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MANAGEMENT SERVICES

a magazine of planning, systems, and controls

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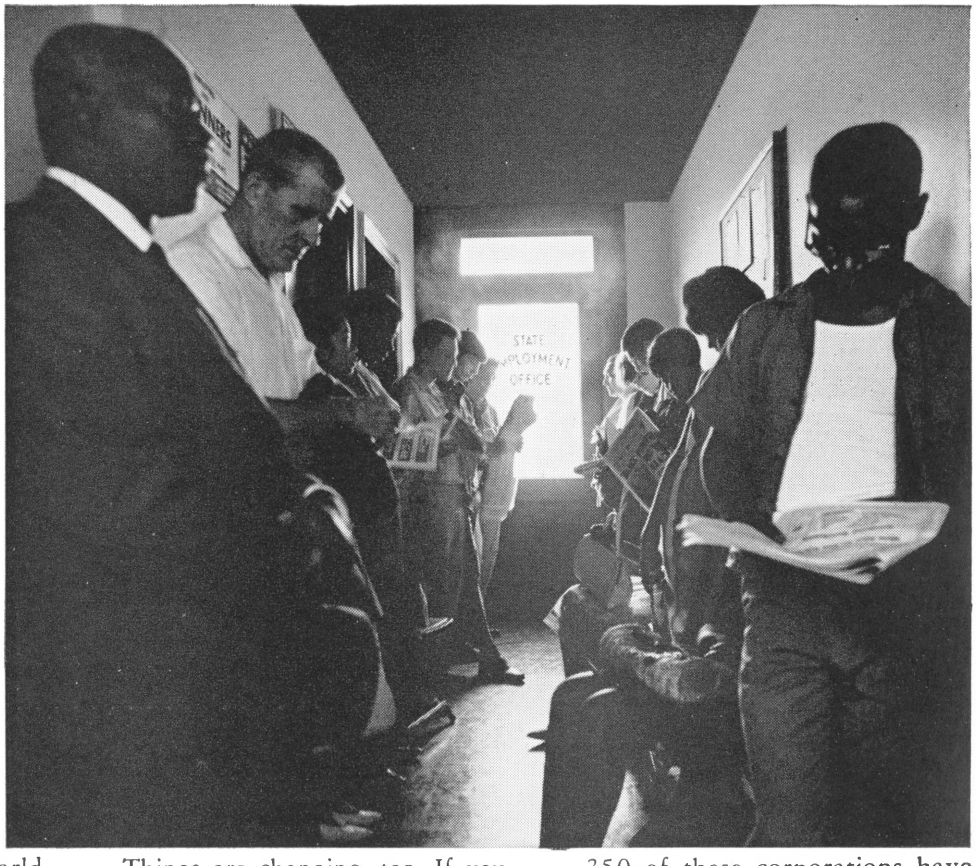
THE SKILLED LABOR SHORTAGE IS A MYTH.



As long as hundreds of thousands of unskilled American workers are unemployed, any talk of a skilled labor "shortage" is 100% nonsense.

You say typists are in short supply? How long does it take to train somebody to become a good typist? About two months. In two months, the shortage of typists could disappear. (Of course, many of the new typists might be from some minority group or other, but would that really matter?)

No welders around? Four months of crash training is all it would take to hatch a new, skilled batch.

Draftsmen, machinists, welders, assemblers, molders—the story is the same. A few months' training could work wonders.

Times are changing. Since World War II, thousands of new products and hundreds of new industries have appeared.

Yet during this time, there has been a systematic neglect of training for skilled trades. Doesn't make sense, does it?

(The companies in best shape today are those that sponsored training for unskilled workers during the non-shortage years. Score one for good old American horse sense!)

Things are changing, too. If you think it's still a buyer's market in labor you're due for a couple of rude shocks.

And if you still "don't like" to hire minority workers—for whatever reason—you'll learn that your business survival may well depend on these same minorities.

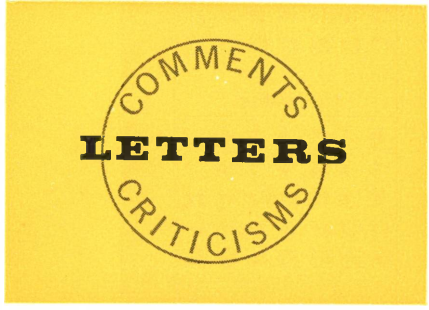
Many of America's top corporations are already spending millions to train people, including Negroes and other minorities, for skilled jobs.

350 of these corporations have formed a voluntary organization called Plans for Progress. They are working hard to spread the word about equal job opportunity and how to make it work for everybody. If you would like more information, write: Plans for Progress, 1800 G Street N.W., Washington, D. C. 20006.

Training the unskilled has many advantages; there are no disadvantages.

If you hear of one, it's a myth.

Things are changing.



Action program

To publish the excellent article by Doris Cook ("Why an Ancient Calendar in the Jet Age?" M/S, September-October, p. 35) is not enough. No change in the world is put to work or is welcomed without effort and exhortation. Miss Cook proved very neatly why accountants should have the most personal involvement in the improvements that a logical calendar would bring to the world, and to business management in particular.

Does the American Institute of Certified Public Accountants have enough concern and drive to organize business and professional societies to lobby for a modern calendar at the U. S. Congress and the United Nations?

Certainly a thirteen-month calendar can't be too controversial if it could receive 2,058 to 9 support at the Vatican Ecumenical Council.

If the only irregularity in the thirteen-month universal calendar is splitting quarters at weekends in the midst of months, it should be worth the effort of selling to the world, until the world is ready for a really logical calendar by discarding seven-day weeks in favor of twelve months of three ten-day weeks each, with an extra holiday at the end of each quarter and year to fill 365 or 366 days as needed. The national and United Nations assemblies would have to pass resolutions adopting the calendar, relocating all holidays (adjacent to weekends, hopefully), and settling a method for converting previous legal anniversaries and contract dates to the nearest equivalent dates on the new calendars. A universal calendar would seem to be one issue ideally suited for action by the United Nations.

James T. Bradbury
Holland-Suco Color Company
Holland, Michigan

Simple solution

One of the reasons, it seems to me, that have roadblocked the adoption of a revised calendar is the fact that it would affect the religious observances of Jewish, Christian, and Islamic groups. I feel that the influence of these religious groups is great enough to block any changes unless the sanctity of the holy days of each group is respected.

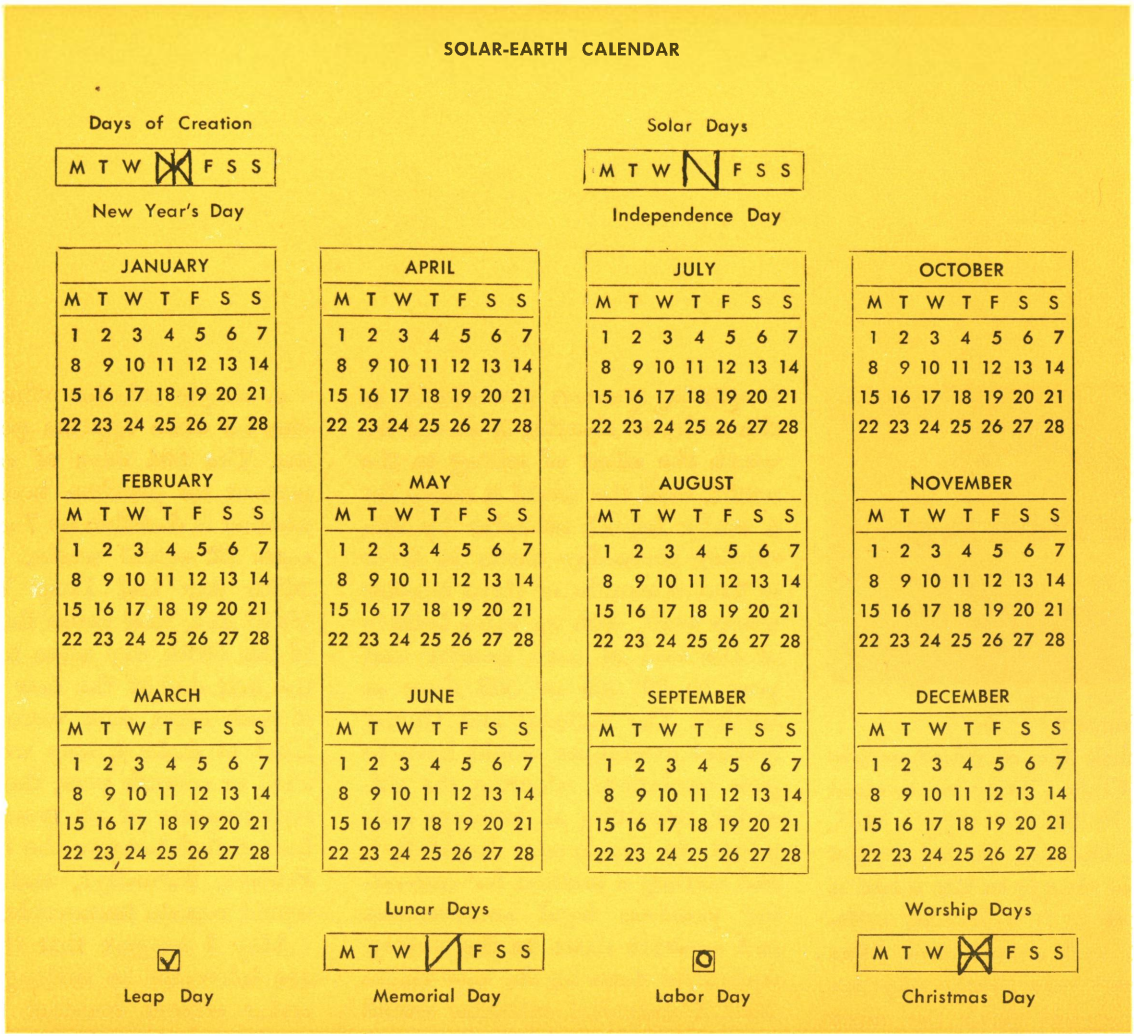
A simple solution whereby this can be done appears possible to me. The 364 days of each year present no problem because that number is divisible by 7 and represents 52 actual weeks. It is the 365th day and Leap Year, the 366th day, that cause the trouble. If the 365th day were to become the first day of the new year and if such extra days were accumulated to make a leap week every sixth or seventh year, the religious requirements of all groups would be satisfied because the respective Fridays, Saturdays, and Sundays would remain immovable.

May I suggest that those who are interested in making the calendar reform consider this suggestion, and perhaps then they could successfully revise the calendar.

Sidney E. Jaffe, Controller
Federation of Jewish Agencies of Greater Philadelphia
Philadelphia, Pa.

Another calendar

I read your article in the September-October issue of MANAGEMENT SERVICES about our ancient calendar. May I compliment you upon a very well written article. Certainly it opened many new avenues of thought for me as well as nicely solving the problems presented by the various calendars. I



really wonder how long it will take to change our present calendar. With the world becoming smaller, it also becomes larger in problems and complexity, and the hopes for a better calendar seem dim indeed.

May I take the liberty of suggesting still another calendar (as shown above), which I believe would gain acceptance by religious and labor groups. Some of the accountants' problems have been overlooked or magnified; however, with some thought, I believe, this calendar could . . . in the long run simplify the accountants' problems.

[It would have the following advantages:]

1. Two two-week holidays per year
2. An extra day (365th) for Labor Day
3. Twenty-one paid holidays per year (compared to ten days normal vacation and nine paid holidays now)
4. All months equal
5. All quarters equal (The first quarter includes Days of Creation; the second quarter includes Lunar Days; the third quarter includes Solar Days; the fourth quarter includes Worship Days.)
6. Each of these vacation weeks would become a separate reporting period for those companies working but would be included with the

proper quarter for quarterly reports.

Leap Day would be a quadrennial holiday. . . . All other holidays would fall on Saturday or Sunday, i.e., Thanksgiving would be November 27. Easter Sunday would continue to be the first Sunday after the first full moon that falls on or next after the vernal equinox (March 17, by my calendar).

New Year's Day has been placed on "The Wednesday of Creation," as this is representative of the fourth day of creation when the stars came into view and for the first time a year could be measured.

Christmas Day has been placed on the fourth day of worship, as it was on the fourth day of creation that the stars appeared, and a star signified the birth of Christ.

I choose to call this calendar the SOLAR-EARTH Calendar, referring to the relationship that exists between the sun and its planet earth.

H. Lewis Guiler, Jr.
Manager, Systems and Procedures
United Vintners, Inc.
San Francisco, Calif.

Historic continuity

Your informative article, "Why an Ancient Calendar in the Jet Age?" . . . was intended to sell calendar revision.

Seventh-day Adventists do not oppose calendar reform, but we do object to any plan that will disturb the historic continuity of the week. Any calendar that begins the year on the same day of the week each year will of necessity interrupt the continuity of the week.

There was a statement near the close of the article that gives the wrong impression. The Vatican Council, October 29, 1963, approved the idea of fixing the date for Easter *in the Gregorian Calendar.** It stated clearly that it would not approve any calendar revision that would disturb the regular succession of weeks. In actuality Mr. Rothe received no approval whatever. The Vatican Council action reads:

"The council considers the wish expressed by many for a fixed Easter Sunday, and for a permanent calendar, to be of no small moment, and hence, after paying due heed to the consequences that may follow from such a new calendar, declares:

"The council is not opposed to fixing Easter on a determined Sunday *in the Gregorian calendar,** provided this is agreeable to all others who are concerned with the problem, especially the Christian brethren separated from communion with the Holy See.

"Similarly, the council is not opposed to the various initiatives for establishing a perpetual civil calendar, provided the week of seven days with its Sunday is safeguarded and *provided the regular succession of weeks** remains intact—unless most serious reasons would, in the judgment of the Holy See, persuade otherwise."

Any Year-End Day inserted at the end of the year to cause the New Year to fall on the same day of the week disturbs the regular weekly cycle. In Miss Achelis' World Calendar the last day of the year is Saturday, December 30. The next day is Sunday, of course, but the new calendar calls it Year-End Day. The next day is designated Sunday, January 1, but it is actually Monday. The weekly cycle has been broken.

The Christian who worships on Sunday in commemoration of Christ's Resurrection will discover that the memorial of the Resurrection falls on Year-End Day, and a week later, seven days later, the Resurrection memorial falls on Saturday in the new calendar.

Similar difficulties will face those who worship on the seventh day of the week. This involves not only Jews but also Christians, such as Seventh-Day Adventists and Seventh-Day Baptists.

M. E. Loewen, Director
Religious Liberty Department
General Conference
of Seventh-Day Adventists
Washington, D.C.

*Italics supplied by the author of the letter

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NOVEMBER-DECEMBER, 1966

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REMINDER

Except for genuine hardship cases, volume mailers must pre-sort by Zip Code on or before January 1, 1967

The Zip Code deadline is January 1, 1967.

After that, only mail that is properly Zip-coded will be eligible for Second Class and Third Class Bulk rates. Unzipped mail will be accepted *only at the higher single piece rate.*

If you have not Zipped yet, you had better start right now!

Plenty of help is available. Both the U.S. Post Office and many private companies in the "mail sector" have already helped thousands of companies to Zip their lists quickly and efficiently. To help speed up your Zip conversion:

1. Call your local Postmaster. He will advise you on ways and means of converting to Zip, and show you how the Post Office can supply the Zip numbers you need for a nominal fee of only $1.50 per thousand.
2. Talk to your lettershop, addressing equipment salesmen, computer firms and other mail-oriented suppliers. They have developed many ingenious methods for Zipping lists at minimum cost to you.

Zip Code is here to stay!

Most businessmen clearly recognize that only through the modern Zip Code system can the Post Office hope to offer low bulk rates. But many are also learning to their surprise that Zip Code offers additional benefits to them.

During Zip conversion it is easy to clean your list of duplicate and dead addresses. Zip filing order makes "look-ups" quicker and easier. Zip Codes are already speeding mail deliveries, and a number of businesses find that Zip territorial divisions are useful tools in marketing, sales and other unexpected areas.

IMPORTANT

Extensions have been given to mailers who demonstrated that they had made a substantial effort in good faith to comply with the deadline but were unable to do so because of circumstances beyond their control.

Remember: Zip Code means better postal service at lowest cost to you. There are and will be problems for all of us to solve. But we can be sure of one fact: January 1 starts a whole new era of postal efficiency and economy that will benefit your government, your customers and your business.

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people, events, techniques

Expanding Economy Will Even Absorb Most Unskilled Workers Faster Than Automation Can Displace Them Through 1975, Labor Department Predicts

Glad tidings for those who fear their jobs will be taken over by the computer come from the U.S. Labor Department. Even the unskilled worker, supposedly hopelessly doomed, will survive the technological developments of the next decade, according to a new manpower survey.

"America's Industrial and Occupational Manpower Requirements 1964-75," issued by the Labor Department's Bureau of Labor Statistics, says the overall demand for workers will grow sharply through 1975. Professional workers will be in the heaviest demand, but, reports the Labor Department, "the major conclusion of this study, which takes into account every technological change in American industry that can be identified and makes a careful appraisal of its potential effect on employment, is that the overall demand for less skilled workers will not decrease over this 11-year period."

The Labor Department's BLS estimates that by 1975 white-collar workers will make up 54 per cent of the work force. Blue-collar workers will represent only 33 per cent of the working force, even though job needs in this sector will increase 17 per cent.

Assumptions

In publicly announcing its projections, the Labor Department emphasized that its estimates were based on assumptions of long-range economic growth provided by the National Commission on Automation and Technological Progress, which asked BLS to make the study.

These assumptions were:

By 1975 a 91.4-million work force would exist, with 88.7 million workers actually employed (meaning an unemployment rate of 3 per cent, virtually full employment).

Peacetime conditions like those existing before the Vietnam build-up would exist in 1975—which would mean 2.7 million in the armed forces, approximately the 1964 level.

Scientific and technological advances would proceed as they have in the past, and research and development expenditures would continue to grow but at a slower rate than has been true during the past 15 years.

The Labor Department warned that its projections of future employment needs will be affected insofar as actual events alter the Commission's assumptions.

Assuming they are accurate, the BLS predicts that by 1975 4.5 million more professional and technical workers will be needed—54 per cent above today's requirements. This is the sharpest increase predicted for any single job category.

Additional needs for engineers and even greater demand for scientists will be brought about by an increasingly technological economy plus expanding research and development programs.

Technological innovations in teaching, such as educational television and teaching machines, will not reduce the need for teachers but will greatly increase the need for researchers, writers, electronic technicians, and broadcast engineers.

Although the rate of growth in manufacturing will be less than in other categories, job needs in this

sector will increase annually by more than 1.3 per cent, which is more than double the rate of growth between 1947 and 1964. This increase will be due mainly to continuing economic growth and to a rising population. Use of computers and instrumentation in manufacturing production will increase employment among technical, maintenance, and supervisory workers, but the need for production workers will continue the decline of recent years.

Some industries will be less susceptible to automation advances than others, the Labor Department says. For instance, little employment change is anticipated for real estate firms because of their small size, while automation is expected to have a sharper impact on banking, insurance, communications, and air transportation. In spite of the job-shrinking effects of automation, most industries will show job growth. For example, construction employment will experience a projected one-third increase in manpower to more than 4 million, and it would grow even faster were it not for anticipated improvements in tools and building technique.

Minority groups

The report also projects employment trends among several minority groups. Nonwhite workers, unless they "gain access to white-collar and skilled jobs at a faster rate than they have in recent years," will continue to have a heavier-than-average unemployment rate.

Although the numbers of female workers will increase faster than the work force as a whole, the rise in white-collar jobs should enable women to find employment easily. However, the report warns, women can expect more competition from men in such traditionally female jobs as social work, teaching, and library work.

With the supply of younger workers growing at such a fast rate, youngsters will continue to experience a high rate of unemployment unless industry takes such steps as promoting them faster to skilled jobs or lowering the minimum age for workers in certain occupations, using the younger workers as apprentices or aides to the relatively more scarce and experienced workers.

Joint Ventures Expected To Become Increasingly Important Abroad: NICB

International joint ventures are multiplying rapidly and are expected to continue to increase over the next decade.

In fact, "many believe that the international joint business venture will become the most important vehicle of private foreign investment," according to a National Industrial Conference Board survey of 146 top-level businessmen in 54 countries.

NICB found the strongest support for joint ventures in the developing nations, where money and technology are desperately needed to build basic industry. Although the consensus of those surveyed was that initially the underdeveloped countries will gain most from the spread of joint ventures, ultimately all countries will share in expanded trade and improved international political climate, the NICB reports.

The majority of companies surveyed believe that joint ventures, by pooling resources, experience, and abilities, can offer widespread benefits—in unlocking new markets; opening up world trade; providing capital, skills, and technology where they are most needed; and helping to erase the wide economic and political gap between the poorer and richer nations.

One of the major appeals of joint ventures, according to the NICB survey, is that they reduce many of the risks, both economic and political, of foreign investments. For instance, having a local partner not only serves as a safeguard against outright expropriation in the more unstable countries but also offers protection against nationalistic sentiment, which exists to some extent in all nations.

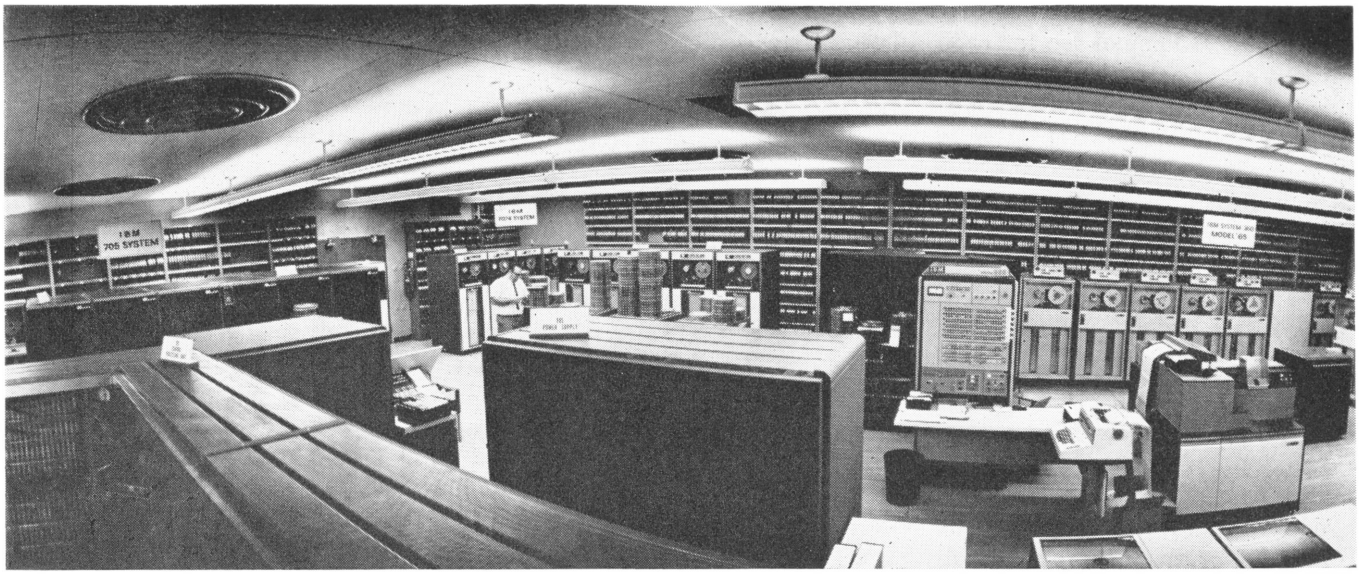
The major hazards of joint ventures are divergent objectives and management practices, lack of mutual confidence and respect, and failure to anticipate and resolve conflicts of interest before agreements are signed. As an Australian executive points out: "Partnership, like marriage, should not be entered into lightly and not at all if there is any doubt that it can be continued."

