Wisconsin engineer. Vol. 72, No. 1 October 1967

Madison, Wisconsin: Wisconsin Engineering Journal Association, [s.d.]

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VOL. 72, NO. 1 MEMBER ECMA 35 CENTS OCTOBER 1967

wisconsin engineer

FLUIDICS - CONTROLS

FEATURES:

REAPPEARING NONENTITIES:

wisconsin engineer

MEMBER OF ENGINEERING COLLEGE MAGAZINES ASSOCIATED

Chairman: PROF. HOWARD J. SCHWEBKE, Dept. of Engineering Graphics, University of Wisconsin, Madison, Wisconsin 53706.

Publishers Representatives: LITTELL–MURRAY–BARNHILL, INC., 369 Lexington Avenue, New York, New York 10017.

Second Class Postage Paid at Madison, Wisconsin, under the Act of March 3, 1879. Acceptance for mailing at a special rate of postage provided for in Section 1103, Act. of Oct. 3, 1917, authorized Oct. 21, 1918.

Published monthly from October to May inclusive by the Wisconsin Engineering Journal Association, 308 Mechanical Engineering Bulding, Madison, Wisconsin 53705. Editorial Office Hours 11:00–12:00 Monday, Wednesday and Friday. Office Phone (608) 262–3494.

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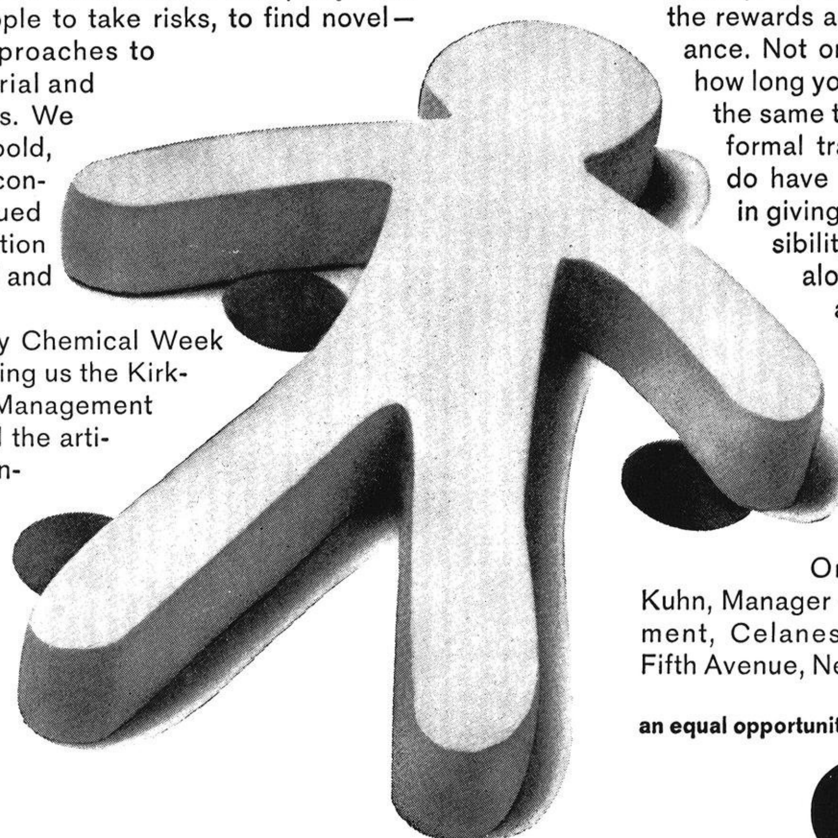

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EDITORIAL

STATEMENT OF PURPOSE

LAST April the *Wisconsin Engineer* tried a new approach to the old song about a school technical magazine—our humor issue. We felt that along about April, almost finals and not quite over twelve-weeks, engineering students would welcome a change. I was quite surprised that among the responses we received were some questionable letters—"if this magazine truly represents the College of Engineering, perhaps one has the answer to the question of why the engineering enrollment continues to drop". This of course is ludicrous, since a humor issue is not even mailed to the high schools.

The letters made one good point however, and I quote a letter from Assoc. Prof. Norman Braton:

> May I suggest that you and your staff take a closer look at the objectives of the *Engineer*. If these objectives are being fulfilled, then may I suggest that you consider liquidation to relieve the students from the work involved in getting the "Engineer" out, as I am certain there must be better ways to spend their time.
>
> Should you decide to continue publication, I have every reason to believe that your magazine will improve. It certainly cannot get worse.

The good point is obviously not the letter itself, but rather that it questions our objectives. Perhaps it is up to me to make them clear. I would like to state now that we published the April Humor Issue of the *Engineer* not in spite of, but *because of* our objective—to provide a readable magazine for the students of the College of Engineering.

We believe that it is not possible for us to produce a "spit polish" technical journal, and also that it would not be possible to find more than a handful of engineers to read it. I certainly wouldn't. There are plenty of good professional technical magazines.

We are interested in publishing a magazine that students, and *most* of the professors, want to read—a magazine that tells others about Wisconsin, that serves as publicity for student and faculty research and achievements, that acts as a thorn where solvable student problems exist, and that provides the type of humor and brainteasers that the college *man* wants to read.

The only measure of our popularity is how fast the *Engineer* disappears from the red boxes, and a few letters, and it is interesting to note that the April issue Mr. Braton mentions above was sold out.

We cannot know, before we print an issue, what the readers reaction will be, since most of the staff is fairly new at this. Therefore, each issue is an experiment. There is a remedy for this inadequacy, if you will only stop in or drop us a note and tell us what you'd like to see and read. Please do.

Mary E. Ingeman

editor

1968

1969

1970

TOMORROW

IS

JUST

BEYOND

TODAY

by thomas fleming

GOLDEN Age **hotels on the moon,** climate control inside homes and cities, robots to clean the house and wash the dishes, radio transmitters sewn inside children's clothes to "beep" their location. Far-out fantasies of science-fiction writers? No, the cool, hardnosed predictions of men trained to deal with facts, men schooled against exaggeration, scientists. A startling number of them are devoting all their time and energy to studying the future —a field that once belonged to mystics and fortune tellers.

At Santa Barbara, California, General Electric's TEMPO (Technical Management Planning Organization) has some 200 sociologists, engineers, economists and physical scientists peering ahead, backed by a $7,000,000-a-year budget. Santa Monica's Rand Corporation spends almost all its time envisioning the next three or four decades. In the East, the Hudson Institute does more of the same for government and private clients.

Here's what prophets like these foresee, for example, on **traffic** jams. By the year 2000 a nationwide system of electronic controls, based on earth-survey satellites, will collect data on traffic flow, feeding it into computers at various urban centers, and the mechanical brains will then adjust speed limits, regulate stoplights, eliminate bottlenecks, within seconds. As for fretting over to 10-ton trucks, or which lane is moving fastest—cars and trucks will cruise on separate intercity speedways at 100 m.p.h. Everyone will leave the driving to "it." Electronic controls will operate all the vehicles on these speedways, guaranteeing accident-free transportation.

Inside our cities people will drive smaller **"urbmobiles,"** which will probably be almost noiseless and odorless—powered by electric batteries already being tested in Detroit.

Researchers at M.I.T. see the **train of the future** as a series of bullet-shaped vehicles riding on air, traveling mostly in underground tunnels or ground level tubes (THIS WEEK, November 14, 1965). Zooming along at its projected 400-mile-an-hour speed, such a train could whisk passengers from Boston to Washington in about two hours. (Right now, the trip takes more than eight.) Cars for such intermediate stops as Providence or Philadelphia peel off electronically without even slowing down the main vehicle.

The arrival of the **supersonic plane** is imminent (THIS WEEK, May 8, 1966). It will cruise from New York to London in two and a half hours, at speeds close to 2,000 miles an hour. Equally amazing will be the way the plane will fly (or be flown)—by computer! Lt. Dorian de Wind, an Air Force computer expert, envisions the following flight to Tokyo, 1964 style:

COMPUTER: Good morning. Shall I print out your flight plan?

PILOT: Never mind, I'm running late. How is the aircraft?

COMPUTER: All pre-flight checks completed. There is a minor deviation error in the manual compass. Shall I double check with remote control?

PILOT: Negative, we won't be needing it anyway. I'll let you do all the flying today . . . had a rough night. By the way, **where are we going?**

Enlarged and improved **helicopter service** is also in the offing for impatient travelers. Malcolm S. Harned, senior vice-president of the Hughes Tool Company Aircraft Division, foresees the day when heliplanes will whisk 100 passengers or more from New York to Washington in 25 minutes and from Los Angeles to San Francisco in 45, using downtown heliports and charging fares lower than present air shuttles. Even more daring is the prediction of M.I.T.'s Professor Rene H. Miller. Professor Miller and his associates visualize, within the next 15 years, airbuses capable of carrying 80 passengers at 400 to 450 miles an hour with vertical take-off and landing, at fares comparable to those of our present on-the-ground buses.

One of the most dramatic changes of the future, however, will undoubtedly be the **design of ships.** The British have had a workable Hovercraft since the late 1950s and they are currently perfecting a model which will be put into ferry service across the English Channel. Hovercraft—called Surface Effect Ships by U.S. engineers—glide over land, water or ice on a thin layer of compressed air provided by internal blower systems. Unlike conventional ships which expend most of their power in simply bucking the ocean swells, these vehicles ride several feet above the water at speeds averaging 70 miles an hour. This accelerated rate would reduce cargo crossings of the Atlantic to less than two days.

While one group of futurists works at speeding people and products around the world we already know, still other researchers are busy trying to find new worlds for us to explore.

In a recent survey by the Rand Corporation, 82 scientists queried believe that **a permanent base** will be established **on the moon** long before the year 2000 and by that date, too, space men will have soared past Venus and landed on Mars.

Dr. B. H. Caldwell, Jr., Manager of Advanced Programs at General Electric's Missile and Space Division at Valley Forge, Pa., says flatly, "The progress with **nuclear-powered rockets** promises to permit a full-scale Mars expedition in the 1980s enabling several men to orbit Mars and descend to the Martian surface."

The communications industry, which has already done so much to turn science-fiction into reality, will continue its **electronic wizardry** in the years ahead. RCA's David Sarnoff looks forward to the day when "television, in full colors, will be completely global, so that man will be able not only to speak and hear all around this planet but to **see the entire world in natural colors.**" Sarnoff also predicts that individuals will be able to hold private two-way conversations and see each other as they talk, regardless of distance. Heads of states may even meet for summit conferences without ever leaving their offices.

For a few dollars a month, **computers** will supply writers with historical or sociological information, lawyers with legal references, public officials with needed statistical data on town, city, county and—good news for parents and kids—any and all material needed to do a term paper or finish the night's homework. Already IBM has been conducting experiments with students in Brooklyn, who are hooked into a 1710 computer in Yorktown Heights, N. Y., 50 miles away. The kids simply dial the Big Brain, and it does the time-consuming chores, such as finding the square root of 86,795. Such a computer could serve as a central storehouse for a family's medical, dental and financial records and even "store" recipes, appointments, household bills, etc.

A slice of the computerized future is already visible in England, where the customers of **several London pubs select their drinks electronically.** If you want a gin and tonic, you dial 145 on a telephone-like instrument at your table. The number comes up in the bar, and a small computer simultaneously reports the table number, and adds up the tab. A bartender still mixes the drink, but a computer may someday do that, too. The system is by no means perfected. "One time a wire got loose," a proprietor says, "and customers who ordered a beer got a double apricot brandy."

Inside the homes of the 1980s, if the prophets of domestic discovery are right, will be **bedside controls** to turn on the breakfast coffee, **electronic ovens** that will cook a roast in 15 minutes, **electronic dishwashers** that clean in a matter of minutes and **laser beams** to disintegrate rubbish.

Tomorrow's housewife may be able to call upon **computer-controlled kitchen robots** to lend an electronic hand around the house. Doctor T. O. Paine, manager of GE's TEMPO, sees no reason why robots could not take over such jobs as dusting, vacuuming and K.P. Nor does it look like the robots—even if they can talk—will complain about overwork. Homes will undoubtedly feature **electronic air cleaners** installed in the heating and cooling ductwork of a house, and specially treated materials that will repel dirt electronically.

The consensus seems to be that the futuristic house will feature a central panel from which you will be able to control any aspect of environment and security anywhere in the house. One of the most startling predictions—it will be completely flexible. **Rooms can be added** as the family expands, **subtracted** when they leave home to marry. And if you decide to move, the house could be **shipped anywhere.**

Scientists are working on a number of devices which will enable the **deaf to hear** and the **dumb to speak.** The day is also approaching when the blind will be able to "see" electronically. Researchers at M.I.T.'s Sensory Aids Evaluation and Development Center have demonstrated an impressive array of machines which they have dubbed "early warning sensors." One gadget uses infrared rays to detect steps from as far away as 50 feet, then nudges a finger as a warning. Another device works on FM ultrasonic waves to warn of differences in texture, such as between a sidewalk and a curb.

And the **weather** of the future: If the forecast doesn't meet with everybody's approval, no problem—just order something else. Dr. C. L. Hosler, Jr., Dean of the College of Earth and Mineral Science at Penn State, believes the day may come when we will do just that. Although Dr. Hosler cautions that we must learn much more about the atmosphere before trying to change it, he feels that with the proper study, scientists will some day be able to send rain, snow, wind or sunshine into specific areas, just as we now pipe water or gas.

If futurists at the Hudson Institute are to be believed, almost everyone will have both the time and the money to take advantage of these **cities of tomorrow.** They see a possible increase of families in the $25,000-a-year bracket from the 1.2 per cent of 1965 to over 30 per cent by the year 2000. Equally pleasant to contemplate is their promise of **three-day weekends** and **13-week vacations** lurking over the same horizon.

