible to make such actuarial studies.

The United Mine Workers Welfare Fund was started in 1946 financed by a levy of 5¢ a ton. The levy is now 40¢ a ton in bituminous mines and 50¢ a ton in anthracite mines. This gives some idea of what might happen when you are determining a ratio where there is incomplete data on incidence for the special group involved and where the incidence (in this case unemployment) may be directly affected by the amount of benefit paid. Once an employer's contribution to any trust fund is subject to negotiation, it would appear that the pressures to increase the amount of contribution are great. At the very least, there would not likely be many pressures to decrease the contribution rate.

If the amount of the "guaranteed" benefits called for are greater than the amount of money in the trust fund, a firm which is making profits or even just breaking even would probably be subject to irresistible pressures to increase its contributions in order to cover the "guaranteed" benefits. Newspaper stories reporting that a firm has paid dividends or merely added to its surplus but did not meet all of its "guaranteed" payments to its workers would undoubtedly make for an unfavorable reputation for the firm.

Many firms oppose annual wage guarantees because they fear that they would mean union participation in decisions traditionally made by management alone. With the steady increase in the number of items subject to collective bargaining in negotiation in recent years, trade unions have been increasingly invading the area of so called management prerogatives. The United States Chamber of Commerce has referred to the current proposals as a foot in management's door. They are especially concerned with the proposed joint union-management administration of trust funds. Negotiations on amounts to be paid into the fund could require extensive probing into company plans and programs for the future and might open the way for unions to demand a voice in price, production and marketing policies.

When a trust fund has insufficient monies to meet payments, union members of varying seniority may differ among themselves as to the division of the limited funds and might even split the union into opposing factions. The U A W foresees the possibility of this happening and takes the position that provision should be made to protect the equity of the higher seniority workers in case they should be laid off later. It is impossible, however, to manipulate inadequate funds in such a way as to pay off everyone and make everyone happy. Somebody will not receive his guarantee. In order to cope with this problem, the U A W proposes that as long as a company continues in business, workers who do not receive their full guarantee payments at the time they are laid off, should receive them at some subsequent date. To insure this, they recommend the use of some form of reinsurance. Unfortunately, we are left in the dark as to how exactly this would work.

Frequently, unions point out that their proposed private unemployment compensation system is no different from the existing supplementation of O A S I benefits via employer pension programs. However, there are several significant differences. A recipient of an unemployment compensation benefit can to some extent control the circumstances which permit him to receive his benefit while an O A S I benefit recipient cannot control the primary entitling condition, namely his age. Even under the present system of state unemployment compensation there are many cases of persons claiming benefits when they are not strictly entitled to them. In 1953, the New York State Division of Employment reported 20, 749 such cases. Certainly this will not be reduced by a guarantee of income when not working which is equal to or almost equal to that received while working.

There are other important differences between employer supplementation of unemployment compensation benefits and employer supplementation of O A S I benefits. Recipients of old age pensions have traditionally worked for a firm for many years, not just a few years or a few months as could be the case under the private unemployment supplementation program. In addition, the future costs of unemployment benefits cannot be forecast with even as much certainty as the rather uncertain estimates of the future costs of old age pensions.

Finally, there is the important point that because of negative effects on work incentives, private supplementation of unemployment benefits is almost certain to create a heavy drain on unemployment benefit funds. The American workman is not lazy, but neither is he stupid. He is smart enough to figure out very quickly the difference between working and not working for the same or nearly the same pay. Our experience with the "52-20 clubs" under the Veteran's Readjustment Act of 1944 offers ample evidence on this point.

SUMMARY

Summing up the various arguments both for and against annual wage guarantees, there is little doubt in my mind but that the current demands would be undesirable for employees, employers and the general public alike. The plans have serious shortcomings both in theory and practice.

It is argued in theory that since annual wage guarantees would be financed by charges on the employer, they would induce employers to regularize employment. In some seasonal industries this undoubtedly would be a factor. However, employers already are subject to innumerable monetary incentives to regulate employment. Given the peculiarly rigid form in which this added incentive would be imposed, it would seem, on balance, that it would much more likely to induce employers to refrain from hiring, thereby creating additional unemployment instead of stabilizing employment at a high level. The possibility that the larger companies might place much of the burden of adjustment to changes in employment and output on their smaller suppliers is too real to be passed over lightly.

Particularly important is the radical change that would be involved in the existing unemployment compensation system. The theory behind the unemployment compensation system is that, while it is a system for compensating wage loss, it must also preserve the incentive to take work in preference to benefits. Paying benefits at or near a full wage level would, of course, represent a reversal of concepts whole workability have been demonstrated by years of experience. Because of the inevitable bonus put on idleness, there is good reason for feeling that the current proposals would destroy the existing unemployment compensation system.

No matter what kind of guarantee plan is adopted, the inevitable result will be two classes of workers. As Mr. George Meany, President of the A F of L has already pointed out, the guaranteed annual wage is feasible in some companies and in some industries but not in others. Because of the necessity for seniority requirements, new workers would find it much more difficult to obtain employment. As Professor Sumner Slichter, of Harvard, has pointed out, the current guaranteed wage plans would result in the most adequate provision for unemployment compensation where the need is least and the least adequate provision where the need is greatest.

Frequently, the erroneous position is taken that giving wage workers a guaranteed annual wage would mean putting them on the same basis as salaried personnel who receive an annual salary. The fact that salary is figured on an annual basis does not mean that either salary or employment is guaranteed for a year. This seems largely to be a figment of the imagination of old professors on life time tenure and young professors who yearn for a life time wage.

Despite these conclusions, it is still my firm conviction that the annual wage guarantee plan is a challenge to industrial statesmanship. Few can convincingly challenge the social and economic desirability of the steady incomes that come from steady jobs. Everyone benefits: the individual through peace of mind, a higher standard of living, and the accumulation of savings; the company through the resulting reduction in the expense of employee turnover and from spreading overhead and capital expenses over more manhours; the union through an opportunity to work constructively within a climate freed from the distractions and problems of unstable employment; and the community through a reduction in the demands for public welfare benefits and related expenses.

But before we can have steady income, production must be stabilized. A wide variety of techniques and methods have been developed and used in American industry in order to achieve the objective of steady work and through it, steady income. Besides all the program which have been developed by government, American industry has adopted such practices as manufacturing for inventory against anticipated seasonal demands, diversifying products or markets or both, scheduling maintenance work for production workers in slack seasons, revising price structures or model change schedules to minimize seasonable peaks in products whose purchase is deferrable. In addition, there are thrift plans, severance pay plans and a whole host of other devices.

Sympathetic attention needs to be paid to the question of the adequacy of state unemployment benefits and the duration of these benefits. Although I doubt the wisdom of the Federal government advising our sovereign states as to what is best for them, there is still much to be said for the substance of the position President Eisenhower took in his Economic Report message of January 20, 1955. In essence, he recommended to the states that (a) the duration of unemployment benefits should be made uniform so that all claimants who qualify for benefits have potential rights to the receipt of 26 weekly payments and (b) maximum weekly benefits should be revised so that the payments to the great majority of covered workers may at least equal half their regular earnings.

When discussing unemployment compensation benefits the importance of fair but strict eligibility requirements cannot be overemphasized. In general, most states do have reasonably satisfactory eligibility standards. As long as the possibility of abuses is kept to a minimum, it should be possible both to increase the amount of individual unemployment compensation benefits and to lengthen the time period during which they are paid. Unless this is the case, increases in benefits are likely to be self defeating and undermine the very purpose for which the unemployment compensation system was established -- to carry the individual worker over periods of temporary unemployment.

Forty-four state legislatures meet this year. Now is the time for the citizens of each state, including labor and management, to let their elected representatives know how they feel on the subject of unemployment compensation so that changes can be worked out which meet the needs and desires of the citizens of each individual state. By this means we will enjoy a form of guaranteed wage which is comprehensive and not limited in coverage to a few, which encourages labor mobility and the searching for new job opportunities, which does not make for restrictionism and which can be administered with ease.

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AUTOMATION SESSION

Session Chairmen: At Berkeley - GEORGE S. DRYSDALE, Partner, Drysdale & Schedler, San Francisco, California; Chairman, The American Society of Mechanical Engineers, San Francisco Chapter.

At Los Angeles - WILLIAM E. KAPPLER, Chairman, Los Angeles Chapter, American Material Handling Society; Senior Manufacturing Engineer, North American Aviation, Inc., Los Angeles, California.

AUTOMATION -- ITS IMPACT ON INDUSTRY

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I would like to tell you this morning about a revolution that is taking place right here in the United States -- right now. Perhaps I had better begin by saying that I know that word "revolution" is a much over-used one. There seems to be a revolution somewhere in the world at least once a year, and every time a new girdle is put on the market, the manufacturer calls it "revolutionary", too. I even saw a sign on a New York bakery recently that read "Revolutionary New Old-Fashioned Doughnuts."

But I am not talking about political revolution, nor about something that is merely new, gadgety, or startling. I am using revolution in its broadest sense-- in the sense with which we speak of the Industrial Revolution.

For when we look back on that great upheaval two centuries ago, what was it that gave to it the name Industrial Revolution? Was it just the wonderful machines that lightened man's toil? No, I think it was much more than that. The Industrial Revolution was revolutionary because it created a whole new environment for mankind -- a whole new way of life. What it gave to history was much more than just the steam engine and the cotton gin, the railway and the power loom. It gave society a whole new tempo, a whole new outlook.

It took men off the fields and out of small shops and put them for the first time into factory life. Hence it gave us mass production, and through mass production the first civilization in history in which luxury was not confined to a few. It gave us as well a sense of hurry, of time, which is still unknown -- in countries that have not gone through an industrial revolution. It gave us a sense of material progress, an itch to get ahead, which is also unknown in those parts of the world which are still pre-industrial.

In other words, the machines which it produced were agents for enormous social change. No one, least of all Richard Arkwright or James Watt, thought that they were changing civilization itself. Yet, for us, looking back, that is precisely what was revolutionary about the inventions they made.

The revolution about which I should like to tell you this morning promises to be just as fundamental as that one. Like the Industrial Revolution of the 1750's, the Second Industrial Revolution of the 1950's also has its crop of machines, which, as you will see, are fascinating. But like its precursor revolution, the current revolution promises to have far wider effects than mere technology. Like James Watt and Richard Arkwright, many of our inventors have no intention of reshaping our entire world. Yet this is what they are unwittingly doing -- and here, if you will permit me to speculate, are the changes which I think they are bringing about:

- A world in which fewer and fewer men will work in factories.
- A world in which less monotonous and tedious work will require human effort.
- A world in which the work week is greatly shortened.
- A world in which the pace of life slows down -- in which leisure becomes the center of life, rather than the fringe.

This is a revolution, in other words, which will take us beyond the civilization of an industrial society -- a revolution in which human beings will be largely freed from the bondage of machines. It will raise an entirely new set of business problems, social problems, economic problems. It will tax our ingenuity to its utmost. And it will bring about its changes -- many of them, at least -- within our own lifetime.

Now just what is this new revolution?

The word I use to describe it is "automation". The old Industrial Revolution could be described by another word -- mechanization. Its keyword was power, and its goal was to substitute inanimate energy for man's brawn. Within a single century, human and animal effort declined from 90% of the total motive power in the economy to 10%.

The new revolution -- automation -- is not going to reduce that figure much further. Its impact is elsewhere. For if we look at the industrial process today, what do we see? Most human beings no longer act as beasts of burden or as mere sources of power. Instead they are controllers of mechanical power, guides for inanimate energy, links between mechanized operations.

Take a typical factory, and watch a man in it. Usually his work consists of taking piece A out of machine B, putting it into machine C, controlling this machine as it performs its work, and then taking out piece A to put on conveyor D.

Or take an office. A file clerk goes to cabinet A, looks up paper B, copies item C onto form D, puts paper A back where it belongs, and places form D in file E.

Perhaps these linking, guiding, controlling functions sound ridiculously simple when I sketch them like this. But many of them are ridiculously simple. Much of our working effort goes into the machines while they perform the work. Yet, the fact remains that until recently, no machines could do such a job.

Why is this? Because machines don't know what they are doing. How many of you have seen an automatic postage machine blithely chewing up envelopes when one got stuck, or punch press ruin a carelessly inserted workpiece? Hence we have needed human beings to do simple tasks, because somebody is needed to guide the machine to its proper function.

It is just this simple -- but immensely complicated -- guiding function which the new industrial revolution is going to do away with. For there is a new principle in technology which enables a machine to "know" what it is doing.

That principle is called feedback, and it is fundamental to the automation revolution. I am sure most of you are familiar with this principle, but for those who may not be, I would like to discuss just what is meant by feedback.

Let's start with imagining a man shooting at a target. His rifle doesn't shoot quite ture and his bullets make a pattern to the left of the bull's eye. What does our rifleman do? He corrects for his faulty weapon by aiming slightly to the right. That correcting ability is what is meant by feedback.

Until fairly recently, no machine could do that simple -- and not so simple task. Guns shot, but they didn't "aim". But now suppose we set up a gun and attach to it a radar antenna, and suppose we have this antenna "scan" the target as it shoots, much as radar scans the sky for planes. It would not be very difficult to build into our gun a circuit which would move the gun after each shot, depending on its accuracy with the last shot. Now our gun wouldn't only shoot. It would aim as well.

Or to go from a rifle range to a factory, let's look at a man working with a lathe and gauging each workpiece that he machines. He has limits within which his workpiece may vary. Perhaps the part is to be three inches in diameter, plus or minus one one-thousandths inch. If the part is, say two thousandths of an inch under size, he rejects it and adjusts his machine. Now suppose his gauge is part of a feedback loop which includes the lathe itself. If the part is two one thousandths under size the lathe will be automatically adjusted. But more than this, the feedback loop can be provided with a "memory" and if several workpieces come out only slightly under size but still acceptable -- the lathe can be adjusted before the design center shifts far enough to cause rejects. Such a feedback controlled gauge can be built to distinguish between random fluctuations and a true drift in the design center. Such a machine would constantly adjust and correct itself as it worked -- and the guiding hand of the workman would no longer be needed.

This is feedback -- the continuous adjustment of the tool to the work, of the task to the job, of the means to the end. It is only now being applied at all extensively to the metal working industry, but actually we find it everywhere in life. When a human being reaches for a glass of water, the way he gets his hand on a glass is by feedback -- for we know that his hand actually "zeroes in" on the glass, first perhaps tending to overshoot, then falling short, and constantly being corrected by his eyes. In the same way a machine that receives information about how well it is doing its job -- which may be finding a plane in the sky, or sending a liquid flowing through a pipe, or maintaining molten metal at a certain temperature — is also "zeroing in" its operation to produce a desired result.

Feedback in itself is simple enough. But when we couple it with such qualities as the ability to control a process from a distance -- remote control -- and at a low energy level -- the pressure of a finger setting in motion thousands of horse power -- its possibilities become staggeringly large. We are then enabled to build machines that handle and store "information" in enormous quantity, and digest and use that information in a matter of micro-seconds.

By linking up machines that store information, machines that count and can calculate maxima and minima within fractions of seconds, and machines that are more sensitive to light, touch, heat, smell, or even taste, than any human being could ever be, you arrive at a machine which can carry out a whole sequence of operations with uncanny speed, precision, and "sensitivity".

In case any of you are thinking of a robot which will rumble "Yes, Master" and then clank off to pick up the groceries, let me hasten to say that we are a long way from a mechanical man. Even the best of our machines are limited in scope, and they have only a fraction of man's versatility. More important, they have none of man's imagination, volition, or purposefulness. An electric-eye door opener, for example, such as we have all seen, is a very nice robot which takes the place of a doorman's eye-arm muscle circuit. But an electric eye doorman will open a door for a robber with a gun as quickly as it will for a sweet old lady.

But the point to bear in mind is that much of what a man does on the floor of a factory, or at a desk also uses only a fraction of his versatility, and very often calls for zero imagination, volition, or purpose. The worker who puts piece A on machine B, or who transfers item C to a paper D isn't using his full range of human capacity. He is only performing those linking, guiding or controlling operations I mentioned before, and however necessary his task, it is basically routine. The technology of automation enables us to build machines which will do those tasks better.

So far we have mentioned automation only in the abstract. So let us turn our gaze to the actual beginnings of the automation revolution as they can be seen in our factories and offices.

