GENERAL ELECTRIC Review

SEPTEMBER 1958

Wanted—Nonconformists

Missile Authority Interviewed

How Television Teaches

High-speed transit brings ball fans directly to turnstiles for . . .

World Series — 1970

PAGE 22

One of a series

Interview with General Electric's Hubert W. Gouldthorpe Manager—Engineering Personnel

Your Salary

Although many surveys show that salary is not the prime factor contributing to job satisfaction, it is of great importance to students weighing career opportunities. Here, Mr. Gouldthorpe answers some questions frequently asked by college engineering students.

Q. Mr. Gouldthorpe, how do you determine the starting salaries you offer graduating engineers?

A. Well, we try to evaluate the man's potential worth to General Electric. This depends on his qualifications and our need for those qualifications.

Q. How do you evaluate this potential?

A. We do it on the basis of demonstrated scholarship and extra-curricular performance, work experience, and personal qualities as appraised by interviewers, faculty, and other references.

Of course, we're not the only company looking for highly qualified men. We're alert to competition and pay competitive salaries to get the promising engineers we need.

Q. When could I expect my first raise at General Electric?

A. Our primary training programs for engineers, the Engineering Program, Manufacturing Program, and Technical Marketing Program, generally grant raises after you've been with the Company about a year.

Q. Is it an automatic raise?

A. It's automatic only in the sense that your salary is reviewed at that time. Its amount, however, is not the same for everyone. This depends first and foremost on how well you have performed your assignments, but pay changes do reflect trends in over-all salary structure brought on by changes in the cost of living or other factors.

Q. How much is your benefit program worth, as an addition to salary?

A. A great deal. Company benefits can be a surprisingly large part of employee compensation. We figure our total benefit program can be worth as much as 1/6 of your salary, depending on the extent to which you participate in the many programs available at G.E.

Q. Participation in the programs, then, is voluntary?

A. Oh, yes. The medical and life insurance plan, pension plan, and savings and stock bonus plan are all operated on a mutual contribution basis, and you're not obligated to join any of them. But they are such good values that most of our people do participate. They're an excellent way to save and provide personal and family protection.

Q. After you've been with a company like G.E. for a few years, who decides when a raise is given and how much it will be? How high up does this decision have to go?

A. We review professional salaries at least once a year. Under our philosophy of delegating such responsibilities, the decision regarding your raise will be made by one man—the man you report to; subject to the approval of only one other man—his manager.

Q. At present, what salaries do engineers with ten years' experience make?

A. According to a 1956 Survey of the Engineers Joint Council*, engineers with 10 years in the electrical machinery manufacturing industry were earning a median salary of $8100, with salaries ranging up to and beyond $15,000. At General Electric more than two thirds of our 10-year, technical college graduates are earning above this industry median. This is because we provide opportunity for the competent man to develop rapidly toward the bigger job that fits his interests and makes full use of his capabilities. As a natural consequence, more men have reached the higher salaried positions faster, and they are there because of the high value of their contribution.

I hope this answers the question you asked, but I want to emphasize again that the salary *you* will be earning depends on the value of *your* contribution. The effect of such considerations as years of service, industry median salaries, etc., will be insignificant by comparison. It is most important for you to pick a job that will *let* you make the most of your capabilities.

Q. Do you have one salary plan for professional people in engineering and a different one for those in managerial work?

A. No, we don't make such a distinction between these two important kinds of work. We have an integrated salary structure which covers both kinds of jobs, all the way up to the President's. It assures pay in accordance with actual individual contribution, whichever avenue a man may choose to follow.

*** We have a limited number of copies of the Engineers Joint Council report entitled "Professional Income of Engineers—1956." If you would like a copy, write to Engineering Personnel, Bldg. 36, 5th Floor, General Electric Company, Schenectady 5, N. Y.** 959-7

LOOK FOR other interviews discussing: • Advancement in Large Companies • Qualities We Look For in Young Engineers • Personal Development.

GENERAL ELECTRIC

GENERAL ELECTRIC Review

SEPTEMBER 1958 VOLUME 61 NUMBER 5

The GENERAL ELECTRIC REVIEW is issued in January, March, May, July, September, and November by the General Electric Company, Schenectady, NY, and is printed in the USA by the Maqua Company. It is distributed to scientists and engineers throughout industrial, consulting, educational, professional society, and government groups, both domestic and foreign. . . . . The GENERAL ELECTRIC REVIEW is copyrighted 1958 by the General Electric Company, and permission for reproduction in any form must be obtained in writing from the Editor. . . . The contents of the GENERAL ELECTRIC REVIEW are analyzed and indexed by the Industrial Arts Index, The Engineering Index, and Science Abstracts and are available on microfilm from University Microfilms, Ann Arbor, Mich. . . . For back copies of the REVIEW—1903 through 1955—contact P. and H. Bliss Co., Middletown, Conn. . . . Six weeks' advance notice and old address as well as new are necessary for change of address. . . . Send communications to Editor, GENERAL ELECTRIC REVIEW, Schenectady 5, NY.

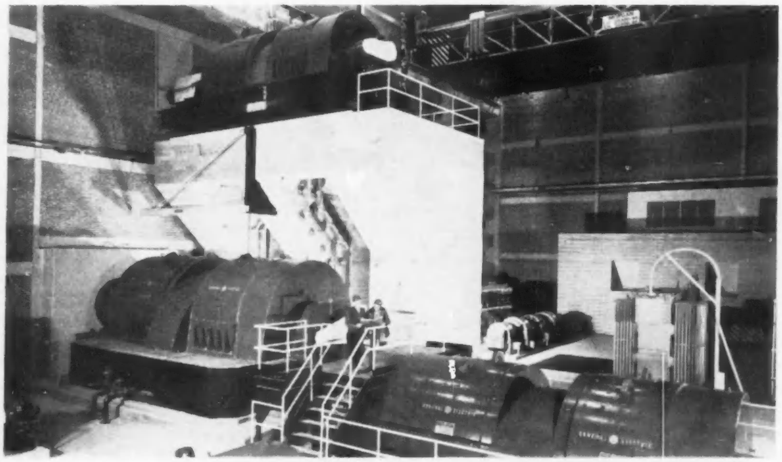
COVER

The rapidly expanding population of the United States will place a greater burden on already strained transportation facilities. But farsighted planning will introduce more than adequate measures, through more efficient interdependence of travel systems. When the umpire yells, "Play ball!" in the 1970 World Series, more people from farther away will watch the game, rain or shine, with no traffic tie-ups to dampen their enjoyment. From downtown business section to modern airport, from civic and shopping centers to your home, travel time will be measured in minutes. For a look at Metropolitan U.S.A.—1970, turn to the article that begins on page 22.

GENERAL ELECTRIC REVIEW editors select . . .

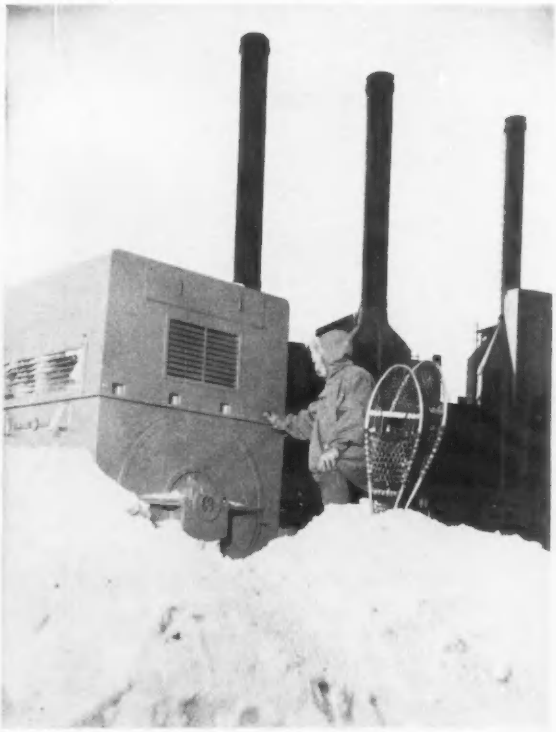
Operation Upturn EXTRA PRODUCT VALUES

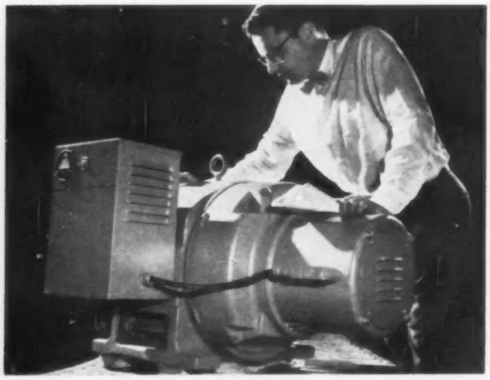
What's more basic to America's economy than electric motors? Today, more customer-focused than ever, they offer real value for years to come. Here are three electric drives that REVIEW editors chose because they typify extra product values.



SLABBING MILL MOTOR, a 12,000-hp double-armature twin drive, with TOP-FORWARD arrangement, is designed to power metal-rolling mills of the nation's steel industry. Part of a new line, it's the result of a complete redesign of mechanical and electric elements made over the past 4 years, based on a thorough review of modern mill-drive requirements. Some 40 special design, performance, and maintenance improvements are incorporated in the main drive motors. Because one hour of mill outage means considerable loss of revenue, these improvements were made to significantly reduce down-time.

WEATHER PROTECTED MOTOR, designed for application by electric utilities and pipeline, chemical, and petroleum industries, is suitable wherever you desire protection from wind, rain, hail, snow, and so on. Two built-in values are high-up ventilation and easy maintenance. Available from 250 hp upwards, this motor exceeds NEMA specifications for Type II weather-protected motors.





BRUSHLESS A-C GENERATOR, a 60-cycle machine with outputs of 40 to 150 kw, finds use wherever you need a reliable source of power—on farms, in industry, even for traveling road shows. In this generator, six hermetically sealed silicon rectifiers replace a multitude of brush and commutator parts that were subject to wearing and frequent adjustment.

Abstracts

For your convenience to clip and file for ready reference: brief summaries of articles appearing in this issue.

Space Technology Spurs New Development Philosophies *Classification:*

METCALF, G. F.

An interview with George F. Metcalf, eminent authority on space technology, reveals the methods used in gathering information from space and concepts in missile nose-cone, or re-entry vehicle, studies. New development methods have been formed to handle the unique problems in this vast new field.

GENERAL ELECTRIC REVIEW Vol. 61 No. 5 pp 9–14

Watthour Meter Registers Thirst for Power *Classification:*

SCHOFIELD, T. F.

The author evaluates the modern watthour meter and explains the design characteristics it must have to operate efficiently under varying environmental effects and fluctuating current loads. Its rated capacity must meet the demands of the future in measuring the rapidly increasing consumption of electric power.

GENERAL ELECTRIC REVIEW Vol. 61 No. 5 pp 15–17

Engineering Headlights for Safer Driving *Classification:*

MEESE, G. E.

With a brief history of the evolution of the headlight, the author describes the criteria and problems that influence today's headlight research, with a box showing an easy method of properly aiming your lights yourself. Three halftones, two illustrations, and a box supplement the article.

GENERAL ELECTRIC REVIEW Vol. 61 No. 5 pp 18–21

Metropolitan U.S.A.—1970 *Classification:*

KEARNS, EARL E.

Projected 12 years into the future, this story describes the integrated transportation systems that will serve metropolitan areas and suburbia by 1970, with emphasis on high-speed rapid transit. Five full-color photographs of artist conceptions of downtown, suburbia, commuter service, civic center, and airport depict 1970.

GENERAL ELECTRIC REVIEW Vol. 61 No. 5 pp 22–28

How Television Is Helping to Improve Education *Classification:*

Review STAFF REPORT

This article, reported by Allan Lytel, points out that educational TV does not supplant the classroom teacher, but rather supplements the teacher's personal instruction. It also describes the difference between open- and closed-circuit ETV. Six half-tone photos and a typical program schedule supplement text.

GENERAL ELECTRIC REVIEW Vol. 61 No. 5 pp 29–32

What Is the Future of Radiation Chemistry in Industrial Processing? *Classification:*

COOK, L. G.

Industrial use of radiation energy from radioactive isotopes or machines depends on economic superiority over accepted practices. The author assesses the merits of various radiation sources. Using vulcanization of rubber and synthesis of nitric acid as examples, he estimates future possibilities. Four halftones and a cost table complete the article.

GENERAL ELECTRIC REVIEW Vol. 61 No. 5 pp 33–35, 43

***G-E Review* Readers Feel Russia Does Not Have Scientific Edge Over U.S.** *Classification:*

HOLZMAN, D. L.

First in a series on The Socio-Economic Scene, the article reveals *Review* reader opinions on scientific research, development, and the race with Russia, as well as education. Readers agree on our complacent attitudes but disagree on solutions. Federal control of research is discussed. A box describes the survey method.

GENERAL ELECTRIC REVIEW Vol. 61 No. 5 pp 36–37, 43

Some Things to Count On *Classification:*

PAXTON, ROBERT

General Electric's President outlines some guideposts for college graduates to use in planning their futures. Industrial growth, generating a need for technical training and continuous self-development, will cause problems as well. Intellectual conformity must be discouraged, for it impedes progress.

GENERAL ELECTRIC REVIEW Vol. 61 No. 5 pp 38–40

Industry Promotes Study of the Three R's *Classification:*

What About the Age of Space and Me?

Addressed to all students, this article—Part 10 in a series—argues for the student's self-decipline in the choice of studies. A program more difficult than the average is recommended, but not one that prohibits enjoyment. (Reprints are available.)

GENERAL ELECTRIC REVIEW Vol. 61 No. 5 pp 41–42

For Extra Values NOW...
Buy General Electric Motors

"Operation Upturn" is General Electric's program to acquaint you with new products and services of such significance that you can justifiably "Buy Now for Extra Values."

During the past year, literally hundreds of "Extra Values" have been added to G-E motors. And, even with significant increases in manufacturing costs, motor and generator prices have been advanced only slightly. Here are just a few typical Extra Values for you to consider. For more details, write for listed bulletins or call your nearby G-E Apparatus Sales Office or Distributor. General Electric Co., Schenectady, N.Y.

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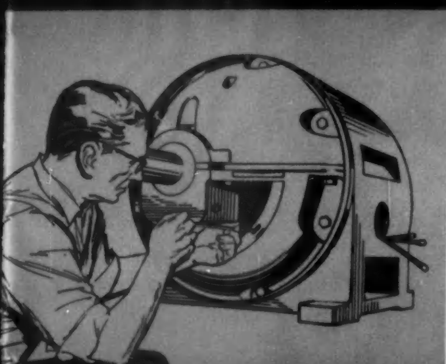
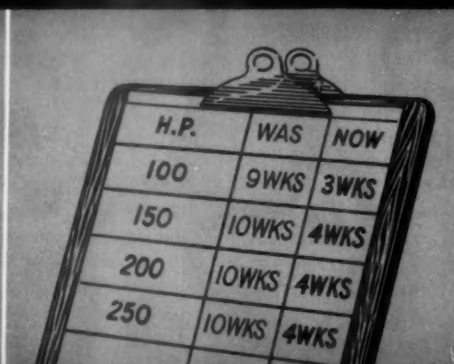
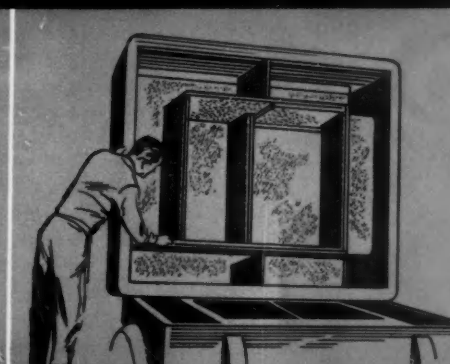
GENERAL ELECTRIC



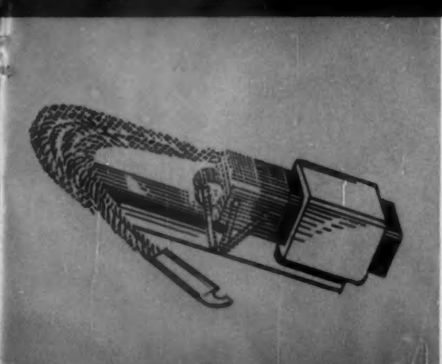
OVER 40 QUALITY CHECKS keynote the rigorous quality control programs operating today to help assure top performance from entire General Electric line.



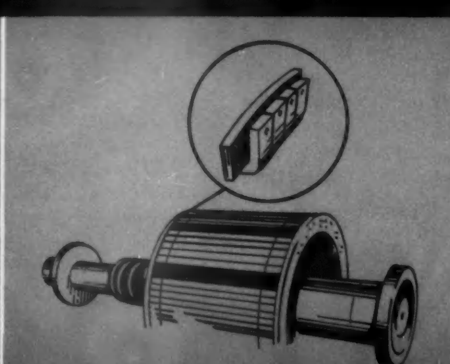
50% CUT IN SHIPMENT TIME for 100 to 350-hp motors has been achieved with new parts inventory system. Shipping time is now reduced to 4 and 3 weeks.



NEW ACOUSTIC TREATMENT for large high speed motors reduces high-frequency "whine" to a quiet hum, improving employee comfort, efficiency. GEA-6571.



NEW "CONSTANT PRESSURE" carbon brush holder eliminates adjustment, offers up to 50% longer wearing length, reduces large motor maintenance. GEZ-1158.



FLEXIBLY-CONNECTED WINDINGS improve starting performance, permit wider application of large G-E synchronous motors to high-inertia drives. GEA-6620.

IMPROVED BONDED FIELD POLES for low-speed synchronous motors. Bonding technique continually advanced in large motor construction since 1938 inception.

Need for Nonconformists

For some time certain circles have bemoaned the loss of modern man's individuality under the press of group conformity. Recently the subject has received searching analysis. Basic factors now are better understood, and some say the tide may be turning.

The *Christian Science Monitor*, for example, has editorially heralded "the rebirth of 'the individual' as a national type." In a lighter vein, a prescient magazine cartoonist wrote the caption: "Why can't you be a nonconformist like everybody else?" Popular magazine articles, businessmen's speeches, and current reassessments of educational methods and goals evidence a growing counteroffensive for individualism. Because conformity pressures are particularly distressing and inhibiting to engineers and scientists, it is essential that all implications of the subject be understood.

In the sense in which the word "conformity" is used by today's social critics, it means the blind, uncritical acceptance of beliefs and choices in the absence of conviction based on evidence and logical grounds. With that definition in mind, a distinction arises between conformity of action and conformity in thinking.

Conformity of action, as expressed by social habits and customs, is essential. Society could hardly struggle through a day if there were not a high degree of conformity to the laws of the land, established business practices, and acceptable manners in personal relations.

But rigid intellectual conformity—without conviction—has no saving graces. It implies suppression of dissent and abdication of moral responsibility. It negates personal freedom and forms the antithesis of personal integrity.

Such conformity in some cases has been nurtured unwittingly by the stress laid upon harmony and agreement in group approaches to technological (as well as other) problems. On this score a great deal has been said about teamwork.

The advantages of the team-group approach to technological problems are well known. As Clarence H. Linder, General Electric Vice President—Engineering, said recently, "It is quite unrealistic to expect individual talent, however great, to encompass the range of disciplines which must be brought to bear on the engineering problems that are really vital to progress . . . we must agree that organized, cooperative effort, from a wide spectrum of human ability, is a requirement that is here to stay."

In any team effort, however, it is important that certain cautions be recognized . . .

- Group harmony and agreement should never become the *end* sought by a "team" of engineers or scientists. For when they become an end, subtle pressures arise to curb dissent and enforce conformity
- The group is not necessarily always right. The history of science contains many examples of instances in which the "best thinking" of many experts was proved wrong by a dissenting individual.

Furthermore, it should be recognized that intellectual conformity—as defined—does not contribute to group effectiveness; it impedes it, because it . . .

- Causes group agreement to be overvalued
- Promotes a tendency to disclaim error in one's thinking when that thinking reflects the group consensus
- Induces inertia, inhibitions, and inflexibility
- Invites participants to express opinions other than their private opinions
- Destroys the validity of group consensus.

