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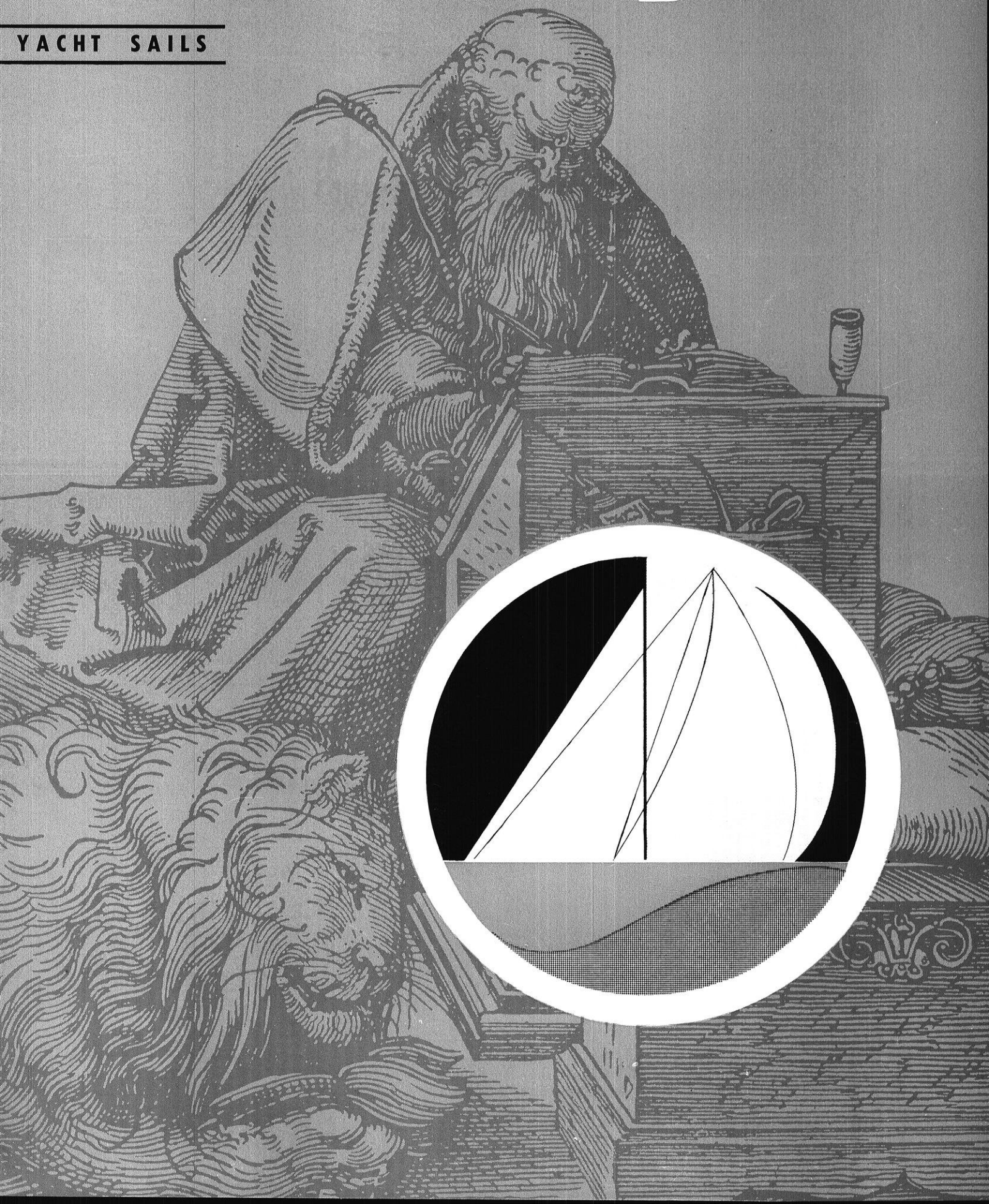
VOL. 72, NO. 2 MEMBER ECMA 35 CENTS NOVEMBER 1967

wisconsin engineer

YACHT SAILS



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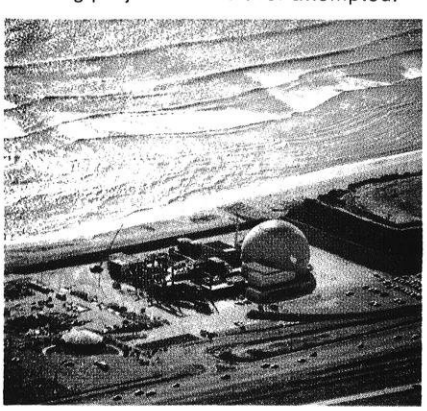

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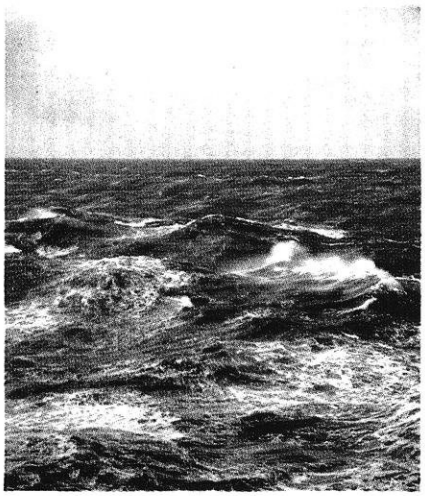

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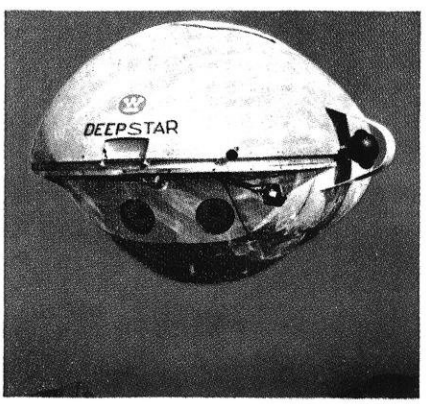

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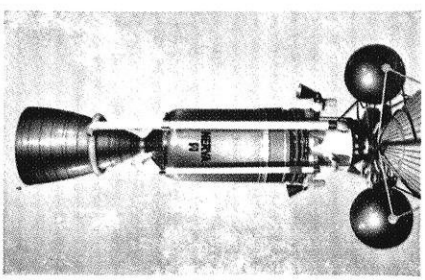

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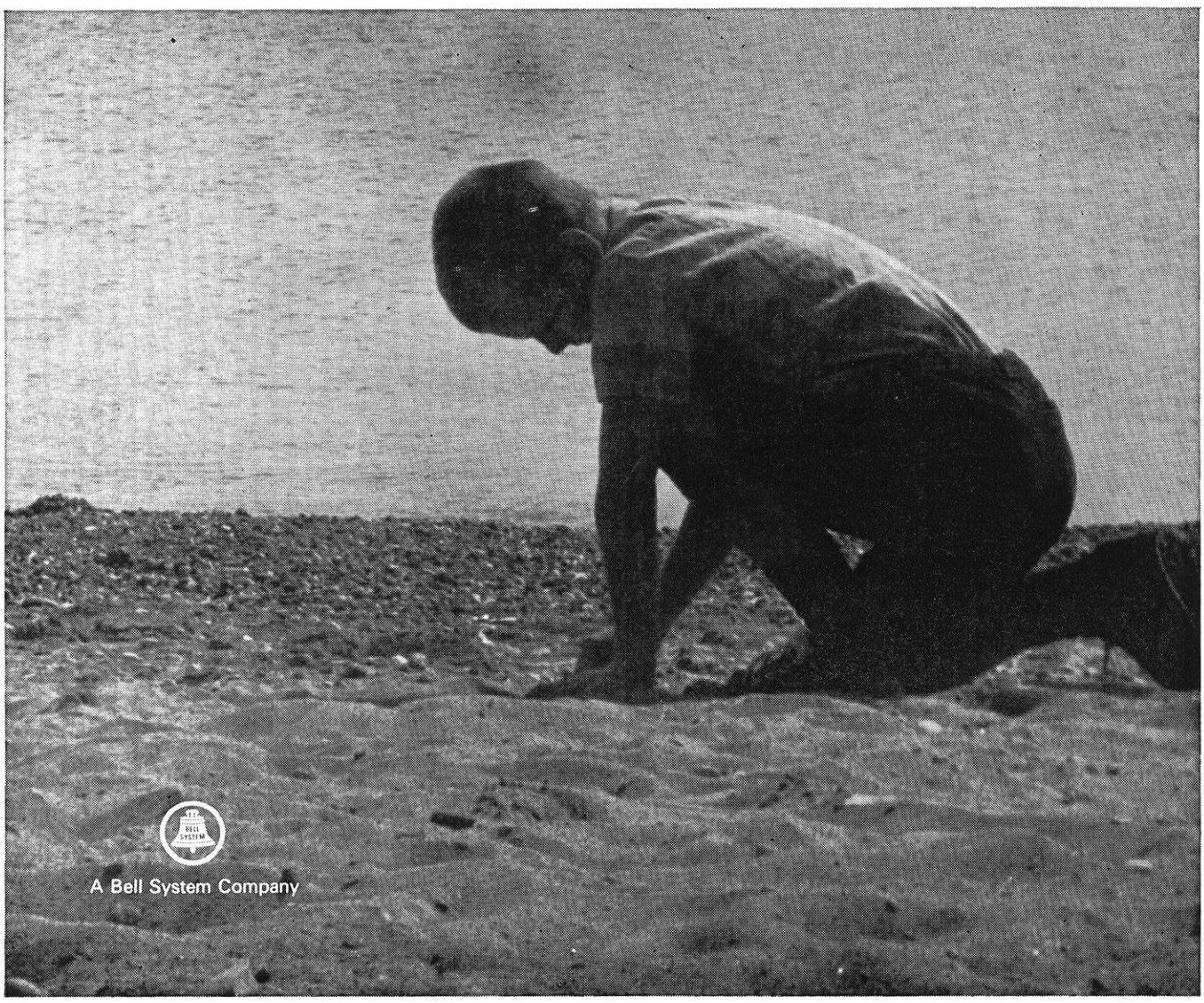

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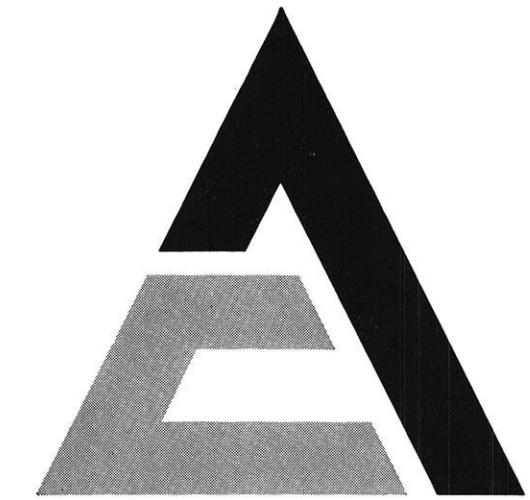

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EDITORIAL

ON POWER

WE HAVE heard a lot of talk about abolishing the placement service, about setting moral standards for companies who use University facilities, and about the right of free speech. But this is not an article about "Black Wednesday" or the Dow Chemical Company—at least not really.

The incidents these past few weeks have demonstrated something about engineers that I find extremely distasteful. The engineers on this campus refuse to get socially involved unless their precious "status quo" is threatened. Somehow, all you have gotten out of these weeks of trouble is the firm conviction that the "convenience of the placement service" must not be tampered with.

Perhaps it never occurred to you that engineers and scientists form one of the strongest "power" groups in the United States, but in a way far more subtle than demonstrating or striking. The responsibility for the growth and progress—economic, humanitarian, and militaristic—of this nation is in our hands. Namely, it is not the "liberal arts" people who are going to synthesize the next chemical warfare compounds, or develop the better bomb, or design the artificial heart or kidney.

The engineering profession supposedly exists to serve mankind. Engineers have taken upon themselves the responsibility of applying the discoveries of science to projects that will benefit people. Our creed lies in the "Faith of an Engineer" hanging in the Mechanical Engineering Building:

> When needed, my skill and knowledge shall be given without reservation for the public good. From special capacity springs THE OBLIGATION TO USE IT WELL IN THE SERVICE OF HUMANITY, and I ACCEPT THE CHALLENGE THAT THIS IMPLIES.

The question is, are we, as engineers, accepting this challenge? For most I would say—NO! Think about yourself. What do you look for when you interview? A glamorous job? A big salary? A chance to be President? A pleasant place to work? Of course these are important, but will you also look at what you will be doing?

I am not going to discuss war, or napalm. This is an individual question you must decide for yourself. But certainly if you are considering working for a company, and you will be involved in bombs, or missiles, or chemical warfare, you will have a lot of serious thinking to do. If you create or help create a weapon, you are directly responsible for its use—both now and in the future. This may involve hundreds or thousands of lives, and the question of what is humanitarian for you to do must be resolved in the light of these thousands.

Your problem—right now—is what are you doing about the "Faith of an Engineer"? You, through research and development, control the future of this country and of our world. Are you willing to give up time and money, if necessary, for an ideal? If not, then quit calling yourself an engineer!

Mary E. Ingeman

editor

Depends on the giant. Actually, some giants are just regular kinds of guys. Except bigger.

And that can be an advantage.

How? Well, take Ford Motor Company. We're a giant in an exciting and vital business. We tackle big problems. Needing big solutions. Better ideas. And that's where you come in. Because it all adds up to a real opportunity for young engineering graduates like yourself at Ford Motor Company.

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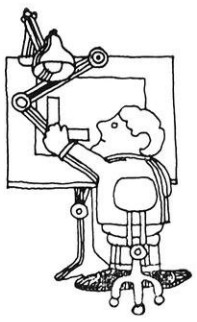
What's it like to engineer for a giant?

Rather enlarging!



BALANCE SHEET

ASSETS			**LIABILITIES**		
Current Assets			Current Liabilities		
Cash		$ 10,000	Accounts Payable		$150,000
Accounts Receivable	$140,000		Notes Payable		50,000
Less: Allowance for Bad Debts	10,000	130,000	Accrued Expenses Payable		15,000
Inventories		200,000	Federal Income Tax Payable		5,000
Total Current Assets		$340,000	**Total Current Liabilities**		$220,000
Fixed Assets			Long-Term Liabilities		
Land	$ 20,000		Mortgage Payable		30,000
Buildings	60,000		**Total Liabilities**		$250,000
Machinery	30,000		**OWNER'S EQUITY**		
	$110,000		Capital Stock		
Less: Allowance for Depreciation	10,000		Preferred	$ 50,000	
Total Fixed Assets		$100,000	Common	50,000	$100,000
Prepayments and Deferred Charges		10,000	Retained Earnings		100,000
Total Assets		$450,000	**Total Owners' Equity**		$200,000
			Total Liabilities and Owners' Equity		$450,000

ASSESSING A

Nearly all of the companies that come to interview for engineers file copies of their Balance Sheet and their Income Statement with the Placement Office.

Why do the companies bother to provide these dull, uninteresting figures when they also spend millions every year on glamorous advertising campaigns? Possibly they feel committeed to show them to you because as a prospective employe, you are a prospective stockholder. Your job security is tied up in the company, and the company's security is a story told by their accounting department.