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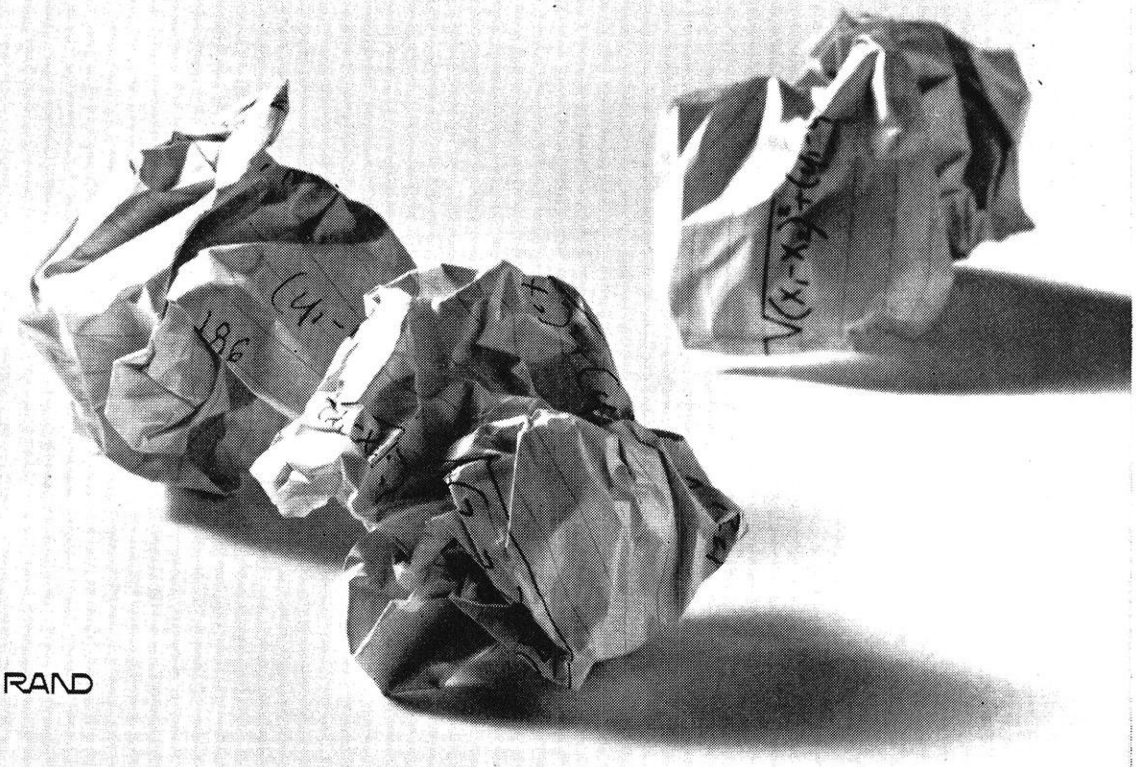

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WHY STUDENTS QUIT

the study of engineering
by dr. roger d. augustine
michigan state university

Of college students who began their education journey by way of engineering, nearly 40 percent quit studying the field by their junior year. Why this high toll?

Some answers to this question are offered in a study completed this year by the Office of the Dean of Engineering, Michigan State University. The study, based on questionnaires and interviews with students at Michigan State, Northwestern, and the University of Wisconsin, reveals that:

- The curriculum posed a substantial hurdle for many would-be engineers.
- Students who quit engineering contrasted sharply with those who persisted.
- Pre-college and college engineering career guidance was a failure.

Of 326 juniors invited to participate in the study, 221 returned completed questionnaires. Interviews of 40 minutes each were held with 176 of the students—104 who had persisted in engineering, and 72 who had switched to non-engineering majors.

Particular emphasis was placed on selecting students who showed similar promise for success in engineering studies at the time of entering college. For this purpose, scores on the College Qualification Test or the Scholastic Aptitude Thesis Test were matched.

All students, moreover, were also eligible to remain in engineering, for each had obtained at least a "C" cumulative grade average while pursuing an engineering major.

In asking the students for their reactions to the freshman year, a vivid account was evoked on the context within which students decide to remain in engineering or to leave it.

The question triggered a flood of memories. The freshman year was recalled as being a time of excitement, of challenge, and of doubt—a time of new friends, new demands, new ideas, new values—a challenge to traditional standards, old loyalties, and deep-seated aspirations. For many, the transition to college was difficult and threatening. For others it was relatively easy—almost a letdown.

"Around six weeks time, I give up living and just exist. I don't eat. I don't sleep. Night becomes the same as day—a blur."

Reprinted from *Engineer*, a Publication of the Engineers Joint Council.

Students Agree Curriculum Is Difficult

But in one matter the students almost all agreed: The engineering curriculum was an excruciating and relentless task master.

Over and over again, the students recalled how they spent night after night "grinding out" solutions to their mathematics, chemistry, and physics problems while their dormitory mates "took off" for coffee dates, intramural sports, concerts, or just a "night out with the boys." Many were chagrined that the demands of their studies severely limited their social lives.

Beneath the surface of the pleasure and excitement of the freshman year a thread of anxiety and tension was identified. All students—both those who eventually dropped out of engineering and those who stayed with it—commonly remarked that they were worried about grades and that they feared "flunking out".

Students were angry and frustrated with the seemingly unrealistic demands which were made of them in many of their courses even before they had time to get their feet on the ground. Many found the freshman year a period of self-doubt and deep discouragement. Some made the candid admission that they had felt very unhappy, lost, or lonely that first year.

Under such trying conditions, who were the students that persevered in engineering? These are some of their characteristics:

- **They tended to come from working class and upper middle class origins.**
- **They tended to come from suburban high schools as opposed to city and rural high schools.**
- **They generally enjoyed repairing things and thinking about how things work; they had an inclination to "tinker around the house."**
- **Often, a close relative or father was an engineer.**
- **Their commitment to engineering was made at an earlier age than those who left engineering.**
- **They met their first exposure to sophomore technical courses with enthusiasm.**

Students who quit engineering seemed to have a strong need for upward social mobility; they attached more importance to working with people rather than with things; and they had tended to choose engineering studies for materialistic and prestige purposes or to acquire a "good" background for careers in other fields. Many left because the technical courses were too difficult; they felt unable or unprepared to succeed in their engineering programs.

Mathematics Proved An Obstacle

A number of characteristics were common to both groups, some surprisingly so. **Mathematics, for example, proved to be a nemesis for a majority of all students. A substantial proportion thought their calculus courses inappropriate and of little relevance to their future needs in engineering.**

Only about one-third of even those who had persisted in engineering reported that they were basically happy or satisfied during their freshman year. They, as well as those who had quit engineering, *criticised the curricula for being too narrow and too inflexible with little opportunity for expression of individual needs and desires.*

Typically, it was the successful student who felt most restrained and frustrated by the rigid sequences of prescribed courses that he felt had confronted him at the outset of his college career. Honors programs, advanced placement, and credit by examination provided welcome but insufficient relief from the rigidity of engineering programs.

Another dimension to the problem was the delay perceived by students before they were able to enroll in "real" engineering courses. The students did not see mathematics, chemistry, and physics as engineering courses, but rather as somewhat peripherally related, preparatory activities.

The dilemma for engineering educators, of course, is that these latter courses build form the foundation laid by mathematics and the engineering sciences during the first year of study. Hence, the frustration of delayed gratification in engineering education seems to arise from the unique nature of the engineering curriculum.

The study suggests a significant screening process is provided by the sophomore year. Few dropouts reported any enthusiasm for their sophomore engineering courses, whereas a large number of students who remained in engineering were very happy with them.

Summer jobs and cooperative work programs also aided students in clarifying their occupational objectives. Those who had worked at engineering-related jobs reported almost unanimously that the experience had proved worthwhile.

As one student put it, "It was great just to find out what engineers do all day!" Some concluded that they should change majors before "getting in any deeper". Those who remained in engineering returned to their studies with a new enthusiasm and dedication.

The influences that led students to choose engineering in the first place were also explored. Almost all mentioned the influence of high school science and mathematics. Proficiency and interest in these courses were clearly primary factors leading to the study of engineering. Only a few respondents cited shop courses, mechanical drawing, or occupations' courses as influencing their decisions.

Other reasons for choosing engineering included monetary gain, financial stability, prestige, and the mystique and glamour of the profession. *More engineering dropouts mentioned these materialistic ends than did those who persevered in engineering.*

Minor Role for Guidance Counselors

Teachers and guidance counselors on the other hand played a relatively minor role in influencing students toward engineering. A large number of students *reported that only a few teachers or counselors seem to know what engineering is about.* Many students admitted, "I really didn't know what I was getting into, but it sounded like the right thing to do".

A large proportion of the students had been surprised at the content of engineering courses. Their high school work and the people with whom they had discussed their plans had provided no clues as to what they would encounter. As they became better informed, many students altered their educational plans.

At the college level also, students relied little on the guidance of academic advisors. Most students indicated that their relationships with advisors were passive, distant, and procedural in nature. On the other hand, only a very small proportion of the students themselves had sought out university resources such as the counseling service and other members of the faculty.

In the light of what seems to be a serious failure in engineering career guidance, one of our most important recommendations is that engineering educators and engineering societies undertake an earnest effort to communicate more widely and more clearly to young people the nature of the work performed by engineers and the content of engineering curricula.

COVER STORY

FLUIDICS: SLOW PROGRESS AND GROWING PREDICTIONS

By WILLIAM P. CHAPMAN
Vice President, Operations
Johnson Service Company, Milwaukee, Wisconsin

Recent articles predict a great future for fluidic devices. Designers see the devices serving as on-off switches, signal amplifiers, counters, oscillators, proximity sensors and proportioning controllers. According to forecasts, fluidic components soon will replace relays, transistors, potentiometers and other electrical and electronic devices. A $250-million annual market for fluidics is estimated by 1970.

So much for glowing predictions. The fact is that we—the industrial firms in the field—are not progressing as fast as we had planned. As a result, fluidic applications still are few and far between.

This doesn't mean that the basic concept of fluidics is faulty or that the current feeling of fluidics is pessimistic.

On the contrary, the future of fluidics is as bright as ever. We're just going to have to work a little longer to solve problems that are typical when taking a new technology from the laboratory to the production line.

Let's look at the growing pains that have slowed our progress. A key stumbling block is lack of knowledge. Despite all the work that has been done, engineering concepts of fluidics are not that well understood and are not complete.

Industry has been forced to admit this by its inability, up to this point, to develop reliable devices needed to amplify low power input signals to usable output levels. Other factors complicating the job include turbulence, inertia and other characteristics typical of compressible flow.

Research expenses also are slowing fluidics development. Essentially, the industry is paying tuition —in the form of research dollars— for what it hopes will be an expanding market.

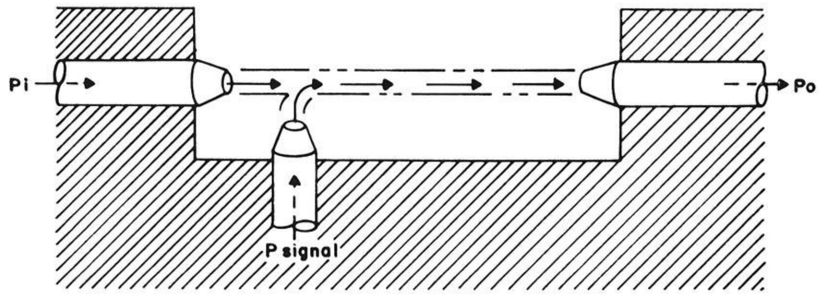
Much of the initial work on fluidics was done by or for the military and cost was not a prime consideration. In industrial applications, however, cost is an important factor.

Any discussion of fluidics costs, whether it revolves around development, production or marketing, touches on the fact that fluid amplifiers don't do anything new.

For the most part, the fluid amplifier competes with long-established control devices such as electronic, electric, hydraulic or pneumatic components. Some controls manufacturers, therefore, have been understandably slow to develop or promote a new family of relatively unknown devices to replace their present lines of well understood characteristics.

Before tackling specific problems, I would like to talk for a minute about how the concept of fluidics was developed.

The basic principle was discovered by Henri Coanda—not in his laboratory but in his bathtub. Sitting in his tub one day, Coanda turned on the faucit and noticed the stream of water was running along his arm instead of falling straight down in accordance with Newton's law.



The three terminal modulator above is a momentum-exchange device in which the control jet deflects the power jet from the output port. A force balance device.

This started Coanda thinking and he remembered a similar experience—one that almost cost him his life. In 1910, Coanda piloted what may have been the world's first jet airplane. He had attached two engine-driven air jets to each wing. A form of afterburner was used to ignite the required additional fuel. Unfortunately, the hot gases streaming from the engines clung to the fuselage. Result: Scratch one airplane and give Mr. Coanda something that he still remembered—rather vividly, I imagine—20 years later.

But getting back to the bathtub story, Coanda reasoned that the entrainment of trapped air caused both phenomena. As the air next to his arm was carried along with the water, it created a partial vacuum. Atmospheric pressure then forced the water stream to cling to his arm. The same principle applied to the hot gases that clung to the fuselage of the ill-fated jet.

Bathtubs and burning airplanes are hardly an auspicious beginning for an industry but in this case they served the purpose.

Nothing much was done with the Coanda principle until after World War II, but recently activity has accelerated.

Today, fluidics is essentially a branch of the controls industry, which embraces electric, electronic and pneumatic components.

Basically, all control devices convert one form of signal to another form. We have devices, for example, that translate temperature to motion and motion to pressure or pressure to motion and back to pressure.

Although we class pneumatic or hydraulic controllers as motion balance, or force balance devices, strictly speaking *all* systems compare the *position* (motion) of the set point with the position of the feedback element. So in that sense *all* systems may be called motion balance systems.

Let's talk for a moment about a pneumatic controller, because fluidics today is operating essentially with air. The set point position probably is established by manually moving a dial. Its position has the physical unit of length—inches. If we are controlling temperature, the sensor is a bimetal. It moves with change in temperature; hence, its unit is also inches. As it moves, it changes the back pressure of a nozzle; hence, the nozzle converts motion to pressure and the nozzle output is measured in pressure, psi. The nozzle output is also the controller output; hence, feedback device input. The feedback device is a bellows. But a change in pressure in a bellows results in a change in volume; a bellows is a pressure to motion transducer. Its output is measured in inches, and we are back to the comparator which is the bimetal. The comparator has input signals measured in inches; therefore, the output signal must be in inches, and we have a MOTION balance device.

Notice, though, that we had motion converted to pressure and then pressure converted to motion. A fundamental of design is simplicity, so since we want pressure as an output, it follows that we would have a simpler, probably better, design if the comparator worked in psi rather than inches.

This fundamental was recognized in 1959 and when the first fluidic device was developed—one that could operate on pressure alone—fluidics was born. By a coincidence often found in science, the Diamond Ordnance Fuze Laboratory and Johnson Service Company were working in this field independently and unknown to each other. The DOFL approach used flip-flop devices.

Johnson Service, on the other hand, took a different approach. Our objective was to develop a proportional device. Essentially, we were aiming at a high impedence device that could be cascaded in circuits that would be independent of barometric or temperature changes. The result, therefore, would be a component that operates independently of its environment.

For all of our research in fluidics—and we've been involved in the field for over seven years—we sometimes feel we've just begun. One of the reasons is production. In one of our fluidic devices, for example, we must control four basic elements during the production phase. Proportions must be maintained exactly, couplings must be uniform, quality control must be close to absolute, and we must maintain repeatability of assembly, materials and workmanship. We have made strides, and, in fact, are in limited production now.

IMPACT ON CONTROLS MARKET

What will be the impact of fluidics in the controls marketplace?

Most engineers feel that fluidic amplifiers will be used to replace certain electro-magnetic devices such as relays or solenoids, and will move into the field of logic circuit where switching times in the mid multi-second range are acceptable.

It is helpful, I think, to keep our enthusiasm for this new field in perspective. No product ever com-

(Continued on page 21)

Can there be this kind of excitement in engineering?

A high-performance car in a four-wheel drift around the first turn at Watkins Glen* typifies the excitement of sportscar racing . . . precision machinery and human skill in cool coordination.

