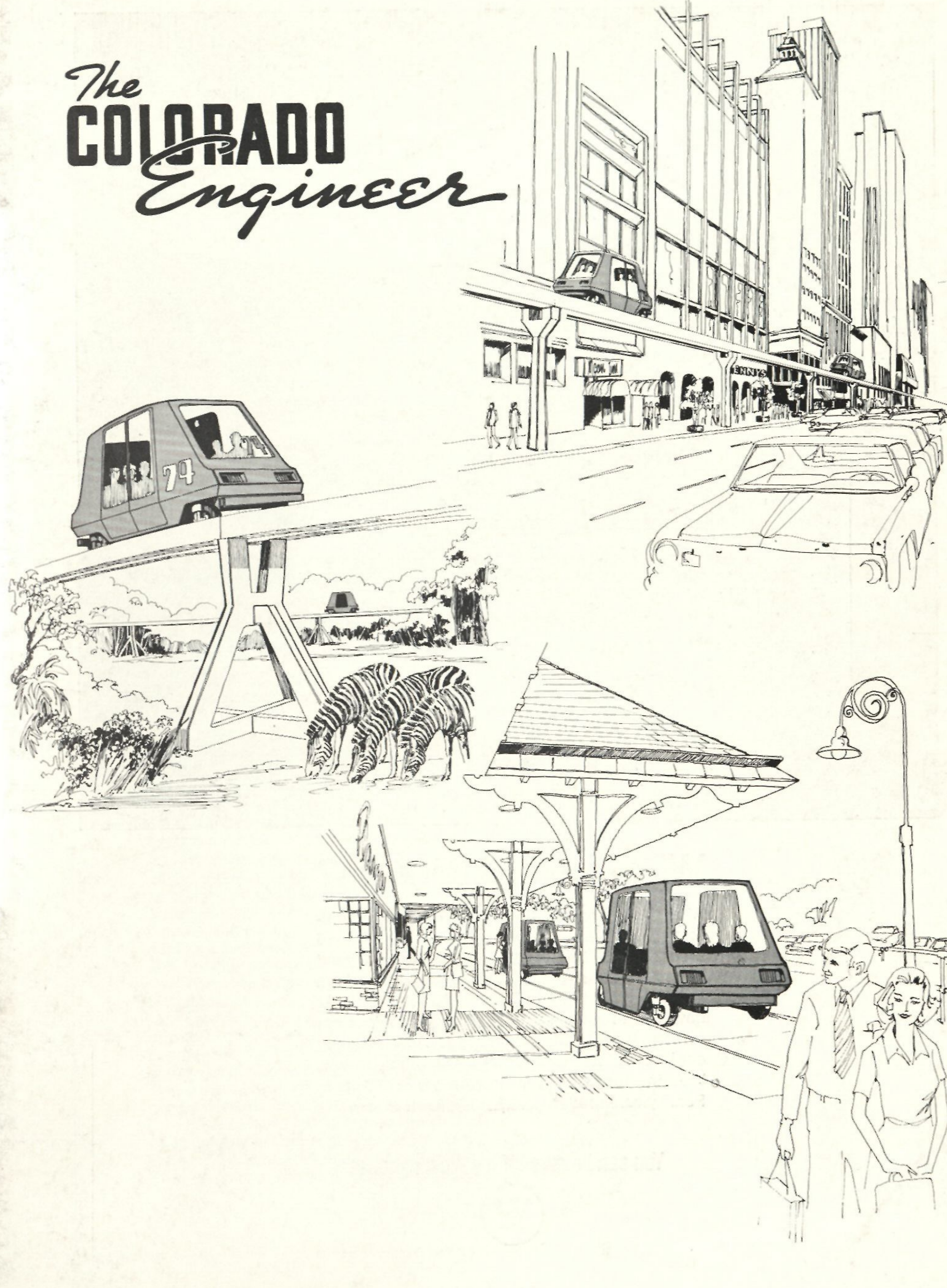
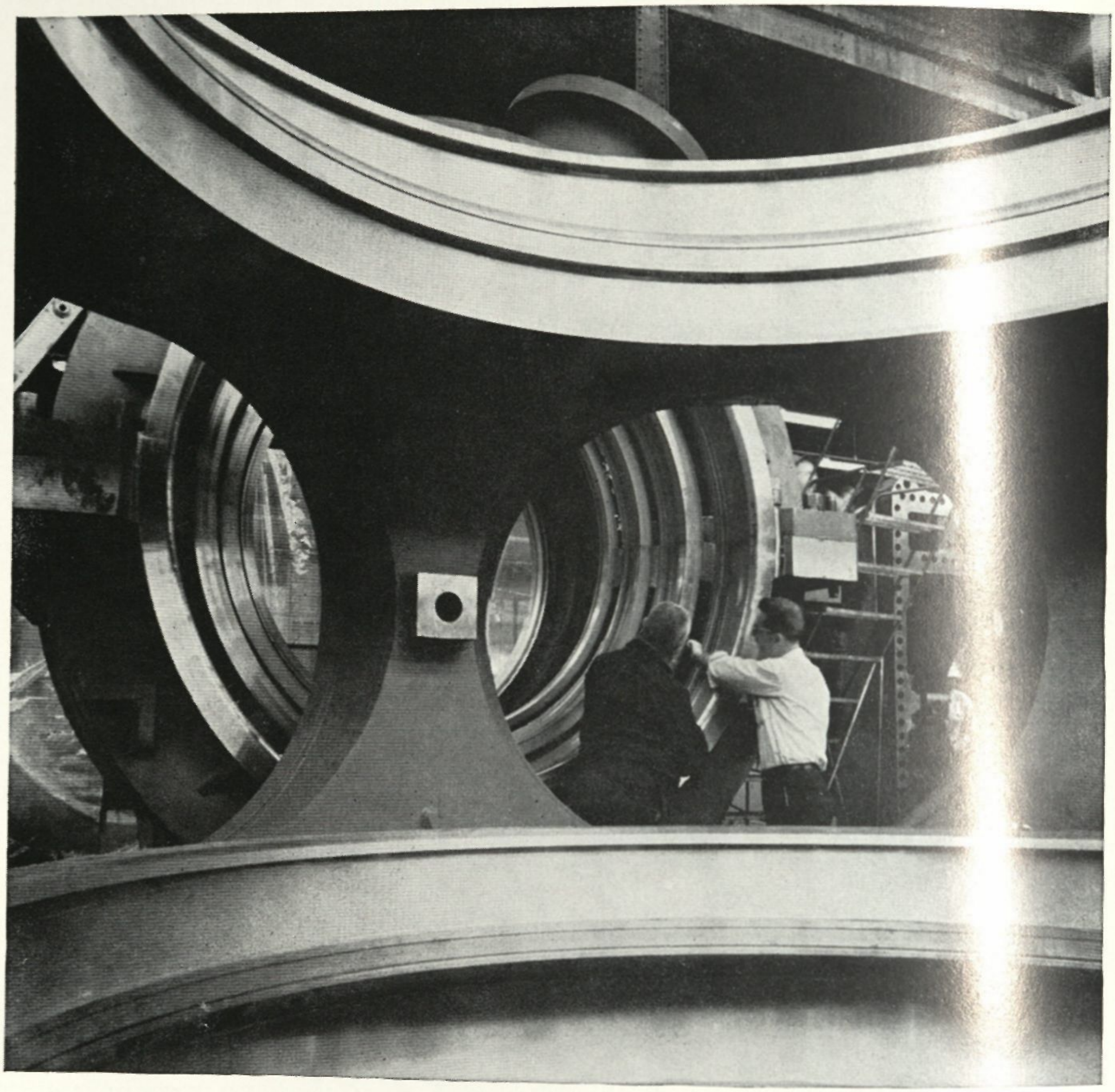
The COLORADO Engineer





Who needs engineers?

After the statesmen, politicians, lawyers, educators, journalists, clergymen, sociologists, and theorists have finished talking about what should be done, we turn it over to the engineers to do it. Nothing, from the Pyramids to Apollo 16, would have been built without them. Nothing important tomorrow will be built without you. So who needs engineers? We do. Write to George Garvey, Westinghouse Education Center, Pittsburgh, Pennsylvania 15221. **An equal opportunity employer**

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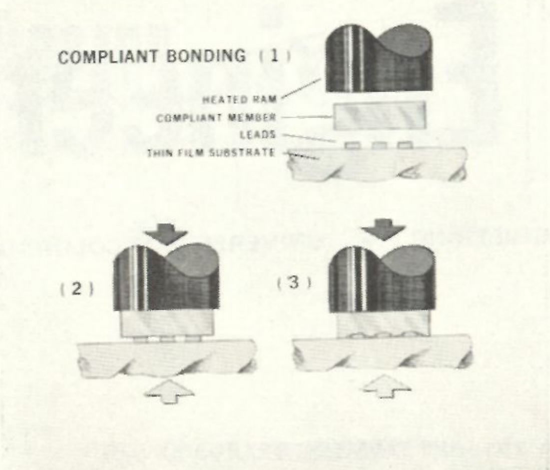
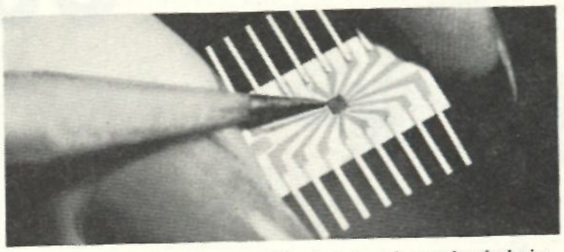
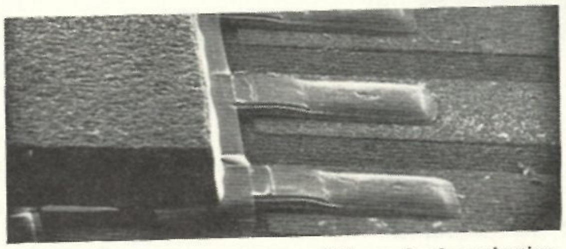
WESTERN ELECTRIC REPORTS



When heat and pressure are applied to the compliant medium, it begins to deform around the gold-plated leads. Deformation of leads is controlled by the flow stress properties of the medium. When the medium bottoms out, it stops the ram and the delicate metal parts are instantaneously and permanently bonded without damage.



Slightly magnified, the pencil points to a beam-leaded circuit chip which has been bonded to 16 gold conductors that converge on it. Within the silicon chip are dozens of microscopic transistors, diodes, resistors.



Greatly magnified, we can see gold beam leads projecting from a chip bonded to thin gold conductors on a thin ceramic substrate.

A new and better way to bond integrated circuits.

Engineers at Western Electric's Engineering Research Center (ERC) and Allentown Works have come up with a revolutionary but simple solution to some very complex circuit bonding problems. It's called compliant bonding.

As in other solid state bonding methods, heat and pressure are used to bond tiny integrated circuits to other components. (Some circuits have fifty or more delicate leads.)

However, our process differs in a very important way. ERC researchers added a compliant or yielding medium between the energy source and leads being joined. On contact, the medium compresses and transmits an equal amount of controlled, predictable bonding pressure to each lead.

There are many advantages to this new technique.

First, it is more reliable. Under heat and pressure, the compliant medium spreads the bonding pressure to all the leads uniformly. It automatically compensates for surface and lead irregularities. Strong, reliable electrical connections are assured for every lead.

It is also more versatile. We can now bond more than one circuit at a time, even with leads of different thicknesses or area widths. The compliant medium perfectly controls lead deformation in even the most complicated multiple bonding. It's no longer necessary to design and test complex bonding tools for each bonding job.

Engineers at Allentown are working to apply the process to large-scale manufacturing. They have developed the first production machines using the process. These machines are now in growing use at Allentown and many other Western Electric plants.

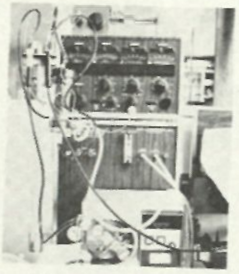
Conclusion: Compliant bonding is technically and economically superior to other solid state bonding techniques. Combined with automated production, compliant bonding promises reliable, high-speed production of circuit packages.

Western Electric

We make things that bring people closer.

The Transistor

See page 4



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Colorado Engineer

COLLEGE OF ENGINEERING • UNIVERSITY OF COLORADO

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ABOUT THE COVER: This month's cover is by Paul Perkins. It depicts man helping man, to combat man's unseen enemies.

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The COLORADO ENGINEER needs staff members to train for the year 1973 - 1974. Positions will be open in photography, layout, advertising, editing, writing, circulation, etc. If you are interested, leave a message at the Office, located in the Engineering Center, Room OT- 1-7. The experience gained will be invaluable.