The process industries have been the first to avail themselves of feedback control. Certain refineries, and several of the AEC plants are almost entirely automatic -- and truly representative of the new technology. In these plants not only do machines regulate the heat, mix, chemical rate of reaction and a dozen other factors, but -- and this is a critical point -- machines tell machines what to do. The whole operation is so complex, swift-moving and delicate that only machines can possibly control it.

Using the principle of feedback in machine tool control allows the flexibility necessary to machine pieces with varying specifications automatically yet economically. When tape programming is used, changes in specifications are noted and adjusted in the control process. Automatic machine tools which are controlled by mechanical devices, such as cams or follower mechanisms cannot change from one product specification to another without costly and extensive adjustments, and can therefore automatically machine only long runs of identical products.

In a consumer economy as dynamic as ours, the producer who is wedded to one product, because of heavy machine investment, soon finds himself in an untenable position. True enough, he is able to produce at low cost because of his highly automatic plant. But his magnificent machines incapable of producing a variety of products, rust long before they are paid for while more conventional manual equipment owned by the shop next door operates to capacity. It is his agile competitor, capable of changing and altering his product with every swing in market demand, who runs off with the business.

It is this very situation, happily, that automation now promises to alter. Through flexible automatic control machines can be made versatile as well as automatic. No longer must the benefits of automatic production be limited to large operations. Now the job and semi-production shop -- which actually account for the largest volume of our national production -- can enjoy the fruits of automation.

But in a way this is perhaps the least interesting and significant part of the Second Industrial Revolution. Automating standard simple operation is no insoluble problem for a good engineer. The really important impact is elsewhere. Feedback control can and will make possible new levels of achievement.

For example, we would not have atomic energy if it were not for feedback control. No man could operate valves or hand controls deep within the dreadful flux of the atomic reactor. Here remote feedback controlled devices must perform our work. Without servo motors and other feedback equipment it would be impossible for us to operate our atomic plants.

Nor would the manufacture of polythelene be possible without the use of feedback control.

This plastic requires exquisite operational precision in reaction time, temperature, and pressure, and without automatic control of this process, the product would turn out to be only a useless wax.

Feedback control, through the medium of electronic data handling systems, is really going to wreak havoc with the most old-fashioned institution in American business: the office. While we Americans have succeeded in building the most efficient factories in the world, our offices have lagged sadly behind. It is paper work, not production work, which is the major headache for many businesses.

Automation is going to affect that mightily. In fact, it has already begun. Some localities, for example, are already keeping their telephone billing and accounting by machine -- and I don't mean with old-fashioned billing machines. Without any human aid except for maintenance, systems such as Bell Telephone's Automatic Message Accounting automatically record both local and long distance calls, assign them to the right subscriber, compute and print the bills. Do such machines make mistakes? About one in 36,000 bills!

If you reserve a seat on an American Airlines plane out of LaGuardia Field in New York, you will be participating in the automation revolution at its most meaningful level. For American Airlines has discovered that the routine job of looking at plane diagrams to find if there is a seat on the 4 o'clock plane to San Francisco doesn't have to be done by a clerk. A machine -- the "Reservisor," it's called -- keeps track of all reservations on a metal magnetic drum, looks up whatever flight is requested, and lets the ticket seller know what is available all within seconds. If you reserve a seat, it records that fact for the next query and it does so in time that space is not oversold, as frequently used to happen when a roomful of clerks ran the system and got as much as hours behind. And the point is this: here the automation revolution can and will mechanize clerical operations.

Last year, the first fully automatic factory accounting operation went into operation in General Electric's Appliance Park in Louisville, Kentucky. This UNIVAC system automatically computes paychecks for several thousand employees, taking into account payrates (which it keeps on record for each employee), hours worked (in which it includes overtime), and deductions. It then automatically types paychecks and payroll accounts. All this will take only a few hours when the full complement of 12,500 employees are at work. The machine will also do certain routine clerical tasks, such as compiling cost distributions and inventory controls and materials scheduling, and when that is done, it will compile the sales records and prepare bills. This year it is being set up to handle the company's complete cost accounting and eventually it is hoped to prepare sales analyses, so fast that shifts in demand can be allowed for right in current production schedules.

Incidentally, since many of you undoubtedly have this question at the back of your minds, these machines do not leave you at their mercy. Most of them check their own arithmetic, inspect their own wiring, and examine themselves for burned out tubes--and then signal you if something is wrong. They offer about 98% reliability, and they're on the job about 85% of the time. That time, by the way, is twenty-four, and not eight hours a day; seven, and not five days a week, 168 and not 40 hours a week.

All these examples -- and I could go into many more -- should be enough to persuade you that the Second Industrial Revolution is no dream for the future. It is here, in the flesh -- or in the steel -- in the country's basic industry. Almost every major industry I know is now studying or carrying out automation.

In offices and stores automation is not yet here -- but it is breathing down our necks.

But this is the technology. What of the revolution I talked about?

First and most obviously, automation means that we have a new industry in America. There are more than 1,000 companies today engaged wholly or partly in the making of automatic control equipment. Their aggregate output last year totaled more than 3 billion dollars. And they are one of the fastest growing industries in America.

Secondly, automation is going to mean new products for business. For the industries that become automated do not merely turn out their old product more cheaply or in larger quantity. More often than not, automation means that the product itself will change. Many products as they become automated, must be rethought and redesigned.

Not only that, but automation can make products economical which are currently impossible to produce. The chemical companies, such as the petroleum companies, would not be able to control their split-second reactions and we would be without many new products without feedback control. A whole line of precision products which would be hopelessly costly if turned out with human supervision suddenly become worth while under automatic supervision.

So the first effect of automation is going to be a technological revolution: new processes, new products, new cost figures, new production schedules, new merchandising and sales problems.

But I think that this will be the smallest of the many effects of automation!

Think, for example, what this revolution is going to do to the labor force! A whole stratum of dull, repetitive, low paid jobs, both in factories and offices, is going to be eliminated. What problems will this pose for the American economy?

It is possible to contemplate the millions of people who will be technologically displaced twenty years from now and to draw the gloomy conclusion that unemployment will be the curse of our next generation. The worst mistake that can be made in assessing how automatic control will affect labor is to make use of what I call "obituary accounting" -- that is, to tote up the number of workers replaced by machine, multiply that sum by the number of machines, and tag the end result as "unemployment". More sophisticated economists would call this "committing the lump of labor fallacy," or assuming that only a set number of jobs exist in our economy.

Such an approach considers our economy to be static. In reality we have the most dynamic and productive economy the world has ever known. To sell short its marvelous capacity for growth and production has been the undoing of more than one pessimistic economist. Our needs increase continually. As we satisfy the material needs for food, clothing, and shelter, we find that we have uniquely human needs -- for books, art, travel, music, sports, and for leisure. The continual emergence of new needs is a basic cause of the dynamic qualities of our economy.

What automation means is that we need less human labor to turn out the goods and services to provision society.

Hence automation will allow us to continue to shorten the work week. Not tomorrow, and not in every industry, of course; we do not expect automated specialty shops or robot stage shows. But the great centers of industry will surely find that they need less labor time to produce a given amount of goods: which means a continuation, on a greatly accelerated scale, of the long-term trend toward less effort and higher rewards. This is unemployment which results in leisure time, not lay-off time.

Within an automated plant, we can expect labor to be upgraded, with fewer and fewer men doing routine jobs, and more and more doing supervisory, or skilled maintenance work. We can expect three shift operation -- or four shift, if the work is cut to six hours, for machines work best around the clock. Hence I think the impact of automation will not be so much to use fewer men, as to use men for fewer hours at better work.

Automation holds out no threat to our economy. By giving us enormously increased productivity, on the contrary, it promises to envigorate it. But automation does hold out a promise of a fundamental shift in our way of life. For it is going to force us to reconsider our whole approach to work itself.

Two hundred years ago, when it was necessary for most people to put in 60 or 70 hours a week in miserable factories, just in order to survive, the question of what to do with non-work -- with leisure -- never presented itself. Today, with our forty hours of work a week, we are already facing the two-day weekend with something of a self-conscious attitude. When leisure time spills over from the weekend to Monday and Friday, when a man leaves his desk or his station after six hours of work, still fresh and full of energy, then, for the first time in history, we will really face the problem of what to do with leisure time.

Like the pioneers of the Industrial Revolution in the 18th Century, we face a world in which only one thing is sure: change, fundamental change. We are leaving the push-button age and entering an age when the buttons push themselves. Industry will usher in this new world ... and industry should greatly benefit from it. Farsighted and aggressive managements see not only the possibility of decreasing operating costs, but also of entering the field with new products and new services. Entirely new markets are coming into existence, and alert businessmen are already seizing the opportunities that they see before them. I think it fair to say that automation offers as great a challenge, and reward as any which industry has ever known.

APPLIED AUTOMATION

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INTRODUCTION

This talk is intended to portray some of the many applications of Automation at Ford. It will also point out that though all of our programs have been engineered with automation in mind, the 'automatic' automotive factory is still far in the future.

In addition to the general discussion of the subject, we will give you a detailed outline of the manner in which we have analyzed some of our most recent automation programs. As this talk progresses, you will note how closely related automation is to sound Manufacturing Engineering, encompassing machining processing, industrial engineering, material handling, and plant layout; and the reason why Ford places extreme emphasis on the subject. In order to establish continuity and assist you in following the subject as it develops, we will use the following outline:

I. THE HISTORY OF AUTOMATION AND ITS RELATION TO MASS PRODUCTION AT THE FORD MOTOR COMPANY.

II. DEFINITION OF AUTOMATION -- ITS ADVANTAGES AND DISADVANTAGES.

III. THE ORGANIZATION AND FUNCTIONS OF AN AUTOMATION DEPARTMENT.

IV. MOVING PICTURES OF APPLIED AUTOMATION.

V. THE FUTURE OF AUTOMATION.

THE HISTORY OF AUTOMATION AND ITS RELATION TO MASS PRODUCTION AT THE FORD MOTOR COMPANY

It is now a matter of record that shortly before World War I, Henry Ford set up an assembly line to produce magnetos. This was the first progressive assembly operation on a moving conveyor, and reduced assembly time from (20) minutes to approximately (5) minutes.

This same method was applied to numerous other parts with these results. Eventually, the final assembly conveyor evolved by applying the same technique, in the following manner:

Chassis were produced in the street alongside the factory by pulling them past stock piles of parts spaced at regular intervals, where men picked up the parts and bolted them to the chassis. This experiment was rewarded by a reduction of (8) hours in assembly time.

From this it was decided to mount the wheels on the chassis, and roll it down a channeled track from one station to the next. The move from station to station was done intermittently, and the signal to move was done by ringing a bell. Introduction of a conveyor chain at a later date eliminated the necessity of pushing the chassis.

These initial successes resulted in the installation of many conveyors, not only in the assembly of parts, but to deliver parts to the final assembly line.

This technique was the most important factor in the ability of the Company to produce the Model "T" car in large volumes, which at that time, made it the largest producer in the industry.

Along with this great conveyorization, there was a mammoth program of development of production processes. Machinery and equipment were constantly being shifted to reduce handling of materials.

As a result of all these advancements, production went up and the cost per unit was cut nearly in half over a five year period. In light of production increases, it was necessary to expand facilities to produce the Model "T" car, and many new handling methods were employed.

Handling was largely by means of overhead conveyors with machines placed very closely together and layouts developed with few aisleways, and with much less stock storage requirements than we find necessary today.

Gradually, the design, styling, size and shape of the product changed, and complicated the processes. Many of you may recall how simple the Model "T" was, and the fact that it could be obtained in any color as long as it was black! As new changes in the product occurred, changes in facilities were made to utilize as much as possible existing facilities without major rearrangements.

In recent years it became apparent that our new products dictated major changes to productive processes. The Plant Layout Department developed layouts on the basis of new products, with many models and present day conditions.

In starting this program of expansion and improvement, two (2) departments were given full recognition. Material Handling Engineering was set up as a separate department to analyze receival and shipping of materials, and worked very closely with Plant Layout. The Automation activity was set up as a separate department, but later became a part of Plant Layout. Both groups contributed substantially to the improvement programs developed as a part of Manufacturing Engineering.

The early automation programs worked out were chiefly concerned with the rearrangement of standard and existing machines, to tie them together with mechanical devices to eliminate the need of manual operations. Here, we feel, was the start of the in-line or transfer machine. Many arrangements were worked out to lower production costs.

At the present time, we find new programs based on the wide introduction of machinery and equipment, which have been designed with Automation in mind.

Automation as a separate and distinct function of Manufacturing Engineering is a development of the last decade. The word was coined by Mr. D. S. Harder, Vice President, Manufacturing, of Ford Motor Company. Automation, like Material Handling Engineering has received proper emphasis since general acceptance of the word.

In the spring of 1947, a separate department was set up to concentrate on the development of systems which could solve the problems connected with the transfer of parts between machines and equipment, and take advantage of maximum machinery and equipment efficiency. A gradual evolution began. Some of the earlier systems were worked out on a cut-and-try basis, due to the fact that existing machinery and equipment had to be utilized to justify cost studies.

Emphasis is now placed on proper and economical design. Simplicity and maintenance reduction is now the keynote of all automation design, while cost savings in direct labor reduction is the underlying purpose served. At present, there are many groups in the various divisions of the Company working on their respective Automation programs. You will find all of Ford's new program layouts based on the introduction of in-line machines, and process equipment designed with Automation in mind, where cost studies and sound Material Handling Engineering surveys justified it.

The foregoing events made it necessary for close coordination of Automation, Machining Process, Material Handling Engineering, Industrial Engineering, and Plant Layout, under Manufacturing Engineering. Manufacturing Engineering at Ford has not only taken on the duties of the master mechanic, but also Material Handling Engineering.

DEFINITION OF AUTOMATION ITS ADVANTAGES AND DISADVANTAGES

Automation is a new manufacturing method and we have seen many attempts made to define it. We simply say that Automation is the automatic handling of materials in process. However, recently in one of the magazines a definition was expressed by Mr. W. E. Brainard of Hughes Aircraft Company, which we quote:

"Automation is more than merely transferring; it is not a push button factory. It is a philosophy that may extend back to the design of the product. It is a new method of manufacture, not necessarily a new way of cutting metal, but a way of controlling various processes. Automation is a philosophy of design, it is a manufacturing method, and it is control within a machine." We like this definition, and the more planning we do for future programs the more we are inclined to agree.

Automation used at Ford in machining plants, moves the parts being handled into and out of the load and unload station of machinery or equipment automatically, and at the same time, due to simple electrical interlocks, actuates the machine cycles.

The current cylinder block Automation at our Cleveland Engine Plant that you will see shots of in pictures later, is typical as far as mechanical movements, and is generally of three (3) types, namely:

1. Lengthwise shuttle -- to index cylinder parts lengthwise with one bar.

2. Broadside shuttle -- to index cylinder parts broadside with two bars.

3. Overhead shuttle -- to index parts either lengthwise or broadside, as requirements dictate.

These same basic principles are applied to stampings, forgings, etc. in varying degrees.

The shuttles have been largely standardized and include the following features: Framework originally was fabricated out of structural steel in all cases. On more recent installations the use of castings has been quite common, due to the volume of like parts involved. Where pneumatic power units are used the cylinder diameter, stroke, mounting and construction in general, have been standardized to keep maintenance and spare parts at a minimum.

The success of Automation between two or more productive machining or process operations depends upon a properly and simply designed electrical control. A signal system, usually by means of limit switches and relays actuated by the part in process, indicates to our Automation panels that parts are in position to be moved by the mechanism, and that all transfer bars from machine tools and equipment are in a position that will not interfere with the movement of the part.

To accomplish this, it is necessary that an interlock be established to indicate that the machine or equipment is "in the clear" and also, that it will maintain this condition even though there may be some delay in the completion of the Automation cycle. For most machine tools, this usually requires an interlock at both the loading and unloading stations. This loading station interlock must indicate that the space is open and that the transfer bar location will permit the loading of the open station. When the open space has been loaded by the Automation, the interlock must indicate that the part is in the proper location, that the automatic transfer mechanism is "in the clear", and if the machine tool is operating in automation cycle it will permit the next machine cycle to start.