The willingness of an individual to accept group values uncritically is sometimes considered evidence of his loyalty. But a close examination shatters that illusion. If there is a fair means of measuring loyalty, it surely must be in terms of a person's willingness to fight and, if necessary, sacrifice for the advancement of his organization. In those terms, dissenters are not necessarily disloyal.

The significance of these points has not escaped the attention of thoughtful business leaders. One such leader, Robert Paxton—General Electric President—stated recently that . . . "industry does not prize men who lack values and principles of their own and who seek to please by uncritical acceptance of beliefs and choices." (The full text of Mr. Paxton's address—presented at Rensselaer Polytechnic Institute's 1958 commencement—appears on page 38.)

Asserting that a company needs creative self-reliant people if it is to prove capable of adapting successfully to changing technological and economic conditions, he added, "At General Electric, we have never doubted that encouraging men to think independently and to stand up for their convictions is essential to our Company's progress. . . . In fact, our decentralization policy may be taken as evidence of our confidence that large numbers of employees possess or can develop those qualities of initiative and leadership required at all levels and locations of the Company."

Mr. Paxton also called attention to broader implications of independent thinking: "An appreciation of the need for competition of ideas, tolerance of dissent, and unquestioned freedom of opinion safeguard the preservation of a free way of life."

What can you do to further intellectual progress? Mr. Linder offers this advice: "Cultivate the urge to know, and beware of waiting to be told. The man who waits to be told becomes overly dependent on others. And after all, what is dependence on others in the matters of the mind but conformity?"

Paul R. Heinmiller

EDITOR

GENERAL ELECTRIC
Review SEPTEMBER, 1958

Space Technology Spurs New Development Philosophies

• Space exploration is still primitive. To rid high-risk research of the frequent reviews for assurance of success, should one agency control it?

• Is there need for advanced management techniques, tailor-made for missile and space technology?

• Defense research ventures demand costly equipment, unique talent—for uncertain and limited profits.

• George F. Metcalf—space-technology expert and General Electric Regional Vice President who appraises the Company's effectiveness in fulfilling its national defense obligations—answers important space-flight questions. As General Manager, Missile and Ordnance Systems Department, Philadelphia, until last month, Mr. Metcalf directed the most critical part of the nation's highest priority military space project—the re-entry vehicle.

"We went all out to mobilize management and scientific talent . . .

. . . we are confident of solving the re-entry problem on schedule . . .

. . . the returns are rich in increased scientific understanding."

METCALF OUTLINES KEY PROBLEMS . . . "To a satellite, missile, or passenger ship returning to earth's atmosphere after a space trip, the first, thin miles-high air stratum will loom like a stone wall. Decelerative stresses will approach those of a 60-mph auto crash. Temperatures will match the sun's heat. Some other conditions surrounding this return of the traveler are still unknown.

"But in they come, anyway—not passenger ships yet, but space vehicles. Some of our equipment, housed in floating capsules so we could fish it out of the South Atlantic, has come home safely from a round trip to space.

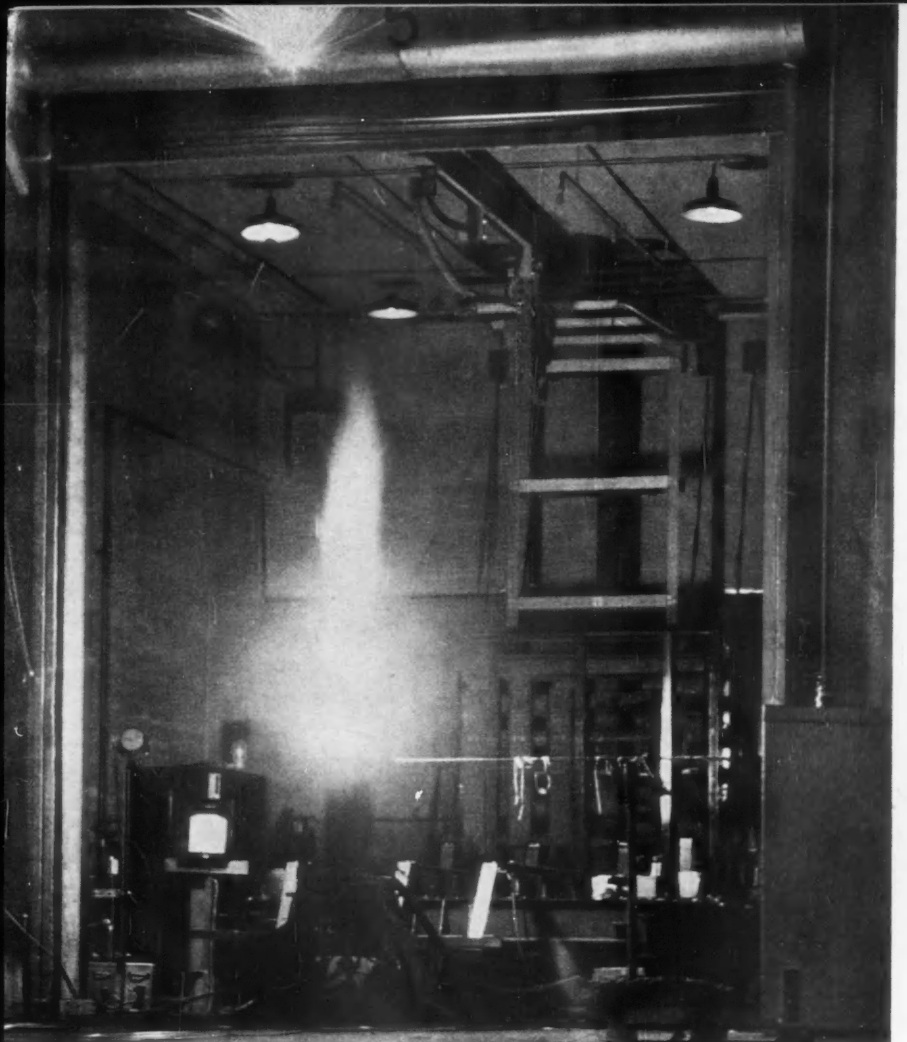
"Although space technology is still in the 'Wright Brothers' stage, we're learning a great deal about what's out there waiting for us."

What principal equipment for space technology is the Company developing?

Though the Company is participating in many aspects of space technology, most important of these is the missile re-entry vehicle work. Sometimes the vehicle is popularly called "nose cone" because it appears to be a simple conical shape forming the missile nose.

Actually, the re-entry vehicle is a complete miniature missile. It has

"Think of the



Newest stabilized plasma jet, believed largest in free world, blasts gas plasma at 26,000 F at larger re-entry vehicle models in improved simulation of flight between Mach 12 and 25. Four times larger than previous units, the jet consumes 15,000 kw—enough alternating current for 5.4 million homes.

all the aerodynamic, structural, and systems problems of any missile. After separation from its booster, the vehicle is on its own to achieve a safe re-entry into the earth's atmosphere.

What kind of organizational competence and experience is appropriate to this business? Don't you need a great deal of aviation knowledge?

We need, and have, a wide variety of experience from a broad range of technological fields. We are not in the sheet aluminum forming business to make wings for airplanes. Space flight with ballistic missile re-entry vehicles makes quite different demands. The vehicle is a heavy structure comparable to highly stressed steam turbine-generator components, yet it must carry sensitive electronic instruments.

We received contracts for this work because General Electric has a wide base of technological and scientific capability. We also have two contracts with the Army for studies of complete missile systems. We're responsible for analysis of all elements of the complete system.

What is the primary objective of current re-entry vehicle shoots?

To gather and analyze information about flight in space and re-entry. We are thus learning to build better re-entry vehicles and missile systems.

What types of information collectors does the vehicle carry?

Perhaps those that measure surface temperatures during re-entry are most important. Our engineers must also know if the surface is melting, and if so, at what points. They monitor stresses on internal structural members and reduce a member's weight if stresses fall below expectations.

Extremely low weight is fantastically important. A precise electronic "clock" in the missile helps relate events to the vehicle's location. Other instruments measure vibration severity, deceleration at each second of time, and surface impact and abrasion from micrometeorites and cosmic dust.

More than 100 separate channels of telemetered data are recorded during a flight.

How thoroughly is a re-entry vehicle tested before it goes up?

Exhaustively. A missile is generally designed for only a half-hour life. Compare that with conventional ground mechanisms, or with aircraft.

When you test a television transmitter on the ground, for example, and spot trouble, your engineer gets in and adjusts it with a screwdriver and some wrenches. You check it out, deliver it to the customer, and then you adjust it further.

With an airplane you have to do a little more advance planning. It must be reliable and safe before it leaves the ground. In the air you can still make adjustments. And you can land, change the engine, spark plugs, bombing radar tubes, or any other component, and then take it up again. In hundreds of flights with one airplane you develop a very dependable mechanism.

The missile, though, is gone when you've pushed the button. There's no man aboard. You cannot recover the re-entry vehicle intact. An undependable link in your chain of components could cost you heavily, so you must check and recheck everything.

But ground-testing begins to wear a missile out in a matter of hours. To preserve the missile, theoretical test flights are staged with electronic computers. A mass of simulating and recording equipment produces literally hundreds of channels of taped technical data. The magnetic tape is then digested by the Data Processing Center, where the tape-handling units "read" every word so rapidly that they could complete an average novel in five seconds. When the results of these projections are all in, the missile is ready for further checking at Cape Canaveral.

How does information get back to earth when the missile is aloft?

By telemetry and recovery of the re-entry vehicle's data capsule.

While the vehicle is in space, telemeters packed into the bomb chamber transmit to the launching base and to ships at sea down the course. But as the vehicle strikes the atmosphere, a highly ionized cloud of air at tens of thousands of degrees F surrounds it and practically blocks radio transmission. At this point data flow to a tape recorder encased in a heat-resisting shell. This "data capsule" has two uses: When the vehicle slows in dense air, the capsule spews out its information by electronic and radio transmission. But if unusual stress or structural failure occurs, a rocket shoots the capsule out the rear end of the vehicle. It drops into the sea, perhaps carrying with it the secret of the failure.

Aside from the data transmitted to the ground during flight, that capsule may be all that's recovered from the test. Consequently, it's designed to attract searching ships and airplanes. When it hits the water, it sprouts radio antennae and transmits beeps. And its own dye marker colors the sea around it. The capsule also releases a bomb, which explodes and creates underwater sound waves that register on sonar gear. Sharks had gnawed the first ones recovered; now current models discharge shark repellent.

Ships and planes converge on the data capsule. As soon as they recover it, military planes fly it directly to the laboratory, and our men work overtime to drain it of information. Fortunately we can find out what happened. We have only one chance.

How successful are the re-entry vehicles? Is the capsule often released by the stress or failure you mentioned?

We are confident of solving the re-entry problem on schedule, but details are classified. At this stage of the game our vehicles are programmed to expel the data capsule automatically. We have made a successful re-entry at intercontinental range.

What is the biggest technical challenge you faced in this work?

The simultaneous combination of extreme heating and tremendous deceleration. In some designs, heat expands the vehicle's outer surface by large amounts. And despite heat and stone-wall deceleration, the structure must retain its integrity without carrying an excess ounce of material. The stresses parallel those involved if an automobile travels at 60 mph and stops in two feet—and it's a real tough problem. But we're meeting these demands with a combination of vehicle configuration and materials.

If used as a bomb-carrier, will the vehicle penetrate enemy defenses?

Countermeasures, or decoys, are increasingly important in this program. After all, we could bypass our atmospheric re-entry problems by floating the vehicle down to the target on a parachute. Then we would have no weapon but simply a target for enemy antiaircraft guns. The vehicle's high re-entry speed is a potent defense against counter-attack.

What civilian benefits will re-entry work offer to a world at peace?

As so often happens in military development, the returns are rich in increased scientific understanding of materials, structures, new electronic techniques, new materials—for example, our engineers have already directly contributed, in cooperation with the General Electric Research Laboratory, to increased high-temperature strength of materials through our alloy studies.

Direct commercial use of a ballistic missile, say, to carry mail, appears rather remote. But think of the possibilities suggested by increased knowledge of space technology!

We might "mine" nickel-steel asteroids, for example: some nickel-steel meteorites have struck the earth. Suppose an asteroid 200 feet in diameter could be captured by advanced techniques. It would be worth $1 billion!

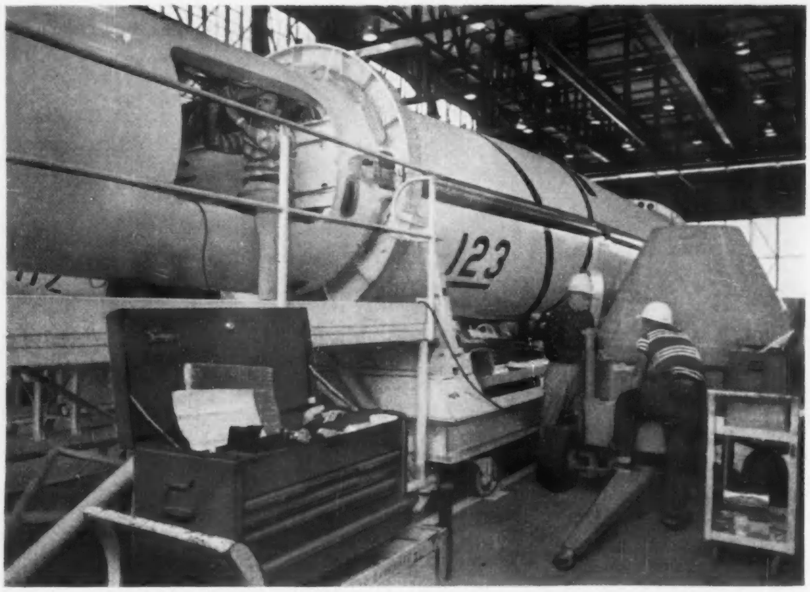
General Electric's Defense Authority in Washington

George F. Metcalf—Regional Vice President, Washington Defense Activities—appraises the Company's effectiveness in defense work, helping to formulate and implement executive decisions affecting General Electric defense activities. Until last month, as General Manager, Missile and Ordnance Systems Department, Philadelphia, he directed the Company's participation in 13 major missile weapons-system projects.

Graduated from Purdue University in 1928, he joined the General Electric Research Laboratory. Later he completed scientific and managerial assignments associated with advanced electronic systems.

During World War II, Mr. Metcalf was awarded the Legion of Merit and the Order of the British Empire. He served in the rank of Lt. Colonel in the Signal Corps and Colonel in the Air Force as Director of the Radar Laboratory at Wright Field. Returning to General Electric, he become Manager, Electronic Laboratory, and later General Manager, Commercial Government Equipment Department.

A former member of the Radar and Communication Panels of the NDRC, Mr. Metcalf served on the Research and Development Board and as a consultant to the Air Force Scientific Advisory Board. In 1956 Purdue awarded him an honorary Doctorate of Engineering for his distinguished contributions.



Re-entry Vehicle

With electronic equipment to relay information back to earth during flight, re-entry vehicle (in orange handling dolly) will be installed on intermediate-range *Thor* missile.

Bring in four a year, and you could meet the entire world demand for steel. Assuming that appropriate nuclear propulsion could be developed, with fuel at $20,000 per gram, this mining operation could become practical at a fuel utilization of 0.01 percent.

The day may come when limits on our planet's raw materials, such as iron ore, may make space exploration an economic necessity.

How would you describe the present state of the art of space technology?

It's primitive—compared with aircraft technology—and certainly it's not far beyond the state of the Wright brothers' first flights. Perhaps we've reached the "bi-plane era" in the last three years. Our accomplishments are almost insignificant as a complete program of space technology. The payload now being placed in satellite orbit is still too small to accomplish more than preliminary investigations. The maximum altitude reached is only about one half the earth's radius.

Perhaps the best measure of our progress is the kinetic energy imparted to the vehicle. Our present satellites have about one half the kinetic energy needed to escape completely from the earth's gravity field. But this is less than one one-hundredth of the energy needed to escape from the solar system.

An important factor in advancing the art, though, is the exponential increase in national and world-wide technology. A greater portion of our population works in science and technology today than even 50 years ago; so we can accomplish much more in a given period.

Have the Russians solved the re-entry problem?

We don't know, but I see no reason to assume they won't.

How is our progress affected by interservice rivalry?

Such competition has been generally helpful. I am sure the Army's *Jupiter* program, the Navy's *Polaris* program, and the Air Force's *Thor* and *Atlas* programs have been enhanced by rivalry. Of course, you can go to extremes by duplication, but this is not happening in the missile programs. We get technical information from the Army, Navy, and Air Force, and we use it.

How important are incentives and profits in this area of defense work?

There is no question about it—inadequate profits are a long-term detriment to the nation's defense effort.

When we proposed to enter this work and the government selected us, we went all out to mobilize management and scientific talent, drawing all the varied, specialized resources General Electric offers. But our financial rewards have been the same run-of-the-mill sort given for routine development work. For unique resources, we have received small rewards. They are running less than half of what we earn with commercial work in other parts of the Company. If our nation is to maintain a proper defense and scientific development program, we must offer increased incentives to all concerned.

Could effective work by a missile team be damaged by short-sighted placement of defense contracts?

For three years our work has carried the highest military priorities; so our effort has been steady and undamaged by minor shifts. We do not foresee any on-again off-again contracting — that would be most regrettable. We expect the defense department to maintain the necessary long-term stable program.

Have you developed advanced management techniques to match the advancing field of space technology?

Yes. We are using what you might call the "system" or "project" approach to major problems. It has been a key to our accomplishments in the last three years and applies both to government and industrial problems. Our organization concepts are vastly different than they were as little as five years ago. We designate a certain weapons system, for example, and staff it with skilled men who understand all phases. While they are specifying and optimizing the system, they simultaneously feed their particular requirements out to other groups, whose skills may be built around electronics or instrumentation or aerodynamics or structures.

Will this management system improve service to customers in civilian business?

Definitely. I am convinced that industry will soon adopt a systems approach to the private home. Certainly the steel mill and electric utility are systems—we must understand them completely before we can even sell them component parts. This kind of management fits them in the same way as it does a weapons system or a missile.

We have heard recent comment about such space wonders as moon-launched military rockets. Would you like to bring us down to earth by commenting on the limits of military space technology?

Well, if I had to defend America, I would rather do it from some place nearer than the moon.

But many direct, valuable, military implications will flow from the increased understanding and exploration of outer space. Certainly we will be learning a tremendous amount about the weather. We will study the earth's scientific and geophysical parameters with much more accuracy. But the highest priority military program involves our learning to intercept enemy ballistic missiles. We must stop them in outer space, before they pierce our curtain of atmosphere.

What events on the earth might be controlled, or partly controlled, from outer space satellites?

A satellite vehicle, because of its altitude and range of coverage with selected orbits, can affect three major military fields: reconnaissance, communication, and meteorology—including weather control.

Military reconnaissance now appears to be the most important. An appropriate satellite might evaluate enemy capabilities, revise charts, warn of imminent hostilities, and identify targets. Even modest early models can provide useful and otherwise unobtainable information about charts and targets. Later and larger vehicles would expand into other reconnaissance areas.

Satellite-assisted radio communication could provide immunity to natural and man-made transmission interference and jamming. And the frequency spectrum could be vastly greater than that presently employed in long-range communication, because the satellite would not depend on the ionosphere for wave propagation.

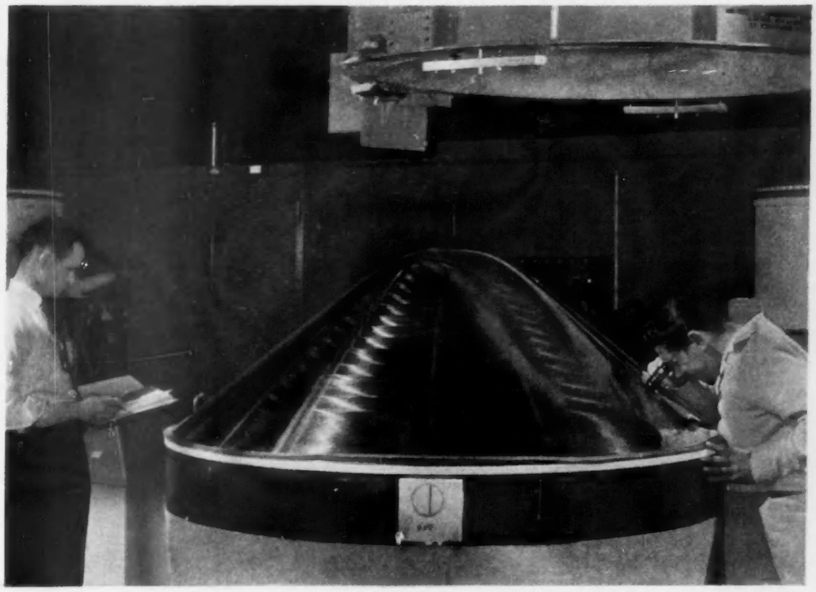
Weather forecasts would increase in scope and accuracy with satellite aid—and weather planning is vital to military operations. For the long term, it appears that improved understanding of weather, made possible by universal satellite coverage, will lead to practical techniques of weather control. Of course, this would have long-term strategic implications.