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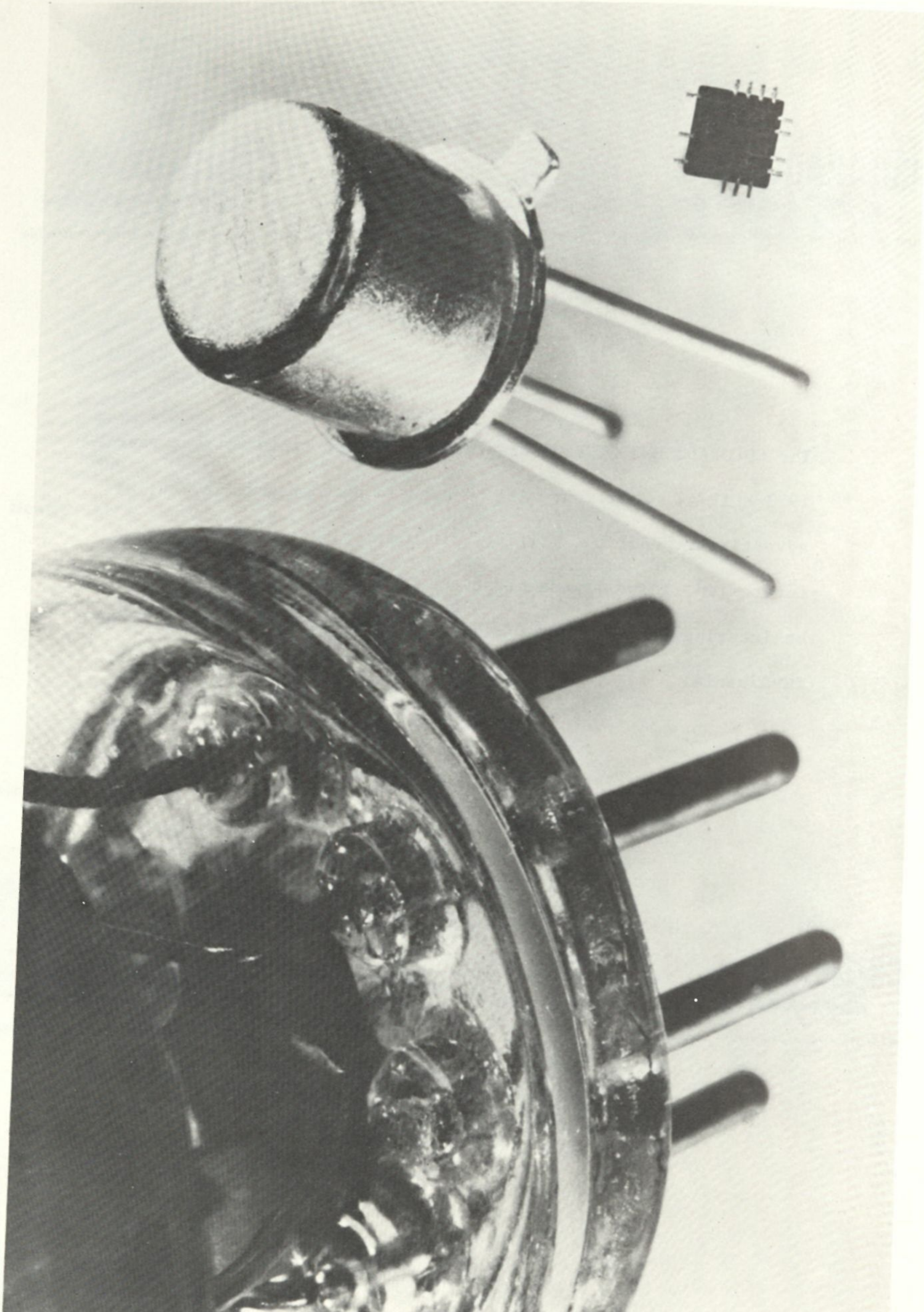


The Transistor at 25

The transistor — the Bell System invention that started the computer revolution and the space age, and created a multi-billion dollar industry — is twenty-five years old.

Originally developed as a solid-state replacement for vacuum tubes in telephone applications, the Nobel Prize-winning invention has become virtually ubiquitous in American life. Most people are never more than a few feet away from a transistor.

The high reliability, small size, and low power needs have made transistors ideal for wrist watches, home appliances, telephones, boat and airplane radios, desk calculators, and manufacturing equipment. Transistors make possible the computers that are used in credit card systems, banking, airline flight reservations, business calculations and scientific research and engineering. Electrocardiograms can be sent reliably over the telephone to specialists at distant locations, using transistorized equipment.

It all began in December 1947 when three scientists at Bell Labs succeeded in amplifying an electrical signla by sending it through a very specially prepared crystal of germanium. The invention was announced to the public on June 30, 1948. By then, a Bell Labs task force was working on the job of making the transistor a practical device. The first commercial application for the transistor was in a Bell System switching office, and within a few years, transistors were already affecting many areas of our lives. In 1956 the three inventors of the transistor, John Bardeen, William Shockley, and Walter Brattain, received the Nobel Prize in Physics for their work.

In the Bell System transistors and other solid-state devices derived from them have made possible more reliable and cheaper microwave radio, and buried coaxial cable system for sending calls across country. These devices also made possible large computer-like electronic central offices that switch customer calls. Transistors and other solid-state devices were also crucial in the operation of the Bell System's experimental communication satellites, Telstar I and II, and are used in modern undersea cable systems linking the U. S. with Europe and the Caribbean. Semiconductor technology is also begin used in the Bell System for TV cameras and solid state lasers.

Since the invention of the transistor Bell Labs and Western Electric have continued to develop new solid-state technologies, some of which paved the way for integrated circuits. Containing hundreds of transistors and other electronic components on tiny chips of silicon, integrated circuits have ushered in the "solid-state age," opening up still more markets for electronic devices.

Where Are They Now?

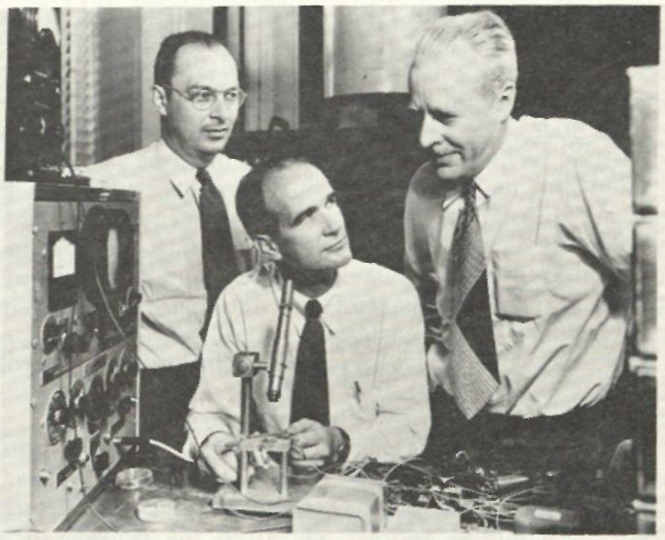
Where are they now?

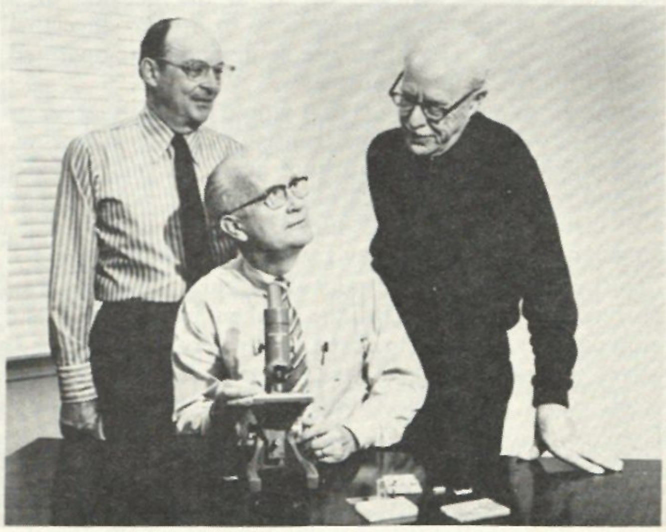
The discovery of the transistor effect and the development of a practical device required the expertise of dozens of scientists and engineers. Physicists, chemists, metallurgists, electrical engineers, and crystal growers, to name a few, all were part of the early team effort at Bell Labs.

Now, twenty-five years later, many of these people are still at Bell Labs, some in management, others continuing semiconductor research and development. But the three men most closely identified with the transistor and the start of the solid-state age are now teaching at universities.

William Shockley is a professor of engineering sciences at Stanford University; he also is an executive consultant at Bell Labs. John Bardeen, who teaches graduate physics at the University of Illinois, recently was named to receive his second Nobel Prize for Physics. He shared the 1972 prize with two others for their work on superconductivity. And Walter Brattain teaches undergraduate physics at his alma mater, Whitman College in Walla Walla, Washington.

Last year John Pierce, the man who named the transistor, retired from Bell Labs and is now teaching at the California Institute of Technology. Pierce coined the word transistor as a contraction from "transfer resistor", which describes the device's electrical behavior.





INVENTORS. Nobel Prize winners, Drs. John Bardeen, William Shockley and Walter H. Brattain (left to right) are shown above at Bell Telephone Laboratories in 1948 with the apparatus used in the investigations which led to the invention of the transistor. The inventors, who received the Nobel Prize in 1956 for their transistor work, are shown below at a 1972 reunion marking the 25 anniversary of their invention which has revolutionized the electronics industry.

Solid State Revolution

You'd think they would have said something momentous like: "One small step for man, one giant step for mankind;" or at least they would have come up with an equivalent to "Mr. Watson, come here, I want you."

But nothing so quotable was uttered on that day in December, 25 years ago at Bell Telephone Laboratories when William Shockley, John Bardeen and Walter Brattain discovered the transistor effect.

Certainly the invention of the transistor was a momentous occasion deserving such a notable quote to be picked up by history book writers.

Think, for a moment what the world would be like today if the transistor had not been invented. Computers would be much less reliable, bulkier, slower and wouldn't have the information-handling capability that they now possess. They probably would have been too expensive for wide use. We probably would never have landed a man on the moon. Space exploration and communications satellites would not have achieved their present degree of sophistication.

The electronics industry, as it is constituted today, is being shaped by the transistor and other solid-state devices spawned by the transistor, such a micro-wave and light-emitting devices and especially integrated circuits.

In 1971, sales of all types of solid-state devices in the United States, Europe, and Japan reached $2.5 billion. In 1971, 13.8 billion solid-state devices were sold, of which 9 billion were transistors. And people employed within the United States alone by business and industries engaged in solid-state technology number in the millions.

Solid-state devices have had an impact on a multitude of markets including military, commercial equipment and systems, medicine, education, broadcasting, musical instruments, automobiles, navigation, test and measuring instruments, industrial control and automation, aerospace and telephone communications.

In hospitals and doctors' offices, solid-state equipment monitors and maintains our health and provides new insights into the working of the human body.

The hard-of-hearing have been helped by solid-state hearing aids built in eyeglasses or concealed behind the ear. People with heart conditions are kept alive by pacemakers. Electrocardiograms can be sent from the bedside of a heart-attack victim via the telephone to a heart specialist almost anywhere. The blind use semiconductor-operated devices to warn them of obstacles.

Count the everyday things that would be much larger or not even around without the transistor and its offspring. Cameras with automatic exposure control wouldn't exist or would require a back-pack of electronic equipment. The era of fast, safe jet travel is due in large part to compact, lightweight sophisticated navigation and radar systems.

To the most isolated corners of the earth, low-cost transistor radios have brought the spoken word and music. From camel riders in the desert to farmers in rice fields to natives in rain forests, the transistor radio is a powerful social force bringing entertainment and educational programs.

Solid-state technology has also meant better and more reliable telephone service. Today, more long-distance and overseas telephone calls can be made faster and at lower costs than in the past.

In the Bell System transistors and integrated circuits have replaced vacuum tubes in a variety of applications to provide customers with better, more reliable, and versatile communications services.

Transistors and other solid-state devices have increased the circuit capacity of microwave systems and reduced their power requirements. For example, the transmission workhorse of the nationwide telephone network, TD-2 microwave, originally had a capacity of 2,400 circuits. Replacing most of the vacuum tubes with transistors and solid-state components helped increase this number to 16,500.

Transistorized undersea cable systems — known as SF — have a capacity of 845 circuits, more than six times greater than the vacuum tube predecessor. And the next transistorized generation of undersea systems — SG — will have a capacity of 4,000 circuits.

Similarly, L4 and L5 coaxial cable systems use solid-state components, the first to carry 32,000 circuits, the latter to carry three times this number.