The design of many machine tools dictates that there may be three (3) stop -- start points in a cycle. One would be the point selected for push button operation of single machining cycles. The second point may be that caused by the part remaining in the interlock unloading station. The third point would be that caused by the lack of a part in the loading station. These points must all be considered, and with the use of limit switches mounted and wired integrally at strategic points, we control the actuation of the automation power units.

The time allowed by the machining operations or machine cycle dictates the average transfer speed that the Automation power unit must be designed for. Where this average speed is high, pre-travel acceleration and deceleration become critical factors. Since the part may be transferred by mechanisms powered by air, oil, AC motor, DC variable speed motor, or AC motor with clutch and brake, the problem at hand must be analyzed to utilize the most efficient and economical power medium.

Automation is not restricted to handling large parts only, but can be used on a wide variety of materials, with substantial savings being realized; and, at the same time, eliminating hazardous handling of items such as large stampings, heat treat, and forging operations, many of which you will see in the pictures.

Now that we have defined Automation and described some basic types, we should take a look at the Advantages and Disadvantages as witnessed at Ford.

Advantages

1. Lower Production Costs by reducing the manual handling of parts. This does not mean elimination of all manpower, but rather, a redistribution of manpower, Much less unskilled labor will be required, but a greater number of skilled labor required to maintain equipment and change tools.
2. Greater Production Per Machine by eliminating inherent delay in the loading and unloading cycles. The machines or equipment are virtually run at full speed 100% of the time, not considering normal maintenance down time and tool changes.
3. Increased Quality of each part manufactured by reducing the damage caused by parts striking each other.
4. Safety is increased to a high degree due to the elimination of hazardous handling of such parts as stampings, forgings, large engine parts, and heat treat operations.
5. Tool Control - Because tools used in machine tools and equipment where Automation has been applied must be pre-set, operated, and changed to predetermined specifications and performance, their usage can be closely observed and controlled. Such control also reflects approved part quality and reduction in tool cost.
6. Floor Space Savings - Where automation has been applied stock handling between machinery and equipment has been virtually eliminated. Consequently, the distance between and around machinery has been reduced. Additional operations and increased machine speeds can be designed into equipment resulting in an important reduction in floor space per part produced. With land and building costs on rise, economy in plant investment is important.
7. Reduction of Manpower Fatigue by using simple interlocked electrical controls to make the decisions and employing mechanical devices to do the actual labor.

Disadvantages

1. Maintenance Costs are always brought up when discussing handling equipment that must be fully automatic. We have found that we must consider maintenance as a decided disadvantage. However, as skill in automation design increased, the details of the systems have been simplified, construction has become more rugged, and preventive maintenance has been and must be practiced.
2. Additional Engineering Costs must also be considered, due to the need of close coordination of so many elements such as Plant Layout, Processing, Tool and Die Design, Machine Tool, and Material Handling, etc. Much careful planning is necessary and many design hours before construction may start.
3. Installation Costs are inherent with all equipment. However, a problem occurs when existing operations are studied and Automation is found necessary. Rearrangement of large machinery and equipment can be very costly when done to suit automation. When this occurs, justification of moves must be dictated by advantages gained.
4. Specialized nature of equipment is another disadvantage. Every part that we study requires special consideration, because of its size and shape. Another item along this line is the varied load and unload stations of machines in the layout, since they came from so many different manufacturers. This problem has been greatly minimized on new programs due to closer coordination of all phases involved and proper planning executed when layout is made.

THE ORGANIZATION AND FUNCTIONS OF AN AUTOMATION DEPARTMENT

Automation systems of the kind you will see in the movies to follow will look quite simple. However, their development is very often not a simple process. Much engineering study is required before they can be accomplished. To explain the development work and type of personnel needed, an explanation of the way we organized and handled a new program would be helpful.

When an Automation Department is organized to handle the requirements for extensive facility expansion programs, you must start with a supervisor who has had considerable all-around experience in the field of conveyor, machine, and process equipment design, who can lead and coordinate the program as it develops. Under this man, you will select a live wire unit supervisor who can lead the designers in carrying out good engineering practice, with standardization and simplicity of design as the keynotes.

The designers must be specialists, having had experience in conveyor and machine design and the amount of them required dictated by the magnitude of the program and time allowed to complete it. The designer in addition to his experience, must have imagination and the attitude that all operations can be performed automatically.

At this point, we are ready to discuss some of the functions or how a program develops at Ford. The first step occurs when the general plant layout has been agreed upon, and detailed layouts are in their early stage. One automation engineer should be given the responsibility for the work on a complete part, such as a cylinder block, cylinder head, hood, fender, etc. In this way, he will be able to get an overall picture of the job, rather than a partial view. This is very important from a coordination standpoint. Naturally, on large jobs, the engineer in charge of a part study will need help.

In preparing the detailed plant layout at this point, the layout man should call on the Automation man freely for consultation as the layout progresses, for developing arrangements which lend themselves to simple equipment designs. At this stage, other interested parties from production, work standards, higher management, etc., are brought in for their comments to see the overall plan under consideration. Many quick calculations and simple sketches are made here, if necessary, to determine in a preliminary way the extent of automation, which is justified on the basis of the overall need, economies, etc.

In some cases, it is found that the right type of automation equipment will not cost much more than standard conveyances which would have to be used anyhow. The value of close coordination on the program at this point, therefore, can not be over-emphasized. The parts must be carefully analyzed for adaptability to automation, and preliminary manpower estimates must be considered. We might find, for example, that if one operator can load and unload several or more machines, or if an operator is required for reasons other than loading and unloading, such as assembly, manual control, observation, etc., that automation can not be justified.

Let us assume that our preliminary study indicates the need for a system. Our preliminary work is done, and we are now ready to do the real job. Copies of the plant layout are made, and the engineer starts his detailed study for preparation of the final recommendation. He must have copies of the Process Sheets utilized on the job to be certain of obtaining correct machinery information as the job develops.

An overall preliminary automation layout is made to show all of the elements required, location, approximate size, etc. In some cases, it is necessary to make small scale models of the proposed equipment. Generally, we find the need for (3) three dimensional drawings to be certain of some features and to make proper presentation as required to Management for approval.

When we feel that our overall study is completed far enough for final evaluation, the entire job is turned over to our estimating department for cost figures.

Our Industrial Engineering Department analyzes the manpower required for the entire departmental layout, both with and without automation to show the actual requirements. When we get answers to these two items, we are then prepared with the following data to make a report:

1. Equipment costs installed.
2. Savings to be made and other benefits, needs, etc.
3. Preliminary layouts.
4. Details of some items which were made to be certain of their practicability.
5. Some three dimensional drawings.
6. Possibly, some scale models.

This data is all summarized. The proper supervision within the department and in other divisions of management are consulted as required, for approval.

Let us assume that we have a program which has reached this point and has been approved. When this occurs, the following are the major steps that are taken:

1. The Plant Layout Section is notified of the approval. Consultations are held so that the necessary final revisions to the layout or to the automation can be made before proceeding with the necessary steps to procure equipment.

2. The Process Department is notified so that process sheets may be revised to include the effects of the automation equipment.

3. Tool and Die Design is notified. Consultation takes place here to be certain there is proper coordination. This is important so that proper clearances are left in dies and tools for introduction of automation devices to load and unload work and in some cases, to allow for the rejection of scrap material.

4. The final automation layouts are now made, and at this time, the electrical control diagrams are engineered.

5. It is the policy of the Ford Motor Company

to write specifications and purchase notices at the source of design, so that the Purchasing Department can obtain proper bids.

6. These specifications and purchase notices are written to set up general terms and conditions for the jobs. They include all those general features necessary to a clear understanding of the job. Prints of the final approved layout are included.

7. The specifications clearly define the part under consideration, the work to be done, the materials required, etc. A description of each automation device is clearly given, and an explanation of the function intended is given.

8. A point worthy of special consideration at this point is the general policy that the contractor shall complete our design layouts, fabricate, machine, deliver, and install all of the automation equipment and test it before acceptance by the Company.

   This point is of utmost importance. We have seen that this type of equipment must be carefully designed from start to finish, and is a key item in the production process. It is not good business to split responsibility in jobs of this kind. There are cases, however, where it is good policy to work out many details beforehand, to fully explain the job and indicate the extent of the job to the bidders.

Naturally, as the successful contractor progresses on the job, there are consultations with the Automation Section originating the work and the Purchasing Department who placed the order -- and later, follow-up in the field to see that the job will operate as planned.

The above outline assumes that the entire job was to be fabricated by contractors outside the Company. This is not always the case, but has been quite generally followed on some of the larger programs being installed. In the case of existing machinery, most of the same procedure applies. However, there are certain differences which should be noted.

The need for very careful field surveys is indicated. Very often, compromises may be needed from the ideal conditions which could be obtained in order to keep production going or to keep costs down. Of course, these factors should come out in the summary of all the factors needed to get a decision on the program as a whole.

APPLICATIONS OF AUTOMATION -- (MOVIE)

The film that you are about to see covers some of the many applications of Automation, and you will agree that it is indicative of our American heritage, the desire to increase our productivity, and raise our standard of living. Still pictures from this movie are shown in Figures 1 through 12.

For this reason alone, automation has come into full view in the industrial picture and Manufacturing operations are being restudied constantly for possible application of automatic methods.

At the Ford Motor Company, as we explained earlier, 'Automation' was first defined as "The Automatic Handling of Parts Between Progressive Production Processes." Today, it engulfs the entire field of Manufacturing operations where automatic handling may be applied to an advantage.

Let us now take a look at our Manufacturing facilities and discuss automation as it has been applied to our operations.

Rapidly fading from today's industrial picture are scenes with men struggling to handle heavy, bulky parts between operations. Loading and unloading the machines was also a back-breaking job. Not much was done to change these conditions, because tool and machine speeds and feed rates were comparatively slow on these operations, allowing ample time for loading and unloading without serious delay in machine operation time.

Many times in the process of manufacturing heavy parts, it is necessary to turn the part over. To do this by hand was not always easy or free from hazards to the man or the part.

Today, the picture is different, with tool and machine speed and feed rates increased to the point where it is now impractical to load the machine manually. Machine tool builders, realizing this, in many cases have built-in automatic loading stations and transfer mechanisms to load their machines and to transfer parts from station to station. At the same time, they met our requirements and made it possible through sound planning to tie groups of machines together with automation and eliminate the factors contributing to hard labor and less efficiency.

In our discussion of machining operations, we will start with the smaller parts and gradually work into the larger parts. This will give an idea of the versatility of Automation.

Small parts with high volume requirements were first to be automated, mainly because the devices could easily be justified by reducing piece cost, as a result of the simple, light-weight systems designed for same.

Valves

Application of Automation to Valve Manufacturing began at Ford Motor Company as early as 1937, beginning in segments of the job and spreading until today virtually the entire process is automatic.

Loading and unloading a moving monorail conveyor automatically is usually quite a trick. Much development work must accompany sound engineering principles before certain complex problems associated with automation designs can be solved. This, along with all handling problems associated with Valve Manufacture has been economically accomplished.

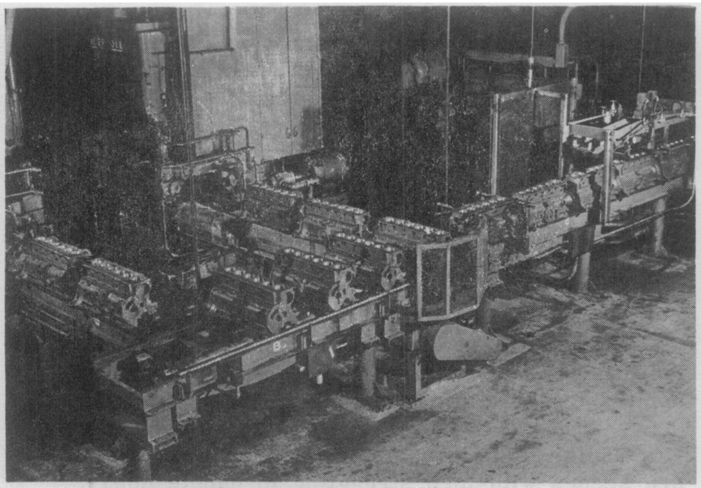


Figure 1

General view of Automated Cylinder Block Department showing lengthwise and broadside shuttles and turntables.

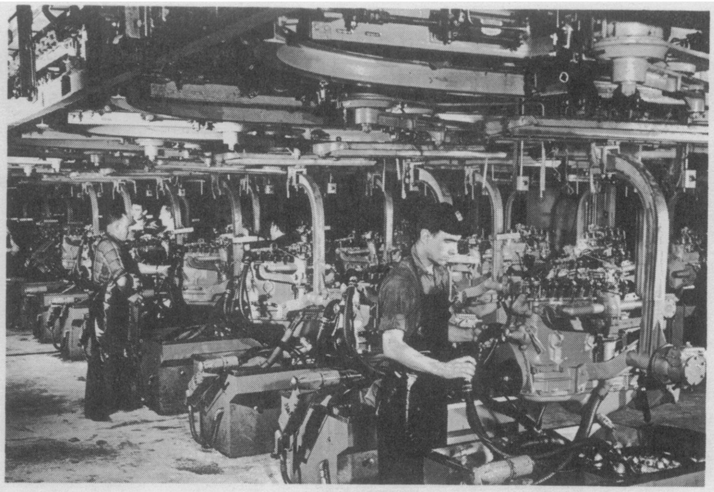


Figure 2

View of continuous overhead conveyors in Engine Assembly.

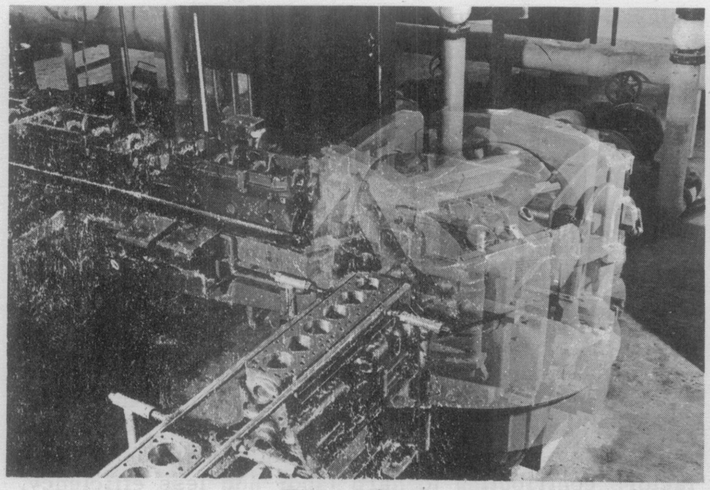


Figure 3

Lengthwise shuttles and automatic rotating device which turns block over and end for end.

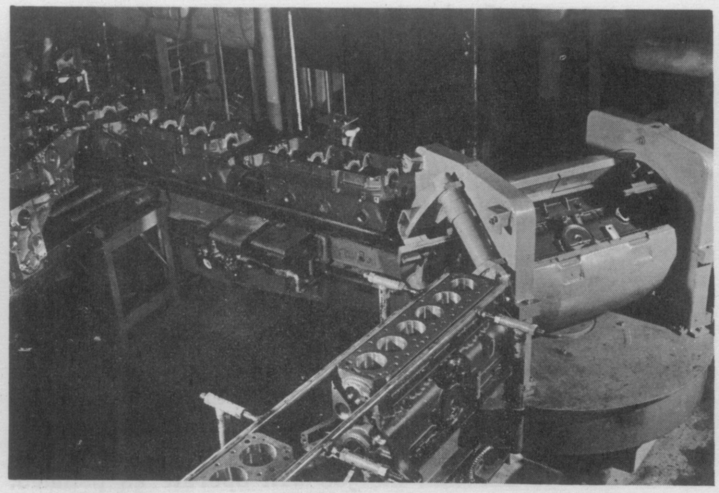


Figure 4

Same picture as Figure 3 with block in rotating device.