Do you foresee a need for actual military control of space itself?

Yes, and the military operations may be comparable to naval activities on earth, rather than to military aviation as we are accustomed to picturing it.

The tactics of space warfare would involve securing command of space by neutralizing, containing, or diverting enemy space craft; attacking enemy space craft in space under enemy control; and defending and occupying space under the command of friendly forces.

The comparison with naval operations stems from the fact that a vehicle placed in space will tend to remain there for a long period, as a ship remains at sea, rather than returning to its base at frequent intervals for fuel, as aircraft do. Military forces in space will be likely to occupy and hold positions, while air forces are best adapted to quick strikes at distant positions.



Nose Cone Polished to enhance the aerodynamic flow, the re-entry vehicle's conical shield (resting on a temporary base) undergoes "pit-plotting" inspection with optical enlarger that measures any minor surface defects.

An adequate military space program, then, must include consideration for use of space to control events on the earth's surface and also to take military control of space itself. More specifically, our nation must have military reconnaissance and surveillance platforms, communication and weather centers, and eventually space vehicles analogous to battleships, destroyers, and even aircraft carriers.

How do you think the United States should organize its outer space activities to insure rapid development with the least waste and the greatest gains consistent with other vital goals?

The recent establishment of a "National Aeronautics and Space Administration" is particularly promising. In the light of our experience with the National Advisory Committee for Aeronautics (NACA), we believe such an organization could be instrumental in developing objectives for civilian space technology as a part of its research function. The excellent pattern established by NACA in effecting close liaison and good communication between itself, the military, industry, and the universities must be continued for effective promotion of space activities.

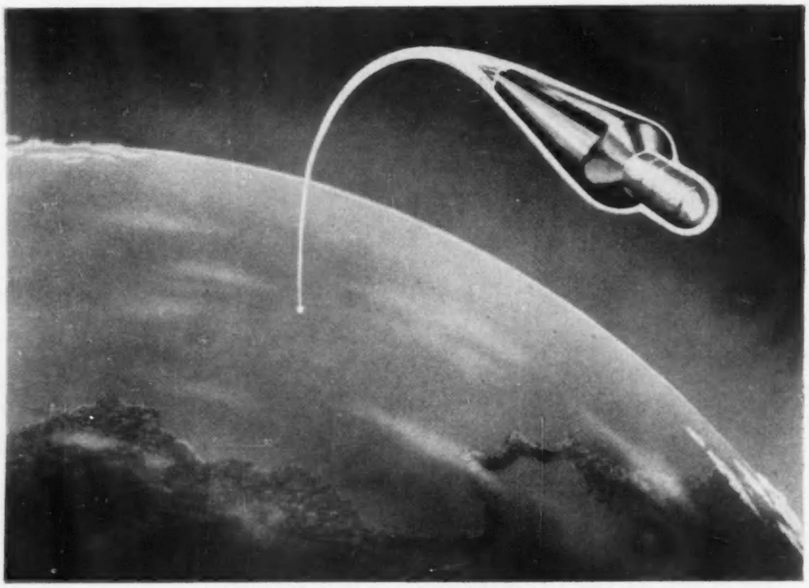
Another good possibility is the reorganization of the defense establishment. We think this might well effect concentration on military programs that best utilize and encourage technological advancements, without regard for interests of a particular service.

The most vexing problem facing any proposed organization will concern the elimination of successive reviews prior to selection of a particular research and development program. At present, the selection of a military procurement program depends heavily on the degree of assurance of success that it can demonstrate. This certainly was true of development of intercontinental ballistic missiles. From 1946 to 1954, all effort on this program was directed toward building additional assurance that it would be successful. The freedom to advance into high-risk areas, with their corresponding high potential, is vitally important to any organization that may finally be established.

What would you specifically recommend for action in the immediate future?

We urge that The National Aeronautics and Space Administration be implemented at the earliest possible moment. We believe that the present ballistic-missile test program could include experimental equipment for environmental, physiological, and re-entry studies without damage to existing schedules. We believe the need for urgency in assigning governmental responsibility cannot be overemphasized.

Could you discuss some of the



Polaris Missile Submarine-launched 1500-mile Navy weapon is aimed by computers correcting for the earth's rotation, wind, and vessel motion; guidance should be immune to electronic countermeasures.

Company's specific activities in military missile programs?

We started work late last year on a $25-million project to supply a handling and launching system for the Navy's *Talos* missile.

For over two years, we have worked with the Navy on development of the fire-control system for the 1500-mile *Polaris* missile for use by submarines. The purpose is to develop a complex and accurate system that will automatically feed computer data on all motions of the submarine, including flexing of the vessel's frame. It will correct for the earth's rotation, winds over the target, and other variables. The system's computer will store data on hundreds of target locations all over the world. As the submarine follows its course, the system will continuously determine firing coordinates for a given target for immediate firing. A submarine armed with this system will be able to fire missiles at a high rate while submerged many feet.

Among several missile-guidance systems under development is the "inertial guidance" for the *Polaris*. This system will use gyroscopes and accelerometers that determine and set direction and flight speed. This system should be immune to the enemy's electronic countermeasures.

Development and manufacture of this system demands carefully controlled conditions. We are installing precision machine tools in a specially constructed building for this work. The floor is supported on pilings to overcome vibration. Inside are "white-coat" rooms, containing filtered, pressurized air. Workers and their materials must enter and leave through airlocks.

Does a re-entry vehicle require a significant amount of ground-handling equipment, compared with the elaborate launching gear for missiles?

When you look at the rugged vehicle —x feet in diameter and full of delicate instruments—you actually see the peak of the "iceberg." Out of sight lies about nine tenths of the associated equipment —ground-support gear, handling devices, check-out consoles, telemetry in trucks, and instrument vans. One truck may cost $1/4 million, including its load of instruments. We have to supply literally hundreds of separate items, all part of a re-entry vehicle system.

Beyond the equipment, we are responsible for training military personnel who will use our equipment. This training will continue when the troops go overseas to handle the vehicles.

Can you tell us something about the dramatic countdown that precedes the test firing of a missile?

The dramatic aspect of that procedure tends to obscure its real significance, I think. When the public reads of the long, seemingly confused hours before a missile goes up from Cape Canaveral, it is generally not clear that those hours are an investment, made to insure a maximum return for the millions of dollars spent on the equipment. The hours go into testing and retesting the vast array of instruments and components involved, within the limits imposed by the wear problem I mentioned earlier.

When these missiles are used by military men under combat conditions, there will be no time and no need for checkout of instruments and countdowns. Although I cannot tell you how much time is needed, military missiles generally can be fired at surprisingly short time intervals.

Have you ever failed to learn useful information from the delays and apparent failures we read about?

I should say not! Usually the delay of a test, or the mishap that the public interprets as failure, is a failure of instrumentation. Even if the missile burns on the stand, our men often gain a great deal of important information from photographs made during the attempted flight test.

Do space technology and development require a different kind of engineer or scientific worker than we had, say, developing the steam turbine or the light bulb?

Well, I think the challenge, the feeling of accomplishment, the urgency were about the same then as they are today. In those days, perhaps you had three people working on a particular development project. Today when we launch a space vehicle, we have thousands associated with the development that went into it. The difference in numbers does not alter the basic feeling of urgency and challenge. We simply have to remember to employ communications techniques appropriate to the complexity of modern technological work.

When a missile flight takes place in Florida, we use a secret teletype circuit to notify all possible persons in our plants and engineering offices of the details of the performance, to remind them that they share the responsibility and the success. We show classified movies to appropiate personnel, to keep them thoroughly informed of the team's activities. We do these things because you are apt to lose the personal touch when large groups of people are involved. I believe the pressure and the challenge that our men are feeling today are the same stimuli felt by the men who took that early major step forward into high-pressure steam turbines. Ω

To minimize the manual handling of components, manufacturing engineers have applied mechanization to the assembly of watthour meters wherever feasible.

Watthour meters must maintain accuracy despite extreme differences in operating conditions, ranging from hot Texas summers to cold New England winters.

Watthour Meter Registers Thirst for Power

With an accuracy range from 0.02 to 6.66 times rated load, the watthour meter will still handle your growing consumption of electricity in future years.

By T. F. SCHOFIELD

Next time you check out with the cashier at your local supermarket, listen to the meaningful sound of the cash register tallying up your grocery bill. Granted, the sound seems to increase as the figures accumulate. But despite this irritation to you, the device is performing an important business function. In one way or another, every business has a similar means of accumulating, for billing purposes, the number of units delivered to the customer.

Electric utilities are no exception. Their product is kilowatt-hours; their silent cash register, the durable and long-lived watthour meter. In 1956, 529-billion kilowatt-hours (kw-hr) of electric energy were consumed in the United States, representing revenue of $8.69-billion.

For obvious reasons then, the modern watthour meter must be exceedingly accurate. And because of its long life, it must be designed with enough extra capacity built in to accommodate the householder's sure-to-increase kilowatt-hour load in the years following installation.

If you're a typical national consumer, you are currently using electricity at the rate of 3200 kw-hr per year. Historically, the trend of domestic customers' thirst for electric energy has doubled each 12 years. And there's every reason to believe it will continue to do so in the future. This anticipated growth may introduce new problems for the electric utility. Before going into this, however, let's look first at the watthour meter itself.

"Elastic Limits"

The size of the modern watthour meter is deceiving. In comparison to the majority of electric apparatus manufactured today, watthour meters are dimensionally small. Nonetheless, it is one of the most important and widely used devices in the entire electric industry.

With the ever-growing consumption of electric power, greater and greater load-range has become paramount. Early watthour meters had only to measure currents of about 5 to 10 amp. But today in many sections of the United States 100-amp installations are not uncommon; they are the rule rather than the exception. This you can readily understand from the increased use of air conditioning, heat pumps, freezers, ranges, and similar electric appliances.

Meters of the latest design must, therefore, be capable of measuring up to 666 percent *rated* load—the latter term denoting the meter's nameplate rating.

For example, General Electric's Type I-60 watthour meter has a rated load, or nameplate rating, of 30 amp at 240 volts. This means that the greater percentage of meters in service will be operated close to this rated-load point.

Mr. Schofield—Design Engineer, Single-Phase Meter Engineering, Meter Department, Somersworth, NH—began with General Electric on the Test Course in 1948. Since 1950, he has been associated with Watthour Meters in both Production Engineering and Design Engineering.

"TOTE BOARD" automatically rates test meter (right) against standard meter—indicating (from top) light load, 0.01 percent fast; lagging load, 0.1 percent fast; full load, perfect.

Accordingly, they are designed to be most accurate in this range. But because some will have to accommodate high-current-loads, they must also measure up to 666 percent overload with suitable accuracy.

Design engineers, then, have provided built-in extra capacity to handle high-current loads.

But what about the domestic user who doesn't have all the latest electrical innovations? His relatively light loads must be accurately measured, too, preferably with the same watthour meter.

To accommodate these light currents, watthour meters are designed with an operating range beginning at 2 percent of rated load. Thus the Type I-60 watthour meter, rated 30 amp, accurately measures load currents ranging as low as 0.6 amp.

Outdoor Installation

As you know, a large majority of watthour meters installed today are located on the outside of people's homes to expedite the job of the meter reader. Inside location often involves additional effort. For when the reader doesn't find the householder at home, he either has to make extra trips or an estimated billing with its associated clerical work for the home office. Suppose the estimated billing were low, and the difference were added to a subsequent reading; depending on the housewife, the electric utility could have a first-class public-relations problem on its hands.

And so, more and more, the trend is to outdoor locations. With this type of installation, problems of compensating for temperature changes become more significant because of the many varied environmental and ambient temperatures encountered throughout the nation.

Think for a minute of the differences in operating conditions encountered when a watthour meter functions in midwinter in a northern latitude (photo, right, page 15) compared with one operating on the side of a house beneath a hot Texas sun in summer. (Inside meter covers, temperatures have been recorded as high as 176 F.)

Practically speaking, to maintain accuracy over a range of −4 F to +122 F, you must design watthour meters that compensate for temperature differences. Perhaps you may not think this is a severe temperature range. But look at it this way: imagine taking a precision measuring device like the watthour meter and expecting it to maintain its accuracy whether operating in your deep freeze at home or in the oven with the control turned to WARM!

Goals: Accuracy and Long Life

Important to both utilities and customers alike is the effect that varying line voltage has on meter accuracy.

On any electric distribution network, you can expect some change in voltage between different points of the system. Watthour meters must take this voltage change in stride and still accurately record the kilowatt-hours of energy consumed. Here again, a compensation problem arises.

As a consumer of electr

Inherently, meters tend to run slower as the voltage increases, which represents a financial loss to the utility. By using a special design, engineers can minimize this effect. They usually consider it adequate if a meter is compensated over the range of ±20 percent of rated voltage. (In the instance of the 240-volt I-60 watthour meter, this would be from 192 to 288 volts.)

In the interests of standardization, some meters today have extended voltage compensation. It allows you to use a meter rated 240 volts on a 120-volt application. In other words, the same meter can be used on a 2- or 3-wire installation. This is like adjusting the carburetor in your automobile by either cutting in half the air or the fuel while still obtaining the same performance at lower speeds.

Practically all newly wired homes, however, have 3-wire single-phase installations to accommodate 240-volt electric ranges. In practice, three wires are brought into your electric service entrance. Two of these are "hot" line wires and the third, a grounded neutral. The two hot wires give you 240 volts when connected line-to-line, and hooking a load across either of these wires to the third, or grounded neutral, gives you 120 volts.

The Power-Loss Problem

Another concern of the utility is power loss in the watthour meter's potential coil, across which the incoming voltage is applied whether the consumer is drawing power or not. In a sense, this is somewhat like sitting in your car with the engine idling while waiting for the traffic light to change.

For illustrative purposes, suppose that a utility company has one-million watthour meters installed in homes along its distribution system. The potential coil in each is constantly energized. If each meter has a power loss in its potential coil of one watt, then the electric utility has to continuously supply one-million watts of power. In a year of continuous operation, this equals 8.76-million kw-hr of electric energy that earns no revenue. It's apparent, then, why engineers design watthour meters with the minimum practical energy loss in the potential coil.

In many instances, the load on an electric circuit may be small—electric clocks, for instance. Accordingly, the tr

icity, "... the watthour meter's accuracy is of prime importance to you."

metering device has to start at a small percent of its rated load. Practically all modern meters start operating at about 0.5 percent of rated load—strictly the minimum load that rotates the meter's disc. For this load the meter doesn't have the measuring accuracy that it has within the 2 to 666 percent of load range.

In designing for accuracy, engineers must consider two other factors that cause errors when not kept to a minimum—variations in wave form and line frequency.

It's essential, too, that watthour meters operate with a minimum of maintenance during their life, to keep utilities' metering costs as low as possible. The design features you find in modern meters have been subjected to accelerated life tests since 1944. During this period of testing, the kilowatt-hours of load accumulated have been equivalent to over 150 years of actual service at normal load, based on the average national kilowatt-hour consumption.

Through continuous life-testing, engineers insure the sustained accuracy and maintenance-free operation necessary in meter applications. Meters are sampled from regular production and added to these life tests periodically, providing a continuous measure of performance.

Precision Plus . . .

How complex a task is preparing a *completely* new watthour meter for production? Consider this: it has taken as many as 353 man-years of work at a cost of $3-million or more in research, design, laboratory testing, and manufacturing development.

Where economically feasible, mechanization is applied to the manufacture of watthour meters. Manufacturing engineers employ conveyor-type assembly operations to minimize manual handling of components and to transport subassemblies (photo, left, page 15).

Final calibration adjustments are made semiautomatically, using electronic counters to indicate a meter's accuracy (photo, opposite page). In the close-up photo, the meter at right has been completely checked, and the "tote board" shows—reading from the top row down—that light load is 0.01 percent fast, lagging load is 0.1 percent fast, and full load is perfectly calibrated. The readings are actually ratios between the watthour meter under test and a standard meter.

Through a combination of controls on incoming material, subassemblies, and finished products—coupled with the latest manufacturing methods—engineers assure the continued high-level quality necessary in metering applications.

But at this point you might ask, "Why all the elaborate handling? A watthour meter isn't a precision measuring device."

Those of us who specialize in this field would disagree with that contention. Many improvements have occurred in the art of metering over the years, both in design and manufacturing. Today, on a high-volume item like the watthour meter, electric utilities expect only tenth-percent deviation in accuracy and repeatability. Truly, this is precision.

. . . Dollar Savings and Looks

Inherently well-designed, a watthour meter needs only a minimum of maintenance and in that way contributes toward lower operating costs of utilities.

And advancements in design of meters have substantially lowered metering costs. Because of their improved stability and accuracy, modern watthour meters require less frequent periodic testing. Some 25 years ago, periodic tests would be made on a meter in your house at intervals of 24 to 36 months. Today they are tested only once every 6 or 8 years.

Over the years the price of meters per kilovolt-ampere of capacity versus time has decreased the cost to electric utilities for metering. This downward trend in single-phase meters has been apparent since 1923. Several factors have influenced this: industry's trend to standardize on meter rating; extended use of the 3-wire service in new and rewired homes; and the successive improvements in the watthour meter's overload capacity that have characterized its growth.

Today, for example, the General Electric Type I-60 watthour meter, with a life expectancy of 25 to 30 years at normal loads, lists at only $26.50. Electric utilities, of course, bear this cost as part of the service entrance to your home.

But as a consumer of electricity, you too have a big stake in watthour meters. You wouldn't look favorably upon a cash register that didn't accurately record what was punched on its keyboard. Accordingly, the watthour meter's accuracy is of prime importance to you.

Accuracy has a twofold effect: First, and most important, the periodic bill you receive from the utility equitably represents the facts. Additionally, because watthour meters are highly accurate, electric utilities can better gage their actual loads, or demands, for electric energy. This way they need only maintain a minimum of generating capacity to meet peak, or abnormally high, loads. Investment in capital equipment is thus kept to a minimum, and this saving is passed on to you as a consumer in the form of minimum rates.

Advances in watthour meters benefit consumers in still another way: appearance. Forty or fifty years ago, watthour meters took the form of a 2 x 2-foot black box. With present architectural trends in residential construction, imagine the esthetic horror created by placing such a black box on a modern structure.

Tomorrow's Problems

Because accurate devices for measuring electric energy are available, utilities spend millions of dollars for new plants and equipment. Undoubtedly their spending for capital equipment will continue to increase as we head into this new technological era. Numerous technical problems have arisen in the past. The steady improvements in watthour meters during the past 65 years have helped solve many of them.

But without question, future problems in the all-important and growing field of power generation will tax the electrical industry's engineering and manufacturing skill. Their solution will add to present progress in the science of metering electric energy.

And progress there must be, in view of predicted increases in electric energy consumption.

You can accurately measure, with present production meters, today's electric loads and those of the immediate future. But historic trends indicate that the electric industry doubles every 10 years. What then of the loads you will consume 10 years hence? Many changes will take place in the art of metering, of this you can be sure. Ω

Lighting test cars evaluate headlight performance under road conditions, to help solve a difficult design problem: how to best maintain your clear-road visibility without blinding approaching drivers.

CRITICAL CORNER (shaded area) needs greatest intensity, to light objects far enough ahead for safe visibility. Superimposed grid defines elements for optimum beam design.

Engineering Headlights for Safer Driving

By G. E. MEESE

In a midwest city, the police traffic detail was conducting a drive to enforce motorists to stop at the broad, white line preceding crosswalks. As a General Electric engineer approached an intersection in his lighting test-car late one evening, the traffic signal abruptly flashed red, and he quickly applied the brakes. The front wheels, beneath an array of headlamps, ground to a halt on the white line.