HELPING THE HANDICAPPED. Mrs. Charlene Hird of Bell Telephone Laboratories holds a pacemaker, a device used by heart patients to regulate their heartbeat. Many devices, which help handicapped persons use transistors. The artificial larynx, a Bell System product for people who have had their vocal cords removed, and the tiny transistorized hearing aid are examples.

TELEPHONE CENTRAL OFFICE. Invention of the transistor enabled telephone switching systems, which identify, switch and route calls dialed by telephone customers, to be converted from electro-mechanical to fully-electrical switching. The circuit pack (foreground) shows typical packaging of integrated circuits used in electronic switching. This modern switching method is fast, accurate and versatile.

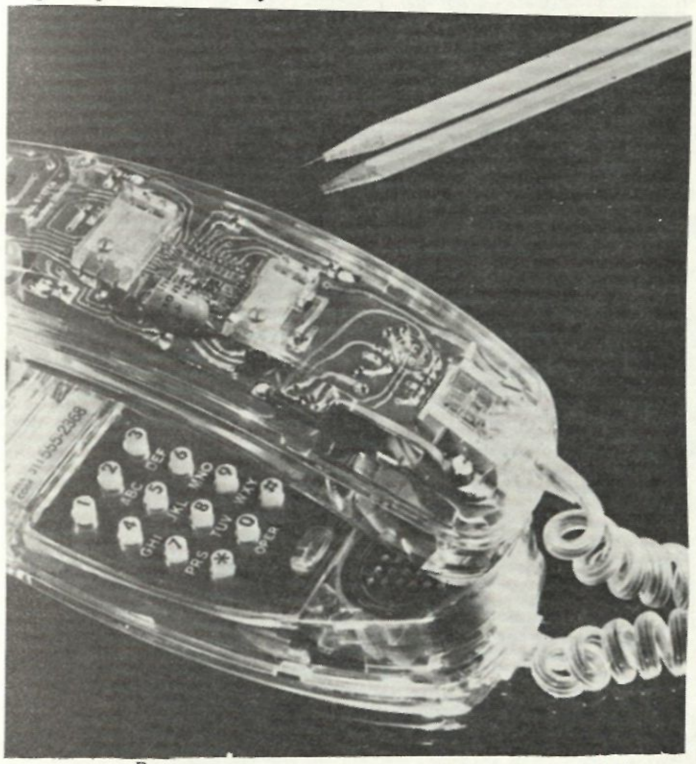
Mission Impossible

Back in 1951, when Western Electric's Allentown Works has handed the imposing task of manufacturing the newly invented transistor, the news was received with the greatest of calm.

This astonishing fact was partly due to the confidence that comes of Western Electric's having been in the business of manufacturing hard-to-make products for more than 80 years. But, as Allentown old timers are the first to admit, it was also due to blissful ignorance of the massive problems to come.

Early map makers used to mark the boundaries of the known world with the quaint caveat, "Beyond this place be dragons." Allentown engineers didn't even have that much warning, and a few of them jokingly claim that, if they'd had, they probably would have stayed with vacuum tubes.

Looking back at some of those dragons, it's easy to see why they felt that way.



TRIMLINE^{R}. In this experimental transparent model of the Trimline^{R} telephone, a pencil points to a tone-generating integrated circuit. The first application of integrated circuit technology to the telephone set, it takes advantage of the compatibility of thin films and beam-leaded integrated circuits.

EARLY TRANSISTOR. The first transistors assembled 25 years ago at Bell Telephone Laboratories by Dr. John Bardeen, William Shockley and Walter Brattain were primitive by today's standards. Yet they have changed our way of life. The first transistor, a "point-contact" type, amplified electrical signals by passing them through a solid semiconductor material, similar to present-day junction transistors.

The overriding problem was the one trailblazers have had to face since time immemorial — the problem of dealing with the unknown. Allentown engineers couldn't run to their books for answers everytime a question came up — the books hadn't been written yet. In fact, it was their own early work, both successes and failures, that was to become the sum and substance of the earliest body of transistor manufacturing literature.

Just as there were no books on manufacturing transistors to turn to, there was very little in the way of suitable equipment to buy. The Allentown pioneers not only had to make transistors, they had to invent, design and construct the equipment for manufacturing transistors.

Another dragon that bedeviled the Allentown transistor makers was uniformity — or, rather, the lack of it. While it was relatively simple to make a single device that came close to specifications, making thousands upon thousands of them — all with exactly the same characteristics — was another story. At Allentown, it soon became something of a ghost story. Some of the early transistors behaved like things possessed. For no visible reason, transistors made in the same way stubbornly refused to behave in the same fashion.

Part of the problem was the incredibly small dimensions involved in transistor manufacture. Transistor action occurs in areas so invinitesimally small, you can fit thousands of them into the thickness of a sheet of paper. Other dimensions are equally fearsome.

But the real name of the ghost in this story was contamination. The purity of the germanium used for transistors had to be several orders of magnitude higher than anything then available. The slightest trace of any unwanted impurity would make a transistor behave erratically or kill it altogether.

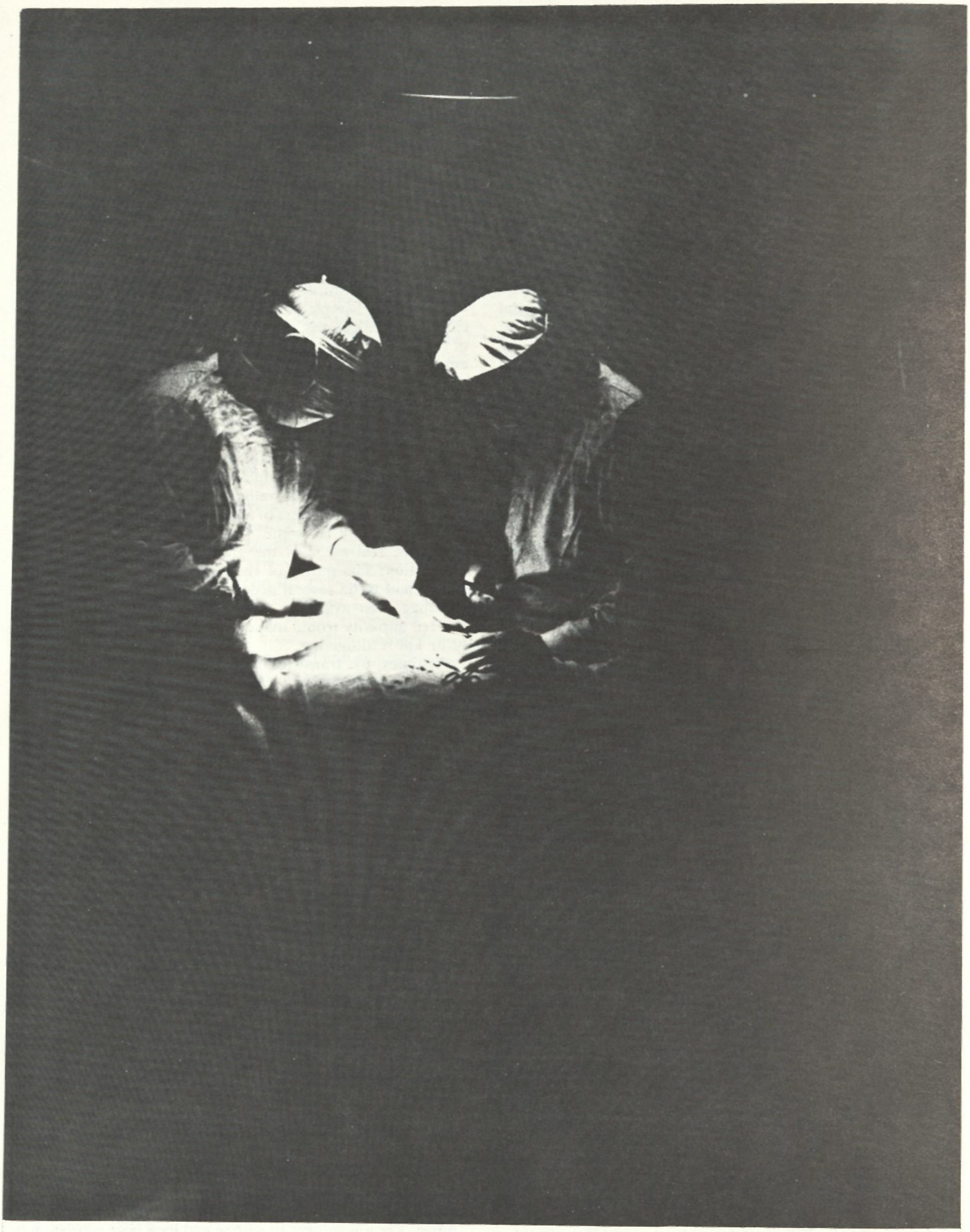
At times, the transistor "death rate" due to impurities was so high, harried Allentown engineers invented a mysterious (and facetious) element called "deathnium" to explain their difficulties. This ominous, and completely fictitious element will never be found on any chemist's periodic table of elements, but the wry humor it expresses helped Allentown through some trying times.

To further complicate the problem, germanium used for transistors had to be cut from single crystals of the element, and nobody had ever grown any before. This meant that, along with new methods for refining raw germanium, methods for growing perfect single crystals had to be developed.

In a beautiful example of necessity being mother to invention, Bell Laboratories came up with zone refining, an ingenious means of refining germanium and other semiconductor materials to a degree of purity never before obtained by man or nature.

Simultaneously, Bell Labs chemists were hard at work turning the ancient art of crystal growing into an exact science. Following hard on their heels, Western Electric engineers quickly transmuted their experimental lab work into efficient factory production methods. How well they succeeded is vividly demonstrated by the seven-pound giant silicon crystals they routinely grow nowadays, compared to the puny three and four ounce dwarfs of two decades ago.

When silicon entered the transistor picture in 1953, it seemed the whole arduous process of learning how to do the apparently impossible would have to start all over again. The advantages of silicon had long been known: it is as abundant as the sands of the earth, can operate at higher



AMERICA'S No. 1 KILLER

New Developments Help Wage War against This Health Assassin

By Ron Fattor

It is not pollution - **today's hot** topic; No. 1 scene. Everyone knows the **elements of** photochemical smog and what causes river pollution. Angry citizen's groups protest against the evils of filling the air with smoke. On any bookstore shelf one can find at least five paperbacks which promise to make an environmental disciple of you. All this is fine and good, **but there exists a killer today in America whose toll of human life far exceeds that taken by a polluted environment.** Unlike pollution, however, this killer is silent and unseen until it is almost too late to do anything about it.

The killer referred to above is **coronary artery disease** (commonly called "hardening of the arteries"), also called **atherosclerosis** or **ischemic heart disease** (IHD in this article). By itself, this ailment is a major source of heart attacks, strokes, and pulmonary embolism (more of which later). And it is unquestionably our No. 1 killer. The National Center for Health Statistics shows that in 1965, out of every 1,828 deaths, 1,000 were due to some form of cardiovascular disease, and of these, 612 were attributed **directly** to IHD. The economic costs of IHD are enormous: in 1965, IHD was the cause of over 200,000 deaths of people under 65. In terms of calculated lifetime earning power, this represents a loss of between **10-15 billion dollars annually.** This does not include the loss due to forced early retirement ecause of chest pain (Angina Pectoris), hospitalization costs, etc. What makes these statistics even more tragic is that premature IHD (the cause of the above-mentioned deaths) is in large part a **preventable disease.** It exists mainly because of man's poor adoption to the modern environment and due to hi ignorance regarding the art of living. But very few people know (or care) enough about the disease to prevent it. Mr. Joe Average, man-on-the-street, knows more about the performance of his car engine than how his on circulatory system works. This type of ignorance can often be fatal, especially when one's first education into this matter comes in a hospital bed or after you visit the doctor to check about those chest pains you've been having. By then it's often too late. The most common misconception is that heart disease s something to worry about only when you're above 40. This is ull, pure and simple.

Atherosclerosis doesn't occur overnight. It is a gradual process, and the man at age 25 s in a far better position to prevent its early manifestations than the man who begins worrying about it at age 38. This fact has been recognized by some of America's largest corporations, who now keep physical health tabs on all executives above the age of 30. The reason is simple: executive talent is orth money; and it does little good to train corporate leadership only to have some of your best men die at age 45 or 50, when their talent is at its peak.

This has been an introduction to the disease. The rest of this article will deal with such topics as to what characterizes IHD, at some of its consequences are, some of the new factors of therapy and diagnosis, and lastly, what can be done to prevent the early onset of IHD. If your own health doesn't interest you, this is a good point at which to stop. But if the possibility of protecting against the premature manifestation of IHD seems like a worthwhile venture to you, read on.

CORONARY ARTERY DISEASE: WHAT IT IS

AtheroMclerosis, or ischemic heart disease (IHD), is a degenerative process relating to the arterial vascular system of the body. The arterial system is that system of blood vessels (arteries) which carries blood away from the heart to body tissues. This is different from the venous system (comprised of veins) which returns blood from the tissues to the heart.