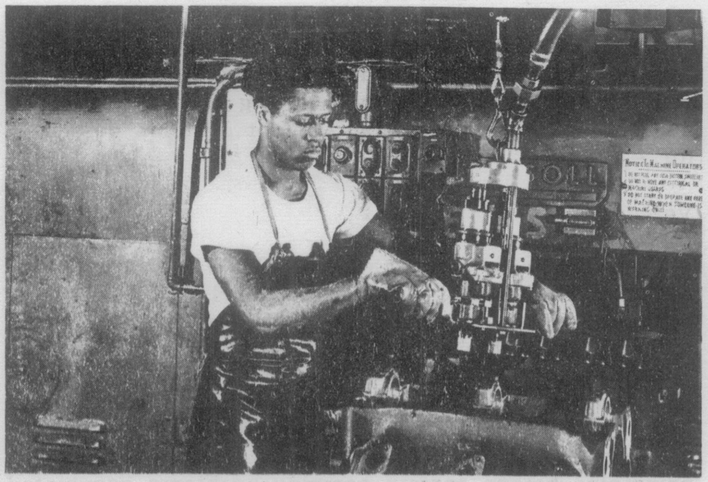


Figure 5

Tightening two main bearing bolts with pneumatic wrench.

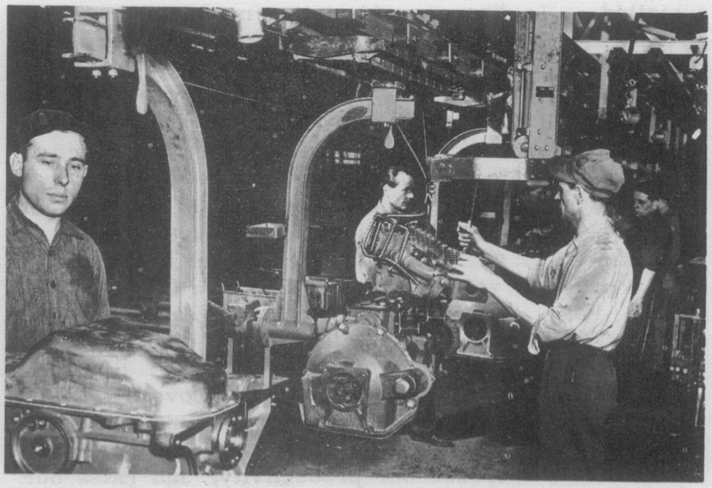


Figure 6

Power and free engine assembly in which engine block is not removed from carrier from time it is picked up in machining area until it is placed on shipping rack.

Valves are processed through an electronic gauge which inspects them for six different characteristics and ejects them into chutes which sorts them. This gauge is capable of inspecting (3,000) valves per hour. On this part, as on others, transfers between operations are accomplished by gravity where possible.

Generator Parts

Inspection of generator commutators for grounds and shorts is another example of many integrated automatic inspection gauges, necessary where automation is applied.

Generator shafts are also handled by automation between operations by a combination of methods, each designed for the simplest way of handling the part at each location. Horizontal travel is accomplished by shuttling through a tube and declined drop is by gravity with steps to reduce part velocity and eliminate part skewing.

Vertical rise is done by an elevator conveyor. All machines in this application are automatically loaded and unloaded.

Pistons

Another earlier application of automation was in Piston Manufacturing. Pistons are received rough turned from the Foundry source, and are automatically loaded and unloaded through the O.D. grinding operations. Here, as a result of automation, a steady flow of pistons through the machines results in utilization of close to 100% of its capacity, compared to about 80% if manually loaded and unloaded. Pistons are then automatically loaded into skirt chamfering machines by pneumatic cylinders.

An operation of this type emphasizes the need for automation, since time spent performing the actual chamfering operation is very short, placing a premium on load and unload time. Automation corrects this by reducing load and unload time to a minimum.

Pistons are weight balanced automatically by an electronic weight recording mechanism, which adjusts the correct amount of material to be milled out. This results in more accurate matching of piston weights.

Coil Springs

Manufacture of Front Suspension Coil Springs at Ford is nearly a fully automatic process. A variety of automation equipment types has been utilized. After end heating, the bar is automatically handled through the swedging operation being rotated in a fixture through 90° to form a rectangular end on the bar.

After swedging, the entire bar length must be headed to 1700° for coiling and hardening. The handling through this operation is accomplished by simple mechanisms, which proves again that automation need not be complicated to accomplish the job it must do.

The spring, having been heated and formed is then automatically rotated, positioned, and quenched.

Coil Springs continue their processing on conventional conveyors, utilizing horizontal transfers between conveyors, a significant difference from the older method of dropping parts off the head end of one conveyor onto the tail end of another.

Rear Axle Housings

Rear Axle Housings begin their manufacturing process as a welded tube. Transfer of parts between all operations is highly automated. Perhaps of most interest are the automatic monorail loaders and unloaders, which we previously mentioned, is often quite a trick.

Crankshafts

With this part we are now getting into the automatic handling of heavier, bulkier parts which point out the unlimited applications of automation. Crankshafts which weigh over (60) pounds are automatically loaded into mass centering machines by transfer mechanisms.

Machine tool builders are expending much effort to bridge the gap between automatic handling equipment and machine operations by building-in automatic loading and unloading equipment. A more compact, smoother operating component is the result. It is far easier to design automation equipment between processes if the machinery builder designs with automation in mind.

To apply automation to any part throughout the entire process of manufacture is best accomplished by planning well in advance of plant layout work. Better integrated components are developed when machine tool builders and Company process engineers work together in advance to develop automation for a new department.

Cylinder Heads

Cylinder head automation uses the same principles applied to other parts; namely, shuttles with pusher bars motivated by air or hydraulic cylinders.

Sequencing of movement, as in other applications, is controlled by limit switches which telegraph their action to a central control center using relays for synchronization of stock movement in large areas.

It should be pointed out again that a program of standardization for automation is necessary to minimize the need for excessive maintenance of stock, and simplification of repair work.

Cylinder Blocks

Cylinder blocks which weigh upwards of (250) pounds are the heaviest parts automated at Ford Motor Company. This application, in spite of the part weight, is nearly 100% automatic. Mechanism for straight travel of cylinder blocks is composed of lengthwise and broadside shuttles, using pusher bars with retractable dogs that engage the block, and air

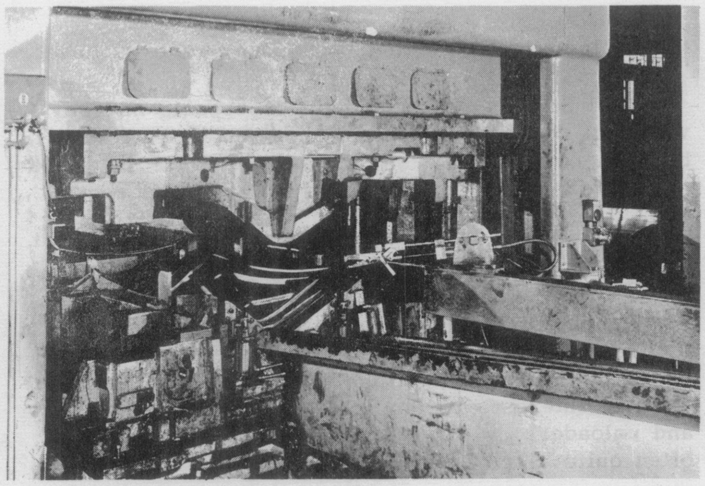


Figure 7

Horizontal extractor removing rear deck lid (trunk) from draw press.

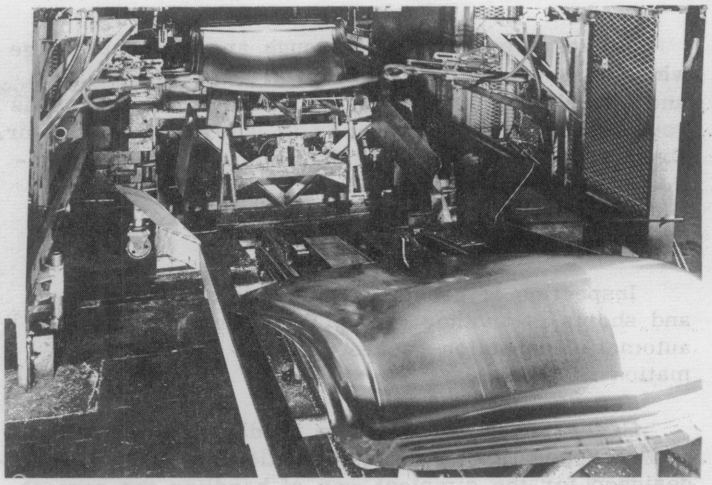


Figure 8

Horizontal extractor removing hood from draw die and and placing same on indexing shuttle to trim press.

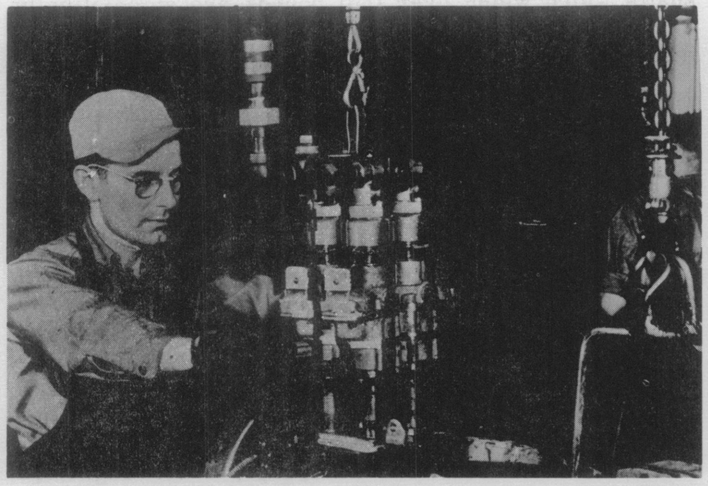


Figure 9

Pneumatic wrench tightening four U-bolt nuts simultaneously.

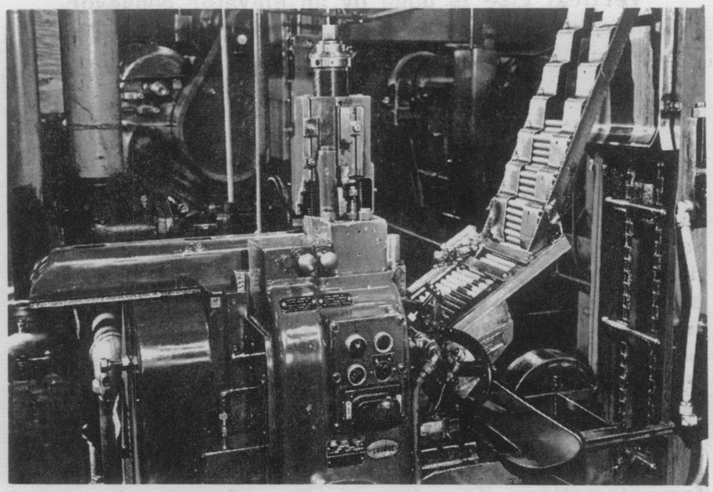


Figure 10

Automatically loading keyway mill using simple device in conjunction with elevating conveyor.

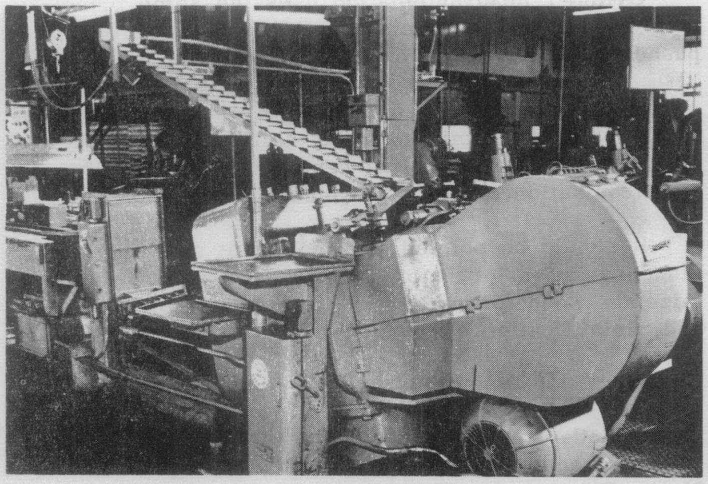


Figure 11

Automatic loading of shaft grinder.

Figure 12

Typical tool control board -- a must in a highly automated machining operation.

or hydraulic cylinders for the motivating force.

Upon arrival from the Foundry, blocks are indexed through a qualifying gauge and oversize castings rejected. This protects the broaching tools. Cylinder blocks begin their travel through the machining operations when they pass through hugh broaching machines for facing top and bottom surfaces. With feed rate vastly increased, these machines have a production capacity much greater than their forerunners, which were manually loaded and unloaded.

After leaving the broach, cylinder blocks enter a network of automation, which carries them through the entire manufacturing process. With the exception of a few spots, blocks are untouched by human hands with automation doing all the tough jobs of moving the block from machine to machine, turning it over, and turning it end for end. At the same time, Automation actuates the machine cycles eliminating inherent delay.

Finished cylinder blocks are bolted to conveyor hangers for engine assembly. Automatically, the hanger carries the block through the entire assembly, testing of the engine, and finally automatically dispatched to scheduled shipping locations, where it releases its load. Transfers into and out of repair stations and junction lines are performed automatically by steel arms which flex at the elbow much like a human arm.

In a highly automated system such as the cylinder block, a controlling factor is maximum tool life; consequently, we have found it necessary to utilize tool control boards to reduce down-time by recording tool wear and having spare tools ready for use.

Foundry

Foundry operations have traditionally utilized techniques which are based on many manual skills, and until recently remained virtually untouched by automation. New foundry facilities for Ford gave engineers the opportunity to explore foundry activities for spots where automation could be used to advantage. Many operations such as transfers, sand handling, shakeout, etc., have been made automatic. Air or hydraulic cylinders are used to push and pull hot stock from conveyor to conveyor. Automatic conveyor sweepers keep the accumulated refuse material moving to a disposal point.

Cylinder block castings are easily and quickly turned over onto a vibrating conveyor for shake-out of core sand in the first stage of cleaning castings. Requiring only the press of a button, many operations are now quicker and safer than the older methods of handling blocks by manually operated air hoists.

Casting annealing operations have been made completely automatic. Castings are annealed in large annealing furnaces and are unloaded from the annealing trays by an automatic fixture.

The fixture then indexes three locations, while each empty container is unloaded automatically onto a conveyor which returns them to the front or load end of the furnaces.

The fixture then continues over to a second annealing furnace to repeat the same function.

Stamping Operations

Automation in many forms has been applied to Stamping Operations. Iron Hands now reach into the press split seconds before closing, and need no safety measures, as was necessary for human hands. As press closes, they dwell for a moment while the dies form a part, then perform their function of extracting the part. Before Automation, many presses required as many as four (4) operators, now presses are virtually run on the "hop", requiring a maximum of one (1) man per press.

Automation is particularly suited to large stampings which are usually awkward to handle manually. The following is a representative outline of Stamping types that Automation has been applied to:

Frame Side Members are blanked and automatically ejected from the press onto live rolls which deliver them to the forming operation.

Quarter Panels are blanked automatically and alternately; one panel is turned over by automation, and two stacks of blanked panels are formed, one for right-hand, the other for left-hand quarter panels. Ejection from the blanker is accomplished by a quick acting air cylinder.

Rear Floor Pan Blanks are manually loaded into an automatic forming press loader, allowing the press to run on the "hop" which would be dangerously fast if manually fed.

Automation then quickly removes the formed floor pan and places it on a shuttle-type transfer which delivers it to the trim press. Accomplishment of a press running on the "hop" is one of the greatest single advantages for automation on press lines. Besides increased productivity, there is less wear on working press parts such as brakes, clutches, and bearings.

Spare Wheel Well Blanks are automatically covered on both sides with drawing compound before entering the draw press. This operation was done by brush swabbing. Now all applications of draw compound are dispensed automatically.

After forming, wheel wells are moved by shuttle transfer toward an assembly operation for welding into the Rear Floor Pan. Good automation planning always strives for simplified mechanisms and wherever possible, the natural force of gravity should be used. Examples of gravitational automation are amplified in this operation.

Wheel wells flop over by gravity---Slide by gravity and, finally---Drop by gravity into the floor pan. The wheel well then is automatically welded into the floor pan, completing the assembly.

Doors

The door press lines are highly automated and as a result of this, productivity has been doubled.

Roof Tops

A single horizontal motion iron hand extracts the large roof panel from the draw operation. The iron hand, operating on the side of the panel, permits turning of the symetrical fixture. Automation has eliminated much worker fatigue on this operation.