A burly policeman standing nearby scowled and at a deliberate pace, strode toward the driver, appraising the strange car with its variety of lights. As he approached, he growled, "What's the matter, Bud, afraid of the dark?" Then he smiled sardonically.

No, not afraid of the dark, this driver was testing experimental headlamps planned to make night driving safer (photo, left). The lights mounted on his car represented another milestone on the road to progress from kerosene lanterns through acetylene, electric bulbs, and myriad optical systems to the present dual sealed-beam system.

The Visibility Problem

By reflecting a bit, you can appreciate the more obvious factors that provoke the problem in headlighting. Consider a straight 2-lane highway. It's a relatively easy matter, with a small intense source of light and simple optics, to project light sufficiently to reveal pedestrians or other obstacles at distances that permit a reasonably fast driving speed. However, when another car appears in the distance coming toward you, the problems begin. How can you maintain your clear-road seeing distance without blinding the other driver?

Historically, early attempts resulted in a beam with a flat top, intended to keep the light on the road and below the oncoming driver's eye level. But another problem arose. Cars have springs, and with the family in the rear seat, the top of the headlamp beams raised. This required aiming the lamps down so far that when you drove alone you couldn't see far enough ahead.

A Major Advance

The two-beam headlamp of the middle 1920's was a major step forward. One filament at the focal point of the parabolic reflector produced a "high" beam for clear-road use. Turning the switch on the dash or at the top of the steering column could cut off that beam and light a second filament, placed just above the reflector focal point. This directed light from the reflector at an angle below horizontal to relieve glare. But because of the "loading allowance," it projected ahead no further than a single-beam lamp.

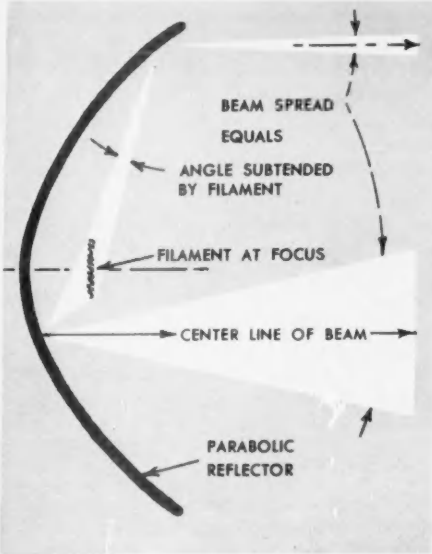
During the 1930's, studies on the highway by General Electric engineers and others revealed that better lower-beam visibility resulted from a nonsymmetrical beam pattern. The light directed to the left of straight ahead was depressed about 1½ degrees, while the top of the beam along the right lane remained closer to horizontal.

Lighting Requirements

In the interest of safety our continuing goal is to illuminate obstacles on the road ahead at a greater distance than required for stopping from normal highway speeds. For instance, from 50 mph and allowing a ¾-second reaction time, a stop based on legally acceptable brakes will require 243 feet. With 75,000 candle power projected along the clear road ahead, a man in black clothing can be seen at 260 feet. However, the lumens generated are limited by the available power; thus, the brightest part of the

Mr. Meese—Senior Specialist, Automotive and Marine Lighting, Miniature Lamp Department, Nela Park, Cleveland, Ohio—has been associated with General Electric for 28 years. Holder of several patents, he was largely responsible for the optical design of the improved All-Weather sealed-beam headlamp and the sealed-beam units for the new dual headlamp system. During World War II, the War and Navy Departments and the National Defense Research Committee awarded him special citations for his development work on military applications of infrared energy.

AIMING HEADLIGHTS is simple and exact with new mechanical device.



BEAM DIVERGENCE from any reflector point varies as the source size and reflector focal point.

beam is directed straight ahead covering about 8 degrees laterally and 3 degrees vertically. Because only short sections of highways are straight or level, illumination of lower intensity spreads out about 40 degrees for curves, directed upward for hills and downward to light the road surface back to the car.

We have a comparable goal for visibility when meeting oncoming traffic. The light reaching the other driver's eyes should not exceed 1000 candlepower per lamp for acceptable comfort and minimum interference with his vision—a serious problem considering the position of his eyes with respect to your lane of travel. When the approaching driver is 1500 feet away—again on a straight 2-lane highway—his eyes are almost in line with the projected axis of your car. Again, you must recognize road contour and keep the light that goes above horizontal on your side of a straight road within an acceptable value when that part of the beam sweeps across the approaching car on a slight right curve.

Let's reconstruct how the lower-beam design illuminates the highway area by placing a grid measured in degrees on your view (photo, right, opposite page). Horizontal and vertical center lines of the grid intersect at the "vanishing point" down the road. The center lines extending forward from your headlamps also intersect this vanishing point. An approaching driver's eyes will be in the upper left quadrant, while your lane of travel is below horizontal and to the right of the road center line. So, with the lower beam, we limit light in the upper left quadrant to a minimum, restrict it in the upper right, and provide appreciable illumination on the road to the left, below horizontal. But to reveal obstacles in our lane far enough ahead to provide safe visibility at reasonable speeds, it is necessary to crowd as much light as possible into the upper left corner of the lower right quadrant—called the "critical corner."

Optical Control

From all aspects the optical control accepted as the most successful system is a small light source in a parabolic reflector, with a lens to distribute the light. Pertinent factors include efficient utilization of the lumens generated, accuracy of reflector contour, control of source focus, efficient distribution of light into the desired pattern, and value received versus cost.

Whether the lower beam is designed with the source at focus or off-focus, the finite dimensions of the source become a principle limiting factor in attaining adaquate seeing distance.

The angle of divergence of the light reflected from any given point on the reflector equals the angle subtended by the source to that point. Rays from the outer edge of the reflector will diverge less than those from nearer the center (illustration). The beam from the entire reflector will therefore spread in proportion to the source size and the reflector focal length.

Image Analysis

In designing a beam pattern in the laboratory, the reflector and filament to be used are independently supported in a fixture. The filament is placed at focus—or off-focus if desired—and the beam is aimed at a screen, marked with a grid in degrees, about 44 feet away. A paper mask blocks the reflector opening, except for one small hole at a time. Light coming through the hole projects an image of the filament on the screen. The filament image may be large or small, lying horizontally or at an angle, depending on the portion of the reflector being exposed. Small, bright images can be bent with prisms into the lower-beam critical corner, while large or distorted images can be spread laterally with lens elements and bent downward with prisms for foreground illumination.

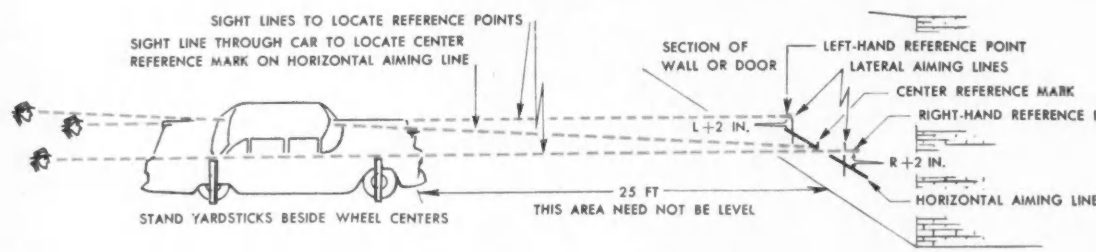
The center of each image is its brightest part. In directing even the small images into the critical corner, care is taken to insure that the outer edges do not stray into the upper left quadrant to cause glare. As a result, the brightest portion cannot be as closely squeezed into the corner as desired but will project somewhat downward and to the right. This definitely limits seeing distance with lower beams.

The hole in the mask is moved successively from one position to another until the entire reflector opening has been analyzed and a record made of the best lens treatment for each position. This work results in a lens "prescription," from which plungers are cut for pressing the borosilicate-glass lens.

Since the introduction of the sealed-beam system in 1939, headlamps have been standardized to the benefit of all motorists. In 1955 the "improved" sealed-beam headlamp shifted design emphasis toward improving visibility with the lower beam, because up to 85 percent of all driving takes place against oncoming traffic on the highway or in the city. But attempting to meet both upper-beam and lower-beam needs with one common optical system requires compromises. In 1933 W. C. Brown and V. J. Roper of General Electric's Lamp Division cited these compromises and proposed independent headlamps for each type of beam. Vehicle design, cost, and lamp-aiming problems prevented adoption until recent developments opened the way for the dual-headlamp system, which first appeared on some 1957 models.

The best lower beam today is nonsymmetrical, making it difficult to be

HOW TO AIM YOUR SEALED-BEAM HEADLIGHTS



The objective: to receive, in full, the performance engineered into your headlamps.

The Type 1 units of dual headlamps and the upper beams of all older 7-inch units are aimed straight ahead but with their centers 2 inches below horizontal on a screen 25 feet ahead.

Type 2 units of dual headlamps and the new 7-inch General Electric Suburban lamps must be aimed only on the *lower beam*. The upper beams of these units will be automatically aimed when this is done.

Setting Up

1) Correctly position your unloaded car, having its headlamps exactly 25 feet from wall or garage door (illustration). The surface should be of fairly uniform reflectance. Give car a good jounce to remove any "set" in springs or shock absorbers.

2) Tape two yardsticks to side of car in exact positions shown. Now, from behind car, sight along tops of sticks to locate a reference point on wall. Repeat on other side of car to locate another reference point. Mark the points with crayon or with a small piece of masking tape. These points are now 36 inches above the ground on which the car is standing.

3) With a yardstick placed in front of the right-hand headlamp, you can find the height from the ground to the center of the lens and the distance from lens center to the top end of the stick. The latter is the distance of the lamp below the right-hand reference mark on the wall. Place a new mark at this point on the wall. Do the same with the left-hand headlamp, and mark the wall. A horizontal line through these marks would represent headlamp height, but upper beams should be aimed down 2 inches; so draw or tape on the aiming line 2 inches below these marks.

4) From behind car, sight through center of rear window and windshield and along hood, to locate center line of car on wall. Mark this point.

5) On the horizontal aiming line, add the two lateral aiming lines as indicated. Make them the same distance apart as the headlamp centers, each equally spaced from the center reference mark. The intersections of these lines with the horizontal line are the aiming points.

Aiming

You may need two screwdrivers—one for slotted, one for Phillips screws. Then you can . . .

1) Remove trim ring. Adjustment screws are on the top or bottom and on the left or right side of retaining ring (as you face into lamps).

2) For all 7-inch headlamps, except the new General Electric Suburban, aim center of hot spot of each upper beam at its aiming point on wall. Do it one lamp at a time, with the other lamp covered. Make lateral adjustments first, then vertical. Replace trim ring.

Dual-Unit System

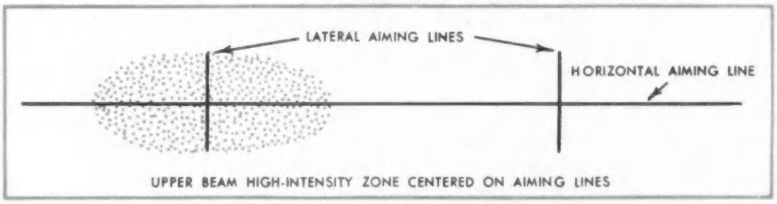
The unit type is indicated by a 1 or a 2 molded in glass at top of lens.

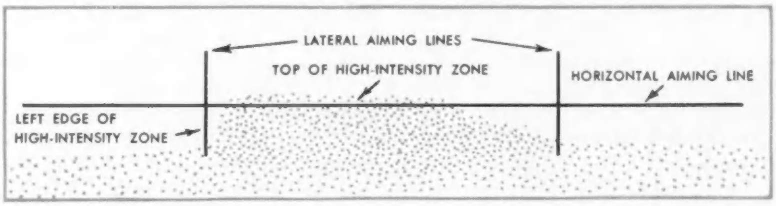
1) Type 1 Units—Aim as described in 2) under *Aiming*. Note: As all four lamps light on the upper beam, cover both Type 2 units and the other Type 1 with a cloth while aiming one Type 1 unit at a time.

2) Type 2 Units—The horizontal aiming line should be at the *same height as the centers* of the Type 2 units. In other words, place the horizontal aiming line as described in 3) under *Setting Up* but omit the "down two inches" from your calculation. Use foot switch to obtain lower beam. Aim *top* of high-intensity zone on the right-hand side of beam from each lamp at the horizontal aiming line. Aim left edge of the high-intensity zone 2 inches to the right of the lateral aiming line directly ahead of the lamp.

Suburban Headlamps

Aim the *lower beams* using the instructions given for Type 2 units.





SHADED AREA (top) locates upper-beam aim for 7- and $5\frac{3}{4}$-inch lamps and lower-beam aim (lower) for Type 2 ($5\frac{3}{4}$-inch) lamps and Suburban headlights, both with left lamp.

aimed by former accepted techniques. There is no symmetrical "spot," or "zone of high intensity," to center at a given point on an aiming screen or in a photoelectric-type aiming machine. To instruct the hundreds of thousands of service people on how to appraise and correctly aim something as indefinite as a "top cut-off" or "left edge" of the nonsymmetrical high-intensity zone could indeed be difficult.

But a few years ago, engineers developed the "mechanical aiming" concept. Three "pads" on the face of the lens are so positioned during lamp manufacture that when the plane across these faces is "normal" to the car's longitudinal axis, the beams will be correctly aimed. This permits aiming lamps with simple, mechanical fixtures containing spirit levels and strings, or optical "sights," without even lighting the lamps (photo, page 19).

Now we can divorce the two beams—placing the uppers in one pair of lamps and the lowers in the other—hence, four headlamps. But the dual system goes still further. True, two lamps (Type 1) are designed only for upper-beam use, and two (Type 2) are designed only for lower-beam performance. However, by placing another filament below focus in each Type 2 lamp and adding this light to the upper beam, appreciably better lighting is provided for your clear-road driving. On the lower beam only the 50-watt filaments of the Type 2 units are lighted; on the upper beam 37½-watt filaments light in each of the four lamps for a total of 150 watts.

You may now be driving a two-headlamp car, and so will most other Americans for many years to come. The concept of mechanical aiming now opens the way for worthwhile improvement for these cars. Major emphasis in design can be placed on the nonsymmetrical lower beam, tailoring it to most effectively light your side of the road without increasing glare for opposing drivers.

Placing the lower-beam filament at focus is the first step in this approach, and it resulted in the new General Electric Suburban headlamp. Aiming is best done mechanically, but you can also aim the lower beam pattern on a screen 25-feet ahead of the car. Properly aimed, this headlamp will materially increase visibility in traffic situations over previous 7-inch headlamps. The upper beam no longer has the conventional, symmetrical "hot spot," but the light distribution more nearly approximates that of the dual headlamp system.

Arriving in the market this fall in time for the early darkness of winter days, it will offer drivers an opportunity to improve their margin of safety when meeting other cars.

Product Accuracy and Uniformity

In our engineering for better headlighting, we are vitally concerned with the detail necessary to achieve product accuracy and uniformity. Statistical quality control plays a key role in delivering value to the customer.

But too often, the American Driver is not convinced of his individual responsibility in creating a safer night-driving climate. All our efforts to produce acceptable lighting fail, unless the lamps on your car are correctly aimed and maintained.

A headlamp out of adjustment by 0.025-inch at the rim will throw the beam 5 feet out of line 600 feet ahead. This can mean undue annoyance to an oncoming driver and reduce his ability to see. If the misaim is downward, it can shorten your visibility on the lower beam to about one half that of correct aim.

If you and all other drivers simultaneously corrected headlamp aim, the cry for "better headlights" would become a soft murmur. However, lack of interest by motorists combined with space and equipment requirements has prompted few service establishments to equip themselves to do the job, except in states having compulsory vehicle inspection.

Now, with mechanical aiming, the automotive industry is attempting to educate the public and popularize the service. If your present mechanic or garage is not equipped to do the job, check your own headlamps (Box).

Our present design parameters resulted from the hard, practical experience gained with the development and use of the auto. We cannot design for the superhighway and ignore the farmer who must travel isolated, unimproved roads. Nor can we forget the women and the great majority of motorists who may be thoroughly competent drivers but are not lighting or electronic engineers.

The headlighting system must be simple and foolproof, sturdy, and require a minimum of maintenance. Service and replacement lamps must be readily available. New systems must be compatible with those of the 67-million vehicles now on the highway. Standardization must be maintained because it serves many of these requirements, giving the user the greatest value for his dollar and facilitating state regulation.

We can "blue sky" many theoretical approaches to glare-free high-output systems. Some have been reduced to working models for road trials, involving ingenious optical and electronic innovations that consistently fail to meet the practical requirements in one respect or another.

Light polarization offers the most nearly practical opportunity for major improvement, and the development of such a headlighting system has been thoroughly studied. Plane polarizers were applied to the lenses of special single-filament 7-inch sealed-beam headlamps. The plane of polarization was oriented at 45 degrees from vertical. Another polarizing screen, called an analyzer, was placed in the driver's line of vision with its plane of polarization corresponding to that of the headlamps.

Polarization Not the Answer

With the 45-degree angle of polarization uniform on all cars, you can see that the polarized light from the headlamps of an approaching car would be at 90 degrees, or crossed, to that of your analyzer. This reduces the apparent brightness of the approaching headlamps to very low levels. Meanwhile, your seeing distance remains essentially what it was for the clear road. With this system a second pair of nonpolarized lamps having lower wattage and conventional lower beams would be used for city driving.

An approximate 60 percent light-loss occurs in polarization at the lamps. Of the polarized light directed down the road, the light that remains polarized after reflection from objects in the field of view passes through the analyzer with relatively little loss. But light depolarized on reflection encounters greater loss. To arrive at clear-road seeing distances equivalent to those of conventional lighting when looking through the analyzer, it was necessary to increase lamp wattage at least three times.

The biggest single obstacle to adoption is that of compatability with existing systems. Drivers of nonequipped cars would lose too much visibility by merely wearing properly polarized spectacles. Drivers of polarized cars would have to shift to lower beams on meeting nonequipped cars. Estimates indicate that from 5 to 10 years would elapse before a sufficient percentage of cars on the highway would have the system to realize its benefits. Meanwhile, you would be paying for the system with each new car purchase, without deriving full value.

The motor car industry thoroughly investigated this system for several years following World War II and decided against its adoption. A comprehensive report appears in the *Highway Research Board Bulletin* No. 11, 1948. Other types of polarization and methods of application are known, and future developments in materials and techniques may offer reduced costs, shorten the changeover period, and open the way to review.

Until that time, our engineering for better headlighting must recognize the practical dictates of today while keeping a firm grip on the promise of tomorrow. Ω

Metropolitan U. S. A.—1970

• A booming city and its thriving suburban areas owe their prosperity to an efficient, thoroughly integrated transportation system.

• Comfortable rapid-transit cars swiftly transport suburbanites to work, metropolitan shopping areas, civic center, airport, stadium.

• Ease and speed in traveling in 1970 reflect the vision and judgment of dedicated planners who wisely anticipated future needs.