The arteries constitute the high-pressure system and are highly elastic. This elasticity serves the dual-fold purpose of helping the heart move the blood to the remotest tissues (when the heart contracts, the arteries expand; during relaxation of the heart, the arteries contract, giving an extra "push" to the blood) and also serves to dampen the pulsating nature of the blood before it reaches the minute blood vessels. The artery walls of the new-born baby are ultra-smooth, which allows the blood to circulate freely without any blood platelets breaking up and forming clots. Ideally, the arteries would remain highly elastic, perfectly smooth, but age and injury conspire to change things. The walls of most arteries thicken up to about 25 years of age. Thereafter there is a gradual loss of elasticity. This is due to the increase of collagen fibers (fibrous tissue) in the arterial walls, which increases the elastic constant of the wall. This loss of elasticity is accompanied by the atrophy of the middle layer of the arteries (which initially contains smooth muscle cells and elastic fibers arranged in concentric spirals). The net effect of this is to increase the workload on the heart and create inefficient transfer of blood to the tissues.

But there is another factor which arises in reducing the effectiveness of the circulatory system, and this is the build-up of fats (mostly cholesterol attached to proteins) in the arterial walls. This, by itself, has serious consequences for the individual, as will be seen. It has long been known that hyperlipidemia—a condition of excess, free-floating lipoproteins (the major lipid which has been measured is cholesterol) in the blood—is definitely associated with increased incidence of IHD

The reasons for this correlation are not hard to grasp. Lipids, containing mainly cholesterol and cholesterol salts, become attached to the interior surface of the artery (along with considerable fibrous tissue which invades the arteries), and may later become calcified over a period of years. This phenomena presents a serious hazard to the person involved. Because of the build-up of fatty material and fibrous tissue, the once supersmooth blood vessel now becomes severely reduced in diameter; and its interior surface becomes much rougher. This rough surface initiates the clotting process (due to the break-up of blood platelets as they pass over the rough surfaces), and a clot begins to form in the artery. Once a small clot develops, more blood platelets become entrapped; and the clot grows larger and larger until the artery is blocked (a clot which is stationary is referred to as a thrombus, regardless of location). This mechanism is what causes most coronary thromboses, which occur when a coronary artery (those arteries which feed the heart muscle) becomes blocked. The portion of the heart which is deprived of blood, no longer functions; and the entire heart is weakened as a whole. This process is also referred to as coronary occlusion or, simply, a heart attack. When this occurs, 4 major risks (anyone of which, if they become reality, can cause death) become present. These risks are as follows:

1)**INSUFFICIENT CARDIAC OUTPUT (heart failure):** If the clot in one of the coronary arteries has formed quickly and major areas of the heart are damaged, the heart will be unable to keep up with its demands; and death will ensue.

2) **DAMMING OF THE BLOOD IN THE VENOUS SYSTEM:** If the blood is not being pumped forward with enough efficiency, then blood from the veins cannot return to the heart, and blood will start "damming up" in the venous systems of the lungs. To make the situation worse, kidney failure often occurs, because the kidneys depend on fast-moving blood (which a severely damaged heart obviously cannot supply), to function; and if this requirement cannot be met, fluids begin building up in the body. This, in turn, adds to the congestion of the venous system. If this congestion becomes very intense, death ensues, usually from pulmonary congestion (pulmonary edema).

3) **HEART RUPTURE:** Occasionally after a portion of the heart is damaged, the dead muscle fibers begin to degenerate and the wals of the heart may become very thin at this point. If this occurs, a portion of the heart may rupture, upon which heart failure immediately ensues.

4) **VENTRICULAR FIBRILLATION:** After a heart attack, fibrillation (irregular, ineffective beating of the ventricles) may occur and unless help is given immediately (in the form of a shock administered to the heart), death occurs.

It should be noted that a heart attack need not be fatal. There are many people walking today who have survived the experience and made a complete recovery. If the clot in the artery forms **slowly** over time, then an alternate blood supply will form (wita much rest) and the person will recover from the attack. This alternate blood supply forms because, in the heart muscle, there are many minute blood vessels which connect the smaller coronary arteries. When a sudden blockage occurs in one of the larger coronary vessels, these minute blood vessels increase in size tremendously over a period of several weeks to several months, so that a new blood supply to the damaged area grows inward from allsides. It is becausA of these developing channels that the patient recovers from a heart attack. Alternatively, in some cases it is possible to perform a "by-pass' operation, using a blood vessel from the leg to by-pass the blocked artery. Recovery in these cases is usually comparatively rapid.

But the clot which forms may not be in a coronary artery—so a heart attack does not occur—but great dangers exist in this case also. Once a clot has developed, continued flow of blod past the Bis likely to break the clot away from its point of attachment, causing the clot to become free-flowing in the bascular system. Such moving clots are referred to as *emboli*. These clots can flow until they reach narrowed portions of the circulatory system.Should they terminate in the pulmonary arteries (those arteries which lead into the longs), the supply of oxygenated blood from the lungs to the heart (which, then, pumps this oxygenated blood to the rest of the body) is cut off, and much damage is done to the blood vessel system in the lungs. This is called pulmonary embolism and can be an immediate cause of death. If the embolus reaches the arteries which feed the brain (or if a thrombus develops in oen of tese cerebral arteries), then a *stroke* occurs. In this case, a portion of brain tissue is damaged or destroyed, because rain tissue is dependent for its existence on the moment-to-moment supply of oxygenated blood. The majority of these cases are caused by atherosclerosis (IHD) in the arteries of the brain, which subsequently leads to a cerebral thrombosis.

@All the above instances of brain, heart, and lung damage can easily be caused by atherosclerosis (IHD), thus the scope of danger presented by IHD is far greater than just a degeneration of arterial function. But atherosclerosis also increases the workload on the heart and if this strain is severe enough (and occurs in the coronary vessels), a condition known as *angina pectoris* may develop. This consists of pain which usually manifests itself after exercise or increase of emotional feeling. This, by itself, does not kill, but the pain felt can be incapacitating; and in many cases, this condition results in early retirement (no economic statistics have been compiled on this) and curtailment of vigorous activities. The condition can be treated by drugs, and sometimes by by-pass surgery. The foregoing are the consequences of IHD, and it is easy to see why such importance is attached to preventing premature forms of coronary artery disease (IHD). The next section will deal with some of the newer techniques of diagnosis of IHD, and what the implications of such procedures are.

THE DIAGNOSIS OF CORONARY ARTERY DISEASE

IHD is a "silent" disease and until recently, no safe, direct means were known to detect it. The most widely used technique of the present is the angiogram. This involves the insertion of a catheter (a tube) through an artery, in conjunction with x-ray visualization of blood flow. Unfortunately, the procedure has built-in hazards, because the catheter may dislodge arterial sludge and consequently cause a stroke or heart attack. The procedure is done only in hospitals, and only when there is a pressing need for it. In short, if you're in for a check-up, you probably won't get a definite answer from your doctor as to whether or not you have IHD. Your blood cholesterol levels and your physical make-up may give strong warning signs, but no clear-cut answer can be given on the basis of these tests.

However, recent advances in bioengineering have lead to the use of ultrasound, to diagnose IHD. The basis behind the procedure is the sound pattern and phasal relationships of reflected ultrasonic waves from arterial walls. Present research also involves the analysis of fluidic flow patterns (using classical equations) in conjuction with sound reflection. This technique, while not yet perfected (expensive and complex analysis details have to be worked out), seems to provide a long-needed method of IHD detection and early warning. The ultrasound procedure is desirable for several reasons:

1) It is inherently safe—using only ultrasound. There is no danger of arterial sludge breaking off and causing a stroke or a heart attack. Furthermore, there are no tissue-damaging x-rays.

2) The procedure is basically cheap and simple. It does not require the ue of several highly trained personnel and extensive hospital facilities. Once the analysis of sound patterns produced has been perfected, the procedure could easily be done in a local clinic (or even in the doctor's office).

3) The technique involves no discomfort to the patient, and no drugs from which to recover.

CORONARY ARTERY DISEASE—FACTORS OF PREVENTION

This last section is perhaps the most important, for the fact remains that *premature IHD is largely preventable* and the person who really wihes to avoid it *can* do something about it (unlike cancer). With this in mind, let us consider the factors which control the risk of IHD—factors which are under the control of the individual.

NUTRITION: After the factor of age, hyperlipidemia (caused by nutrition) is ranked as the most important risk factor in determining incidence of IHD. It is a well-known fact that blood-cholesterol levels are determined by what is eaten. There is a defnite relationship between blood plasma cholesterol level (which, when very high, is called hyperlipidemia) and the incidence of coronary artery disease (while blood cholesterol does not solely determine lipid build-up in arterial walls, it plays an important part in this process).

The sum of all geographic studies, to data, strongly shows a correlation between IHD and high intake of saturated fat and sucrose (tale sugar). The three primary determinants of plasma cholesterol level are: the intakes of cholesterol, saturated, and polyunsaturated fats (for a more precise definition of these terms, consult any organic chemistry text). The relationship between these factors and plasma cholesterol level is given by an equation developed by Keys, Anderson, and Grande. This equation is as follows:

$$(C_2 - C_1) = a\,(2S - P) + bZ$$

where $(C_2 - C_1)$ = the change in plasma cholesterol in mg per 100 ml of plasma

S = saturated fatty acids

P = polyunsaturated fatty acids

Z = the square root of the dietary cholesterol in mg per 1,000 cal of diet

a,b = constants of about equal weight

From this it can be seen why polyunsaturates are preferred over saturated fats for health reasons. It is obvious that high intake of polyunsaturates and low intake of cholesterol can reduce the level of plasma cholesterol which is so often the precursor to IHD.

Although to present a "safe" diet is beyond the scope of this article, it is interesting to contrast the various foods ingested by man. For instance, some foods which are high in saturated fats and contain much cholesterol per gram of food weight are: eggs, liver, whole butter, and cheddar-type cheeses.

Those foods which are relatively low in cholesterol and high in polyunsaturates include such items as fish, salad oils (excepting olive oil), potato chips, and most bakery products. Of course, protein and vitamin requirements must also be taken into account, when planning an optimum nutritional level.

For those, however, who seek to find the "evils of alcohol" in IHD, forget it; yours is a lost cause. Irrespective of what damage alcohol does to the brain or liver, it is nowhere near a major risk factor, concerning the development of IHD.

—It has also been found by researchers at MIT that if one's diet contains *choline* (a key structural element in cell membranes and a fat and lipid metabolizing agent), in normal amounts for good health, that atherosclerosis seems to be hindered in its development. Thus far, research has mainly centered around laboratory animals, but it appears that a choline-deficient diet may be a stepping stone to premature atherosclerosis.