Reluctance

Some companies, however, are still wary of joint ventures and accept them only when they are made mandatory by the policies of the host country. The chief reason for this reluctance is that shared ownership means shared management and shared profits, plus a loss of the essential freedom and control that go with single, complete ownership. Other companies wanting to take advantage of shared risk and knowhow nevertheless insist on majority equity or extensive contractual safeguards to protect their financial and management interests. Still others will voluntarily accept a minority ownership in order to enter highly competitive markets or those markets which are virtually closed to outsiders by protective trade or investment barriers.

In general, the survey finds that while executives show a strong preference for majority ownership in joint ventures with foreign partners, a considerable number of them favor the practical and psychological benefits of the "50-50 partnership."

The NICB survey also notes that to a great extent the acceptability of the joint venture depends upon the type of venture to be established. Many executives stressed that they would consider forming joint ventures in manufacturing but preferred to avoid them in mining



In a rare display of almost the entire history of computers, this data processing room at Aetna Life & Casualty Insurance, Hartford, Conn., houses three generations of computers all of which are still in use. At left is IBM 705, which uses vacuum tube circuits; in center is IBM 7074, which uses transistorized circuits; at right is IBM System/360 Model 365 with micro-miniaturized circuits. A job that took the 705 four minutes takes six-tenths of a second on the 360.

or other extractive operations which might lead to conflicts of interest caused by the general instability of raw materials prices and governmental pressures to bring national resources under local control.

Western Union, Job Search Group, Form National Service

Information Science, Inc., White Plains, New York, is offering a new, nationwide job-finding service, using a computer to match qualified men and women with professional positions on a continuous, confidential basis.

The service, called PICS (Personnel Information Communication System), is being marketed for Information Science, Inc., by Western Union. Western Union has purchased a one-third interest in the system with an option to acquire the remaining interest at a later date.

The purchase is Western Union's first investment in an outside business in the new information field it is entering.

Information Science plans to use Western Union's computer center network, its communication system, and its nationwide network of telegraph offices to automate PICS so that the job-search service will operate coast to coast on a real time basis.

The PICS service, which uses computers to match the qualifications, earnings, and other data about professional, technical, and administrative people with the requirements of employers looking for identical talents, works like this:

Executives, scientists, accountants, engineers, salesmen, and others who want to be kept informed of opportunities in their own or related fields, simply call Western Union and ask for "Operator 77." Operator 77 takes the caller's name and address, and he is sent information about the service including special forms for listing the applicant's skills, qualifications, present position, and salary requirements.

When the applicant returns the data, they are stored in a central computer system. For a membership fee of $1 a month, payable annually, an individual's skills, preferences, and background are classified in more than 1,300 different categories. These individual profiles are matched daily with all career opportunities.

Employers seeking talent call Western Union and ask for "Operator 88." They are sent "recruitagram" forms on which they list job specifications and salaries being offered. When these forms are returned, this information is also fed into the PICS computer, which matches individual skills against the job opportunity.

Skill-matching process

The computer checks each job against all PICS members. Each time an individual's record matches an opening which represents a higher salary for him, he receives a detailed description of the job. At the same time, a confidential resume is sent to the interested company. The individual is identified on the resume only by code.

The identity of any PICS member is revealed only if the company is interested in interviewing him. He is under no obligation to accept or even consider the position and if he does accept a position there is no placement fee.

Employers using the PICS ser-

vice pay a fee for each computer search and a nominal fee for each resume which matched the position on the computer search. An employer can specify the number of resumes desired.

In addition to its skills-matching function, PICS provides its members with a comprehensive salary analysis showing each member where he stands in his profession with comparisons according to age group, experience level, and educational background.

Information Science emphasized that it is not in the employment agency business and PICS is not primarily for the unemployed job seeker. A separate information service for agencies concerned with immediate job placements will be announced early in 1967, the company said.

Western Union Receives Hospital Planning Contract in New York

The Hospital Review and Planning Council of Southern New York, Inc., has awarded Western Union a contract for a study of the feasibility of a computer communications system which will provide information on hospital beds available for emergency cases in Brooklyn, New York.

The study will determine the most effective means by which the 42 municipal, voluntary, and proprietary hospitals in Brooklyn may exchange information on the status of hospital beds according to hospital departments—i.e., beds for emergency adult medical and surgical, pediatric medical and surgical, and obstetrics.

The 16-week study is being conducted in ten representative hospitals in Brooklyn. When it is completed, Western Union will make a complete report to the Council which will include recommendations for system design and specifications for hardware, programing, and operations.

The Council is a nonprofit organization dedicated to coordinating hospital and health services and to planning the development of these services in relation to community needs.

This assignment to Western Union follows the earlier development of a similar system for pediatric bed assignment. Inaugurated in June of this year, the system links nine Brooklyn hospitals and medical centers to a computer center located at the State University of New York Downstate Medical Center in Brooklyn.

Survey Shows Most Large Firms Use Outside Executive Recruiters

Nearly three-fourths of the nation's 500 largest corporations engage the services of outside executive recruiting firms to locate executive employees.

This was the conclusion of a survey of executive hiring habits recently conducted by DeVoto Associates, Inc., a Chicago-based management consulting firm which specializes in executive recruiting projects for its clients.

The 500 companies polled in the survey were those listed in *Fortune* magazine's directory of America's largest corporations.

According to the answers of nearly two hundred directors of industrial relations responding to questions posed in the survey, seventy-four per cent of the companies engage recruiting firms one or two times a year; ten per cent use them to hire from ten to twenty executives annually; and five per cent use outside firms more than twenty times a year.

Although top corporations prefer to promote from within whenever suitable executives are available among their own staffs, the survey showed that—

- Forty-four per cent of the companies hire more than ten per cent of their executive replacements with the aid of outside search firms.
- Only thirty-eight per cent promote as many as ninety per cent or more of their own executives from within their own ranks.
- Fifteen per cent promote half or fewer of their executives from within.
- Ten per cent conduct their own staff searches to find fifty per cent or more of their executive replacements.

As Donald E. DeVoto, president of DeVoto Associates, pointed out, the very large corporations surveyed have large personnel departments of their own and can probably rely on promotion from within much more than the thousands of middle-sized businesses throughout the country. Another survey is planned for the future, he said, to explore the full extent of outside recruitment of executive personnel.

Honeywell Announces Price Increases on Entire 200 Line

Honeywell, Inc., recently announced a range of price increases in the rental and purchase prices of its Series 200 computer equipment.

Effective December 15, the increases will vary from 2 to 4 per cent, depending upon the type of equipment and the term of the lease involved. Present leaseholders will not be affected by the increase until their contract terms expire, the company said.

According to Walter W. Finke, vice president of Honeywell's computer group, Honeywell intends to increase its expenditures for software (compilers, operating systems, applications packages, and other types of programs) by more than 50 per cent this coming year.

"This factor," Finke said, "combined with the increasing costs of obtaining money to finance the rapid growth of our deferred-in-

come business, has necessitated the selected price increases."

The increases only apply to the six computer systems in Honeywell's third-generation Series 200 line.

Other major manufacturers have indicated that they are keeping close tabs on the computer price situation. Shortly before the Honeywell announcement, IBM Corporation announced a 3 per cent increase in renting prices of most elements of the IBM System/360 computer line, effective January 1. IBM also reduced the purchasing prices of the same items, however, by 3 per cent, retroactive to September 19. RCA and Control Data Corporation indicated that they are studying the price situation but as yet have not announced any decisions. General Electric announced an increase of about 4 per cent in rental charges on its GE-400 and GE-600 series of computers and the Datanet-30 communications controller, effective October 24.

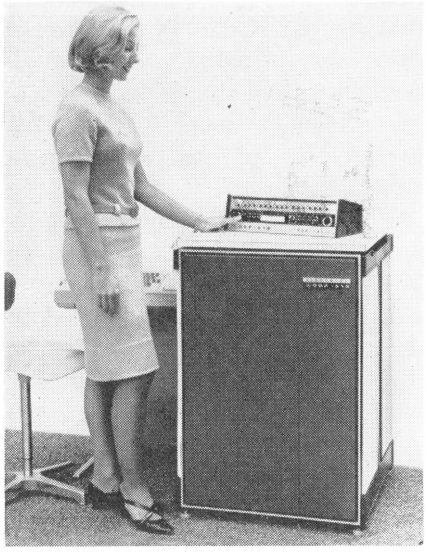
Honeywell Shows New Control Computer at California Meeting

Honeywell, Inc., showed its newest control computer, the μ-COMP DDP-516, at the San Francisco Fall Joint Computer Conference held early in November.

Company authorities say DDP-516 is designed to double Honeywell's share of the small control computer market, currently growing at a rate of 20 to 25 per cent each year.

The on line-real time machine can be used for a variety of purposes. Honeywell claims it is equally adapted to such applications as physics research, railroad control, data reduction, and process control.

The new product, which is available for delivery in 90 days, is a product of Honeywell's Computer Control Division, the entity created when the Computer Control Company, Inc., joined Honeywell, Inc., in May of this year.



Honeywell introduced its new Model 516 control computer at the recent San Francisco Fall Joint Computer Conference, held early in November.

Basic price for the machine with teletype is $25,000, says Honeywell. It has a 72-command instruction repertoire with a memory capacity of 4,096 words. Memory can be increased to 32,768 words. Cycle time is 960 nanoseconds (billionths of a second).

Electronics Invades The Animal Kingdom, Measures Milk Output

If Elsie the cow hasn't been producing her share of milk and butter fat, she had better get to work, because her pasture may soon be under the watchful eye of a computer.

The Dairy Herd Improvement Computing Service in Provo, Utah, is now using an IBM 360 to help take some of the guesswork out of herd management. DHI serves 1,400 member farms of the Dairy Herd Improvement Association and keeps records on a total of 120,000 cows.

Under the new DHI system, dairymen are supplied with special forms on which once each month they enter the daily weight of milk and percentage of butter fat each of their cows produces. They then send these forms to DHI's headquarters where the information is punched into IBM cards and fed into the 360 computer.

The computer then prints out a record of the cow's current production along with its historical production figures, which have been on file in the computer. Another sheet is printed out showing the individual cow's standing in relation to the rest of the herd.

"By comparing production records with breeding," said Bliss H. Crandall, owner of DHI, "the dairyman knows which sires and dams to breed, which to provide additional feed, and which to cull from the herd."

So watch out, Elsie, or you may soon be culled by an IBM 360 Model 30 computer.

Managers, Not Owners, Main Beneficiaries of Mergers, Study Says

It is not the stockholder who benefits from mergers but the managers of the acquiring company. It is not the merger-minded firm but the firm that relies exclusively on internal growth that offers the stockholder the most profitable deal.

At least these are the conclusions drawn in a study conducted by John Bossons, Kalman J. Cohen, and Samuel Richardson Reid, which Reid recently presented before the Senate Subcommittee on Antitrust and Monopoly.

The authors are, respectively, assistant professor and associate professor of economics and industrial relations at Carnegie Institute of Technology and visiting Ford faculty research fellow at Carnegie Tech.

In testing their hypothesis that "large firms which merge are firms

which tend to be oriented more to managers' interests than to stockholders' interests," the three economists studied merger and stock market performance of 478 large U.S. industrial firms from 1951 to 1961. The following are among their more important findings:

- Common stock prices of companies that grew only internally shot up 680 per. cent during the ten years under study, while actively acquiring companies (with 11 or more mergers on record) advanced only 307 per cent, on the average.
- Companies growing internally showed better results in earnings per share than merging companies, where earnings for pre-merger stockholders were diluted by new acquisitions.
- Even when the economists broke down the list of companies into various industries, the results for the most part were similar, although in some sectors, such as machinery, petroleum, and paper, the merger rate did not reflect any significant statistical difference in stock prices. However, considerable disparities showed up in other industries. For instance, in chemicals stock prices advanced 2,003 per cent for the internal growth companies as compared with a 158 per cent advance for the most active merger-makers. Stocks in primary metals rose 294 per cent for the companies depending on internal growth, while stock prices declined 174 per cent for those most active in the merger game.

Why mergers?

The big question is—if mergers don't generate profits for the pre-merger stockholders and thus do little to boost the company's stock performance (presuming that one affects the other), then why do companies persist in playing the merger game?

The authors suggest that the profit motive is no longer first on the list of managerial objectives. Instead the authors attribute this persistence of continued merger programs to management's independence from stockholders and to management's desire for "security, power, prestige, and advancement within the firm."

It is not surprising that this study has raised a howl from those on Wall Street who play the merger game with gusto and has stirred up controversy among experts in Washington and in the academic world. Some critics question the authors' statistical work, and bankers and brokers active in mergers deny that management puts its interests before those of the stockholders. They explain mergers by pointing to management's desire to exploit new markets, arguing that mergers help save time and mistakes and that the new acquisition usually adds stability, diversity, and ultimately bigger profits to company operations.

The authors say it would be nice if this were so, but the figures say otherwise. Economists are just as unwilling to dispute the classical economic theory of the profit motive as prime mover in an efficient market economy as are the merger-makers, but, Reid warns, "If economists are going to have any impact at all in this area, they must explore the possibility that managerial and stockholder interests may differ, and that the profit motive may not operate as well as theory supposes in large, publicly held firms."

Federal Trade Commission economist Willard F. Mueller told the Senate subcommittee that the number of large-scale mergers had continued to increase through the first half of 1966 and offered the authors some support, saying that "their explanation may be oversimple, but it may also be as good a single explanation of mergers as profit maximization."

The three economists do admit the possibility that the study covers too brief a time span to indicate the ultimate profitability of large-scale mergers. But even though they eventually plan to update the study, they doubt that their findings will be altered significantly.

The study does not present an entirely gloomy picture for merger-minded companies, however. In addition to the 74 companies that actively merged and the 48 companies that did not merge at all, the economists studied the performance of 356 companies that only made from one to ten acquisitions from 1951 to 1961. The authors found some evidence that the more active merger-makers (those with 11 or more acquisitions) do a better job for their stockholders than the mere dilettantes in the merger game—perhaps because managers improve their administrative procedures after grappling with the first few acquisitions. However, the authors still warn that even the more experienced merging companies can't beat the stock or profit performance of the companies that expand internally.

The study, "Mergers for Whom—Managers or Stockholders?" was published by the Graduate School of Industrial Administration, Carnegie Institute of Technology, in April, 1966.

Executives in Charge Of Foreign Operations Rise Fast, NICB Says

The executive responsible for international business operations in many American companies is becoming increasingly important in the company hierarchy as international business itself becomes more important.

A recent report by the National Industrial Conference Board, based on a study of 200 large and small firms doing a substantial business abroad, documents this change.

"The signs are all about us," reports H. Bruce Palmer, Conference Board president, "with presidents of international divisions becoming presidents of the parent company, with international units disappear-

ing from the company organization chart, and with the internationalization of the top management structure and the merging of international and domestic responsibilities into integrated global assignments.

"Some believe that before another fifty years have passed the separate foreign division will be an anachronism," he continued. "Companies with serious foreign interests will no longer think or act as if the United States were 'home' and other countries were 'abroad' but will view the whole world as home."

The NICB study also finds that the international executive's authority is often equal to or greater than that of executives in charge of domestic divisions. Approximately seventy per cent of the executives have officer status in their firms, while an even larger percentage are members of top-level committees and thus have a voice in broad company policy decisions.

IBM Service Bureaus Establishing National Network, Based on 360s

IBM's Service Bureau Corporation has announced that more than seventy of its local Service Bureaus will be tied into a national network linked by 12 central processing stations by 1969.

Each of the local bureaus will be equipped with a System/360 data processor, ranging in size from the basic Model 30 up to the Model 75. Local customers requiring the use of even larger 360s will have them available through data communications links between the local bureau and the Central Processing Bureau.

This will make it possible, according to SBC spokesmen, for the corporation to offer a complete range of services to any customer at any location, whether his need is for scientific or commercial data processing.

Twenty-five System/360s have already been installed, and each of the Central Processing Bureaus is scheduled to have two Model 30s and one Model 20 360 installed and operating within eight months. All 12 of the Central Bureaus will be tied together by data transmission lines within nine months. The entire network, utilizing more than 125 System/360s and 181,000 miles of leased private communications lines, will be completely operational by 1969.

IBM offers hospital unit

To help hospitals cope with a rising flood of laboratory tests, IBM has announced an electronic information-gathering system especially designed for clinical laboratories.

The new IBM 1080 records the results of hundreds of varieties of clinical tests, as they are performed, in machine-readable form — either on punched cards or punched paper tape. The cards or tape are then processed by a computer to yield printed reports on test results for immediate delivery to doctors or laboratory managers.

Directly connected to laboratory instruments, the IBM 1080 eliminates most of the errors that can occur in transcribing instrument readings by hand. Patient specimens, for example, are each assigned an identification number which is automatically recorded along with each test result so that mix-ups will not occur. The computer can also be instructed to perform a "reasonability test" to see if a patient's test results are in keeping with his medical history.

The basic 1080 system includes an IBM 1081 Model 2 control unit, through which all information about laboratory tests and specimens is fed, and either a card or paper tape punch. Test results can be processed by IBM computers already in use in many hospitals. The basic 1080 data acquisition system can also be expanded for use with automated instruments. Deliveries will begin in mid-1967.

AICPA Calls for More Stress on 'Concepts' in Accounting Education

Developments in management brought about by new methods in mathematics, statistics, and probability and the problem solving potential of computers are two of the factors creating a need for sharp changes in the traditional accounting curriculum.

That is the principal theme of "Horizons for a Profession" in the September issue of the *Journal of Accountancy*, official publication of the American Institute of CPAs.

The article, by Robert Roy, dean of engineering science, Johns Hopkins University, and James H. MacNeill, chairman of the department of accounting, Fordham University, is a preliminary report on a study to be published next year by the AICPA.

The study, jointly financed by the Carnegie Corporation and the AICPA, was aimed at finding the "common body of knowledge" needed by those entering the accounting profession in the future as beginning CPAs. The findings stress the need for today's accounting education to emphasize "conceptual understanding over procedural skill."

The authors predict an accounting education trend with much heavier emphasis on instruction in basic disciplines and relatively less on descriptions of experience. There should be more instruction in mathematics, statistics, and probability than there has been, the article says, since mathematical and statistical techniques are being applied to problems of decision making in business.

"Accounting," says the article, "as the oldest and best established of the quantitative techniques to aid in managerial decisions, is in a singularly strong position with respect to those new methods, provided there is requisite knowledge, creativity, and imagination to use them."

Traditional accounting has different techniques for almost every field in which it deals. Yet the use of simple matrix algebra could make all such procedures almost uniform—and simpler, as well—

A PROPOSAL FOR CONDENSING DIVERSE ACCOUNTING PROCEDURES

by A. Wayne Corcoran
University of Connecticut

WHENEVER a person proceeds from one accounting area to another, he encounters what seems to be an entirely new set of inputs, rules, definitions, and procedures. As traditionally presented, such diverse accounting areas as partnerships, process cost accounting, liquidation statements, consolidated financial statements, variance analysis, determining overhead absorption rates, and preparing depreciation lapse schedules—to mention but a few—seem to be virtually unrelated. In 1953 A. C. Littleton recognized this problem when he wrote:

"In actual historical evolution, accounting principles have been slowly distilled out of accounting actions. That is to say, accounting rules, having first been the fruits of tentative actions, grew in significance until they became guides to predetermined actions. As these accounting particulars grew increasingly diverse and complex, so did accounting actions and the accompanying rules, customs, practices. And as this diversity of particulars falls under more and more critical consideration, it becomes increasingly advisable to decide whether there are elements of order, sequence, interrelation within the mass."[1]

Not only is this lack of interrelationship annoying, bewildering, and time-consuming, but it is also unnecessary. This article advocates the use of the mathematical tool of matrices to interrelate diverse accounting areas from a procedural viewpoint. It shows how just a few, simple matrix manipulations may be used as substitutes for the myriad procedures now employed to accomplish allocation.

Accounting procedure structure

Much of traditional accounting procedure involves the acquisition, valuation, and allocation of input

BASIC STEPS IN ACCOUNTING PROCEDURE

Process Cost Reports		Liquidation Statement
The listing of material, labor, and overhead components	Acquisition	The listing of all available assets
The determining of historical cost outlays of components	Valuation	The determining of realizable values of assets
The distributing of valued cost components to output designations	Allocation	The distributing of valued assets to various types of creditors and owners

EXHIBIT 1

data. Concentrating on these processes makes it possible to interrelate diverse accounting areas. Let us illustrate this idea by referring to two accounting areas that perhaps, at first glance, seem related only in that money and accounting are concerned. These areas are the preparation of process cost reports and the preparation of liquidation statements. These areas may be viewed in terms of their acquisition, valuation, and allocation phases as shown in Exhibit 1 at the top of this page.

The similarities between these areas are now more apparent. Both involve listing a set of inputs (acquisition phase), determining appropriate values for these inputs (valuation phase), and distributing the valued inputs to output destinations (allocation phase). Likewise, the differences between the two areas are evident: The inputs in process costing are data on materials, labor, and overhead while those involved in liquidation are data on all available assets. The values assigned to inputs in process costing are historical cost outlays while those in liquidation are realizable values. The output destinations in process costing are product costs while those in liquidation are claimants' equities.

Because these two accounting areas are most similar to each other in the allocation phase, it would seem that their interrelationship could best be accomplished by concentrating on allocation processes. The inputs and outputs in the various accounting areas differ, and so do the methods of input valuation. Thus, the acquisition and valuation processes are not likely to lead to extensive interrelation. This leaves us with allocation processes as the most promising avenue. We seek, therefore, the answer to the question, "Can the allocation of inputs to outputs be standardized so that diverse accounting areas may be interrelated?"

In mathematics the framework for allocation problems is found in vector spaces, and the allocation process itself is carried out by transformation matrices. A matrix may be defined as something that consists of rows and columns of numbers. These rows and columns of numbers are referred to as vectors, and a matrix consists of one or more vectors. This is a row vector: (1, 3, −1, 4); this is a column vector: $\begin{bmatrix} 8 \\ 2 \\ 0 \end{bmatrix}$. An example of a matrix containing more than a single vector is $\begin{bmatrix} 2 & 1 & 0 \\ 1 & -2 & 5 \end{bmatrix}$.

Vectors and matrices may be added and subtracted element by element, provided they have the same dimensions. For instance:

$$\begin{bmatrix} 2 & 1 & 0 \\ 1 & -2 & 5 \end{bmatrix} + \begin{bmatrix} 3 & 5 & 2 \\ 6 & -1 & 0 \end{bmatrix} = \begin{bmatrix} 5 & 6 & 2 \\ 7 & -3 & 5 \end{bmatrix}$$

Vectors and matrices may be multiplied, provided the number of columns in the lefthand matrix equals the number of rows in the righthand matrix. The exact procedure for multiplication is expressed in the formula:

$$c_{ik} = \sum_{j=1}^{n} a_{ij}\, b_{jk} = a_{i1}\, b_{1k} + \cdots + a_{in}\, b_{nk}$$

where: $i = 1, 2, \ldots, m.$
$j = 1, 2, \ldots, n.$
$k = 1, 2, \ldots, r.$

EXHIBIT 2

DEPRECIATION MATRIX

b (depreciable bases)	r (rates per time period)	L (lapse schedule)				Totals
60,000	.4, .3, .2, .1	24,000	18,000	12,000	6,000	60,000
80,000		32,000	24,000	16,000	8,000	80,000
20,000		8,000	6,000	4,000	2,000	20,000
	Totals	64,000	48,000	32,000	16,000	160,000

Consider this problem:

$$\underset{(2\times 3)}{\begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \end{bmatrix}} \underset{(3\times 4)}{\begin{bmatrix} b_{11} & b_{12} & b_{13} & b_{14} \\ b_{21} & b_{22} & b_{23} & b_{24} \\ b_{31} & b_{32} & b_{33} & b_{34} \end{bmatrix}} = \underset{(2\times 4)}{\begin{bmatrix} C \end{bmatrix}}$$

a_{ij} represents any element from Matrix A; the subscript i indicates the row number and the subscript j indicates the column number.

b_{jk} represents any element from Matrix B; the subscript j indicates the row number while the subscript k indicates the column number.