How to examine a Balance Sheet and Income Statement is a problem for most engineers—and the following is a brief, simple approach to looking at these financial reports. Let's look at the fictitious Widget Manufacturing Company.

THE BALANCE SHEET

The Balance Sheet is a financial report which shows the position of a company on a specified date. In our case, it is December 31, 1967.

The Widget Manufacturing Company's Balance Sheet lists, on the left side, the property and goods that it owns as well as claims that it has on others that have not been collected. These items are called the Company's Assets. On the right side, the Widget Balance Sheet has listed all that it owes, called the Liabilities and Owner's Equity. Liabilities are the company's debt to its stockholders. Owner's Equity is also called "stockholder's equity", "net worth", "capital", or simply "ownership". It actually represents the money value placed by the books of the company on the owner's interest in that company. A very important point is to recognize that the Owner's Equity is calculated as the Assets minus the Liabilities.

Assets The Assets side of the Balance Sheet is divided into several catagories, the first of which is Current Assets. Current Assets include Cash, Accounts Receivable, and those assets that are turned into cash within a reasonable period of time, usually a year from the Balance Sheet date.

Cash is the money in the checking account, as might be expected.

Accounts Receivable is the amount of money that others owe the company for goods or services. Business experience has shown that not all the accounts will be collected, due to fire, bankruptcy, etc., and so a percentage, usually of sales, is allowed for these bad debts. It would not be justifiable to show the full amount on the books when it is assumed that it will not all be collected.

Inventories in the manufacturing company are of three major kinds; the raw material going into the product, the partially finished product being manufactured, and the finished product ready to be sold when listing a monetary value for Inventory, the value of these plus the expenses associated with the production process is included.

The Current Assets, then, are the assets the company has to currently operate its facilities.

Another subclass of the Assets are the Fixed Assets, or Property, Plant, and Equipment. As you might expect, these assets are the ones used over and over in producing, storing, and transporting the product. (2) The values placed on these assets are not the current market prices or the replacement prices, but, in most cases, represent the purchase prices.

Prepayments and Deferred Charges are assets which occur, for example, when payment is made for insurance to cover the next three years, or a yearly advertising contract paid in advance. These are assets to the company as some-

INCOME STATEMENT

Net Sales	$600,000
Less: Cost of Goods Solds	500,000
Gross Profit on Sales	100,000
LESS: Operating Expenses	
Selling and Administrative	75,000
Net Operating Profit	25,000
Miscellaneous Income	5,000
Net Income	30,000
Less: Interest Expense	10,000
Profit Before Provision for Federal Income Tax	$ 20,000
Provision for Federal Income Tax	5,000
Net Profit for Year	$ 15,000

RETAINED EARNINGS STATEMENT
Year 1967

Balance January 1, 1967	$ 95,000
Add: Net Profit for Year	15,000
Total	$110,000
Less: Dividends Paid	10,000
Balance December 31, 1967	$100,000

CORPORATION

by Don Holloway

thing it owns but has not received yet.

Liabilities Similar to the assets, Liabilities are usually subdivided into current and long-term items.

Accounts Payable and Notes Payable are similar Current Liabilities in that they are both the amount of money the company owes, however the form of the obligation is different. Specifically, the Notes Payable represents the promissary notes that the company has given saying that it will pay within a particular period of time. Accounts Payable is the amount owed from the invoices that have been received.

Accrued Expenses Payable, another Current Liability, are the expenses that have occured but are not yet due. One example is the Federal Income Tax Payable in the Widget Balance Sheet. This is separated since the Federal Income Tax is an important amount. It is an expense during the past year but is not due yet.

Owner's Equity Owner's Equity is the difference between the Assets and the Liabilities. It is the stockholders interest in the company and is divided into two areas in the Widget Balance Sheet; Capital Stock, and Retained Earnings.

Capital Stock is the stock that has been purchased. This includes both Common and Preferred Stock.

Retained Earnings, sometimes called Earned Surplus, are the profits that are retained in the business and not paid out in dividends. It is the tie to the Profit and Loss Statement from the Balance Sheet since it includes the income from the past year.

In summary, the Balance Sheet is divided into three areas: Assets, Liabilities, and Owner's Equity. The Assets will always equal the Liabilities *plus* the Owner's Equity.

Balance Sheet Analysis

In analyzing the Balance Sheet, several ratios are normally used as guides in determining the performance of the company. It must be noted that the ratios themselves offer very little information. They must be compared to the ratios of other companies in the industry.

The following ratios or terms are discussed with regard to the Balance Sheet:

Net Working Capital
Current Ratio
Fixed Assets to New Worth
Inventory Turnover
Net Sales to New Worth

Net Working Capital, or simply Working Capital, is defined as the difference between the current assets and current liabilities; in the Widget example $340,000 — $220,000 = $120,000. It represents the money that the company would have after paying its current debts.

The *Current Ratio* is another name for the ratio of current assets to current liabilities and in the Widget Manufacturing Company it is 340,000/220,000 = 1.55. A rule that many analysts use is that the current ratio should be about two. However, once again, caution must be taken in using absolute values, rather than comparing the ratio to other companies in the industry. The current ratio of two means, then, that the current assets should be about twice the current debts.

The *Fixed Assets to Owner's Equity* ratio measures directly the extent to which the owner's invested capital are tied up in permanent, depreciable assets. A high ratio may mean the owner's equity is not enough, or that the investment in plant and equipment was on impulse and not supported by income. The effect may mean the company must borrow to finance any expansion. Widget's ratio is 100,000/200,000 = .5, which of course must be compared to other companies.

The *Inventory Turnover* ratio is the Net Sales divided by Inventory.

Although we have not discussed Net Sales (it is not included as such in the Balance Sheet), the figure can be obtained from the Income Statement, which will be discussed later. For Widget, 600,000/200,000 = 3. This means then that the products in inventory are manufactured and sold, on the average, three times during the year. If the industry average is 6.0, it may be that Widget has unsalable inventory. This would decrease the net profit and the working capital. If Widget's ratio were higher than the industry average, it may mean that they have a good inventory system or perhaps they have not invested enough in inventory.

Net Sales to Owner's Equity measures the degree to which the company has balanced its sales with investment. If the ratio is high, the company is an overtrader and is attempting to stretch its invested money, while if it is low, the company is an undertrader and has inadequate sales to support the business. Widget's is 600,000/200,000 = 3.

In summary, the above ratios are only a guideline and must be viewed with the knowledge that any attempt to attach significance to them is purely speculative. However, they can be useful if compared to the rest of the industry, and may indicate the relative position of the company.

The Income Statement

Although I have chosen to call this financial report the Income Statement, some companies call it the "Earnings Report" or the "Profit and Loss Statement". In any case, it reports the net earnings, profit or loss, of the company and lists in general terms the Revenues and Expenses over a period of time.

Revenue The first item on the Income Statement is normally the most important source of revenue. In a manufacturing enterprise it is naturally sales or Net Sales. It represents the primary source of funds to the company.

Expense The Cost of Goods Sold is then subtracted from the net sales to give the gross profit on sales. The Cost of Goods Sold figure includes all the costs incurred in the factory, even depreciation, to transform the raw material into the finished product. Thus, raw materials, direct labor, and any overhead expenses like supervision, rent, heat, power, and light are included in the Cost of Goods Sold.

Miscellaneous Expense and Revenue Selling and Administrative expenses are usually listed separately, so that those who examine the Income Statement may see the extent of the selling costs.

Miscellaneous Income may include interest received on notes or securities the company holds, etc.

In summary, the Income Statement is a listing of the expenses and revenues during a period of time; the year 1967 for the Widget Manufacturing Company. In the end, the Statement gives a final figure—Net Profit—for the year.

The Retained Earnings Statement

The Retained Earnings Statement is often included with the two major financial statements. Its purpose is to show how the Retained Earnings figure in the Balance Sheet is obtained from the Income Statement. The Net Profit is added to the balance of the Retained Earnings at the beginning of the year; the dividends paid to the stockholders are subtracted, and the final balance appears in the Owner's Equity portion of the Balance Sheet.

Income Statement Analysis

As in analyzing the Balance Sheet, several ratios can be used to guide the analyst in evaluating the company's operations. Remember, the ratios mean nothing unless they are compared with other companies in the industry. Many Income Statements include the previous year's figures next to the current values. This is to aid in analyzing a company's continuing worth.

The following ratios are discussed with regard to the Income Statement: (2)

Operating Margin of Profit Ratio
Operating Cost Ratio
Net Profit Ratio

The *Operating Margin of Profit Ratio* is defined as:

Operating Profit/Net Sales and for the Widget Company is: 25,000/600,000 = 4.16%. This means that for each dollar of sales, 4.16 cents remained as gross profit. Comparison of this figure to previous years may reveal the relative efficiency of the company this year or perhaps indicate the introduction of a new product. In any event, it is an interesting value to know and to be able to compare it with other companies.

The *Operating Cost Ratio* is the complement of the margin of profit ratio and for Widget is 95.84, 100 — 4.16. It is the ratio of operating costs to operating profit, where the operating cost includes the cost of goods sold. This ratio indicates the same characteristics as the margin of profit.

The ratio of net profit to net sales is called the *Net Profit Ratio.* It measures the success with which the company has obtained its objective of realizing a profit from sales. The Widget Company's Profit Ratio is 15,000/600,000 = 2.5%. This means for every $1 of product sold, 2½ cents went to the company in profit. The higher the ratio, generally the greater the opportunity for growth.

CONCLUSION

The purpose of this article has been to help you when you interview with a company. In planning for your interviews, you can now briefly examine the company's Financial Report and determine for yourself whether the company offers the opportunities you want.

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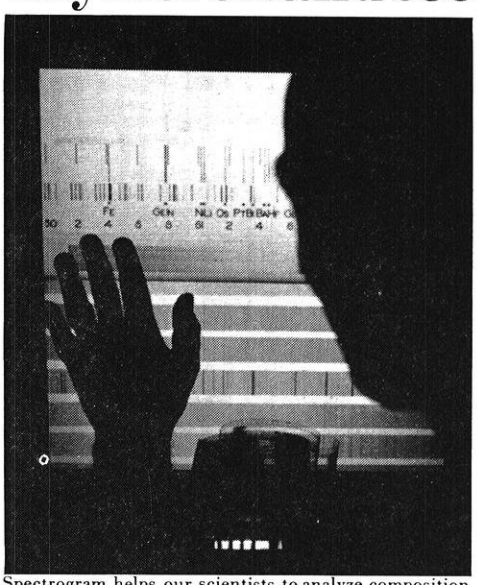

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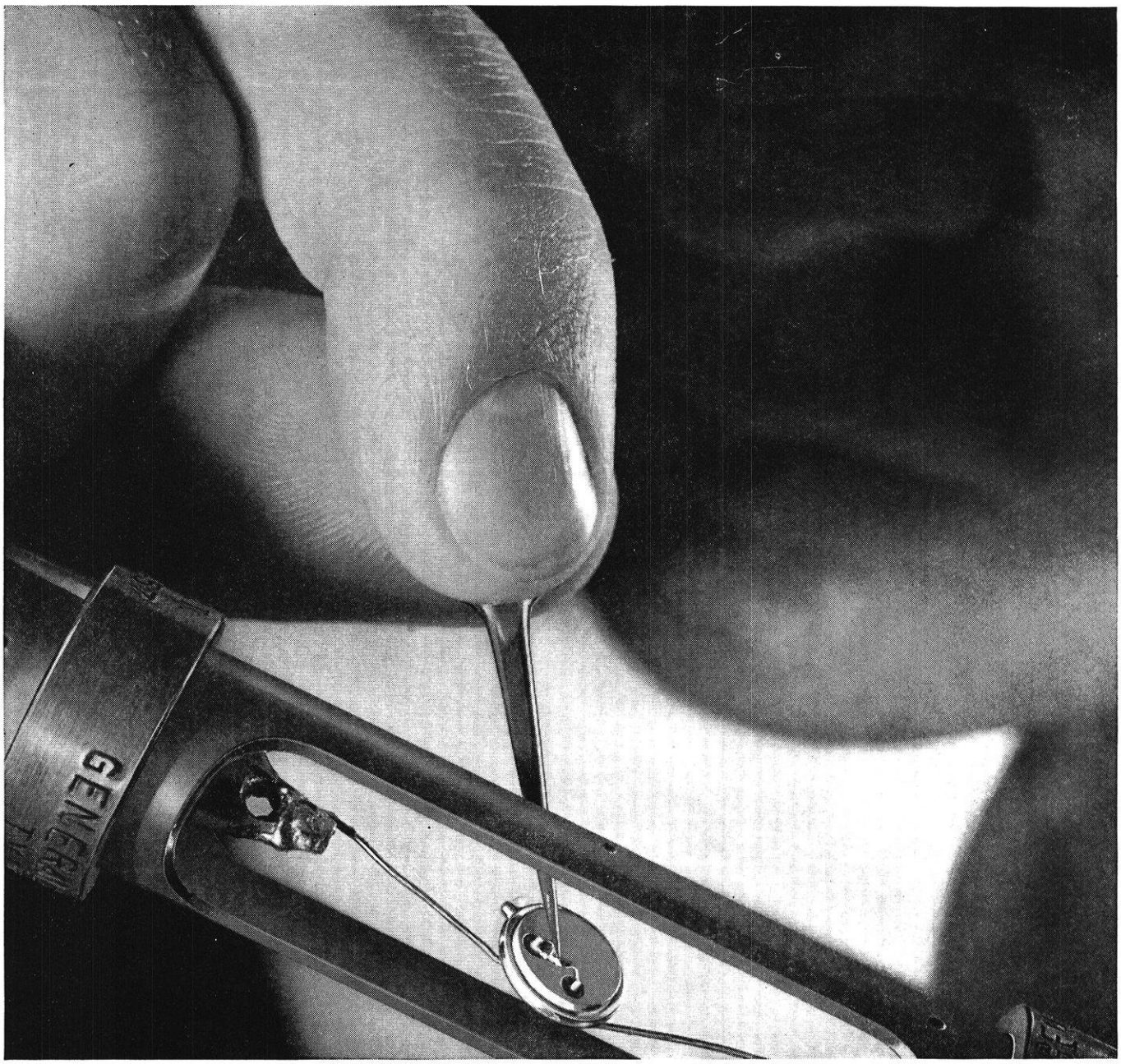