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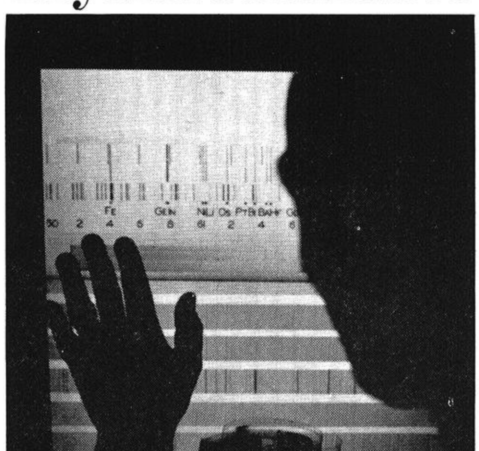
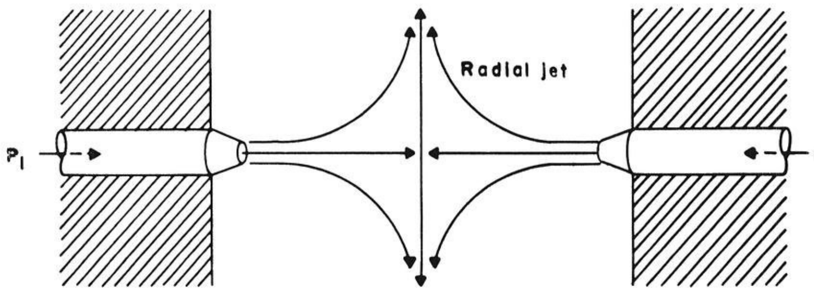


Spectrogram helps our scientists to analyze composition of materials used in xerography.

*1 hour's drive south of Rochester

 continued from page 18



Direct impact of the two power jets produces a radial jet whose position depends on the relative pressures, P_1 and P_2.

pletely captures a market; it merely takes a part. We're still using a number of Stone Age products, for example, to build our homes—for even though many products have been introduced, stone still is an important material.

But back to fluidics. When the electronics boom hit, people in the pneumatics industry were fearful their days were numbered. Obviously, they were wrong, electronics captured just a part of the pneumatic market. But now fluidics may capture part of the electronics market.

Let's look at the market another way. Why use fluidics instead of electro-pneumatic relays? The first reason is money. It will be costly to train mechanics and technicians to handle the new technology, but the low cost of fluidic components will help industry pay for the training programs. The longer life and higher reliability also adds to the economic advantage of fluidics.

What are the capabilities of fluidic components? Well, for the first time we can design pneumatic systems the same way we design electronic systems. There are fluidic counterparts for resistors, capacitors, transistors, neither-nor circuits and memory banks. And, the lack of moving parts indicates almost infinite operating time.

All of this suggests new design techniques and new technology—from the lab to the shop. At Johnson, we have found that the basic design element must be the black box—not the components that go into the black box. There is a basic reason for this attitude: There aren't enough qualified people in the field that understand the principles of fluidics. In addition, the components have not been described mathematically; hence, the teaching of this new technology is lagging.

THE FLUIDICS ENGINEER

From Mr. Coanda's time until today, and most certainly through tomorrow, people will be the single biggest problem in fluidics. Unquestionably, they represent our greatest need.

What type of man is needed most? If I were to advise engineers or engineering students on a career in fluidics, I would suggest they train themselves to be original thinkers, philosophers who can cut through the haze of tradition to the basic problem.

The fluidics man should be a bit of a dreamer, a man interested in solving problems, not designing new gadgets. He should, for example, avoid abortive attempts to follow fads or to force a fluidic circuit down the throat of a problem that really requires an electric system.

On the technical side, I feel the fluidics man should be strong in electrical engineering and also have a solid background in fluid mechanics.

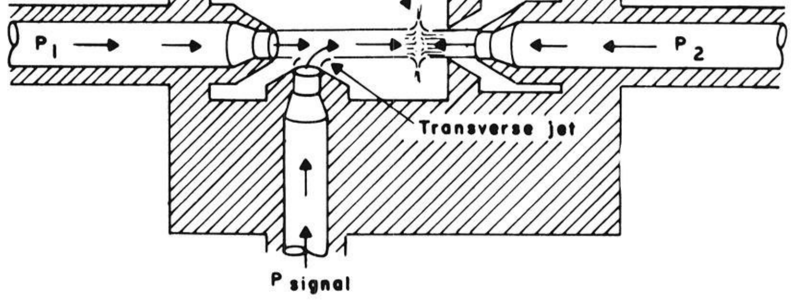
Naturally this poses a problem because these two fields normally are not related. It seems, therefore, that a man should take his B.S. in E.E. and M.S. in fluid mechanics.

I say the E.E. background is essential because control theory is more closely related to electrical circuits. For example, transient response is quite similar to the transient response of a d.c. circuit. Since fluidics is part of the controls industry, it follows then that an E.E. background is advantageous.

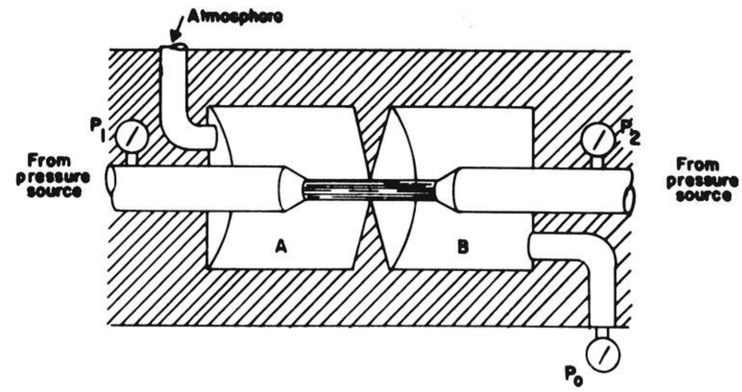
Why should fluidics interest an engineer today? Primarily, I think, because it is a new field and because now is the time to get in on the ground floor.

THE OPPORTUNITIES

The list of companies interested in fluidic devices is a Who's Who of industry. They can't all be wrong. Included are General Electric, Brown and Sharpe, Warner and Swasey, Kearney & Trecker,



The transverse impact modulator (above) holds both power jets constant, modulates one with signal pressure from transverse jet.



Though fluidic devices such as the impact modulator above are based on simple concepts, a lack of qualified engineers has slowed research progress.

Cincinnati Milling, Eaton Manufacturing, Weyerhauser, Imperial-Eastman, Speidel and General Motors—just to mention those that are thinking fiuidics outside the control field.

Process controls also offer a broad field of applications. Moore Products Company uses fluidic devices to proportion air flow in photographic film drying. Bowles Engineering Company is building an integrated fluid logic sequence programmer to control a storage process. Devices developed by Corning control tank levels in the food industry. We, at Johnson, have developed an air conditioning control system.

General Electric uses fluid devices in an automatic system for drawing control instrument air. Philco and Westinghouse are interested in using fluidics to control water and time sequences in home washing machines. The New York Central Railroad controls locomotives with fluid amplifiers and is looking at track switching and other applications.

Applied to the control system of an industrial scrap baler, a small jet of air from a fluid device triggers enough hydraulic force to crush an automobile into a one-foot cube.

In the field of medicine, Harry Diamond Laboratories, previously Diamond Ordnance Fuze Laboratory, has developed fluid amplifiers for controlling heart pumps, respirators, oxygenators and heart massage machines.

It is difficult not to be enthusiastic about fluidics. The applications are ready and waiting for the products to be developed. And, despite current problems, they will be developed.

First, however, we have to climb the mountain of technology foot by foot. The first steps have been harder than we anticipated, but we expect the climb to become a little easier as we broaden our technological base.

Today's problems are many, but they will be solved as all problems are solved—by people. As successful applications of fluidic components increase, more people will be attracted to the field. The more people that get on with the job, the faster the job will be done.

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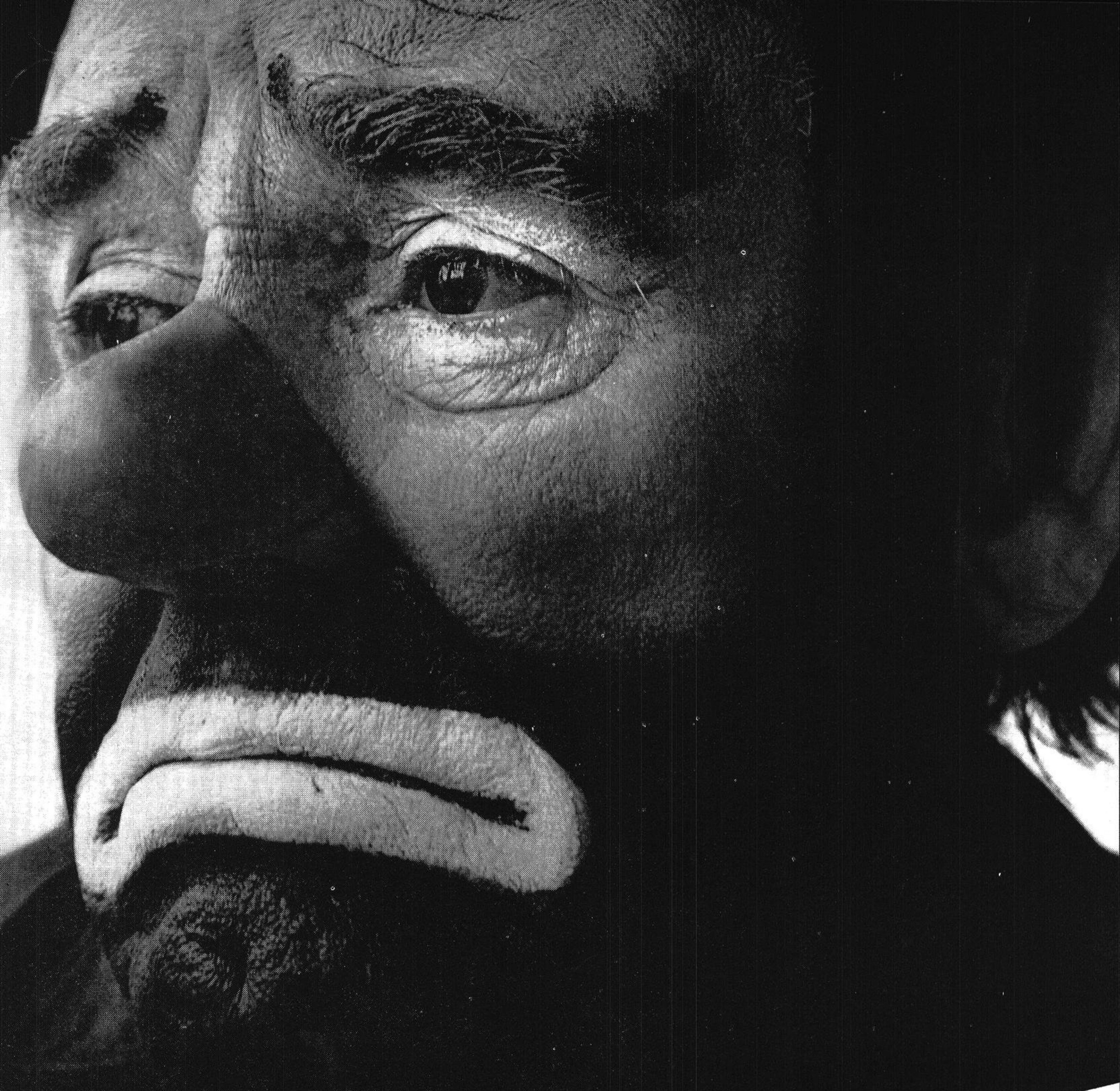

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The Facts About

CO-OP PROGRAMS

by edward ellingson

It seems that the semester has barely started, and already the placement office is beseiged by company representatives, looking for new engineers. Are you looking for permanent work, or a company that will send you through graduate school on a tuition remission program, or what? Most likely you don't know, because you don't really have any idea what an engineer in today's industry does. Of course security and income are important to you, but it is far more important to know what area you want to work in. Nearly every company has many areas of specialization for the engineer, but knowing what area to choose is not something that you'll find in a text book. This type of knowlege comes only after you have started work, and unless you like job-hopping, you can't afford to make a mistake.

The answer lies in experience, and one of the best ways to gain experience is to participate in a Co-op program with a company that appeals to you. Because information about the Co-op program at Wisconsin is scarce, this article is intended to answer some of the common questions that come up.

Q **Just what is the Cooperative Education Program?**

A The Cooperative Education Program—the Co-op program—is an education plan where the engineering student alternates semesters at school with semesters of directed work experience. Each succeeding work period, he returns to the same company for further training in *new* areas, until he has explored that company's engineering opportunities fully. The semesters at school are spent in the curriculum of his choice.

Work assignments are usually planned with the company so that the student uses what he studied in the previous semester, giving him a chance to see how Physics, or Calculus, or Thermodynamics fits into the business world. He is assigned to departments such as product design, testing labs, research and development, sales engineering, and other departments unique to the individual company.

Q **How much actual working time do you put in for the co-operating company?**

A The actual amount of time varies from company to company. The program we have just outlined above, you would start working at the end of your freshman year, alternating work and school for three years, and then finish with two consecutive semesters at school to graduate at the end of five years. A total of about 20 months is spent working.

This doesn't mean that, if you're a sophomore or a junior, you can no longer get into the Co-op program. Some companies won't even hire students until they are Juniors. Most companies will modify their programs to fit your needs, although they want the student to work a minimum of one year.

Q **How many colleges and companies have Co-op programs?**

A About 90 colleges and universities throughout the country have a Co-op program. There is no one list of companies that participate, but Marquette University, for example, lists 59 companies that it cooperates with.

Q **Where does the University of Wisconsin fit into this picture?**

A Wisconsin is just starting on the Co-op program, and now has about 10 Co-op students. Nearly 25 companies are available through the placement office and your advisors.

Q **What about the money?**

A The so-far standard procedure is that the student becomes a regular salaried employee of the company and receives pay and benefits as such *only* while he is working. While he is at school, the company lists him on an educational leave of absence and all the company benefits cease.

Salary level is based on your level of education and on the work experience gained. The student, when interviewing for the Co-op program, should be sure that they thoroughly understand just what the company is offering. For example, some companies offer educational aid as well as the regular salary.

Q **What about the draft?**

A When a student goes to work for a company on the Co-op program, he registers for a zero credit course called Cooperative Engineering Education, 612–001–8. This costs the same as a one credit course. This way he is a registered University student and can obtain his 2-S deferment.

Q **Are you required to stay with the companies after graduation?**

A In most cases no, but this should be clearly worked out with the company before you're hired.

Q **How does the program help your schooling?**

A Being able to earn money while going to school is very important to some students, even though doing so extends the time needed to get your degree.

But more than the money, the work experience solidifies the theory that you learn in class. You are exposed to every facet of both engineering and the business world, and associate with engineers and engineering problems, giving you a better idea of what engineering in industry really is. It is possible that you will find engineering is not what you really want after all—and isn't it better to find this out while you can still change your mind and study other things?

Q **What is a typical Co-op experience?**

A I became interested in the Co-op program during my Junior year. I interviewed two companies, and in June, 1966, I went to work for Deere & Co. I chose them because their program is well-organized, flexible, and fairly large, as well as having good monetary benefits. Their minimum G.P.A. was 2.5 and the starting salary then was $507/month.

The Dubuque factory was just expanding their Co-op program from 6 to 12 students, so I was working with new "Co-opers" from the University of Detroit, the University of Cincinatti, Iowa State, and Northwestern University. There were also about 25 students working on summer jobs there.