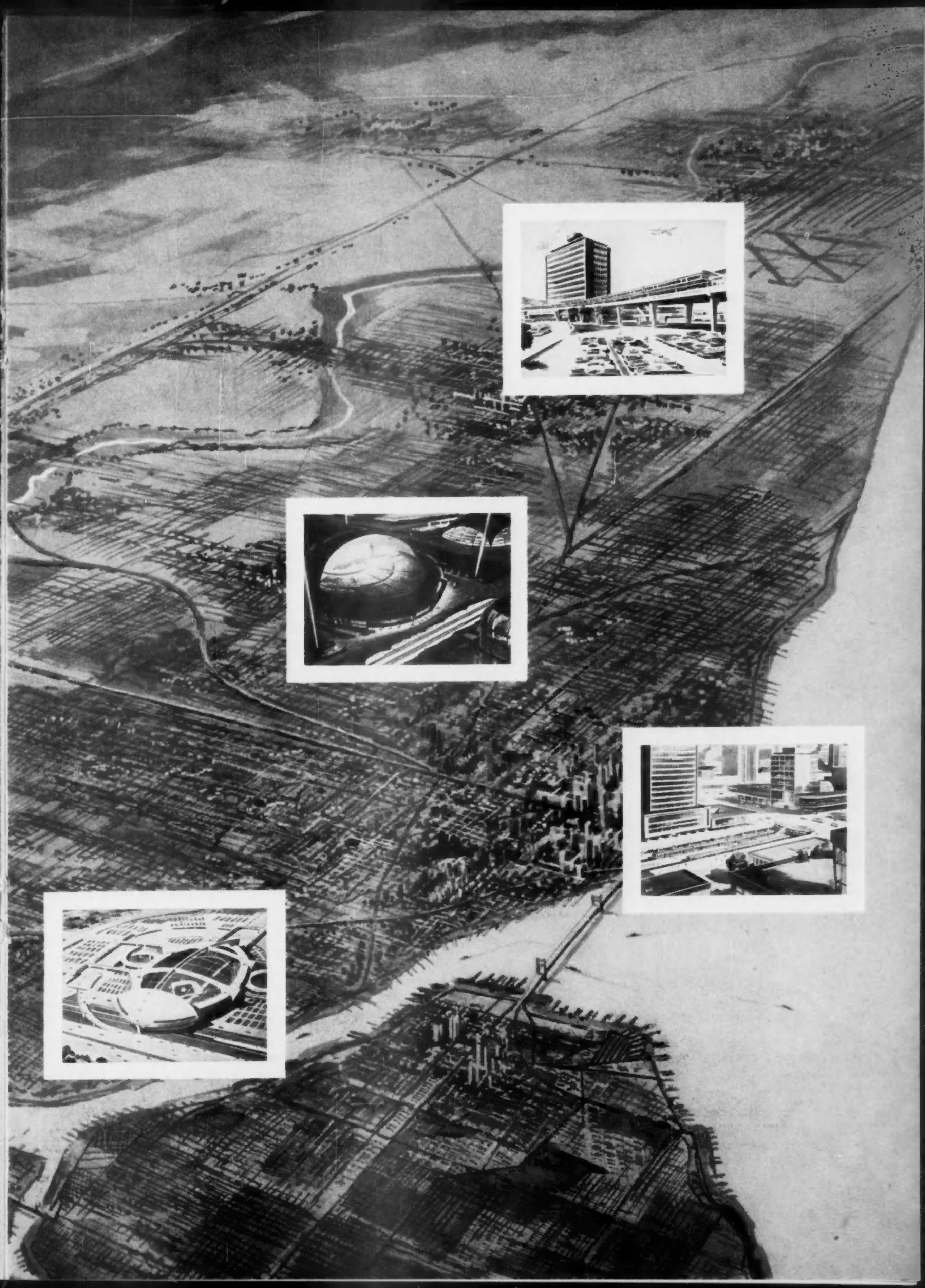
By EARL E. KEARNS

Everyone likes to peer into the future and imagine how we'll progress 50, 100, or even 1000 years hence. In this look at the metropolis of 1970, your imagination has only to bridge 12 years. Yet in that short span of time, the transportation services have been coordinated into a completely integrated system of expressways and transit.

The majority of people choose the rapid transit both for commuting to work in comfort or seeing the World Series at the stadium without tangling with thousands of motorists. It also takes the family to the Civic Center for an evening of entertainment, avoiding bumper-to-bumper driving on the way home. And ideal for traveling to the airport or downtown shopping areas, the rapid-transit rider arrives in record time.

Participation in your own community planning can hasten the day of fast, convenient transportation and alleviation of traffic congestion and parking headaches in your metropolitan area. And the pleasure of anticipation can be replaced by the excitement of reality.

STORY CONTINUES ON PAGE 24



Metropolitan U.S.A.—1970

(Story begins on page 22)

Yesterday my son Larry and I went to the first game of the 1970 World Series. It was a great game. Good old Lawn City won 6 to 4. More than 103,000 fans! Can you imagine all those people and no traffic jams? Why, a few years ago we would have sat in our cars, bumper to bumper, for hours.

Not in 1970 Lawn City though. Our secret is an area-wide system that coordinates *all* transportation and permits each kind to do the job for which it is best suited. This system allows us to travel throughout the entire area quickly and conveniently.

For instance, Larry and I had no trouble at all getting to the game; yet we live way out in the country past Lawnview. We just jumped in our antique turbine-puffing 1965 station wagon and drove to the transit park-and-ride lot.

Mr Kearns—Manager, Metropolitan Transportation Equipment Sales, Locomotive and Car Equipment Department, Erie—began his career with General Electric in 1926. His experience includes railway-control, motor, and transportation engineering. Author of numerous papers, he has significantly contributed to the development of electrified transportation systems in many major cities.

Riding the Rapid Transit

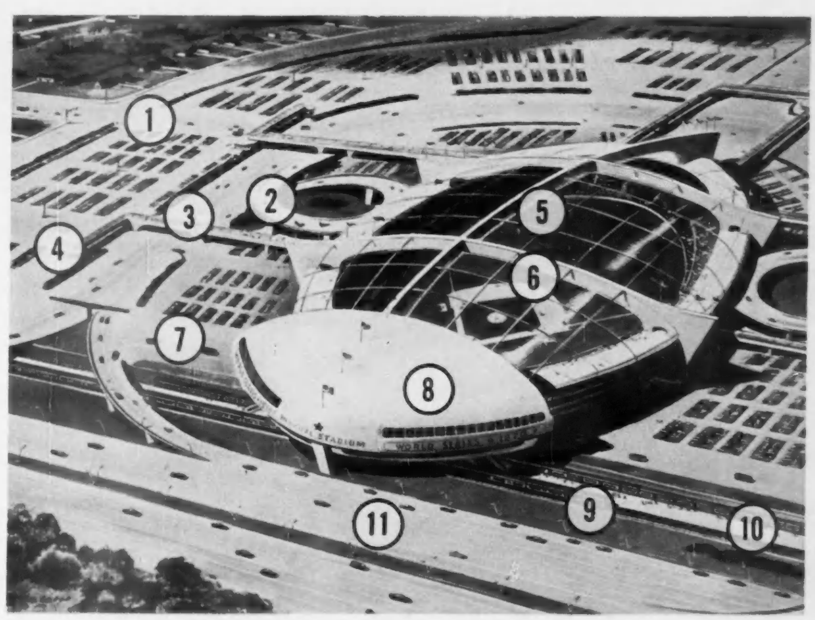
We then hopped on the rapid transit, which is situated in the center mall of the freeway. I understand that the additional cost of providing the extra right-of-way for the transit center mall was about 10 percent. But it increased the carrying capacity of the freeway 500 percent.

CIVIC CENTER

Culture and the fine arts flourish in the Lawn City metropolitan area. One reason is our Civic Center, built three years ago as part of the downtown redevelopment program. The amphitheater has a roof that can pivot open on pleasant summer evenings. Its beauty and accessibility attract thousands of visitors daily. Most people in Lawn City and its suburbs travel to this cultural center in fast, comfortable transit cars.

WORLD SERIES

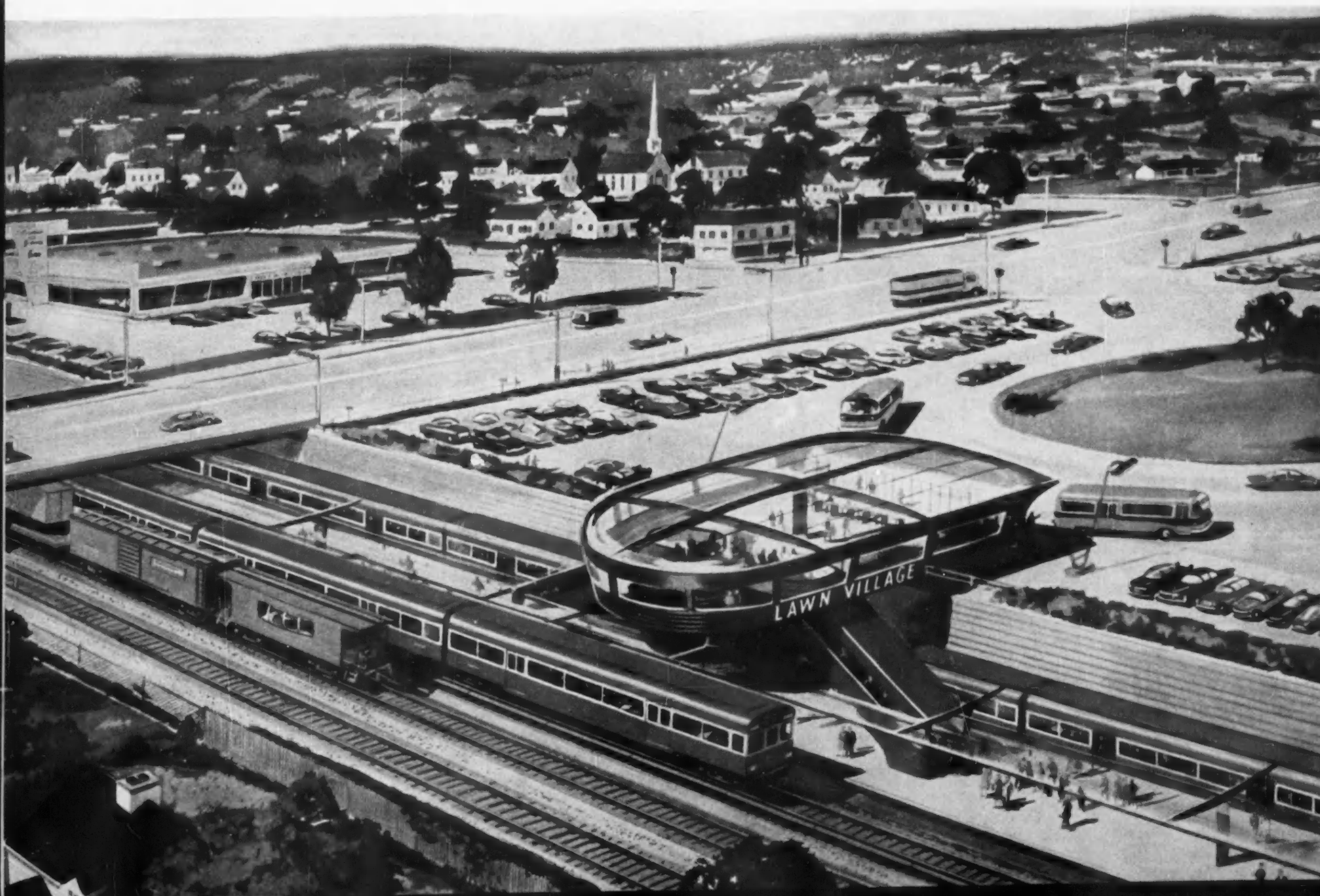
Our baseball stadium has these important features: 1) Large parking area that doubles as transit park-and-ride lot, 2) Loop ramp for buses and cars, 3) Plastic-covered moving sidewalks, 4) Parking-lot ticket windows, 5) All-weather plastic cover, 6) Overhead lighting, 7) Feeder buses, 8) Rotunda for team business offices, restaurant, and lounges, 9) Rail rapid transit, 10) Platform transit stop, 11) Expressway. (The paintings in this article and on the Cover were done by John Gould.)



And does this transit mall do the job? Why, last night we caught a transit car in two minutes. Our new automatically operated transit cars zip past the autos at more than 100 mph and maintain an average speed of at least 50 mph, because the station stops average two miles or more apart.

A great majority of the 103,000 fans traveled either by rapid transit or one of the feeder bus lines that normally services the stadium transit station from nearby communities. Using park-and-ride lots all along the transit line greatly expanded the stadium parking lot.

". . . we have saved hundreds of millions of tax dollars by our system



AIRPORT

Jet airliners and high-speed transit cars operating on exclusive rights-of-way have teamed up to make our long distance trips truly fast and efficient. It is no longer true that flying takes less time than getting to the Lawn City Metropolitan Airport.

of transportation."

COMMUTER SERVICE

Our Metro uses several existing railroad rights-of-way for its rapid-transit operation. Strategically located, these rights-of-way were added to the transportation network at a fraction of the cost of building new ones. Some had never been used before for commuter service.

Larry made one request: Next time he wants us to drive all the way to the stadium so that he can ride one of those plastic-covered moving sidewalks in from the parking-lot ticket windows. It will take much longer to drive, but I'm anxious to ride those sidewalks myself.

My wife Alice is a transit fan the same as I. Next week when the fall Music Festival begins at the newly completed Civic Center, we will drive to the Lawn Village commuter station. From there we will hop a downtown express that will take us to the Civic Center in a matter of minutes.

Using Existing Rail Lines

Our Metro transportation district was fortunate in obtaining this express right-of-way in from Lawn Village. An existing railroad right-of-way was leased to the Metro for transit service. Autos on a single expressway lane can carry 2000 people per hour; buses can economically carry up to 3000; while one lane of rail rapid-transit cars transports 40,000 people per hour. Can you imagine the fabulous costs if they had to construct enough freeways to handle the peak rush-hour load? Yet back in the 1950's some people believed that you could do the entire metropolitan transportation job by auto alone.

About that time several other basic factors also caught up with them. Population growth far exceeding the predictions was one of these. My father remembers that estimates made right after World War II were 13 million less than the actual 1958 population! Metropolitan areas continued to grow four times faster than the rest of the nation, further compounding the problems of providing adequate transportation of people and goods. As late as 1958, estimators predicted that our present 1970 population would be only 200 million. But they sure underestimated.

Integrated Commuter Service

Another of these factors was the increasing desire of people to go more and more places every day. Commuting patterns have changed drastically. People who live on the north side of town work on the south side. And why not? It's easy to reach because of the integration of all railroad commuter service, rapid-transit lines, bus routes, expressways, and streets into one Metro district.

Our transit system has kept pace with our modern jet airport. As jet service greatly reduced flight time, it became obvious that this speed advantage would be completely lost because of traffic congestion on the new expressway to and from the airport. By extending our rail rapid-transit service to the airport on exclusive rights-of-way, more people could reach it quicker than ever before.

Perhaps automobiles on expressways might have been the whole metropolitan transportation answer if it weren't for the ageless parking problem. Even with the new pocket-size engines, cars still occupy lots of room. It has been estimated that if everyone drove to Lawn City, three out of four buildings would have to be devoted to parking.

Mobility—1970

Lawn City is the focal point of a great and prosperous metropolitan area. Much of this prosperity can be traced to the Metro transportation setup. For we have saved hundreds of millions of tax dollars by our system of coordinated metropolitan transportation. Our suburban areas are thriving as never before because of their easy accessibility to the city and adjoining communities. And downtown Lawn City itself is booming because of the expanding metropolitan area it serves and its efficient transportation system.

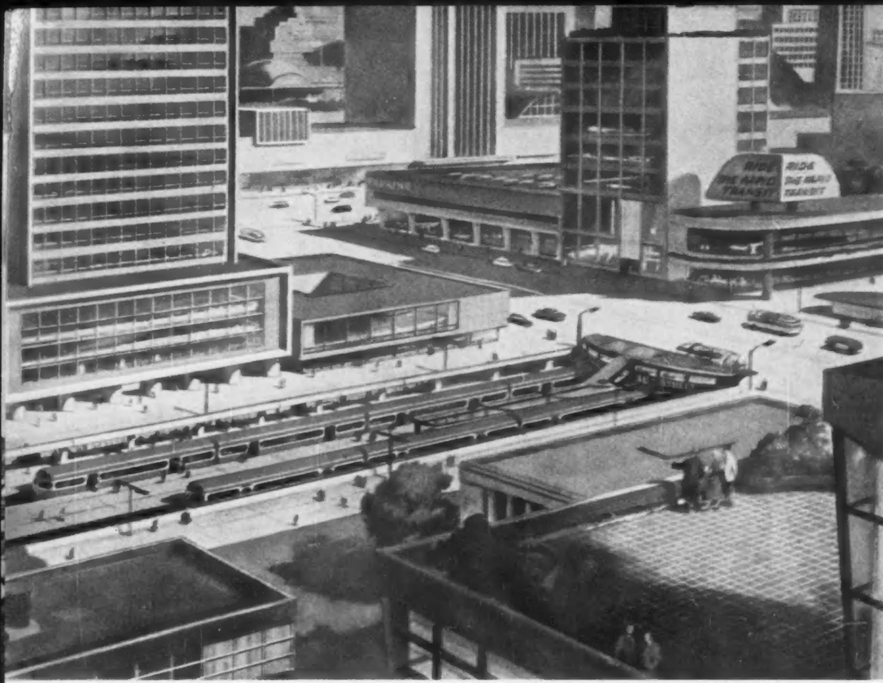
And do you know, here's a strange anomaly. The highway system has benefited most of all. You see, instead of spending millions of highway tax dollars to obtain metropolitan expressway rights-of-way and gigantic parking lots, efficient rail rapid transit and feeder buses handle the peak rush-hour loads. This allows the highway money to be spent where it provides the most mileage and also does the job best.

Planning Begun—1958

Not all metropolitan areas have as successful a transportation system as Lawn City. We had a tough time getting started ourselves. It was back in 1958 that a group of our leading citizens formed a committee to investigate transportation planning on an area-wide basis. If you recall, congestion then warranted immediate action; but the toughest part was getting the communities and local governments together to form a transportation district with a source of revenue to study our problems.

Once formed, however, the Metro received a grant to make studies, and top consulting engineering firms were hired.

To predict our future transportation needs, the consultants made an economic projection to determine the future size and location of our metropolitan busi-



DOWNTOWN Once downtown, transit cars maintain their high speeds by using open cuts situated just below street level, subways, and modern elevated structures. Some downtown stops are located at the sublevel of the stores and office buildings.

SUBURBIA Life in our suburbs is truly wonderful. And it has all been made possible by modern, attractive, coordinated transportation. Center-mall rapid transit is teamed with expressways and outlying park-and-ride lots to make travel fast and convenient.

ness activity. This economic projection considered future markets for the products and services to be produced in this area, our local business climate, raw material availability, labor supply and skill level, and past economic growth.

Based on the economic projection, the planners estimated our future area population growth. Then they made extensive land-use studies to determine how the land would be used. And origin-destination travel paths were plotted on a metropolitan area map.

On top of all this data the planners superimposed the then existing system of expressways, streets, and transit. And, as you might guess, it proved totally inadequate for the projected requirements.

To handle indicated rush-hour traffic requirements, the experts tried various combinations of transportation methods. They found, for example, that to do the entire job by additional expressways would require some of them to be more than 20 lanes wide.

Their final recommendation? A combination of main-line rapid transit, expressways, and feeder buses. The planners said that rapid transit, because of its inherent ability to move large numbers of people, should be used to carry the bulk of the rush-hour traffic along heavy travel "desire lines."

They made one basic decision: "Any time there were more than 2000 people per lane per hour at the peak point on the line during the rush hour, an exclusive right-of-way would be provided for public transportation." Only through *exclusive rights-of-way* can public transportation best do its job of carrying people quickly and conveniently.

The planners were confident that the faster service—so vital to our pyramiding transportation demands—would attract increasing patronage.

Armed with these studies, the Metro put on a realistic public information program. By the time the Metro District made its proposal to the various legislative bodies, the public was enthusiastically behind it. Subsequent legislation provided the district with the tax money to construct the needed facilities. All publicity releases emphasized "how much we can save by doing the job this way" rather than "here's how much we must spend."

Today our transportation system is fast and convenient. And it has saved us millions of dollars. I sure pity people in the congested metropolitan areas today who are only now in 1970 getting started on transportation planning. Ω

In largest closed-circuit educational TV experiment, students at Washington County (Hagerstown) Md. schools receive instruction in one or two subjects daily.

How Television Is Helping to Improve Education

Many controlled experiments prove that educational TV, supplementing the classroom teacher, is equally as good as conventional instruction.

***Review* STAFF REPORT**

Teaching—according to one widely held theory—actually comprises two things: instruction and assistance. The theory holds that instruction consists of imparting knowledge to a student. Assistance, on the other hand, enables the student to absorb and utilize that knowledge.

If you can assume this analysis to be correct, then educational television (ETV) can form one part of a nearly perfect teaching combination. Talents of teachers, who brilliantly and dramatically present their subjects, can be spread en masse to groups of students via the television screen (photo), and the teachers specializing in teacher-pupil relationships can follow up the TV presentation with concentrated classroom assistance to small groups.