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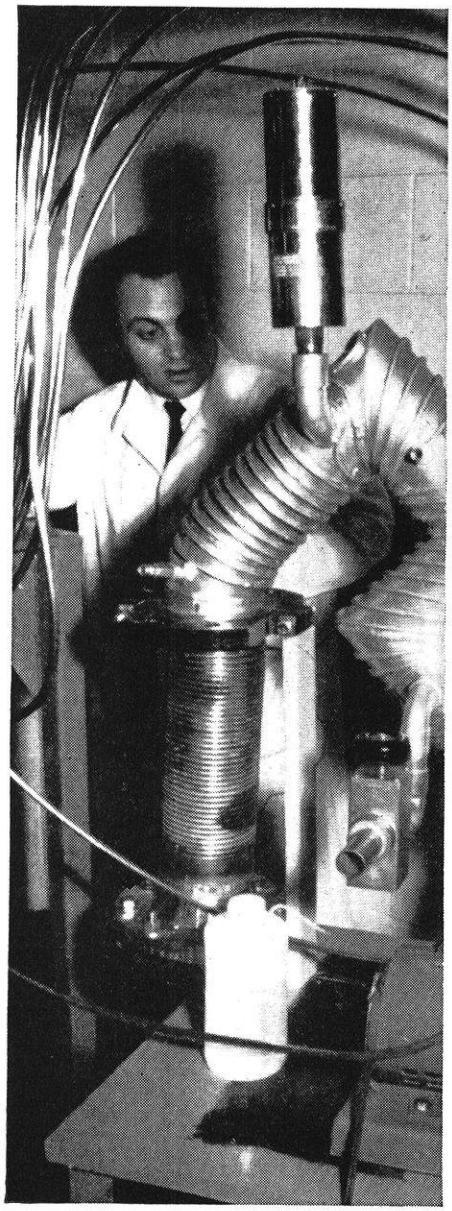

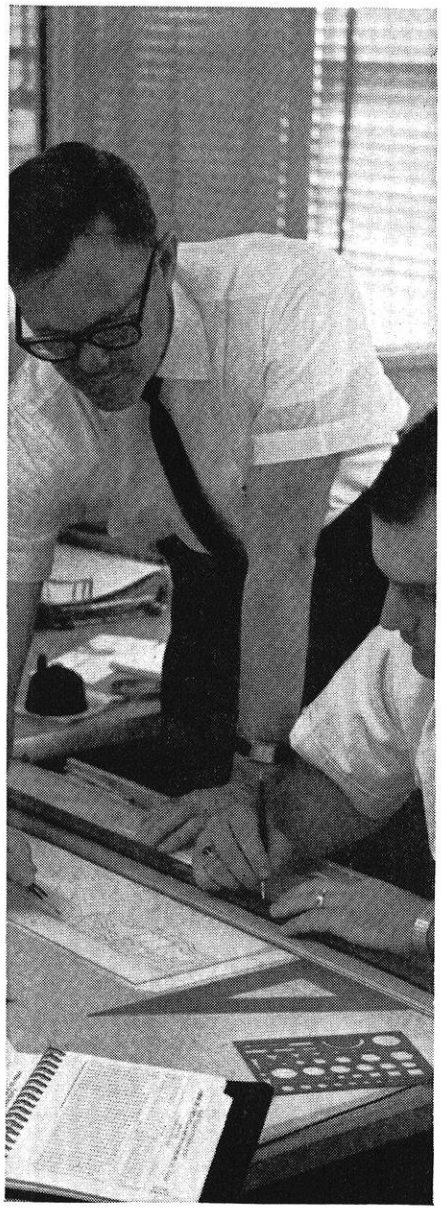

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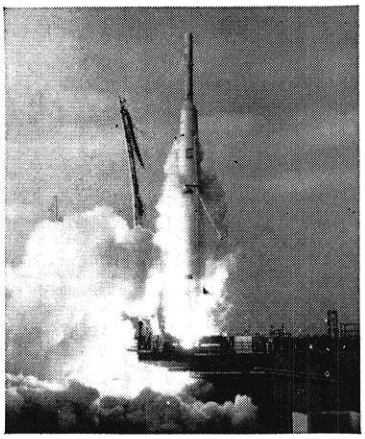

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COVER STORY

THE AERODYNAMICS OF YACHT SAILS

by Steve Wheeler ME 67

BACKGROUND

The use of sail boats as pleasure yachts dates from the late seventeenth century. During the last 200 years, many advances in construction, hull form, rigging, and sails have produced a modern, comfortable, efficient yacht. The aerodynamic studies of sailing have lagged behind and, as a result, many loose ends are present. We will attempt to bring some of this loose material together here.

Because a sailboat moves as a result of the aerodynamic force of the wind upon its sails, the reader should have a knowledge of the nature of this force and the wind that produces it.

Characteristics of Wind

Wind is an unstable fluid. It is influenced by land masses, thermals, and air-water temperature differences. These influencing factors produce *local* variations (sometimes considerable) in the main airflow. While these variations must be kept in mind by the sailor, we will assume constant velocity and direction for simplicity.

Any sailboat in motion is propelled by the apparent wind which is produced by its own direction and velocity of the true (actual) wind. The apparent wind is shown in Fig. 1. The apparent wind can change considerably with fairly small changes in the true wind. This is extremely important in the analysis to follow.

A sail is an airfoil much like the wing of an airplane. The airflow over this foil produces a low-pressure area which creates the basic forces acting on a sail and produces motion. The center of effort ("A" in Fig. 2) is the point on the sail where all forces are assumed to originate.

Lift Forces

Aerodynamic lift is the result of the low pressure area mentioned above. It acts perpendicular to the apparent wind and produces the desired forward motion.

The drag force acts perpendicular to the lift force in the direction of the apparent wind and, as has been determined by wind tunnel tests, has approximately one tenth the magnitude of the lift force. We can now draw the force diagram for a sail (Fig. 3, a).

The total force can be resolved into components parallel and perpendicular to the motion of the boat (Fig. 3, b). The heeling force produces the characteristic "tip" of the hull or heel, while the forward force (which must be balanced by the drag of the hull) produces forward motion.

FORCE ANALYSIS FOR VARIOUS SAILING ANGLES

The analysis here is basically a lift-drag analysis for the three

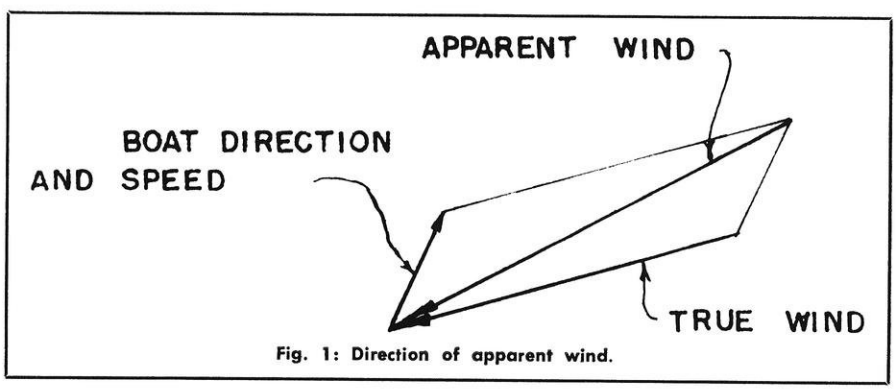

Fig. 1: Direction of apparent wind.

major points of sailing—The upwind case (the beat), the reach, and the downwind case (the run).

The Beat

A boat is beating when it is sailing as close to the wind (wind, in this report, is always apparent wind) as possible—generally at an angle of about 30 degrees. The apparent wind parallelogram shows that wind increases in magnitude on this point of sail. This is an important point, as will be seen later.

Jibsails are the controlling factor when sailing to weather—they produce the main forward forces. The action of the wind on a jib produces heeling forces very large compared with the total forward force. The forward force appears small in the figure, but because of the increased wind velocity it may, in fact, be quite large.

From Fig. 6, it is evident that the initial flow over the jib influences the flow over the mainsail. This occurs most with large jibsails and small slot widths. The effect is to cause backwind—Flow which strikes the mainsail from the back, destroying its shape. Eddy currents are formed which decrease the

(Continued on page 22)

This U. W. Hoofer Club M-20 is shown flying a "chute" or spinnaker. The jib and mainsail are well trimmed to get the most speed for the given wind direction.
Photo by Paul Neevel, Hoofer Sailing Club

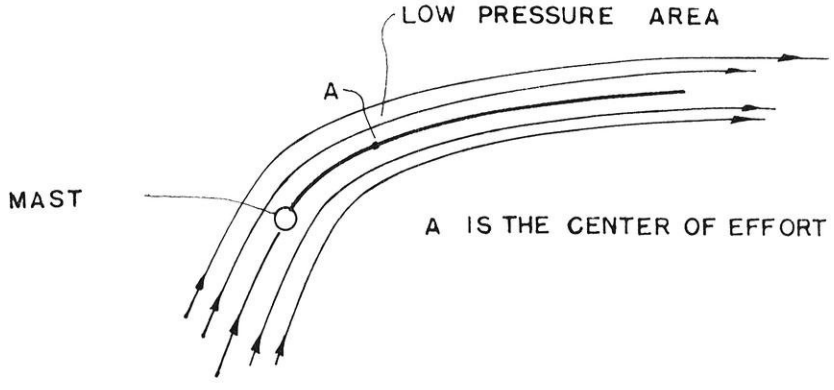

Fig. 2: Location of center of effort.

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CELANESE

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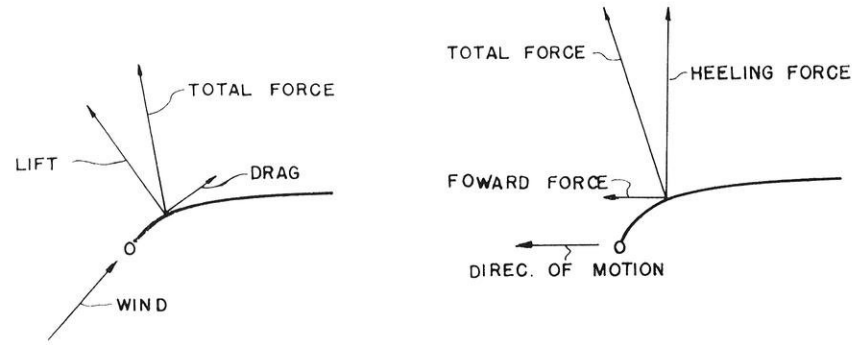

Fig. 3: Resolution of forces.

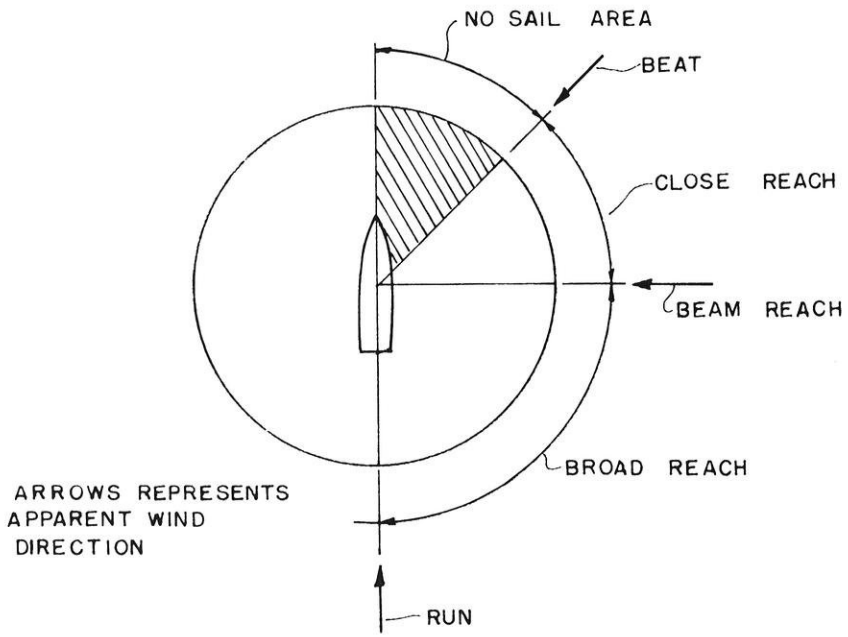

Fig. 4: The sailing circle.

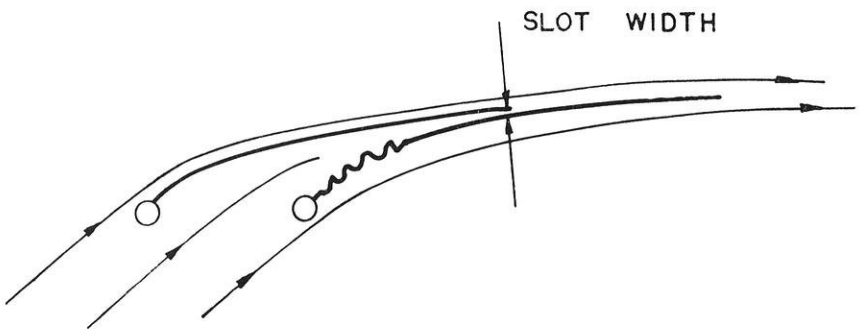

Fig. 6: The slot effect.

pressure drop on the main. This "slot effect" is hard to avoid and must be lived with on the beat.

Because of the slot effect, analysis of forces on the mainsail is more difficult. The eddies produced do not exhibit the properties of well oriented flow, but have random, highly turbulent, motion. Tests conducted with this type of flow have found that the lift force decreases in magnitude by about 50 percent, while the drag force *increases* by about 10 percent. The directions of these forces do not change. The result of the reduction is lift and the increase in drag is to reduce the forward force to a point where it is almost negligible while leaving an appreciable heeling force.

If we add all of the above forces (Fig. 7), we find the following things:

1). The total heeling force is very large compared with the total forward force.

2). The forward force is small, but due to the large wind velocity is greater than would be expected.

3). The mainsail adds little to the forward force.

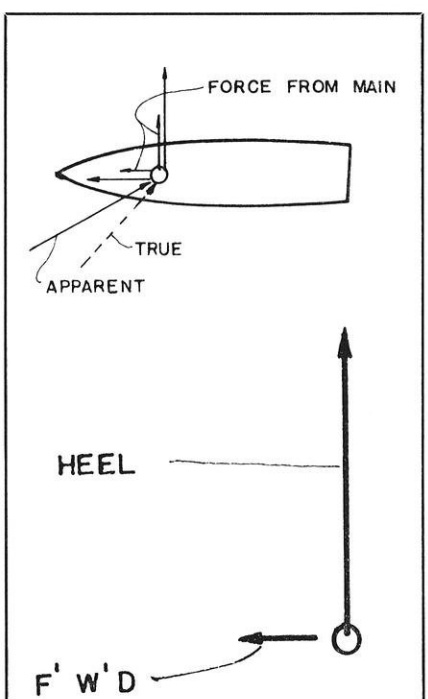

Fig. 7: Forces on the boat.

Sail Trim

At this point, a discussion of sail trim becomes necessary. A sail is properly trimmed if the apparent wind is just parallel to the sail at the point of entry (Fig. 8). As the sail is eased (let out), the length "A" in (b) becomes straight and begins to luff, an action similar to the flapping of a flag. This is different from the back winding discussed earlier, but has the same effect.

The mainsail of this M-20 is luffing badly.

When the sail is trimmed too tight the flow velocity must increase over the top of the sail. It attempts to do this, but becomes turbulent in the process. Again, eddies are produced and the sail is stalled, reducing efficiency.

All of the forces discussed previously are altered if the sails are not perfectly trimmed. Keeping this in mind, we are ready to discuss the reach.