At the start, Deere & Co. took all the Co-op and summer students down to its corporate offices in Moline, Illinois, for a two-day orientation program. This involved talks and movies on everything from the history of the company to its complete operation at that time.

My work schedule for summer and the fall semester was:

Week	Assignment
1 (Summer)	Foundry
2	Transmission Maching
3	Engine Maching and Assembly
4	Tractor Assembly
5– 6	Reliability and Inspection
7–12	Tool Design
13–15	Routing
1 (Fall)	General Engineering Orientation
2–20	Stress Analysis—testing sections

This schedule for the summer was set up beforehand, and is similar to most beginning Co-op schedules. Due to Union contracts, etc., co-op students aren't allowed to operate the machines. The factory work was strictly to learn something about factory operation, usually while acting as assistant to the foreman.

At the beginning of the fall semester, I went to the engineering division. At this time, I also received a raise and my salary was now $578/month.

The first week in engineering I talked to people from each different group. At the end of the week, I chose the group I wanted to work with, Stress Analysis.

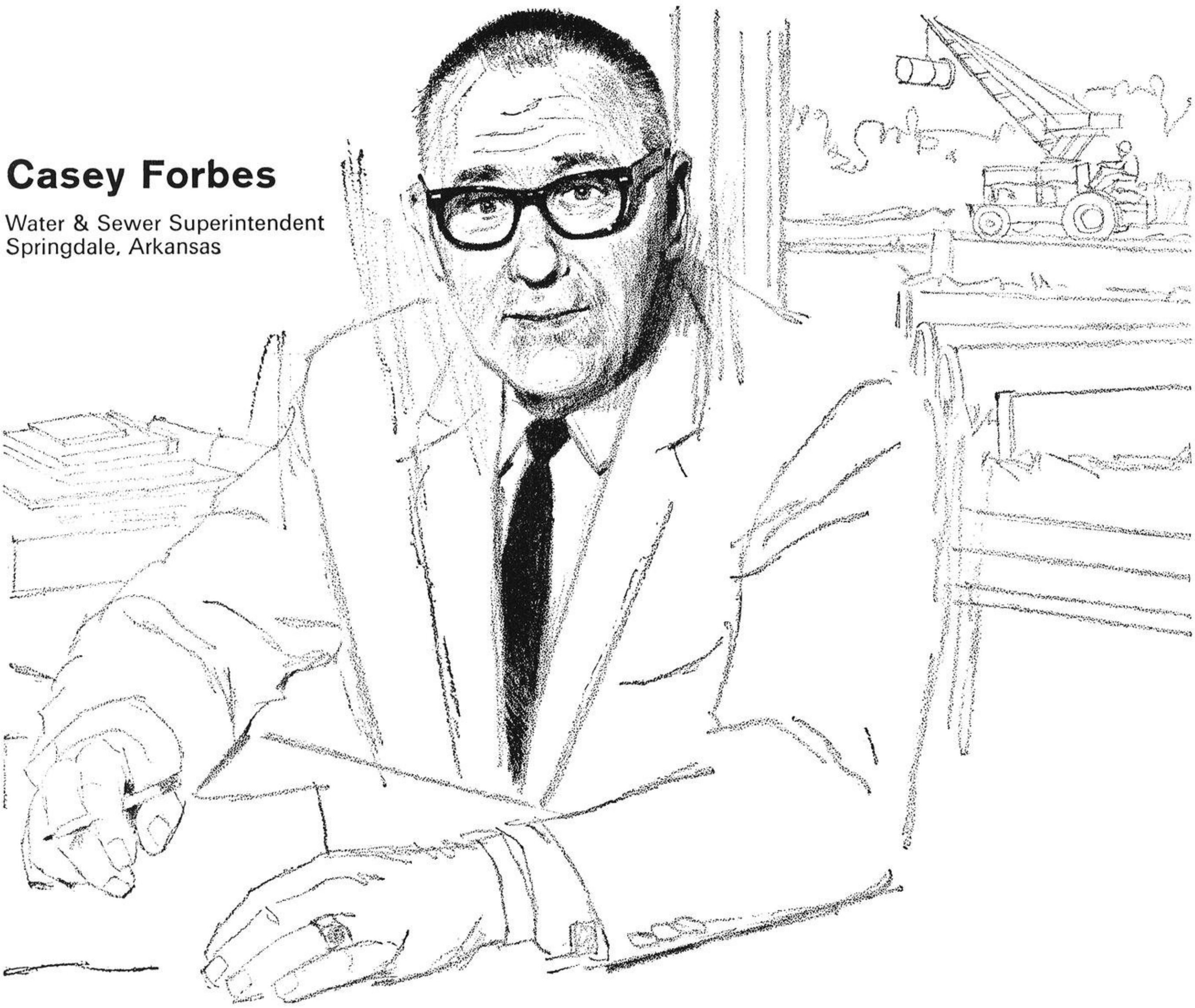
My first actual job was writing up reports on tests that were already completed—to get me acquainted with the people and procedures in my department. After two months, I was being given complete assignments to carry through from the beginning analysis to the completed report. I was to switch to another section in a few weeks, but I liked Stress Analysis and decided to stay there until school started again.

This last summer was my last work period, making a total of 11 months. I had decided to work in research, so I spent the summer working for the Engineering Research Center. My salary moved up again, this time to $662/month.

I plan to graduate this June, making a total of five years to get my degree, and from there I don't know what I'll do yet. But whether I work for Deere & Co., or someone else, the experience I've gained is worth every minute of the extra year I spent getting my degree.

Q **What do you do if you're interested in the Co-op program?**

A Although my Wisconsin people recommend the Co-op program, there has been little positive action in promoting the program here at the University in Madison. You have to go out of your way to find the information, since there is no *one* person really concerned with it. The best bet is to see Professor George Sell in the Mechanical Engineering Department, or Professor James Marks in the Placement Office, in the EE building.



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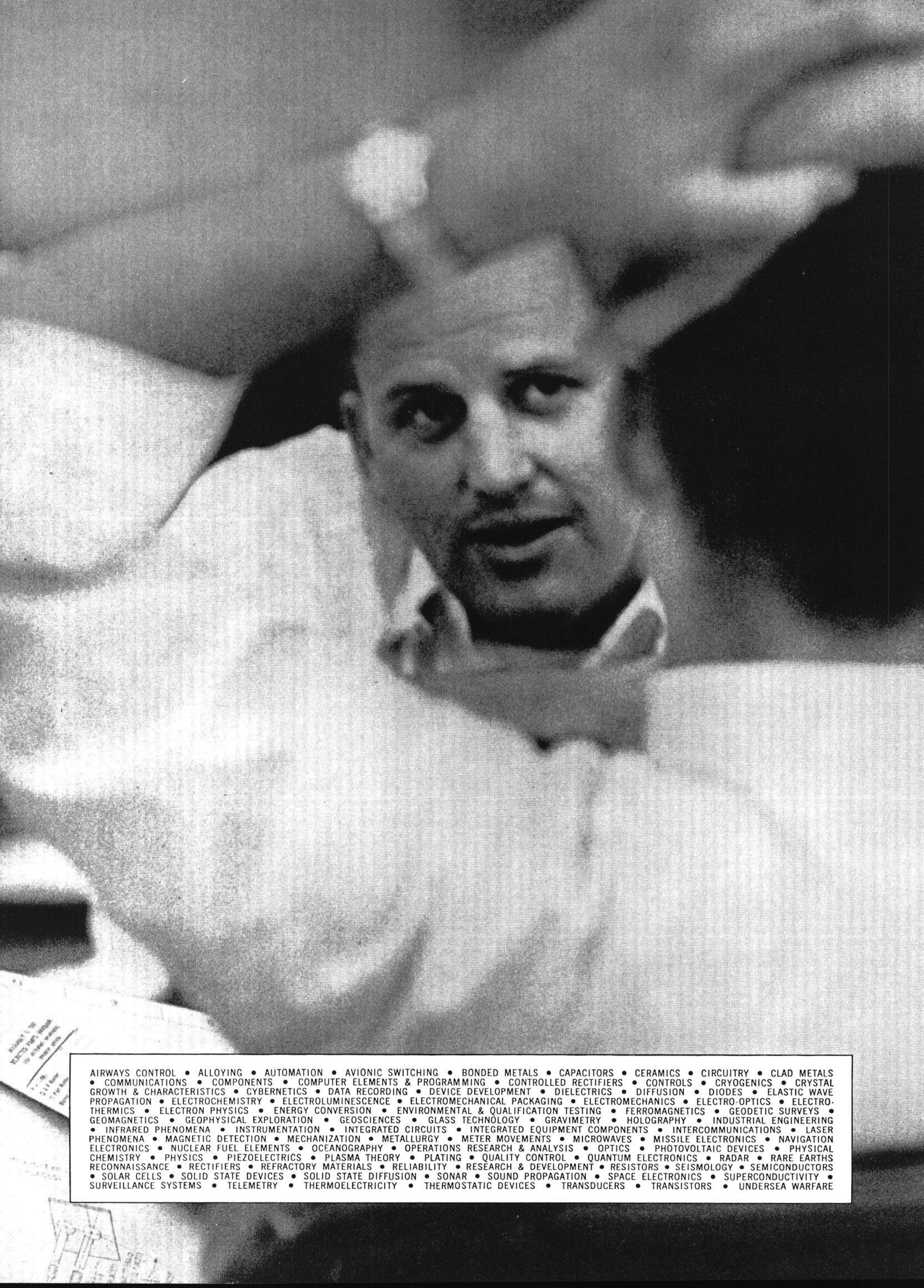

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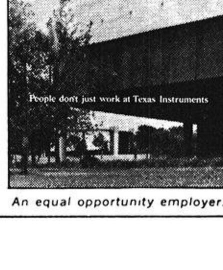

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WEDNESDAY, OCTOBER 25

Aluminum Co. of America
Applied Physics (2 or 2)
Arthur Anderson & Co.
City of Los Angeles—Bureau of Engineering and Department of Water & Power
Factory Mutual Engineering Corp.
Harvard University—Graduate School
Hoffman LaRoche Inc. (2 of 2)
Mallinckrodt Chemicals (2 of 4)
Mead Corp. (2 of 2)
Outboard Marine Corps
Rayonier
Raytheon (2 of 2)
Square D (2 of 2)
Standard Oil of California (2 of 4)
Stanford University
UCC—Mining and Metals Division
Western Union Telegraph Co.
Wisconsin Public Service Corp.

THURSDAY, OCTOBER 26

American Cyanamid (1 of 2)
Argonne National Labs
Armco Steel Corp.
Bechtel Corp. (1 of 2)
Beloit Corp.
Diamond Alkali—PhD's
R. R. Donnelley & Sons (3 of 3)
Hamilton Standard (1 of 2)
E. F. Johnson Co.
Mallinckrodt (3 of 4)
Martin Co. (1 of 2)
Nalco Chemical
Owens Corning Fiberglas Corp.
Standard Oil of California (3 of 4)
The Torrington Co.
Vanity Fair Mills

FRIDAY, OCTOBER 27

American Cyanamid Co. (2 of 2)
Bechtel (2 of 2)
Crown Zellerbach
Hamilton Standard (2 of 2)
LTV—Michigan Division
Martin (2 of 2)
The Mitre Corp.
Oak Electro/netics
Pratt & Whitney Aircraft
Standard Oil of California (4 of 4)
Wagner Castings
Whirlpool Corp. (3 of 3)
Xerox Corp.

MONDAY, OCTOBER 30

Ayerst Labs
Bemis Co.
Bergstrom Paper
Brunswick Corp. (1 of 2)
Detroit Edison
Eaton Yale & Towne
General Telephone of Wisconsin (1 of 3)
Goodman, Div. of Westinghouse Airbrake
Honeywell (1 of 2)
Imperial Chemical Ind. Ltd.—117 Bascom
Kleinschmidt, Div. of SCM Corp.
National Steel
Raychem Corp.
Reynolds Metals
Upjohn Co.
Wheeling Steel
U. S. Naval Weapons Center
U. S. Geological Survey

TUESDAY, OCTOBER 31

The Louis Allis Co. (1 of 2)
Babcock & Wilcox Co.
Leo A. Daly
Esso Res. & Engr. & Humble Oil & Refining (1 of 4)
FMC—Hudson Sharp
Falk Corp.
Harris Trust—117 Bascom
Honeywell (2 of 2)
Standard Oil of Ohio (1 of 2)
Swift Res. & Dev. (1 of 2)
Warwick Electronics (1 of 2)

WEDNESDAY, NOVEMBER 1

Louis Allis Co. (2 of 2)
American Electric Power
Amphenol Borg (2 of 2)
The Ceco Corp.
Esso (2 of 4)
General Motors, including A. C. Electronics (3 of 5)
Geo. A. Hormel & Co. (1 of 3)
Ladish Co.
Pure Oil Co.—Div. of Union Oil (1 of 3)
Harris Trust—102 Commerce
RCA—PhD's
Standard Oil of Ohio (2 of 2)
West Bend Co.
West Virginia State Road Commission

THURSDAY, NOVEMBER 2

Baxter Labs (1 of 2)
J. I. Case Co. (Racine)
Commonwealth Edison Co.
Esso (3 of 4)
General Foods Corp.
General Motors, including A. C. Electronics (4 of 5)
The Heil Co. (2 of 2)
Lawrence Radiation
Scott Paper Co. (2 of 2)
Shell Companies (1 of 2)
Stauffer Chemicals (PhD's)—Chemistry
Vanderbilt University—117 Bascom
N.A.S.A.—Lewis Research Center (1 of 2)

FRIDAY, NOVEMBER 3

General Motors (5 of 5)—All divisions
Gulf Research & Development
Scott Paper (2 of 2)
Shell Companies (2 of 2) if needed

MONDAY, NOVEMBER 6

The Bell System (1 of 5)
Chamberlain Corp.
City of Milwaukee
Clark Dietz & Associates
Clark Equipment
Eastman Kodak Co. (1 of 2)
Green Giant
Kellogg Co. (1 of 2)
Kimberly Clark (1 of 4)
Line Material Industries—now McGraw Edison Power Systems
Northern Natural Gas
Peoples Gas Light & Coke
Swift & Co. (1 of 2)
Wisconsin Power & Light (1 of 2)

TUESDAY, NOVEMBER 7

American Can Co. (1 of 3)
Bell System (2 of 5)
Caterpillar Tractor (1 of 2)
Charmin Paper Products (1 of 2)
DeSoto Chemical Coatings
Eastman (2 of 2)
Northwest Paper
Jos. Schlitz Brewing
Zenith Radio
Dept. A. F.—Los Angeles

WEDNESDAY, NOVEMBER 8

American Can (2 of 3)
Bell System (3 of 5)
Caterpillar (2 of 2)
Charmin Paper (2 of 2)
Elliott Co.
General Tire & Rubber
N. Y. Central R. R. (2 of 2)
Parker Pen
Scientific Design
Sherwin Williams Co.
Snap on Tools Corp.
Twin Disc
UCC—Food Products Div.
Youngstown Sheet & Tube Res.