Let us substitute arbitrary numerical values and see what Matrix C looks like.

$$\underset{A}{\begin{bmatrix} 2 & 1 & 0 \\ 1 & -2 & 5 \end{bmatrix}} \quad \underset{B}{\begin{bmatrix} -2 & 3 & -1 & 4 \\ 1 & 8 & 1 & 0 \\ 4 & 0 & 2 & 4 \end{bmatrix}} =$$

$$\underset{C}{\begin{bmatrix} -3 & 14 & -1 & 8 \\ 16 & -13 & 7 & 24 \end{bmatrix}}$$

To see how an element of Matrix C is determined, let us apply the formula to determine c_{23}.

$$c_{23} = \sum_{j=1}^{3} a_{2j}\, b_{j3} = 1(-1) - 2(1) + 5(2) = 7.$$

Depreciation application

Perhaps the simplest accounting application of matrix multiplication is to be found in preparing depreciation lapse schedules. Here the accountant is concerned with allocating portions of the depreciable bases of assets—the inputs of the problem—to appropriate time periods—the output designations of the problem. This problem is illustrated in Exhibit 2 on page 16.[2]

Note that Matrix L arrays inputs (assets) according to outputs (time periods). This form of schedule clearly depicts allocation and is easily understood. It can be made to result from other types of matrix multiplication, but the important thing is that the more widely used the matrix schedule is the more interrelation among accounting areas will exist.

Process cost application

Let us return now to the preparation of process cost reports and statements of affairs and see how matrices may be used to further interrelate these accounting areas.

Exhibit 3 on this page contains a generalized presentation of a matrix approach to preparing a process cost report. The dashed lines in Matrix A and Vector b indicate partitioning. Wherever the partitions are drawn, the usual procedure of multiplication of column and row elements and the summing of individual products must be halted, and the results to that point must be entered in separate vectors.

For instance, without partitioning we would determine the elements in a product matrix, C, as was described previously, that is

$$c_{ik} = \sum_{j=1}^{n} a_{ij}\, b_{jk}.$$

Suppose now that Matrix A is partitioned after Columns 3 and 7 and hence Matrix B is correspondingly partitioned after Rows 3 and 7. There would be three matrices resulting from the multiplication of the separate partitioned matrices,

$$\sum_{j=1}^{3} a_{ij}\, b_{jk}, \quad \sum_{j=4}^{7} a_{ij}\, b_{jk},$$

$$\text{and} \quad \sum_{j=8}^{n} a_{ij}\, b_{jk}.$$

The separate vectors may then

PROCESS COST MATRICES: AVERAGE METHOD, SINGLE PRODUCT

Equivalent Production Computation:

A

Outputs / Inputs	T	E	L
"Preceding"	1	1	1
"Materials"	1	f_M	g_M
"Conversion"	1	f_C	g_C

b e

$$\begin{bmatrix} T \\ E \\ L \end{bmatrix} = \begin{bmatrix} T \\ T \\ T \end{bmatrix} + \begin{bmatrix} E \\ f_M E \\ f_C E \end{bmatrix} + \begin{bmatrix} L \\ g_M L \\ g_C L \end{bmatrix} = \begin{bmatrix} E_P \\ E_M \\ E_C \end{bmatrix}$$

Unit cost formula:

$$U_i = \sum_{j=1}^{2} I_j \div E_i$$

Cost Allocation:

$$\underset{U}{\begin{bmatrix} U_P & O & O \\ O & U_M & O \\ O & O & U_C \end{bmatrix}} \underset{D}{\begin{bmatrix} T & E & L \\ T & f_M E & g_M L \\ T & f_C E & g_C L \end{bmatrix}} = \underset{R\ (\text{cost report})}{\begin{bmatrix} U_P T & U_P E & U_P L \\ U_M T & U_M f_M E & U_M g_M L \\ U_C T & U_C f_C E & U_C g_C L \end{bmatrix}}$$

KEY:
- A = Matrix containing proportions of each output quantity appearing in each input category. Note that the rows (labelled) show the input categories while the columns show the output designations.
- b = A vector showing the total quantities in each of the three output designations (T, E, L).
- e = A vector that shows the equivalent production (E_i) for each type of input.
- T = Units transferred.
- E = Units in ending inventory.
- L = Units lost.
- f_i = Fraction of ending inventory completed in terms of input i.
- g_i = Fraction of lost units completed in terms of input i.
- U_i = Unit cost if input i; i=P (Preceding department's transferred production costs), M (Direct materials), C (Conversion costs).
- I_j = Total cost of input I ($I' =$ P, M, C, as defined above under index i) appearing in opening inventory (j=1) or in the costs incurred during the present period (j=2).
- E_i = Equivalent production of i.
- D = Matrix composed of the equivalent production vectors.

EXHIBIT 3

PROCESS COST PROBLEM

Key: (P, M, C) = portion of production done during present month for P (goods received from preceding department), M (departmental materials), C (departmental conversion costs).

QUANTITY DATA

Opening inventory (0, 1/4, 1/2)	40,000
Received from preceding department during period	360,000
Units added by present department	100,000
	500,000
Transferred out	320,000
Ending Inventory (1, 2/3, 1/2)	150,000
Lost units (normal loss occurring gradually during processing; no provision in overhead rate: 1, 2/5, 1/3)	30,000
	500,000

COST DATA

Opening inventory:		
Preceding department's costs		$ 120,000
Departmental material costs		60,000
Departmental conversion costs		60,160
Costs during month:		
Preceding department's costs		1,380,000
Departmental material costs		804,000
Departmental conversion costs		1,187,240
	TOTAL	$3,611,400

EXHIBIT 4

Another advantage of the use of a diagonalized matrix in multiplication is that it results in an input-output-type matrix. . . . Such a matrix arrays inputs according to outputs, and, after all, this is what allocation is all about.

be added to obtain the total equivalent production vector e—which, parenthetically, could have been obtained by ignoring the partitioning and performing the multiplication Ab. The elements E_i in Vector e are used in the computation of the unit costs, U_i. The unit costs are then entered in Matrix U, and the cost report results from the multiplication UD. Exhibit 3 essentially reduces to a system of equations for solving process cost problems under the average method.

The form of Matrix U in Exhibit 3 deserves further comment. In this form—that is, with non-zero numbers on the main diagonal of the matrix and zeros everywhere else—the matrix is called a diagonalized matrix. A diagonalized matrix has a number of properties, the most interesting of which for present purposes is that the elements of Matrix R, the cost report, can be obtained by multiplying the elements of U and D in a distributive manner (that is, so to say, straight-across multiplication) rather than by observing the ordinary rules of matrix multiplication (which would generate the same results—but in a more complicated way). In a nutshell—a diagonalized matrix simplifies matrix multiplication.

Another advantage of the use of a diagonalized matrix in multiplication is that it results in an input-output-type matrix such as shown in Matrix R. Such a matrix arrays inputs according to outputs, and, after all, this is what allocation is all about. No other form for re-

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porting allocations is as appealing as the input-output form. No other report format shows correspondence of inputs to outputs as well. No other report format is as easy to understand. No other report format is as simple. We shall use a numerical example to make this argument more concrete.

Exhibit 4 on page 18 presents the data for an illustrative problem. The problem deals with several of the usual complicating features of process costing, including opening inventories, incomplete products received from a previous department, units "gained" through adding departmental materials, lost units, and the reallocation of lost-unit costs.

The matrix solution to the problem appears in Exhibit 5, shown below. Exhibit 5 traces the generalized presentation of Exhibit 3. Three inputs—costs from preceding department, departmental materials, and departmental conversion costs—have been allocated to three designations—units transferred, units in ending inventory, and units lost.[3] The reallocation of lost-unit costs to the transferred- and ending-inventory designations has been done in the proportion these output designations have in the equivalent production of conversion.

Exhibit 6 on page 20 presents a conventional cost report treatment of this same process cost report. The purpose of presenting this exhibit is merely to provide something to compare with the input-

EXHIBIT 5

MATRIX SOLUTION TO PROCESS COST PROBLEM

Equivalent Production

A

Inputs \ Outputs	T	E	L
"Preceding"	1	1	1
"Materials"	1	2/3	2/5
"Conversion"	1	1/2	1/3

b

$$\begin{bmatrix} 320{,}000 \\ 150{,}000 \\ 30{,}000 \end{bmatrix} = \begin{bmatrix} 320{,}000 \\ 320{,}000 \\ 320{,}000 \end{bmatrix} + \begin{bmatrix} 150{,}000 \\ 100{,}000 \\ 75{,}000 \end{bmatrix} + \begin{bmatrix} 30{,}000 \\ 12{,}000 \\ 10{,}000 \end{bmatrix} = \begin{bmatrix} 500{,}000 \\ 432{,}000 \\ 405{,}000 \end{bmatrix}$$

e

Unit Costs:

$U_P = (\$120{,}000 + \$1{,}380{,}000) \div 500{,}000 = \$3.00$

$U_M = (\$\ 60{,}000 + \$\ 804{,}000) \div 432{,}000 = \$2.00$

$U_C = (\$\ 60{,}160 + \$1{,}187{,}240) \div 405{,}000 = \$3.08$

Cost Allocation:

U

$$\begin{matrix} 3.00 \\ 2.00 \\ 3.08 \end{matrix}$$

D

$$\begin{bmatrix} 320{,}000 \\ 320{,}000 \\ 320{,}000 \end{bmatrix} \begin{bmatrix} 150{,}000 \\ 100{,}000 \\ 75{,}000 \end{bmatrix} \begin{bmatrix} 30{,}000 \\ 12{,}000 \\ 10{,}000 \end{bmatrix} = R$$

R

COST REPORT

	Transferred	Ending Inventory	Lost	Costs to be Accounted for
Preceding department's costs	$ 960,000	$450,000	$ 90,000	$1,500,000
Departmental material costs	640,000	200,000	24,000	864,000
Departmental conversion costs	985,600	231,000	30,800	1,247,400
Totals	$2,585,600	$881,000	$144,800	$3,611,400
Reallocation of lost costs	117,306	27,494	(144,800)	—0—
Costs accounted for	$2,702,906	$908,494	$ —0—	$3,611,400

Reallocation: $\$144{,}800 \left(\frac{320{,}000}{395{,}000}; \frac{75{,}000}{395{,}000}\right) = (\$117{,}306;\ \$27{,}494)$

Note: The totals surrounding the basic matrix, R, have been obtained merely by adding and cross adding. The multiplication UD did not produce these totals. Similarly, UD had nothing to do with reallocation.

CONVENTIONAL COST REPORT

	Total Cost	Unit Cost
Costs to be accounted for:		
Cost from preceding department:		
Opening inventory	$ 120,000	—
Costs during period	1,380,000	$3.00000
Departmental costs:		
Opening inventory		
Departmental material costs	60,000	—
Departmental conversion costs	60,160	—
Costs during period:		
Departmental material costs	804,000	2.00000
Departmental conversion costs	1,187,240	3.08000
	$3,611,400	$8.08000
Adjustment for lost units	—0—	.36658
TOTAL COST TO BE ACCOUNTED FOR	$3,611,400	$8.44658
Costs accounted for:		$2,702,906
Transferred (320,000 x $8.44658)		
Ending inventory:		
Preceding department costs (150,000 x $3.00)	$ 450,000	
Departmental material costs (100,000 x $2.00)	200,000	
Departmental conversion costs (75,000 x $3.08)	231,000	
Adjustment for lost units (75,000 x $.36658)	27,494	908,494
TOTAL COST ACCOUNTED FOR		$3,611,400

Additional computations:

Unit costs:

Preceding department costs: ($120,000 + $1,380,000) ÷ 500,000 = $3.00

Departmental material costs: ($ 60,000 + $ 804,000) ÷ 432,000 = $2.00

Departmental conversion costs: ($ 60,160 + $1,187,240) ÷ 405,000 = $3.08

Adjustment for lost units:

(30,000($3.00) + 12,000($2.00) + 10,000($3.08)) ÷ 395,000 = $.36658

EXHIBIT 6

output format of the cost report. It seems probable that only the initiated could follow the traditional cost report. The allocation of inputs to outputs is much more clearly presented in matrix format.

To expedite the discussions ahead, we introduce a form of matrix shorthand, shown in Exhibit 7 below.

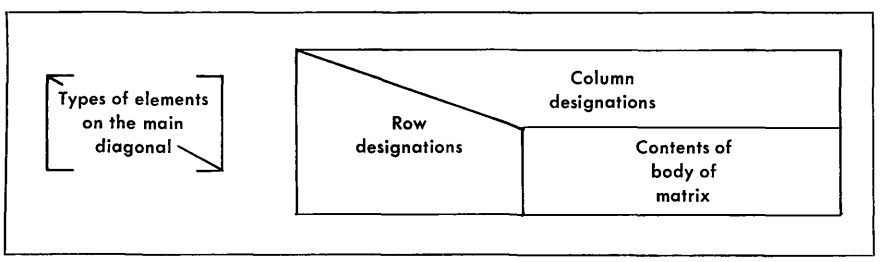
We could use this shorthand to summarize the matrices U, D, and R in Exhibit 3 as shown in Exhibit 8 on page 21.

Now let us turn our attention to Exhibit 9 on page 21, which contains an illustrative statement of affairs. Exhibit 9 presents the traditional format of this report, which again is probably understood only by the initiated. Exhibit 10 on page 22 shows how this report would look in input-output format. The matrix format emphasizes the distribution of inputs (types of assets) to output designations (types of claimants). With the exception of the row and column totals which were obtained by addition, the matrix report results from the multiplication shown in Exhibit 11 on page 23.

How well have matrices succeeded in further interrelating the process costing and statement of affairs areas? The matrix approach in both cases employed diagonalized matrices. The transformation matrices were composed of either quantities or proportions depending on whether the non-zero elements in the diagonalized matrices were dollars per unit or total dollars. Hence, the procedures of allocation in these areas are very similar under the matrix approach. The reports that resulted from matrix allocation are identical in format, and this is significant.

EXHIBIT 7

MATRIX SHORTHAND



When process costing and statements of affairs are first encountered, perhaps the single most time-consuming chore is to understand the separate report formats. Under the matrix approach only one, easy-to-understand report format is necessary.

Many accounting areas can be approached in exactly this same manner, that is, by the formulation of a diagonalized matrix and a transformation matrix to obtain an input-output matrix report.[4] The trick is to recognize data inputs and outputs as such and to determine the accounting criteria that govern the allocation. Usually, the accounting criteria can be reduced to simply measuring ownership or to reflecting usage. If any difficulty is encountered, it is likely to be not so much in recognizing inputs as in recognizing output designations.

Bonus-tax computations

There are other types of matrices that are important in accounting allocations. One of these is the inverse matrix. Although it would take too long to develop matrix inversion in full here, the broad concepts can be presented briefly if we restrict ourselves to systems in which there are two unknowns and two equations.

Consider the situation where it is necessary to calculate simultaneously an executive bonus based on profits after tax and a tax of some sort:

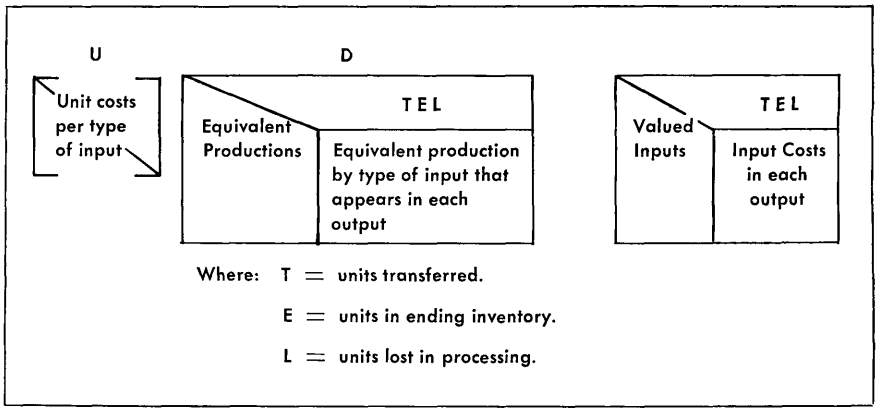
Key: B = Bonus
T = Tax
$90,000 = Profits before B and T
B = .20($90,000 − T)
T = .50 ($90,000 − B)

This system of equations can be restated and put into matrices as follows:

$$B + .2T = \$18{,}000$$
$$.5B + T = \$45{,}000$$

$$\underset{A}{\begin{bmatrix} 1 & .2 \\ .5 & 1 \end{bmatrix}} \quad \underset{x}{\begin{bmatrix} B \\ T \end{bmatrix}} = \underset{b}{\begin{bmatrix} 18{,}000 \\ 45{,}000 \end{bmatrix}}$$

It is always wise to check the



PROCESS COST MATRICES

EXHIBIT 8

EXHIBIT 9

ILLUSTRATIVE STATEMENT OF AFFAIRS

Book Value			Expected to Realize
	Assets pledged with fully secured creditors:		
$25,000	Land and buildings:		
	Estimated value	$25,500	
	Less mortgage payments—contra	15,000	$11,500
	Assets pledged with partially secured creditors:		
3,000	Bonds of X Company—deducted contra		
	Estimated value	$ 3,200	
	Free assets:		
300	Cash		300
9,000	Accounts receivable:		
	$8,000 Good		8,000
	$1,000 Doubtful		600
	$9,000		
18,700	Merchandise		19,200
	Total free assets		$39,600
	Deduct liabilities having priority—per contra		600
$56,000			$39,000

Book Value			Expected to Rank
	Liabilities having priority:		
$ 600	Accrued wages—deducted contra		
	Fully secured liabilities:		
15,000	Mortgage payable—deducted contra		
	Partially secured liabilities:		
5,000	Notes payable	$ 5,000	
	Less bonds of X Company	3,200	$ 1,800
	Unsecured liabilities:		
23,000	Accounts payable		23,000
	Net worth per books:		
12,000	Capital stock		
400	Retained earnings		
	Total unsecured liabilities		$24,800
	Excess of net free assets over unsecured liabilities		14,200
$56,000			$39,000

An example of a case where matrix manipulation is useful is secondary overhead allocation . . .

matrix set-up by mentally performing the matrix multiplication $Ax = b$ to see that the original equations are obtained.

Now, as matrix algebra is ordinarily put forth, division by a matrix is undefined, that is, one could not solve for x by performing $x = b$ divided by A as one would solve $5x = 20$ by performing $x = 20$ divided by 5. Instead one must use an inverse matrix; this corresponds to solving $5x = 20$ by performing $x = 20(.2)$. Recognize that the multiplication of a number by its inverse yields the number 1 (for example, since the inverse of 5 is 1 divided by $5 = .2$, we have $5(.2) = 1$). So it is with matrices; the multiplication of a matrix A by its inverse A^{-1} yields the identity matrix, I. I has the property that when it multiplies another matrix the product of the multiplication is the other matrix. Note that this is the same result produced when we multiply the number 1 by some other number, for example, $1 \times 5 = 5$.

The procedure for solving our bonus-tax problem is as follows:

$$\begin{aligned} Ax &= b \\ (A^{-1}A)x &= A^{-1}b \\ (I\,x) &= A^{-1}b \\ x &= A^{-1}b \end{aligned}$$

We may form A^{-1} by interchanging the main diagonal elements of A, putting minus signs next to the cross diagonal elements, and dividing the resulting elements by the product of the main diagonal elements minus the product of the cross diagonal elements (in our example: $1(1) - .5(.2) = .9$). The solution to this example is shown in Exhibit 12 on page 23.

Secondary overhead allocation

Another example of a case in which this kind of matrix manipulation is useful[5] is secondary overhead allocation. Here primary overhead costs (such as indirect labor, repairs, depreciation, insurance, heat, light, power, and so forth) have been distributed to both service and production departments, and it remains necessary to

EXHIBIT 10

STATEMENT OF AFFAIRS—MATRIX FORMAT

	Liabilities Having Priority	Fully Secured Liabilities	Partially Secured Liabilities	Unsecured Liabilities	Owners	Totals
Assets: Pledged in full security (Land)	$—0—	$15,000	$ —0—	$ —0—	$ —0—	$15,000
Pledged in partial security (Bonds owned)	—0—	—0—	3,200	—0—	—0—	3,200
Free (See note)	600	—0—	1,800	23,000	14,200	39,600
	$ 600	$15,000	$5,000	$23,000	$14,200	$57,800

Note: Free assets include:	
Cash	$ 300
Accounts receivable	8,600
Merchandise	19,200
Land & buildings ($26,500 — $15,000)	11,500
	$39,600

DEFICIENCY ACCOUNT

Owners' equity per books	$12,400
Gains on realization:	
Land and buildings	1,500
Bonds of X Company	200
Merchandise	500
	$14,600
Loss on realization:	
Accounts receivable	400
Amount payable to owners in liquidation	$14,200

. . . where primary overhead costs have already been distributed.

reallocate service department costs to service-consuming departments (secondary allocation) so that overhead absorption rates may be determined. Deciding the percentages of services consumed involves the accountant in estimating potential and actual usage of departmental services.

Let us consider a simple illustration. Assume that the percentages reflecting usage have already been determined and are as shown in Exhibit 13 on page 24.

There are two approaches to be considered: (1) the traditional approach, whereby the primary costs of the service-rendering departments are first augmented by the costs these departments are responsible for as service consumers and then the new totals are allocated to the production departments and (2) the "linked" approach, whereby the intermediate stage is omitted since it serves no purpose.

Under the traditional approach, augmenting the service department primary costs is accomplished by solving the following system of equations:

$$S_1 = 90 + .25S_2$$
$$S_2 = 180 + .40S_1$$

The system may be stated in matrices as follows:

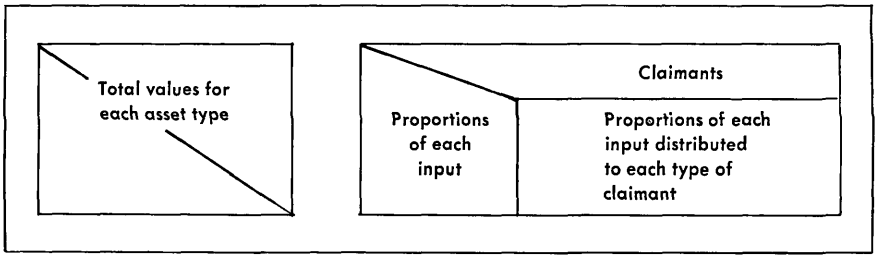
$$\underset{A}{\begin{bmatrix} 1 & -.25 \\ -.40 & 1 \end{bmatrix}} \quad \underset{x}{\begin{bmatrix} S_1 \\ S_2 \end{bmatrix}} = \underset{b}{\begin{bmatrix} 90 \\ 180 \end{bmatrix}}$$

TOTAL = 270

The solution is:

$$\underset{x}{\begin{bmatrix} S_1 \\ S_2 \end{bmatrix}} = \underset{A^{-1}}{\begin{bmatrix} 1/.9 & .25/.9 \\ .40/.9 & 1/.9 \end{bmatrix}} \underset{b}{\begin{bmatrix} 90 \\ 180 \end{bmatrix}} = \underset{x}{\begin{bmatrix} 150 \\ 240 \end{bmatrix}}$$

Vector x contains the augmented service department costs.



MULTIPLICATION FOR STATEMENT OF AFFAIRS—MATRIX FORMAT

EXHIBIT 11

SOLUTION TO BONUS—TAX PROBLEM

$$\underset{x}{\begin{bmatrix} B \\ T \end{bmatrix}} = \underset{A^{-1}}{\begin{bmatrix} 1/9 & -.2/.9 \\ -.5/.9 & 1/.9 \end{bmatrix}} \underset{b}{\begin{bmatrix} 18{,}000 \\ 45{,}000 \end{bmatrix}} = \begin{bmatrix} 10{,}000 \\ 40{,}000 \end{bmatrix}$$

This says that B = $10,000 and T = $40,000.