Roof panels then automatically pass through the Trim Operation. A retractable iron hand extracts the panel from the press and ducks down for the panel to pass over.

Deck Lids (Luggage Compartment Door)

The Deck Lid outer panel is ejected from the draw die with a pneumatic kicker cylinder. Taking advantage of the "V" shape of the panel, it rolls by gravity into an automatic turnover which sends it on its way for trimming. The balance of Automation are typical for Stamping Operations.

Instrument Panels

Instrument panels receive an automatic pre-bend operation before entering the first forming operation, due to the deep draw it will receive. An air cylinder kicks the panel through the side of the press and into the die. The end of the panel rams a cushioned stop gauge which positions the panel correctly in the form die.

After forming, a double jaw extractor drops the panel onto a turn-over device. From here, it goes to the Trim Operation. There are many other operations that we could speak about, however, it can be said that in Stamping Operations at Ford Motor, all major parts have been automated.

In reviewing what we have discussed of automation in Stamping Operations, the following points can be made:

1. Automation can be applied to a wide variation of sizes and shapes of parts.

2. Automation can increase productivity of machines and presses by reducing load and unload time.

3. Automation can eliminate hard labor jobs on operations handling large bulky parts. Automation also eliminates safety hazards.

Wheels

Wheel Manufacturing at Ford is a pioneer in application of automation on a broad scale. Many good examples of automation devices can be found here. First, the wheel rim blank is formed in a circular shape. Then a vertical elevator delivers the wheel blanks to an automatic device for distribution to three lines of welders and presses.

Wheel blanks are then quickly pushed into continuously running presses by automatic press loaders. The blank begins to take a wheel shape as it is leaving this operation and entering automation.

An automatic device loads the wheel rim into a rolling machine which forms the flanges on both edges. Rims then roll by gravity into a vertical shuttle mechanism, which feeds into an automatic press loader.

Rims then receive a final size forming operation, and are ready for delivery for assembly with the spiders into wheels. Automation moves the wheel spider through a line of progressive forming operations. Shuttle mechanisms have expanding and retracting dogs which engage the spider and move it forward.

An automatic turnover fixture indexes in unison with the shuttle mechanism to turn the part over for subsequent operation.

Wheel rims and spiders are brought together for assembly on an automatic line. First, twelve holes are pierced through both parts. Rivets are automatically inserted into the twelve holes and in the next station they are squeezed down to lick the rim and spider together, forming a wheel.

Last, a hole is punched and coined in the rim for the tire valve stem. Completely and automatically assembled, wheels are ready for painting and tire mounting.

General

Automation seems to have an endless field where it can flourish in automotive manufacturing operations. Besides the major manufacturing processes just discussed, there are many more that have adopted automation principles in the huge network of automobile manufacturing. The following discussion will point out a few of these.

Automatic surface coating of parts is being done in several different ways. One system that we have adopted used a revolving parts hanger suspended from a monorail conveyor. Paint spray gun operation is sequenced with the conveyor movements and part contours. The system automatically carries parts through phosphating, prime coating, final painting, and drying operations. Besides a direct labor savings, parts are more uniformly covered.

Various automatic devices are used to transfer bodies in process of manufacture. These automatic transfers are of simple design and standardized throughout all of our assembly plants.

A continuous supply of tire wheel assemblies are fed to the final assembly line by a gravity chute which ends at the point of assembly on the car. Wheels are automatically ejected from the delivery conveyor by an air cylinder device which sends wheels rolling down the gravity chute, to each side of the assembly line.

THE FUTURE OF AUTOMATION

Automation has been applied to most manufacturing and some final assembly operations at Ford Motor Company. In the pictures shown today, you have seen only a few selected applications; however, automation has been applied to many other parts of varying size at Ford Motor with great success, and its future at Ford is established.

At Ford, we feel that it is an important "in process" Material Handling tool, and that it is the missing link which assists us in obtaining the maximum usefulness of our tremendous capital investment in machine tools and process equipment. It is a must in the industrial picture of today and the future.

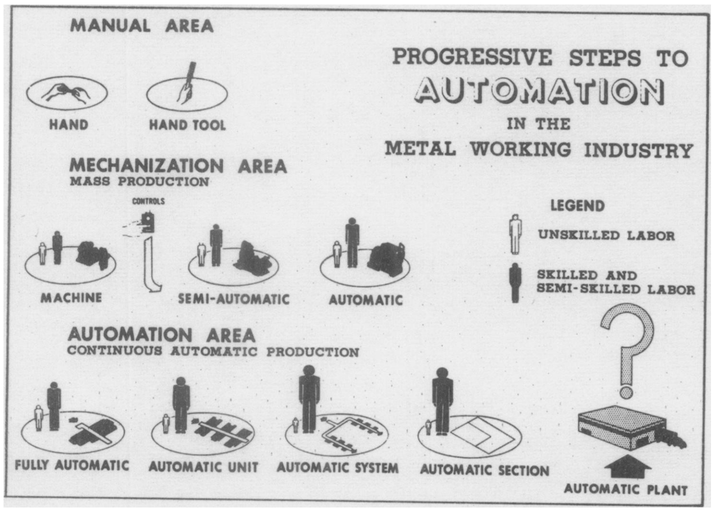
Our organization is a large one with many divisions all operating as separate profit centers on a competitive basis. Since many programs are going on simultaneously, we need all of the help that is available from the machine tool, material handling, process equipment manufacturers, and educational institutions, now and on future programs.

If you have ever had any contact with our Rouge Operations, you can understand the complexity of the problem with so many activities concentrated there, and the further complication of expansion and decentralization.

The Future of Automation, to a great extent, lies in the hands of top management of industry, and educators, manufacturers of machine tools, material handling, and process equipment.

In discussing the future of Automation, the question "What about the effects of automation on the Labor Force in Industry?" is usually raised.

To answer this as we see it, we should retrace our steps of progress to show the trend in utilization of labor. In the Chart that we have prepared,



skilled and semi-skilled labor is represented by the White portion of a man, and unskilled by the Shaded portion.

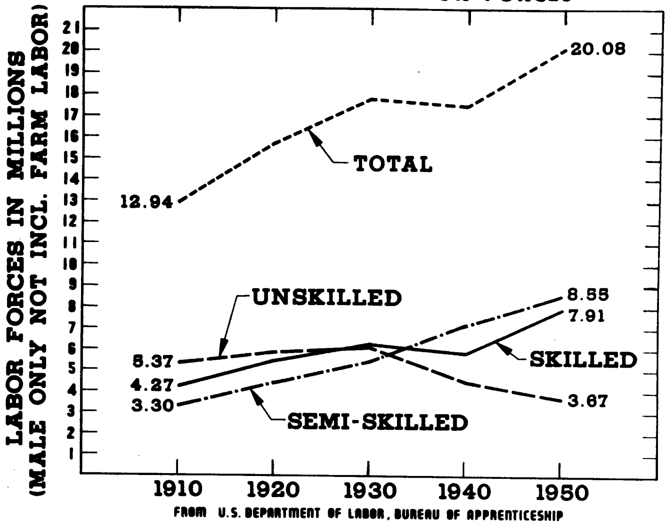
The Top line represents a period prior to the mechanization of industry. Here men worked with crude tools to make a few pieces of consumers goods.

The Second line represents the mechanization period when machines were developed to increase man's capacity to produce goods. Machines improved gradually from performing single operations fully manually controlled, to automatic machines that perform many operations and require only manual loading. Labor skills and productivity have increased with the increase of more complex machinery.

The Third line represents the automation period which we are in today. Highly complex automatic systems require many more skilled occupations to design, develop, and build; also, to operate and maintain. The plant equipped with automation is a distinct challenge to manufacturing people and probably will come only in gradual steps in the normal year-to-year improvement and expansion of our manufacturing industries.

Automation has generated a need for many additional skilled personnel and to portray this, we have prepared another graph. The figures on this graph have been obtained from the United States Bureau of Labor. They show the changes in skilled and unskilled labor forces through the mechanization area and the automation area on the previous chart. Following the lines on the graph, we find that the unskilled labor force has been declining while the skilled labor force has been increasing. At the same time, the total labor force has increased.

GROWTH IN SKILLED, SEMI-SKILLED AND UNSKILLED LABOR FORCES



This graph reflects the point in our previous chart of a growing skilled labor force with the year-to-year developments in industry.

This, we feel, in a simple way answers the question as to the effects of Automation on our Labor Force.

In the future, there will undoubtedly be many factors of engineering design and economics, which when analyzed and applied properly will work for the benefit of mankind.

It is our belief that if the following program is perpetuated, the Future of Automation will be assured.

1. Spread information on the subject to groups not now actively working on automation as a definite program, through similar institutes and seminars of this type.

2. Continue to develop machine tools, material handling, and process equipment, taking into account the full significance of Automation.

3. Develop closer coordination with the Purchaser of machine tools and equipment.

4. Closer cooperation among the various builders of machine tools and equipment.

5. Develop additional sources for the design, building, and installation of Automation.

There are several industries in the Country today, which are completely automatic. The Future will certainly find more. A trend has developed, the possibilities are clear. It is a matter of continued and increased management attention, engineering study, and coordination to keep the trend going and to extend it for the benefit of all.

Before closing, we should again summarize the benefits realized at Ford Motor by a well-planned automation system.

1. Reduction in handling labor costs.

2. Greater efficiency from machine tools and equipment by eliminating inherent delay in loading and unloading cycle.

3. Better quality by a reduction in damage to parts in process.

4. Greater degree of safety.

The disadvantages were discussed at some length to point out that there are some problems in the development of Automation. It is very important to know these disadvantages when analyzing a problem for the application of automation.

The items that we listed as disadvantages are gradually being eliminated by our accent on design simplicity. The Future of Automation is tied in with the Future of our Manufacturing Industries, in the never-ending battle to reduce costs, increase volumes, outsell our competitor, and to increase the general standard of living.

The Future of Automation at the Ford Motor Company is assured, based on experiences so far. It is now a definite part of all of our programs. The future looks promising. The entire program is one which no industry can afford not to be conscious of.

In closing, we wish to thank you for your kind attention. We hope that we have made your time worthwhile, and have contributed to your knowledge of Automation.

ENGINEERING ECONOMY SESSION

Session Chairmen: At Berkeley - THOMAS A. FANTE, Supervisor of Freight Production Merchandise and Station Service, Southern Pacific Company, San Francisco, California; Chairman, American Material Handling Society, Northern California Chapter.
- EMIL M. MRAK, Professor of Food Technology and Chairman of the Department, University of California, Davis, California.

At Los Angeles - RAYMOND B. ALLEN, Chancellor, University of California, Los Angeles, California.

THE EFFECT OF ECONOMIC POLICIES ON PLANT AND EQUIPMENT EXPENDITURES

Neil H. Jacoby
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During the course of these remarks, I shall try to clarify and demonstrate the truth of several propositions.

First, that expenditures by business enterprises on plant and equipment play a role of central importance in the growth and stability of the American economy, and should be a matter of deep interest to makers of public policy.

Secondly, that while the amount of plant and equipment expenditure by business firms is determined by numerous factors, long-term considerations appear to have become dominant during recent years.

Thirdly, that there is now no general "surplus" of plant and equipment in the United States, despite large wartime and defense outlays on manufacturing facilities; the current rate of spending for this purpose is in line with the present size of our economy and its normal growth requirements.

Fourthly, that governmental policies to help promote a high and sustained rate of plant and equipment expenditure in the future should focus upon measures to create public confidence in an expanding economy, free from serious depressions or inflations, and upon actions to accelerate the pace of technological progress.

ECONOMIC ROLE OF PLANT AND EQUIPMENT EXPENDITURE

When viewed simply as a proportion of total national expenditures, the outlays of business concerns on new plant and equipment do not appear to be very important. In 1954 they amounted to less than $27 billions in an aggregate gross national expenditure of $357 billions, or only 7.5 percent of the total. In other words, what we may call, for simplicity, "capital spending" by business amounted to about $1 out of each $15 of gross expenditure in the nation.

Capital spending during 1954 -- a typical year in this respect -- was small in comparison with either personal consumption expenditure of $234 billions, or with Government expenditure on goods and services of nearly $78 billions. Yet there is no doubt that the dollars spent by business on plant and equipment were a more important determinant of the course of economic events than any equivalent amount of other expenditure. Plant and equipment expenditures are the heart of the process of economic growth. They hold the key to the business cycle -- that rhythm of boom and depression which has caused our country great difficulty in the past. It will repay us to examine carefully the ways in which the flow of plant and equipment expenditure can be kept strong and steady in the future.

EFFECT OF CAPITAL SPENDING ON ECONOMIC GROWTH

The outlays made by businesses on plant, equipment, and machinery are the very core of our economic growth. Unless the tools and equipment used by workers on farms, factories, mines, and offices are multiplied and improved, the average output per hour of work cannot increase much, if at all. Our hope for a better scale of living and more leisure in the future, as well as for the continued security of our nation in a troubled world, depends mainly upon increasing the productivity of human effort. And this, in turn, hinges principally upon the quantity and quality of mechanical power, tools and machinery which we provide to each productive worker. It is now well recognized that the high wages and living standards of Americans, which are the marvel of the world, result largely from the fact that the skills of the average American worker in agriculture and industry are backed by plant, tools, and equipment costing, in current prices, an average of about

$10,000 per worker. This is a figure vastly larger than its counterpart in any other industrialized nation.

EFFECT OF CAPITAL SPENDING ON ECONOMIC STABILITY

Business expenditures on plant and equipment are also of prime importance in determining the relative stability of our economy and its freedom from booms and depressions. Dollars spent -- or unspent -- on capital goods are "high-powered" dollars, having a manifold influence on total demand and therefore on the health of the economy. For example, a decision to spend $1 million to build and equip a plant at a time when all resources are fully employed means that, during the process of completing the plant, $1 million additional spending power will be paid out to construction workers, equipment makers, and contractors. They, in turn, will increase their demand for consumer goods and services; although there will be no increase in the supply of consumer goods and, in a fully-employed economy, there may even be a reduction in the supply if there is a transfer of manpower and resources from consumption goods to investment goods. Hence, a business decision to increase capital spending will be highly stimulative to the economy, in comparison with a business decision to increase by an equal amount outlays for the production of such consumer goods as shoes, or butter, or gasoline, since in the latter case both incomes and the supply of consumer goods will rise concomitantly. By the same token, a reduction in the rate of capital spending can have a sharp contractive effect. By reducing the demand for consumer goods at the same time that it tends to shift resources into their production, prices tend to fall, and a process of cumulative economic contraction may begin.

Historically, business spending on new plant and equipment has been very unstable -- up to recent times. During the Great Depression of 1929 to 1932 such spending fell by 75 percent. Between 1937 and 1938 it fell by 42 percent. In contrast, between 1948 and 1949 the reduction was 13 percent; between 1953 and 1954 it was only 6 percent. The greater stability of capital spending during the last two periods of cyclical contraction is a noteworthy tendency which helps to explain why these economic recessions were comparatively mild.

WHY BUSINESSES MAKE INVESTMENTS IN PLANT AND EQUIPMENT

Granted that a strong and steady stream of business expenditure on plant and equipment is necessary to maintain a prosperous economy, how can the economic policies of government help bring this result about? To answer this question, we do well first of all to examine capital expenditure from the point of view of the business manager. What considerations lead him to buy new plant and equipment?

Students of business administration and finance have identified a number of reasons which lead business managers to invest in new plant and equipment. Some of these factors involve immediate or near-term considerations, the principal ones being the following: The percentage of productive capacity currently being utilized; the near-term prospect for sales; recent and prospective trends of profits; the amount of liquid assets held by the business; current costs of new equipment; interest rates and costs of borrowed money; and stock market prices and equity financing costs.

In addition to these short-term factors, a number of long-term motives underlie business investment. Current investment is influenced by a long-range capital plan involving an estimate of the firm's competitive position in its market five or ten or more years away. Business managers calculate on reducing costs and prices by taking advantage of equipment utilizing a new technique. They speculate upon improving the quality of their products through better processing apparatus. They add new products to the firm's line, rounding out the sales appeal to distributors. They seek to make their production processes more efficient, in many instances by acquiring highly-specialized machinery and even structures, which cuts the costs of mass-produced items. Or, they are obliged to match past or expected actions of a competitor to improve his market position by investment in the lastest type of equipment.