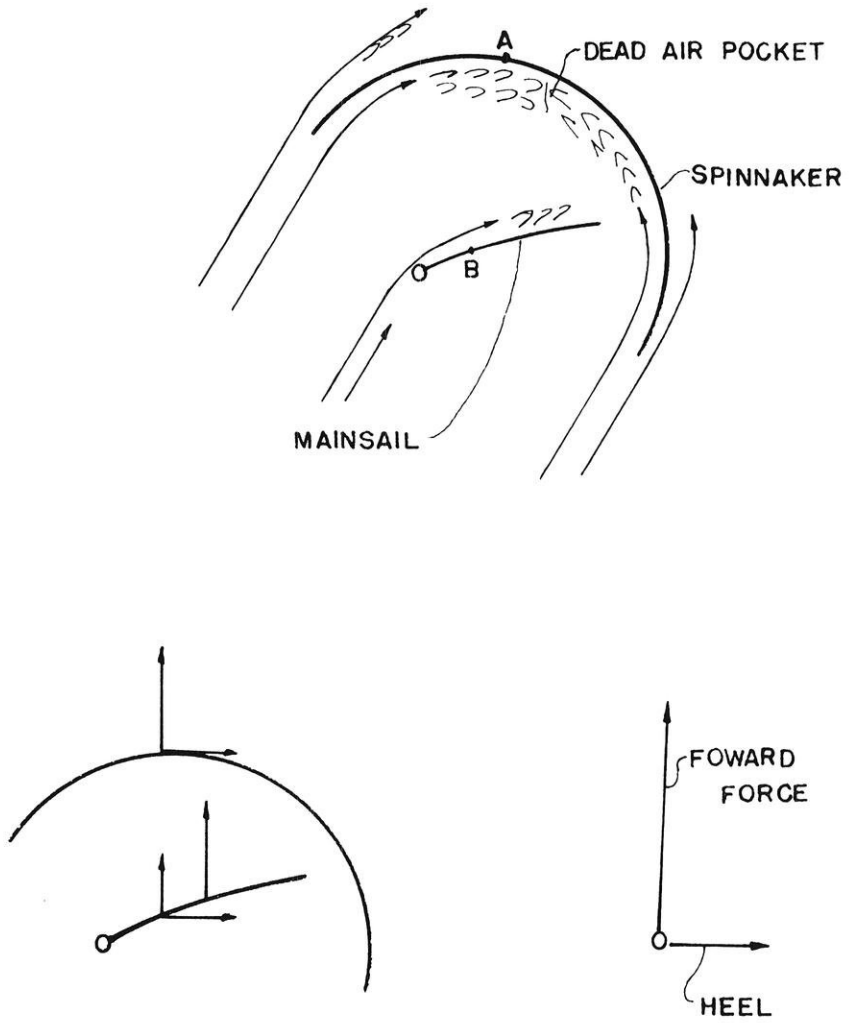

Fig. 9: Forces on a board reach.

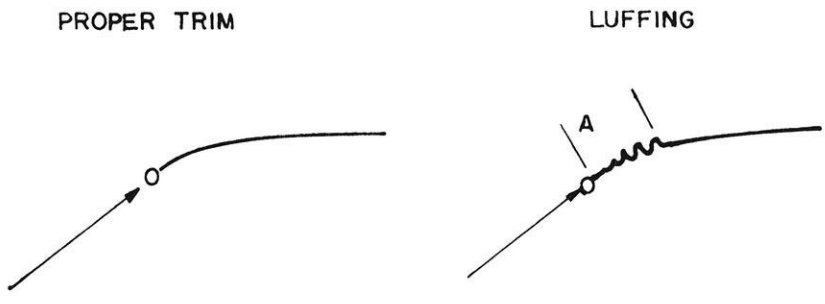

Fig. 8: Luffing of the sail.

The Reach

A boat is sailing on a reach when the wind is between 30 degrees of the bow and dead aft. Two cases will be considered—The close reach and the broad reach. Wind directions producing these cases will be seen in Fig. 4.

The close reach is similar to the beat, with the following exceptions: the slot effect is reduced or eliminated, allowing the main sail to do its full share of work. Although the wind has moved aft and has decreased in velocity, the new sail trim has forced the lift force to assume a more forward direction, resulting in a larger forward force.

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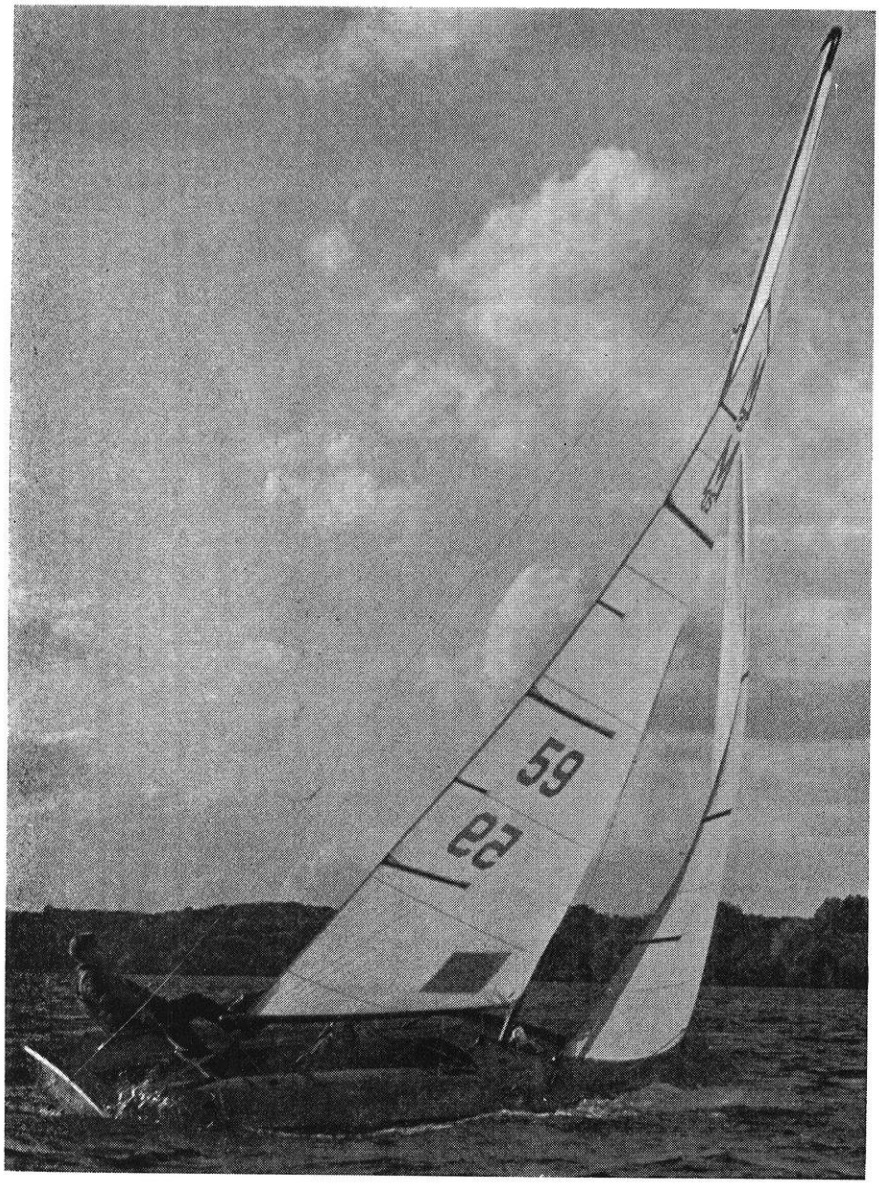

The close reach. Notice how the skipper is "hiked out" to counteract the large heeling force.

The mainsail acts very much the same as the jib, producing a larger total force due to its bigger size. Because of the large resulting forward force (Fig. 9), the close reach is the fastest point of sailing.

As the wind moves aft, a number of things begin to happen. First, a headsail change to a spinnaker or "chute" is advisable. Second, the "flat plate" effect begins to make itself felt. In detail:

1). The headsail change. The use of a chute is dictated because of the better aerodynamic shape it will assume when the wind is aft of the beam. A jib is not suitable for this point of sail.

2). The flat plate effect. This is an extremely important consideration in all down wind sailing. Sails can only be eased about 90 degrees; with the wind far enough aft, a normal airflow is not possible and the sail acts like a board held perpendicular to a stream of water. The normal lift and drag relation disappears and the forward force becomes dependant on sail area and wind velocity only.

The broad reach is perhaps the most difficult of all points of sail to analyze because of the interaction of the flat plate effect and the normal airflow relations on the mainsail. The spinnaker is also an influencing factor on the main because it exhibits more or less normal airflow patterns. This creates the interesting effect of a mainsail with two distinct sets of forces. An analysis is shown in Fig. 9. The approximate airflow patterns are shown in (a). Point "A" is the general location of the pressure drop in the spinnaker, while point "B" is the location of the mainsail pressure drop *produced* by the chute. Notice that some normal flow over the main still occurs. In (b) of the Figure, the forces are reproduced composed into forward and heeling components. Note that the heeling force is becoming small.

The Run

With the wind dead astern, the flat plate effect is only influence on both the main and the chute (by virtue of the dead air pocket in the center of the sail). This case can be analyzed by using a simplified representation as shown in Fig. 10. The heeling force has now disappeared.

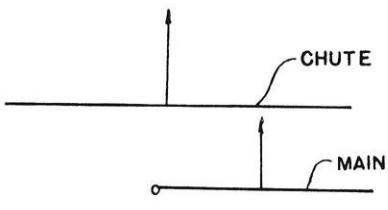

Fig. 10: The flat plate effect on the run.

CONCLUSION

It is hoped that the analysis in this report will aid the sailor in seeing what makes his boat go. We have covered, in qualitative terms, the basic aerodynamic concepts of airflow over a sail, and have extended this to a force analysis of a boat under various points of sailing.

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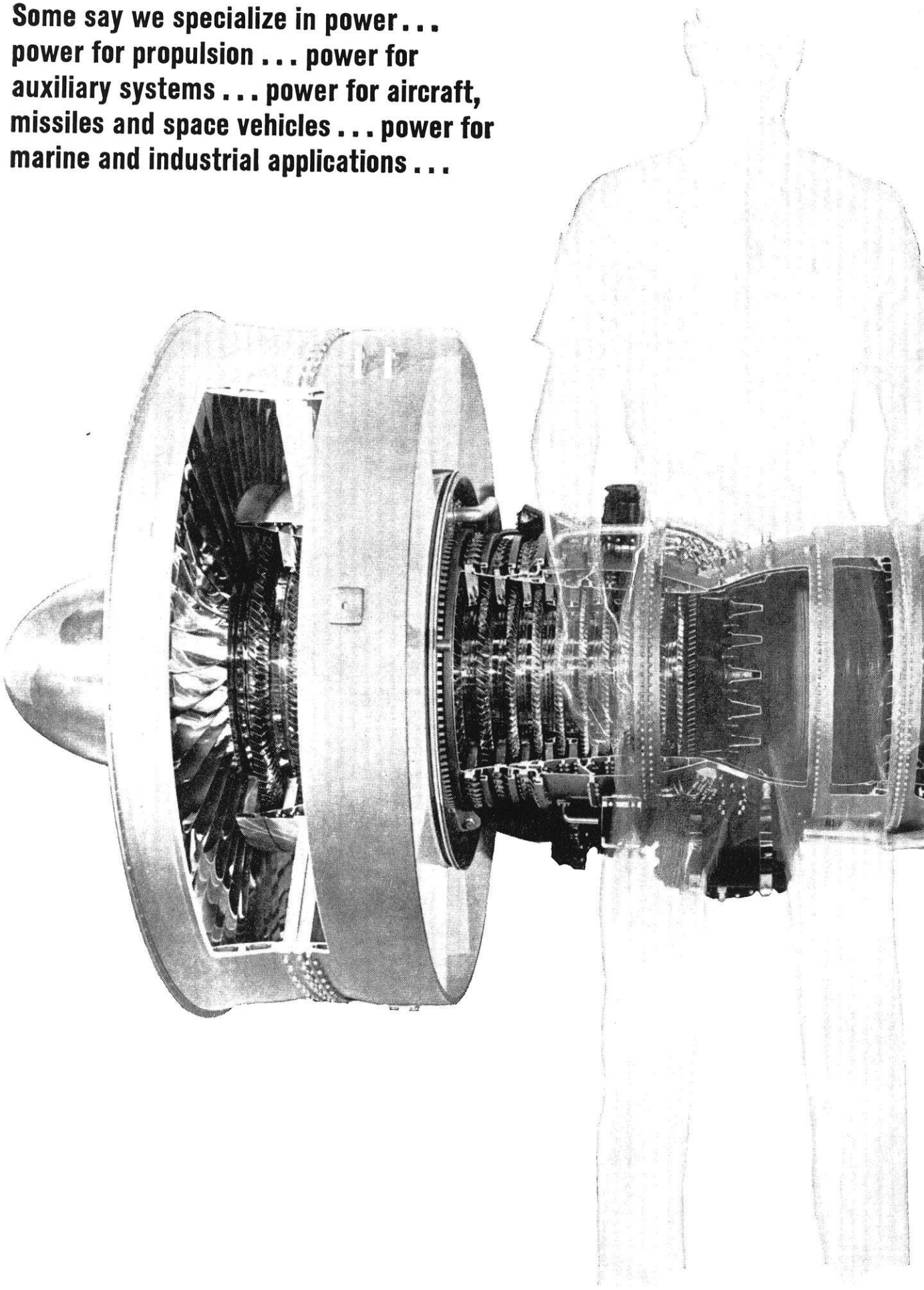

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LAKE MICHIGAN: *May Be Hazardous To Your Health*

by Dean Schultz
CE4

ALTHOUGH Lake Michigan as a whole is not yet seriously polluted, it is in great danger of becoming so in the near future. Indicative of the mounting problem is the situation in Green Bay and its tributary streams. In this area alone, industry discharges some 160 million gallons of waste per day into rivers, streams and Green Bay itself.

In the following article these two areas will be discussed as to the major sources of pollution, the quantities of the polluting wastes and the actions recommended by the Federal Water Pollution Control Administration to correct the problem. The discussion will also include a look at the effects of the pollution to date and thus illustrate the manner in which the pollution problem is affecting everyone in the State of Wisconsin. This discussion will by no means cover all the sources of pollution of Lake Michigan; only the major contributions by the inhabitants of the State of Wisconsin will be investigated.

WHAT IS WATER POLLUTION?

Such things as the presence of refuse, oil on the water's surface, or high concentrations of undesirable chemicals are all considered to be pollution. The presence of organic wastes, however, is commonly considered to be the most significant indication of pollution. Pollution as a result of such wastes must be measured relative to an accpetable standard or base value. The most widely used index to pollution is the dissolved oxygen content of the water.

Oxygen Requirements

Organic wastes are decomposed and rendered relatively stable by micro-organisms found naturally in the wastes themselves and in the general environment. In order for these organisms to act on the wastes, they require oxygen which they obtain from the water into which the wastes are dumped. The presence of a large amount of wastes significantly reduces the dissolved oxygen content and hinders the reduction of further added wastes. The result is pollution. Thus by measuring the oxygen content of the water, we have a good indication of the degree of pollution of the sample.