EXHIBIT 12

Now the amounts in Vector x must be allocated to the production departments. Accordingly, we form Matrix P by transposing the percentages shown under the P_1 and use this matrix to obtain our ultimate amounts for redistribution (shown in Vector r).

$$\underset{P}{\begin{bmatrix} .10 & .45 \\ .30 & .20 \\ .20 & .10 \end{bmatrix}} \underset{x}{\begin{bmatrix} 150 \\ 240 \end{bmatrix}} = \underset{r}{\begin{bmatrix} 123 \\ 93 \\ 50 \end{bmatrix}}$$

TOTAL = 270

The amounts in Vector r must then be added to the primary allocation amounts for the production departments (say, Vector d) to obtain the total overhead costs (Vector t) for each production department.

$$\underset{r}{\begin{bmatrix} 123 \\ 93 \\ 54 \end{bmatrix}} + \underset{d}{\begin{bmatrix} 377 \\ 307 \\ 246 \end{bmatrix}} = \underset{t}{\begin{bmatrix} 500 \\ 400 \\ 300 \end{bmatrix}}$$

The amounts in Vector t would next be divided by the respective estimated standard machine hours to obtain the desired overhead absorption rates of $500 divided by 200 = $2.50, $400 divided by 50 = $8.00, and $300 divided by 150 = $2.00.

The alternate or "linked" approach recognizes the uselessness of the augmented service department totals of $150,000 and $240,000 (shown in Vector x). Control over the reallocated portions of these totals (that is, over $150,000 − $90,000 and $240,000 − $180,000) is typically achieved by the "departmental cross charges" of responsibility accounting. Hence, for product costing purposes the intermediate augmented service department totals may be bypassed, provided the effects of these totals are provided for.

Since matrices may be multiplied and added, it is possible to "link up" several stages of allocation. In our secondary overhead allocation

SECONDARY OVERHEAD ALLOCATION PROBLEM

P_i = Service department i.
Key: S_j = Production department j.

Consumers / Renderers	S_1	S_2	P_1	P_2	P_3
S_1	0	40%	10%	30%	20%
S_2	25%	0	45%	20%	10%

	S_1	S_2	P_1	P_2	P_3
Primary overhead allocation totals (000 omitted)	$90	$180	$377	$307	$246
Standard Machine hours (estimated, 000 omitted)			200	50	150

EXHIBIT 13

Besides organizing the calculation of variances and aggregating inputs to aid in determining the overall significance of the respective variances, the matrix approach permits ready calculation of the significance of individual input variances.

example, for instance, we could proceed as follows:

$$t = d + PA^{-1} b$$

Let us first form PA^{-1}. It would always make sense to do this where the departmental interrelationships can be expected to remain stable —as they might for planning purposes.

$$\underset{P}{\begin{bmatrix} .10 & .45 \\ .30 & .20 \\ .20 & .10 \end{bmatrix}} \quad \underset{A^{-1}}{\begin{bmatrix} 1/.9 & .25/.9 \\ .40/.9 & 1/.9 \end{bmatrix}} =$$

$$\underset{PA^{-1}}{\begin{bmatrix} .3111 & .5278 \\ .4222 & .3055 \\ .2667 & .1667 \end{bmatrix}}$$

We see that the equation for t holds.[6]

$$\underset{t}{\begin{bmatrix} 500 \\ 400 \\ 300 \end{bmatrix}} = \underset{d}{\begin{bmatrix} 377 \\ 307 \\ 246 \end{bmatrix}} +$$

$$\underset{PA^{-1}}{\begin{bmatrix} .3111 & .5278 \\ .4222 & .3055 \\ .2667 & .1667 \end{bmatrix}} \quad \underset{b}{\begin{bmatrix} 90 \\ 180 \end{bmatrix}} =$$

$$\begin{bmatrix} 377 \\ 307 \\ 246 \end{bmatrix} + \begin{bmatrix} 123 \\ 93 \\ 54 \end{bmatrix}$$

Other applications

Matrices may be helpful in price-level work and traditional variance analysis. Let us consider the analysis of labor variances. Here the inputs involve wage rates for different categories of labor; transformation involves labor hours, and the outputs are the standard costs and variances. An example is shown in Exhibit 14 on page 25.

Individual input calculation

Besides organizing the calculation of variances and aggregating inputs to aid in determining the overall significance of the respective variances, the matrix approach permits ready calculation of the significance of individual input variances. For instance, since the vector of standard wage rates is arrayed on top of the rate changes vector, it would be an easy matter to determine percentages of change (for example, —.25 divided by 3.00 = —8 1/3 per cent, 1 divided by 4 = 25 per cent, etc.). Then those percentages that exceed a stipulated amount can be further investigated. Similarly, calculations could easily be made for changes in hours. In this way, the matrix approach could be used to implement statistical "quality" control techniques.

Conclusions

This review of some of the rudiments of matrix algebra and its ap-

LABOR VARIANCE ANALYSIS

Given data:

Labor type A:
Standard = 600 hours at $3 per hour
Actual = 640 hours at $2.75 per hour

Labor type B:
Standard = 1000 hours at $4 per hour
Actual = 900 hours at $5 per hour

Labor type C:
Standard = 800 hours at $2 per hour
Actual = 1000 hours at $2.50 per hour

Matrix solution:

Key:
P = standard wage rate
$\triangle P$ = change in wage rate
$P+\triangle P$ = actual wage rate
Q = standard hours
$\triangle Q$ = change in standard hours
$Q+\triangle Q$ = actual hours

$$\begin{array}{c} \\ P \\ \triangle P \end{array}\begin{array}{c} \begin{array}{ccc} A & B & C \end{array} \\ \begin{bmatrix} 3 & 4 & 2 \\ -.25 & 1 & .50 \end{bmatrix} \end{array} \begin{array}{c} \\ A \\ B \\ C \end{array} \begin{array}{c} \begin{array}{cc} Q & \triangle Q \end{array} \\ \begin{bmatrix} 600 & 40 \\ 1000 & -100 \\ 800 & 200 \end{bmatrix} \end{array} = \begin{array}{c} \begin{array}{cc} \text{Standard} & \text{Net Efficiency Variance} \end{array} \\ \begin{array}{|c|c|} \hline \$7{,}400 & \$120 \\ \hline \$1{,}250 & -\$\ 10 \\ \hline \end{array} \\ \begin{array}{cc} \text{Net Wage Variance} & \text{Net Mixed Variance} \end{array} \end{array}$$

Note: The signs attached to the net variances may be interpreted as follows: — indicates a favorable variance; + indicates an unfavorable variance.

EXHIBIT 14

plications to the field of financial accounting offers a basis for putting forth the following claims:

1. With matrix algebra, inputs and outputs in the various accounting areas can be more easily recognized as such.

2. Matrix algebra can be accepted as a basic way of accomplishing the allocation of inputs to outputs.

3. Matrix algebra may be considered as offering one or two procedures to accomplish allocation instead of the myriad of procedures presently in use.

4. The input-output form of report may be recognized as being superior to most other forms. This is true not only because it is readily understood but also because it is of significant help in the interrelation of a number of diverse accounting areas.

---

[1] A. C. Littleton, *Structure of Accounting Theory,* Monograph Number 5, American Accounting Association, 1953, p. 123.

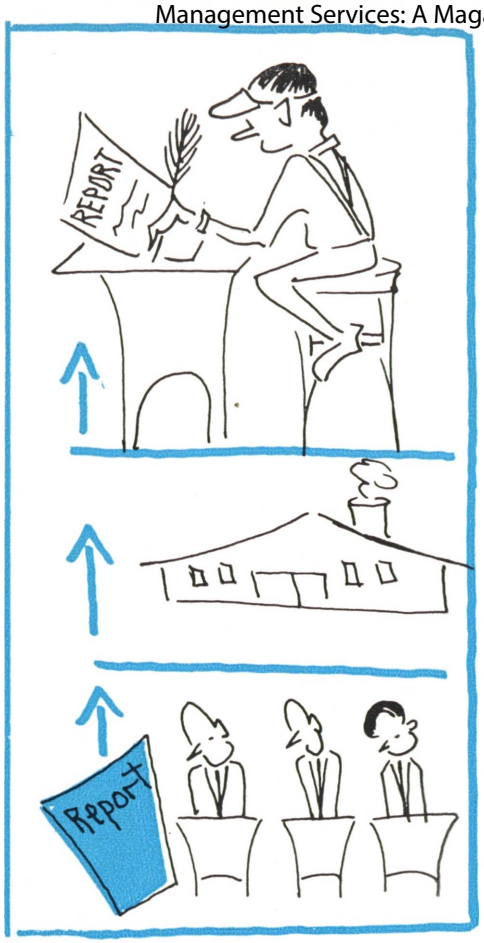
[2] Note that the multiplication of the vectors would yield only the body of Matrix L; the rim totals have merely been obtained by addition. Such addition could be accomplished in matrix algebra by use of sum vectors, that is, vectors all elements of which are ones. However, this use of sum vectors would only be a mathematical nicety and would needlessly complicate our example.

[3] These outputs exhaust the set of possibilities; units can still be in process, or they can be completed, or they can be lost in some way—nothing else can take place. The matrix approach accords lost units full status as an output designation. This logical view of lost units is not found in most cost accounting texts, but it is ably put forth in Charles T. Horngren, *Cost Accounting—A Managerial Emphasis,* Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1962.

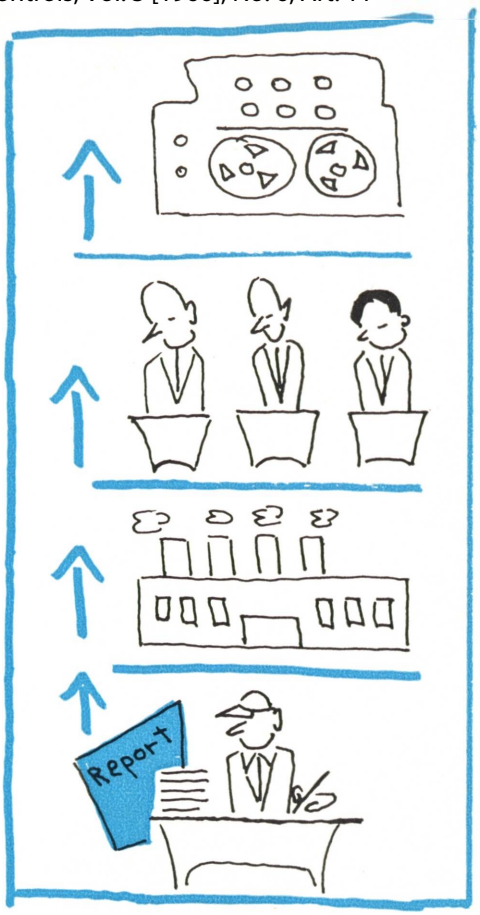
[4] Some of the other accounting areas that can be treated this way include job-order costing, standard costing, period budgeting, primary overhead allocation, and responsibility accounting.

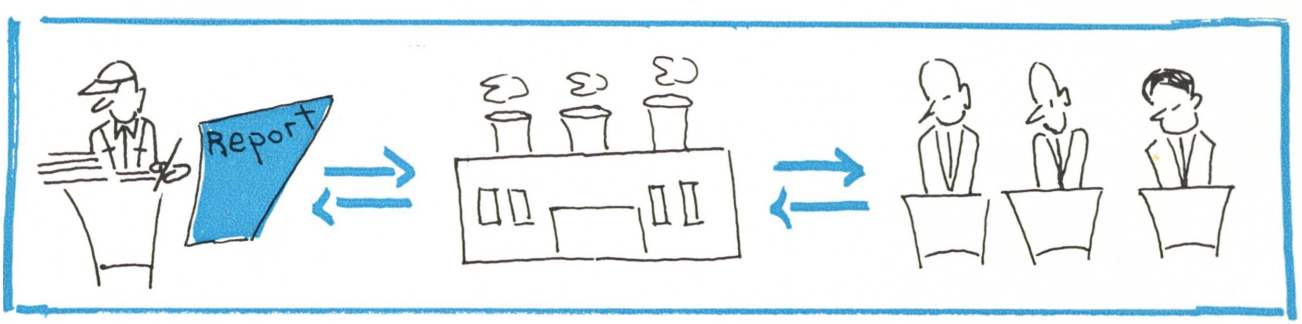
[5] A third example involving an inverse matrix occurs in consolidated financial statements. Here the inputs are intercompany profits in inventory, fixed assets, and bonds that are made by each constituent company. The outputs are the majority and minority interests. When the intercompany relationships are entered in a matrix and adjusted to reflect effective interests, the resulting transformation matrix may be used to determine the adjusting entries to correct the various retained earnings accounts.

[6] Further discussion of this type of transformation may be found in Neil Churchill, "Linear Algebra and Cost Allocation: Some Examples," *The Accounting Review,* October, 1964.



The time when accounting was "the information system" of a company is drawing to a close. The movement is toward "total information systems," of which accounting is only one segment. Accounting data are fast becoming a by-product or at least a joint product of information generated for other than accounting purposes.





USE OF ACCOUNTING DATA IN DECISION MAKING

by K. E. Tigges
Owens-Illinois, Inc.

THE DAYS of accounting's role as "the information system" of a company are fast drawing to a close. It is becoming increasingly difficult to segregate accounting data and accounting reports as entities unto themselves. The movement is toward so-called "total information systems," of which accounting is only one, although a vital, segment.

Accounting data, defined here as the monetary expression of business conditions and activity, have in many cases become a by-product or at least a joint product of information generated for other than accounting purposes. A good example is the sales order entry-billing system. The principal objectives of such a system are to state the conditions of the sale and to authorize delivery of the goods. The system will determine whether goods are available to be shipped and may even be geared to determine whether the order is an economic

order to produce. Once all of these data are available, the preparation of the billing, its costing, and the summarization of sales and cost data are relatively simple operations. Since the accounting data are really a by-product of the production of the other information, we must look to the level of draw-off of the information as the best way of distinguishing accounting data from operating data.

Accounting reports also are becoming more difficult to distinguish. Even the traditional ones are being supplemented or supplanted internally by new or special-purpose reports as accounting becomes combined with other disciplines. Long-range projections were at one time almost purely financial extrapolations of sales, earnings, and assets. Today business projections are more nearly integrated operating plans with financial interpretations. Performance reporting also reflects nonaccounting conditions such as share of the market, operating efficiencies, and interpretative comments.

Much of the merging of accounting information with nonaccounting information is being facilitated, if not caused, by the advent of computers. Their ability to assimilate and manipulate masses of unlike data into one system has tended to dissolve the lines of distinction among the various types of information and push toward the "total system." With the possibility, if not yet practicability, of almost continuous input of data into these systems, with output on demand through viewing devices, there will be expanded use of exception-type information and also an ability to penetrate deep into the exception to identify its specific cause.

The decisions that a manager makes generally can be broken down into the following categories: (1) Where are we? (2) Where do we want to be? and (3) How do we get there? It is rather obvious that accounting data cannot answer all these questions. It is almost as obvious that, given only the three

Long-range projections were once almost purely financial extrapolations of sales, earnings, and assets. Today, business projections are more nearly integrated operating plans with financial interpretations.

traditional accounting statements prepared on an historical basis, the manager is not in a position to answer any of these questions fully even from a financial viewpoint.

Need for projections

Although trend data from the past have been the traditional product of management accounting, projections of the future hold more promise. Forecasts, plans, or budgets permit a realistic interpretation of the potential effects of various actions on future results. For example, if we have an immediate need for a sizable amount of cash, is it best to borrow short term? Will there be a continuing need? If so, can we achieve a better interest rate by medium-term or long-term financing? Only when we know where we are going can we answer these questions.

Our company is in the process of completing a $100,000,000 loan. The financial interpretations of our long-range operating plans played an important part both in management's decision to undertake the expansion and in determining the amount, timing, and nature of the loans. No one will undertake a program of this nature unless he can be assured that each of the expansions will make a substantial contribution to future earnings and that the existing operations are capable of carrying the heavy financing charges and preoperating costs until the new facilities are in operation. Only after the concepts of the plans and programs of the marketing and manufacturing groups have been translated into the universal language—financial statements—does he have such assurance. The financial interpretation of the plans indicated

This article describes the actual operating philosophy of a major American company, Owens-Illinois. It was first presented at a symposium held in March of this year at The Ohio State University. The symposium was designed to explore the ways in which executives in typical American corporations use accounting data in making operating decisions. In order to do this, it drew on the experience of five representative American companies. Presenting the viewpoints of their respective firms, besides Mr. Tigges, were the following:

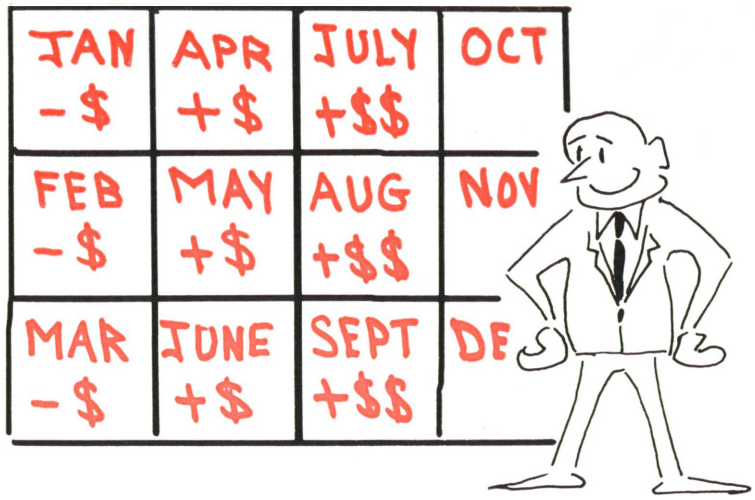
R. S. Hager, Controller, Stresenburgh Laboratories, Rochester, N.Y.

Orville H. Mertz, Vice President—Finance, Koehring Corporation, Milwaukee, Wisconsin.

J. J. Schofield, Vice President, Finance, Dura Corporation, Oak Park, Michigan.

John K. Smucker, Assistant Controller, Firestone Tire and Rubber Company, Akron, Ohio.

The papers presented were analyzed in written critiques by five professors from various universities. Excerpts from three of the critiques appear on pp. 30 and 31.



Financial interpretation of the plans indicated not only at what time expenditures would exceed cash resources and in what amounts but also at what point cash inflows would again exceed outflows.

to us not only at what time expenditures would exceed cash resources and in what amounts but also at what point cash inflows from operations would again begin to exceed outflows. With this information our treasurer was able to establish a combined program of long-term and short-term borrowing and to determine the ideal timing of the borrowing, subject to the availability of funds and trends of interest rates.

Performance reporting

Projections are also of prime importance in connection with performance reporting. The comparison to planned performance (both in terms of monetary achievement and operating objectives) has been the primary performance reporting measurement in our company for a number of years. Our executives seldom look at a complete monthly balance sheet or profit and loss statement. We attempt to highlight for them those factors on the traditional accounting statements that can have a significant effect on the soundness of the corporation and on its operating performance and to present these factors in such a manner as to emphasize those areas where the corporation has varied from its planned course —either favorably or unfavorably.

For example, let us look first at the balance sheet. Operating management cannot control on a month-to-month basis depreciation, most current liabilities, or long-term debt. It can, however, react and change trends in inventories, receivables, and the capital expenditure program. It must also be aware of its cash situation and any possible need for short-term borrowing. Therefore, we highlight these items in our monthly performance reporting, commenting briefly on the reasons for the variations.

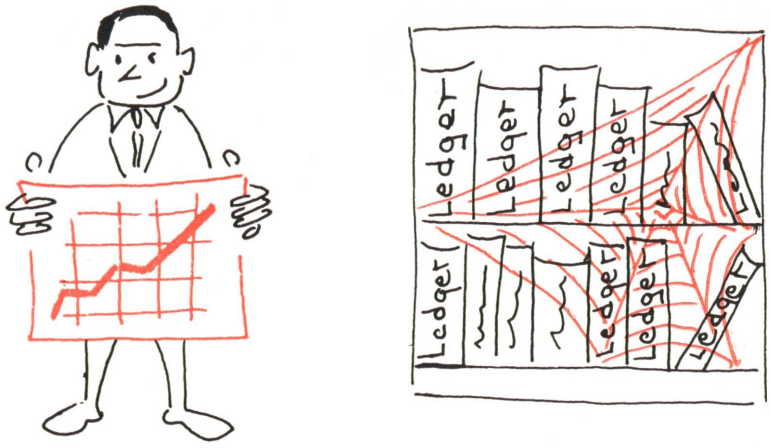
On the earnings side, our management reporting system highlights variances from planned performances, not by the traditional categories shown on the profit and loss statement but rather in terms of responsibility areas. Our performance reporting can be likened somewhat to a pyramid. At the lowest level of supervision would be exception-type reports on sales branches, plants, research, and administrative departments. These are summarized into regional data and finally divisional and corporate data. The expressions of variances from plan in terms of monetary values are supplemented by brief comments on the reasons for the variations from plan, and our performance reports also include statistical data on operations. These comments are just as important as, and possibly more important than, the variances. Proper interpretative comments may trigger a manager's judgment that this is a permissible variance or that an operating division has already advised him that remedial action is being taken.

What decision then can the operating manager make from the performance report? He can decide that he either is satisfied with the situation or that some action on his part is required. In the latter case, he would, through discussions with the next level of operating management and/or through special analyses prepared by applicable members of his staff, attempt to ascertain whether the variance is a result of circumstances beyond control or whether some action can improve the operating results.

The relative importance of an accounting report in decision mak-

KENNETH E. TIGGES, CPA, is comptroller of Owens-Illinois, Inc., in Toledo, Ohio. He has also served as general manager, accounting, and assistant comptroller for that company. Prior to joining Owens-Illinois, he was an accountant at Konopak & Dalton (now Peat, Marwick, Mitchell & Co.). Mr. Tigges is a member of the board of directors of the Toledo chapter of the Financial Executives Institute, the Ohio Society of CPAs, and the American Institute of CPAs.

ing is governed, in part, by management's understanding of the data and its confidence in their accuracy. Management's confidence in the reasonable accuracy of the data can only be built up over a period of time. Management's understanding of the data is something that must be achieved both through the clarity of the individual report and through a continuing education program. The accountant, being an information specialist, must work with management to determine what information it needs and to structure this data in a useful form. Some managers can consume and assimilate great volumes of data while others would require and want only exception-type information supplemented by special analyses where desired.



The significant items should be highlighted in the management reporting system as well as variances from planned performance. Variances are reported not by traditional categories but rather by responsibility areas.

Emphasis can bring profits

A good example of the need for manager education and understanding is the use of the return on investment calculation. For a number of years we used not only the return on sales ratio but also the return on assets invested, and the procedure was generally well understood at top management levels—and quoted at lower levels. However, when we began to emphasize this tool and to report it in its components—return on sales and asset turnover—we found that some managers who previously had indicated no interest in the balance sheet began to ask questions: Safety stocks of inventories suddenly did not need to be quite as large. That deposit in the local bank that handled our payroll could somehow be reduced. Maybe we could sell this line of product without such extended terms on receivables. The accounting data, when properly explained, had resulted in decisions to reduce operating assets, freeing cash for use elsewhere.

Possibly the best example is standard cost information, which is intended to give a reasonable estimate for inventory purposes and for comparison with selling price to indicate the profitability of an item as well as a monetary measure of manufacturing performance against a standard. However, for any particular item in a multi-product plant, it may be necessary to do a more detailed analysis to determine the true contribution to corporate earnings.

A few years ago a manager asked why a certain long-run item was marginal when produced in a multi-product plant when, at the same time, he could see that a single-product plant producing this same item was showing a very nice profit and that operating efficiencies according to industrial engineering standards were comparable. Investigation disclosed that a portion of the variance was due to the manner of spreading supervisory overheads. Because of the variety of items produced in the multi-product plant, a greater amount of supervisory help was required. While the long-run item in question did not require a great deal of supervisory time, it was being allocated its share of the total based on an arbitrary formula

The accountant, being an information specialist, must work with management to determine precisely what information it needs and to structure the data.

rather than on actual experience.