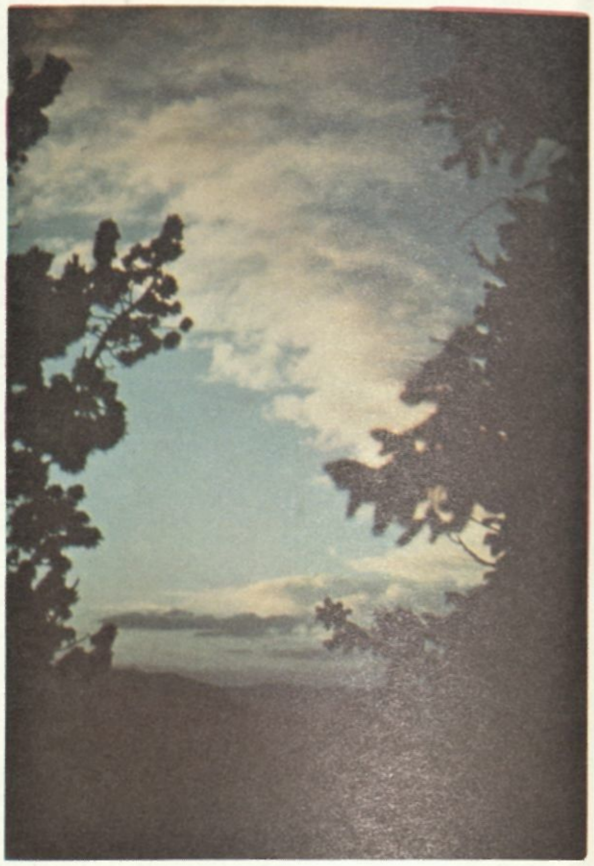
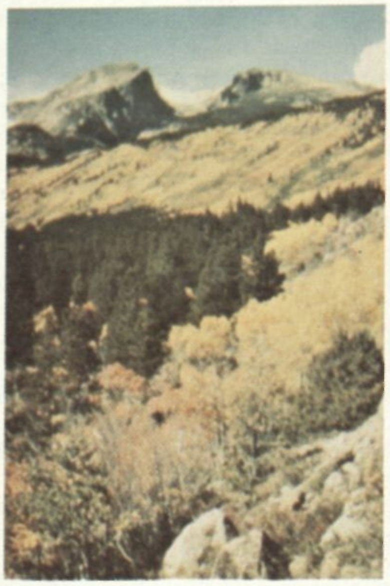
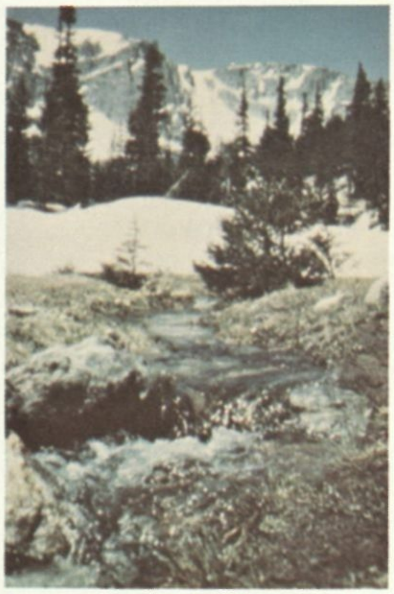
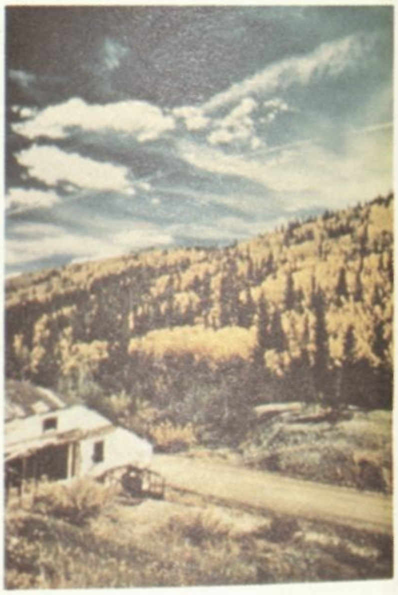
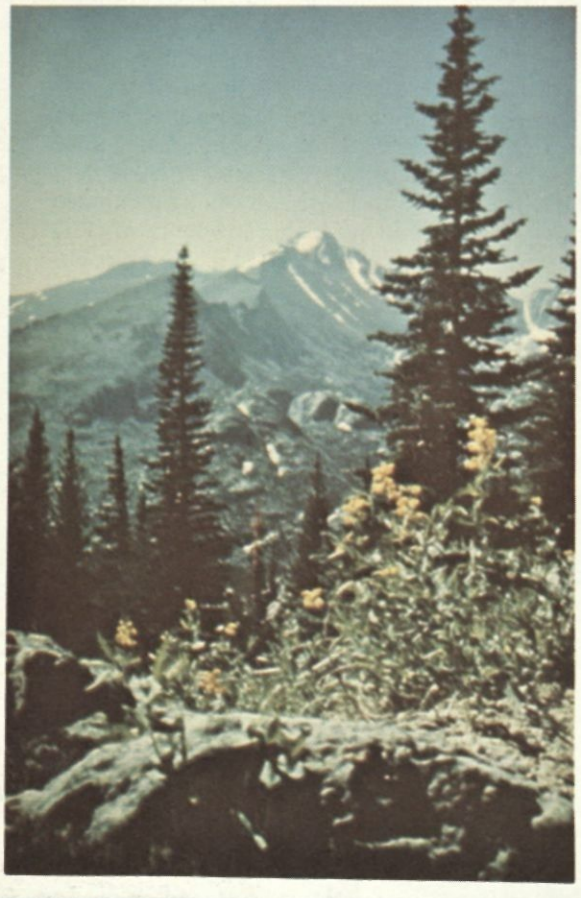
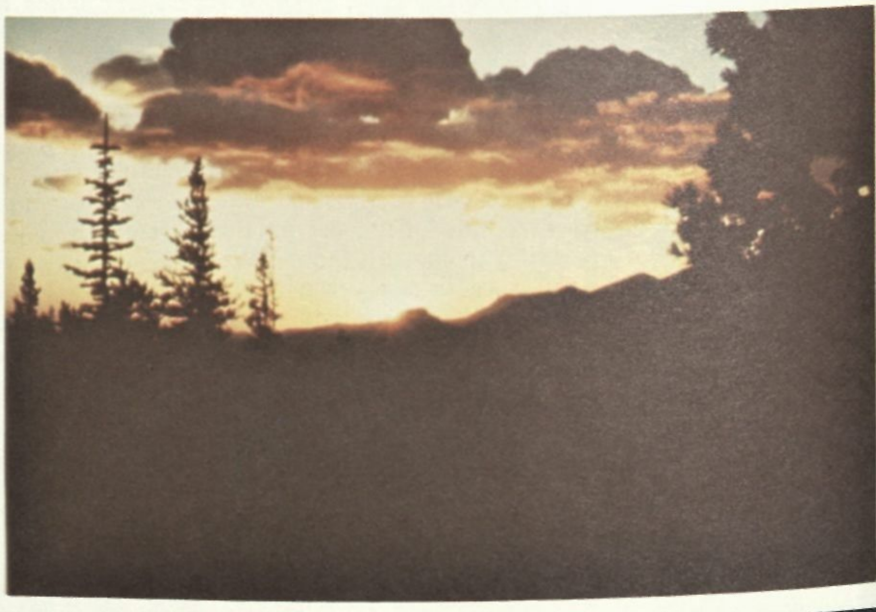
It was also found that *anti-oxidants* (such as are found in commercial products to prevent oils and fats in processed foods from turning rancid, and also found in Vitamin E) tended to be vital in keeping arterial walls free of clogging. Unfortunately, more research must be done before definitive answers can be given.

It also has been found that *lecithin* (which contains large amounts of choline), which is a powerful emulsifying agent, can be very useful both in the prevention of atherosclerosis and in its elimination. This is because blood is essentially like water in chemical nature, and fats cannot dissolve in such a medium. But lecithin, if present in the blood stream, causes cholesterol deposits to be broken down into microscopic particles, which then can pass through the arterial walls and be utilized by the tissues.

—Thus, although diet and nutrition is certainly not the only determining factor in the cause of premature IHD, it very definitely plays an important part (perhaps *the* most important(and, therefore, cannot be neglected if one would avoid getting IHD.

CIGARETTE SMOKING: "Warning: The Surgeon General Has Determined That Cigarette Smoking is Dangerous to Your Health"—so reads the sign on all cigarette packages and magazine ads. But these are nice, general terms, which can be glossed over and easily forgotten. So try this on for size: ample statistical evidence supports *a mean increase of about 70% in the death rate from IHD in men who smoke one pack of cigarettes per day when compared to nonsmokers.* So, besides increasing your chances of lung and mouth cancer, cigarettes also kill very nicely via IHD, presumably because the smoke is inhaled (pipe and cigar smokers show no higher incidence of IHD than nonsmokers). If you still smoke, good luck; you're going to need it.

PHYSICAL ACTIVITY, MENTAL REFERENCE FRAME, etc.: While precise evidence is as of yet lacking, all available data indicate that the less sedentary an individual is, the less susceptible he is to sudden death. The reasons for the benefit of exercise seem to lie in the improved ability of the heart to keep up with its demands, and the possible improvement in the efficiency of the collateral circulation (it is this collateral system which develops after a heart attack, to allow recovery). This may be an indicator a to why active people, in general, recover faster from heart attack than those whose only challenge is to move a pencil across a pad, or those whose only "sports activity" is that of a spectator.


← South Satellite Transit

RAPID TRANSIT
Past becoming Future

by LYNN COPLEY

THE PROBLEM

The inundation of automobiles in this country has brought on problems of transportation that can only be solved by new outlooks and developments in the field of rapid transit. The trend of building new roads to decrease congestion fails, for new roads generate additional traffic and the need for more roads to connect to the new roads and to connect the new roads to existing roads, thereby slowing traffic with new interchanges and intersections. Instead of enticing Americans with new roads, the government and private industry shoùld be directing their attentions toward the alternatives of travel, especially in urban areas where the transportation methods shape the core of a city. Research indicates that urban transportation planning should aim immediately toward reducing the number of private automobiles on the road.

Several obstacles constrict the non-automotive transportation industry. The psychological and social attitudes of Americans toward their cars and against mass transit delay the effectuation of rapid and efficient systems. Private cars symbolise individuality and escape to many people. Egocentric Western man needs to be resocialized because shrinking world space requires his trust of movement within crowds. Also, because fares on existing public transit remain too low and upkeep has been neglected, the middle class considers rapid transit a lower class means of transportation. Increased fares would raise the image of traveling en masse and pay for maintenance.

Some of the arguments that people pose against mass transportation such as inconvenience of getting to and from the pick-up and drop-off points, dislike of crowds, and mistrust of scheduling simply do not hold weight when airports are considered. People put up with long taxi rides or impose on friends neighbors to get to the airport, stand in multiple lines just to check in their luggage and board the plane, tolerate delayed and cancelled flights, as well as misplaced baggage from time to time, with few complaints. Could not these same people learn to walk a few blocks to meet a public vehicle that keeps a tight schedule? In a study, men who pay $100 a month to drive to work and pout up with limited parking facilities, increased insurance rates, and 10mph rush hour traffic balk at the idea of paying $48/month in train fares. These excuses become all the more flimsy when we examine the inconveniences and frustrations that man accepts routinely in the name of prestige (flying in airplanes) and privacy (one car per person paying gasoline, upkeep, parking, tolls, etc. to go to work).

Why do Americans, who think nothing of spending great chunks of time on a weekend doing physical recreation, dichotomize physical exercise? They accept exertion as a form of pleasure but refuse to walk 10 minutes to a bus or train as part of getting to work.

DOLLARS

In economics, transport markets resemble those of non-regulated industries. The best incentive toward efficiency and progress in any industry is competition. When restrained, the railways suffer consequences. A free supply-demand market could bring about rational pricing. As of now, the transportation problem is contained within a circularly negative trap. Rapid transit remains inadequate because of a lack of increment in pricing. Constantly pelleting advertising exalts the one-man-per-car concept. The U.S. government outlays vast amounts of money to roads and airways (the latter servicing a small portion of the travelling public), aiding an already economically inflated construction industry. New jobs could abound in the building of rails, vehicles to put on those rails, and people to collect fares, schedule departures, protect passengers, operate the vehicles and maintain upkeep. Road construction solves transport crises in the short-run. Investments in rapid transit would aid the economy on a long-term basis. Consider freeway systems expected to reach maximum capacity within 10-20 years. Generally, they get overloaded in two or three years.

The Yonge St. subway in Toronto, Ontario exemplifies the economic growth potential of one rapid transit investment. A tremendous building boom of high-rise developments revitalized the city at all the key stations, spreading the core and making it a safer and more desirable place to move about in because of the increased circulation of working people and people searching out the entertainment facilities. The Bay Area Rapid Transit (BART) in San Francisco has begun to transform Market St. in like manner. Real-estate values and business investments cannot help but respond favorably to mass transit.

President Nixon took initial steps by signing the Urban Mass Transportation Assistance Act. Secretary of Transportation John A. Volpe would like to see growth in this direction. His department allocated $60.5 million to mass transit, $29.4 million of which goes to new systems. The remainder serves buses and railways. Now investors, sociologists, advertisers, taxpayers and potential passengers must voice support toward rapid transit because—

75 square feet of space are required by each passenger in a moving private vehicle. 92 square feet are required for that person to park.

90% of all intercity travel is by car. 70% of these cars carry commuters on the average of 1.5 persons per vehicle.

More than 50,000 are killed each year in roadway accidents. Since the advent of the automobile, 1.5 million have lost their lives because of it, more than all the combat deaths in all wars.
$12,000 million, the total annual cost of roadway accidents in the U.S., triples the annual cost of the U.S. space program.

Each new miles of freeway removes 40-50 acres of taxable and liveable property from the earth.
In Kansas City, one expressway interchange alone occupies 50 acres of land.

In 1941 there were 11.4 cars per mile of road; in 1965, the figure had risen to 22 cars. The 1971 vehicle report for the U.S. listed 112.9 million road vehicles: 92.5 million cars; 19.77 million trucks; only 400,000 buses.
In 1970, 75% of all U.S. mass transit consisted of buses. Five cities supplied railroad commuter service.

In 1960, 1500 intercity trains serviced American cities.
By 1970 the number had dropped to 450.

During the 3/4 hour period from 4:45-5:30 PM in Chicago, six rail transit lines and eight commuter railroads carry 120,000 passengers away from the downtown area.
To move 120,000 in automobiles, with typically existing passenger loads per car, 70 express highway lanes going in one direction only, would be needed.