THURSDAY, NOVEMBER 9

American Can (3 of 3)
American Institute of Foreign Trade
Celanese Corp.
Chicago Bridge & Iron
Chicago Milwaukee St. Paul. R. R.
Cornell Aeronautical Labs
Owens Illinois
Procter & Gamble (1 of 2)
UCC—Linde Div. (1 of 2)
Waukesha Motor

FRIDAY, NOVEMBER 10

Armour Industrial Chemical Co.
Cummins Engine Co.
Firestone—PhD's (2 of 2)
Firestone (3 of 3)
Hughes Aircraft
Institute of Paper Chemistry
Los Angeles County
Parke Davis & Co. (2 of 2)
Procter & Gamble (2 of 2)
UCC—Linde Division (2 of 2)
Wheelabrator Corp.
Wyandotte Chemicals

MONDAY, NOVEMBER 13

Atlantic Richfield (1 of 2)
Diamond Alkali Co. (1 of 2)
FMC—American Viscose Division (1 of 2)
B. F. Goodrich Co. (1 of 2)
Iowa Electric Light & Power (1 of 2)
Los Alamos Scientific Labs (1 of 2)
Minnesota, Mining and Mfg. (1 of 5)
Mobil Oil (1 of 2)
Monsanto Co. (1 of 2)
Pullman Standard
RCA (1 of 2)

IEW DATES . . .

Universal Oil Products
University of Illinois—Graduate School
U. S. Patent Office (1 of 2)

TUESDAY, NOVEMBER 14

Ansul Co. (1 of 2)
Bucyrus Erie Co.
Celotex
City of Philadelphia
B. F. Goodrich (2 of 2)
Illinois Division of Highways
Minnesota, Mining and Mfg. (2 of 5)
Monsanto (2 of 2)
RCA (2 of 2)
Squibb Co.
Stephens Adamson Mfg.
UCC—Group I (1 of 2)
Dept. Housing & Urban Development

WEDNESDAY, NOVEMBER 15

Abex Corp.
Avco–Lycoming
City of Minneapolis
M. W. Kellogg Co.
National Castings
Ohio Dept. of Highways
Phillips Petroleum (1 of 2)
Rohr Corp.
UCC—Group I (2 of 2)
Westinghouse Electric (1 of 2)
U. S. Naval Ordnance—Illinois

THURSDAY, NOVEMBER 16

Air Reduction
Allis Chalmers (1 of 5)
Deere & Co.
Ford Motor Co. (1 of 2)
Goodyear Aerospace (1 of 2)
Goodyear Tire & Rubber
Oscar Mayer Co.
McGill Mfg.
National Cash Register
Northern Illinois Gas Co.
Phillips Petroleum (2 of 2)
Salsbury Labs
Union Tank Co.
Westinghouse (2 of 2)

FRIDAY, NOVEMBER 17

Allis Chalmers (2 of 2)
Argonne National Labs
Burroughs Corp.
Container Corp. of America (3 of 3)
Ebasco
Goodyear Aerospace (2 of 2)
Goodyear Tire & Rubber (2 of 2)
Kennecott Copper
Minnesota Mining & Mfg. (5 of 5)
Olin Co.
TRW Systems (2 of 2)
Tektronix
Worthington
N.A.S.A.—Ames Research Center

MONDAY & TUESDAY, NOVEMBER 20 & 21

U. S. Air Force
U. S. Navy
U. S. Marines
(Thanksgiving Vacation Week)

MONDAY, NOVEMBER 27

C. I. A. (1 of 2)

TUESDAY, NOVEMBER 28

Amana Refrigeration
Automatic Electric
Columbia Gas of Ohio
Crane Co. (1 of 2)
General Dynamics—Liquid Carbonics
Magnavox Co.
Montana State Highway
Penberthy Mfg.
Public Service Electric & Gas Co.
Rex Chainbelt
Sparton Electronics
Standard Oil—Div. of American Oil (2 of 2)
The Trane Co. (1 of 4)
Union Oil Co. of California
Univac—Data Processing Division and Defense Systems Division (1 of 2)
Defense Intelligence Agency
C. I. A. (1 of 2)

WEDNESDAY, NOVEMBER 29

Anderson Clayton—Foods Divisions (1 of 2)
Belden Mfg. Co.
Carrier Air Conditioning
Continental Can Inc.
FMC—Canning Machine Division
FMC—Chemical Division
Hercules Powder
Joslyn Mfg. & Supply and Joslyn Stainless Steel
Racine Hydraulics & Machinery
Sangamo Electric Co.
Shure Bros. Incorp.
State of Minnesota
Sundstrand Corp.
Trane (2 of 4)
Vollrath Co.
U. S. Navy Ordnance Labs (Calif.)
Pacific Missile Range

THURSDAY, NOVEMBER 30

Chrysler Outboard Corp.
City of Detroit (1 of 2)
City of Rockford
Columbia Gas System Service Corp.
Douglas (now McDonnel–Douglas (1 of 2)
Ingersoll Rand
Maytag Co.
North Electric Co.
Northern Indiana Public Service
St. Regis Paper
Sperry Phoenix
Standard Brands
Trane (3 of 4)
U. S. A. F.—Aeronautical Systems
U. S. Naval Ammunition Dept.
U. S. Naval Air Station
Naval Ship Engr.—Virginia Center

FRIDAY, DECEMBER 1

Abbott Labs (3 of 3)
Aerospace Corp.
Atlantic Richfield (California)
Blaw Knox Co.
Douglas McDonnel (2 of 2)
Freeman Chemical Corp.
General Dynamics—Electric Boat Div.
Gulf Oil
Industrial Nucleonics
Marshfield Electric & Water Dept.
A. O. Smith (2 of 2)
Sola Basic Industries and Hevi Duty
Western Contracting
N.A.S.A.—Marshall Space Flight

MONDAY, DECEMBER 4

Alleghney Ludlum Steel
Avco—New Idea
Bailey Products & Systems
Barrett Cravens
Baxter Labs International
Douglas United Nuclear
General Electric—PhD's (1 of 2)
Great Northern Railway
Hercules Powder Research
Nuclear Chicago
Petro Tex Chemical
Texas Instruments (1 of 2)
Weyerhaeuser (1 of 2)
Wisconsin State Highway Commission
Youngstown Sheet & Tube Co.
U. S. Forest Service
National Security Agency (1 of 5)
U. S. Navy—Naval Ship Res. & Dev.
General Services Administration
Veterans Administration

TUESDAY, DECEMBER 5

Atlantic Research
City of Chicago Sanitary District
Electro-Mechanical Res.—Computer Div.
General Electric (2 of 2) PhD's
Kelly Springfield
Lear Siegler
Marvel Schebler
Mason & Hanger
Moore Business Forms
The Rand Corp.—PhD's
Reserve Mining
Rex Chainbelt Technical Center
Sprague Electric
Texas Instruments (2 of 2)
United Aircraft Corp. Systems Center
Vickers Inc.
Washington State Highway
Naval Ship Engineering Center
U. S. Bureau of Public Roads

WEDNESDAY, DECEMBER 6

Brown Engineering Co.
Cities Service
City of Madison—Personnel
Kearney & Trecker (1 of 2)
Wayne County Road Commission
Wisconsin Electric Power Co.

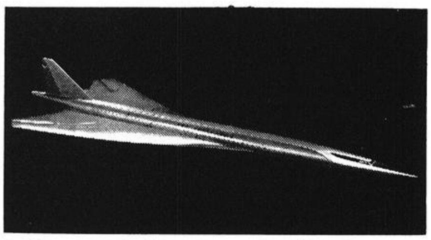
THURSDAY, DECEMBER 7

American Appraisal
Atlas Chemical
Cutler Hammer
Grede Foundries
I. T. & T.
G. T. Schjeldahl Co.
N.A.S.A.—Goddard Space Flight Center

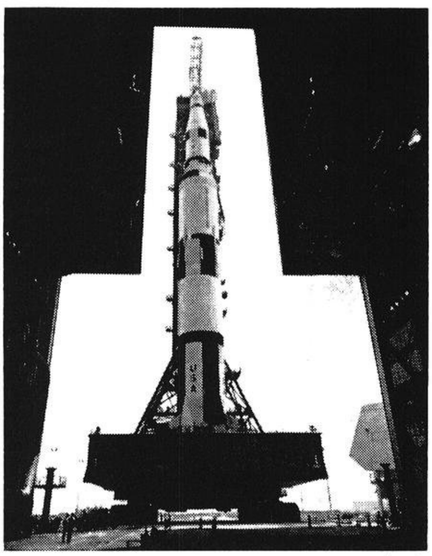
FRIDAY, DECEMBER 8

Addressograph—Multigraph
Peter Kiewit Sons Co.
Sarkes Tarzian
Navy Department—Civilian Personnel

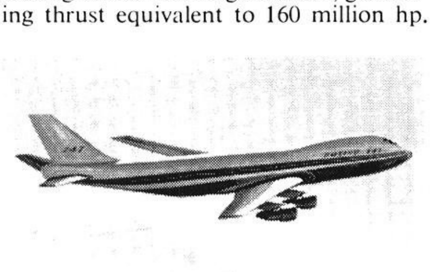
Opportunity has many faces at Boeing



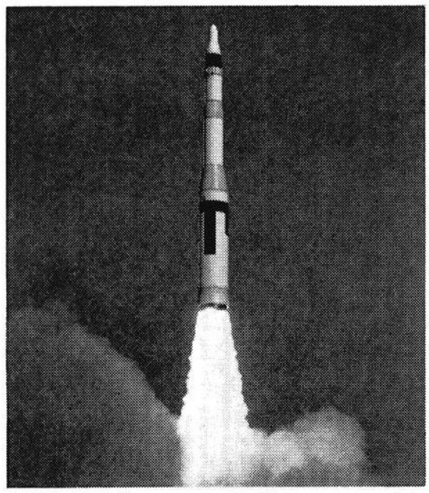
1. Supersonic Transport. Boeing has won the design competition for America's supersonic transport. The Boeing design features a variable-sweep wing, titanium structure and other new concepts and innovations.



2. NASA Apollo/Saturn V. America's moon rocket is the largest, most powerful in the free world. It is moved on a transporter as big as a baseball diamond. Boeing builds first stage booster, generating thrust equivalent to 160 million hp.



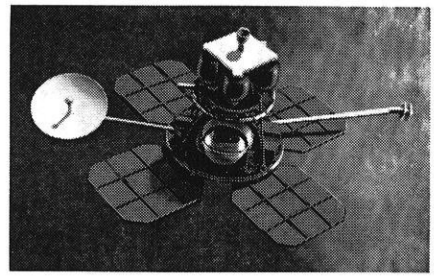
3. Boeing 747. The 747 is the largest airplane ever designed for commercial service. It will carry from 350 to 490 passengers and be the first jet with promenade-deck roominess, staterooms, lounges.



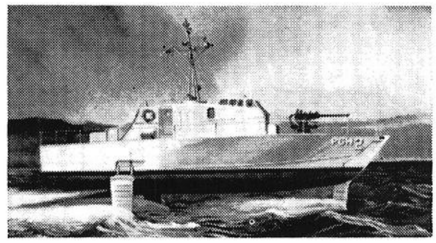
4. USAF Minuteman II. Compact, quick-firing Minuteman missiles are stored in blast-resistant underground silos ready for launching. Boeing is weapon system integrator on Minuteman program.

5. Boeing/Vertol Helicopter. Twin turbine Boeing/Vertol helicopters are now in military or commercial service in the U.S. and many parts of the world. Two of the largest helicopter programs in the free world are under way at Boeing.

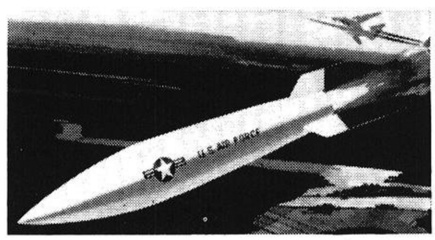
6. Boeing 737. America's newest, most advanced short-range jet will provide more head and shoulder room than any other comparable jet. It will carry up to 113 passengers, cruise at 580 mph, operate from shorter runways.



7. NASA Lunar Orbiter. First U.S. spacecraft to orbit the moon, to photograph earth from the moon and to photograph far side of moon. The Orbiter, designed and built by Boeing, has already sent back more moon information than had been learned in past 50 years.



8. USN PGH (Patrol Gunboat-Hydrofoil). Designed and being built by Boeing, this seacraft will be first powered by water-jet for U.S. Navy. Boeing's hydrodynamic research facilities include system which can test watercraft shapes at actual speeds up to 100 knots.



9. USAF SRAM. New U.S. Air Force short-range attack missile, now being designed and developed by Boeing, is a supersonic air-to-ground missile with nuclear capability. Boeing also will serve as system integration and test contractor.

These are some of the challenging aerospace programs at Boeing that can provide you with a dynamic career growth environment.

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NOISE

by robert schaffer
ME 67

THE world in which we live is becoming increasingly dominated by noise. The problems in industry that arise from noise are causing great concern of workers and supervisors alike. The workers complain of noise and the damage to their hearing. The supervisors wonder how noise is affecting production and how it can be controlled.

THE BASIC NATURE OF NOISE

For some years now exposure to noise above certain levels has been known to have an effect on working efficiency. To understand the reasons for this adverse effect it is necessary to understand the basic nature of noise.

Sound

By definition noise is unwanted sound. Sound is a form of energy propogated as a series of pressure waves or pulses in air or other elastic media. It travels approximately 1100 feet per second in air and its intensity decreases according to the square of the distance from the source. It can be continuous, that is, constantly vibrating, or it can be impulsive, such as a hammer blow.

Being a form of energy, sound is associated with the application of power. No process involving energy is completely efficient. Most surplus energy of a process is dissipated in heat, but a small quantity is converted to vibration and hence, noise. Unfortunately, it takes a fair amount of energy to produce comparatively little heat but very little energy to produce a very loud noise.

Sound Intensity

In order to compare different levels of sound we must have a way of measuring sound intensity. Sound intensity is measured by the amount of energy per unit time (watts) passing through a unit area (sq cm). This level may be recorded by a meter which gives a reading in terms of decibels.

The Decibel

The decibel (dB) is defined as ten times the logarithm of the ratio of the actual intensity to a reference intensity which corresponds approximately to the threshold of audibility. A log scale is used in measurement for convenience and because it corresponds to the way the ear interprets intensity.

Loudness

Loudness is a function of frequency and intensity. A sound of 50 dB at 50 cycles per second (cps) will not sound as loud as one of the same intensity at 2000 cps. For measuring loudness, the intensity in decibels must be converted to sones, defined as the loudness of a 1000 cps pure tone at 40 dB.

WAYS IN WHICH NOISE AFFECTS PRODUCTION

Now the question must be answered: When does noise affect the workers in a factory?

The Danger Level

The human ear can discern frequencies between 20 and 20,000 cps. The normal range of frequencies lies between 500 and 5000 cps. The effect that noise levels have depend on the individual and his surroundings. Tests by Charing Cross Hospital Medical School indicates that a steady sound of 4000 cps is the danger line as far as injury to the human ear is concerned. At 4000 cps, deterioration of hearing occurs relatively rapidly in the first years of noisy work and slows down after ten to fifteen years of noisy exposure.