This situation was corrected. It does, however, emphasize that we must make managers aware of the degree of accuracy a particular type of accounting data has if they are to utilize it properly. Nowadays, the ability of computers to process large volumes of data is allowing us to accumulate and manipulate much more information on actual cost performance, thus permitting more realistic preparation of standards as well as retrieval of actual cost information on jobs to determine the profitability of items.

Not only must we be sure that an operating manager understands what figures go into a report but we must also be sure he understands the purpose behind the report. Some time ago I asked one supervisor why a certain action had not been taken that would mean extra expense to his department but a saving to the company. His answer was simply that he couldn't do it because the expenditure was not in his budget.

Accounting and taxes

In tax planning, forecasts are frequently more important than historical information. For example, assume that a small company was acquired for cash at a cost in excess of its book value and that this company also had a loss carryforward for income tax purposes. With proper tax planning management would recognize that there were two potential areas of tax savings available and that a decision was required as to which would yield the greater profit. The first alternative would be this: If the company were dissolved within two years of acquisition, its assets could be written up from their net book values to the purchase price, thus allowing greater depreciation expense for tax purposes.

Critiques

Gordon Shillinglaw, Professor of Accounting, Columbia University: As I see it, information systems are going to continue the trend toward integration, and if accountants don't take the lead they are likely to be relegated to a very subordinate role. As Mr. Tigges says, "Accounting reports also are becoming more difficult to distinguish. . . . The ability to assimilate and manipulate masses of unlike data into one system . . . has tended to dissolve the lines of distinction between the various types of information. . . ."

Accountants also serve management in decision making by preparing reports that will direct attention to situations or conditions that need investigation. This is one purpose of the periodic performance reporting activities described by all five of our contributors and would probably be regarded as a primary accounting function by even the most jaundiced observer.

Accounting's role in this area seems likely to develop in two directions. First is the trend reported by Mr. Tigges, toward a greater selectivity in what is reported. Data will only be reported if they have information value, based on the exception principle. This practice could be carried too far, so that management would be encouraged to live in a dream world populated only by large cost variances in the maintenance department or sales variances in the New England states. To counteract this, certain broad summary data should be reported merely to provide a frame of reference and a sense of proportion. The selectivity movement is long overdue, however. The typical accounting report just contains too many numbers, even when some special effort is made to point out the most important ones.

The second likely development is for the information system to be called upon to report quantitatively on parameters that are now reported as outside the ken of accounting. Sales and inventories held by customers are perhaps obvious examples; measures of managerial leadership, creativity, and employee morale are less obvious but no less productive and far more challenging to the accountant. Many companies are not trying to pay more than lip service to the notion that performance has many dimensions, and it would be interesting to learn whether any of the companies represented here today have been successful in developing quantitative measures of aspects of performance that have traditionally been evaluated solely in qualitative terms.

William J. Vatter, Professor of Accounting, University of California, Berkeley: One last quotation brings us face to face with what I believe is a basic issue. I quote from Mr. Tigges of Owens-Illinois:

"At best, accounting data and reports are only tools to supplement a manager's judgment and other available data."

Later, this writer says:

"The days of accounting as the information system of a company are fast drawing to a close. It is becoming increasingly difficult to segregate accounting data and accounting reports as entities unto themselves. The movement is toward total information systems of which accounting is only one, although a vital, segment."

This last observation is of vital importance; it raises the question of what restricts the processes of accounting, to keep it from being more than a segment of the information system. It is true that a number of technological advances have been made with respect to computers and related software; but computers are not information systems, even though they make the processing of data easier and faster. There have been developments in model building and mathematical tools – but these do not make an information system, either.

If this were done, however, the tax loss carry-forward would be lost. The second alternative would be to continue to operate the company as a separate corporation so as to utilize its tax loss carry-forward.

Obviously, the correct answer would depend on how fast the acquired corporation could be turned into a profit contributor. Projections of its markets and manufacturing performance by operating personnel would have to be translated into financial forecasts. The answer might even be a combination one if the corporation could be made profitable quickly, absorbing a portion or all of its loss carry-forward prior to the expiration of the two-year period. The loss carry-forward given up by its dissolution just prior to the end of the two-year period might then be worth less than the future benefit gained by writing up the assets.

Accounting systems have been strained by the changes in tax law relating to property and equipment over the past several years. As a result of the 1954 act, many companies adopted one of the accelerated methods for financial reporting to preclude the need for two sets of records. The guideline procedures utilized averaging techniques that were not completely adequate for financial reporting, and, as a result, many companies decided to separate depreciation for financial reporting from that for tax purposes. Accurate predictions of depreciation for book purposes are a necessity if management is to be informed of future earnings potential. Accurate predictions of depreciation for tax purposes are equally important in attempting to predict cash flows from operations. Thus, two depreciation forecasts were required.

The investment credit had an impact on forecasting. Since it was allowed only at the time the equip-

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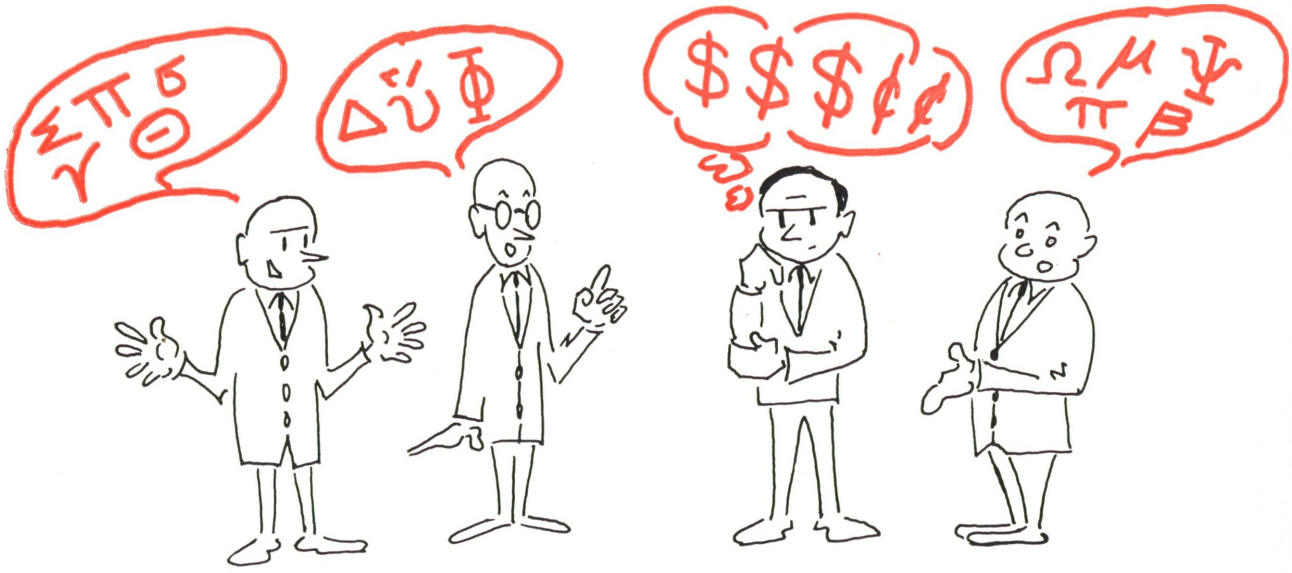
There must be some other element or condition to explain the position of accounting in the overall information system. I suggest that this factor is merely the attitude taken by accountants in dealing with their material. Accountants too often appear to consider themselves mere collectors and reporters of financial data. Discussions of current practice show this. The accounting function is overly concerned with tabulating financial data or preparing financial counterparts of business operations, even when it deals with standard costs and budget variances, subclassifications of sales revenues or operating charges. Accounting is too much concerned with following out changes in assets or equities to present more or less stereotyped summaries supposed to reflect what has happened. These are data, but they are not information. Data become information only when they convey a message which has some specific relevance to a problem or situation — a relevance which may be expected to capture attention and to precipitate action. Without those attributes data are likely to be ignored, if they are perceived at all. Reporting only what has happened in terms of tabulated financial details expects too much of those to whom the reports are sent — the mere delivery of data does not contribute much to management decision making. Unless the accountant is willing to do more than this, he cannot expect to hold a place in the decision process, or to be considered an essential part of the information system.

Abraham Charnes, Professor of Mathematics, Economics, and Engineering Science, Northwestern University, and William W. Cooper, Professor of Economics and Industrial Management, Carnegie Institute of Technology: Turning next to the paper by Mr. Tigges of Owens-Illinois we should note that we prefer a slight rephrasing of his statement that "the days of accounting as 'the information system' of a company are fast drawing to a close." We prefer to interpret this as meaning that the advent of total information-instantaneous display systems (e.g., of the kind Mr. Tigges describes) carries with it, rather, the need for viewing accounting in a much broader light. Conversely, we should say that the concepts associated with such systems carry in their train the opportunity for securing a still broader view of the accounting function in that the latter should no longer be regarded as confined only to the treatment of data that have first been accorded a uni-dimensional (e.g., dollar) scale. From the broadened standpoint that such an interpretation admits we may then judge and evaluate the methods of accounting relative to their ability to deal with *all* aspects of business information. That is, from this point of view all such "information" must be regarded as a part of accounting whenever such data (intangible or not) are relevant. To state the issue even more sharply, we should say that it is now becoming necessary, increasingly, to distinguish between "information" and "evidence" where, once again, the latter is to be interpreted as information that has been processed in a way that will, by and large, produce correct actions by management. With this rephrasing and change in emphasis, then, we are wholly in agreement.

Note that this then carries with it certain important connotations and implications relative to the way businesses are (or should be) organized. This, too, is mentioned by Mr. Tigges as he implicitly notes the need for varying the time and content of the reports (or displays) by reference to the levels of management involved. But we doubt that even this will be enough and it may well be the case that system design will also have to be extended to take account of . . . managerial capabilities as well as potential interaction patterns. . . .



In research and development budgeting, the judgments of the various operating managers are translated into financial form, both as to investment and income.

ment was actually placed in operation, it required supplementary data. We found it necessary to develop a computer-oriented property system, which both provided better control in forecasting of capital expenditures and allowed faster processing of asset records in order to compute and predict depreciation for book and tax purposes.

Better data for pricing

One of the areas where accounting has made some of its greatest advances over the past few years has been in providing information for pricing decisions. The computer permits the manipulation of greater amounts of detail, facilitating more frequent revision of cost data as well as the accumulation of more actual performance information, which, in turn, permits substantially more analysis for justification of price differentials based on cost/price relationships. The computer also provides the opportunity to compare each prospective order with an estimated standard cost, thus allowing us to be selective during periods of extremely high-capacity operation and to determine what orders will be accepted under a marginal contribution theory when excess capacity is available. As a sidelight, of course, good cost information allows us to be selective as to where we will meet competition.

How much for R&D?

Managers continually ask "How much should we spend on research and development?" Historically, we have given them little help. As a result, the research and development budget has often competed for funds with other activities on the basis of the manager's selling ability, or sometimes a certain significant breakthrough in research and development has attracted more funds to that effort when the funds could be better spent elsewhere.

One of the most useful developments recently has been the use of some of the new mathematical techniques. For each major development project the judgments of the various operating managers are translated into financial form, in terms of both investment and income. Originally these analyses were made either on the best guess of each manager as to what would happen or on a minimum, most likely, and maximum basis. More recently, through the development of a computer program, we have been able to incorporate risk analysis to a much greater extent, since the computer allows us to enter a number of assumptions as to quantities, prices, operating efficiencies, etc., together with the various managers' best judgments as to the probabilities that each of these levels will occur.

This procedure has been limited primarily to developmental projects rather than true research, and it does not identify what the total research and development budget should be. Nevertheless, it certainly is an aid to management in screening out projects that, even if successful, would have a relatively nominal impact on the business. Through post-audits of these project analyses we are attempting to sharpen the abilities of both the engineering staff and operating units in their analyses of future programs.

These are only a few examples to illustrate my point: If we are innovative in integrating the product of other disciplines with accounting, the future for the use of accounting data in decision making is bright.

Increasing mechanization on the production line has outmoded some traditional costing and pricing techniques. This author proposes methods of calculating overhead costs and of pricing that are better suited to automation.

RETURN ON INVESTMENT COSTING AND PRICING

by Thomas S. Dudick
Ernst & Ernst

In American manufacturing the value of fixed investment per production worker is rising steadily. Whether you call this trend automation or merely a continuation of the mechanization that began with the Industrial Revolution, it is a fact of business life, with many implications for management planning and control.

Introduction of more and more costly equipment has substantially increased such overhead costs as depreciation and maintenance. As a result the proper assignment of overhead in product costing — never an easy task — has become both more difficult and more important than ever before.

Automation of manufacturing processes is not always followed by corresponding improvements in costing practices. All too many highly mechanized companies still cling to the traditional practice of using direct labor as the basis for applying overhead to the product. It is much more logical to use machine hours as a base since the overhead costs associated with the equipment are usually more closely related to the hours of running time than to the amount of direct labor required to operate the machine. Direct labor costs also should logically be applied to the product on the basis of machine hours.

To continue the use of direct labor as the base for applying overhead to the product can result in distorted product costs, particularly when the ratio of direct labor operators to machines varies from one product to another. Distorted

This article describes a method for developing machine-hour rates for overhead costing . . .

product costs can produce serious errors in pricing.

Misapplication of overhead costs is not the only problem that automation creates in pricing, however. As mechanization increases, direct labor costs usually shrink in relation to material and overhead costs. Since the end purpose of capital invested in a business is to obtain an adequate return on such investment, it follows not only that any procedures used to arrive at product costs should allow for differences in the investments associated with the various products but also that the application of a markup on each product should reflect a return on the investment employed to produce that product. Thus, pricing policies should recognize and provide for an adequate return on two major types of investment — inventories and fixed assets.

This article offers partial solutions to both the costing and pricing problems raised by automation. It describes a method for developing machine-hour rates for overhead costing, and it proposes a concept of pricing for return on investment.

Machine-hour rates

A multiplicity of machine-hour rates must be developed to reflect differences in various types of automated equipment. In this case, unfortunately, the difficulty of accurately allocating large service department costs to small machine centers creates risk of distortions; a small percentage error in apportioning costs to a machine with a small machine-hour base can have a substantial effect on the rate.

To minimize such distortions, a two-step apportionment of costs is desirable. The first step is to apportion "basic" or general overhead to broad machine groupings. Then each type of equipment within the larger group should be charged with its share of such specifically assignable costs as depreciation, maintenance, and occupancy — all of which are measurable by machine types with a reasonable degree of precision. These specifically measurable costs are converted to a "differential" machine-hour rate that measures the cost difference from one class of equipment to another within the broad groups.

Computing machine-hour rates

Exhibits 1 through 5 demonstrate the steps required for computation of the machine-hour rates. The function of each of these exhibits may be summarized as follows:

Exhibit 1 on page 35 shows how the available machine hours are calculated and adjusted by a utilization factor to arrive at the total machine-hour base for the major machine groupings as well as for the individual types of machines within the groups.

Exhibit 2 on page 36 summarizes the overhead costs that must be allocated to the machine groups and to the types of equipment within the groups.

In Exhibit 3 on page 37 the total overhead summarized in Exhibit 2 is split between basic overhead and differential overhead. The computation of basic overhead rates by major groups is calculated in this schedule.

In Exhibit 4 on page 38 the differential overhead calculated in Exhibit 3 is assigned to types of equipment to arrive at the differential rates.

In Exhibit 5 on page 38 the basic and differential rates are consolidated into a single rate for each type of equipment. The labor cost per machine hour is determined, and the combined overhead and direct labor rate is adjusted for machine efficiency.

Machine-hour base

Exhibit 1 lists the production equipment for which machine-hour rates must be developed. Compression molding and injection molding are considered as separate major groups because of basic differences in the molding processes and types of equipment used. The compression molding group is then broken down by the types of equipment making up this major group. Within the injection molding group the eight- and twelve-ounce machines are combined because the products of these machines are very similar — and frequently interchangeable.

The automatic and semi-automatic groups have been combined under the heading of Assembly because of similarity in costs and interchangeability of certain of the products. Except for the pin machines, the equipment listed under Metal Fabrication has been grouped into a single center in this example.

Within each of the foregoing groups, the number of machines of each type is extended by the number of shifts to determine the available machine hours per day. Available machine hours are then adjusted to allow for normal downtime of equipment for interruptions such as those occasioned by repairs, adjustments, and changeovers. The daily running hours are then multiplied by 21 days to ar-

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. . . and proposes a concept of pricing for desired return on investment.

rive at the number of hours in the average month.

Assignment of overhead

The average monthly overhead of $73,188 is listed by item of expense. Exhibit 2 allocates each of these expense items to the major equipment groupings on seven bases. Direct charges, which account for 43 per cent of the overhead dollars, are represented by specific charges to a machine group. For example, indirect labor in the production department is a direct charge because such labor is native to the department and does not require allocation from a general pool. Maintenance is another such example. Here, historical records of maintenance costs have been used as a basis. Since manufacturing gas is used in only one center, it is specific to that center.

Floor space is used as the basis for allocating occupancy (rent-equivalent costs). Fringe benefits are distributed on the basis of the amount of direct and indirect labor payroll. Such costs as service department labor, small tools, and electricity are allocated on the basis of machine hours.

All the items listed in Exhibit 2 are categorized for convenience in identifying those that are fixed and those that are variable. Salaried labor, which includes supervision and clerical labor, would be considered as fixed while hourly paid labor would be treated as

EXHIBIT I

CALCULATION OF MACHINE HOURS

Equipment	Machines Available for Production	Number of Shifts	Machine Hours Available Per Day	% Utilization of Equipment	Machine Hours Per Day Available for Production	Machine Hours Per Month (21 Days)
Compression Molding						
Rotaries	16	3	384	75	288	6,048
Stokes	9	3	216	81	176	3,696
Transfer Press	8	3	192	63	121	2,541
Strauss	10	3	240	75	180	3,780
Total	43	3	1,032	74	765	16,065
Injection Molding						
4-ounce	6	3	144	80	115	2,415
8- & 12-ounce	3	3	72	70	50	1,050
96-ounce	1	3	24	60	14	294
Total	10	3	240	74	179	3,759
Assembly						
Automatic Stakers	9	2	144	70	168	3,528
Semi-Automatic & Hand Stakers	4	2	64			
Semi-Automatic & Hand Stakers	4	1	32			
Closure Liners	6	1	48	75	36	756
Total	23	—	288	71	204	4,284
Metal Fabrication						
Z & H—9-ton Presses	18	1	144	28	81	1,701
V & O—#0, #1, 25-ton, & 50-ton	8	1	64			
Minster—22-ton	5	1	40			
Benchmaster—4-ton & B & J	3	1	24			
Brandeis—30-ton	1	1	8			
Henry & Wright—60-ton	1	1	8			
Pin Machines	9	2	144	90	124	2,604
Total	45	—	432	47	205	4,305
Wheelabrator	1	1	10		9	189

EXHIBIT 2

BREAKDOWN OF OVERHEAD BY MAJOR COST CENTERS

	Total Plant	Compression Molding	Injection Molding	Staking	Lining	Metal Fabrication	Allocation Code
INDIRECT LABOR-PRODUCTION DEPTS.							
Salaried	$ 1,757	$ 502	$ 431	$ 660	$ 164	$ —	
Hourly	3,992	274	136	2,552	638	392	
Total Indirect Labor	$ 5,749	$ 776	$ 567	$ 3,212	$ 802	$ 392	1
INDIRECT LABOR-SERVICE DEPTS.							
Salaried	$10,006						
Hourly	5,042						
Total	$15,048						
Less Transfers Out	1,114						
Net Charge	$13,934	$ 7,942	$ 1,811	$ 1,672	$ 418	$ 2,091	4
PROCESS ENGINEERING							
Salaried	$ 4,679						
Less Transfers Out	2,067						
Net Charge	$ 2,612	$ 1,489	$ 340	$ 313	$ 78	$ 392	4
MANUFACTURING EXPENSES							
Variable							
Maintenance	$ 8,620	$ 1,795	$ 1,500	$ 1,900	$ 125	$ 3,300	1
Small Tools	200	114	26	24	6	30	4
Manufacturing Gas	1,000	1,000					1
Supplies	1,400	350	364	350	42	294	1
Total Variable Mfg. Expense	$11,220	$ 3,259	$ 1,890	$ 2,274	$ 173	$ 3,624	
Fixed							
Telephone & Telegraph	$ 550	$ 314	$ 71	$ 66	$ 16	$ 83	4
Miscellaneous	200	114	26	24	6	30	4
Power	2,000	1,140	260	240	60	300	4
Travel	550	314	71	66	16	83	4
Postage & Stationery	600	342	78	72	18	90	4
Water	125	63	62				7
Employee Insurance	700	231	105	252	42	70	3
Depreciation	7,200	2,808	1,512	1,584	216	1,080	1
Employee Service	85	28	13	31	5	8	3
Periodicals & Membership	15	9	2	2		2	4
Raw Material Losses	650	215	58	240	59	78	5
Mold Maintenance	4,818	4,818					1
Overhead Transfer	2,000		1,800	200			1
Professional Services	25	14	3	3	1	4	4
Occupancy	4,600	2,116	644	782	414	644	2
Discount Earned	(825)	(273)	(74)	(305)	(74)	(99)	5
New Equipment Design	1,260	403	164	478	76	139	6
Division Assessments	3,045	1,736	396	365	91	457	4
Warehousing Cost	3,150	1,040	283	1,165	284	378	5
Total Fixed Cost	$30,748	$15,432	$ 5,474	$ 5,265	$1,230	$ 3,347	
LABOR FRINGE BENEFITS							
Variable	$ 6,930	$ 2,287	$ 1,039	$ 2,495	$ 416	$ 693	3
Fixed	1,995	658	299	718	120	200	3
Total Labor Fringe Benefits	$ 8,925	$ 2,945	$ 1,338	$ 3,213	$ 536	$ 893	
Total Overhead	$73,188	$31,843	$11,420	$15,949	$3,237	$10,739	

BREAKDOWN OF ALLOCATION BY CODE

Code	Amount	% of Total
1 — Direct Charges	$30,787	43%
2 — Floor Space	4,600	6
3 — Direct & Indirect Payroll	9,710	13
4 — Machine Hours	23,731	32
5 — Material Consumed	2,975	4
6 — Adjusted Gross Sales	1,260	2
7 — Other	125	100%
	$73,188	

BREAKDOWN OF BASIC AND DIFFERENTIAL OVERHEAD BY MAJOR COST CENTERS

	Total Plant	Compression Molding	Injection Molding	Staking	Lining	Metal Fabrication
Total Monthly Overhead	$73,188	$31,843	$11,420	$15,949	$3,237	$10,739
Less Differential Overhead						
Maintenance	$ 8,620	$ 1,795	$ 1,365	$ 2,000	$ 160	$ 3,300
Manufacturing Gas	1,000	1,000	—	—	—	—
Depreciation	7,200	2,808	1,512	1,584	216	1,080
Mold Maintenance	4,818	4,818	—	—	—	—
Overhead Transfer	2,000	—	1,800	200	—	—
Occupancy	4,600	2,116	644	782	414	644
Warehousing Cost	3,150	1,040	283	1,165	284	378
Total Differential Overhead	$31,388	$13,577	$ 5,604	$ 5,731	$1,074	$ 5,402
Total Basic Overhead	$41,800	$18,266	$ 5,816	$10,218	$2,163	$ 5,337
Total Machine Hours	28,413	16,065	3,759	3,528	756	4,305
Basic Machine-Hour Rate		$ 1.14	$ 1.55	$ 2.90	$ 2.86	$ 1.24

EXHIBIT 3

variable. Non-labor expenses are grouped as either fixed or variable. Availability of this type of breakdown provides management with analytical tools needed for determining breakeven points and the relative profitability of products in the line and for marginal contribution analyses.