We even talk about "teachers' aides" and a "team approach" to teaching. In medicine, so the argument goes, the general practitioner has yielded to the medical team—surgeon, internist, anesthetist, nurse, and nurse's aide. And so perhaps it's only natural to ask, why not apply the same philosphy to teaching?

If this philosophy is true, then educational television may well be the solution to one of the nation's stickiest problems of the post-Sputnik era—the shortage of qualified teachers.

According to the National Education Association (NEA), we must build 328 classrooms and hire 493 teachers each day for the next year just to catch up with the 32,329,000 children presently overflowing America's schools. By 1965, we will need 460,000 more teachers to offset our increased population. And ½-million more will be needed to replace those who leave or retire from the teaching profession.

Closed-Circuit ETV

For the many routine classroom activities of small groups, the presence of a teacher or teacher's aide is vital; but a single specialist in biology, physics, or art can reach hundreds, even thousands, of young minds through a televised lecture. With classroom receivers, the effectiveness of all qualified teachers can be multiplied. What's more, ETV cameras attract the best teaching talent available.

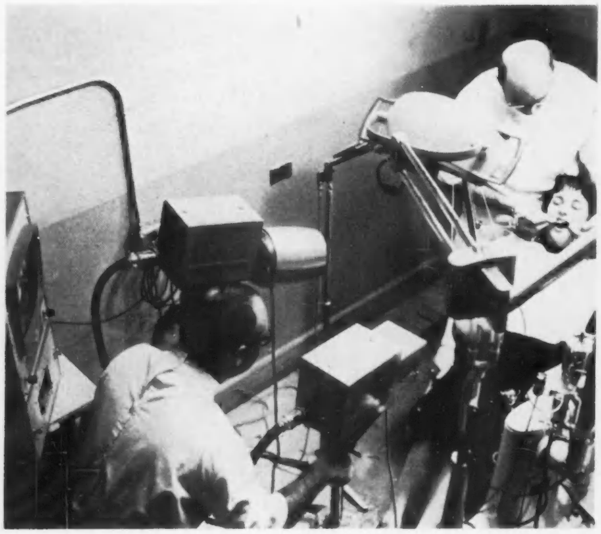
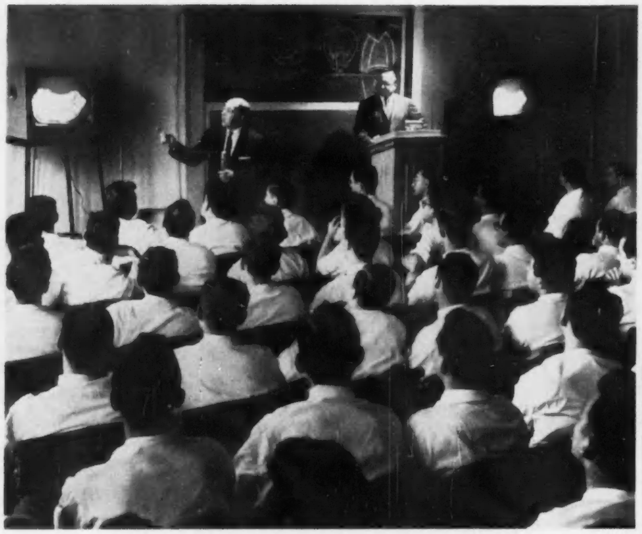
Before going into specific examples of what educational television is actually doing today, I should like to distinguish between the two kinds of ETV transmission systems under discussion.

Dominating the field of formal education is closed-circuit ETV. In this system, coaxial cable connects TV cameras to receivers much the same as the one in your home. But because the picture is transmitted through cable, it requires less amplification and suffers little interference compared to broadcast, or open-circuit, TV. The cable can either be installed in a single building containing many classrooms or strung between several structures. For long runs, you can utilize telephone poles by special arrangement with the local telephone company.

Closed-circuit TV cameras are relatively simple to use—almost as simple as taking pictures with a home movie camera. As a beginning, one camera and one, sometimes two, receivers are used. You can readily expand by adding more cameras and receivers and also film projectors. Equipment is sturdy and reliable. And some projection receivers throw a movie-size picture on a screen.

Washington County Experiment

In September 1957, a five-year program of closed-circuit ETV got under way in Washington County in Hagerstown, Md.—a city of 40,000 people. Dr. Alexander J. Stoddard, former chairman of NEA's education policies commission, has called the Washington County experiment, ". . . the most significant thing going on in America today." Approximately 12,000 elementary and high school children in 23 schools are being taught music, art, English, history, geometry, science, general mathematics, and social studies by television.

Closed-Circuit ETV

Television camera literally peers into a patient's mouth at New York University's Dental College. Laboratory demonstrations are carried by cable to lecture halls (center) on various floors of the building, with

"To understand what we are trying to do," says William M. Brish, Superintendent of Washington County Schools, "it's important to disregard the popular notion of some people that television is just a gadget. In fact, television deserves a place alongside the textbook as a most important educational advance.

"Contrary to what many people believe," Brish continues, "we are using television to *supplement* personal instructions, not to supplant the classroom teacher or to make teachers less necessary. In fact, television should even enhance the importance of teachers by exploiting the special talents of each to the fullest and making them available to many students rather than just a few."

In Hagerstown, only one or two subjects are televised each day to a class, and these last perhaps 30 minutes. Preprogram discussions and classroom study after the TV viewing are vital to this planned approach. With regular lessons and assignments, the classroom teacher builds her work around the television lecture. She has the advantage of an interesting, informative picture lesson for her class.

On the other hand, the lecturer before the camera has more facilities, a greater range of materials, and—most important of all—more time to prepare a lesson. For instance, ETV science lessons frequently involve the use of equipment that Washington County couldn't afford to buy for every one of its schools. And these lessons often involve laboratory demonstrations requiring both dangerous materials that couldn't be brought into a classroom and experiments that take several hours to prepare and wouldn't be feasible unless they could be shown to large groups.

This year, all 20,000 students in Washington County's 48 schools will be part of the educational experiment. Backing the project are the Ford Foundation Fund for the Advancement of Education, the Joint Council on Educational TV, the Chesapeake & Potomac Telephone Co., the U.S. Office of Education, and the Washington County Board of Education. Electronics Industries Association, a nonprofit organization of components manufacturers, supplied the TV equipment; the Ford Fund supplied money for teacher training; the telephone company installed interconnecting cable; and the community paid all remaining costs.

Across the Nation

For presenting actions that take place in a limited visual area, TV is without equal. Close-ups give students a better view than they could get even from the front row of a class.

At dental schools, for example, a TV camera literally peers into a patient's mouth, permitting a number of students to follow the dental surgeon's every move (photo, left).

Using this new teaching medium, the Dental College of New York University (NYU) expects to broaden subject courses within its present heavy curriculum and to inform students immediately of rapidly changing practices without additional courses. Here, demonstrations are televised from a central studio at the college and transmitted by cable to several lecture halls on various floors of the building (photo, right). Close-up views and over-all scenes of professional techniques and actual operations being described by doctors in the laboratory are carried to darkened auditoriums where large groups of students simultaneously view the work being performed. And for added flexibility, a two- or three-way microphone hookup allows question-and-answer exchanges between students in the lecture halls and demonstrators in the laboratory.

How effective is this technique? Dean Raymond J. Nagle of NYU reports a saving of 5½ hours in the teaching of one particular course that comprises a demonstration and lecture on filling a person's tooth. Before the advent of ETV, each of 10 small groups clustered around the professor at the dental chair required about 35 minutes—or a total of nearly 6 hours. The entire process can now be accomplished in 20 minutes by telecasting the demonstration to all students simultaneously. The 5½ hours thus saved can be devoted to additional time in laboratory classes or instruction in other dental practices.

Elsewhere in New York City—Manhattan's Chelsea district—the Board of Education sponsors a closed-circuit ETV program for adults financed by the Ford Foundation. Under this arrangement, a small network of closed-circuit ETV links 608 families in four apartment houses, a public school, and two community organizations: the Hudson

two-way microphone pick-up for question-and-answer exchanges. At Los Angeles Junior College, hundreds of students can simultaneously view a microscopic specimen.

Guild Neighborhood House and the Lower West-Side Health Center.

In Pennsylvania, 39 24-inch classroom receivers and two 21-inch monitors are in use at the State University, making it feasible for one professor to instruct 1000 students. Inside a typical ETV classroom of 50 students, two receivers are placed on high stands so that everyone has a clear view. In the large lecture halls at Pennsylvania State University, ETV receivers mounted in various places give every student—in any part of the room—a front row seat.

On the nation's West Coast at Los Angeles Junior College, biology students no longer stand in line for microscope viewing. Closed-circuit television does it for them (photo, top). Now at one time hundreds view the same specimen.

In the same city, a single instructor teaches several hundred pupils in three different colleges simultaneously. The director of this experimental program hopes that closed-circuit ETV will provide a partial solution to the shortages of teachers and student housing and to the mounting construction costs that confront education.

Broadcast ETV

In April 1952, the Federal Communications Commission (FCC) made a far-sighted and courageous decision: it allocated 242 television channels for non-commercial educational broadcasting. Since that FCC decision, a number of other channels have been reserved also.

This fact points out the basic difference between the two distinct forms of ETV. Literally anyone can purchase closed-circuit TV equipment and put it into operation without needing a broadcasting permit or channel assignment from the FCC, because programs are piped from studio to classroom over a coaxial cable.

On the other hand, with open-circuit ETV, you need not only FCC permission and channel assignment but also transmitters, towers, and antennas. Anyone can tune in. In a heavily populated metropolis such as New York or Los Angeles, however, ETV channel allocations may be insufficient to serve the needs of all the people.

But wherever in operation, broadcast ETV has been highly effective.

Located in Houston, Texas, KUHT was the country's first station to operate on an FCC reserved channel, initially going on the air May 25, 1953. In four years of operation, the station broadcast 5000 hours of educational programs. One of its programs, a forum on international affairs, attracts more viewers each week than the total yearly attendance at lectures on these topics in the area.

Station WQED Pittsburgh last year conducted 28 classes in 5th-grade reading, arithmetic, history, and geography, plus an introductory course in physics for high school students.

Some of the finest work in broadcast ETV today is taking place in the state of Alabama (photos, below). In fact, the Alabama Educational Television Network is the only statewide ETV network in the country at the present time. April

Open-Circuit ETV

Part of daily programming, music lessons are picked up on estimated 800,000 TV receivers in Alabama, and an experienced high-school teacher conducts especially adapted biology course.

ALABAMA'S STATEWIDE OPEN-CIRCUIT ETV NETWORK

The Alabama educational television network comprises three stations: WAIQ on Channel 2 transmitting with a visual effective radiated power (ERP) of 100 kw; WTIQ on Channel 7 with a visual ERP of 316 kw; and WBIQ on Channel 10 with a visual ERP of 30.9 kw—all VHF.

Consisting of 11 hops, 362 route miles of microwave circuits connect three TV transmitters with studios at the Alabama Polytechnic Institute in Auburn, the University of Alabama in Tuscaloosa, and the Educational Television Association in Birmingham.

Based on its present total of 3250 program hours per year, *technical* operation of the complete network costs $36.98 per hour.

During the 1957–58 period, approximately 78 percent of the programs were live, with the remainder on film. Broadcast weekly by the Alabama ETV network were 25 hours of in-school telecourses. Five daily telecourses were direct teaching in plane geometry, Alabama history and civics, biology, Spanish, and general sciences including high school physics. Other programs were basically for intellectual and cultural enrichment.

A survey conducted last year indicates that the majority of Alabama schools using ETV have only one receiver. Generally speaking, the students exposed to ETV in-school courses view them in a designated classroom where the TV receiver is permanently located. In a few instances, where schools have no TV receiver, classes utilize sets in nearby homes to take advantage of particular courses.

SCHEDULE TELECAST BY ALABAMA EDUCATIONAL NETWORK ON MONDAY, MAY 19, 1958

Schedule		Program Content
AM		
9:15	Test Pattern and Sign On	Standard alignment chart.
9:30	World History	History; its value. Utopia coming? (High school enrichment)
10:00	Civics	Measuring your aptitudes and intelligence. (High school direct)
10:30	Sense of Poetry	Appreciation of poetry: Today's selection, *Ecstasy*
11:00	Nuclear Energy and Cosmic Rays	Peacetime uses of atomic energy: Atomic transformation; submarine; battery. (High school enrichment)
11:30	Heredity	Inbreeding and hybridization in animals and plants. (High school direct teaching)
PM		
12:00	Spanish	
12:30	Farm Facts	Changing trends in food buying as described by Ruth Hammett, School of Agricultural Economics.
1:00	Citizenship	(Lower elementary enrichment)
1:15	Primary Spanish	(Lower elementary enrichment)
1:30	Plane Geometry	Special parts of a circle. (High school direct teaching)
2:00	Tempest in Test Tube	Chemical reactions of acids, bases, and salts.
2:30	Improve Your Reading	Suffix "-ED." (For slow readers)
3:00	Industry on Parade	Role U.S. industry plays in national economy.
3:15	Home Decorating	Interior decorating tips.
3:30	Skylines	
4:00	Puritans	Bash Kenneth traces history of the Puritans; their folklore and their music.
4:15	Number of Things	The little man who wanted to stand on a cloud. (For tots)
4:30	Science and Scientists	Two theories on how light waves function.
5:00	Play Production	Necessity of duties off-stage. (For amateur theatrical producers)
5:30	Shorthand	Speed test. (Commercial Credit Course)
6:00	What's Your Game?	(University of Alabama athletic department feature)
6:30	Science	Making inexpensive lab equipment. (Teacher training)
7:00	Medical Center Report	Anatomy is discussed by Dr. James Foley and Dr. E. Carl Sensening, both University of Alabama Medical Center representatives.
7:30	Background	International current events panel.
8:30	Alexander City Schools	Activities at public schools; guests include instruction Supervisor, Charles Farrow, and the Benjamin Russell High School choral group.
9:00	Parlons Francais	"Carmen" is read in French. (College level course)
9:30	Nature of the Enemy	Viruses (Medical) research. (Produced by NBC)

28, 1958, marked the beginning of its third year of operation. On the air from 9:15 in the morning to 10 o'clock in the evening, this network programs more hours of TV weekly than the British Broadcasting Corporation (Table in Box) and reaches an estimated 800,000 TV receivers in private homes.

The network (Box) comprises three VHF-TV stations: WAIQ on channel 2, WTIQ on channel 7, and WBIQ on channel 10. Programs originate from studios of the Alabama Polytechnic Institute at Auburn, the University of Alabama at Tuscaloosa, and the Educational Television Association in Birmingham.

Raymond D. Hurlbert, general manager of the Alabama ETV Commission, thinks that noncommercial educational television will live and grow. For today we have a popular hunger for general information, systematic learning, and intellectual and cultural enrichment. "In our country and in our time," says Hurlbert, "educational TV is the best practical means for informing the electorate and increasing public understanding."

How Good?

One of the big questions in the use of educational television is: Just how good is it?

To find out, the U.S. Army in 1954 completed a study to determine whether closed-circuit TV would effectively teach recruits their basic training. About 12,000 basic trainees were selected, and the same instructors taught both the television and conventional instruction.

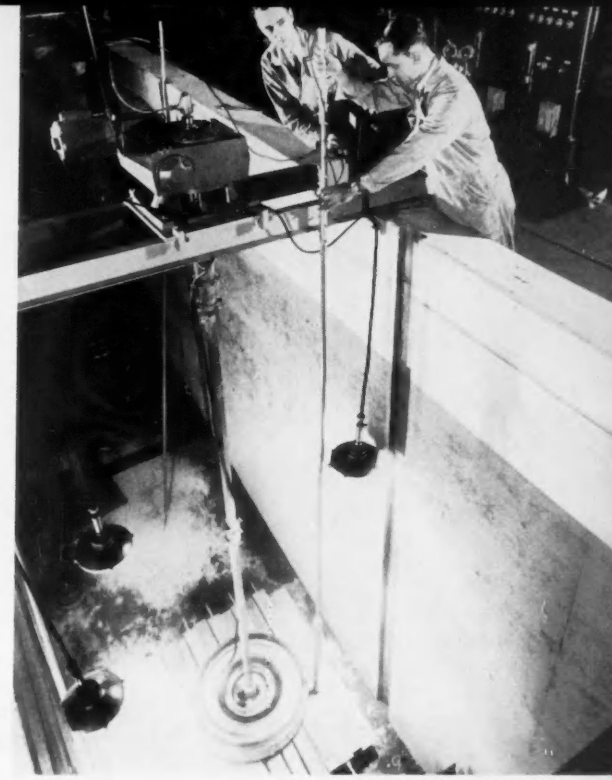
Results of this mass experiment proved that TV instruction was at least as effective as the conventional and that trainees remembered at least as well.

The Cincinnati public schools, utilizing the facilities of ETV station WCET, more recently conducted an experiment involving several hundred "control" students who studied chemistry via television. Their findings showed a significant difference in grades favoring students who took the courses by television.

In a study guide for a course in plane geometry presented last year over the Alabama ETV network, Mrs. Peggy Crum, the instructor, made a comment on the supplemental nature of ETV: "In this course, because of the interest television itself creates, we must avoid this pitfall—the student must not depend entirely upon watching the television presentation for his learning. We wish to cement the three-way triumvirate of classroom supervisor, television instructor, and textbook into one learning process."

Speaking of the Washington County experiment in closed-circuit ETV, the late John K. Weiss of the Ford Foundation noted that there are still too many unknowns to draw any firm conclusions on educational television. The requirement, he said, is simply patience and open-mindedness on the part of all.

One thing seems certain, however. Television offers the greatest opportunity for progress in education since the invention of printing by movable type. —ALLAN LYTEL



Age-Old Radiation Use

Radiation processing is employed by Greek peasants as days of hot sunshine shrivel grapes to raisins in clay beds.

New Radiation Task

Radiation now vulcanizes rubber. Laboratory Tests, with tire suspended over radioactive fuel elements under 17 feet of shielding water, produce longer wearing tires.

What Is the Future of Radiation Chemistry in Industrial Processing?

By DR. L. G. COOK

Radiation in its various forms supplies the energy for all of nature's chemistry. Yet man's direct use of radiation energy has been restricted largely to such simple operations as the manufacture of salt by the evaporation of sea water or the drying of cod fish or raisins in the sun. Why? Let us explore the reasons behind this neglect of a seemingly free source of energy and examine the prospects for the future.

Actually for chemical operations of any complexity, the sun does not provide a satisfactory source of radiation energy. The reasons? An industrial plant would need collectors spread over acres to obtain a practical amount of power—a much too expensive method. Moreover, the vagaries of cloudy-day shutdowns would be unacceptable. So, although this radiation energy is literally free, its direct use is still uneconomic. The potential user must turn to artificial sources that produce concentrated beams of radiation at will.

Unfortunately, neither the machines nor the radioactive isotopes to produce these concentrated beams come free: they require both capital investment and maintenance charges. Hence the radiation produced is not free either; in fact, costs may range from a few cents per kilowatt-hour (kw-hr) for ultraviolet to a few dollars per kw-hr for x-ray and electron radiation. These costs have proved to be too high to allow radiation processing to compete with alternative processes.

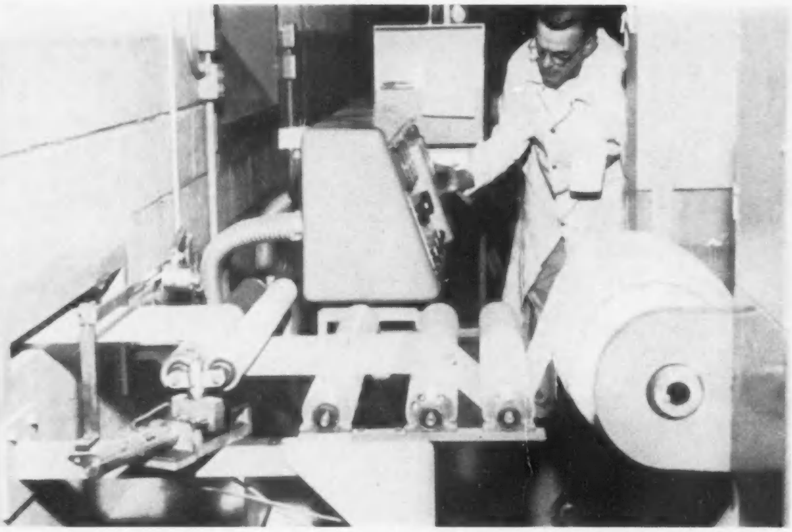
A typical example was the installation in 1917 of an ultraviolet water-sterilization plant at Henderson, Ky., handling up to 3-million gallons a day—using a mercury vapor arc in a quartz tube as the source of radiation energy. Several other installations have been reported since. Advantages claimed are that no disagreeable tastes or odors are produced in the water and there are no chemical additives of which an overdose could be disagreeable or even dangerous. In spite of this, chlorine sterilization has become the accepted industrial method of water sterilization because—although it produces objectionable tastes and odors—it is about 100 times cheaper.