Another indication of the presence of organic wastes in a water supply is the presence of a certain type of bacteria. These bacteria are called coliforms and are found naturally in the intestines of all warm-blooded animals. These coliforms pass out of the body with the feces and are able to survive relatively well outside of their environment. They are not harmful in themselves, but they serve as good indicators of the presence of human or animal wastes. By counting the number of coliforms in various samples and keeping records of these counts over a period of years, one may see the pollution trends over this period.

Polluting Potential

Thus far we have decided to measure the degree of pollution by measuring the amount of dissolved oxygen in the water which, in turn, indicates the approximate amount of organic wastes present. But we are mainly interested in the source of these polluting wastes, not in how much damage they have already done. Therefore, we must measure the ability of a waste to cause pollution, that is, its oxygen consuming capacity. By running certain tests on waste samples, it is possible to determine the amount of oxygen micro-organisms

(Continued on next page)

required to reduce a waste to a stable condition. This quantity is known as the biochemical oxygen demands of the waste. Human wastes also require oxygen to be decomposed, and by expressing industrial wastes in terms of the oxygen consuming capacity of human wastes, one may easily visualize the polluting power of industrial wastes relative to human wastes. This correlation is designated as the Population Equivalent (PE). Thus an industrial waste load of 100 PE is equivalent in oxygen consuming power to the raw wastes of 100 people. With these general concepts in mind, let us take a look at the major sources of pollution in the previously mentioned areas.

SOURCES OF POLLUTION

Pollution sources are varied and widely distributed. They range from paper mills to lighthouse stations and contribute an equally wide variance of waste types and quantities. Some of these wastes are extremely strong, same are relatively weak. The effects also vary in type and degree. By breaking the sources down into several main categories, it will be much easier to study the exact problem and compare relative pollution figures. Let us first consider the Milwaukee Area.

Milwaukee Area

The Milwaukee area includes a large portion of Southeastern Wisconsin. Included in this area is nearly one-third of the state's population and a good portion of its industry. Nearby Lake Michigan has proved to be a handy receptacle for the area's wastes, but the consequences are beginning to show.

Municipal. Municipal waste effluents represent the largest source of pollution in the Milwaukee area. The 19 municipal waste treatment plants in the area serve a present population of 1,080,000. In addition, these plants handle an industrial waste load of 1,570,000 PE. The total daily discharge to the waters of the area is an effluent of 360,000 PE—1/3 the population of the area (and this is after treatment).

Industrial. Although a great deal of industrial waste is handled by the municipal treatment plants, some industries in the area do discharge their treated wastes directly into Lake Michigan. A 1964 study showed four industries to be discharging a total of 4 million gallons per day of waste into the Lake. The total waste load is estimated at 150,000 PE per day. Table 2 summarizes the data.

Combined Sewers. Yet another source of pollution in the Milwaukee area are the combined sewers. These sewers carry both storm water runoff and sanitary sewage, and it is estimated that during peiods of heavy runoff an approximate 111,600 PE waste load is discharged into the Milwaukee Harbor per day. This overflow, consisting of large amounts of storm water along with the industrial and raw sewage, comprises a primary source of Milwaukee County stream pollution and thus greatly affects the adjacent waters of Lake Michigan into which they empty. The sewage reaches the streams because the treatment plants are not designed to handle the additional flow caused by the storm waters. All the sewage cannot, therefore, be properly treated and some of it is expelled into the county's streams. Designing plants to handle storm water flows is impractical, but a separate sewerage system would virtually eliminate the problem. Let us now look briefly at some of the pollution sources other than those which supply organic wastes.

Agriculture and Land Runoff. In 1963–1964 a survey was conducted in the Lake Michigan watershed to determine the amounts of phos-

Table 2—Major Industrial Waste Sources (Direct Discharge)

Industry (Product)	Location	Effluent PE/day	Waste Flow (mgd)
Peter Cooper Corp. (Glue and Gelatin)	Oak Creek	25,000	3.7
Western Condensing Co. (Condensed Milk (Products)	Adell	40	0.1
Libby, McNeil, & Libby (Canned Vegetables)	Jackson	150	0.2
Krier Preserving Co. (Canned Vegetables)	Random Lake	70	0.1
TOTALS		25,260	4.1

Table 3—Miscellanous Pollution Sources Milwaukee Area

Pollution Source	Type	Amount
Federal Installations		
1) U. S. Coast Guard Station Milwaukee Harbor	Raw sewage from 3-man complement	150 gpd
2) Milwaukee Defense Area Housing—Brown Deer	Sanitary wastes	1,000 gpd
3) Milwaukee Defense Area Housing—S. W. Bayshore Estates	Sanitary wastes	200 gpd
Milwaukee Metropolitan Sewerage District (Jones Island Plant)	Phosphates	6,600 #/d
Milwaukee River and Tributaries	Phosphates	2,700 #/d
Ships and Boats		
1) Commercial	Cargo, dunnage, bilge, ballast water, fuel, garbage, sanitary wastes	not measured
2) Recreational	Oil, gasoline, garbage and sewage from cooking and toilet facilities	not measured
Dredging	Dredged material deposited in other portions of Lake	not measured

phates and other chemicals which reach Lake Michigan through runoff. Phosphate pollution can result in uncontrolled growth of algae and its following decay. This decay results in oxygen depletion and is also undesirable because of its unsightly appearance, objectionable odors, and filter-clogging properties. In the Milwaukee River basin soluble phosphate runoff is estimated at 11,000 pounds per year. Other chemicals are also becoming nuisances because of high concentrations in some rivers and streams in the area. Examples of these are the pesticides DDT, EPN, Malathion and Parathion, all of which are being employed in increasing amounts.

Miscellaneous. Other sources of pollution in the area which are not yet major polluting forces are listed, along with their pollutants, in Table 3. It should be noted that considerable amounts of phosphates are contributed to the lake each day, in addition to those from runoff, from the municipal waste discharges into rivers and Lake Michigan itself.

This completes the list of significant pollution sources in the Milwaukee Area. In summary, it may be seen that the major pollution source is that of domestic sewage. The treatment plants in the area discharge some 167 million gallons of treated wastes into Lake Michigan every day. In addition, there are various amounts and types of pollutants from industry and agriculture which add to the pollution problem in the area. The Green Bay area presents another view into the pollution problem; let us now investigate the northern portion of the state.

Green Bay Area

The Green Bay area includes most of the northern part of the state bordering Lake Michigan. Within the area is centered the major fishery in the state, as well as a major portion of the state's paper industry. This area, in contrast with the Milwaukee area, receives its greatest waste volume from industry.

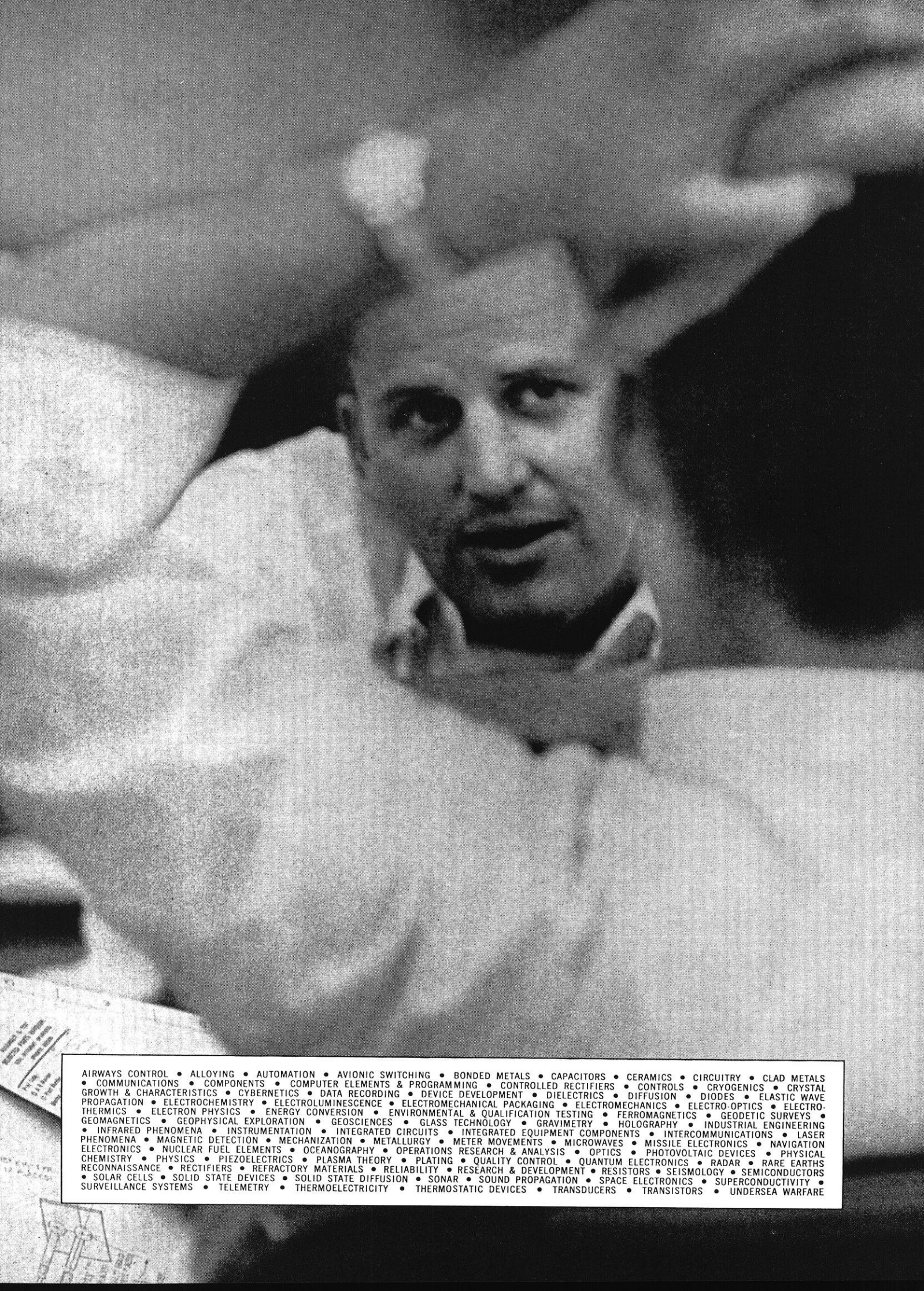
Municipal. Seventy-five municipal waste sewage treatment facilities in the Green Bay area, after removing 60% of the oxygen demanding material, discharge a waste load of 306,000 PE into Green Bay or its tributary streams. Sixty percent of this effluent comes from eight treatment plants along the Lower Fox River between Neenah–Menasha and Green Bay. Table 4 presents the municipal waste inventory of the area. Examination of Table 4 reveals that some facilities remove as little as 20% of the oxygen consuming wastes and that some municipalities actually discharge wastes greater in oxygen consuming power than the wastes of the city's

(Continued on page 35)

Table 4—Municipal Waste Inventory of Major Communities, Green Bay Area, Michigan and Wisconsin

Community	Receiving Stream	Miles Above Mouth	Treatment	Population Connected	Raw PE*	Discharged PE
		GREEN BAY PERIMETER				
Oconto	Oconto River	1.30	Secondary	4,700	10,300	1,360
Peshtigo	Peshtigo River	11.70	Secondary	2,800	2,800	933
Marinette	Menominee River	1.60	Primary	13,000	15,000	10,000
Menominee	Menominee River	1.60	Primary	11,280	3,610	2,130
Escanaba	Portage Creek	1.20	Secondary	15,390	11,750	2,580
Gladstone	Little Bay de Noc	0	Primary	5,260	5,200	4,100
		LOWER FOX RIVER				
Green Bay	Fox River	0.30	Secondary	88,280	190,000	62,000
De Pere	Secondary	6.80	Secondary	10,000	13,500	6,380
Appleton	Fox River	29.80	Secondary	47,000	110,450	70,030
Little Chute	Fox River	25.80	Secondary	5,100	5,100	1,000
Kimberly	Fox River	27.10	Secondary	5,400	5,400	540
Kaukauna	Fox River	23.60	Secondary	10,100	9,600	4,800
Neenah and Menasha	Little Lake Butte Des Morts	37.60	Primary	32,705	50,000	36,000
		UPPER FOX RIVER				
Fond du Lac	Lake Winnebago	74.30	Secondary	33,000	54,000	11,000
Oshkosh	Fox River	57.40	Secondary	50,685	60,000	31,200
Ripon	Silver Creek	120.70	Secondary	6,765	8,000	200
Berlin	Fox River	87.90	Secondary	4,830	14,580	2,412
Portage	Fox River	161.40	Secondary	7,800	13,000	1,500
		WOLF RIVER				
Waupaca	Waupaca River	112.80	Primary	4,000	4,840	3,630
New London	Wolf River	114.00	Secondary	5,300	15,400	5,460
Clintonville	Pigeon River	150.80	Secondary	4,800	6,000	1,320
Shawano	Wolf River	184.30	Secondary	6,300	15,000	2,600
		MENOMINEE RIVER				
Iron Mountain–Kingsford	Menominee River	95.40	Primary	14,370	9,400	5,530

*P.E. = 1/6 pound per-day BOD_5.



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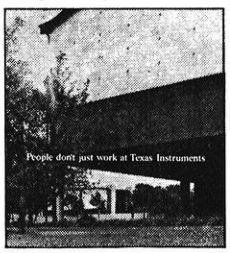

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MARK OF EXCELLENCE

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total population! It is in these facilities, then, that corrective action is necessary. But industry is an even bigger offender.

Industrial. Industries in the Green Bay area are by far the largest pollutors. They discharge into tributary streams and Green Bay itself some 160 million gallons per day of waste flow. This amounts to an equivalent raw waste flow from 2,840,000 people—more than six times the number of people served by the area's municipal treatment plants. Table 5 presents the major offenders and their contributions to pollution with respect to strength of waste effluent, revealing that the paper mills are the area's largest pollutors.

Many of the above companies only screen their wastes before expelling them into the rivers, thus removing only a small part of the polluting material. It is recommended that these companies be required to remove 90% of the oxygen demanding materials rather than the present 30% to 50%. Only when these industries are forced to clean up will the rivers once more be suitable for recreation and water supply.

Phosphates. The Green Bay area provides a tremendous amount of soluble phosphates to its streams, and the bay each year. Based on studies done on samples taken from eight pilot watersheds in the area, the phosphate runoff is estimated at 0.1 pound per acre per year. This amounts to a total of 1,167,000 pounds per year total. Another even greater source is the municipal sewerage system. The phosphates present in human wastes and synthetic detergents are responsible for a total discharge of 2,770,000 pounds of phosphates per year to the area's streams. Sampling of the major Green Bay tributaries at the mouth indicates that about five million pounds of soluble phosphates enter Green Bay each year! Here, then, is another point on which attention and action must be focused.

Wisconsin is faced, then, with the choice of forcing her cities and industries to provide adequate waste treatment or allow pollution to destroy its waters. In this brief look at the major sources of pollution in the state, one may see that it is primarily from industry and municipal sewage treatment facilities that the wastes emanate. Now that we know where these pollutants come from, let us take a look at the damage they have already done.