Calculating the basic rate

The last line on Exhibit 2 becomes the first line on Exhibit 3. From this is subtracted $31,388 in differential overhead made up of items such as maintenance, manufacturing gas, and depreciation, which are specifically identifiable by individual type of equipment. Subtracting the breakdown of the $31,388 by major machine groupings from the breakdown of the total overhead of $73,188 results in a breakdown of the basic overhead. Dividing this by the machine hours of the major machine groups gives the basic overhead cost per machine hour for all types of equipment within the group.

Using injection molding for illustrative purposes, the total monthly overhead determined for this group in Exhibit 2 is $11,420. Subtracting from this the differential overhead in the amount of $5,604 leaves $5,816. This is the basic overhead for all the classes of equipment in injection molding. Dividing this figure by the total injection molding machine hours of 3,759 results in a basic rate of $1.55 for all types of equipment within this major grouping.

Determining the differential rate

Following through with the illustration of the injection molding group, the $5,604 shown in the total differential cost column, which was determined to be the differential overhead, is assigned in Exhibit 4 to the various types of equipment within the major machine group.

The total of the differential overhead cost for each type of equipment is then divided by the machine hours of that type of equipment to arrive at a differential machine-hour rate.

Combining the rates

Exhibit 5 is the consolidation schedule, which brings the basic and differential rates together. For injection molding the basic rate is $1.55 per machine hour, while the differential rate is $1.05 per machine hour for the four-ounce equipment, $1.85 for the eight- and twelve-ounce, and $3.86 for ninety-six-ounce equipment.

To the overhead cost must be added the hourly cost of direct labor, which for the four-ounce machine is $.45 per machine hour, for the eight- and twelve-ounce, $2.21, and for the ninety-six-ounce, $2.30. Ordinarily the total overhead and direct labor per machine hour would be adjusted for machine efficiency to equate for productivity. In the case of the injection molding equipment, this allowance was included in the utilization allowance because the equipment had been newly installed and no definitive historical information was available to make a separate determination for machine downtime as opposed to machine productivity while running.

Return-on-investment pricing

Many small fabricating companies have for years determined the selling prices of their products by doubling prime cost (material plus direct labor). As fabricating equipment has become more and more sophisticated in the last ten to fifteen years, direct labor has become the smallest of the three elements of cost while overhead, on

BREAKDOWN OF DIFFERENTIAL OVERHEAD BY COST CENTERS

	Maintenance	Mfg. Gas	Depreciation	Mold Maint.	O. H. Transfer	Occupancy	Whse. Cost	Supplies	Power	Total Differential Cost	Total Machine Hours	Differential Machine-Hour Rate
Total Plant	$8,620	$1,000	$7,200	$4,818	$2,000	$4,600	$3,150	$20	$50	$31,458*	28,502	
Total Compression Molding	1,795	1,000	2,808	4,818		2,116	1,040	20	50	13,647*	16,524	.84
Rotaries	700	1,000	2,364	3,151		727	676	—	—	7,618	6,048	1.26
Stokes	130		344	368		296	42	—	—	1,180	3,696	.32
Transfer Press	433		392	726		741	187	—	—	2,479	2,541	.98
Strauss	482		633	573		317	135	—	—	2,140	3,780	.57
Wheelabrator	50		75			35		20	50	230	189	1.22
Total Injection Molding	1,365		1,512		1,800	644	283	—	—	5,604	3,759	1.49
4-Ounce	550		529		1,080	277	92	—	—	2,528	2,415	1.05
8- & 12-Ounce	550		519		540	251	81	—	—	1,941	1,050	1.85
96-Ounce	265		464		180	116	110	—	—	1,135	294	3.86
Total Staking	2,000		1,584		200	782	1,165	—	—	5,731	3,528	1.62
Total Lining	160		216			414	284	—	—	1,074	756	1.42
Total Metal Fabrication	3,300		1,080			644	378	—	—	5,402	4,305	1.25

*Includes $20 for supplies and $50 for power to cover wheelabrator machine rate.

EXHIBIT 4

EXHIBIT 5

CALCULATION OF MACHINE RATES

	Overhead						
	Basic Machine-Hour Rate	Differential Machine-Hour Rate	Total Machine-Hour Rate	Labor Cost Per Machine Hour	Combined Machine Rate	Machine Efficiency	Adjusted Machine Rate
Compression Molding							
Rotaries	$1.14	$1.26	$2.40	$ .36	$2.76	95%	$2.90
Stokes	1.14	.32	1.46	.19	1.65	95	1.73
Transfer Press #1	1.14	.98	2.12	.54	2.66	95	2.80
Transfer Press #2	1.14	.98	2.12	1.40	3.52	90	3.91
Strauss	1.14	.57	1.71	.25	1.96	95	2.06
Wheelabrator	—	1.22	1.22	1.77	2.99	95	3.15
Injection Molding							
4-Ounce	1.55	1.05	2.60	.45	3.05	Allowance for machine efficiency incuded with % utilization of equipment. See Exhibit 1.	
8- & 12-Ounce	1.55	1.85	3.40	2.21	5.61		
96-Ounce	1.55	3.86	5.41	2.30	7.71		
Staking							
Automatic	2.90	1.62	4.52	1.40	5.92	90	6.58
Semi-Automatic	2.90	1.62	4.52	2.10	6.62	90	7.36
Hand Staking	2.90	1.62	4.52	2.10	6.62	90	7.36
Lining	2.86	1.42	4.28	1.85	6.13	90	6.81
Metal Fabrication							
Pins	1.24	1.25	2.49	.26	2.75	85	3.24
Automatic	1.24	1.25	2.49	.39	2.88	85	3.39
Non-Automatic Metal	1.24	1.25	2.49	1.81	4.30	80	5.38

the other hand, has become substantially larger — often the largest of the three elements.

Since automated equipment and the associated support facilities represent a fairly large investment in capital assets, it seems logical that selling prices would be more appropriately based on a proper return on investment — inventory as well as fixed assets. Although fixed assets and inventory are not the only items making up total investment, they are very substantial in most automated factories. In addition to representing the predominant segment of invested capital, these two asset groups can be fairly well pinpointed to the product line for which the investment was incurred and are generally controllable by the factory manager since he is responsible for effective utilization of his facilities and proper turnover of inventory.

If it is agreed that fixed assets and inventory should be the basis for measuring return on investment, the problem then is to arrive at a vehicle for equating markup with return on inventory and with return on fixed assets.

Calculating the desired markup

In the interest of simplicity, let us assume that a 20 per cent return on inventory and fixed assets results in an adequate return on total assets. Exhibit 6 on this page shows how the two markup factors would then be calculated:

If management's goal is an annual return of 20 per cent on total inventory and fixed asset investment, then the amount to be recovered for the material content in inventory is $100,000, while the amount to be recovered for the labor and overhead content is $75,000. The amount to be recovered on fixed assets is $125,000.

The logical vehicle for recovering the first item of $100,000 is the material content of the product being sold. Let us assume for purposes of illustration that the amount of material consumed during the year (a turnover of four times per year) is two million. Dividing the desired return of $100,000 by two million results in a markup factor of 5 per cent.

Labor plus overhead is the logical vehicle for recovering the investment on the balance of the inventory as well as the investment in fixed assets. The desired return to be recovered on a labor and overhead basis then is $200,000 ($75,000 on labor and overhead content in inventory and $125,000 on fixed assets). Assuming that labor and overhead content of products made in a normal year totals one million dollars, the markup would be 20 per cent ($200,000 divided by $1,000,000).

Thus in costing up the product for sale, the cost and markup to arrive at selling price would be determined as shown in Exhibit 7 below. A pricing formula of the type illustrated is, at best, only a guide. Obviously no mathematical formula can be applied universally; it must be tempered by good business judgment. However, such a formula can be very helpful in maximizing profits through a more logical application of the factors that affect prices.

Some basic principles of pricing products for maximum profits were summarized by Bertrand J. Belda, a partner in the firm of Ernst & Ernst, Cleveland, Ohio, in the following words:*

Illinois Certified Public Accountant, vol. XXI, no. 2.

CALCULATION OF MARKUP

	Amount of Investment	% Return	Amount of Return
MATERIAL-RELATED INVESTMENT			
Inventory (material content)	$ 500,000	20	$100,000
INVESTMENT RELATED TO CONVERSION			
Inventory (labor and overhead content)	$ 375,000	20	$ 75,000
Fixed Assets	625,000	20	125,000
	$1,000,000	20	$200,000
TOTAL INVESTMENT	$1,500,000	20	$300,000

EXHIBIT 6

"Pricing products for maximum profits must take into account three fundamental factors: careful market analysis, sound costs, and markup techniques that are based upon carefully planned business objectives.

"The market analysis should include a penetrating study of product and territorial potentials, competitive conditions, and customer needs and desires. Costs for pricing purposes should be based upon current and future price levels and should be determined in a manner that will separate direct variable elements from fixed charges. Finally, profit markups should be calculated in a fashion that will recognize the significance of the varying investment factors involved in the production and sale of different products."

EXHIBIT 7

CALCULATION OF SELLING PRICE

	Cost/M
Material (53 pounds @ $.10)	$5.30
Direct labor and overhead (.50 hours at $5.30/machine hour)	2.65
Total manufacturing cost	$7.95
Markup on material—5%	.27
Markup on labor and overhead —20%	.53
Selling price	$8.75

Note: In the interest of simplicity, only manufacturing costs are considered.

Automation presents serious enough problems to the giant organization that can easily afford its own computer. Such problems are multiplied for the smaller company, where computer usage can be very problematical. Here's the experience of one such company — and the solutions found —

A PRACTICAL DATA PROCESSING APPLICATION FOR A SMALL BUSINESS

by Stanley Shein
Baker & Baker

Articles and talks on data processing all too often discuss such advanced applications that the reader or audience is more overwhelmed than helped. And generally the applications involve giant industrial corporations or government agencies which can afford a lot of money and which have little difficulty in absorbing and justifying the economic burden of expensive data processing projects. Unfortunately, most of us have very few clients in these categories.

For the public accountant whose clients are primarily small businesses with annual sales volumes of from one to ten million dollars, these grand-scale projects seem to offer little practical information.

However, the public accountant engaged in systems analysis (and a growing number are these days) should welcome every opportunity to examine the expectations, methods of implementation, successes, and failures of various computer projects. The study of others' experiences with data processing will not provide him with a thesaurus of ready-made solutions, but it will contribute to a working knowledge from which he may develop the appropriate solution to a particular client's problem.

Since data processing facilities are fairly accessible today at a reasonable cost, the advantages of the computer are no longer out of reach for the small businessman. Time-sharing computer service organizations have begun to grow and probably will become as common a utility as electric companies. The forerunner of these utilities has been with us for some time in the form of the service bureau. With the broad range of hardware and software economically available, there is no excuse for the systems analyst's failing to provide data processing solutions whenever they are appropriate to a client's needs.

Management's reasons for wishing to convert to computer applications may range from sincere and studied judgment to a misguided desire to keep up with the Joneses next door. Frequently what management claims to be the problem is not the real problem at all. And very often the installation of a computer will merely serve to wreak havoc with an already faulty system.

The entire question of the feasibility of installing a computer is merely a hard-headed dollars and sense approach to return on investment. The projection of substantial cost savings by converting from a manual to an automated system should not be made with-

The projection of cost savings by conversion from a manual to an automated system should not be made without first maximizing efficiency of the manual method.

out first maximizing the efficiency of the manual method. It is true that not all feasible computer projects rest chiefly upon substantial reductions in clerical labor. However, whatever the objective, electronic data processing proposals should always be approached with caution, with every possible consideration given to the manual system already in effect.

Fortunately, a clear definition of the problem to be solved and the development of a good system do not necessarily require a computer installation. What is required is a good systems analyst who can examine the problem and decide whether an abacus, a slide rule, an adding machine, or a computer offers the most feasible solution.

Another point to be considered when determining the feasibility of installing a computer arises from the GIGO principle – which, as most people know by now, means "garbage in – garbage out." Inherent in computerized data processing is the need for sound, reliable input. Even though the computer tends to reveal many inconsistencies or inaccuracies in input, it cannot within itself correct these errors. No matter how sophisticated the hardware or how comprehensive the programing, the computer will merely produce "garbage" if the source information is inadequate. In fact, many companies, if pressed, will admit that the greatest benefits of installing a computer were derived from the examination and revision of inefficient or ineffective manual procedures.

Our firm recently conducted a feasibility study for the XYZ Company. The improved system that resulted from the study could have been accomplished years ago had such a project been conducted then. No technological breakthroughs were required, although at times these scientific breakthroughs seem easier to achieve than the corresponding necessary social and business adjustments accompanying systems revision.

The XYZ Company has an annual sales volume of around six million dollars. The company manufactures, jobs, and packages approximately five hundred different items. One of XYZ's top executives proposed the acquisition of a small, newly introduced computer to be used primarily to replace the manual preparation and invoicing of customer orders and shipments. The president of XYZ requested our firm to review the proposal and make appropriate recommendations.

The feasibility study

A feasibility study revealed the following:

1. Three clerks manually posted orders to a preprinted stock list form, which served as order, shipping copy, and invoice.
2. These three clerks handled approximately 100 orders per day, with an average of fifteen items per order.
3. If the present manual system were to be handled by a computer, each *item* ordered would have to be keypunched as input –resulting in an approximate total of 1,500 punched cards daily, or 7,500 per week.
4. The present inventory situation was inadequate to permit prebilling, so that a shipping order would have to be prepared, either on a new document or on a car-

EXHIBIT I

		ORDERS RECEIVED (IN UNITS)						
Catalog No.	Description	Week #1	Week #2	Week #3	Week #4	Minimum Inventory*	Open Orders (Unshipped)	Inventory on Hand

*Minimum inventory is simply addition (by computer) of weeks 1 + 2 + 3 + 4, representing a four-week supply of finished goods inventory.

The systems analyst must first examine the problem and then decide whether an abacus, an adding machine, or a computer offers the most feasible solution.

bonized copy of the order, which eventually would be followed by the actual invoice.

5. The costs of the proposed computer would be approximately $24,000 annually, plus the expense of programing, training, and staffing, estimated at $20,000—a total of $44,000 as compared with the present operating expense of around $12,000 annually.

6. Examination of other operations, such as payroll, accounts receivable, and accounts payable, revealed no major functions for which conversion to a computer would provide any substantial benefits.

7. The proposed computer was basically scientifically oriented and offered high computational speed, but it also had low-speed input and output rates and included some unnecessary features such as random access.

After reviewing the above findings, we came to the following conclusions:

1. The proposed computer was capable of handling the preparation and invoicing of orders and shipments, but it would cost approximately three to four times as much as the very simple but highly efficient existing manual system it would replace.

2. The automated system would replace relatively unskilled personnel with highly skilled personnel. This would make the operation more susceptible to employee turnover.

3. An additional clerk would be the simplest and most economical way of handling the anticipated increase in volume.

4. A simple tabulating installation would be more feasible than the computer. (The client wanted a computer or nothing.)

5. The absence of good production and inventory control resulted in a loss of profit to XYZ, and these were probably the best potential areas for mechanized data processing.

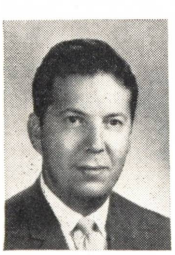
6. A comprehensive status report would provide the most effective tool for production and inventory control.

7. Such a report, to be timely, should be updated weekly—and the instantaneous response of an on line-real time computer was unnecessary.

Recommendations

We recommended consideration of the production and inventory control status report shown in Exhibit 1 on page 41. We further recommended that this report be furnished by a service bureau each Tuesday morning, reflecting the status of production and inventory at the end of the preceding week.

With the installation of a tabulating machine, at the present volume level, we expected a total of 15,000 cards to be keypunched each week—7,500 cards representing order details and 7,500 shipment details. Since this was to be an internal report involving units on order and in inventory, verification would not be required. Orders would be processed in batches and adding machine taped to provide batch control totals.



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This program offered the advantage of complete flexibility. It was based on the modular concept of building blocks, so that other functions could be incorporated as desired. The program could be stopped at any time without repercussions on the basic day-to-day operation. The status report would parallel but not affect the present manual system.

We estimated a total cost for the project of approximately $125 per week. This expense would be justified not only by more efficient production and inventory control but also by the educational and experimental benefits to be gained from being involved in the actual capabilities and problems of data processing.

XYZ's management decided to proceed. A keypunch machine and an office temporary keypunch operator were obtained. All cards would be keypunched on XYZ Company's premises. Arrangements were made for a service bureau using a 1401 computer to tabulate the report.

Rather than take an immediate physical inventory of merchandise and orders, newly received orders were coded as having been punched, so that only these orders would be initially tabulated as shipments. At the end of four weeks, management was confident that all nonpunched orders would be eliminated from the system.

At the end of four weeks the report looked like Exhibit 2 above. Even without the physical inventory, the report is quite meaningful in terms of the rate at which orders are received and the rate at which finished goods are provided for these same items. The substantial volume of unshipped orders, as related to the minimum inventory, reflects the inadequacy of the inventory on hand.

At the year end, the physical inventory was taken and made an integral part of the status report, as shown in Exhibit 3, page 44. Initially the report was confined to one major line, which represented 60 per cent of the items. At year end the entire line was included, and arrangements were made to explode assortments and sets back into basic items.

ORDERS RECEIVED (IN UNITS)

Catalog No.	Description	Week #1	Week #2	Week #3	Week #4	Minimum Inventory*	Open Orders (Unshipped)	Inventory on Hand
7915288	Pieces	112	82	92	102	388	288	

*Minimum inventory is simply addition (by computer) of weeks 1 + 2 + 3 + 4, representing a four-week supply of finished goods inventory.

EXHIBIT 2

At this point, all that really remains are the usual glowing approbations. Most descriptions of automated data processing applications are notoriously deficient in describing some of the seedier aspects. The sheer volume of detail involved in keypunching and verifying or batch totaling comes as a shock to executives infected with "computeritis" who see only the impressive, instantaneous response at the airline ticket counter. Our client had to discover the truth of the "garbage in—garbage out" principle before appreciating the necessity of what he had considered as our over-elaborate control procedure.

The client now has an important tool to enable him to ship orders faster, yet reduce inventory and short-run production costs. At the end of a few weeks, at a very small cost, XYZ gained greater insight into production and inventory control than some companies that spend over $100,000.

Management's reluctance to batch control or verify basic input has delayed satisfactory completion of this phase of the program and subsequent development in additional areas.

The educational benefits of working with the installation and tackling related problems have seasoned XYZ's management in the vital area of data processing.

The value of the status report and its use in production and inventory control has been demonstrated. Management has been pressing for additional reports to be run from the same basic cards. For example, by keying in salesmen's territories, we could sort the keypunched cards of shipments to provide a commission report and analysis of sales by territory. The analysis of territory sales by item could disclose which items are doing well in one territory and not selling at all in others—a matter

The status report would be timely if updated on a weekly basis. Obviously the instantaneous response of an on line-real time computer was unnecessary.

STATUS REPORT

WEEK ENDING - 3/22/66 PAGE NO. 9

CATALOG NUMBER	TYPE	DESCRIPTION	ORDERS WEEK 1	WEEK 2	WEEK 3	WEEK 4	MIN INV	SHIPMTS THIS WK	OPEN BALANCE	INVENTY ON-HAND	ACQUI-SITION
80112		PIECES	20	122	440	670	1,252	142	1,344	2,243	
80113		PIECES	218	270	281	370	1,139	635	1,096	675	
80114		PIECES	120	61	125	180	486	247	1,179	3,195	
80115		PIECES		111	130	50	291	82	739	243	
80116		PIECES	150	571	270	740	1,731	322	6,290	8,029	
80117		PIECES	40	181	3,620	90	3,931	142	4,000	5,902	8,170
80118		PIECES	170	191	323	150	834	497	1,733	1,150	
80119		PIECES	10	121	393	210	734	327	5,182	1,876	1,739
80120		PIECES	1,900	202	200	190	2,492	222	4,494	6,196	4,470
80121		PIECES	480	580	814	398	2,272	392	4,716	2,772	
80122		PIECES	32	101	171	30	334	196	2,941	4,683	
80123		PIECES	60	85	185	40	370	85	615	3,058	
80124		PIECES	95	261	145	140	641	406	654	2,253	
80125		PIECES	250	551	305	250	1,356	556	6,689	3,277	1,304
80126		PIECES	210	306	270	200	986	816	831	4,208	
80127		PIECES	40	230	215	286	771	370	5,811	166	
80128		PIECES	185	552	230	745	1,712	847	4,870	5,728	
80129		PIECES	607	1,666	870	620	3,763	781	10,198	5,622	1,000
80130		PIECES	520	1,272	1,268	695	3,755	817	9,098	18,551	18,683
80131		PIECES	440	1,016	852	230	2,538	1,211	3,803	6,299	3,600
80132		PIECES	460	262	450	176	1,348	277	1,592	1,573	
80133		PIECES	130	282	140	120	672	252	1,280	8,683	
80134		PIECES	60	402	365	580	1,407	347	1,590	31,063	
80135		PIECES	410	296	370	190	1,266	466	2,746	22,682	
80136		PIECES	210	391	200	191	992	661	2,890	9,847	700
80137		PIECES	240	171	348	75	834	516	1,520	17,620	6,000
80138		PIECES	140	190	200	580	1,110	285	1,722	20,330	
80139		PIECES	30	326	433	70	859	196	1,553	18,482	
80140		PIECES	140	421	628	90	1,279	471	3,916	26,064	900
80141		PIECES	50	311	130	480	971	291	930	33,628	2,100
80142		PIECES	115	516	200	130	961	361	1,516	8,357	
80143		PIECES	110	471	370	305	1,256	406	2,326	15,480	
80144		PIECES	90	321	145	220	776	386	1,236	25,822	
80145		PIECES	190	211	190	210	801	401	710	17,100	
80146		PIECES	80	151	80	150	461	351	1,400	37,169	
80147		PIECES	65	270	180	230	745	470	660	15,229	
80148		PIECES	100	275	125	220	720	410	685	29,112	
80149		PIECES	30	296	215	205	746	446	660	32,404	
80150		PIECES	150	756	320	290	1,516	641	3,615	18,430	
80151		PIECES	150	405	180	220	955	360	1,955	22,249	5,000
80152		PIECES	160	455	200	250	1,065	490	1,941	6,843	
80153		PIECES	50	461	125	120	756	216	1,380	20,484	
80154		PIECES	80	366	310	381	1,137	271	1,716	27,968	15,800
80155		PIECES	130	311	380	291	1,112	651	2,196	17,236	
80156		PIECES	130	356	150	131	767	381	1,637	15,416	
80157		PIECES	125	440	210	101	876	210	1,082	24,348	
80158		PIECES	120	260	270	141	791	320	731	15,433	
80159		PIECES	150	290	185	221	846	410	1,152	22,422	2,200
80160		PIECES	170	620	470	261	1,521	660	5,336	24,811	
80161		PIECES	20	70	10	10	110	50	545	6,530	
80162		PIECES	40	60	10	70	180	60	80	3,990	
80163		PIECES	10	100	10	40	160	30	208	7,249	
80164		PIECES		70	60	1,624	1,754	1,634	165	231	

EXHIBIT 3

of some significance to sales management.

With account numbers keypunched into the card, we could analyze open orders by accounts (an area of dwindling importance once the inventory is in balance). We would produce sales reports by account throughout the fiscal period and observe the growth or erosion of each account. This could be another useful tool for sales management.

As accountants, we would like to see manufacturing costs of labor and material among the next applications.

We could also introduce decision making capability by having the keypunch machine print out data on an exception basis, e.g., items which are less than minimum inventory, items which exceed minimum inventory by 50 per cent, etc. This could reduce the present inventory report from 25 pages, 1,500 lines, to a one-page, 30-line report—an inevitable requirement in a large volume application.