An impulsive noise of 150 dB is generally considered harmful. For a steady factory noise it is generally recommended to keep the noise level below 85 dB.

"Corrective measures should be considered," advises Martin Hirschorn, president of Industrial Acoustics Co. Inc., Bronx, New York, "whenever the noise level exceeds 85 dB, particularly in the fourth and fifth octave bands." Surveys indicate that more than 50 per cent of the machinery in industry produces noise between 90 and 100 dB.

Factory noise can be an expensive nuisance. One source estimates noise costs industry two million dollars per day, figured in terms of workmens' compensation for noise, related injuries, lost manhours, and decreased efficiency. It behooves management to take every reasonable step in cutting down the noise level in the factory.

Permanent Hearing Loss

Perhaps the most costly effect of noise is that it can cause permanent hearing loss. A company is bound morally as well as by law to protect the health of its workers. Unions have been demanding that the workers be given adequate hearing protection and the failure to do so has resulted in millions of dollars worth of workmens' compensation suits. New York, California, Wisconsin, and Missouri have set limits on industrial noise or have laws requiring compensation, and several other states are now contemplating such action.

Workers' Fatigue

Excessive noise adds to workers' fatigue. Tests have shown that constant exposure to loud noise can cause, besides deafness, muscular fatigue, loss of balance, and nausea. Thus noise becomes another cause for absenteeism and lost time.

Workers' Discomfort and Annoyance

Noise also tends to increase workers' discomfort and annoyance. It is common knowledge that a worker is generally more comfortable and agreeable in nature when working in a quiet atmosphere rather than a noisy one. A worker who is irritated by noise is bound to cause friction with his fellow workers and with his supervisors.

Interference With Communications

Another result of noise in the factory is its interference with communications. It would be impossible to account for all the damage in terms of scrapped work, damaged machinery and equipment and personal injuries that have been caused because warnings or instructions were not heard or understood over the noise.

Distraction of Workers

The final major effect of noise in regard to production is that it distracts workers. It has been a theory that noise affects workers' production rates, but it has been difficult to determine just how great the effect is because of the many factors that change in a production situation. For example, when testing the workers while varying the noise level, factors such as weather, personal problems, and employee friction also affect production rates.

Yet there are concrete instances which bear out the fact that noise does affect production rates. A company making temperature regulators moved an assembly department away from a nearby boiler shop to a quieter area. After the shift, assembly output went up 37.5% and rejections fell from 75% to 7%.

In the shipping room of another plant, the volume of work handled increased 12% when a noisy ventilating fan was silenced with new bearings and sound absorbing materials.

These two examples support the theory: decrease noise, increase efficiency.

WAYS TO CONTROL NOISE

Once management realizes that noise is cutting down on production efficiency, it asks how it can control noise. There are three basic ways of controlling noise. You can control noise at its source, that is, improve the machines or processes that make the noise. You can control the transmission of noise by placing barriers to cut down the vibration of the sound waves. Finally, you can control noise by furnishing protective devices for the employees.

Control at the Source

It is the opinion of most experts that noise should be controlled at the source whenever it is practical. Reducing sound at the source means that treatment will be less extensive and a greater number of people will be protected.

There are two kinds of sources which cause the most noise—machines and operation processes. There are many ways to cut down the noise of machines and it would be impractical to list all the different methods for each machine, but there are some basic methods which apply to many machines.

The vibration of machine parts is one of the major causes of noise in the factory. There are several ways in which vibration can be reduced. Damping materials such as rubber or asbestos can be put on vibrating parts. Braces and stiffeners help cut down vibration. Increasing the mass of the machine parts is another way of obtaining quiet.

Slowing down the driving force of a machine will decrease vibration and friction and thus decrease the noise. A reduction in impact force on a press, for example, will reduce noise. Putting mufflers on air operated tools will quiet annoying noises. The substitution of worm gears and herringbone gears for spur gears and putting protective covers over gears are protections which should be used but are often neglected.

Operational processes in production departments also contribute to high noise propagation. Probably the most irritating are the processes which use air pressure. This shrill noise can be reduced by a reduction in pressure or by repairing or redesigning the hose nozzles which often get damaged by rough usage.

Another process which can be quieted down is the sliding of pieces such as nuts or screws down a chute. Simply put a fibrous lining such as asbestos underneath the metal covering. A process can often be quieted by substituting a quieter operation for the one now in use. Welding makes less noise than riveting; squeeze tools are quieter than impact tools; and grinding is quieter than chipping.

NOISE

continued from previous page

Controlling the noise at its source is not always practical. The cost of making the improvement may be too high or it may be impossible to quiet down a machine to a safe sound level. Different methods must then be used to control noise.

Control of the Transmission of Noise

The next way to control noise is to hinder the transmission of noise. Sound waves can be reduced by the use of vibration isolators and local isolaters, by partial and total enclosure, and by the treatment of walls and ceilings.

Vibration isolators are simply pads of absorbant material, such as rubber, placed under the base of the machine. They absorb the vibration of the machine and the floor.

Local isolators are devices such as belt drives and fiber gears on rotating shafts which are used in place of ordinary gears and bearings. They work to keep the inside of the machine quiet.

A partial enclosure is a three-sided wall which cuts off a large part of the transmitting noise of the machine in every direction except where the operator works. Partial enclosures are mainly used on multi-station lines.

A total enclosure is used to reduce single source noises. It consists of a small sound-proof room built around a machine. Some factories put their drop-hammers in sound-proof enclosures with guillotine access doors. The controls are set up so the machines can be operated from outside. Total enclosures are used mostly on automatic equipment.

A common and yet sometimes ineffective way to control the transmission of noise is by treating the walls and ceilings with acoustical tiles. For this treatment to be successful, the room must first be reverbant and the noise must come from multiple sources.

The wavelength of audible sound varies from one-half inch to 55 feet. An acoustical barrier is more effective in cutting out short wave, high frequency sound, thereby reducing intensity and loudness. On the whole, sound absorbant materials of fibrous and perforated paneling cannot be used to reduce noise transmitted through walls, only to reduce the reflections of noise within the enclosure. The amount of noise that is transmitted through a wall depends on the weight of the insulation.

When used under the proper conditions, sound absorbant paneling will bring about a seven to ten decibel reduction in noise.

Control by Personal Protection

Under some factory conditions it might be financially impractical to install noise control devices. Workers may still be protected from harmful effects of noise by the use of earplugs, earmuffs, and helmets.

Earplugs can cut the loudness level for the user almost 80 per cent and still permit ordinary conversation. They have the advantage of being lightweight and easy to put on.

Earmuffs cover the entire ear with a spongy material which soaks up dangerous large amplitude sounds and keeps them from reaching the ear. They are not as lightweight as earplugs but they have the advantage of not having to be individually fitted.

Helmets with ear protectors give about the same protection as earmuffs. Helmets would only be worn under dangerous working conditions to protect the head as well as the ears.

CONCLUSION

Management is finding that the problems of noise in industry cannot be ignored. Noise brings the problems of lost efficiency, wasted money, and harm to physical and mental health.

There are various ways of controlling sound depending on the particular factory situation. There are organizations throughout the country such as the California All-Industry Noise Committee, a non-profit group which analyzes industrial noise problems and suggests ways to control them.

It is now possible to keep noise in any department in any factory at a level which is safe and unannoying to the workers. This will lead to improved morale and greater efficiency.

Tc Tc Technetium Tc Tc Tc

By ROGER VOLTZ and M. L. HOLT, U. W. Chemistry Department

TECHNETIUM, the first artificial element to be synthesized can be purchased from Oak Ridge National Laboratory as the salt NH_4TcO_4 for about $90 per gram of activity. This availability suggested to the authors that a study of the electrodeposition of technetium on a macro scale from aqueous solution would be a worthwhile addition to the already extensive literature dealing with the electrochemistry of the element and its compounds. An excellent review article by Boyd and a book by Colton gives information about the production and properties of Tc so detailed information will not be repeated here.

Tc^{99} has a half life of about 2.12 x 10^5 years and emits weak beta rays with a maximum energy of 0.32 Mev; thus the walls of ordinary laboratory glassware give sufficient radiation protection when Tc and its compounds are being used. Since information about the physiological effects of Tc is still incomplete, great care should be taken to protect the worker as well as the laboratory from contamination. Several sources of information describing the handling of Tc and its salts are available. Use of rubber gloves, protective clothing, a "film badge," a well-ventilated hood [$HTcO_4$ is fairly volatile], and a covered plating cell are mandatory protections for the laboratory worker.

A number of reports of the electrodeposition of technetium from aqueous solutions have appeared in the literature, but most of them necessarily deal wiht dilute baths in the order of 10^{-12} to 10^{-5} m/l (mole per liter). The discoverers of Tc, Perrier and Segré, reported the deposition of a thin layer on a platinum wire from a very dilute acid solution. Other investigators obtained bright cathode deposits from solutions of NH_4TcO_4 in 2*N* H_2SO_4 and NH_4HF_2. Black or brown cathode deposits were obtained when various pertechnetate salts in H_2SO_4 were electrolyzed. Lietzke and Stoughton obtained semi-quantitative data on the electrodeposition of Tc on Pt and Hg cathodes indicating that up to 97% of the Tc could be removed from an acid bath but not necessarily as the pure metal An alkaline bath containing a Tc salt in 2*N* NaOH produced dark deposits. Polarographic studies have indicated the reduction of TcO_4^- to the metal or even to the hydride.

A survey of the literature suggested that two plating baths producing macro electrodeposits of Tc should be tried before further work was undertaken. The first was the bath reported by Eakins and Humphries which contained NH_4TcO_4 in 2*N* H_2SO_4 with H_2O_2 added to prevent formation of a colored reduction product. We found that electrolysis of this bath at the conditions recommended by the authors gave a metallic appearing plate with a CCE of about 10%. The second macro bath developed by Box uses various minimum amounts of H_2SO_4 (depending on the metal used as a cathode) with ammonium pertechnetate in 0.7M ammonium oxalate and a specially designed electrolysis cell. Plates up to 18 mg/cm^2 were reportedly obtained from this bath at a current density of 130 amp/dm^2, and no H_2O_2 was needed. We were not able to duplicate exactly these results in our electrolysis set-up which consisted of small (1 cm^2) cathodes and anodes in 50.100 ml of plating solution contained in a 150 ml beaker. We found that a light green reduction product formed when the NH_4TcO_4 concentration was about 1 g/l although the bath continued to plate at a low efficiency (about 2%). The extremely high C.D. makes it necessary to take special precautions, and apparently it is necessary to use the plating cell described in the article in order to operate this bath effectively.

Both of these reports indicate that virtually 100% of the Tc can be removed from the plating solutions as what appears to be metallic Tc. Neither of these baths was studied in detail. The first seemed unsuitable for our purpose because of the variation in CCE with each addition of H_2O_2 and the rapidity with which the bath darkened if H_2O_2 was not added. The second was unsuitable for our purpose because of the low CCE and because we were unable to obtain consistent results in our electrolysis set-up. For example, five different baths containing 1–2 g/l of NH_4TcO_4 (Made according to directions, were electrolyzed using both gold and copper cathodes. The deposits on the gold were very loose but metallic gray in appearance whereas those on copper were dark and obviously heavily oxided. All of these baths containing 1–2 g/l of NH_4TcO_4 turned light green after 15 min of electrolysis.

Experimental Methods

The source of Tc in all plating solutions was NH_4TcO_4. Boiled, distilled water was used for making the solutions. One hundred ml of bath was used for each plating run. The electrolysis cell, a 150 ml beaker, was fitted with two 3 x 3 cm Pt anodes and either a gold, copper, or stainless steel cathode of of the same size. Direct current was supplied by a variable voltage rectifier. Cells were covered during electrolysis by specially fitted hard plastic plates, and all runs were made in a well ventilated hood. All *p*H determinations were made with a Beckman, battery operated *p*H meter. When semi-quantitative results were required a copper coulometer was used in series with the plating cell. The bus bars were arranged so that the coulometer electrodes and the plating cell electrodes could be removed simultaneously from their respective cells. In cathode current efficiency calculations, the equivalent weight of Tc was assumed to be 14.4g (99/7). Shielding and possible spillage or spattering were monitored with a model 107C Professional Geiger Counter.

Preliminary observations.—A

number of different plating solutions each containing 0.006 mole of NH_4TcO_4 per liter of solution were electrolyzed at room temperature for about 15 min with a cathode current density (CCD) of about 4 amp/dm^2, and the results are given in Table I.

The results given in Table I indicated that the sulfuric acid bath containing $(NH_4)_2SO_4$ was quite promising. Hull cell tests showed a plating range of approximately 0.6 to 15 amp/dm^2 for a *p*H 1.0 solution of this bath compared to about 0.1 to 4.0 amp/dm^2 for the acid solutions without $(NH_4)_2SO_4$. Also, this bath had a higher CCE (about 18%) than a comparable bath containing NH_4MF_2 (about 12%). Both the K_2SO_4 and Na_2SO_4 baths gave CCE's (16 and 17%, respectively) comparable to the ammonium sulfate bath, but the solubilities of these salts limited a study of their concentration effects. Thus all additional experimental results were obtained using the NH_4TcO_4-$(NH_4)_2SO_4$-sulfuric acid bath.

cipitate on the electrolysis is indicated by the low CCE of these runs (about 3%). Addition of small amounts of H_2O_2 removed the color and dissolved the precipitate. If the bath was to be restored to its former plating efficiency, it was necessary to decompose the excess H_2O_2 by heating with Pt black. Failure to do so resulted in a plating solution that gave a lower CCE.

Cathode current density and CCE.—The results of this study are given in Table II and show that CCE decreased as CCD in-

Table II. Effect of CCD on CCE; pH 1.0; room temperature; fresh bath for each 15-min run

CCD, amp/dm^2	Wt. of deposit,* g	CCE, %
1	0.0050	27
2	0.0075	18
3	0.0103	14
4	0.0101	11

*All deposits were shiny and metallic in appearance.

Continued electrolysis and CCE.—A plating solution originally con-
creased and that a CCD of about 1–2 amp/dm^2 was satisfactory.

Table 1. Electrolysis of 0.006M MH_4TcO_4 solutions; room temperature; 15-min runs at 4 amp/dm^2

Solution	pH	Appearance of cathode deposit	Remarks
NH_4TcO_4 aqueous	6.0	Shiny, metallic	Poor conductivity
$NH_4Tc_4 + H_2SO_4$	2.0	Dark, loose	Bath darkened
$NH_4TcO_4 + H_2SO_4$	1.0	Shiny, metallic	Bath darkened
NH_4TcO_4 + 1M H_2SO_4	—	Shiny, metallic	Bath darkened
NH_4TcO_4 + 2M H_2SO_4	—	Shiny, metallic	Bath darkened
$NH_4TcO_4 + H_2SO_4 + NH_4HF_2$	1.0	Shiny, metallic	Bath darkened
NH_4TcO_4 + citric acid + H_2SO_4 or NH_4OH	2 to 9	All black	Bath darkened
$NH_4TcO_4 + (NH_4)_2SO_4 + H_2SO_4$	0.5 to 1.5	Shiny, metallic	Bath turned light pink
$NH_4TcO_4 + Na_2SO_4 + H_2SO_4$	1.0	Shiny, metallic	Light pink
$NH_4TcO_4 + K_2SO_4 + H_2SO_4$	1.0	Shiny, metallic	Light pink
NH_4TcO_4 + NaOH	12.0	Black	Bath dark

Experimental Results

The bath used to obtain the following experimental results contained (unless otherwise stated) 1 mole of $(NH_4)_2SO_4$ and 0.006 mole of NH_4TcO_4 per liter of solution with H_2SO_4 added to give the desired *p*H. Electrolysis resulted in pink or brown solution; this was shown to be a cathode reduction product when the cathode was placed in a porous cup during electrolysis runs. The solution in the cup became black and heavy with precipitate while the solution outside the cup remained clear and colorless. The effect of this pre-

Bath pH and CCE.—H_2SO_4 was used to vary the *p*H. The results given in Table III indicate that a *p*H range of 0.5–1.5 is satisfactory for producing metallic appearing plates, and thus a bath *p*H of 1.0 was used for additional work.