EFFECTS OF POLLUTION

The effects of pollution are as varied as the sources. Those effects that we can see, smell, feel and taste are all very real and tangible to us. Pollution, however, has many

Table 5—Industrial Waste Inventory (Major Industries)

Company Name	Location	Effluent MGD	Effluent PE
FOX RIVER			
Green Bay Packaging	Green Bay	2.10	199,800
Charmin Paper Prod.	Green Bay	14.53	276,520
Marathon Paper	Green Bay	21.33	282,520
Fort Howard Paper	Green Bay	13.42	170,640
U. S. Paper Mills Corp.	De Pere	—	—
Nicolet Paper	De Pere	1.49	1,200
Charmin—Little Rapids	Little Rapids	0.03	1,368
Thilmany Pulp & Paper	Kaukauna	23.63	198,480
Combined Locks Paper	Combined Locks	2.98	25,200
Kimberly-Clark	Kimberly	12.69	316,440
Consolidated Paper	Appleton	7.96	201,720
OCONTO RIVER			
Scott Paper Co.	Oconto Falls	11.30	168,000
PESHTIGO RIVER			
Badger Paper Co.	Peshtigo	5.50	137,400
MENOMINEE RIVER			
Kimberly-Clark	Niagara	10.10	104,160
Scott Paper Co.	Marinette	7.30	317,400
Scott Paper Co.	Menominee	1.00	5,460
Marathon Corp.	Menominee	1.60	26,460
FOX RIVER (Cont.)			
Riverside Paper	Appleton	1.89	11,640
Fox River	Appleton	—	—
Whiting Paper	Menasha	0.15	768
Marathon Paper	Menasha	—	—
John Strange Paper	Menasha	1.74	10,080
Gilbert Paper	Menasha	1.11	6,240
Kimberly-Clark	Neenah	5.71	14,400
Bergstrom Paper	Neenah	1.10	22,080
Kimberly-Clark (Badger Globe)	Neenah	1.07	2,040
Kimberly-Clark (Neenah Div.)	Neenah	0.83	3,528
Chicago Pickle	Redgranite	0.03	1,800
ESCANABA			
Mead Corp.	Escanaba	6.80	66,900

Table 5—Miscellaneous Pollution Sources, Green Bay

Pollution Source	Type	Amount
Combined Municipal Sewers	Raw Wastes	3–5% of the combined sew flow
Agriculture and Land Runoff	Pesticides, Fertilizers	not measured
Green Bay Harbor Light Station	Sanitary wastes (untreated)	150 gpd
Ships and Boats	Same as for Milwaukee Area	not measured

indirect effects which are often more serious than those mentioned above. Lack of oxygen, the presence of high concentrations of phosphates, and the contamination of water supplies lead to effects which threaten not only our comfort but our very existence.

Effects on the Commercial Fishing Industry

Oxygen is necessary for fish life as well as for the reduction of organic wastes by micro-organisms. The dissolved oxygen content of the water determines the number and species of fish which will inhabit a certain area. The rough fish, scavengers, and those of least commercial value are able to exist in waters having a lower dissolved oxygen concentration than game fish. Catfish, for example, can survive in water with as little as 1mg/liter of dissolved oxygen while trout require about 6mg/liter. The greater the degree of pollution, the smaller is the dissolved oxygen concentration, and consequently the water can support fewer fish in general and fewer game fish in particular.

Table 7 illustrates the effects pollution has had on the commercial fish production in Green Bay over the past 20 years. It reveals an overall reduction (in pounds) of more than 35%! But closer examination of the table reveals that the situation is even worse than the totals indicate. The game fish have decreased, in general, while the less desirable rough fish have increased. The perch production has dropped 90% in the past 20 years, 35% of which has been in the last two years. Trout production decreased from 27,000 pounds annually in 1948 to no significant production in 1953. Although this decrease was due partly to the invasion by the sea lamprey, pollution also accounted for part of this reduction. A significant factor in the reduction of commercial fishing income is the alewife. This fish was not present to any commercial significance until 1956, but by 1965 it constituted almost one-half of the area's total production. This fish has a commercial value of $.01 per pound and has displaced good quality native species which command $.15 per pound or more. Is it any wonder commercial fishermen are leaving the business? The alewife is also a pollution nuisance in itself due to the high mortality rates associated with their spawning migrations. These are a few examples of the changing picture of the fish life in Lake Michigan. In the words of Charles N. Lloyd, Superintendent, Fish Management Division, Wisconsin Conservation Department:

> "Clearly the fishery has changed. Changes have been largely adverse, and poor quality fish have been substituted for good quality fish. Pollution is not hidden in this picture; it has deteriorated coldwater habitat and rendered desirable spawning grounds useless. High biochemical oxygen demand and enrichment of bay waters . . . has accentuated plant growths, plugged nets, and favored carp. Fishermen complain of catching fish unacceptable for market becauses of off flavors, probably a direct or indirect result of pollution. A sharp decline in production as a result of reduced fishing is ample testimony of the quality of these waters and their fishery. Both pollution control and aggressive management measures will be necessary to restore the fishery to its normal status."

CORRECTING THE POLLUTION PROBLEM

Because man is selfish by nature, he will not spend a million dollars

Table 7—Fish Production from Southern Green Bay from 1944 through 1965. Figures are in pounds.

Year	Trout No. 1	Whitefish No. 1	Menominee or Pilot Fish	Black Fin	Blue Fin	Perch	Mullets	Carp	Catfish	Bullhead
1944	1,500	3,000	10	85,000	475,000	2,400,000	100,000	1,160,000	60,000	150,000
1945	24	1,200	700	123,000	1,436,000	700,000	1,078,000	1,751,000	85,000	289,000
1946	270	1,920,000	9	44,000	2,471,000	682,000	868,000	1,167,000	89,000	171,000
1947	2,900	616,000	10	19,000	3,101,000	654,000	705,000	973,000	38,000	219,000
1948	27,000	402,000	27	68,000	4,427,000	830,000	537,000	1,024,000	25,000	106,000
1949	5,000	183,000	23	78,000	3,782,000	606,000	608,000	1,320,000	26,000	81,000
1950	394	77,000	7,000	56,000	3,275,000	481,000	384,000	1,113,000	22,000	58,000
1951	04	52,000		42,000	2,575,000	667,000	234,000	1,101,000	10,000	41,000
1952		21,000	79	4,000	2,548,000	1,088,000	242,000	1,068,000	7,000	48,000
1953	36	6,000		33,000	1,602,000	1,191,000	360,000	1,102,000	4,000	62,000
1954		860		35,000	1,430,000	1,009,000	319,000	1,329,000	8,000	93,000
1955		23	110	9,500	1,361,000	1,330,000	342,000	1,847,000	4,000	88,000
1956				7,000	1,242,000	1,353,000	361,000	1,822,000	8,000	44,000
1957				7,000	895,000	1,073,000	380,000	2,032,000	5,000	31,000
1958		16		8,000	514,000	994,000	363,000	1,223,000	500	22,000
1959		25		4,000	240,000	713,000	353,000	1,911,000	300	5,000
1960		31		5,000	38,000	682,000	472,000	1,382,000	2,000	13,000
1961		2,000	2,000	400	30,000	1,469,000	363,000	1,794,000	75	32,000
1962		3,000			17,000	1,714,000	213,000	1,200,000	200	41,000
1963		1,000			8,000	1,749,000	217,000	1,250,000	2,000	41,000
1964		11,000	110		2,000	1,090,000	172,000	1,305,000	100	32,000
1965		743	50	12,000	4,000	238,000	121,000	2,006,000	500	18,000

to dispose of his company's wastes safely when he can simply dump them in a nearby river and never see them again. It is this part of human nature that we must attack. We must *enact* laws and *enforce* these laws to keep our rivers and lakes clean. Pollution programs are complicated, but it does not take many words to state what is wrong with our present programs. Cities and industries cannot or will not spend funds to adequately treat their wastes. The enforcement of present antipollution laws is weak. But laws are not the only answer. A court order cannot purify wastes. We must first know how to purify them. Sewage and new chemical wastes are being treated by methods which just do not do a satisfactory job. With more dangerous wastes, better methods of disposal must be found. What we need is more knowledge, more money, and a new method of enforcement. Once these three factors are supplied, pollution will be on the way out.

It must be pointed out that the only way pollution of our streams and Lake Michigan can be arrested is through the concern of the citizen. The private citizen's representatives make the laws which will provide us with safe water. If the public does not show concern for their resources, no one will.

Looking back, we see that the wastes of cities and industry are fast becoming a problem in the pollution of Lake Michigan. This is not a problem in theory, but a very physical problem which we can see, taste, and feel. Our tourist industry (worth almost a billion dollars a year) is in serious danger. Commercial fishing is becoming as unprofitable as shoeing horses and our favorite beaches are no longer useable. The old river where you caught trout as a youngster now provides nothing more than unsightly algae and unpleasant odors. Our laws need improvement and enforcement. Our disposal methods need updating and expansion. There is a very real need for public concern and action. It is the citizen who is to blame for the pollution and the citizen who can stop it.

AIR TRAFFIC CONTROL

by James L. Anderson CE '67

"A Trans World Airlines jetliner with 25 persons aboard and a small private plane apparently collided in flight today, sending both planes crashing to earth. There were no survivors.

The air control center at nearby Dayton, Ohio—the next stop for the jetliner—reported both planes were on a collision course when the blips disappeared from its radar scope, an official said. He said the Dayton center informed the TWA plane of the collision course."

Such incidents as this cause many people to be deathly afraid of air travel. In fact, it causes some people to be so afraid that they will not travel by airplane. The purpose of this report is to show how air-traffic is operated in the United States and how this affects the safety of air travel. To do this, some background statistics on the comparative safety of air travel and automobile travel will be given first: then a few of the control systems and electronic devices such as radar and automatic landing systems will be explained.

SAFETY STATISTICS

Just how safe air travel is can best be illustrated by analyzing statistics compiled throughout the development of air travel. When a person steps on a commercial airliner the odds of him reaching his destination safely are 200,000 to 1 in his favor. These odds are improving every year. In 1940, there were 30 passenger fatalities per 100 million passenger-miles. In 1950, the percentage was 1.1. In 1959, the percentage was .7 passenger fatalities per 100 million passenger-miles. During 1959 there were 2.3 passenger fatalities per 100 million passenger miles in motor vehicle transportation. So one can see from these statistics that air travel is statistically safer than automobile travel and that it is improving every year; whereas, in travel by automobile the accident rates are increasing.

DEFICIENCIES AT NATIONAL AIRPORTS

Although these safety statistics are impressive, it is still evident that there is much room for improvement. A spokesman for the Airline Pilots Association said that more runway lighting and marking is needed at 62% of our national airports, rescue and fire fighting services are below standard at 92%, runway visual range equipment is not available at 96%, airport surveillance radar is not available at 86% of the airports, tower facilities are not available at 58%, there are inadequate runway clear zones and overrun areas at 60%, and additional approach lighting and runway end identification lights are needed at 70% of the airports. These figures include many of the smaller airports which are not serviced by the major national airlines, but are serviced by the numerous regional airlines. They do not include private airports with grass runways or those which only service private planes.

COST OF FUTURE DEVELOPMENT

The above percentages are very impressive and tend to make one wonder just how responsible the airlines and airports are in performing their service. This lack of facilities is not due to incompetence, but to a lack of funds. In the September 28, 1959, issue of *Aviation Week*, it says that the funding of air-traffic control facilities by the Federal Aviation Agency will equal over one billion dollars by 1970 and that this will only be a little of what actually is needed. With the development of the SST (super sonic transport), the costs for further development of control systems will increase and keep increasing with every new innovation in aircraft design.

The main process of any air-traffic control system is the same. The system determines the actual and intended positions of all aircraft under its guidance; it processes all the incoming data to arrive at the present and future relative positions of the aircraft and it then displays this information to the controller. The controller must then decide whether or not any action need be taken to avoid a collision; and if action is necessary, it is his responsibility to decide what should be done. Although he acts in accordance with standard regulations as to the separation of aircraft, he must temper these regulations with his own judgment in such cases as bad weather, and so on.

Growth of Systems

The controller's job has become more complicated because of the tremendous increase in air travel. In 1939 there were approximately 29,000 licensed aircraft in the United States. In 1960, there were more than 110,000 licensed to fly. These include 42,000 military planes, 2,000 air carrier planes and 65,000 general aviation aircraft, which include private planes. The air-traffic control system has also grown in an attempt to keep pace. As of January, 1961, there were 12,350 ground controllers as compared to 4,700 in 1956. These controllers are divided into teams, consisting of two to five members, each of which is responsible for a certain sector of air travel such as commercial, private, and military.

Network of Airways

The basis for air-traffic control between airports is a nationwide network of airways which are

staked out by radio transmitters. These airways are the property of the federal government and are operated by the Federal Aviation Agency which took over these and all other regulatory duties from the Civil Aeronautics Association (CAA) on December 31, 1958. These airways act as navigational highways in the sky and therefore restrict airline traffic to certain air corridors.

PRE-FLIGHT CHECKS

Before a pilot can even take his plane off the ground, he must go through an entire series of operations. One thing he must do is to file a flight plan with the nearest air-traffic control center telling them which airways he intends to use. It is also the pilot's responsibility to check the weather with the weather bureau to find out what kind of weather he will run into on his route. If there are any major storms on route, he should plan a different route using different airways. The last thing he should do before starting his journey is to go through his pre-flight check list. This includes looking at the exterior features of the aircraft and an exterior check of the instruments in the cockpit.

CONTROL OF FLIGHT

Five of the basic methods of control of the aircraft while in flight will be now discussed. One of the ways that a pilot can determine his exact position as he travels the airways is by obtaining a "fix". This is given to the pilot when he passes over a radio transmitter which tells him his exact position. These transmitters are located throughout the country at the intersections of the airways.

To help the pilot navigate along the airways, engineers are developing new systems that will be contained entirely aboard the aircraft. These systems will apply the basic concepts of celestial navigation (using the stars) and dead reckoning; both of which use the record of time flown along a known initial position. This initial position need not be on the ground but can be an artificial earth-satellite. If a pilot flies on a known heading, and if he knows his position relative to an initial point, such as a satellite, he or an on-board computer can calculate his position.

Estimated Time of Arrival

The estimated time of arrival (ETA) is also a method of controlling planes while in the air. The traffic control center at which a pilot has filed his flight plan uses this information to prepare a "flight progress strip" on which it enters the ETA of the flight at each one of its fixes. By keeping to these times, the pilot assures himself that he will not conflict with any other traffic on his airway. The traffic controller also keeps records of the times that planes pass his fixes and if he finds a conflict between two planes, he will tell one to hold its position until the desired separation between the two aircraft is obtained. Under ordinary conditions the time difference of ETA's of two planes should be ten minutes.

By requiring minimum distances between planes in flight the FAA actually provides a "protective cocoon" around the aircraft. An aircraft flying at 300 miles per hour needs a longitudinal separation of fifty miles and for a speed of 600 miles per hour, the separation should be 100 miles. As one can see the length of the "cocoon" varies directly with the speed. The width of the "cocoon" is fixed at ten miles and its depth is also fixed at 1,000 feet when below 29,000 feet and double these values at higher altitudes. When planes are under constant radar surveillance, the controller may allow three miles between aircraft, thus changing the "cocoon" to a disk with a radius of three miles and 1,000 feet deep.