Whether XYZ Company eventually expands its tabulating equipment, time shares a computer, or even installs its own computer will depend on many factors—but the status report and the experience gained from implementing a keypunch system will form an important cornerstone of any future development.

Make or buy decisions can be vital to the financial health of a company. And they are among the most delicate and complicated questions management must resolve. Such decisions should be reviewed and analyzed periodically in terms of all current factors.

THE MAKE OR BUY DECISION

by Myron J. Hubler, Jr.
The Reliance Electric and Engineering Company

MAKE OR BUY analysis is an area of management theory and practice with which every accountant should be familiar. Make or buy decisions must be made periodically by nearly every manufacturing company, and for many these decisions are major determinants of profitability.

The procedures for make or buy analysis can be applied to a wide range of decisions—new buildings, new equipment, tooling, parts needed for the production of goods for sale, etc. For the sake of simplicity the subject matter of this article is limited to consideration of make or buy decisions for component parts of products manufactured for sale in the normal course of business. The following definition applies: "The right part at the right time in the right quantity at the lowest cost."[1]

Thus limiting the scope of the discussion makes it possible to use the various levels of productive capacity available from the existing facilities as the basis for cost analysis. Additional complicating factors that would have to be taken into account with a broader definition of make or buy, such as the discounted cash value of the funds that would have to be invested in new equipment, the anticipated useful life of the equipment, and the like, can be omitted from consideration. Therefore, this discussion is confined to selected factors to be considered in evaluating the proposed purchase of parts from outside sources of supply even though existing internal

[1]C. C. Cadiz, "Stampings — Should You Make Them or Buy Them?," *Iron Age*, September 23, 1954, p. 107.

manufacturing facilities are adequate for the manufacture of these products.

Even with these limitations the make or buy decision is frequently a complex one. There are many ways of designing the same product, and there are many materials that might be used for one reason or another. Any of these choices may require a change in manufacturing method or scheduling, inside or outside the company. With such a multiplicity of choices available, it is not surprising that a somewhat less than scientific answer is often forthcoming.

It is important that the chief executive officer of the company spell out the basic policies governing make or buy decisions—the formulas to be used and factors to be taken into account might well be included in the management procedures manual—and specify the division of responsibilities among the members of the management team. The cost accounting function might appear to be the logical one to determine whether a product should be produced or purchased, but that is not necessarily the case. Frequently the purchasing department is the one to initiate make or buy studies, and the production and industrial engineering departments often take part. For an established product line, many of the production details (including make or buy) may be left up to the particular cost centers most closely concerned.

Whatever the exact form of organization, all the specialized knowledge and skills of the management team should be applied to these decisions, and an effort should be made to ensure that the basic policies become ingrained in management thinking. Attention to the profit improvement possibilities of such decisions should become an established part of the corporate routine.

Noncost factors

Normally the make or buy decision may be assumed to rest upon an analysis of comparative costs. There are, however, a number of factors other than product costs that may be of significant—in some cases overriding—influence in the make or buy analysis. Among these factors to be considered are the following: capacity, product quality, seasonal and cyclical sales and production fluctuations, process secrets, employee welfare and good will, and technological innovation.

Capacity—Any decision to make or buy must be preceded by an analysis of the capacity of existing facilities. Issues to be considered include the number of shifts the facilities will be in operation; when overtime should be included (for example, if three shifts are already working); and, possibly, when work must be subcontracted at maximum capacity levels.

Quality—In most cases it is assumed that comparable quality is available from internal and external sources of supply. This is not necessarily so. When special tolerances or special skills are required in the manufacture of a part, the advantages of specialization may favor the buy decision. To some extent, however, product quality is an intangible value. Appearance may affect subjective "quality," as in the use of chrome vs. aluminum boat fittings, without necessarily relating to "quality" as expressed in terms of product performance. Whether the part is to be an internal or external component may be an influencing factor in practical quality requirements.

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Fluctuations—In some industries the existence of seasonal and cyclical sales and production fluctuations may make internal manufacture of a part more desirable than it would be otherwise. Items that would normally be purchased on the outside can be produced on existing facilities to level out production.

Trade secrets—The need to protect trade secrets may tip the scales in favor of the make decision. Companies in defense production or those enjoying a definite market advantage from design patents or process secrets may want to do their own manufacturing in order to make sure to retain this advantage.

Employee welfare and good will—Even when a buy decision seems fairly obvious, management may, for reasons of community stability and retention of skilled labor, wish to continue to manufacture products that might be purchased more economically. The continued availability of a dependable, trained manufacturing labor force is an intangible asset whose value defies quantification for make or buy analysis. Such decisions should be re-evaluated periodically by top management.

Technological innovation—In industries that characteristically have a substantial amount of change in product from one year to the next, there is a tendency to favor outside sources of supply. The greater potential for technological obsolescence creates the risk of a much shorter period of cost recovery for manufacturing facilities and equipment. Particularly when exotic materials, highly specialized labor, special tooling, and the like must be used, manufacturers often prefer to shift the risk to suppliers if they can.

Other factors—There are other factors that may favor either a make or buy decision. If the prices charged by vendors appear unreasonably high in comparison with estimated costs of manufacturing or if special product guarantee or liability responsibilities are in-

volved, the company may lean toward manufacturing the parts itself. Trade practices of competitors, the estimated future demand and continuity of design of the product, and the value of the component as compared to the total volume of business of the product (usually based on one year's usage) may influence the decision either way, depending on the outcome of the analysis. These and other pertinent considerations that may be known to the management should be included in the list of factors to be evaluated in making an informed decision.

A schedule similar to the one shown in Exhibit 1 on this page is frequently prepared for use in evaluating the factors other than product costs.[2]

MAKE OR BUY ANALYSIS

Reasons for Making	Reasons for Buying
1. Cost studies indicate it is cheaper for you to make than to buy.	1. Cost studies indicate it is cheaper for you to buy than to make.
2. Making fits your knowhow, your equipment, and your tradition.	2. Space, equipment, time, and/or skill are not available for you to develop the necessary production operations.
3. Idle capacity is available to absorb overhead.	3. Because of small volume, or because of other capital needs, the investment in making is not attractive.
4. What you are considering is unusual or complex; direct supervision is needed to assure control.	4. You wish someone else to face seasonal, cyclical, or risky market demands.
5. Making will facilitate your control of parts changes, inventories, and deliveries.	5. The need for special techniques, or equipment, makes buying more logical.
6. The part is hard to transport.	6. You think it is best for your executives to concentrate on your specialty.
7. The design of the part or its processing is confidential.	7. You want a check on your own operations.
8. You do not wish to depend on a single outside source of supply.	8. Patents or customer-supplier relationships favor going outside.

EXHIBIT I

Product costs

There is a wide range of opinion as to the costs that should be included in make or buy analyses. Out-of-pocket, incremental, and total costs may be pertinent and should be included when appropriate.

Generally, an analysis of make or buy comparative costs should be done on a worksheet that provides for comparison of vendor quoted (or known) prices and company manufacturing costs. A worksheet form such as that shown in Exhibit 2 on page 48 is suggested for use in formal make or buy analyses. (The use of such a form is assumed in the following comments about selected costs; it should be referred to for a clearer understanding of this discussion.)

Direct variable costs—It is generally agreed that the direct variable costs should be included in the accumulated manufacturing cost. Among the direct variable costs are all direct material and direct labor and any other out-of-pocket costs. Under unusual circumstances (such as tight production capacity) subcontract work costs may be incurred; they should be included as direct variable costs.

A common fallacy in make or buy studies is the assumption that material costs will be the same for both the vendor of parts and the manufacturer of the final product. The vendor's history, regularity, or quantity of purchases of a material may enable him to obtain lower prices than a newcomer to the field might pay. The vendor's knowledge of sources of supply is likely to be superior to that of the manufacturer. Sometimes purchasing may even be from different levels of supply; for example, the vendor may be able to buy his materials directly from the processor while the company proposing to make its own parts may have to buy from distributors.

Another fallacy is the assumption that the two companies have similar labor costs. The company proposing to manufacture may have, for example, a standard labor rate of $3.50 an hour, while the vendor may use semi-skilled labor, students, etc., for a standard rate of $1.75 an hour.

Direct variable overhead is more difficult to define as an out-of-pocket or incremental cost. Among the overhead cost items that may be pertinent are the following:

1. Additional material handling costs
2. Indirect labor
3. Additional hourly supervision
4. Special skills or training required of employees
5. Overtime premiums (as capacity costs begin to creep in)
6. Fringe benefit costs and other variable overhead costs peculiar to a particular industry
7. Set-up and tear-down time required for equipment conversion. (Conceivably there could be down time initially to halt an operation already on the machines, set-up time for the next part, tear-down time upon completion of manufacture of the new part, and new set-up time required to resume production.)

Any unusual capacity costs incurred as a result of exceeding the normal capacity of the existing plant facilities should be included under variable overhead costs. For some products there also may be

[2]Carter Higgins, "Make or Buy Re-Examined," *Harvard Business Review*, March-April, 1955, pp. 118-119.

Dept. No. _____
Project or Part # _____
Quantity Needed _____
Date Needed _____

MAKE OR BUY ANALYSIS WORKSHEET

DECISION
MAKE ☐ BUY ☐
Date _____
Prepared By _____
Approved By _____

	Purchased Cost	Manufactured Cost
A. Direct Variable Costs - Note A:		
1. Material - Include Variations for Major Products	$	$
2. Labor - Include Variations for Major Products		
Reroute		
Shift Premium		
Incentive Pay		
Etc.		
3. Subcontract		
B. Overhead:		
1. Material Handling		
2. Indirect Labor		
3. Hourly Supervision		
4. Training - Include Special Skills		
5. Set up		
6. Overtime Premium		
7. Vacation and Holiday Pay		
8. Fringe Costs		
9. Other Variable Costs:		
_____		
C. Semi-Variable and Fixed Costs - Note B:		
_____		
D. Other Costs and Expenses - Note C:		
1. Purchasing, Shipping, Storage, Testing, Etc.		
2. Division Administration		
3. Division Engineering		
TOTALS	$ (NOTE D)	$

NOTES:

A. Separate departmental labor hour and overhead rates may be preferable to the use of composite rates.
Total direct labor standard hours required _____

The divisional rate for overhead applied should be redetermined as substantial amounts of direct labor hours are absorbed in the make or buy products.

B. Semi-variable and fixed costs may be included for specific items.

C. These incremental and out-of-pocket costs are included only when quantities being considered are substantial in amount.

D. Includes vendor's invoice price and adjustments for out-of-pocket non-compensating costs included in the manufactured cost column.

Excess capacity costs should be included. YES☐ NO☐

Tooling charges should be included. YES☐ NO☐

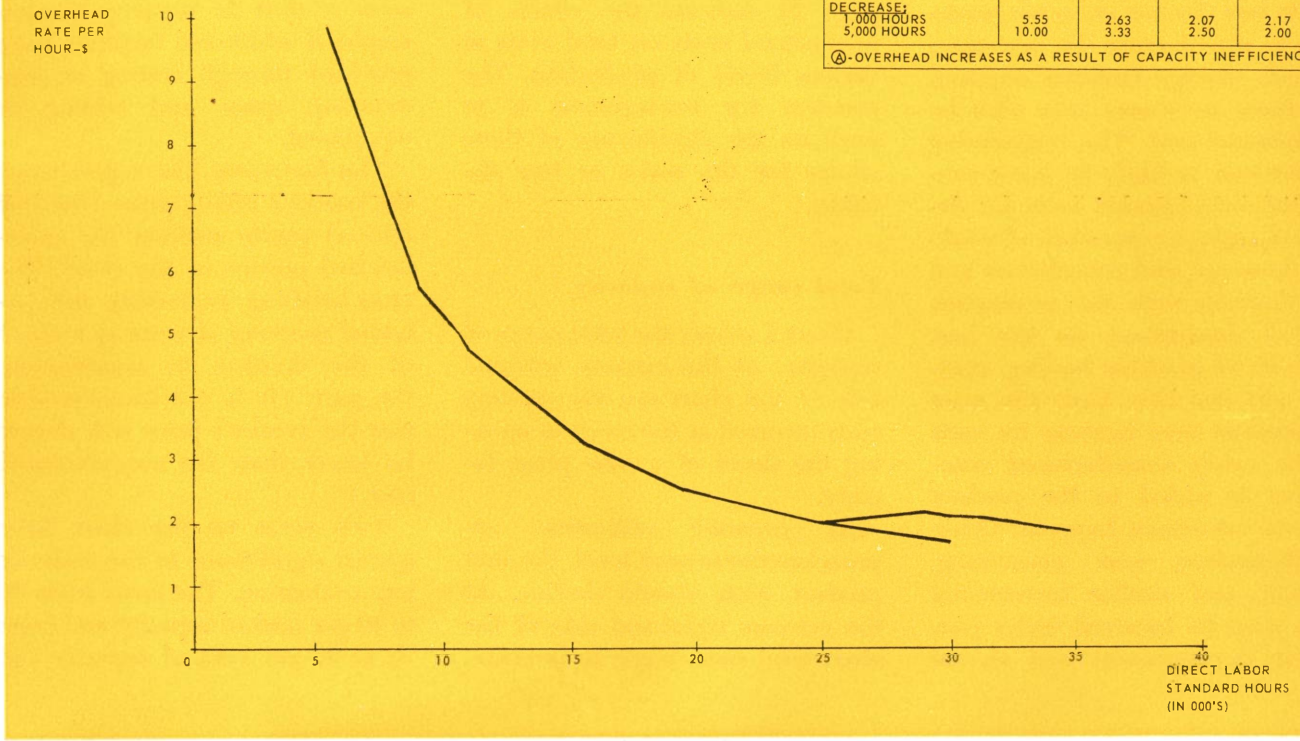
COMMENTS:
(Include vendor reference, delivery time, etc.)

MAKE OR BUY WORKSHEET

EXHIBIT 2

	LEVEL OF CAPACITY (%)			
	40	80	100	120
DIRECT LABOR STANDARD HOURS	10,000	20,000	25,000	30,000
OVERHEAD TO BE APPLIED	$50,000	$50,000	$50,000	$63,000 Ⓐ
OVERHEAD RATE	5.00	2.50	2.00	2.10
EFFECT OF THE MAKE OR BUY DECISION ON PRODUCTION HOURS:	EFFECT OF THE MAKE OR BUY DECISION ON THE OVERHEAD RATE:			
INCREASE:				
1,000 HOURS	4.55	2.38	1.92	2.03
5,000 HOURS	3.33	2.00	1.67	1.80
DECREASE:				
1,000 HOURS	5.55	2.63	2.07	2.17
5,000 HOURS	10.00	3.33	2.50	2.00

Ⓐ-OVERHEAD INCREASES AS A RESULT OF CAPACITY INEFFICIENCY



EFFECT OF CHANGES IN DIRECT LABOR ON OVERHEAD RATE

EXHIBIT 3

special tooling charges of substantial size.

Semi-variable and fixed costs

The question of whether to include semi-variable and fixed costs in the analysis is one of the most controversial in the discussion of make or buy. Most production supervisors will insist that only direct variable (out-of-pocket) costs should be considered in any make or buy decision. Conversely, almost all the technical literature on the subject contains warnings that it may well be disastrous to ignore the fixed and semi-variable costs.

The answer probably lies in the length of the time period to be covered by the make or buy analysis. A short-run make or buy decision—for example, temporary internal manufacture of the component—may very well be based on only direct variable costs. However, since semi-variable and fixed overhead costs will inevitably change over the long run, they should always be included in any analysis involving the long-range manufacturing program.

What is meant by the short run, and what is meant by the long run? For purposes of make or buy analysis, an adequate definition of short-run production may be devised on the basis of a representative allocation of direct labor standard hours. Production hours in excess of this would be considered long-run.

Management often assumes that if there are direct labor hours available because of idle capacity, then this labor should be put to work on manufactured products. It is important to remember, however, that as substantial amounts of direct labor hours are applied to the manufacture of a product, any distribution of overhead based on such direct labor hours should be revised accordingly. Exhibit 3 above illustrates the effect on overhead of changes in the utilization of the manufacturer's production capacity.

Even in short-run make or buy analysis, it is frequently desirable to determine separate departmental labor hour and overhead rates instead of using a composite rate for the company. Thus, the manufacturing costs that are calculated will correspond more closely to the costs quoted by outside vendors, and departmental overhead responsibility will be more closely defined as a result.

For the long-run make or buy decision, such additional semi-

variable costs as shift premiums and incentive pay should be considered as incremental costs. Other incremental semi-variable costs may be incurred outside the direct production areas:

The purchasing department may be more costly to operate when it has to buy the raw materials necessary to manufacture the new component. Storage facilities required for these purchases may also be incremental cost. The engineering department is likely to incur substantial out-of-pocket costs for design changes, preparation of working drawings, and consultation and coordination with the production control department on the best methods of machine loading, routing, and the like. Even the sales department may increase its costs if the newly manufactured component is added to the product line, as sometimes happens. Other administrative, cost accounting, clerical, and similar incremental costs may be incurred under particular circumstances and should be evaluated for possible inclusion in the long-run analysis of comparative advantages and disadvantages.

Effect of incremental costs

Chart 1 below and Chart 2 on page 51 indicate the effects of incremental costs on total costs at various levels of production. The problem for management is to evaluate the significance of these effects for the make or buy decision.

Total range of capacity

Chart 1 covers the total range of capacity. At the extreme lefthand side of the chart are the start-up costs incurred as the result of opening the doors of a new plant facility.

As capacity utilization approaches the normal level, the unit product costs should decline. At the extreme righthand side of the chart total costs begin to increase, adding substantially to the cost of producing the additional or incremental units.

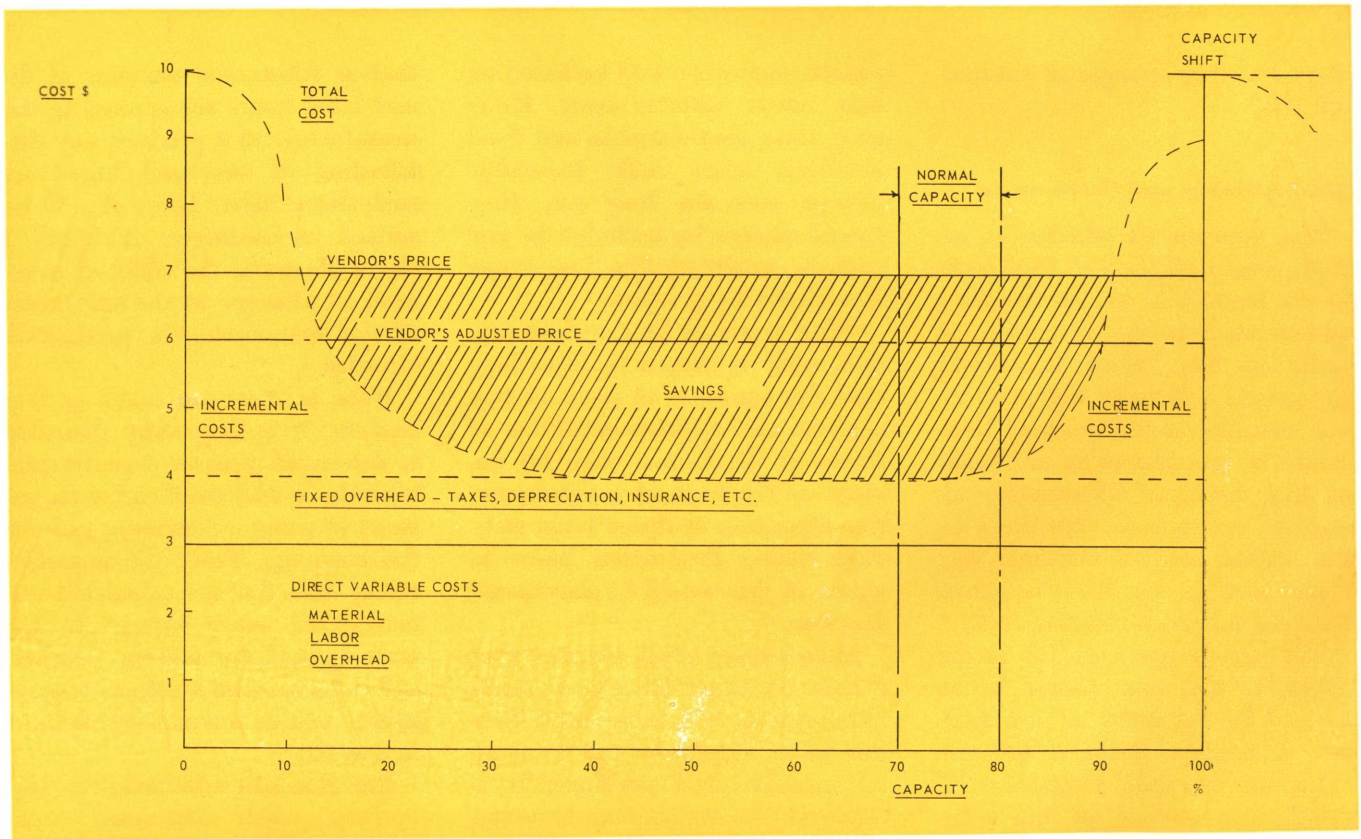
The righthand vertical margin of this chart represents the ultimate capacity of the existing facilities. The dotted line above and to the right of total capacity represents a shift in capacity—for example, if additional facilities were provided through renting or constructing space and adding to equipment.

The horizontal line representing the vendor's selling price (the buy option) partly outlines the cross-hatched portion of the chart. The cross-hatching represents the potential recovery of costs as a result of the decision to manufacture the part. (It is not inconceivable that the vendor's price will always be lower than the manufactured cost.)

Two areas on the chart have special significance in the make or buy evaluation. The areas from 10 to 40 per cent of capacity and from 70 to 95 per cent of capacity (as

CHART 1

EFFECT OF INCREMENTAL COSTS AT ALL LEVELS OF CAPACITY



shown) may involve price concessions negotiated from vendors as an added incentive to buy.

The fixed overhead section of costs is shown directly above the direct variable costs. In many short-run make or buy studies no attempt would be made to recover these costs; only direct variable costs would be included.

Normal capacity levels

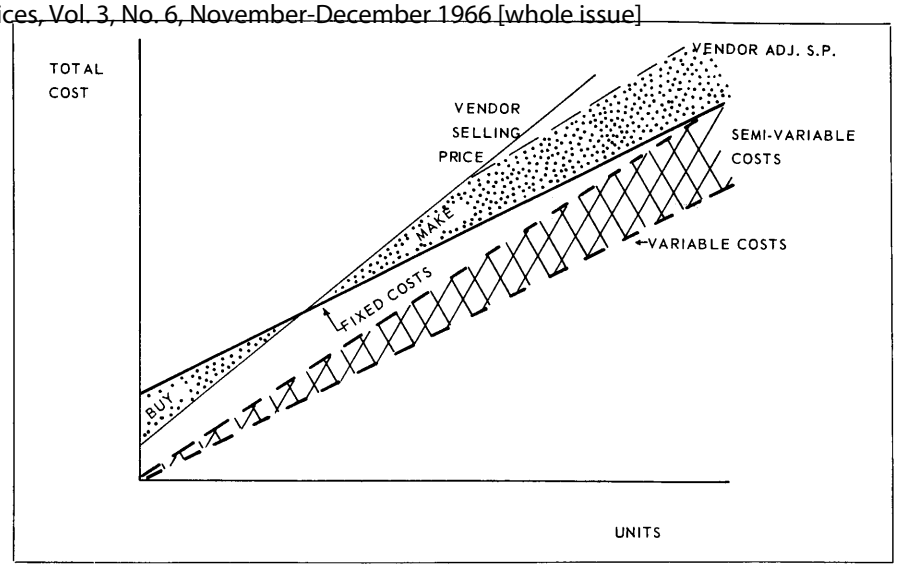
Chart 2 concentrates on costs at normal capacity levels. In this chart the usual cost relationship has been reversed; the total variable cost is shown as the initial cost incurred. The portion of fixed and semi-variable costs that will remain constant at a given capacity level has been added as a parallel diagonal line above the variable cost line.