There is persuasive evidence that more and more American business concerns are scheduling expenditures on plant and equipment by reference to long-term considerations. As a result, these expenditures in the aggregate are becoming less erratic through time than they have been in the past. Thus, when sales in many lines fell off after mid-1953, businessmen did not call a halt to investment in fixed facilities. Generally, they held to their long-term plans for modernizing, replacing, or expanding their machinery and their factory, store, and office buildings.

FACTORS MAKING FOR MORE STABLE CAPITAL SPENDING BY BUSINESS

There are two basic reasons for a more stable rate of capital spending by business. In the first place, confidence has been rising among businessmen, as well as among other people, in the ability of the American economy to grow rapidly in the future and to avoid prolonged depressions and runaway inflations. In the second place, there has been a great increase in the amount of research and development activity, a quickening pace of technological change, and an intensification of competition between products of different kinds as well as among those of the same kind. These two fundamental forces have caused an increasing number of business firms to carry out systematic long-range capital expenditure plans.

Businessmen are becoming increasingly aware of the great changes that have occurred in the United States economy during the past generation, changes which make the country less vulnerable to prolonged economic depressions. They have seen the beneficial influence upon their own markets of such factors as these: high and widely-distributed personal incomes and liquid savings; a flexible Federal revenue and expenditure system, which "cushions" changes in personal incomes; unemployment compensation; old-age pensions; deposit and home mortgage insurance; and farm price supports. Above all, business executives now generally appreciate the force of the Employment Act of 1946, which makes it an obligation of the Federal Government to use all practicable means within its power to foster and promote, under free competitive enterprise, "maximum employment, production and purchasing power." No wonder that the horizons of capital planning of all but small enterprises have lengthened. As a result of confidence in the prospect of economic expansion, long-term investment plans tend to be carried out steadily, despite intermediate dips in the business curve.

The other basic cause of well-sustained capital expenditures by business is the fast pace of technological change in our country. This has been a consequence of the great expansion of research and development activities, in industry, in Government, and in the universities. The total amount of money expended during 1953 on basic and applied research in the sciences, and in the design, development, and testing of prototypes and processes, was estimated by the Council of Economic Advisers at $4 billions. The figure may have risen close to $5 billions in 1954. About half of this gigantic sum was spent by Government, largely in connection with national defense; most of the balance was expended by industry.

While it is generally known that research and development expenditures are increasing, the economic consequences of this increase are not so well understood. As research produces new scientific discoveries, and as science is applied to industry, new products are created, existing products are improved, and more efficient processes of production are developed requiring new equipment. Scientific research and development is, therefore, a great destroyer of the value of existing capital equipment, constantly eroding away apparent "excess capacity." By the same token, it is a great creator of demand for new capital goods. Not only does it tend to enlarge plant and equipment expenditures; it tends to stabilize them through time. Suppose one firm in an industry cuts its costs by re-equipping and making use of a new process. It then is able to cut its prices and take sales away from its competitors. The other firms in that industry will now have to make large capital outlays, in order to take advantage of the new process and to protect their positions in the market. For example, if petroleum company A produces high octane gasoline from a new refinery to meet the demands of motorists, then petroleum companies B, C and D are likely to spend hundreds of millions of dollars on new refining equipment simply as a defensive measure to meet this threat to their market positions. Technological change makes much capital spending by business compulsory, and not optional, in a very real sense. This process continues through good times and bad.

CAN PLANT AND EQUIPMENT OUTLAYS BE SUSTAINED AT A HIGH LEVEL?

It has been argued by some persons that business will not continue to spend money on plant and equipment at the current level, and that expenditures will fall off and be a drag on the economy for a number of years. These persons reason as follows: During World War II huge expenditures were made on manufacturing facilities by the Defense Plant Corporation as well as by private enterprises. These outlays were followed, not long after, by further extraordinary plant and equipment expenditures under the stimulus of military contracts for the Korean conflict and the subsequent defense build-up. Unusual stimulation was also given by the five-year write-off permitted under the tax laws of new facilities deemed essential for the national defense. Now that these extraordinary sources of demand for capital equipment have waned, and these unusual stimuli to their production have diminished, several years will be needed by the economy to absorb or "grow up" to the current surplusage of capital facilities. Hence, the current level of capital spending is not sustainable. So runs the argument.

Although one cannot deny the presence during the past decade of extraordinary stimuli to sales of capital goods, the conclusion that demand will fall off, from this point on, does not necessarily follow. Indeed, the facts appear to warrant the opposite conclusion. The current rate of capital spending is not only sustainable but is capable of considerable increase, if public policies favor rapid economic growth and vigorous technological development.

Studies by the Machinery Institute reach the conclusion that since 1940 there has been an increase of about 110 percent in the nation's stock of machinery and equipment, of about 20 percent in the amount of plant, and of about 50 percent in the two categories of capital investment combined. These are "real" and not dollar increments. The rates of utilization of the nation's stock of plant and equipment, according to these studies, was well above normal during the war period. Large postwar investments by business have served merely to restore normal rates of utilization, and to make good the long period of under-investment during the depressed Thirties. Currently the national stock of plant and equipment is expanding at a little more than 3 percent a year, a rate well in line with the normal growth of aggregate national production. Moreover, retirements of industrial equipment from service recently have been unusually low, because of the comparative "freshness" of much of the stock. During the years ahead, normal retirements may be expected to increase. This is an excellent augury for a rising demand for capital goods.

The prospect for financing a rising volume of expenditures on capital goods appears favorable. Depreciation allowances are now increasing by more than 3 percent a year. Generous depreciation allowances are available under the 1954 Tax Revision Act. The current financial position of business is, in general, excellent. Credit is readily available. The rise in stock prices has made equity money once more available on a reasonable basis to many businesses, as the announced $300 million stock issue by General Motors Corporation illustrates.

One may conclude that basic economic forces are favorable to a sustained and rising level of capital expenditure by business. There is no large postwar "surplus" of productive capacity to be "absorbed" before progress may be resumed. But we should not permit our thinking to be bound by historical relationships. The dominant factor in the future demand for capital goods will be the vigor of our economy and the climate for private investment. These are matters of public policy that lie within our own control.

PUBLIC POLICIES TO PROMOTE A HIGH AND STEADY RATE OF CAPITAL SPENDING BY BUSINESS

Our analysis points plainly to the kinds of economic policies by which government can help bring about a high and sustained rate of plant and equipment expenditure by business. It indicates that the broad objects of such policies must be: in the first place, to foster an attitude of confidence among businessmen and other people in an economic future that is expansionary and free from paralyzing depressions or inflations; in the second place, to accelerate the rate of technological development and industrial innovation.

The first objective -- to extend the horizons of business planning by cultivating an attitude of confidence in the economic future -- obviously covers a multitude of possible measures. Rather than try to describe them all, we may recall the basic tenets upon which an economic policy for growth and stability of the American economy should be based. I am unable to formulate these tenets more simply and effectively than they have been stated in the January 1955 Economic Report of the President.

> "The role of the Federal Government in the achievement of (our) goals is to create an atmosphere favorable to economic activity by encouraging private initiative, curbing monopolistic tendencies, avoiding encroachment on the private sector of the economy, and carrying out as much of its work as is practicable through private enterprise. It should take its full part at the side of State and local governments in providing appropriate public facilities. It should restrain tendencies toward recession or inflation. It should widen opportunities for less fortunate citizens, and help individuals to cope with the hazards of unemployment, illness, old age, and blighted neighborhoods."

The legislative and administrative acts of government should aim to extend the application of these tenets in future years, continuing the progress that has been made in the recent past.

The second objective of public policy is to accelerate the rate of technological progress and industrial innovation. Actions are required on several fronts:

First, to augment the number of young people who have scientific, engineering, managerial and technical skill.

Second, to encourage creative thinking and invention, mainly by appropriate patent and tax laws.

Third, To induce business firms and non-profit organizations to support expanding programs of basic scientific research.

Fourth, to enlarge the range and depth of Federal research and development programs in fields that cannot be covered adequately by private efforts.

Fifth, to hasten the industrial application of new methods and ideas by encouraging the replacement of old plant and equipment, and by fostering risk-taking investment in a competitive environment.

Let us glance briefly down each of these avenues of policy to see where we now stand and what specific problems confront us.

We must augment the number of young people who have scientific, engineering, managerial and technical skill. A shortage of young men and women trained in these fields now exists. Unless it is relieved, it may limit the growth of research activity and retard its industrial application. Congress has been asked this year to expand the fellowship, research, and teacher-training program of the National Science Foundation. But the problem needs to be tackled farther back in our educational system -- at the high school and even the grade school level. Technological progress cannot be expected unless our human resources are developed for these tasks.

Creative thinking and invention can be encouraged by making sure that our patent system gives rapid and effective protection to the inventor, and that our tax system does not so heavily burden his income as to dull his incentive to creative effort. The number of non-processed applications for patents in the Patent Office is approaching 200,000, and it now takes about 3-1/2 years to process an application. It may be wise for Congress to provide the Patent Office with the funds necessary to reduce both the backlog and the processing time. Consideration should also be given to modernizing the system of classifying patents in the light of contemporary science. So far as personal taxes are concerned, we must hope for economic growth and a quieter world of reduced military expenditure, making possible a reduction of present tax burdens.

The Federal Government has already taken important steps to encourage research and development activities by business firms and non-profit organizations. The tax laws now offer strong encouragement to wealthy persons to transfer their property to non-profit foundations which can and should support basic scientific inquiries. Last year the tax laws were revised to permit businesses to treat all outlays for research as current expenses. With a current corporate tax rate of 52 percent, this means that the Federal Government, in effect, makes a major contribution to the research and development program of a profitable business. The new Atomic Energy Act authorizes the Atomic Energy Commission to license the use of nuclear material in private-owned reactors, and it broadens substantially patent protection for private investors in the atomic energy field. The door to competitive enterprise in the industrial use of atomic energy has been opened.

The Federal Government itself plans to spend more money on scientific research and development during the coming fiscal year than at any time in the past in fields not adequately covered by private efforts. The Budget Message for the fiscal year 1956 puts these outlays at $2,218 millions -- a 7 percent increase over those made during the current fiscal year -- despite an over-all reduction in governmental expenditures. Nevertheless, there are fields of research activity which may well deserve greater Federal attention, such as the basic physics and geology of petroleum and mineral deposits, water and air pollution control, and the development of solar and tidal power.

The industrial application of new methods and ideas has been hastened by recent structural revisions of our tax laws, and by other measures to invigorate enterprise. Depreciation allowances were liberalized; the period over which business losses could be carried back for tax purposes was lengthened; the ploughing-back of earnings for expansion was facilitated; a limited tax credit on dividends received by shareholders was granted. Yet there are additional steps along the same path that may well deserve consideration at the proper time in the future. They include revisions in the taxation of capital gains, a privilege of rapid write-off of a limited amount of new property each year, and a further extension of the period for which losses may be carried back.

CONCLUSION

Once we recognize clearly that the main source of improvement in our economic welfare is the size and excellence of the stock of tools and equipment which we put into the hands of our workers, there is no doubt that we shall give priority to public policies calculated to promote a sustained high rate of capital expenditure by business. Our recent progress along this route is highly encouraging. It affords ground for the belief that the pre-eminence of the American economy -- an economy of free men and free institutions -- will be extended and enlarged in future years.

WHERE WILL TOMORROW'S COST REDUCTIONS COME FROM?

Fred V. Gardner
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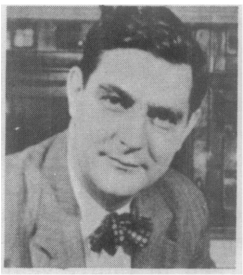

As I look at the problems of management, I see many things which some of you do not have time to stop and look at. I see new horizons, I see challenges, none of which are in bold face as yet, but I do see one clear and positive problem in tomorrow's cost reduction.

Whenever the pressure is on to get costs down, like the proverbial fireman who reaches for his boots and slides down the pole, when the fire alarm rings, we in industry reach for our stopwatch and start a cost reduction program mainly centered around labor reductions. We are at it again for today we have a new major slogan to give us and our brewing cost reduction requirement a false sense of security. That slogan is AUTOMATION. Management men in general, seem to complacently feel that if the fire alarm bell rings they will have or can immediately solve their cost problems with bells, buzzers, selonoids and flashing red lights. This is their visualization of applied automation. But these hopes won't be that easy to attain for several reasons. First, because profits have been easy to come by for so long, organizations are full of too many decision makers who have seen nothing but good times and have to learn rough times by trial and error, that requires bumps, bruises, education and time, usually too much TIME, and second, because automation is an expensive time consuming mechanical reorganization which cannot be done at the drop of the hat.

UP TO NOW

I must start with this subject of where tomorrow's cost reductions will come from by a brief review of the past, for the past holds the keystone from which we can appraise the course of tomorrow's cost reduction structure. Look at the growth of American industry since 1900. The value of output from our industry in 1918, immediately after we had won a war and demonstrated ourselves as the greatest industrial power on earth capable of producing more than all other countries put together, was $20 billion.

Today that production is nearly $300 billion, and according to the President's Economic Council, it will be $450 billion in 1965. In 1917 we had $15 billion invested in our enterprises, of which one-third was working capital; at the start of the second World War we had increased our net worth to $50 billion, of which $20 billion was working capital; and today we have $140 billion invested of which $90 billion is working capital. In 1965, according to the President's Council, we will need another $45 billion of working capital, a fifty percent increase, to carry on the $450 billion of output then planned.

Today we include in each years' costs, approximately $5 billion in depreciation. In 1965 we will charge to costs over $8 billion for depreciation. Even then our depreciation will not cover new capital expenditures. Today we employ 60 million people working 40 hours a week; in 1965 our productive force will be 73 million people working 35 hours a week. This provides less than 10 percent more hours to do 50 per cent more output 10 years hence.

Get this significant point, because it has a great bearing on yesterday's cost reductions. I would like to refresh your minds concerning wage rates during the period since the first World War. In 1929 the average wage rate for American industry was 25 cents an hour. In 1940 the average was only up to 75 cents an hour. By 1950 it was $1.50 an hour. Today the average wage rate for American industry is $1.90, and the President's Council says that in 1965 it will be $2.50 an hour. An increase of 10 fold in 35 years (1929 - 1965).

With this change in the wage rate there was a basic growth in our industry, normal and natural, one took care of the other, one was necessary to produce the other. But the important thing is that in this same period of time, while our wage rates have gone from 25 cents to $1.90 an hour, and industry roughly spent twice the rate of depreciation for additional capital expenditures, a substantial part of this was used to produce productive labor savings.

In 1936 the direct labor, the labor of producing the products, was almost 20 per cent of the manufacturer sales dollar. Today the average is 7-1/2 per cent. In other words, while the wage rate was increasing from 25 cents to $1.90 an hour, with labor-saving devices, better time study, better plants more scientifically laid out, we have been able to reduce the direct labor costs from 20 per cent to 7-1/2 per cent of output values. At the same time, however, the indirect labor has been on an increase.

This past pattern leads one to a very startling observation, for herein lies a clue to tomorrow's cost reduction. A 25 per cent reduction on a 7-1/2 per cent productive labor content in the future is less than two percentage points on the future sales dollar. We have raked over this avenue of saving time and time again. It has been covered so much that sometimes the relationship between those who supervise and those who produce actual products has become strained. Because of this and because routine cost reduction comes high today in plant and equipment investment, let's look at a few neglected items right in front of our nose.

Until we have tapped the reservoirs through ingenuity, change in habits, and just plain lack of interest, we have no right to spend the stockholder's money far in excess of the return we can get in the costs on already low profits.

MATERIAL COSTS

Substitution of Materials

The first pay vein to tap is in material costs through the substitution of materials. Our economy is passing through the most glorious age of chemical development in our history. The possibilities for substitutions of material in American industry are almost unbelievable. I work in the chemical industry and I see products that have not been generally accepted as yet, simply because management people have not taken enough time to find out about them, which will give lower costs, greater quality.

New materials are popping up every day. Put some open minded engineers exclusively in this field, get him out of general star-gazing research that may take five years and produce nothing. Put him exclusively in finding and presenting new materials. If you go at it sincerely, one will be surprised at what will happen through cost reduction.