Under bad weather conditions all aircraft must fly under air-traffic control, but when the skies are clear certain smaller aircraft can fly by the see-and-be-seen method. This does not apply to military or jet transport aircraft because of their excessive speeds. The pilots of two jet airliners on a head-on collision course have only fifteen seconds to avoid a collision when their planes are five miles apart. This is not enough time to avoid the collision because at the higher altitudes, the controls of the big planes take several miles to "bite" into the air and cause an appreciable change in direction.

"Stacking" of Aircraft at Airports

As the pilot approaches his destination, he calls the control tower to announce his flight and get land-

ing instructions. When the weather is good, the aircraft can generally be cleared for landing as soon as it calls in. In bad weather and when aircraft arrive faster than they can be landed, they are ordered to wait their turn in a "stack" above the airport. The aircraft assemble over radio beams which help to keep them in precise holding patterns. In such holding patterns, the planes are separated by 1,000 feet, and, as each plane lands from the bottom of the stack, all the planes in the pattern drop down a level until it is their turn to land. Since no two aircraft can occupy a runway at the same time, an aircraft cannot land until its predecessor has left the runway. Similarly, no departing aircraft may enter the runway if the next one scheduled to land is within two miles of the runway threshold.

Problems Posed by FAA's Lack of Control

Problems are posed by the FAA's lack of control over the flights of many of the nation's private aircraft. All commercial airlines and some of the larger and speedier private planes use the airways, operating under instrument flight rules (IFR) even in clear weather to take advantage of the separation and protection afforded by FAA controllers. But many small planes fly by visual flight rules (VFR), permissible when visibility is greater than three miles. Pilots flying VFR are responsible only for seeing and avoiding other aircraft, and are not even prohibited from entering the busy FAA control zones. The collision mentioned at the beginning of this report was between a TWA DC-9 on an IFR approach and a twin-engine Beech being flown under VFR on a bright, cloudless day.

SAGE AND GROUND-TO-AIR-TRAFFIC CONTROL

In late 1963, a new system went into effect which will greatly increase the efficiency of the air-traffic control system in the United States. This system is the integration of air defense and air-traffic control at the nine super-combat centers in the United States. The key to the integration is a large capacity transistorized computer. This computer enables the centers to fulfill their air defense missions while providing, enroute, high altitude air-traffic control by maintaining separation of aircraft and permitting direct, area, and airways flying. Direct air travel is usually associated only with high altitude flying because at high altitudes there is less traffic—so planes fly a straight course to their destination. The principal elements of the new plan are as follows:

1) *Arrangement.* Arrangement of these integrated functions at the super-combat centers will permit the use of the radar inputs from both FAA and Air Force radars. In other words, both sets of radar can be used by both organizations thus giving each more equipment.
2) *Control Areas.* The control of such a system will be limited to en route traffic, mainly above 24,000 feet, except in less-traveled zones where the coverage will reach the ground.
3) *Systems Communications.* Control information will be transmitted to aircraft primarily by means of direct controller-to-pilot radio. Eventually automatic ground–air communications systems will be incorporated. Coordination of material from one center to the other will be constantly relayed via automatic computers in addition to the use of voice communication.

The main functions to be performed by the integrated system are very similar to those of the single air-traffic control system. The new system will process flight plans, progress reports, and weather data. In addition, all input messages sent by automatic communication systems will be decoded and subjected to error detection processes. The acceptance or rejection of such information will be automatically sent back to its source. Also, the system will automatically keep a running computation of all aircraft positions and velocities based on information sent by the pilot which will be supplemented by the pilot's flight plan. Using its continuous computations of aircraft positions, the system will predict conflicting situations. At the terminals, the system will analyze traffic within the en route center and compare this with the terminal's present acceptance rate. One additional function will be the checking of aircraft over their fixes for possible conflicts. These conflicts arise when estimated times over a fix differ by less than ten minutes, when the altitudes of two planes differ by less than 2,000 feet, or when either aircraft has not filed a specific altitude.

NEW ELECTRONIC DEVICES OF AIR TRAFFIC CONTROL

The increased speed of jet travel has necessitated the development of high speed methods of control. Since the pilots of two planes on a collision course have so little time to react, they need to know instantly of any danger and what evasive action to take. To provide this information, high speed computers which can handle many different problems in a fraction of a second are being developed.

One of the newest computers being developed is the central data processor which is a fully transistorized digital computer with a high speed core memory and file control unit. This computer will receive proposed flight plans, calculate ETA's, probe for conflicts among flight plans already in progress, and remember flight plans to be activated at the proper time. By means of appropriate signals, the computer is alerted and can display on a cathode ray tube the predicted aircraft tracks as much as 30 minutes in advance. This system is also designed to automatically prepare and distribute flight progress strips, detect and notify en route controllers of any conflicting situation, and

propose corrective action under conflicting situations.

Automatic Landing Systems

Using automatic landing systems, several U. S. airlines have already been cleared for "Category II" landings at some airports. These permit properly equipped planes to be guided electronically and automatically toward a landing when the ceiling is as low as 100 feet and visibility is as little as 1,200 feet. At an altitude of 100 feet, the pilot takes over and completes the landing if he can see the lights and markings—or he uses full throttle to climb away if he cannot see them. The FAA is also considering such aids to blind-landing systems as Bendix Microvision, which uses microwave radio signals beamed to the plane by ground transmitters from the sides of the landing strips. The signals form an image of the runway on a display in front of the pilot, enabling him to find it in zero visibility.

New Communications Systems

New automatic communication systems are also being developed to aid the pilot. For certain ordinary exchanges, the pilot will merely push a button to relay the information. Instrument readings can also be relayed automatically as in a spacecraft telemetry system. Certain instruments—such as the altimeter, airspeed indicator, and position instruments—are wired to a sending device and when the pilot pushes a button, a computer in the plane codes all the existing reading in a fraction of a second and sends these readings to a computer on the ground such as the central data processor which decodes the message. These give the pilot more time for the actual flying of the aircraft and therefore increases the safety of landings and takeoffs.

Lockheed Tracking and Control Systems

One new development although very expensive is the Lockheed Tracking and Control System, or Loctracs. It is estimated that the cost of nation-wide ground installation would be $700 million and to equip all planes with Loctracs beacons would cost another $30.5 million. With such a system, airborne beacons would continuously send out altitude and positional information which would be read on a screen on the ground. With such a device the ground controllers would have the location of all aircraft in their sector right at their finger tips.

One problem that has developed with this system is that when there are a large number of planes in the vicinity the data on the screen overlap and become illegible. When this occurs the controllers at the desk shut off the readout data and follow only the blip produced by the plane. Each plane is then identified by placing a toy model on the screen.

Radar

The backbone of an air-traffic control system is the radar. This method of tracking has been around for many years and has undergone many improvements. Although it is perhaps the main tool of air-traffic control, it still has one big fault in that it cannot distinguish height. Therefore a private plane flying at 500 feet may appear to be on a collision course with an airliner flying at 50,000 feet.

A new system using radio beams has been developed recently so that planes can detect each other in the air with greater accuracy. It employs two radio signals sent out from one plane to another. One of the signals travels directly from plane to plane, while the other is bounced off of the ground. Inside the second plane a small electronic computer uses the two messages to calculate where the first plane is, whether a collision is possible and what evasive action to take.

Low level radar is very important to air-traffic control around airports because of the large concentration of aircraft. For the purpose of ground control, the Doppler system has begun to go into service. Through the use of beams of microwave energy, the Doppler system can, (1) detect the presence of aircraft and other vehicles on selected portions of runways, (2) display direction of travel and identity of each aircraft to the controller, and (3) provide for the direction of traffic flow in a prescribed manner.

Although the statistics show that there are certain deficiencies at airports and throughout the entire air-traffic control system, one can readily see that the situation really isn't that bad. The safety statistics bear this out. Things are also getting better with the development of new types of radar and more sophisticated communications and airline guidance systems. A truly impressive record is being established by the airlines and the future holds many new challenges to air-traffic control.

Soon air-traffic control will give way to space-traffic control. Some new development will be the use of laser beams instead of radio beams in the fields of guidance and communication. Instead of jet power and speeds around the speed of sound, atomic power will be used and perhaps speeds close to the speed of light. So one can readily see that although many problems have already been solved in the field of air-traffic control, many more lie ahead.

TEASERS


RAT
CELLAR
Legalize
Pot
DOW
KILLS
PAINT
BLACK
TURN ON
TUNE IN
DROP OUT

SPRAY YOUR BYRD!

by J. P. Byrd
BS 69

An irate reader has complained that the Byrd uses the words "the Byrd" too often. Now the Byrd doesn't feel that the Byrd uses the words "the Byrd" too often. In fact the Byrd doesn't feel that even if the words "the Byrd" were used too often, that the words "the Byrd" would not even then bother most people, seeing as the words "the Byrd" haven't bothered the Byrd. So leaving " " altogether the reader will find this month's problems spotlighting other members of the Animal Kingdom.

* * *

This puzzle itself is simple, but can you read it?

Hanging over a frictionless pulley there is a rope with a weight on one end; at the other end hangs a monkey of equal weight. The rope weighs four ounces per foot. The combined ages of the monkey and its mother are four years and the monkey's weight is as many pounds as its mother is old. The mother is twice as old as the monkey was when the mother was half as old as the monkey will be when the monkey is three times as old as its mother when she was three times as old as the monkey was. The weight of the rope and the weight is half as much again as the difference of the weight of the weight and the weight of the weight plus the weight of the monkey. How long is the rope?

* * *

A cross-eyed woodpecker with bow legs and a synthetically shaped rubber bill requires one hour to peck through a cypress log which is 29 years old. Shingles cost $.38 a hundred and weigh 8 pounds a piece. The log being pecked upon is 20 feet long and 40 pounds a foot. Assuming the coefficient if friction between the woodpecker's bill and the cypress log is 0.232, and that there is a negligible resistance to diffusion, how many units of radioactive Vitamin B will be required by the woodpecker if he is going to peck out enough shingles to roof a $3000 barn with a detachable chicken house? The woodpecker has an efficiency of 27% and gets double time for overtime. Got it?

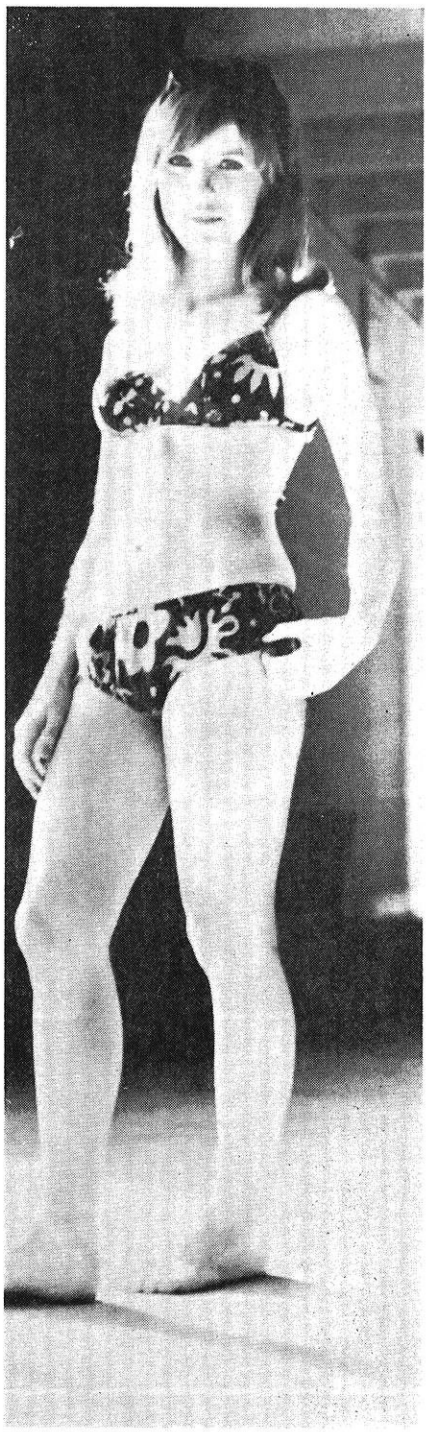
* * *

Answers may be sent to what's-his-name, c/o the Wisconsin Engineer.

PICTORIAL

wisconsin's finest presents

Joanne Jackson



Joanne has:

a Chevy with no reverse;

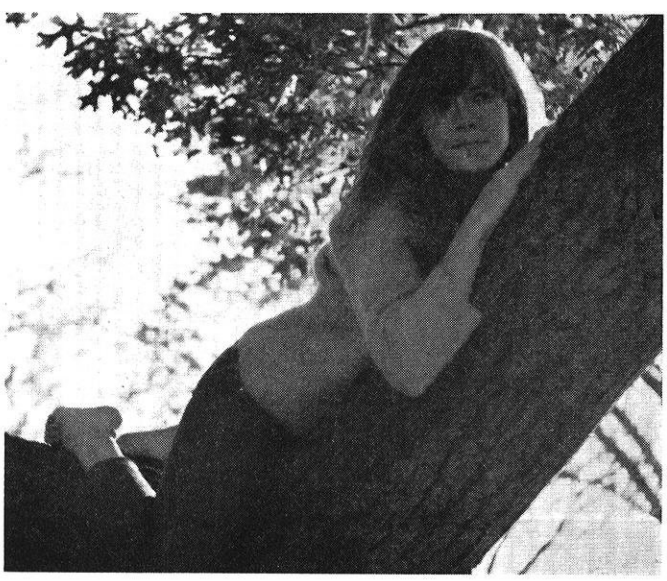
freckles;

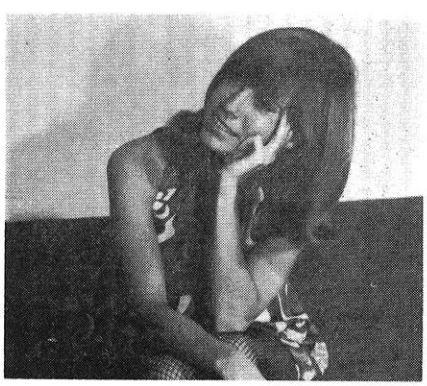
ambitions in social work;