The line representing the vendor's selling price is based on an assumption. This line has been started at a point above the variable costs and includes a portion of the fixed costs. This line rises diagonally to the right and above total costs for the manufactured part. The assumption made in thus drawing this line is that it will cross the total cost line at some point, providing the initial point for the decision whether to make or buy.

A diagonal line is drawn from zero capacity through the point at which the total cost line touches the maximum capacity level. Its purpose is to illustrate that as production increases within the capabilities of the present facilities, all variable and fixed costs must eventually be recovered.

Conclusion

This brief discussion of make or buy analysis has been designed to emphasize the importance of careful and intelligent appraisal of make or buy factors. All make or buy decisions should be completely re-evaluated on a periodic basis to avoid manufacturing stagnation and the effect of what has been



EFFECT OF INCREMENTAL COSTS AT NORMAL CAPACITY

CHART 2

termed "creeping overhead."[3] Regular and systematic make or buy analysis should be a part of corporate management procedure. Responsibility for the make or buy program begins with the president of the company; specific responsibilities are frequently delegated to the controller, purchasing agent, industrial engineering department, plant manager, and/or other specialists within the corporate structure.

The statement, "It is always cheaper to manufacture than to buy," is patently erroneous and can lead to costly errors. If plant capacity is used to excess, overcrowding and other operating inefficiencies may lead to additional variable cost absorption. Rerouting of materials through the production process may disrupt load levels and scheduling on the machines. Long, efficient equipment runs may be replaced by shorter, less continuous cycles, greatly increasing such charges as set-up time, overtime premiums, and the like.

The use of out-of-pocket costs as the sole criterion for evaluation of make or buy alternatives should be avoided as inadequate. Incremental costs, overhead absorption, and any other factors that may appear important to the management team should also be considered.

If short-run manufacturing cycles consume a large part of the production schedule for the manufacturing facilities, the total costs incurred should probably be analyzed on a job shop basis. This type of analysis is also appropriate for a series of long production runs on manufactured parts that use a substantial portion of the direct labor hours within the limitations of the facilities.

The final point of this discussion —and one of great importance—is that an analysis prepared for a make or buy decision should never be used as the basis for the cost computations needed to increase the gross profit percentages on sales product lines. The application of make or buy principles should not be allowed to obscure the analysis of other more complicated problems confronting management.

There is always some way to reduce product costs. The problem for those responsible for the make or buy decision is to determine which choice will save money, how much it will save, and whether the time required for the analysis is justified by the saving eventually achieved.

[3] A. R. Oxenfeldt and M. W. Watkins, *Make or Buy*, McGraw-Hill Book Company, New York, 1956, p. 62.

"Operations research" still has an esoteric and forbidding sound to many businessmen and their advisors. Yet it can be a significant aid—if supported by the right data. And this accountants can supply if they know the needs—

WHAT OPERATIONS RESEARCH MEANS TO THE ACCOUNTANT

by Joe F. Moore

Bonner & Moore Associates, Inc.

Intimidated by the mathematical symbolism and scientific jargon of operations research, many accountants have tended to view this relatively new field of management thought with hostility or indifference. Often they have either opposed it as a potential competitor in the supplying of information to management or ignored it as a fad that will go away.

Such reactions are shortsighted. The interplay between the operations researcher (or management scientist) and the accountant is already extensive, and it is growing. Accounting is both a supplier to and a customer of operations research; much of the management scientist's raw data must come from the accounting department, and many of his recommendations must be carried out through the accounting system. As the operations research approach begins to exert a strong influence on management thinking, it is becoming more and more important for the accountant to understand this new discipline and learn to work with its practitioners.

Definition

The term operations research can be defined on two levels: in terms of philosophy and in terms of technique. On the philosophical level, operations research may be defined as the application of scientific methods to problems that have traditionally been considered nonscientific. In terms of technique, operations research may be defined as a methodology that includes such techniques as mathematical simulation, statistics, optimization, and various methods of electronic computation.

Operations research can properly be called a scientific discipline. It was originally formalized during the years of World War II and began to find industrial appli-

cation a few years after the war.

As an approach to problem solving, operations research may be compared with the early work of John Galbreath and other pioneers in the field of industrial engineering. Galbreath's classic study of bricklaying is a good example of the application of scientific methods—in that case analyzing the various energy and motion requirements of mortaring bricks into place in a vertical wall.

The concept that many manual tasks could be studied, organized, and made more efficient through observation and calculation was revolutionary at the beginning of the Twentieth Century. Today, this concept is commonplace, and virtually all industrial companies have industrial engineering departments. Operations research is closely related to this discipline, and, indeed, many universities place their operations research curricula in schools of industrial engineering.

However, the subjects for operations research study differ from the various production operations that are subject to study by the conventional industrial engineering techniques. Operations research study in industry concerns activities at the management level in a corporation. Usually, the problem involves situations that cannot be counted or measured by weight, color, or dimension. Typically, the operations research study deals with the interactions among management decisions, production efficiency, product demand, manufacturing costs, and product price. Therefore, an operations research study is primarily based on economic measurements. Ordinarily, the principal objective of an operations research study is the reduction of all measurements of efficiency and performance to common economic units.

Although application of operations research techniques began before the advent of the electronic computer, the practice of operations research today is almost completely dependent on these machines. Since operations research frequently involves systems that cannot be reproduced in a laboratory or on a microscopic scale, the techniques of mathematical simulation become important. The simulation of an economic system having any degree of complexity is impossible without the modern electronic computer. Statistical analysis of large quantities of data, such as marketing, manufacturing, and price data, is also impractical without a computer.

Objectives

There is no such thing as an "average" operations research study, but all projects have certain things in common, including organization of the work effort. Any operations research study must begin with a definition of the problem. This initial step is more important in operations research work than in any other field of scientific study because the problems to be solved are generally broad in scope with many facets.

The original problem statement may simply consist of describing two or three symptoms of trouble and stating that the purpose of the study is to find the cause or causes. Occasionally the problem can be stated more succinctly, e.g., to define an optimum strategy for scheduling production and controlling inventory to supply a specific market.

During the problem definition phase a good operations research team determines the potential profit that may be realized as a result of the study. Information must be available to calculate the economic effects of various actions if the researcher is to predict what profit improvements might be possible through some increase in efficiency, either in decision making or in the operation of a plant or organization.

JOE F. MOORE is president of Bonner & Moore Associates, Inc., in Houston, Texas. While employed by Humble Oil and Refining Company, he gained experience in process operation, process design, and economic evaluation. Mr. Moore has directed Bonner & Moore activity in industrial expansion studies, investment evaluation, plant simulation, and operations research. He is a registered professional engineer and a member of the American Institute of Chemical Engineers and the American Management Association.

Information gathering

When the objectives of the study have been clearly defined, the next step is to survey the information available. This information can be of two types. The first type, data that objectively measure events, includes such traditional data as manufacturing costs, production rates, sales prices, and transportation costs. The second type of information includes management experience developed through years of decision making that can provide insight into cause and effect relationships.

One specific technique of operations research, industrial dynamics, uses only data that reflect cause and effect relationships and ignores the traditional types of data used to measure performance. If all cause and effect relationships can be properly understood and correctly related to each other, then the dynamic operation of a business or physical system can be simulated and controlled to improve performance.

Model building

The next step in an operations research study is usually the construction of mathematical models, which serve the same purpose as laboratory equipment. These models permit experimentation with the system to study present performance and to develop new methods of improving performance. Many specific techniques have been developed for solving specific classes of mathematical models. Some common ones include linear programing models and transportation or distribution models. Experi-

mentation with these models and the use of optimizing techniques to determine how a system operates best under a specific set of circumstances provide data that the operations research analyst uses to develop his broad conclusions.

Recommendations

The conclusions and recommendations for actions resulting from an operations research study can take several general forms.

First, a specific recommendation might be made to modify some operating practice or to pursue some specifically different sales strategy. In the same manner, a recommendation might describe a new raw material purchasing policy or new manufacturing procedures to reduce operating costs.

A second type of recommendation might list several alternative actions for management decision. These recommendations could include capital investment programs, new product introductions, or the elimination of certain unprofitable operations.

Both of these first two types of recommendations provide specific objective answers that could be implemented to obtain the desired results. It is possible, however, to reach a totally different kind of recommendation or conclusion, which reviews the decision processes and attempts to define better decision structures or procedures for performance of day-to-day corporate business. For example, the operations research study might recommend a new information or reporting system to inform specific managers of facts needed to make routine decisions. This sort of conclusion would be appropriate if the operations research analyst simulated the cause and effect relationships among events and decisions and discovered that decisions were not being made in accordance with the profit objectives of the corporation. This inconsistency could arise because events were being measured inadequately, because the measurements of events were being reported to the incorrect corporate officer, because decisions were being made at the wrong level of management, or because measurements were being made and reported in terms that were not compatible with the experience and judgment of the man making the decisions. The implementation of study recommendations in each of these cases would involve the development of a new management information system or modification of an existing system.

Another kind of conclusion that might result from an operations research study is a recommendation that some particular mathematical model or simulation be used to evaluate certain operating decisions. In this case the operations research study would create a tool that would be added to others that executives use in making their decisions. The management information system could be considered to include mathematical models and simulations that reflect the effects of certain decisions on operations and on corporate profitability.

Operations research study can result in a number of conclusions. Some are: A recommendation might be made to modify some operating practice or pursue some specifically different sales strategy. Another might list several alternative actions for management decision. These recommendations could include capital investment programs, new product introductions, or the elimination of certain unprofitable investments.

Relation to accounting

An operations research study and a company's accounting system are closely related in several ways. The accounting system is the primary source of much of the data used in the preparation of mathematical models or in statistical studies. The accounting system provides a type of information useful in defining cause and effect relationships in the decision making process since most data for decisions must evolve from the accounting system. And the accounting system may be used as a vehicle for implementing the recommendations and conclusions of the study.

Data availability

The use of accounting data in operations research work can be discussed from two standpoints: (1) how these data are developed and recorded, and (2) the ease

with which various types of data can be retrieved.

The most important data that an accounting system must provide for management decision are those that provide a basis for estimating the effect on profitability of some particular projected action. If the cost of an operation is particularly low, a manager may decide to increase the extent of this operation. If the cost appears to be unduly high, the manager may decide to reduce or eliminate the operation. Since operations research personnel are interested in devising methods for improving decision making, the operations research analyst needs the same data that the manager would use.

The proper aggregation and accumulation of costs will vary according to the type of decision involved. For example, a decision to eliminate—or expand—a marketing area must take into account the total cost of the marketing effort. Since the decision affects a major segment of the marketing function, the total costs must be all-inclusive, from the salesman to headquarters administrative overhead. Conversely, a decision to reallocate customers to warehouses or distribution points requires a different accumulation of costs. In this case, many costs are fixed with respect to these choices and are not involved in evaluating the alternatives.

Before making a decision to build a new process plant, the executive must consider different cost factors from those involved in a decision to expand an existing plant. To build a new plant, more land must be provided, new equipment must be stocked for maintenance and repairs, and new operating personnel must be hired. Expansion of an existing facility might not require hiring more operating personnel, and additional labor costs would be negligible. Addition of a similar process in an existing plant would probably not require maintaining stocks of new equipment, and the administrative burden for an expanded plant would be different from that for a new manufacturing facility.

Analysis of these problems depends heavily on the separation of fixed, semi-fixed, and variable costs. An operations research specialist recognizes that different questions must be answered with different classes of cost data.

Data deficiencies

It is certainly not reasonable to assume that all accounting systems will be readily able to provide cost breakdowns tailored to every individual's specific need. However, an accounting system that recognizes the difference between fixed and variable costs is more useful for analysis and decision making than one that treats all costs equally. In our operations research work we have been able to make ready use of existing accounting data where costs have been individually categorized in detailed reports before their accumulation for overall profit and loss calculations. When costs are accumulated methodically into categories that have a reasonable relation to the physical events that incur those costs, the accounting system can be directly useful to the manager and the operations research analyst.

Conversely, an accounting system that does not develop individual cost breakdowns related to physical events but produces only accumulated and allocated cost reports is not useful for operations research analysis. In addition, such a system is dangerous for a manager to use if he is not completely cognizant of how all the cost data are developed. In one recent case it was necessary for the operations research analysts to develop a complete data processing retrieval system, starting with magnetic tape reels containing source transaction files. The company accounting system, through meaningless descriptions of cost categories and arbitrary allocations, made it difficult to determine the relation of costs to physical events.

An example of cost allocations

An accounting system that recognizes the difference between fixed and variable costs is more useful for analysis and decision making than one that treats all costs equally.
When costs are accumulated methodically into categories that have a reasonable relation to the physical events that incur these costs, the accounting system can be directly useful to the manager and the operations research analyst.

that obscure the relationships the operations research analyst is trying to develop can be cited from a recent study. The client had an oil terminal located near a state line; different tax structures existed for the two states. A pipeline to a truck-loading rack was constructed across the state line. The truck-loading rack was assigned a separate location code from the pipeline and expenses were allocated to the two location codes by the terminal accounting clerks. The costs of the combined operation of loading rack and terminal were allocated on a capital investment basis. There was no way to determine from the cost accounting system the effect of increasing or decreasing the rate of loading at the truck-loading rack.

Another example is a situation in which a warehouse distributes products to dealers and also serves as a retail outlet operating through a single office. If different location codes are established for these two operations and the cost allocated on some basis, cost records will not show whether or not the retail operation is actually showing a profit or what are true costs of warehouse distribution.

These problems pose particular difficulties in operations research studies because the studies are usually not limited to a single terminal or single warehouse but include all the terminals and warehouses of a given company. Frequently, a laborious search through each cost center structure is necessary to determine cost allocation methods and to ensure that all costs are included and that costs relevant to the operations research study are available.

It is usually assumed that an accounting system must be designed to fulfill certain specific requirements. A management information system, however, must be designed to fulfill a myriad of information requirements, many of which cannot be foreseen or predicted at the time the system is developed.

Data retrieval

Personnel performing an operations research study also encounter the problem of retrieving data from an accounting system. There is no single method that can conveniently provide retrieval for all varieties of cost accounting data. However, it is common in operations research studies to require retrieval of data that are closer to the source transactions than the finished accounting reports. This may necessitate development of an accounting system designed to permit starting with source transaction files, which would be saved, and to provide facilities for intermediate processing and aggregation without having to complete the prescribed fiscal accounting procedures.

The modern concept of a computer-based management information system implies flexible data retrieval capabilities and modularity in the structure of data processing programs. It is usually assumed that an accounting system must fulfill certain specific requirements. A management information system, however, must be designed to fulfill a myriad of information requirements, many of which cannot be foreseen or predicted at the time the system is developed. Therefore, retrieval ability and modularity of processing become primary design criteria. When these design criteria are satisfied, corporate operating data may be used by various people for a variety of purposes. The operations research analyst becomes one of a large group of people who utilize the corporate information system.

Cost center application

As was previously discussed, the allocation of costs is a major problem in determining the relation of accounting data to particular physical events. This same problem of cost allocation appears in another form: the definition of cost center and profit center. Giving a manager profit responsibility and some incentive to improve performance seems like a good practice. However, there are so many pitfalls in such an arrangement that it would not surprise me if more of these systems were detracting from corporate profits than contributing to them. A direct consequence of this management practice is that cost and profit center definitions be-

come imbedded in the accounting system.

Misapplication

An example of cost center accounting misapplication that resulted in financial loss may be cited from our experience. A company set up all of its plants as profit centers and accumulated all fixed and controllable operating costs at the plant level. Sales and administrative costs were allocated on a relatively fixed formula. The sales outlets were also placed on a profit center basis and given the opportunity of buying products from that plant which would supply them at the lowest cost. Freight was equalized on all shipments.

As a result, if one plant begins losing volume, its unit cost rises because of the fixed cost allocations not under control of the plant manager. When the plant's costs rise, then it cannot compete with other company plants in supplying products to sales outlets. The plant's volume becomes distributed over all other plants, lowering their apparent costs and raising its apparent costs still further. This process continues until the corporate management decides that the plant is unprofitable and must be closed. This decision is then followed by a decision to build a new plant. In this particular case, new plant designs have not achieved any operating economies over plants of much earlier vintage. Therefore, when new plants are constructed, they have controllable operating costs virtually identical to those of the plant that was closed. All overhead costs are then reallocated to the new plant, and the cycle begins all over again.

Not only are these events resulting in the expenditure of substantial capital funds with questionable justification, but transportation costs paid to move products from plant to distribution point are disguised through the practice of equalizing freight rates. The company in question is slowly approaching a financial crisis because of this situation. However, results of the operations research study have demonstrated to company management that the accounting system is not providing appropriate information to the managers and that the existing concept of allocating and treating costs is destructive to rational decision making.

Conclusion

Operations research is profoundly affecting the thinking and actions of modern managers. Therefore, the needs of the operations research analyst are rapidly becoming the needs of the scientific and analytical manager.

It becomes necessary for people designing accounting systems to attain an understanding of the decision processes that are inherent in their particular company or industry. This knowledge is not limited to understanding the physical operations of a particular plant or its methods of transacting business. It requires an understanding of the decision processes involved in conducting the corporation's business on a short- and long-range basis.

The information requirements for these decision processes must be delineated. The resulting accounting system must fulfill the fiscal and auditing requirements of the corporation. It must also provide a flexible capability for retrieving and analyzing corporate statistics of all kinds by methods not necessarily foreseen at the time the total system is designed and initiated.

Finally, the modern accounting system must reflect the constant change that occurs in the structure of modern corporations. Modern management control requires that information systems expand and keep pace with the rapid changes in products and organization that are dictated by our economy. This requirement presents a challenge that can be met by effective use of modern operations research techniques.

It becomes necessary for people designing accounting systems to attain an understanding of the decision processes that are inherent in their particular company or industry. This knowledge . . . requires an understanding of the decision processes involved in conducting the corporation's business on a short- and long-range basis.

what people are writing about

BOOKS

Concepts for Management Accounting by WALTER B. MCFARLAND, National Association of Accountants, New York, 1966, 166 pages, $4.95.

This little volume is an attempt to build a theoretical framework to guide the practice of management accounting. Although some may quarrel with some of its premises, particularly when applied to public reporting, it is worthy of every accountant's attention.

Unlike most of NAA's research studies, which merely report on existing practices, this book is intended to be prescriptive rather than descriptive. The author, the association's research director, has sought to unify the findings of previous research studies into "statements of what constitutes good practice."

Good practice is defined as "practice which yields information which is relevant, valid, and consequently reliable for its intended uses." In order to be useful, Mr. McFarland asserts, accounting data must be relevant to the purposes of its recipients. Thus, it is the principal thesis of his book that relevance to intended purpose is the fundamental test for appraising accounting theories and techniques. Such standards as fairness, rationality, conservatism, and nondistortion, he argues, are merely matters of opinion.

Utility to management is a reasonable criterion for internal financial reporting. Some eyebrows may be raised when Mr. McFarland goes on to apply it to external reporting, as he does. (He defines management accounting as encompassing the entire range of economic information needed by those who manage a business enterprise and by those who provide its capital.)

The last part of the book, in which the author discusses income statements and balance sheets from the standpoint of relevance to their intended uses rather than from that of generally accepted accounting principles and procedures, may be controversial. The first part, in which he outlines management's information needs for profit planning and measuring performance by projects, by products and markets, and by management responsibilities, is not.

The focus is on the kinds of financial information accountants should present rather than on the ways of measuring and reporting this information. Thus, specific techniques are described only briefly.

The result is a tightly written, somewhat abstract set of generalizations. As a complete theory of management accounting, this book may not be the last word. But it does provide a theoretical framework that is worth developing further.

Zero Defects by JAMES F. HALPIN, McGraw-Hill Book Company, New York, 1966, 228 pages, $10.50.

The latest fad in quality assurance programs, Zero Defects, is described here by the man who originated it.

Zero Defects, a management program aimed at the reduction of errors and defects through prevention ("do it right the first time"), has been widely copied in American industry since it was developed by the Orlando, Florida, division of Martin Company some five years ago. An article in MANAGEMENT SERVICES ("Zero Defects and You" by Robert Smith, January-February, 1966, p. 35) described its application at General Motor's Allison Division.

Now Martin-Orlando's quality director has produced a how-to-do-it manual for establishing a ZD program. He tells how to organize the project; how to motivate management, employees, and suppliers; how to measure performance of production, clerical, administrative, and professional workers; and how to maintain momentum.

This book is not unbiased. The author has a vested interest in his technique. The carping of skeptics, who note that Zero Defects is basically a propaganda effort and thus vulnerable to the vagaries of shifting psychological forces, is largely ignored. But for those who have already decided they want to attempt a Zero Defects program, this is probably the definitive work.

MAGAZINES

Are CPA Firms Taking Over Management Consulting? *Forbes,* October 1, 1966.

This article reviews the growth of management services practice in the CPA firms and forecasts more of the same.

As others have noted before, management services is playing an increasingly important role within the CPA firm, and CPAs now occupy an increasingly important place in the world of management consulting.

Forbes attributes the "booming" consulting practice of the CPA firms to the computer, which has forced them into electronic data processing, not only by threatening to eliminate low-level accounting work but by presenting them with the opportunity to combine computer knowhow with understanding of information systems. The big firms, the magazine reports, are expanding rapidly into the field of general management consulting. (Most of the CPA firm partners interviewed pooh-poohed the problem of potential loss of audit independence.) The small firms are computerizing their write-up work, often with the help of service centers, and adding management services to retain their audit clients. The small industrial engineering consulting firms and the small CPA firms that haven't kept up with the computer are the two groups most squeezed by the competition, according to *Forbes.*

Some of the magazine's conclusions may be questionable—for example, its prediction of mergers between general management consulting firms and CPA firms—but its report on the new look in public accounting is timely, lively, and reasonably accurate.

Some Cost Accounting Problems in PERT/Cost, by LAURENCE S. HILL, *The Journal of Industrial Engineering,* February, 1966.

The focus of this article is on a general category of cost accumulation problems affecting the operation of the PERT/Cost system. These cost accounting considerations are based on findings derived from field investigation in several companies during early attempts to implement the system.

After opening with a brief discussion of the essence of PERT/Cost, Mr. Hill is quick to point out that some of the difficulties discussed are inherent in more traditional cost accumulation systems as well as in the PERT/Cost system. Basically, it appears that the major costing problems discussed are occasioned by the "work package" concepts of PERT/Cost.

The principal problems of cost planning, determination, and control of direct labor stem from the greater number and definition of work orders (or counterparts) required for PERT/Cost than is usually necessary with other systems. Lack of full cooperation of employees in charging to correct work orders is one problem. A second problem is that certain discrepancies exist between levels and categories for application of labor rates in traditional accounting methods and PERT/Cost.

The work package, as originally

conceived, presents a somewhat different problem for material accounting. It calls for an allocation of materials costs to various work packages and has a tendency to so scatter the materials charges throughout various accounts that proper control and analysis of price and quantity variances are difficult. The author suggests that separate work packages for materials may be more appropriate than present concepts. In addition, the timing of charges to the project can be important in predicting material variances far enough in advance to allow adequate corrective action to be taken.

Overhead is reported as a single line item in PERT/Cost, and overhead activities are usually not included in the network. Better control might be attained by expanding overhead into its basic categories, such as indirect labor, operating supplies, and so on. Also, the fixed and variable elements of burden cost should be defined for better control.

Finally the author points out the possible necessity of including general and administrative expenses, that is, corporate-level burden, if PERT/Cost is to be most effective. The problems presented, as well as others, may well be solved as experience is gained with PERT/Cost. Mr. Hill indicates that solutions may consist of modifications and redefinition of certain PERT/Cost concepts as now conceived plus some extension of the analysis and reporting functions.

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STATEMENT OF OWNERSHIP, MANAGEMENT AND CIRCULATION (Act of October 23, 1962; Section 4369, Title 39, United States Code)

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