Table III. Bath pH and CCE; room temperature; 2 amp/dm^2; fresh bath for each 15-min run

Bath pH	Wt of deposit, g	CCE, %	Deposit appearance
0.5	0.0080	13	Bright
1.0	0.0075	18	Bright
1.5	0.0096	21	Bright
2.0	—	—	Dark, loose

Bath temperature and CCE.—Although most electrolyses were made at room temperature, the results given in Table IV show that a higher CCE is obtained at elevated temperatures.

It was noted that the plate taken from the bath at 90°C was much duller than those from lower temperature baths, probably indicating deposit of some oxide and accounting for the apparently much higher CCE. It was also noted that the baths darkened much faster at elevated temperatures than they did at room temperature.

NH_4TcO_4 concentration and CCE.—A series of runs were made with baths containing larger amounts of NH_4TcO_4. Table V shows that at about 0.018M NH_4TcO_4 the CCE begins to level off.

All plates were bright and metallic in appearance. Two further runs were later made on fresh baths at 0.030 and 0.036M NH_4TcO_4 concentration. They produced CCE's of 32 and 33%, respectively, again showing the tendency for the CCE to level off at a maximum near 30%.

$(NH_4)_2SO_4$ concentration and CCE.—The results, shown in Table VI, indicate that any concentration of $(NH_4)_2SO_4$ above 1 m/l produces a darker plate. For all subsequent studies, the concentration of $(NH_4)_2SO_4$ was 1 m/l.
taining 0.012 m/l of NH_4TcO_4 was used in a series of 15-min runs with no treatment between consecutive runs. A dark precipitate gradually formed in the bath and, as shown in Table VII, the CCE decreased. All plates, however, remained shiny and metallic in appearance.

After this series of runs, a small amount of H_2O_2 was added to the solution to oxidize the black reduction product back to the colorless TcO_4^-. The solution was then warmed with Pt black to decompose the excess H_2O_2. The resulting solution, made up to 100 ml and *p*H 1.0, on electrolysis gave a CCE only slightly (2%) less than the original solution. A bath originally containing 0.03 m/l of NH_4TcO_4 gave similar results with 12 consecutive 15-min runs, and H_2O_2 treatment also restored this bath so that on electrolysis it gave almost its original CCE (29 instead of 32%).

Table IV. Bath temperature and CCE; pH 1.0; 2 amp/dm^2; fresh bath for each 15-min run

Bath temperature, °C	Wt of deposit, g	CCE, %	Deposit appearance
25	0.0075	18	Bright
40	0.0089	19	Bright
55	0.0101	24	Bright
70	0.0145	26	Bright
90	0.0166	37	Dull

Table V. Effect of NH_4TcO_4 concentration on CCE: room temperature; pH 1.0; 2 amp/dm^2; fresh bath each 15-min run

NH_4TcO_4, mole liter	Wt of deposit, g	CCE, %
0.006	0.0075	18
0.012	0.0126	27
0.018	0.0153	30
0.024	0.0163	32

Table VI. Effect of $(NH_4)_2SO_4$ concentration on CCE; room temperature; pH 1.0; 2 amp/dm^2; fresh bath for each 15-min run

Concentration of $(NH_4)_2SO_4$, m/l	Wt deposit, g	CCE, %	Deposit appearance
0.0	0.0062	14	Bright
0.5	0.0065	14	Bright
1.0	0.0077	18	Bright
2.0	0.0096	20	Dark on edges
3.0	0.0076	17	Dark on edges
4.0	0.0080	17	Dark and dull

Table VII. Effect of consecutive runs of CCE; 0.012 m/l NH_4TcO_4 in first 15-min run; room temperature; p H1

Consecutive run	Wt deposit, g	CCE, %
1	0.0126	27
2	0.0095	21
3	0.0078	17
4	0.0062	12
5	0.0055	11

Nature of the Cathode Deposit

The cathode deposit obtained from the ammonium pertechnetate-ammonium sulfate-sulfuric acid bath at *p*H 0.5–1.5 appeared very metallic. It was not attacked by HCl and only slowly by concentrated H_2SO_4. It was attacked readily by HNO_3 of various concentrations and also by H_2O_2 in either sulfuric acid or ammonium hydroxide, as others have reported. When the bath *p*H was 2.0 or higher, the deposit became dark and quite loose. Accordingly, the possibility that the deposit was an oxide of technetium existed. Three series of tests were developed to explore this possibility. These were hydrogen reduction studies, precipitation studies, and x-ray diffraction studies. Other methods for quantitative determination of Tc are summarized by Colton.

Cathode deposits for these studies were obtained from 100 ml of the $(NH_4)_2SO_4$-H_2SO_4 bath containing 0.012 mole of NH_4TcO_4 per liter (*p*H 1.0, C.D. 2 amp/dm^2) on gold, platinum, and stainless steel cathodes. Before electrolysis, cathodes were rinsed with distilled water and then alcohol and dried to constant weight in an evacuated dessicator and after the plating run was completed, the plated cathodes were treated in the same manner.

Hydrogen reduction.—Ten plated cathodes, along with the control plates (unused stainless steel cathodes), were heated in a hydrogen atmosphere at 350°–400°C for 2 hr. They were then allowed to cool to room temperature, with the hydrogen still passing over them, before reweighing. Calculations, based on the stoichiometry: $Tc + TcO_2 \cdot 2H_2O + 2H_2 \rightarrow 2Tc + 4H_2O$, showed the deposit to be 92 ± 5% metallic Tc. Allowance was made for standard weighing deviations and control plate weight loss (average 0.0001g), but there was no way to measure the weight loss involved in the mere handling of this deposit that was not very adherent. Hence the evidence from this study can only be interpreted as indicating that the plate is essentially Tc metal.

Precipitation studies.—Three cathode deposits, whose weights had been previously determined, were dissolved in HNO_3 to remove the deposit from the gold cathodes and the solution adjusted to *p*H 8.0 with NH_4OH. Tetraphenylarsonium chloride was then used as the precipitating agent using the procedure described in the literature. Preliminary tests on this procedure had indicated a recovery of Tc was 98–100% which was in accord with the results of other investigators and well within our standard weighing deviations. After drying the tetraphenylarsonium pertechnetate to constant weight, calculations were made based on the stoichiometry: $Tc + TcO_2\ 2H_2O + 10\ HNO_3 + 2NH_4OH + 2(C_6H_5)_4AsCl \rightarrow 2(C_6H_5)_4AsTcO_4 + 2NH_4Cl + 10\ NO_2 + 8H_2O$. The results obtained showed the deposit to be 100 ± 2% Tc metal.

Alloys

Attempts to electrodeposite a Ni-Tc (TcO_4^- added to a Watts bath) and a W-Tc alloy (TcO_4^- + Na_2WO_4 solution) were not successful. There was some evidence, however, that it might be possible to codeposit Re and Tc from a solution containing ReO_4^- and TcO_4^-.

Conclusions

The results presented show that Tc can be deposited in macro amounts as the bright metal from various aqueous solutions. The $(NH_4)_2SO_4$-NH_4TcO_4-H_2SO_4 bath described here gives good CCE, is reasonably stable, can be readily rejuvenated by H_2O_2, and with reasonable precautions can be used safely in ordinary laboratory equipment. A bath containing 1M $(NH_4)_2SO_4$ and from 0.006 to 0.024M NH_4TcO_4 with H_2SO_4 added to give a *p*H of about 1.0, can be electrolyzed at 1–2 amp/dm^2 to produce a metallic cathodic deposit of Tc with a CCE range of 18–30%.

Electrodeposited Tc metal has few uses at the present time outside of medicine. However, its super-conductivity at low temperatures as a metal and as an alloy may find value in the rocket guidance systems and computer systems at a future time. Certainly, the possibility of plating an alloy to Tc deserves consideration.

Acknowledgment

The authors express their thanks to Dr. Chin-Hsuan Wei, of this department, who gathered and interpreted the x-ray diffraction data. One of us (REV) is grateful to NSF for financial support that made this work possible.

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Exercise

Your Byrd!

by J. P. Byrd
B. S. '69

Once again Truax Field is growing a crop of marijuana, busses rustily rest before the Badger Depot. The echos of cheering parents have long died away. Freshmen's teddybears and security blankets have been stored away and replaced by the carousing, consoling powers of the State St. saloons and the opposite sex.

Yet the wonderful world of college has not completely worn off that thick coating of green hometowness from every freshman. So begins the annual reverse migration of homeward bound letters, a phenomenon even the Byrd was susceptible to in his frosh days. Digging through his file (liberally translated: the lower bureau drawer), the Byrd recently discovered just such a letter. In honor of those who have struggled through their frosh year of engineering, the Byrd has printed the same letter, unexpurged and uncensored, below.

October 3, 1963

Dear Mom,

Need money and some homemade apple pie, hopefully in that order.

Boy, I'm glad I'm going to be an ME. Being in engineering means I get a lot of special attention. When we registered, all the engineers went to see their advisor first. So while other kids were out running around to their assignment committees, we engineers got to talk to our advisor, who checked our schedules before we registered. This is an example of close faculty/student relations, because by the time we got to our assignment committees, a lot of sections were closed, and we got to see our advisor again to change our schedules so that by the time . . .

There is even a special class that I get to go to because I'm in engineering. It's called Freshman Lectures. There is always someone to lecture on nuclear, or civil, or some other kind of engineering. Because it's my only class on Wednesday (but I do have two classes on Saturday), I don't mind getting up early to get to class at 8:50.

By the time I finally graduate, I figure that I'll have gotten a "well-rounded" education, as they say around here. "Well-rounded" means that I'll know everything about all kinds of mechanical engineering, because, after looking at a list of courses that I'll have to take in order to graduate, I won't have room to take courses in any other subject.

As ever,

J. P.

Frosh! Is this what you have found out through your own experiences? If you agree/disagree with me, write to—The Byrd, c/o The Wisconsin Engineer.

CAMPUS:

THE ROVER BOYS AT CAMP

or

SUMMER CAMP STRIKES BACK

THERE'S something about a soldier—but that's not the half of it. When June turned 59 school-weary Wisconsin R.O.T.C. men loose upon a quaking civilization, something had to be done. As in most emergencies, Uncle Sam stepped into the breach, herding them all off to Camp Custer, Michigan, for six weeks of character-building or something. Now, having paid their debt to society, they are all back with us again, with many a tall tale to tell. They like to relive the warm summer nights, with a gentle wind wafting in from the cavalry stables, when they sprawled about, full of the delicacies of Sergeant Murphy's incomparable (!) cuisine, feebly slapping at Michigan mosquitoes and chattering about the Battle Creek frails. And bed-check, what a word. Experiments were occasionally performed with dummies in bed under the mosquito bars, but in general these fooled neither the C.Q. nor the mosquitoes. Of course, other things besides dummies were discovered in beds, as Bates can testify.

Nor were the days in any way dull. A glance at the records shows Wisconsin's Signal Corps, paced by "Buffalo Jim" Vaughn, winning the Co. E beer competition for pistol markmanship, while their Engineer rivals helped Co. C gain their rather unstable possession of the totem pole signifying all around range supremacy. It was interesting to watch some of the light-weights in the firing line—these boys with a low moment of inertia, who would brace themselves, aim, fire, then crawl back up again to the line from which the recoil had knocked them. Some, like OConnor, who forgot on the range that old saw about action and reaction being equal and opposite, turned up with glorious shiners.

While the Engineers dug trenches and filled 'em up, laid barb wire and rolled it up, built bridges and blew them up (strange people), the Signal Corps conducted a very private war, stringing miles of telephone line over hill and dale, turning the air blue with short-wave double-talk, attacking, retreating . . . fun, no end. It was at the end of a retreat that "Sparks" Lingard, radio operator, was reported missing in action. The C. O., reconnoitering deep in (supposedly) enemy territory, found him an hour later—found him hitting off some "bunk fatigue" in a thicket, while the frantic "beepings" of the receiver at his side mingled with his peaceful snores.

Johnnie "Slots" Neighbors, Engineer, was the victim of a near tragedy when tossed to a watery grave in Eagle Lake by his comrades on pontoon detail. As he gurgled, yelled, and thrashed about to keep his head above water, someone on the bank reminded him that the water there was only four feet deep—which made him feel twice as bad.

All those Engineers, incidently, seemed obsessed by the illusion that every day was St. Pat's Day and brawled from morn till nite. If they weren't fighting with the Infantry on one side or the Signal gang on the other, they were out pasting each other. For the "Number, please" boys of Company E, life was less strenuous but lively. What with B. B. Westerman maintaining an active and dangerous correspondence with two different B. C. babes, Red Rucks always volunteering to carry the beer across the border, Miller, Pritchard, and "Guides post" Wright busy corralling all the choice literature in camp, time never dragged. Some day we'll set down the legend of what the Colonel, one fine day, said when he came upon our Aldro relaxed (though supposedly on guard duty) on the fender of a car with his famous box camera in hand. But for the present, we'll let you guess. . . . .