One railway track headed in one direction can handle from 40,000-60,000 passengers per hour.
One highway headed in one direction handles 3,000 passengers per hour.

The Federal Government spends less than 1% of its total research and development budget on transportation.
The Federal Government paid 90% of the Interstate Highway System, and the states paid the remaining 10%.

Each mile of urban expressway costs on the average $30 million.
One two-track mile of cut-and-cover subway construction costs $17.5 million.

Traffic increments on the average of 5-10% per annum.

ALTERNATIVES

Reduction of the number of private vehicles on the road can occur in many ways, each of which applies to certain problem areas. Improvements in each mode of transportation and integration of all are necessary to achieve efficient movement. Hitchhiking manifests young peoples' return to such concepts as conservation of energy, trust and sharing. Law enforcement agencies would do well to legalize hitchhiking only at stop signs and red traffic lights to eliminate the hazards of suddenly stopping cars in metropolitan areas. Recognizing bicycles as a valid means of transportation by paving bikeways, crosshatching one lane of multi-lane streets for the exclusive use of bikes, and even closing off one north-south and one east-west road for bike use in school and university areas, can prolong the life of cities. Bicycles constitute the rapid transportation of many New York City streets. Cities should take advantage of their spatial and healthful values by reducing the dangers of biking. Pedestr*ans, hitchhikers, and cyclists experience a more personal contact with the world around themselves. This return to awareness of surroundings benefits transportation by revitalizing pre-automotive trust in fellow man.

Earth Day 1970 encouraged carpools. Similarly, 10-20 person capacity Dial-a-Ride buses, a recent throw-back to the '30s jitney concept of shared door-to-door bus service, reduced not only the need for individual taxis but also the cost per person. The elderly living on social security, people in sprawling suburbial housing developments designed to slow traffic, and mothers from one-car families who must shop with infants are among tose who gain access to the outside through demand-responsive buses.

Traditional buslines have revamping possibilites. Because of the low initial cost outlay for buses, certain lanes and minor roads parallel to major streets should be shut off to all but bus traffic to peed operation of these high volume capacity vehicles. Bus schedules and route are flexible enough to change when demand needs alter. The frequency of service, greater than that of rail transportation because buses carry fewer passengers, yields reduced waiting time. Buses have an advantage over railraods temming from their ability to start at a number of target points in the suburbs and end at diverse sites in the center of the city. Also, diesel buses emit less than 1/3 of the hydrocarbons and CO that cars spew out.

The railway's suffering reputation stems from too low fares and, thus, inadequate upkeep. In many cases, bus and train fares are nearly identical, even when the train traverses many more miles *n a shorter length of time. Anyone who has traveled on European electric trains knows how comfortable, clean, enjoyable, speedy, and convenient train rides can be. Effective and economically feaible railway use in everyday mass transit depends on the following criteria: that the line serves travel demands from outlying areas to the city center; that certain main corridors and a high-density core exist in the city plan; that quick access, parking facilities, taxis and buses on the outkirts enable passengers to get to the train conveniently. Several innovations which will be discussed further on offer possibilities for sound investment and hopes for renewal of the railway concept as a viable means of transportation.

@Non-vehicular alternatives can aid the future of transportation. Besides depending on exorbitant parking costs and extreme congestion to force people onto public transportation, artificially imposed means such as charging tolls to enter the city core except to buses and cars that carry three or more people, the levying of a special tax on cars that enter the city every day, and developing beltways and "park and ride" facilities at the edge of cities to link freeways with a mass transit system at the city limits. Legalizing the import of small cars like the British Mini Cooper for in-city ue only, development of rent-and-drive electric cart depots, staggered shifts in business and industry. computerized traffic control to move vehicles faster and reduce stream turbulence, construction of pipeline facilities to transport freight, and development of slide-out bus seats so that buses can carry freight in lack hours (eliminating the need for each small business to own and park a transport van, and increasing busline profits), are all means for reducing congestion. Automobile insurance companies offer lower rates for cars used exclusively for recreational purposes; widespread advertising campaigns should encourage car owners to take advantage of these rates. Concerned groups could stage anti-auto shows to promote the concept of zero auto growth.

DIAL-A-RIDE

Approximately ten cities have demand-responsive buses in operation today. The Bay Ridges, Ontario experiment proves that dial-a-ride can earn more profit and cost less per revenue mile than ordinary bus systems. Loer maintenance and fuel bills more than compensate for the added cost of dispatching. Rear-engine vehicles make maintenance easier and usually increase gas mileage. Sprawling, low-density, homogeneous towns and diffuse cties such as Los Angeles lend themselves well to this concept. The smaller, air-conditioned, easy-entry buses have potential use a chool buses and airport-carpark shuttle buses. They could serve pasengers transferring between terminals as well as university students in cities with two or more campuses.

Dial-a-ride eases unemployment in two ways: by requiring more drivers and dispatchers and by making jobs more accesible to those who live away from major bus routes or who have to work in remote areas. Passengers know when they will arrive at their destination, do not have to transfer, and are guaranteed seats during the trip. These smaller buses follow the most direct route possible in a timespan competitive with the private car.

TRANSPO 72

Held at Dulles Airport in Washington, D.C. late last May, Transpo 72 presented and demonstrated new systems of rapid transit. San Francisco's BART began operations several months ago, and more track miles are planned. The city contains the heaviest concentration of cars in the world - 7,000 per square mile. During the planning stage, BART interviewers questioned people about their feelings toward a new rapid transit system. Responses favored the construction, but many people admitted later that they hoped their neighbors would ue it so that the roads would be less crowded for themselves. Time will probably eventually tell a success story about this and similar operations being built in L.A., Washington, D.C., Baltimore, and other forward-reaching cities.

Both the San Francisco and Washington systems have automatic fare-collecting gates to eliminate the need for carrying money. The passenger inserts a magnetic encoded ticket into a slot which subtacts te amount, proportionate to the distance, from the ticket. Washington intends completing its 98-mile outfit by 1980. Planning emphasis in both cities has been placed on comfort and convenience; no passengers will have to stand. BART travelers have an adequate system of feeder buses at their disposal.

@Personal rapid transit (PRT - the minitram "horizontal elevator") also got recognition at Transpo 72. Small vehicles move along tracks at very frequent intervals. The prototypes displayed had demand-activated push button mechanisms to select the destination, emergency call buttons, and doors with elevator-like access to eliminate steps. At Morgantown, Virginia one PRT system will connect the central business district to two of the three campuses and the campuses with each other, stopping at two-second intervals.

@Other innovations such as the tracked air cushion vehicle (TACV), linear induction motor (LIM), and unitran, a monorail, displayed possibilities for rapid transit. France's TACV from Orly Airport to central Paris cruises at 150 mph. Because LIM has no moving parts it creates no air pollution and little noise. Two electromagnets pull the car. Another prototype, a small electric auto called dual-mode, can run on roads under battery power and on exclusive lanes under guideway electric propulsion. Finally, capule transit consists of small cars moved by belts or variable-speed roller. These new tranportaiton modes point out the fact that huge, lumbering, noisy trains are not the only alternatives to highway and street travel.

Experiments show that lithium chloride, sodium sulfur, and zinc-air batteries can replace traditional types. Gas-turbine electric motor, the Rankine cycle engine, propelled on steam, four-stroke engines hich decrease vapor loss by means of a nitrogen oxide catalytic converter, and finally engines that can switch from lquified or compressed natural gas to gasoline cover the gamut of clean and resource diversifying motors displayed at Transpo 72.

G.M. presented "Metrip", now being tested in Rochester, N.Y., an automated system to double the speed and passenger carrying capacity of traditional buses. Approaching downtown in random oder, buses prepare to enter the congested areas by identifying themselves electronically. A telephone data line transmits their signals to a central computer which processes the arrival data. Then the computer transfers the messages to passenger information igns at bus stops, at the same time signalling the drivers, via an advance light, to move out. The stoplight remains green long enough to allow the whole platoon of buses to move through the ntersection. Washington, D.C. also extends green signals for buses. Speeding up bus travel with lengthened lights and exclusive bus lanes means that more passengers can utilize the service because, during rush hour, more buses can return to the starting pointto pick up new loads. Metrip also increases the desireability of bus travel by saving the passengers' time.

The Transportation High-Speed Ground Test Center at Pueblo, Colorado has been chosen as the site for testing the best currently available rapid transit technology in the U.S. The competition will eliminate those models which have uneconomical and non-durable characteristics.

AIRTRANS

The Ground Transportation Division of the LTV Aerospace Corporation in Dallas, Texas is currently activating many of the above-mentioned methods of rapid transit. Personalized rapid transit, collection and distribution systems, and movers of people, luggage, mail and trash make up an automated transit network being installed at the new Dallas - Fort Worth Airport. High speed tracked air cushion and magnetically levitated vehicles utilize aerospace technology to solve ground transportation problem. The system can serve as the core of an urban transit plan, satisfying the double needs for slow and fast-moving vehicles.

The passenger compartments, automatically propelled by electric power through a concrete U-shaped guideway, receive electricity in their 60 hp traction motors. An operator at a central control console monitors the entire route. Physical characteristics of the units include open floors to permit easy maintenance access, an air-cushion suspension system to soften the ride, and foam filled tires to privde safety and low maintenance.

The inexpensive Multi-Purpose Transporter, propelled by LIM, features few components, uncomplicated guideway steering, and positive entrapment. The body and seats of the vehicle are fiberglass over a welded aluminum frame which is enclosed for all-weather protection. The suspension units use standard automobile tires, weels, and bearings, with a spring strut or kingpin as the steering pivot point of the wheel and axle assembly. Beneath the vehicle, mechanically linked to the frame, LIM secondaries move along the gu*deay on their own small, hard polyurethane tires.

The LIMs of the Multi-Purpose Transporter are in two parts, the econdaries attached to the vehicle chassis and the primaries *nstalled in the guideway. Electrical interaction between the two propels the vehicle, eliminating any need for wheel traction. Power varies according to passenger load, maintaining relatively 'niform acceleration, speed, and decleration. A linkage between the vehicle chassis and the LIM secondaries beneath adjusts the height of the secondary according to load, thereby reducing the gap between the secondary and primary and automatically increasing propulsion power.

4ZSpeed is controlled by two different types of primaries, one for maximum speed (long pole pitch) and one for slow speed (short pole pitch) in station areas. DC magnets at the entrance to stations and at other decleration places control the braking. Reversing the voltage to LIM motors also brakes the vehicle. Mechanical friction rakes serve emergency use.

Airtrans' TACV design, already mentioned in the Transpo 72 section, should have wide application in high-speed ground transportation by filling the gap between rail systems and short haul air travel, and by providing an alternative to the automobile for medium distance trips. TACV speeds more than 150 mph while maintaining safety, low cot, and comfort. Applied aerospace fail-safe design technology and high-strength materials, including double-pane rockproof windows and impact resistant windscreens, combine with a complete lack of fuels on board to ignite and isolation of the passenger compartment from electrical equipment to provide)aximum afety. LIM also propels this vehicle so that there are no orking parts nor polluting devices. Hinged air cushions which minimize air losses, allowing smaller, less expensive operating motors, a soft secondary suspension system which easily absorbs the jars and jolts of an uneven track surface, and a flexible air cushion design that accepts rough, uneven, low-cost tracks all attribute TACV its name.

LTV Aerospace Corporation has also designed an external combustion engine bus (ECE bus) wch runs on an Organic Rankine Cycle Engine, operating in the following manner: an organic working fluid with suitable expansion and condensation characteristics, varying ith temperature, circulates through a system consisting of a vaporizer, prime mover, and condenser; the working fluid. recirculated by a pump, is changed from a liquid to vapor in the vaporizer by heat; the vapor is expanded through a prime mover which will provide power to the driveshaft and engine accessories; in the condenser the vapor is converted back to its liquid state and is ready to go through the cycle again.

The low-pollution characteristics of a Rankine Cycle Engine stem from the fact that combustion of fuel takes place in the open ar and is more complete than the burning in an enclosed cylinder of the conventional internal combustion engine. This particular ECE bus uses CP- 25 (Toluol) as the working fluid, turbine for the prime mover, and propane as the fuel. The maximum working fluid temperature of 700 F meshes with a maximum working fluid pressure of 700 psi to put out a horsepower rating of 120 gross.