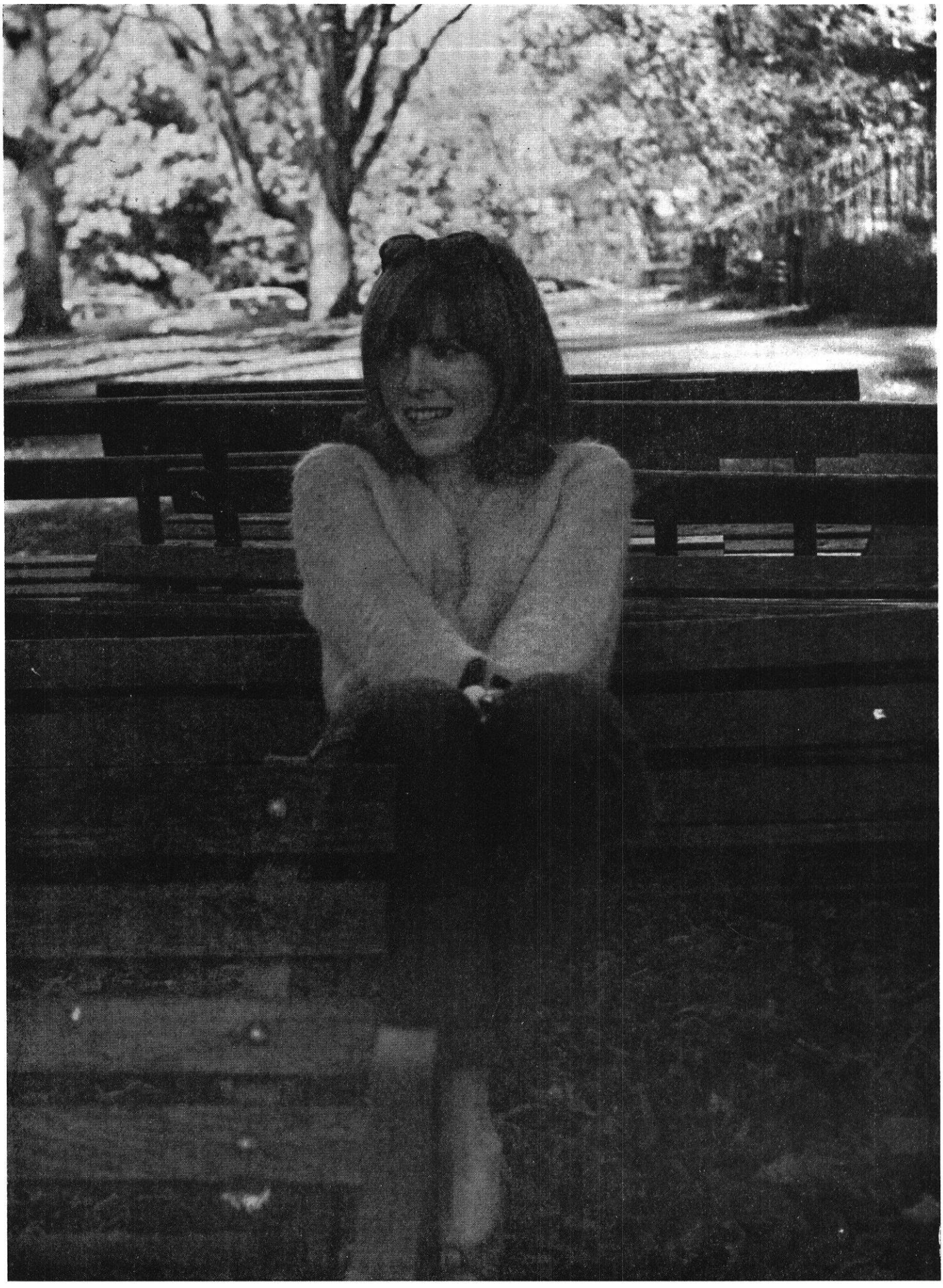
4'12" of petite wonderfulness;

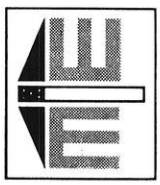
a fan club—

anyone who meets her.



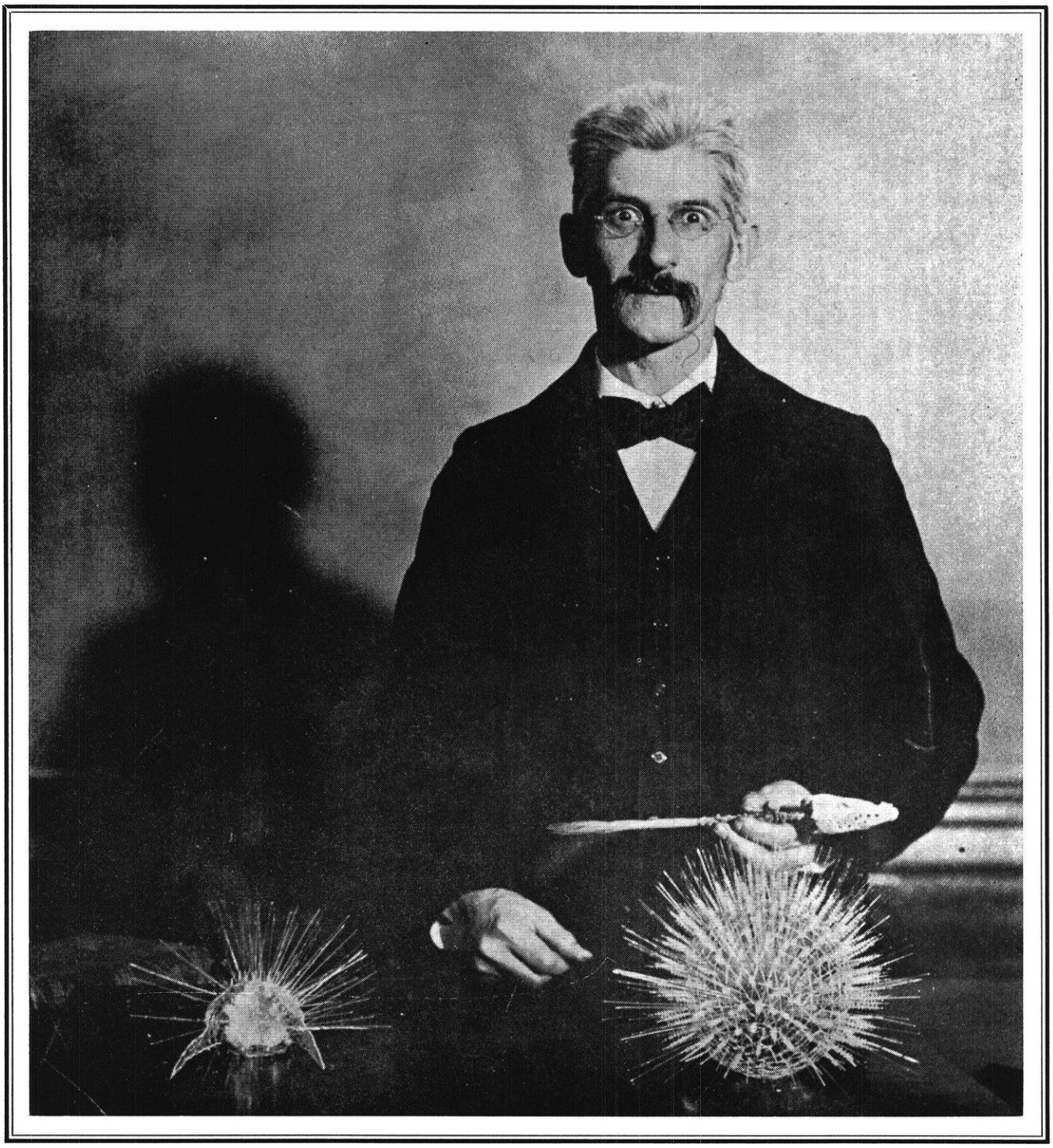






PICTORIAL

wisconsin's album



Will the girl with the red micro-miniskirt see me after class.

Somehow we think these lads have promise.

They look about ready for the *really* big league, where Bethlehem Steel has always fielded a winning team. You, too, can learn the score, by reading "Careers with Bethlehem Steel and the Loop Course." Pick up a copy at your placement office, or write Manager of Personnel, Bethlehem Steel Corporation, Bethlehem, Pa. 18016.

An equal opportunity employer in the Plans for Progress Program

BETHLEHEM STEEL

HUMOR

FILEABLES

Do you suffer from terrible attacks? Do you feel disease is wearing your life away? Do you lack pep? Are you just dragging through life? Are you tired, weak, run down, nervous, and gloomy? Do you feel older than you are? Do you suffer from getting up nights? Are you satisfied with your present physical development? Do you suffer from terrible wheezing? Do you itch? Do your feet hurt you?

So what! We eat at residence halls too.

* * *

Mark Anthony: "I wish to see Cleopatra."

Slave: "She is in bed with laryngitis."

Mark Anthony: "Darn those Greeks."

* * *

The best way to get through Engineering is to be like a swimming duck. Keep calm and cool put paddle like hell underneath.

* * *

A young lady had a dream in which a handsome male angel flew into her bedroom and scooped her up into his arms. They flew out the window together and traveled through the air. Finally, they reached a castle in the sky and soared in through an open window. He gently tossed her on a luxurious bed.

"What are you going to do now?" she asked in a frightened voice.

"That's up to you," he said, "it's not my dream."

* * *

There's this new fly spray made of spirits of Amarousa and Spanish Fly. It won't kill flies, but you can swat two every time.

Angry widow (after learning husband has left her nothing): "I want you to take 'Rest in Peace' off that tombstone I ordered yesterday."

Engraver: "I can't do that, but I can add something else."

Widow: "All right. Add 'Till We Meet Again'."

* * *

The doctor had just completed his examination of the teenage girl:

"Madam," he said to her mother, "I'm afraid your daughter has syphilis."

"Oh, dear," exclaimed the embarrassed mother. "Tell me, Doctor, could she have possibly caught it in a public lavatory?"

"It's possible," replied the physician after a moment, "but it would certainly be uncomfortable."

* * *

Are you sure he was intoxicated?

No sir, not positive, but his wife says he brought home a manhole cover and tried to play it on the stereo.

* * *

A young husband received a telegram stating that his mother-in-law's body had been found floating at the seashore, a lobster attached to each toe. He was asked to telegraph instructions for disposition of the body.

He wired back: "Sell lobsters and reset bait."

He: "Give me a kiss."

She: No answer.

He: "Won't you please give me a kiss?"

She: Still no answer.

He: "Are you deaf?"

She: "No. Are you paralyzed?"

* * *

Caller: "Is your sister expecting me tonight?"

Small boy: "Yeah."

Caller: "How do you know?"

Small boy: "She's gone out for the evening."

* * *

Three turtles decided to have a cup of coffee. Just as they went into the cafe it started to rain, so the biggest turtle said to the smallest turtle, "Go home and get the umbrella."

The little one said, "I will if you don't drink my coffee."

"We won't," promised the other two.

Two years later the big turtle said to the middle turtle, "Well, I guess he isn't coming back, so we might as well drink his coffee."

Just then, a little voice called from just outside the door, "If you do, I won't go!"

* * *

A man finally bought a parrot at an auction after some spirited bidding.

"I suppose the bird talks," he said to the auctioneer.

"Talks?" was the reply. "He's been bidding against you for the past half hour."

* * *

Now go back and read the rest of the magazine!

SPACE-AGE POT ROAST

One of our out-of-this-world products is a new system for dining beyond the pull of gravity . . . where food crumbs float around and water won't pour. It provides astronauts with everything from shrimp cocktail to pot roast to apricot pudding!

This food is freeze-dehydrated and vacuum packaged in special flexible bags. The astronaut adds a few squirts of water from a special metering gun . . . kneads the mixture . . . then squeezes the food into his mouth.

Whirlpool scientists are accustomed to working on new concepts in living convenience. In fact, most of the appliances we manufacture today were considered pretty "far-out" when our engineers first began perfecting them. This includes such things as automatic dishwashers, refrigerators that stay frost-free and make ice cubes automatically, clothes dryers that sense when the desired degree of dryness is reached, a vacuum cleaning system piped inside the walls of a home.

These are but a few of the major appliances made by Whirlpool . . . leading manufacturer in this field. Last year our production totaled over 5,700,000 units. A decade from now, we expect to more than double that volume by providing space-age appliances of a variety and utility which can scarcely be imagined today!

Life is always presenting new problems which require imaginative answers. In our new research building, soon to be completed, we'll be better equipped than ever to provide them.

Contact: Manager, Corporate Recruiting
Whirlpool Corporation Benton Harbor, Michigan 49022

An equal opportunity employer

Whirlpool CORPORATION

Here in the hills of East Tennessee we are known as Eastman and the atmosphere is sort of different

Ladies' picnic on a Thursday afternoon in Warrior's Path State Park near Kingsport, Tenn. Down in the valley the chemical engineering is as up to date as any on earth, but the tensions of the big cities seem slow to penetrate the hills of East Tennessee. Some call this isolation and like it. Some wouldn't. We offer choice.

You may have first heard of Kodak when you were eight years old and grandpa pointed a camera at you. In Kingsport, Tenn., Longview, Tex., and Columbia, S.C., there are 15,000 of us who make no cameras and no photographic film but turn out fibers, plastics, and chemical ingredients for a hundred other industries. In fact, we can offer no less a variety of chemical engineering opportunities in those communities than in Rochester, N.Y., where we produce our renowned photographic goods for enjoyment, for business, for education, and for the professions.

Although many Kodak chemical engineers eventually move into production or management functions, none start there. First assignments are in development and process improvement, or systems and research. A chemical engineer might also make full use of his professional competence in liaison with our customer companies, in which case he is in marketing and had better count on moving around quite a bit. Otherwise we are so set up that we can give an engineer all the opportunity for advancement he wants without ever asking him to change communities.

We make the same promise to mechanical, electrical, and industrial engineers, by the way.

Drop a note about yourself to Business and Technical Personnel Department, Eastman Kodak Company, Rochester, N.Y. 14650. If you have any geographical preferences or any other category of preferences in work, mention them. We are an equal-opportunity employer.

And here, just to be specific, are what occupy the chemical engineers down in the valley:

RATHER SPECIAL

- Solid-phase polymerization
- High-temperature vapor-phase pyrolysis
- Liquid-phase air oxidations
- Non-Newtonian flow
- Drying of tacky pastes
- Extrusion of hot, viscous, temperature-sensitive materials
- Design of systems for melt- and solvent-spinning
- Oxidation of ethylene to acetaldehyde and ethylene oxide
- Oxo process
- Olefin polymerization
- Vapor-phase dehydrogenation

MORE GENERAL

- Design of pilot plant and plant equipment from laboratory data and basic chemical engineering unit operations
- Drying operations for fibers, plastics, and chemicals
- Viscous flow and heat transfer
- Chemical kinetics rate models
- Dispersion systems
- Mixing studies
- Use of computer hardware and software in plate-to-plate distillation program, hydraulic design, heat-exchanger design, mass transfer equipment design, reaction simulation

Kodak

"Traffic is terrible today!"

". . . Accident in the left hand lane of the Queens-Midtown access ramp. Right lanes moving slowly. Fifteen minute delay at the Brooklyn Battery Tunnel. Lincoln Tunnel backed up to the Jersey Turnpike. Extensive delays on Route 46 in the Ft. Lee area. That's the traffic picture for now, Bob."

However, technical people at GE are doing something about it. Development and design engineers are creating and improving electronic controls and propulsion systems to guide and power transit trains at 160 mph. Application engineers are developing computerized traffic control systems. Manufacturing engineers are developing production equipment and new methods to build better transportation products. And technical marketing specialists are bringing these products and systems to the marketplace by working with municipal and government agencies.

Young engineers at GE are also working on the solutions to thousands of other challenging problems—products for the home; for industry; systems for space exploration and defense. When you begin considering a career starting point, think about General Electric. For more information write for brochure ENS-P-65H, Technical Career Opportunities at General Electric. Our address is General Electric Co., Section 699-22, Schenectady, New York 12305.

GENERAL ELECTRIC