ONE-HORSE-SHAY ENGINEERING

You remember the deacon's one-hoss-shay that went to pieces all at once? That's just what I am expounding here -- products that do the same. We had an occasion in business not very long ago to analyze white goods consumer products. Our findings were startling, for we found that the internal parts of those products as designed by the engineering department and produced for the customers varied from a life of three years to 80 years in the same product. Have you ever thought in terms of reviewing the engineering specifications, material lists, tolerances, and other sources of product fitness as defined by your engineering department? There are many dollars of savings here, for if you will review your engineering drawings on a cold calculating basis, you will invariably find a series of parts which are made to live as long as Methuselah, along with parts that will not live through the nursing stage.

I don't mean by this that a company has to degenerate their product. I only mean we must have an audit of our sense of proportion between quality, quantity, and their cost binder. This means bolstering up those parts that are constantly wearing out but certainly not overmaking the products that won't wear out during a reasonable product life.

Experiments to date have shown there are several of the latter to each item, short on life expectancy. In fact one company I know doing $10 million in business has saved three-quarters of a million dollars by the process of equalizing, through one-horse-shay engineering, their tolerances and their materials used to produce the final product. You can all do the same but results don't come to you. It takes work, brains and more work, and a courage to realize that while the engineering department is the custodian of quality, they often lose their sense of direction as they run in product development.

PRODUCTION CONTROL

Production control is like leprosy. You get it, it sticks with you. So often production control comes your way because your next-door neighbor has it. You don't know very much about it, but it must be good; it is a system - yes a system of THINGS - which is not human, but which measures the course of human conduct.

I have found too often, that problems of turnover were created or magnified when production control was installed. Lead times were materially increased instead of reduced and all the problems one tried to solve by a rigid system were not improved, for the system lost the human touch and put you in a straight jacket.

Too often the system caused everybody in authority to end up by protecting themselves against their associates by figures they kept in their own desk drawer. All this adding lead time to the point that one ordered a part six weeks before it was needed, when only two weeks was necessary. What happens when this pattern unfolds:

1. It ties up working capital in inventory, thus cuts down range of sales.

2. It breeds obsolescence.

If you are going to save money you have to cut down the hazards of obsolescence. If you are going to save money you must reduce inventory. If you are going to save money you must have the parts when you need them, but not before, too long before they are needed.

You say that all sounds good, it all talks well. Sure it does, but the trouble with production control in modern industry today is that it has grown with clerks and not with management. It needs your thinking, your time, your observation, your audit, your analysis. You give it that and you will have cost reduction because you will put personality into a system which increases turnover efficiency if healthy.

STANDARD DATA BOOK

Many of the pieces which are used in the final product have standard parts with S. A. E. specifications or other common number designations. Too often, however, when an engineer is designing a new product he so concentrates on his basic design that instead of using standard parts he makes a part which appears to fit his particular project better, thus creating an off-standard and a higher cost piece. The standard data book is engineering reference material which lists the most commonly used standard parts by each individual part number, describing its characteristics and listing in a schedule similar to an airline rate schedule between cities, size versus length, and other similar types of common information placing an "X" in each square which is standard. No engineer can design a special part similar to the standard piece without special approval and permission. After a few years the results are phenominal, unlike products of common parts thus cutting down the inventory and the stocking problem. Large quantities can be ordered cutting down unit costs, flexibility of substitution becomes easier and by far the most important, engineers become more orderly in basic cost reduction design of a product the first time around.

ENGINEERING - CHANGE NOTICES

I have seen some very pathetic things in my time on engineering change notices. I will give you one illustration. In one company 1047 engineering-change notices on one order cost $44,000, plus thousands of dollars of overhead and clerical costs which can't be analyzed, plus a disruption of the manufacturing departments beyond belief. Why? Because engineering was steeped in the tradition that quality was the only thing that counted, not in the tradition that engineering is a combination of cost and quality, quantity and quality. Consequently, whenever the engineer got a bright idea, whenever a salesman complained, whenever somebody down the line didn't like a part, he designed a new one. What did he do when he designed the new part? Perhaps he improved your product tremendously; but there is a time and place even for that. So make the change, but when he obsoleted $5,000 worth of parts, he cost you more money than you could get back on a hundred, two-hundred, three-hundred saleable items. To stop this waste, engineering-change notices in companies I am interested in have to be made out to show the amount of obsolete material changes will create. If they create more than "X" dollars, they must be approved by an operating committee before the change is put in operation, or the engineer must demonstrate that the change is required absolutely for quality and for no other reason. Here is cost reduction money just waiting to be saved.

RESEARCH VS. PROCESS ENGINEERING

During the last World War, many companies began to build up research departments in the hopes that they would have products to fill up plants which would be empty if the war effort was suddenly halted. There has been no apparent let up in this planning since the war, in fact it has grown. We all seem to be trying to find ways to make everybody else's product. This, coupled with a desire to take full advantage of new technical processes which have been unfolding quite rapidly, has resulted in the average company continuing to expand research and development. Most of these star-gazers have been assigned to the engineering department with the net result that the average engineering department today is a combination of long-range planning and short range policing. The two requirements are not compatable with the result that too many engineering departments are not doing a good job of research engineering or current production engineering. Men who are supposed to keep sales competitive quality-wise have lost their touch because they mingle too much with their brethren who are making long range suppositions which may never pay off or which, if they do, may take 5 years to show any signs of results. If tomorrow's cost reductions are to be such, much of it must be crystalized in an engineering department whose one objective is to make a going product better and cheaper.

To accomplish this requires almost a complete isolation of the two types of engineering theory referred to here. We would suggest that you make a complete audit of the functions of your present engineering department, for in it may be two types of cost reduction:

1. The department may have outgrown its usefulness as an engineering function, and,

2. The people who are in it will save you money if their individual objectives are conquired basically to current or long-range and not a mixture of these these two.

In one engineering department in a modern sized company in the east, the segregation of the engineering department into these two basic components resulted in a savings of a hundred thousand dollars a year when the groups were isolated by the length of a fifteen hundred foot building.

PRODUCTION LABOR - SAVINGS AUTOMATION

I have mentioned a few of the things that lie right in front of you, outside your office door, every moment of your working day, things you can work on, without much "fan-fare." Let us then turn to labor. We all talk about automation as though it were the answer to all cost reduction problems. We too readily believe that if we can get a push-button machine in our shop, tomorrow will solve about all our production problems. We do not solve problems that way. We only create entirely new types of problems for most of us are not ready for automation. Many managements are not ready because their thinking capacity isn't ready for it. Some are not ready for automation because the people who must operate it are not ready psychologically. This is important because haphazard automation can unbalance the whole scheme of things now being accomplished. Don't misunderstand me, this does not mean we should not spend a lot of time thinking about automation and working towards it. But to go out and plunge thousands of dollars on a machine or series of machines, just because they are supposed to do things faster or cheaper can result in a waste of cost-reduction money. There are two types of automation problems which develop as the problem is thought out. Each has a different characteristic. To illustrate, one of the big three in the automobile industry spent many millions on a hope that automation would cut costs drastically. They have reduced the labor costs of their engineer drastically, but as they do so they create two new problems, two new cost potentials. Those two new problems, if they are not solved, will cost them more than the labor costs they save for they have created an unbelievable new type of set-up problem. Now with automation it takes three days to make a set-up change in equipment. Since the company has over 30 different engines to make, when they make engine number one they have to make ten times as many as they want to because it takes weeks before they can get around to engine number one again. In fact, it takes 75 acres to store the parts while the cycle is running from A to Z in types.

All I am trying to tell you is that you can jump from the frying pan into the fire. You create problems of set-up and inventory, turnover, and investment, and handling of material and these problems can cost many times what you save.

The second type, the single automation machine, placed here and there to speed up an operation, even has more danger. The first type of automation, i.e., an overall plant installation, is at least on a flow basis, but this individual piece automation can unbalance the complete flow of manufacture in an operating unit. We found, during the last war, one of the most serious hazards in production was an unbalancing machine in a line, simply because of the problems of getting the material to it and away from the unbalanced or uncycled piece of equipment. If you cannot solve the problem of getting an adequate supply of material to and from a machine that is going to run several times faster than any equipment you now have, don't put in lone "automation" tool. It takes wider aisle space, better production control, stronger supervision, more inventory -- a lot of things you may not have or are ready to have.

Thus automation is not necessarily the answer to cost reduction tomorrow. It may be five or ten years from now, well planned and well cycled, but by putting in automation just because it is supposed to be "it", may create costs that you will be saddled with for the next 20 years, for it is this simple, "all that glistens is not gold."

LAY-OUT OF PLANTS

Many of us have been moving from one place to another to find cheaper labor rates or cheaper something else to offset higher costs. Many times these moves were in the right direction, but before you move have you ever thought about better movement or flow within your present plant? Have you made a good flow chart recently? Not just a piece of paper you work on a few days then stick in your desk drawer, but an honest to goodness "he man" chart in color and scaled to actual conditions. The cost reductions resulting from a real "flow" chart will be many dollars, for it is surprising what flaws you see when it is scaled out to facts, but don't rearrange your plant until you study it on a real flow diagram.

CLOCK - CONTROL EQUIPMENT

Today most labor in an average plant is not controlled by the tempo of the man; it is regulated by the tempo of a machine, or a line. If we control that tempo well, we can usually get an honest day's work for a days pay, at least before concessions creep in. But if one studies the time in each eight hours the average equipment operates, one may be quite surprised.

In a well-known firm there is an overhead rate of 4,000 per cent for direct labor, we depended on our ability to keep $1 million worth of machines busy, to get good costs. Profits came by working that equipment hard.

Clocks were put on key machines in the foreman's office, little Telechron kitchen clocks with a solenoid on each machine to measure true cutting production or output time. At the start of each shift these clocks were turned back to zero-zero-zero and the actual cutting time was recorded at the end of each shift. The average cutting time was 4-2/10 hours out of every 8 hours. Half busy men, half busy machines and for $4.00 for a clock and $15.00 for a solenoid, and the time of the electrician from the maintenance department to install these clocks we got a new concept of efficiency and consequently lower costs. The challenge of that clock in the foreman's office has time after time ensured that the productivity of a machine goes up 20 per cent in 90 days. The foreman will make it his business to see that it does. This is cost reduction, and it doesn't cost much to acquire beyond ingenuity and desire.

OVERHEAD COST REDUCTION

As direct labor has diminished in content per unit of output, indirect labor and other items of overhead have increased, so that today, overhead is perhaps the largest single element in costs. Since its growth has been in a period of rapid industrial expansion, overhead has been added to cost as an expedient to improve the problems of the moment with the result that today, service and clerical departments are full of functions which are stilts holding up the sagging structure, rather than well thought out and integrated functions even with the plateau in our growth of the last several years. This problem has not been solved as it is not an easy one to solve. When you deal with indirect or overhead costs, you are dealing with cost which cannot readily be seen in the final product. Costs which have their origin as an expenditure in departments which have nothing to do with the actual production of goods for sale, must be prorated and distributed from department to department before they can find a final resting place in our production costs. It is evident then, that here lies tremendous possibilities for cost reductions, but to root them out also requires that the control be at the level of spending, not at the level of record (the cost sheet). To get these cost reductions tomorrow will require more than a superficial amount of energy, which first must be supported by a positive modern method of cost control. We believe that the steps necessary to accomplish this objective are as follows:

1. The determination of a breakeven point.

2. The details of the satellites to the breakeven

point, standby (fixed) and variable cost subdivisions where the money is spent.

3. A chart of accounts which distinguishes departmental structure to supervisory levels rather than accounting subdivisions, and further, a definition of account structure which segregates the kinds of overhead and clearly defines the shadings between direct and indirect labor.

4. The establishment of flow accounting as a basic concept of labor cost accumulation which puts more emphasis on labor as a cost than labor as a payroll. One of the most important things in modern cost control is to cut down the period of time necessary to accumulate information.

5. "Department doing" control at fountain head of expenditure -- the cost sheet is too late. As far as overhead is concerned (LAG) which is nothing more than slow figure recording conduct, is the greatest usurper of profits.

DISTRIBUTION OF COSTS

There is no time here for a complete reiteration of the problems surrounding distribution cost and the potentials of cost reduction. The problem resolves itself into two fundamental types. Internal costs of the movement of material within the plant, which can be improved by a sounder overhead recommended above and by better internal flow which has previously been discussed. The major problem in distribution cost, the cost of getting the product to the consumer, is in an economic revolution which will change many of our habits and a lot of your costs if it continues. The struggle between the discount house and our old methods of distribution are pointing out the seriousness of this problem as it exists today. The effect that it will have on tomorrow's cost reductions is not yet clear, but it can not be neglected for it ends up in too much of the end value to be neglected.

Let me give you one typical illustration in closing. There is a certain white goods selling for $9.95 (discount house for $6.75). If I gave you the name of the product you would recognize it because many of you would have it in your home. The manufacturer sells this product to the first channel of distribution after making a fair profit for less than $3.50 and of this $3.50, only 25 cents is productive labor in the manufacturers plant. The balance, or 2/3 of the costs are needed in the channels of distribution to cover the costs and provide a profit for those who are involved.

Maybe we have the cart before the horse. When we think of control, cost reduction is coming from the manufacturer who only gets a third of the ultimate costs.

CONCLUSION

Perhaps all our cost reduction energy should be restricted to the distribution field. I am not here to say that is so because a penny saved is a penny earned and cost reduction starts with the making of the product so why reach in desperation to the fantasy of automation and other costly installations to provoke a cost reduction. Do these things surely, but do them on a long term basis, get your tomorrow's cost reduction like the items we have discussed here, the ones you can do with a little energy, a little planning, and hard work.

INDUSTRIAL ENGINEERING -- FOOD PROCESSING INDUSTRY

L. V. Burton
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Food Industries (Food Engineering)

While I feel deeply honored to be invited to address you on Industrial Engineering in the Food Processing Industries I cannot but feel very humble, in speaking to a group of professional Industrial Engineers, for I have never held a job title that even remotely resembles Industrial Engineer.

Industrial Engineering seems to me to involve the application of the basic sciences plus the often unpredictable factor of people to industrial operations. And when we get into the food processing industry we need nearly all our basic sciences plus human psychology, and a huge amount of common sense.

Before we get far into the subject I must give you some idea of the size of the Food Processing Industry. It is the biggest industry in the country. It has some 13,000 plants that produce an annual value of product amounting to $50 billion. It is a huge industry and operates on very narrow profit margins. Volume is constant, but prices fluctuate in a most disconcerting way.

I want to cite you two examples of industrial engineering -- taken from the dairy field, where workers in the U.S.A. are highly paid and in New Zealand are rather low paid. When the 57th Street plant of Sheffield Farms in New York City was opened, LeRoy Van Bomel, President of National Dairy Products Corporation, pointed out that every foot of sanitary milk piping had to be demounted, washed and sterilized twice every day, 7 days a week, In those days the cost of washing sanitary pipe, sterilizing it and reassembling it was about $0.02 a foot. All the sanitary piping was 2-inch stainless steel and Mr. Van Bomel was quite proud of the fact that the new plant had almost no piping in evidence. As he explained it to me, National Dairies Corp. could afford to buy any known quantity of stainless steel pipe but the real cost was in keeping it clean. This plant was operating on 2 shifts, hence each foot of pipe cost $0.04 per day to wash and, because the plant operated 365 days a year, it would cost them about 8 times the cost of the original pipe just to keep it clean and sterile for a year. Thus, there was a notable incentive to minimize the length of the piping when laying out the new plant.

Well over a year of planning the plant layout was necessary before the industrial architects began to draw plans. Mock-ups of the several pieces of equipment were made and tried in a hugh number of assemblies until the right combination of arrangements was discovered. In the new plant there was so little piping for carrying fluid milk that one momentarily wondered if they had not forgotten to include some important pieces of equipment. This plant proved to be a very low cost operation and was a very profitable plant until a new set of conditions was faced.

In contrast to this plant, let us consider another plant in New Zealand where more milk is produced per square mile than almost anywhere on earth. It is not uncommon in the North Island to find 12,000 milking cows in a 10-mile radius. A British-owned and British-designed plant near Auckland has only about half the fluid milk capacity of the Sheffield Farms plant I just mentioned. But never in my entire, somewhat lengthy, career have I ever seen so much stainless steel piping in one place! They, too, cleaned and sterilized the piping every day. But they operate on only one shift and wages are so much lower that this item of cost receives scant attention. Products there are excellent and the company, a well known concern, operates at a satisfactory profit. Yet, to a cost-conscious American, that maze of glittering, stainless steel pipe, resembling ice on trees after a winter sleet storm, was a terrific shock. In the U.S.A. in the past few years milk pipe systems have been permanently installed. These in-place systems are now sanitized without disassembling.