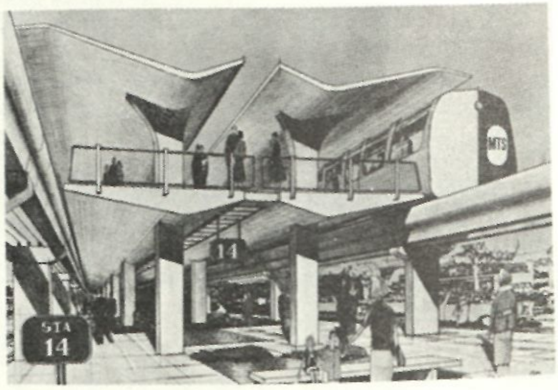
SUMMATION

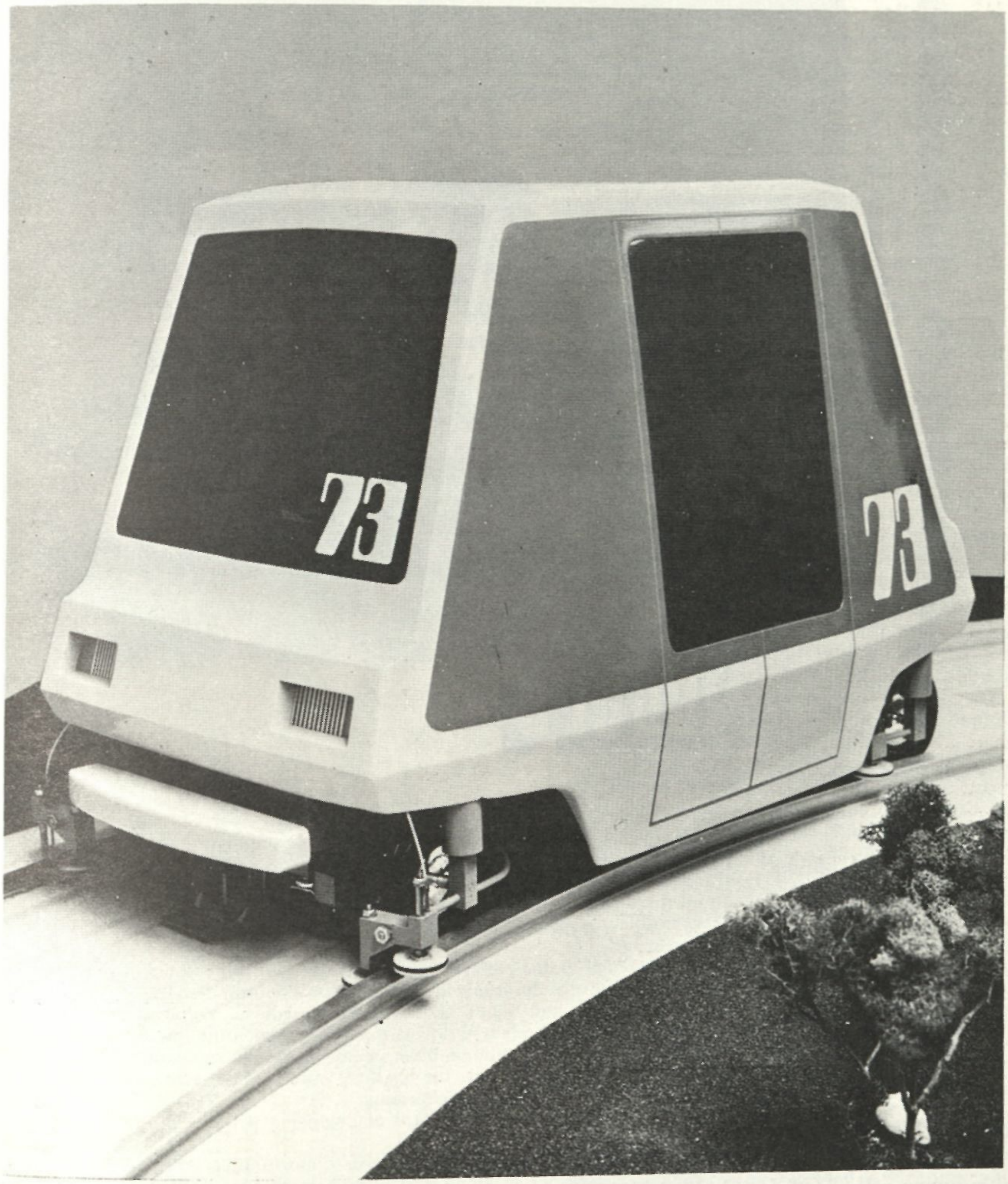
The balance sheet between automotive and rapid transit does not present an entirely irreparable situation. Industrial research, aakening to the investment possibilities of rapid transit, youth, aware and concerned about black-strip trends in the country, and workers, anxious to travel rapidly and comfortably to their jobs, all aim toward a lessening of traffic congestion and its hazards. Countries like Denmark can afford to suspend driving licenses after one drunken driving offense because of the prevalence of public transportation. When we change our attitudes from individual ownership of all desired material good to goup onership of multi-purpose facilities, we will conmore people, and, hopefully, learn to move about in contact crowd instead of in our protective shell cars. Socially deviant incidents caused by frustrated societal alienation can be lessened by increased public interaciton.

The disuse and subsequent decay of rapid transit in the '60s how igns of being temporary trends thanks to a rebirth of technological interest in this field. Statistically, 64% of the population drove to and from work in private cars in 1960, and only 12% used public transportation. Perhaps by 1980 we can reverse those figures.

ACKNOWLEDGEMENT

Colorado Engineer *extends appreciation to the Ground Transportation Division of the LTV Aerospace Corporation both for the information supplied about the recent innovations and programs and for the fact that the Corporation has made advances in the field of rapid transit. Further information can be obtained by contacting the above diviion at P.O. Box 5907, Dallas, Texas 75222.*

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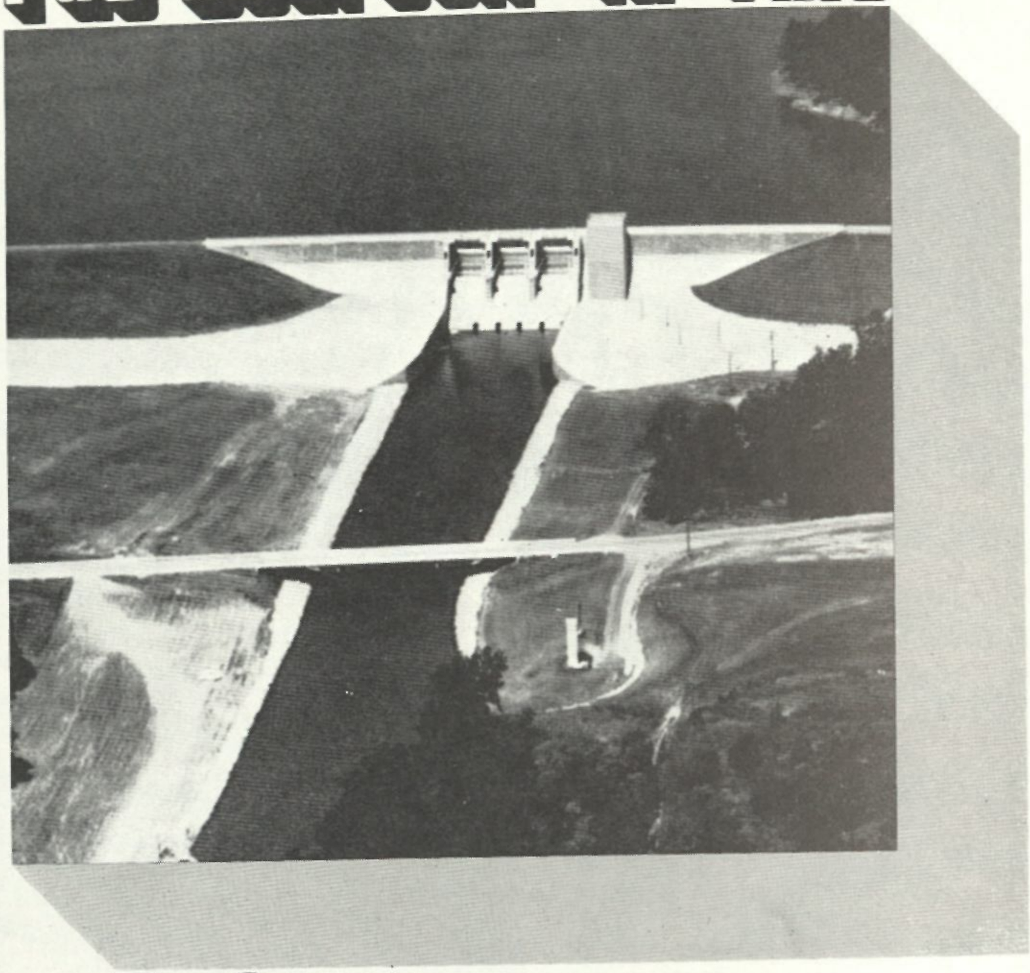
Put Yourself in This



Picture

In less than thirty years, around the year 2000, our population will grow from 210 million people to over 300 million people. Three people for every two of us now!

It means we must all work doubly hard today to preserve for future generations our many natural resources that we have taken for granted. The Corps of Engineers, for example, is responsible for planning, development and management of our nation's principal water resources.

If you "put yourself in this picture" you can identify with the kinds of things we do. This is Deer Creek Dam and Reservoir in Ohio, part of a coordinated system of flood protection in the Deer Creek and Scioto and Ohio River valleys. Water stored in the lake is used for conservation and released downstream for augmenting low flows. During the first full year of operation almost one million visitors used the recreational facilities which are provided in the reservoir area for boating, water skiing, swimming, fishing, picnicking, camping, hiking, hunting and sightseeing.

The project is typical of many the Corps of Engineers will design and complete during the next few years.

Want to put yourself in this picture? Career opportunities with the Corps of Engineers go beyond water resources alone. We work in modern construction, engineering design, systems analysis, computer technology & R&D—these are just a few of the other areas where you can build a career of total involvement, achievement and satisfaction with the world's largest engineering/construction organization.

Interested? Write for our new brochure describing the challenges awaiting civilian engineers with the Corps of Engineers. Department of the Army, Washington, D.C. 20314 Equal opportunity employer

CORPS OF ENGINEERS

There is also some evidence that the hard-driving person, who is deadlineconscious, striving, and compulsive, seems to have more incidence of IHD than the more passive, sluggish-type of individual. In one study, this former group had nearly three times the incidence of new IHD when compared to the latter group.

However, it should be noted that Japan has one of the *lowest* rates of death from IHD. And no intelligent person would try making the claim that life in industrial Japan is sluggish or passive. It is possible that Japan's very low death rate from IHD is due to the fact that the Japanese eat much larger percentages of fish in their diet than do Americans and, in general, are in better physical condition. Genetic factors may also be present. But in any case, cause-and-effect evidence is, at present, lacking in the link between personality-type and incidence of IHD.

Whatever harm getting "all wound up" may cause to your circulatory system is, as of yet, unproven; but it is certain that such a condition increases your blood pressure and does wonders to your stomach. The best advice would seem to be to enjoy life more and worry less about nonvital details.

It is hoped that this article has been informative about the causes and effects of IHD. Absolute cures remain to be found; but, as of now, the responsibility for prevention points its finger at *you, the individual.* Whether or not one *does* lower the chances of IHD really boils down to how much one cares to stay alive. It's that simple. Do you care?

notes & news

There's a future in our diversity.

Bethlehem has traditionally been not only a steelmaker, but also a producer in more than 50 other steel-related manufacturing businesses. Now we have diversified into many new areas. Recently acquired subsidiaries produce a broad range of products—plastics, including toys and sporting goods, minerals, and residential properties. And there's more on our diversification horizon.

The fight goes on.

We're continuing our environmental quality control investments at a $25-million-a-year clip. Recent examples: we just completed a $22-million water pollution abatement project at our Lackawanna Plant; improved air pollution controls have just been installed on electric furnace shops at Seattle and Bethlehem; and we're adding a $2½-million gas cleaning system at our Sparrows Point, Md., open-hearth department.

A new product from R & D.

The development of new processes and products at Bethlehem's Homer Research Laboratories relies on a surprising range of science and engineering fields; metallurgy, chemistry, electronics, even biology to name a few. One of our new sheet steel products, Galvalume, was developed by the surface-chemists of our corrosion group. Galvalume is a coated sheet steel product with excellent heat and corrosion resistance imparted by an aluminum-zinc alloy coating. Galvalume sheets have a wide range of applications, especially in the automotive and appliance industries.

Recycling? We've been doing it for years.

By now most students interested in the environment are aware that about 50% of all new steel is made from iron and steel scrap. Lots of folks overlook the fact that many other "products" of the steel-making process are recycled. For example, gas generated in the blast furnaces and coke ovens is cleaned. Some of it goes back into the stoves. The remainder serves as fuel for other processes in the plant. Iron ore particles trapped by pollution control devices monitoring the steel-making furnaces are collected, processed, and charged back into the furnaces.