New Developments

The discovery of fission in 1939 wrote a new chapter in the story of radiation sources. Radioactive nuclides can now be produced on a large scale, and indeed some are unavoidably produced as by-products of reactor operation. Is this the key to cheaper radiation? Will it result in the wider use of radiation chemistry in man's chemical industry? Over the past 10 years, the reaction to these questions has been a burst of research activity directed particularly to exploring the effects of the types of radiation which would become available from reactors or their by-products. For

Dr. Cook—an analyst in the Project Analysis Section, Research Application Department, General Electric Research Laboratory, Schenectady, NY—has been with the Company for 2 years. He was formerly with Atomic Energy of Canada, Ltd. as Head of the Chemistry Research branch for 9 years and Director of the Chemical and Metallurgical Division for 2 years.

A 1936 graduate of the University of Toronto in physics and chemistry, he received his PhD at Berlin University in 1939.



RAW POLYETHYLENE streams through 2-foot protective wall and beneath a million-volt electron generator for polymerization by cathode ray, during developmental production run.

RESEARCH SCIENTISTS prepare experiment on polyethylene film irradiation. Lead bricks block stray beams from the million-volt electron radiation generator, situated overhead.

despite the potential availability of these radioactive sources prepared from chemical plant wastes or by direct manufacture in reactors, sources with as much as 1 kw of radiation power have rarely been prepared.

It has proved advantageous in research programs to make extensive use of machine accelerators as sources of radiation—Van de Graaff, resonant transformer, or linear accelerators. These are readily available in higher power ranges, and one machine can provide a wider variety of types of radiation than can any radioactive source.

Radiation Economics

How much will it cost to make the product using direct radiation processing? Has the product or process such merit compared to alternates that the cost is attractive?

In answering the first question we must be careful to estimate the costs of using the radiation as well as the cost of producing it. As the solar example teaches, even free radiation may cost too much to use.

On the question of merit, we must assess whether the product is identical, superior, or inferior to its competitors; whether the process is simpler and cheaper or more complex and expensive than its competitors. As the water sterilization example teaches, a process that is inferior on several technical and personal-preference counts may nevertheless be preferred to the superior method because it is so much cheaper. In essence we must think of a kind of

$$\text{"flying index"} = \frac{\text{Uniqueness of product}}{\text{cost of production}}.$$

A product may "fly" even at high cost if it is unique. Or an inferior product may fly, if it is cheap enough. But if a slightly too high cost is combined with a small superior merit, the flying index is low and the proposal uneconomic.

Where can we get the information to make these appraisals?

The research laboratories can tell us how much radiation energy the product must absorb for different types of processes. For example . . .

- The radiation synthesis of simple inorganic compounds, such as ammonia or nitrous oxide, requires 10 to 100 kw-hr per pound of product.
- The radiation induced polymerization of monomers requires approximately 1 kw-hr per pound.
- The vulcanization of rubber, the cross-linking of polyethylene, the cross-linking of silicones, and the preparation of graft polymers require approximately 10^{-2} kw-hr per pound of product.
- The sterilization of meat, bandages, and drugs requires 2 to 6×10^{-3} kw-hr per pound of product.
- Insects are killed and the sprouting of potatoes and other life processes interfered with at 10^{-4} to 10^{-5} kw-hrs per pound.

From the laboratory, too, we can learn the expected merit of the product—whether technically better or worse than its competitors.

There is sufficient experience in uranium reactor technology and the chemical process technology of radioactive materials to enable the techniques and costs for producing sources to be appraised. For example, Co-60 is made by exposing ordinary cobalt to neutrons in a uranium reactor so that it is really the cost of the neutrons that must first be appraised. For Cs-137 on the other hand, we must appraise the costs of recovering it in a usable form from the waste by-products of reactors.

The manufacturers of machine sources of radiation are well established and experienced. They can provide reliable estimates for the initial costs and operating expenses for machines to provide any of these types of radiation—and other types that radioactive materials cannot provide.

Next come the problems of application—the user costs. For example, although an automobile tire requires only 10^{-2} kw-hr per pound of radiation to vulcanize it, this radiation has to be delivered to the tire through a metal mold. How much radiation has to be delivered to the outside of the mold to allow for the delivery of the right amount inside depends on many things; but 10 or 100 times as much could easily be required—a serious factor in the economics.

Another example is a recent proposal for the preparation of nitric acid, which to be low in cost would involve the intimate mixing of the raw materials with uranium in a reactor. This would leave the acid heavily contaminated with radioactive by-products. The removal of these radioactive by-products to the level presently accepted in the industry would be a chemical problem of considerable magnitude, and could be a serious factor in the user economics—even though the "nitric acid" had been "made" at a low cost. For estimates of the problems and costs at the user end, we must go to the potential users and manufacturers.

Finally comes the financing of the plant. From business managers concerned with keeping firms in business, we learn that under today's tax conditions an investment in a new plant must promise 20 to 30 percent on investment before taxes, to be worth considering. Moreover, there must be an expectation that the capital will be returned in five years if the product is a new chemical with a high possibility of obsolescence or 10 years if the equipment involved has a general market value. Only special contracts or subsidies can ameliorate these conditions.

RADIATION-SOURCE COST

Assume purchase cost of the radiation source to be $10,000 per kw

Conditions	Cost (per kw)
Annual capital recovery (allowing a 10-year depreciation)	$1000
Annual earnings before taxes at 30 percent per annum (0.3 × 5000) required on the average capital investment over a 10-year period	$1500
Annual charge for maintenance parts replacement, and employees . .	$ 300
Total annual cost	$2800

With 1600 operating hours per year at 50 percent absorption efficiency, this amounts to $1.20 per kw-hr absorbed.

Costs of Cobalt-60 . . .

Let us estimate the cost of procuring radiation from Co-60. To purchase a specialized reactor to make the neutrons would cost at least $100 per kw of reactor power. Depreciation over 10 years would make a $10 annual capital recovery necessary. Thirty percent return before taxes on the average investment over the period ($50) would mean $15 per kw per year. Finally a year's supply of fuel, and other maintenance and operating costs could easily run to at least $50 per kw. Adding these three items—capital recovery, earnings, and working costs—gives $75 per kw as a minimum annual charge. Using a neutron yield of 0.0013 moles per reactor thermal kw (0.8 neutrons per fission), we can convert directly to a cost of approximately $60,000 per kw of gamma ($\gamma$) radiation from Co-60.

Because radioactive sources only produce radiation as their individual atoms destroy themselves, the strength of such a source continually decreases. With Co-60 a 1-kw source will deteriorate to a ½-kw source in 5 years; other radioactive materials have different deterioration rates.

. . . Cesium-137 . . .

Cs-137 is one of the radioactive materials occurring as a by-product in used reactor fuel. As with solar radiation, it is free for the taking but not cheap to use. Several estimates of the possible future lowest costs of extraction and preparation have been made. The lowest (30 cents per curie) amounts to $70,000 per kw of γ radiation power, and many people prefer to use a figure about 3 times larger. To be safe we will use $1 per curie, or $240,000 per kw of γ radiation. The deterioration for Cs-137 is to ½ kw in 30 years.

. . . Machine Sources . . .

Machine radiation sources can be purchased now in the general price range of $10,000 to $40,000 per kw (electron beams), and costs of $5000 to $6000 or even less may be projected for the near future if machines of 10- and 100-kw power are needed.

. . . And Costs to the User

User costs may be more important to a particular product or process than the cost of the radiation . . . they cannot really be assessed without relating them to a particular example. The following fairly optimistic assumptions might apply in a fortunate case . . .

- As small a charge for maintenance, parts replacement, and employees as possible.
- A two-shift five-day week (1600 hours per year).
- That 50 percent of the radiation "produced" is actually absorbed in the product.
- No allowance for user costs, such as removing radioactive materials from nitric acid.

Over-All Economics

This leads to some simple costs (Table) and to an appraisal rule of thumb. . .

- For each $100 per kw of investment, allow 1 cent per kw-hr for radiation in the product, or
- For each 1 cent per kw-hr the product can afford for its radiation, allow $100 per kw for source costs.

Like all rules of thumb this is only a rough guide to indicate whether one is, so to speak, even in the right "ball park."

Typical Appraisals

We now have all the necessary elements to make some typical appraisals.

TEXT CONCLUDED ON PAGE 43

FIRST IN A SERIES OF READER OPINIONS

G-E Review Readers Feel Russia Does Not Have Scientific Edge over U.S.

By DAVID L. HOLZMAN

"Taking all kinds of weapons into account, we are at least even with Russia now," say 56 percent of a sample of GENERAL ELECTRIC REVIEW readers. Their opinion directly contradicts the Soviet claim made after the successful launching of *Sputnik I*, that "Moscow has taken over world leadership in science." Only 19 percent of the G-E REVIEW sample agree that we lag behind Russia in scientific weapons development, and 25 percent feel that, ". . . on the whole we have the edge in advance weapons now developed or being developed." In short, G-E REVIEW readers are not unduly alarmed; neither are they taking a head-in-the-sand view of Russia's claim of superiority.

But is a "tie" with Russia in weapons development enough? Does our present position afford us any real security? Not according to Walter Lippmann. In a post-*Explorer* column he says the nation's problem is ". . . that the Russians have achieved a *rate* of scientific and technological development which is faster than our own." That the United States sent into orbit its own satellites does not, in Lippmann's view, ". . . wash out the main portent of *Sputnik*."

For the first time, Americans realized that the United States could become a second-rate power and that they have lacked a sense of urgency about national defense and education. A sample of both professionals and businessmen, interviewed *before* the *Vanguard* and the *Explorers*, and a sample of G-E REVIEW readers, interviewed *after* the *Vanguard* and the *Explorers*, agree that ". . . we Americans have been too smug and complacent about national defense" and that ". . . our schools have put too little stress on science."

Mr. Holzman joined the General Electric Company in 1954. In his present position as Analyst, Applied Communication Research, Communication Operation, Public and Employee Relations Services, New York, he measures and analyzes public attitudes toward issues affecting the Company's reputation and interests and evaluates the effectiveness of its communications programs. In succeeding issues Mr. Holzman will continue to analyze these G-E REVIEW reader-opinion surveys on the socio-economic scene.

Comparing Opinions

The primary purpose of this survey was to compare the opinions of engineers, other professionals, and businessmen concerning efforts the United States could make toward increasing its rate of scientific research and development and improving its scientific education. (For the sampling procedure and research design for these surveys, see Box, page 30.)

Though our three groups concur on our smug and complacent attitudes, they disagree on the proposed solutions. The sample of G-E REVIEW readers—all engineers or professors of engineering—take a position that relies on society's private sectors to solve the problem of increasing our scientific education, research, and development.

The businessmen generally favor Federal expenditures for education and Federal direction of scientific research and development. The other professionals fall somewhere in between. Sometimes siding with the engineers but more often with the businessmen, this group favors some degree of Federal action, particularly in the field of scientific education.

Federal Intervention

What seems to be a sharp contradiction between the expected responses of businessmen generally and those reported in the survey is reduced considerably by closer examination of the particular businessmen we surveyed. Our sample of businessmen consists mainly of proprietors of small businesses and those in managerial or supervisory positions other than farming. They are not the men usually found at a meeting of the National Association of Manufacturers. These businessmen are probably less aware of the inherent strength of America's schools and scientific technology than are the engineers and, to some degree, the other professionals. Consequently, in their deep concern the businessmen are responding with what has become America's indigenous reflex: turning to the Federal government.

When asked to express their agreement or disagreement with the statement that ". . . Congress has been too economy-minded on spending for defense," significantly more businessmen (49 percent) agreed than did professionals (38 percent) or engineers (29 percent). In contrast, significantly more engineers (78 percent) disagreed with the statement that ". . . leading companies have neglected their defense job" than did businessmen (56 percent) or other professionals (46 percent).

Military Services

The engineers indicate their disenchantment with the "indescribable labyrinth of Federal bureaucracy" by their views toward the military services. According to an article in the *New York Times Magazine*, May 18, 1958, the military services control ". . . between 60 and 80 percent of all Government funds appropriated for science . . . and it is toward the Pentagon that the anger and bitterness of most scientists, rightly or wrongly, are directed." This point is not lost on any of the three groups, but engineers agree significantly more (88 percent) with the statement that ". . . there's been too much rivalry between the Army, Navy, and Air Force" than the businessmen (75 percent) or other professionals (74 percent).

Education

The three groups closely agree (82 percent to 90 percent) on the general statement that ". . . colleges and universities should put more money into building up their staff of scientific teachers and paying them better." But when it comes to the specific programs of Federal aid or control of scientific education, they widely disagree. For example, businessmen (62 percent) and

TABLE I

In the future we may see more and more of our scientific research financed and directed by the Federal government in Washington. Do you think that would be good or bad for scientific progress?

	Businessmen (Percent)	Professionals (Percent)	Engineers (Percent)
Good	66	49	21
Bad	17	18	44
Qualified	4	16	31
No Opinion	13	17	4

TABLE II

If we have to spend a great deal more on education, where do you think most of the added money should come from—should it come from local taxes, from state aid, from federal aid, or from contributions by business and industry?

	Businessmen (Percent)	Professionals (Percent)	Engineers (Percent)
Local Taxes	27	19	36
State Aid	29	30	34
Federal Aid	35	38	29
Industry and Business	16	23	26
Other	9	15	4
No Opinion	12	11	6

Total replies exceed 100 percent because respondents selected a combination of sources.

professionals (64 percent) feel that "... there should be Federal or state laws that say what science courses every high school must offer," whereas only 28 percent of the engineers share the opinion. Similarly, 64 percent of the businessmen and 72 percent of the professionals concur that "... the Federal government should give money to our colleges and universities for basic research to spend as they see fit," while significantly fewer of the engineers agree (47 percent).

On the specific proposal that "... the Federal government should provide scholarships for the best-qualified science students," the majority of all groups are in accord, but with significantly fewer of the engineers agreeing (67 percent) than businessmen (89 percent) or professionals (87 percent).

Research under Federal Control?

To summarize opinions regarding the need for scientific research under Federal aid and control, we asked the following question: "In the future we may see more and more of our scientific research financed and directed by the Federal government in Washington. Do you think that would be good or bad for scientific progress?" For the results, see Table I.

We then raised a question, hotly debated in America for some time, that carries a new sense of urgency as a result of the *Sputniks:* "If we have to spend a great deal more on education, where do you think most of the added money should come from—should it come from local taxes, from state aid, from Federal aid, or from contributions by business and industry?" The respondents were allowed multiple choices which most of them took, giving no one source of revenue a clear majority (Table II).

The major differences between groups are that fewer professionals (19 percent) select local taxes as a source for the "added money" than do businessmen (27 percent) or engineers (36 percent), and that businessmen (16 percent) select contributions from business and industry with less frequency than do professionals (23 percent) or engineers (26 percent). It may strike you as somewhat surprising that engineers (29 percent) choose Federal aid with not a great deal less frequency than businessmen (35 percent) and professionals (38 percent). This seems a bit contradictory to the views expressed earlier by the engineers. But this apparent inconsistency could in reality indicate the basic conflict facing anyone who opposes increasing the scope and size of the Federal government. That is, the Federal government unquestionably has at its command the largest source of revenue, and when the national need for money is *urgent*, one has to consider the use of Federal funds.

Taxes

The 16th Constitutional amendment has existed for 45 years, but Americans

TEXT CONCLUDED ON PAGE 43

SAMPLING PROCEDURE AND RESEARCH DESIGN

The data on businessmen and professionals were obtained as part of a national survey of 1000 respondents. The Opinion Research Corporation, Princeton, NJ. conducted the survey during December 1957 and January 1958. The sample of 1000—selected by probability methods—represents the national public. It contains representative subsamples of major occupational, demographic, and socio-economic groups in America. Out of the 1000 national sample, 85 were classified as proprietors and managers and 102 as professionals. These classifications are based on the occupational classifications employed by the U.S. Bureau of Census.

The data on engineers were obtained from a randomly selected sample of G-E REVIEW readers. McGraw-Hill Research, New York, conducted the survey during April 1958. The sample of 100 does not represent all engineers but does represent engineers who are readers of the G-E REVIEW. The McGraw-Hill sample of G-E REVIEW readers was selected from each region of the United States and consists of electrical engineers (44 percent), mechanical engineers (20 percent), engineering professors (11 percent), chemical engineers (5 percent), and other types of engineers (20 percent).

Identical questions were asked of both samples—all of whom were interviewed personally by professional interviewers. But the research design differed in two ways: the context of the questions asked and the periods of time in which the questions were asked. To enlarge on this, proprietors, managers, and professionals were asked additional questions about *Sputnik*, national defense, and other subjects. Engineers were asked additional questions about their readership of the G-E REVIEW. And the interviews with the proprietors, managers, and professionals occurred before the launching of a U.S. satellite; the engineers' interviews took place after successful launching of *Explorer I*, *Explorer II*, and *Vanguard*.

United States satellite achievements undoubtedly allayed some of America's anxiety, but in our opinion they did not change the nature of the problem: whether Russia's rate of scientific and technological development is advancing faster than ours.

Some Things to Count On

Those who intelligently evaluate the future will plan for a vigorous industrial growth. The socio-economic problems will expand as well, requiring individual self-development and a nonconformist's critical evaluation.

Even though commencement is nine months away, senior science and engineering students have already begun to focus their thoughts on future careers.

To help give them insight into what lies over the horizon—future industrial growth, economic and union problems, conformity, and individual self-development—we are printing General Electric President Robert Paxton's remarks presented at the June 6 commencement exercises of Rensselaer Polytechnic Institute, Troy, NY.

Other G-E REVIEW readers, their outlook tempered with experience in business, government, and teaching, also will find Mr. Paxton's perspective on the future both challenging and stimulating.

Additional copies of this presentation may be obtained upon request to: GENERAL ELECTRIC REVIEW, Schenectady 5, NY. Ask for publication PRD-168. —EDITORS

By ROBERT PAXTON

. . . I would like to speak from my vantage point as a businessman about certain economic questions that I suspect may be in your minds.

The American economy is the most productive system ever developed for transforming physical resources, capital, and human effort and intelligence into useful goods and services. It permits efficient, broad, and equitable distribution of its fruits. It is the only kind of economic system that is compatible with self-government under free political institutions.

Our economy also has some weaknesses, one of which is its unpredictability. Since it depends not on central plans and controls but upon the voluntary, self-directed behavior of millions of individuals, its operation is so complex that no one knows exactly what is going to happen next. As a result, some people seem to feel that nothing about the future of the economy can be safely hazarded. That is a mistake.

As young men about to take your places as contributing members of the economy, you should know that there are some things you can count on with considerable assurance.

Need for Technical Training

First, you can count on a growing need for your trained services future.

With your technical training, you are about to become agents in a happy form of world revolution—a technological revolution that promises the means of solving many of the age-old problems of mankind.

Perhaps the most pervasive cultural force at large in the world today is the drive for industrialization. It transcends national boundaries, shapes political policies, and alters social customs. It furnishes hope for a better life to peoples who for centuries have had no reason for hope. It is pursued by all nations, the advanced and the backward, new and old, large and small.

It is safe to predict that some nations which today are still largely agrarian will emerge as new industrial powers in the years ahead. Why not? After all, scientific knowledge is available to whoever seeks it, and intelligent, capable people are to be found in all lands among all races.

Stepped up industrialization abroad will inevitably mean the acceleration of efforts to keep our own technology as far advanced as possible. The grim contest now taking place between Russia and our country offers an excellent case in point.

Fortunately, American companies have proved extremely adept at organizing and utilizing the talents and services of engineers, scientists, and other technical people. Industry has embraced technological advance as the first requirement of progress.