After visits to plants in different parts of the world one is forced to conclude that, what we in the U.S.A. consider to be essential, is not always economic necessity elsewhere under far different conditions.

Time will not permit me to recount many case histories of the value of good industrial engineering in food processing plants. I can only generalize on the following lines about the corporate benefits from good industrial engineering that result in low-cost production. What I am about to say assumes that the product is good, that nobody has been cutting "cost-corners" by robbing formulas or substituting less palatable but cheaper ingredients in the processed foods.

Now any businessman knows that it is often possible to sell an item at a higher price than a similar item but it requires better salesmanship and considerably more sales promotion. So, as costs go up, relatively speaking, the selling expense goes up. In time the consumer may easily decide that her preference is for the lower priced item, and then sales may decline.

The remedy is, of course, lower manufacturing costs and to bring this about Industrial Engineering plays a very important role. There are, of course, other avenues of attack on the problem of high-cost products, but we shall stick to the Industrial Engineering aspects of the problem. Let me illustrate with another case history, that of Company D. This company was a pioneer in a new type of food product that was a convenience to the housewife. It could be cooked and ready to eat in about 20 minutes versus a couple of hours if it were wholly prepared in the home. A few years ago I had casually visited the plant and had no special purpose in view. The visit was over in about 40 minutes. Imagine my dismay, when I was invited to attend a weekly company meeting then in session and asked to criticize their operations.

In vain did I argue that any outsider who walked rapidly through a factory and then would attempt to tell the management how to run its business was not only an idiot, he was a damned fool! My argument went unheeded. They insisted that I tell them anything that I saw that could be improved. So I gave them my stock answer to the effect that anyone who asked my opinion did so at his peril! Then I sailed into their drying operation that had about a 20-hour cycle and was the bottle neck in the works. I realize that drying is a Process Engineering function rather than Industrial Engineering.

The story does not end here, however, although the company did not solve the drying problem until it had new owners. About a year after my visit, the old president asked my advice on how to get a competent review of their manufacturing methods. I suggested the employment of a consulting Industrial Engineer. And, on further request, I nominated one that I knew and respected. He was finally engaged for the job.

In two weeks of study (a contrast to my 40 minutes) he discovered a very curious fact: If everything worked steadily the plant could produce about 24,000 packages of food every 8-hour working day. But it never produced more than 10,000 to 14,000 packages a day. In time he found that by inserting a surge point at the proper place, when one department was held up by delays, the rest of the plant could go on operating. This change resulted in doubling the production without adding any new equipment and with only a few more workers at the surge point.

Just about this time, negotiations for a merger were under way but had not been concluded when the consulting engineer had solved the particular problem given above. He had not yet tackled the drying problem. As soon as capacity had been doubled, the president refused to continue merger negotiations on the old tentative basis and insisted on a new basis or -- no dice.

In time the deal was concluded but the buyer later blistered the consulting engineer with this remark:

"You so-and-so! You cost us just $2,000,000 more than we should have paid!"

BENEFITS FROM GOOD INDUSTRIAL ENGINEERING - A FEW CASE HISTORIES -

A few examples of good Industrial Engineering in food plants may be cited here:

Apple Growers Association, Hood River, Oregon, recently employed an industrial engineer on a consulting basis and liked him so well that they hired him permanently. A brief story of what he is accomplishing may be found in April, 1954 "Food Engineering." Like so many reports in this life, we can learn what has been done but why it is done is sometimes well nigh impossible to ascertain. In this case, according to my understanding, the plant property was completely surrounded with occupied property, yet the plant capacity had to be expanded from a capacity for handling 8,900 tons to 18,000 tons of Bartlett pears per season. This required expansion could be predicted several years in advance on the basis that the trees, in the orchards of the fruit growers whose association owned the plant, were maturing and each year bearing an increasing amount of fruit.

The engineering study developed a 5-year plan that has gradually been put into effect without seriously interfering with production. Part of the job involved the material handling operation from orchard to plant or cold storage warehouses. As a sample of what has been accomplished, consider the unloading of trucks of fruit in lug boxes at the plant. In 1952 it required 48 trips by two hand truckers to unload 288 lugs in 18.5 minutes. Standard unloading time was 40 man-minutes. Under the new system that employs clamp lift trucks that pick up a flock of lug boxes at a time, only 8 trips are required by one man and the standard unloading time is now only 6 man-minutes.

The man-hours per ton of raw material handled through the plant will be reduced by 34 per cent by 1957, yet employment will be increased by 29 per cent! Those who want further details are referred to the article by Clyde A. Skinner who carried out the job.

Another example is found in Heidelberg Brewing Company, Tacoma, Washington. Here, however, only one small operation was revamped: The uncasing of empty dirty bottles that had been returned for credit. The cases were for both 12 and 24 bottles and, to uncase them by hand for feeding into the bottle washing equipment at the rate of 575 a minute, 8 men were required. In breweries, the rule of thumb says that the average employee costs $6000 a year. So it was costing about $48,000 a year to uncase the bottles. After adequate study, an automatic uncaser was installed that requires machine attendance of 5 men, representing a saving of $18,000 a year. Other benefits, not included in this figure, are greatly reduced breakage, and elimination of a very fatiguing job.

ADVANTAGES OF EXTRA HIGH SPEED PACKAGING

This brings up a recent development that may be of considerable interest to you. Many plants, in food production as well as many other lines, produce quite a variety of different products. All must be packaged, and each change-over from one product to another requires a period of clean-up and, perhaps also, a change of parts on some of the machines to accommodate a different size of package on the same line.

About a year ago the chief chemist - not an industrial engineer - of a medium sized food company had been studying the problem of how to get increasing production of about 20 different products through the plant without building an addition to existing buildings. The plant was in a built-up area where further land acquisition would be exceedingly costly. Finally he came up with some calculations that seemed absurd to him, yet he could not find anything erroneous about his basic assumptions nor his computations. He came over to my office and together we went all over them again, but could find nothing wrong.

Here is what was bothering him. His theory was to purchase a high speed line of machinery that would operate at 240 a minute compared to the 60 a minute machines then on hand. The high speed line would have to operate only about 1/4 of the time to produce what the company could then be expected to sell. The rest of the time the line would be idle. High speed automatic packaging lines cost like sin, and several units, costing from $15,000 to $35,000 each, would be needed. Perhaps one complete high speed line would cost $80,000 to $100,000. Everything considered, his figures showed that it would be a paying investment and would permit the company to expand its sales for several years without adding more buildings. Yet how could so expensive an installation be profitable while idle about 3/4 of the time?

After I failed to find any errors in his figuring, I suggested that we call in a man whom I regard as knowing more about packaging machinery and production in general than any man I have met. We three had lunch together and when the chemist started to explain the problem, the third man interrupted him by saying, "You are absolutely right! We have done it ourselves. It looks screwball, but it is profitable."

Then he told us about his first discovery of the solution to a similar problem. His company had needed a much larger warehouse to hold its multiplicity of products. The problem he faced was that of determining how much larger to build it. After considerable study he concluded that, if higher speed machinery were installed, and if the speed of production were high enough, no additional warehouse space would be needed. He had been persuasive enough to get an appropriation to do what he wanted, and when the installation was complete it was found to have cost about half of what the new warehouse would have cost.

Better yet, because of the ability to produce at high speed, the company has a better balanced inventory in the warehouse; back ordering of "out" items has stopped; and the production costs are lower than ever before.

LAST FRONTIERS OF COST REDUCTION

Both Materials Handling and Packaging are important aspects of Industrial Engineering. These two are often said to be the last great frontiers of cost reduction.

Materials handling has had many spectacular advances in the food processing industry, particularly in the matter of handling the food raw materials from the field to the plant. For example:

Harvesting of pineapples in the Hawaiian Island plantations has been mechanized in large level fields by outriggers or booms on two sides of a truck. These booms extend outward about 20 feet from the truck body and each carries a narrow belt conveyor. The workers cut off the "apples" from the stem and deposit them on the belt which, in turn, carries them to the truck where other workers carefully stack them into large movable bins. The harvesting truck moves slowly down the field and workers exert no more effort than cutting the fruit and placing it on the belt. In prior practice the fruit was placed in a field box that weighed about 60 to 70 pounds when full. This required considerable walking to and from the boxes. Then the boxes were gathered up by a truck. This required more lifting. Next the truck had to be unloaded at the plant. More lifting. Under the new system the 8-ton loaded bins on the truck are lifted bodily by a Ross Truck that straddles the load and carries it to the processing or storage point. In this manner 16 tons of pineapples can be unloaded at the plant in one minute.

MANAGEMENT, PACKAGING, MATERIALS HANDLING AND INDUSTRIAL ENGINEERING

Now let us pay some attention to top management and its relation to packaging and the interrelation of packaging, materials handling and industrial engineering.

One of the strange phenomena of American industrial managements is the very sketchy way they handle the packaging function. Often the packaging materials and labor cost as much as, or even more, than the product in the package. Yet how is packaging managed as an industrial function?

It is not an easy problem or it would have been solved long ago. It is seemingly impossible to diagram the packaging function in any organization diagram I have yet seen.

No matter where you place it, Packaging must be related to nearly every department in the company. Yet packaging takes in more than a mere staff function. A very few companies have a Packaging Coordinator whose principal task is to be sure that every interested department has its say-so on any and every packaging decision. A few companies try to solve it by having a Packaging Committee with a permanent secretary and sometimes a staff of assistants. If time would permit, I could tell you tales for the next three hours that illustrate the problems of control (or lack of control) of the packaging function. And in most of the untold tales, the corporation president is unaware of what's going on or the waste it entails.

One of my gripes about top management in industry whether it be food processing, drugs, pharmaceuticals, chemicals, toiletries, paints or what have you - is management's seeming inability to see the obvious. Perhaps it is because the "Tops" seldom get out into the plant, and the normal records do not bring the obvious to their attention. While I have many criticisms about the management of industry my remarks here shall be restricted to Packaging.

How many of my listeners have any idea of how many people it takes to produce a food product and how many it takes to package that same product? Or to put it in another way, what percentage of total direct labor-hours are packaging labor-hours? The latter question is one that I love to put to chairmen, presidents and first-string vice presidents. Only two executives in the past four years have come even close to the actual figures pertaining to the business they are supposed to be managing.

In a survey I once conducted, covering 117 different products in 37 different plants, I learned the true figures. In the survey, the lowest figure we found was 26% in a brewery where beer was being canned at 450 per minute.

For the entire food processing industry the arithmetical average percentage was 59.6. It may interest you to know that in our survey the food processing industry showed the lowest percent. Yet more than half the direct labor hours are packaging labor hours.

The arithmetical average for all industry was 87.8%! Thus, on the average, roughly 4 persons are required to package the product turned out by 1 person. If any of you are skeptical, go into any plant where consumer goods are being manufactured and observe where the people are working.

An Example

Not long ago I was asked to criticize the packaging operations of a food plant. How could it be made more efficient? What new equipment should they buy? After a 2-hour inspection, my answer was that all they needed was a whole new factory -- that if they were spending MY money I would not consent to toying with a serious problem. The response was interesting.

"Oh we've heard all that before. We were hoping to learn something new. Isn't there anything we can improve without completely re-building?"

"Sure there is. Take that building over there--"

"What's the matter with that? It's a good operation."

"Well, here's what I saw. One dough mixer man. One oven man. One handy man to wait on the women. Twenty-two women putting the product into folding cartons. One man operating the carton closing machine, and packing the filled cartons into corrugated shipping containers and loading them onto the motor trucks. 22 persons out of 28 = 78.6% of your labor is contributing nothing but convenience to the retail purchaser of your goods."

He was flabbergasted and wanted to know what was the right percentage -- also what machines to buy to accomplish the labor reduction. Unfortunately there is no clean cut answer to either of his questions. If the machines were in existence I was sure he would have already purchased one. My suggestion was that he aim at not over 10 persons on the packaging line. I felt he could develop some home-made gadgets that would increase the productivity materially.

Packaging and material handling are very closely related. It is often a great mistake to consider one without simultaneously considering the other. It is not always possible to adopt optimum packages and optimum material handling techniques. Compromises are often necessary and sometimes very hard to attain.

An example of management's failure to utilize good industrial engineering is found in Company E which has just changed ownership. I call it a failure of common sense. Here is one of their principal problems --- packaging. The Company makes a powdery food product and packages it in small metal cans. They make the cans in their own plant -- a procedure that in this decade is pure luxury for, unless one uses a huge volume of cans (about 1/2 billion a year in a single plant) it is cheaper to buy from a can manufacturer -- and usually you get better cans.

This company owns old equipment in its can-making department. That means slow speed operations and consequent higher unit labor costs than with high speed operations. The company would not modernize its can-making equipment (1) because the slow speed operation produced empty cans at the rate at which the product was sold, and (2) the owners didn't want to.

To make cans, one must first buy the plate, and plate purchasing is a complex affair. It had been found to be cheaper per pound to buy unsorted plate. Here the term refers to sorting for weight which, in turn, is a measure of thickness. Hence the unsorted plate was of extremely variable thickness, which was all right up to this point. Unsorted plate is cheaper than sorted plate and the cans are probably just as good for this particular product as those made from uniform plate. The only difference is that the cans will be extremely variable in weight.

In that weight variation, the trouble begins, for Company E's packaging equipment employs what is known as gross-weight filling. In automatic packaging there are three methods of filling dry materials: gross weight, net weight and volumetric filling. If gross weight filling is used the presumption should be that the containers are of uniform weight if uniform weight of contents are to be obtained.

Probably most Industrial Engineers, outside the food industry, are not familiar with the Food and Drug laws of the United States or the several States and Municipalities. In brief - a package of a product must actually contain the same net contents as are declared on the label. If the label says "Net

Contents 1 lb.", the package must contain 1 lb. Time will not permit a review of the tolerances permitted nor of the principles employed in the enforcement of the law. Suffice it to say that usually the average net contents of 15 successive containers must average the net weight declaration while any deviations must not exceed a very small figure below the net-weight declaration.

Now to return again to the problem of Company E. This company produces a product that costs about $0.20 a pound before packaging. The container variations amount to a maximum of 0.12 oz. So Quality Control, well aware of the legal requirements, decided that all cans must be filled with 1 lb. plus 0.06 oz. That extra 1/16 oz. is to take care of the variation of weight of the container that comes about because Purchasing Department finds that unsorted plate is cheaper to buy than sorted plate. It was a choice of playing safe or running the risk of a federal seizure of goods for short weights. Lawsuits are very expensive and sometimes the attendant adverse publicity is even more expensive.

Now let's do some calculating. The company's 1-lb. line runs at 90 cans a minute for an 8-hour working day. That means they fill 90 x 60 x 8 = 43,200 packages a day and each one of them gets an extra 1/16 oz. of product worth $0.20 a pound in order to keep out of the toils of the law. So the company was giving away about $34 a day on one line because it thought it was cheaper to make its own cans, to buy cheap plate, and to continue to use its old gross-weight fillers instead of changing its ways. The company operates several lines.

There are opportunities for industrial engineers the food processing industries but don't say you were not forewarned about two important matters:

(a) The possible unfamiliarity of top management with the term Industrial Engineering.

(b) The desirability for somewhat more than a nodding acquaintance with Food Technology and the maze of federal, state and municipal laws and regulations with which food processors must comply.

SUMMARY

To sum up --- if my understanding of industrial engineering is correct, there is a big market for Industrial Engineers in the Food Processing Industry. In some plants the management is aware of what to do with an industrial engineer. In many plants the term is not understood and I doubt if the management would know what to do with one if he should offer to work for nothing -- as an Industrial Engineer.

But, if such a situation is encountered, and you want a job there, take almost any job they will give you and by your superior abilities you can soon gain recognition.

The venerable food processing industry has not yet attained the technical level of many of the newer industries.

Why there is so little acceptance of the term Industrial Engineering or why so few Industrial Engineers are employed as such in the food processing industries is a problem for your profession to solve. The opportunities are there to make considerable showings.

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