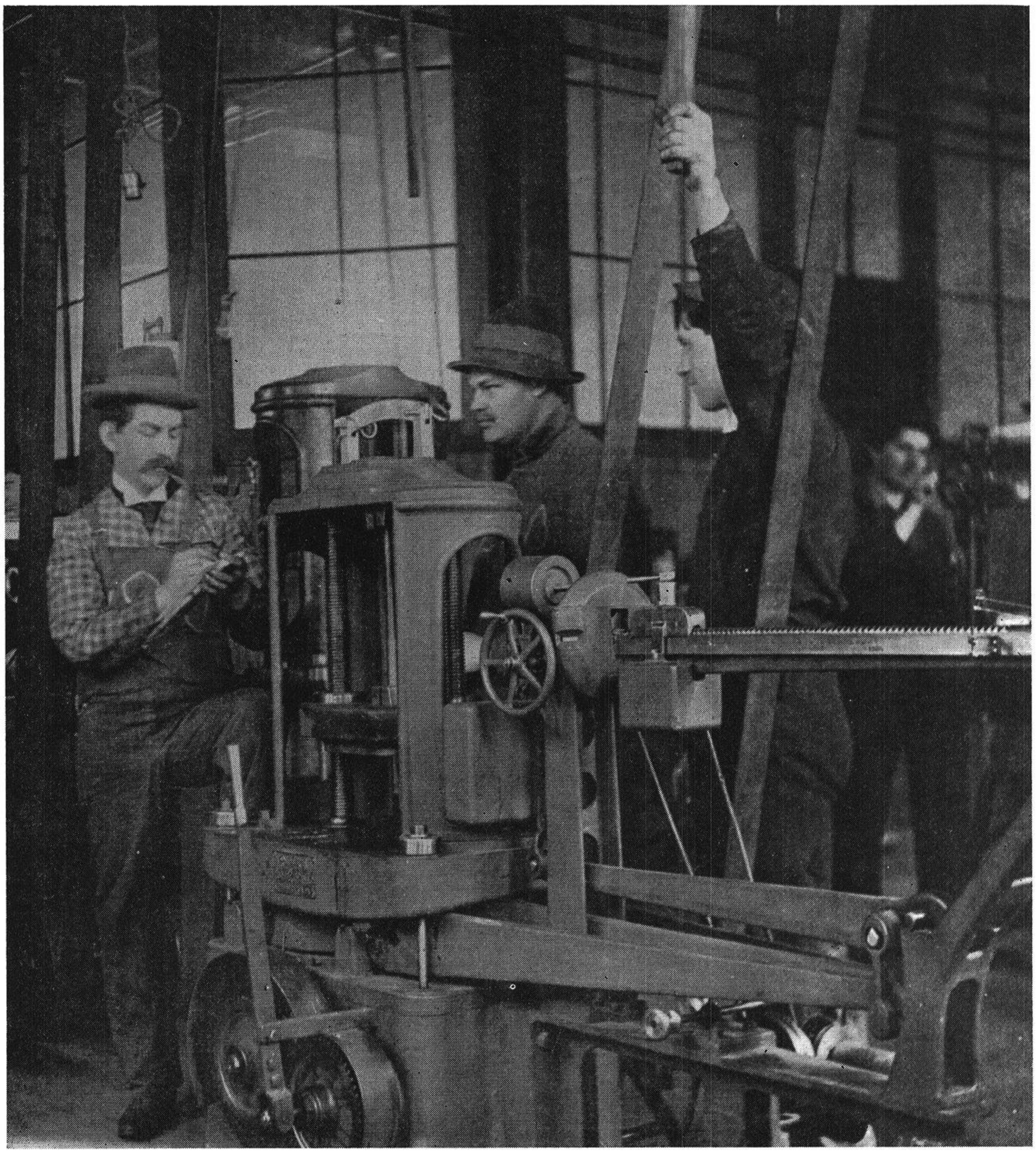
Does this sound like the time you had at ROTC camp or at the surveying summer camp?

It should.

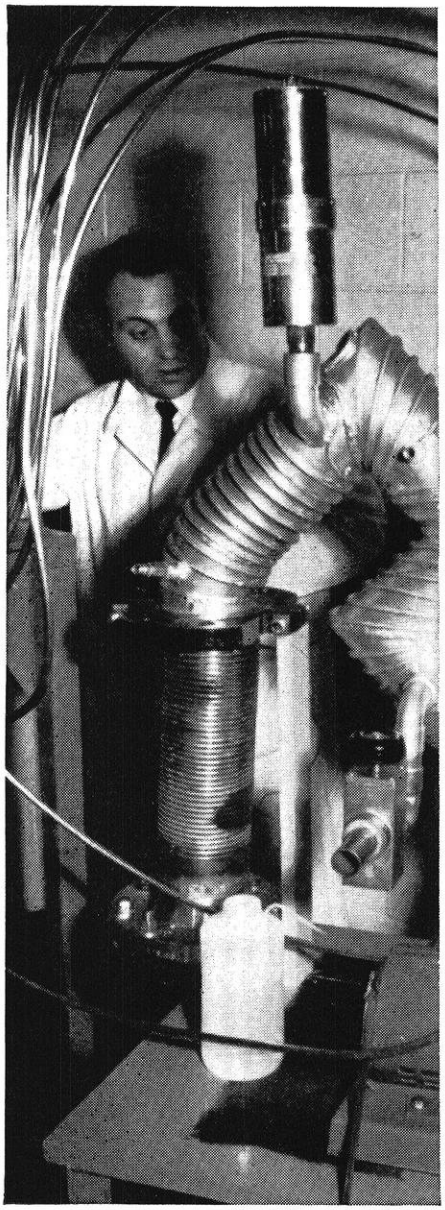
This story was written expressly for *The Wisconsin Engineer* by an unidentified student. In 1937.

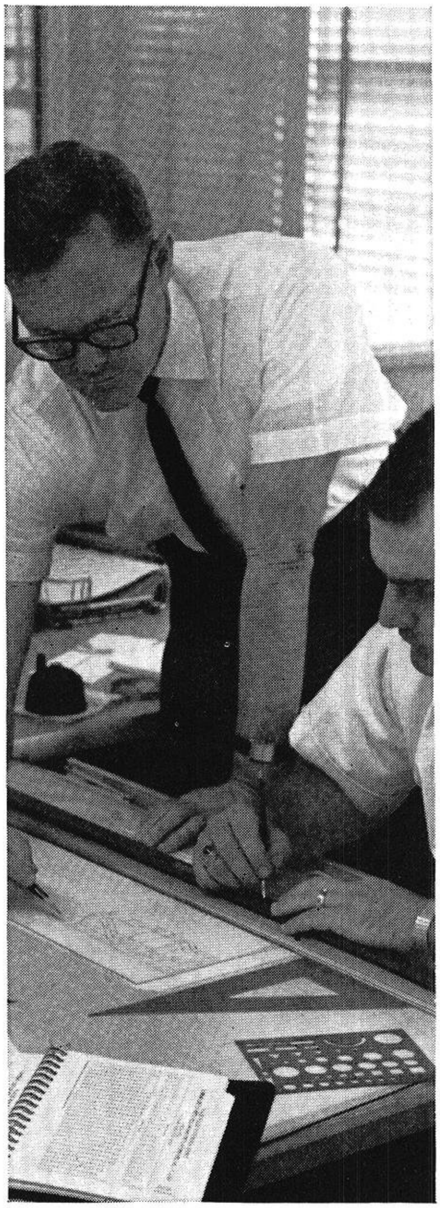
PICTORIAL:

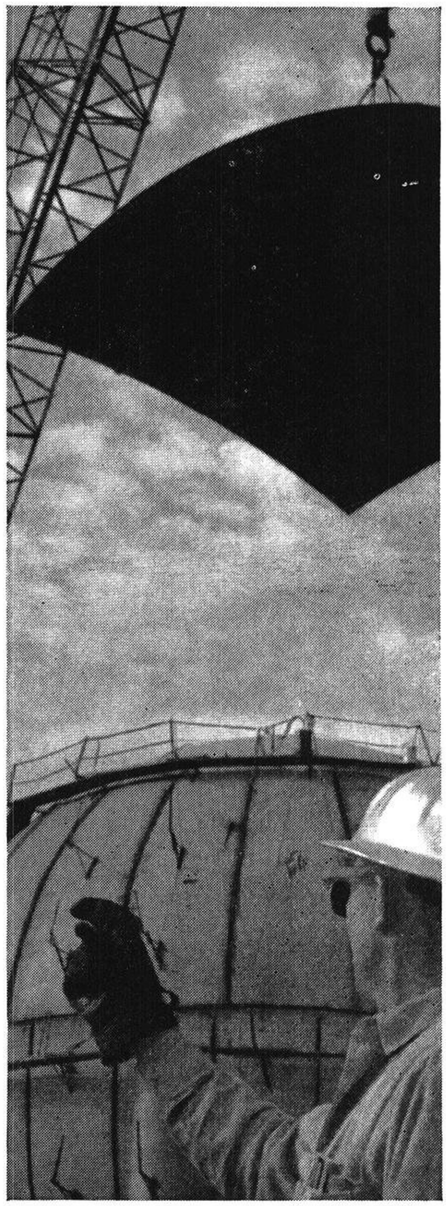
wisconsin's album



some well dressed engineers in mech lab.







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HUMOR:

FILEABLES

A lunatic was leaning out of the asylum and watching the gardener.

Lunatic: "What are you doing there?"

Gardener: "I'm putting manure on the strawberries."

Lunatic: "I usually put sugar on them, but of course, I'm crazy."

* * *

"Boy, am I scared! I got a letter from a man saying he'll shoot me if I don't stay away from his wife."

"Well, all you have to do is stay away from his wife."

"Oh yeah?" He didn't sign his name!"

* * *

"She's a new girl with us and just fresh from the country so we'll have to show her what's right and what's wrong," said the engineer to his assistant.

"Very good sir," replied the assistant, "you show her what's right."

* * *

★ He only drinks to calm himself,
His steadiness to improve.
Last night he got so steady,
He couldn't even move.

* * *

There was a little boy who had just gotten a pen pal from Holland. He was so happy about it, that when he came home that night he said cheerfully, "Guess what, Mom? I got a girl in Dutch."

* * *

A modern country is one which bans fireworks and produces H-bombs.

* * *

Prof: "Well, what did you think of the course?"

M. E.: "I thought it was very well covered. Everything that wasn't covered during the semester was covered on the final."

* * *

The regular noontime poker session of a group of Phoenix, Arizona electronic engineers is neatly labeled with a sign reading: "Probability Seminar."

* * *

The Russian school teacher asked a pupil who the first humans were.

"Adam and Eve," the kid replied.

"And what nationality were they?"

"Russian, of course," said the kid.

"And how do you know," asked the teacher.

"Easy," the kid replied. "They had no roof over their heads, no clothes to wear, and only one apple between the two of them—and they called it Paradise!"

* * *

Familiarity breeds attempt.

* * *

★ And then there was the rather forlorn engineer who, on seeing a pigeon flying directly overhead, exclaimed "Go ahead, everyone else does!"

* * *

Cannibal King: "What am I having for lunch?"

Cook: "Two old maids."

Cannibal King: "Ugh! Leftovers!"

* * *

Signs along the highway:
"Dangerous Curves"
"Soft Shoulders"
"Five Gals for a Dollar"
"Try Ethyl!"
and as a final warning
"Watch Out for Children"

* * *

★ There is an engineer on this campus who never takes a drink. You gotta hand it to him.

* * *

C. E.: "Pho's that?"

M. E.: "Girl I used to sleep with."

C. E.: "Shocking! Where?"

M. E.: "Chemistry lecture."

* * *

Anyone who thinks he is indispensable should stick his finger in a bowl of water and notice the hole it makes when he pulls it out.

* * *

It is reported that a Scotchman decided to go places and see things, but after collecting many travel folders, he decided to stay at home and let his mind wander.

* * *

Frontier coroner's verdict: "We find that the deceased came to his death by an act of suicide. At a distance of a hundred yards he opened fire with a six-shooter upon a man with a rifle."

* * *

"My wife is scared to death someone will steal her clothes."

"Doesn't she have them insured?"

"She has a better idea than that. She has a guard in the closet to watch them. I found him there last night."

Space contributed as a public service by this magazine.

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Some engineers are strongest on theory. We are big enough to need that kind. More engineers are intuitive gadgeteers, despite a first-class engineering education. We need more of that kind. To illustrate a few of the different kinds of systems among which, for example, our mechanical engineers can move, we show here how results of the work are presented to the public. Accompanying comments are from the boss engineers.

Correspondence with a view to joining us should be directed to Eastman Kodak Company, Business and Technical Personnel Dept., Rochester, N.Y. 14650.

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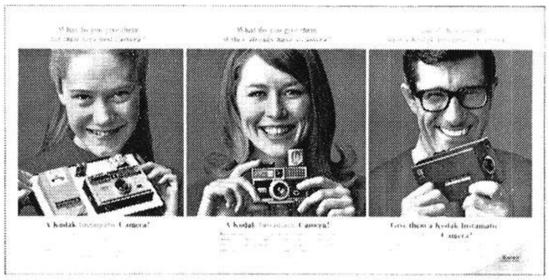
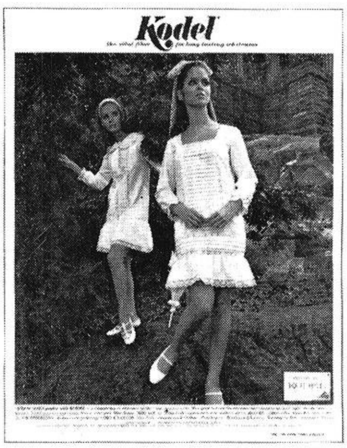
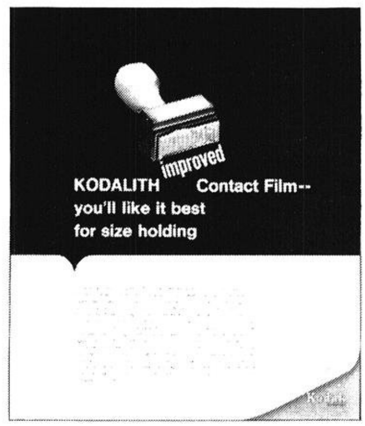


"The simplicity of design in our simpler cameras only looks that way. The engineer is balancing off the stringent demands of light-sensitive materials against what millions of non-technical people the world around can afford to pay for the idea that good times are picture times. And they won't tolerate disappointment any more than do buyers of our cameras and projectors farther up the price range, who get fine instruments at a lot less than instrument prices."

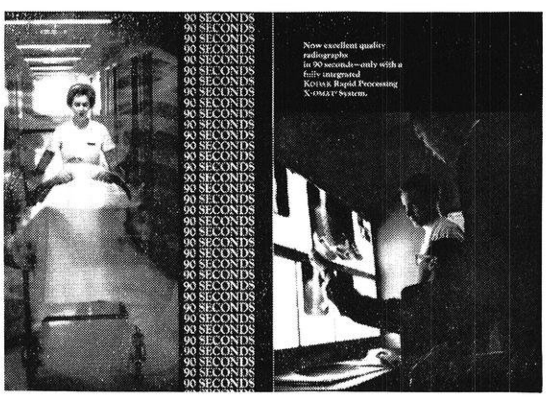


"Down here at Tennessee Eastman (in Kingsport, Tennessee) we mechanical engineers take over the polymers that our chemical engineering brethren deliver through their pipes and turn them into miracle fibers. Then we send out our own mechanical engineering patrols to where the looms and sewing machines are working, just to make sure the ladies don't lose their faith in miracles."

"Aerospace photography, as in our Lunar Orbiter assignment, differs in that we push reliability to lengths that would be wasteful and ridiculous for other photographic systems work."



"A printing house discovers that our brand of photolithographic film cuts their costs by requiring fewer makeovers. Why should this be so? You might trace it all back to a mechanical engineer using our analog computer for three-dimensional heat-transfer calculations for the polyester casting wheel that the film base came from."



"With today's volume of demand for medical care, mechanical engineers had to put an end to hand-dipping of x-ray film. Our idea of an m.e.'s responsibility is big enough to cover not only mechanical drive systems but also fluid mechanics (as in recirculation and temperature control for corrosive photographic solutions), air hydraulics (recirculation and temperature control of heated air), industrial design (styling for a medical environment), and plenty of interfacing with the electrical circuitry people."