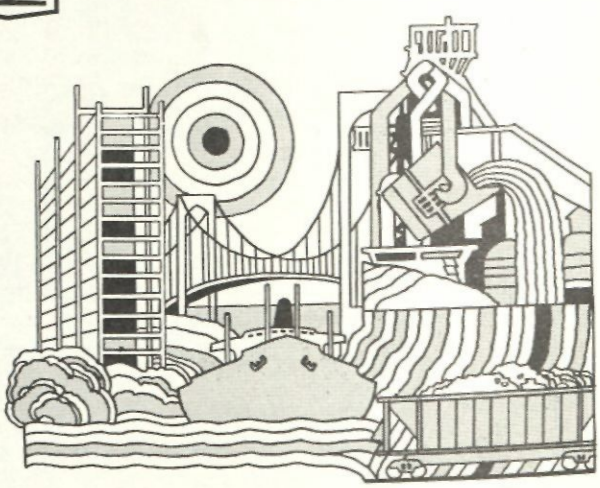
265,000-dwt supertankers ordered.

Bethlehem has a $215-million contract for three large crude oil carriers, the largest commercial vessels to be built in the U.S. They'll be built in our huge (1,200 x 200-ft.) new building basin at our Sparrows Point, Md., shipyard. Each tanker will need about 50,000 tons of our steel products.

Watch for our interviewers.

They'll be visiting your campus soon. Why not sign up for an interview and find out about a future in steel? In the meantime, pick up a copy of our Booklet, "Bethlehem Steel's Loop Course" in your placement office. Or write to: Director—College Relations, Bethlehem Steel Corporation, Bethlehem, PA 18016.

BETHLEHEM STEEL an equal opportunity employer



temperatures, and has better electrical characteristics than germanium. What wasn't known was how to work with this intractable element.

Silicon has a melting point of 1417 degrees centigrade (compared to only 937 for germanium) and reacts with any material used to contain it at that temperature. Impossible as it seemed, some means of melting and refining silicon *without actually touching it* had to be devised.

Once again, the Bell Labs-Western Electric team put their heads together and came up with a solution. The answer was a variation of zone refining called float zone growing, in which high-power radio waves are used to melt a thin section of silicon rod and move it and its impurities down the rod. The same kind of surface tension that lets you fill a water glass to just beyond its brim without sloshing, keeps the molten zone from spilling out of the rod.

For all the endless series of problems that beset Western Electric engineers in those days, there were some compensating advantages to being first. One of these was that the patents which resulted from the numerous inventions have been an asset in negotiating cross license agreements with other companies in the industry.

Because of them, the Bell System obtained rights to use the patents of others so that it has been able to take advantage of inventions made by the semiconductor industry for the benefit of its communications customers. At the same time, the Bell System has shared its hard earned knowledge with others.

Realizing the potential impact of this technological breakthrough, in April 1952, Western held the world's first transistor manufacturing symposium for its transistor patent licensees. For five very crowded days, representatives of 9 foreign and 25 American companies heard Western engineers reveal the details of what they had learned.

The April symposium led to the publication a few months later of a definitive two-volume work on transistor technology. Between getting out this massive work and getting the transistor into manufacture, many Western engineers became almost strangers to their families.

Today the 1952 symposium is remembered at Western not only for the impetus it gave to worldwide transistor technology, but also for a memorable bit of prophecy.

Western management knew the transistor would never really get anyplace unless it could eventually be made cheaply. The enormous potential was there and immediately recognizable, but would the mighty midget ever become economically feasible?

Don Wilkes, Allentown's General Manager, was one of those who thought so right from the beginning and who managed to instill his faith into Western Electric people and wary outside managers.

On the last day of the symposium, after four days of discussion that sometimes seemed to make the problems of manufacturing the transistor economically and technologically insurmountable, the question of cost finally came up. One attendeed, dazzled and bewildered by the technological demands of making the strange new device, asked the question that had been looming large in everyone's mind — "How much will the darned things cost?"

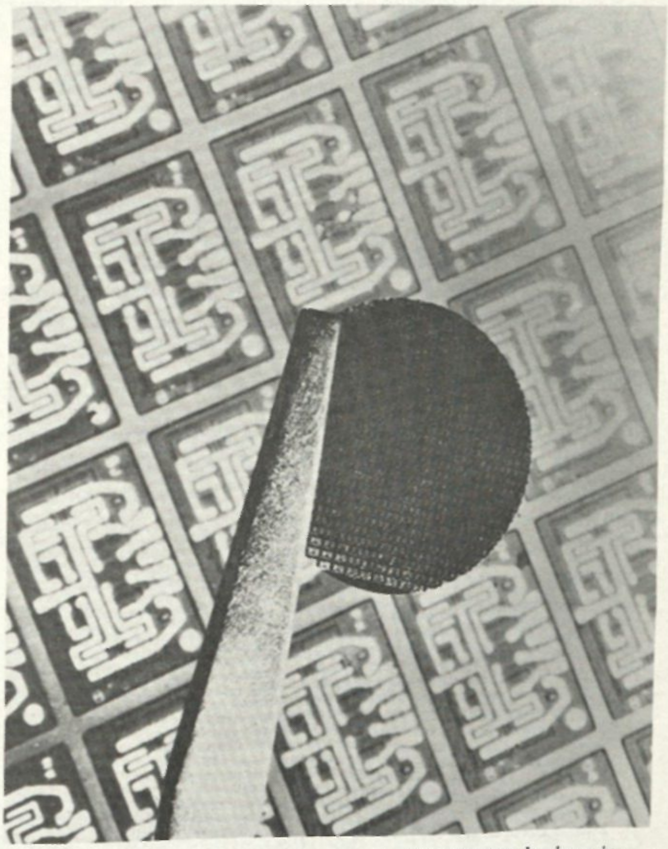
There was a hushed, almost embarrassed silence, and then Don Wilkes, secure in his faith in Western know-how, boomed out loud and clear, "Twenty-nine cents!"

Wilkes' faith has long been vindicated. At the time he spoke, transistors were running between five and ten dollars each and a good month's production was measured in the hundreds. Today, transistors can be purchased for well under twenty-nine cents and annual production numbers in the United States alone run over one billion.

The mighty midget has passed through several generations since the original point-contact transistor and during this time, the Bell Labs-Western Electric team has come up with one innovation after another. Understandably, the price of this progress has been high. Swiftly changing technologies have effectively meant starting over again and again. It has been estimated that Western Electric scientists, engineers, technicians, and assemblers have had to learn a whole new array of methods, theories, and techniques many times since 1951.

Through all this, the Bell Laboratories-Western team has built a broad and solid base of transistor technology, much of which will endure for years to come.

Take the matter of bonding. From the start, a major manufacturing problem has been to make good electrical connections to transistors. As the devices have become smaller and more complex, this problem has intensified. The trouble isn't simply that the connections can easily become larger than the minute junctions they are supposed to contact, but also that heat, solder, adhesives, or whatever medium is used to make the connection can alter the nature of the transistor material.



INTEGRATED CIRCUITS. An outgrowth of transistor technology, integrated circuits can be made hundreds at one time on a slice of semiconductor material. The semi-conductor slice, being held by tweezers, is magnified in the background.

To solve this difficult problem, a method called thermocompression bonding was developed. A particularly useful variation known as stitch, or needle, bonding, uses precisely applied pressure and moderate heat to join two metals without melting either one as would be the case with soldering. The method is cheap, simple, and highly reliable. Here again, Bell Labs did the early experimental work and Western turned their ideas into production realities.

The same kind of teamwork led to the solution of an even knottier problem. Early transistors required protective cans and vacuum seals just like tubes. This kind of encapsulation is a complex and costly business, and an early dream at Allentown was to find a way of doing away with it.

This dream, too, has been realized and today, Western is making transistors that prove you can't judge these devices by their covers any more than you can judge books by theirs.

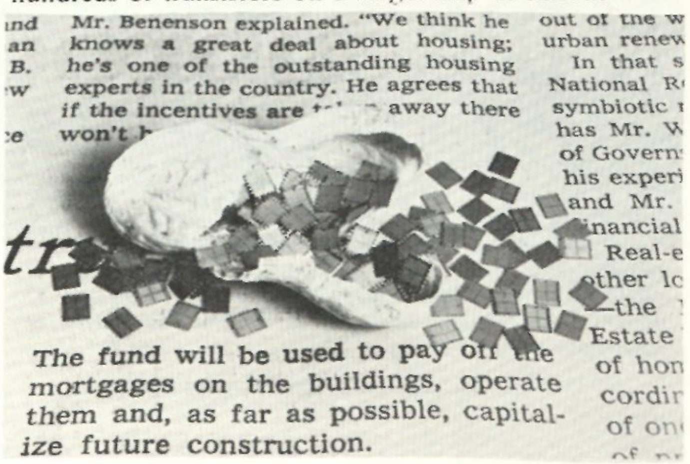
Known as sealed junction transistors, these unprepossessing looking beads of plastic give no hint of the fantastic reliability they are capable of. Beneath the plastic — which serves only for mechanical protection — a microscopically thin chemical layer protects the transistor against any kind of contamination. Sealed junctions have laid the chimerical deathnium to rest for all time.

Because of these and a host of other innovative developments, transistor capabilities have grown by leaps and bounds. Western's current crop of transistors can operate at frequencies well above anything even thought possible twenty years ago and can handle high power assignments with the greatest of ease.

But, above all, Western's transistors are reliable beyond the fondest hopes of any of the Allentown pioneers. The average life expectancy of its transistors can be measured in thousands of years — in some cases, even in tens of thousands of years.

This may seem excessively cautious until you take into account the enormous numbers of transistors used in Bell System equipment. A typical electronic switching office, for example, may have as many as 54,000 transistors, and every one of them must function perfectly for 24 hours a day, 365 days a year — year after year after year. Because these stringent requirements are unlike those of any other industry, Western's transistors are unlike those of many other manufacturers.

As the transistor's capabilities have grown, its size has shurnk. Transistors built into integrated circuits — the sophisticated decendants of discrete transistors — have shrunk almost to the vanishing point. Five or more of these miniscule devices occupy less space than the cross-section of a human hair, and some integrated circuits incorporate hundreds of transistors on a single chip of silicon.



Because of its many new capabilities and incredible reliability, the transistor has found its way into every nook and cranny of the Bell System. Solid-state devices of one kind or another have become the vital organs of telephone switching and transmission systems. You can find them in Data-Phone® sets, Picturephone® sets, Touch-Tone® sets, and in many other Bell customer products as well. In addition, a number of new technologies, such as millimeter waveguide, which promises to provide hundreds of thousands of telephone channels in a single metal pipe, are almost entirely based on solid-state devices and technology.

And, finally, in a classic example of boot-strapping, transistors are playing an increasingly vital role in their own manufacture. They are used extensively in the control circuits of the machines that make them and they have made possible the small, economical digital computers without which modern transistor and integrated circuit manufacture would be virtually impossible. These indispensable transistorized brains test transistors and keep tabs of the status and location of everything involved in the myriad steps of their manufacture.

Naturally, the burgeoning transistor has resulted in the swift spread of solid-state economies from one Western Electric plant to another. Thousands of employees are busily assembling solid-state devices and systems in North Carolina, Indianapolis, Lisle, Hawthorne, Reading, Merrimack Valley and other Western locations.

For Western Electric, the transistor has also meant the birth of a new breed of manufacturing engineer. Its early experiences with the transistor made it clear its engineers would have to become a whole lot more conversant with physics, chemistry, metallurgy and a number of other fundamental disciplines formerly of interest only to pure science types. The old "factory engineer" soon began fading into antiquity. In the age of the transistor, what was needed was the kind of knowledgeable engineer who could work forehead-to-forehead with Bell Labs scientists. Western has helped this new breed come into being with a number of 5&A education programs and a Corporate Education Center in Princeton, New Jersey, that is unsurpassed in industry.

What does the future hold for Western? Dr. Morris Tanenbaum, Western's former Vice President of Engineering, now Vice President of Transmission Equipment, feels that solid-state technology is just beginning to reach its maturity.

Dr. Tanenbaum, who joined the Bell System 20 years ago as a young engineering PhD because it was the company that had invented the transistor, says solid-state manufacture is still on the exponential part of its growth curve — meaning it will continue to grow by leaps and bounds. Integrated circuits are only now starting to find their way into telephone equipment in large quantities.

Like transistors before them, integrated circuits will spread rapidly into every facet of the Bell System. The next ten years will see the emergence of bigger, more complex integrated circuits, taking advantage of recent advances in other technologies such as charge-coupled devices, magnetic bubbles, and optics. For Western Electric's new breed of engineer, the challenge will constantly renew itself. As integrated circuits become more sophisticated, so will the equipment and techniques for manufacturing them.

What comes after integrated circuits? Nobody really knows. The transistor ushered in a new era in communications and manufacture. Inevitably, some new breakthrough, still unknown, will usher in yet another era.

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