Research and Development Climb

It is significant that during the current recession, when many types of business expenditures are being curtailed, private industry's research and development expenditures in 1958 will be an estimated 8.3 billion dollars, a full billion more than was spent last year.

For competitive reasons, as well as for reasons of national security, the dependence of American industry upon technological progress will grow increasingly strong. Your opportunities will grow apace.

Future Industrial Growth

Another thing you can count on is vigorous industrial growth in the years ahead.

The current recession is the turbulence of a stormy sea, but do not be misled by surface indications. This tide flows in but one direction—toward expansion and growth—and the forces of that tide are irrepressible. I have already suggested three . . .

- The world-wide sweep of industrialization, opening tremendous markets abroad for capital equipment and other products
- The billions being spent on research and development, resulting in new and improved products capable of commanding new and enlarged markets
- The Russian threat, which, from the standpoint of American industry, is not only a matter of furnishing technologically superior military hardware but also a matter of demonstrating to the world that our economic system is superior in all respects.

Two additional forces should be mentioned.

One is the expansion of our population, currently growing by about 3 million a year. That is like adding another Kentucky to the nation every

"You can count on vigorous industrial growth in the years ahead."

twelve months. Population growth will be accelerated when the exceptionally large number of youngsters born in the 1940's begins setting up housekeeping in the 1960's. They will provide expanded markets for the companies that are preparing now to compete for their business.

The other force is the change occurring in family income distribution. On the basis of constant dollars, so as to eliminate the distortions of inflation, only 37 percent of all American families had annual incomes of less than $4000 in 1957, compared with 49 percent in 1947. And 38 percent of all families had incomes of $6000 or more last year, compared with 26 percent in 1947. When people move into higher income brackets, their buying habits change. They offer expanded markets for goods and services that were formerly beyond their means. Industrial growth thrives only on expanded markets.

The five factors I cite—world-wide industrialization, research and development expenditures, national defense requirements, population growth, and the movement of families into higher income brackets—these will prove far stronger than the particular conditions that are responsible for the present slump in business activity. Before many more months have passed, they will again assert their expansive force.

Continuing Problems

I take no delight in telling you what comes next on my list of things you can count on. Your generation can, I am afraid, count on having its full share of economic and political problems to solve.

Three that promise to be around for some time are fluctuations in our economy, labor union power, and inflation. Obviously, each is too complex to discuss in detail here. I shall talk about them but briefly.

Although devices are being developed to mitigate economic fluctuations, no means have been found to prevent them. Possibly we should not even try to prevent them entirely. One of the great virtues of our economy is that rates of production in particular lines do change in response to changes in the tastes and habits of customers. The customer, not some central planning agent, is master. Operating methods change to take advantage of new technology and improved managerial techniques. These changes are beneficial—in fact, they are essential.

On the other hand, it must be conceded that to some extent economic fluctuations stem from decisions resulting from imperfect knowledge. Everyone has a responsibility to do what he can to eliminate the causes of fluctuations. That includes employers, employees, union officials, government officials, farmers, and all whose decisions determine the course of the economy. The problem is twofold: to minimize fluctuations without destroying necessary flexibility and to eliminate the human distress that economic fluctuations cause. In time, I believe, we will do better with this problem.

Another problem is abuse of power by labor unions. Unions arose to combat abuses by management. They developed into powerful, militant institutions.

But as industrial managers become more understanding of economics and more conscious of their social responsibilities, the need lessens for old-fashioned militancy in unions. When that happens, some union officials attempt to assume management functions. Others continue as before, using outworn techniques of abuse, distortion, and slander to maintain a posture of militancy. They try to keep their members excited with wild talk, making big issues out of minor provocations.

The important point is, however, that union officials are in a position to exercise irresponsible, monopoly power stemming from special immunities which make them privileged in the eyes of the law as are no other citizens.

ROBERT PAXTON—GENERAL ELECTRIC'S NEW PRESIDENT

A veteran of 35 years with the General Electric Company, Robert Paxton brings to his new position broad operating experience. He joined the Company immediately following his graduation from Rensselaer Polytechnic Institute in 1923.

After a year on the Company's training program for engineers, he joined the Switchgear Department in Schenectady and in 1927 transferred to the switchgear plant at Philadelphia. Thirteen years later, after gaining major experience in manufacturing, engineering, and managerial activities, Mr. Paxton was named assistant to the manager of the Philadelphia plant. The following year he was appointed manager, a post he held until 1945.

In 1945 he was appointed manager of the Pittsfield, Mass., apparatus plant, and in 1948 he became manager of the Transformer and Allied Products Division. In this capacity he was in charge of all phases of one of the Company's most important operations, with plants in Pittsfield and Holyoke, Mass.; Fort Edward, NY; and Oakland, Calif.

In 1950 Mr. Paxton was appointed manager of manufacturing policy for the Company. In September of that year, he was elected an executive vice president of the Company, with responsibility for the Industrial Products and Lamp Group.

Mr. Paxton was assigned responsibility for the Apparatus Group in 1954, which, in addition to product divisions, included Canadian General Electric, Apparatus Sales Division, and the commercial vice presidents. In September 1957, he was appointed vice president in charge of operations and elected a member of the Company's Board of Directors.

In April of this year, he was elected President of the Company.

"Thoughtful young men will not make a fetish of uncritical conformity."

General Electric favors the development of a modern national labor policy that recognizes the realities of present-day monopoly union power, with its restrictions of output and its strong inflationary effects. The situation can be improved by corrective legislation. But that is not a complete answer. In the end, the community at large must provide the answer by insisting that union power be exercised responsibly in the interests of the whole economy and nation as well.

Antidote for Inflation

As for inflation, it is a pernicious disease that throughout history has attacked imprudent nations like a rot, undermining values and wrecking economic stability. I shall make just one point about it.

The ability of a nation to lick inflation depends upon the moral character of its people. A few questions help us test ourselves. Are we proud people who desire to pay our way, or are we constantly looking for something for nothing? Do we give a full day's work for our wages, or do we shirk our tasks? Are our wages determined by the economic value of our services or by the coercive power of our organizations? Do we disdain excessive debt, or do we habitually attempt to live beyond our means?

In controlling inflation, of course other considerations are also important. Certainly monetary and fiscal policy are critical, and so is the curtailment of union power so that wage increases can be better geared to productivity. But in the long run, the outcome will be determined by the character and the integrity of the people.

I suggest that each of you would be well advised to make a continuing study of these three problems—business fluctuations, union power, and inflation—for I am afraid you can count on having to face them for years to come.

Individual Self-Development

Fourth on my list of things you can count on is a continuing need for additional knowledge and for individual self-development.

Technology is advancing so fast that everyone associated with it must plan a continuing program of re-education. Do not think you have now completed your education.

I know such statements are standard in commencement addresses. I would not repeat it here if I did not believe earnestly in its essential importance.

At General Electric, we regard the self-development of individuals as a key factor in the future success of our Company. Consequently, we spend many millions of dollars each year on personnel development activities. We offer more than a thousand courses in factory skills and more than 500 other courses at various locations to professional, technical, and semitechnical employees. Formal courses are but one aspect of the self-development activities of our employees, but even at that, in an average year one out of eight takes advantage of Company-conducted courses.

Just as personnel development is of critical importance to a company like General Electric, so planned self-development is of fundamental importance to your personal success. I am not referring merely to the advancement of your competence in your chosen field of specialization. Equally, or perhaps even more important, is the need for broadening your understanding of society as a whole, for, as you rise to positions of increased responsibility, you will find yourself dealing to an ever greater extent with social, economic and political considerations. Any investment of time and effort that you may make along this line will prove well worthwhile.

Nonconformists Encouraged

Finally, you can count on integrity of character to further your success in pursuing industrial careers. That is a very loose generalization, but I have something specific in mind.

One of the worst canards circulated about industry is the notion advanced in recent years that industry seeks men who are blind conformists—men who lack values and principles of their own and seek to please by uncritical acceptance of beliefs and choices. Nothing could be farther from the truth.

That such men are to be found in industry, as in all walks of life, cannot be denied. Industry does not prize them. The men most sought are those who have the qualities of self-reliance, courage, resourcefulness, and independence of judgment that all through history have distinguished superior men from their inferiors.

At General Electric, we have never doubted that encouraging men to think independently and to stand up for their convictions is essential to our Company's progress. We seek to maintain an atmosphere of freedom for such expression. In fact, our decentralization policy may be taken as evidence of our confidence that large numbers of employees possess or can develop those qualities of initiative and leadership required at all levels and locations of the Company.

Creative New Ideas

After all, if a company is to adapt quickly to changed conditions and meet the competition of the market place successfully, it must have a constant flow of creative new ideas. It needs the contributions of men who can escape the bonds of conformity to recognize emerging new problems and offer fresh solutions. What is progress but successful adaptation to new problems and opportunities?

A thoughtful young man will not make a fetish of uncritical conformity. Neither, of course, will he scorn or resist situations calling for teamwork and cooperation. His self-respect will prevent the first, and his intelligence the second.

A profound understanding of this general point is necessary, not alone for the sake of a successful career and not only for the advantage of companies that need creative, resourceful people. More fundamentally, an appreciation of the need for competition of ideas, tolerance of dissent, and unquestioned freedom of opinion safeguard the preservation of a free way of life.

The progress we all seek as Americans compels a high degree of organization in society, and some may assume that that fact requires the extension of authority over the thoughts and actions of men. On the contrary, a prerequisite to progress, I deeply believe, rests in the encouragement, rather than the submersion, of the differences in men, of their individuality, their freedom, and their dignity.

The world sweeps ahead with blinding speed. At times you may think all is flux and change. But through it all, you will find things you can count on—things to sustain your hopes and guide your feet. I wish you a lifetime of success. Ω

What about the Age of Space and Me?

George, who represents thousands of General Electric people, adds a few words to the millions already written about the education of boys and girls since the first man-made satellite found its orbit. And "I," listener and reporter, take pleasure in recording his thoughts.

I wondered what was eating George. It was Saturday morning—a sparkling morning—and my neighbor wasn't singing or whistling. Usually he acts as if his mind is doing a jig.

This was too much for me. So I returned his stepladder.

"In another week I'd thought I owned it," I said as I clumped past him up his driveway. "You know," I said to the back of his head, "all you had to do was to holler."

George closed the window he was washing with a bang, stepped down from an old chair, and slowly turned my way.

"Don't be ridiculous," he grunted. "Drop it anywhere."

I grinned. "Come on over for a cup of coffee."

"Might as well. Rockets and people have got me down."

George usually sits on my workbench, swinging his legs. But now he dumped himself into one of my canvas beachchairs. I plugged in the battered percolator.

"Why have people and rockets got you down?" I asked.

"Well, I don't like very much the way many people are questioning the free versus the 'directed' society. If I believe my eyes and my ears, there are those who are hinting that we will have to be just a little more like the country that got into space first. They hint that we will have to take our directions from a centralized agency.

"It is difficult for me to think of Americans stampeding like cattle. We are not a nation of second-raters. All the way from Concord Bridge to atomic power plants, we have moved ahead with one purpose—to guarantee freedom and better living for everyone. I don't mean to sound like a Fourth-of-July orator, but I'd like to shake a fist back at those who would adopt just a few of the methods of a dictator to achieve the military strength needed to prevent war.

"I don't think Americans are going to let themselves down, or sleep when our way of life is in danger. We are going to put to work the incentives of our free society to meet defense challenges. And we will do it with the same spirit and progress we have demonstrated so often in our civilian technology."

I asked a foolish question, because I enjoy seeing George just a little disturbed: "What about force-feeding our boys and girls with science, math, English, foreign languages . . . really loading 'em up with tough subjects, giving 'em hours and hours of homework, and sending off the failures to Siberia? That would take care or our country's future."

"Ouch!" said George. "You too have been reading the papers and magazines."

"It would work," I said with a laugh.

George ignored my poor efforts to joke. "As you know, the education of boys and girls is everyone's concern today. We have such a wonderful country today because of education."

George climbed out of the beach-chair and took his usual position on the edge of the bench. He began swinging his legs.

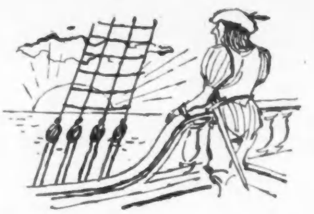
"I have been wondering," he said, "what teen-agers of long ago thought when they heard about Columbus' successful voyage. His ships did not fall off the edge of a flat earth. Did they dream of swashbuckling adventures, of a new land of opportunity for themselves? A tiny, flat earth had become a huge sphere sailing in the heavens. Now we have just stepped off into space. This is such a terrific feat—well, I guess I'm disappointed because so many teen-agers are near-sighted. They take folk-dancing for credits instead of trig; they say that scientists are egg-heads; they play gangster; something like a fifth of the students in the top quarter of their class don't even graduate from high school; three out of four turn down physics . . ."

"Hold on!" I said. "You've earned a good reputation for being the young people's friend."

"So help me," George said, "I am! I just like 'em so much, I'd like to bump some of their heads together." George was now talking earnestly. "It's just that I can't convince myself that we can keep on making America a land of happiness and opportunity if too many of us, whatever our ages, make soft choices. It is apparent that the orbiting satellites are shaking us older people out of our lazy ways of thinking. There'll be more and better schools, and in general, better educational advantages. I think that those states that do not require even a single course in science or math for a high-school diploma will see the light."

I poured two cups of coffee.

"George," I said. "I have become accustomed to marvels. A little chunk of fuel drives an atomic sub for months. Jets crash the sound barrier as a matter of course. We have the Salk vaccine and the antibiotics. Electronics is becoming a bigger part of the electrical industry . . . Why all the fuss about the Age of Space? What does it, or should it, mean to young people?"



"Let me be very clear about one thing," said George. "I do not believe that any technological achievement is of so much importance that we should rate it higher than the miracle of human life, or the human being's ability to enjoy the world about him. What a miserable world this would be without music, drama, poetry, canoe trips, and even workshops like this.

"I haven't been able to make my words come out just right, so far, but I sincerely believe that our millions of gifted boys and girls have an obligation, to themselves and to others. This is the obligation to use the brains they were born with, so that the best possible means can be developed to keep us a free, happy people.

"For example, we need wise statesmen to keep us, and with honor, from senseless war. We need great churchmen, lawyers, manufacturers, musicians, engineers and scientists, doctors, homemakers, teachers—oh, the list is endless.

"If I were young again our recent entry into the Age of Space would excite me to doing a better job in school than I had before dreamed possible. I would lay out a program of solid courses that I couldn't possibly find time to take, and then narrow them down to those I could handle, by hard work but without becoming a grind. Fun, too, is part of living. But you can be sure the basic things would not be eliminated . . ."

"No folk-dancing for credit?" I asked.

"Well, I can imagine that might be fun. I might try it. But on my own. My diploma would mean something."

"George," I said, "I just happen to have copies of letters sent by boys and girls to General Electric." I ducked into my study and came back with a handful of papers. "Here's one student who wants to know about the construction of the plasma jet, another on the measurement of pressure created by rays or wavelengths of light from different sources, such as ultraviolet and infra-red."

"I know," said George, "we have hundreds of thousands of promising boys and girls. I don't know whether we have enough. We hear usually about only those who are interested in science, but I imagine there are as many who excel in the tremendous non-science areas. There is no war between the arts and the sciences, except the make-believe one manufactured by writers. In general, an in-the-process-of-education person, young or old, tries to learn as much as he can about science, for the sake of science, and about the humanities, for the sake of humanity.

"It is my belief that educated people don't say—because they don't have to—'math is over my head' or 'English? I get nowhere with that subject.'

"If I were young, I would do my best. I myself saw a letter from a boy who wanted to become an atomic scientist, but there was neither physics nor chemistry in his high school. I understand that the boy is now being tutored by an engineer neighbor. There is always a way.

"I would be very much excited about the Age of Space, even if I had determined to become a Latin teacher or a nurse. That Age is here. It is a fact. I simply should hate to live in these marvelous times if my mind could not at least grasp what was going on about my ears.

"My dad used to say: 'I don't care what you choose to become as long as you don't choose to be a bungler. What I can't give you, in the line of opportunities, you will have to get for yourself. Some day we may have planes that fly to the moon, and you will want to know the how's and the why's. Live with your times . . . Well," George laughed, "a rocket is a kind of plane . . . Thank goodness, I have tried to hitch my wagon, if not to a star, to every rocket that tears upward through space.

"Thanks for the coffee. You know, I have windows to wash."

INDUSTRY PROMOTES THE STUDY OF THE THREE R's (PART 10)

You may want reprints of this article "What about the Age of Space and Me?" to help guide the young people with whom you come in contact. You can obtain them free by writing to the General Electric Review, Bldg. 2-107, General Electric Company, Schenectady 5, NY. In your request, please ask for publication PRD-167.

Future of Radiation Chemistry

(Continued from page 35)

They will tell us whether a given process is at least worthy of more detailed consideration. If it is not in the right ball park, the appraisal will tell us how far out it is and what factors must change to bring it in.

The cross-linking (vulcanization) of rubber by radiation requires 1 to 4×10^{-2} kw-hr per pound. For specialty items (such as fluorinated hydrocarbon rubbers) retailing for, say, $10 a pound, a surcharge of a few dollars per pound would be tolerable, if the product had even modest superiority. This would allow $25 to $50 per kw-hr to be paid for radiation absorbed—or, by our rule of thumb, an investment of $250,000 per kw of source equipment. This is an ample allowance at present machine prices and at Co-60 prices, though it would barely cover Cs-137. We can conclude that using radiation to make improved specialty rubber products is worth careful study.

The vulcanization of ordinary rubber, say for automobile tires, is more restrictive. A 30-pound tire has a chemical vulcanization charge of about 50 cents in its price. It would need about 1 kw-hr of radiation to do the same job. Thus, for equal product merit, radiation could not cost over 50 cents per kw-hr absorbed. By our rule of thumb this is $5000 per installed kw. It appears that the process is therefore on the verge of feasibility, especially if some superior merit—such as longer wear—were evident in the radiation vulcanized tire. Unfortunately, our assumption that 50 percent of the radiation produced can actually be absorbed in the product does not yet hold for tires; no one has found out how to dispense with the metal mold. This problem must be hurdled to make radiation vulcanization of rubber products really feasible.

The synthesis of basic chemicals is even more restrictive. Nitric acid, for example, sells for a few cents per pound of contained NO_2. Because the radiation-produced acid is identical to the acid produced by any other process, any superiority must lie in the economics of the process alone. Even if we could allow as much as a cent per pound of acid for the radiation content (10 to 20 kw-hr per pound), we find ourselves faced with 1/10 cent per kw-hr as the maximum allowable cost of radiation. By our rule of thumb this means at most $10 per kw of installed radiation power—a figure that appears to be impossibly low at the present time.

Thus we see that radiation source investments of $10,000 to $20,000 per installed kw already restrict the direct use of radiation in man's chemical industry to three areas: specialty products selling for several dollars per pound, products where superior merit is conferred, or processes where really substantial cost savings are brought about. It is hard to see anything but machine sources meeting these capital charges.

Wanted: New Technology

Radiation source investments of $5000 per installed kilowatt or less would open much wider fields of application—the vulcanization of rubber products, the cross-linking of other polymers, and the preparation of copolymers —provided the technology of efficient utilization of the radiation can be surmounted. Before radiation chemistry can play a substantial role in man's chemical industry, we need a new radiation source technology—a technology that will enable investment costs to come down to a few thousand dollars per installed kilowatt or less combined with a reasonable efficiency in the utilization of the radiation produced.

Often the most expensive part of any operation is getting the reactants together—actually the downfall of many radiation processes. Alternative chemical agents—whether gases, liquids, or powders—are much easier to infiltrate to the points requiring action.

Ultraviolet radiation is especially poor at penetration. And nature, to use this life-giving energy, has developed plant leaves as extended surface chemical factories. The failures of ultraviolet radiation in water sterilization as well as in other applications have resulted largely from the expense of getting the product intimately exposed to the radiation.

X-rays, γ rays, and high-energy electrons are more penetrating, but the costs of mixing are still high. It looks as though the really widespread use of radiation directly in man's chemical industry must await the solution to the problem that nature has overcome—how to make more effective use of lower-energy cheaper radiation or, alternatively, how to produce the higher-energy radiations somewhat cheaper and use them much more efficiently. Ω

Review Opinions

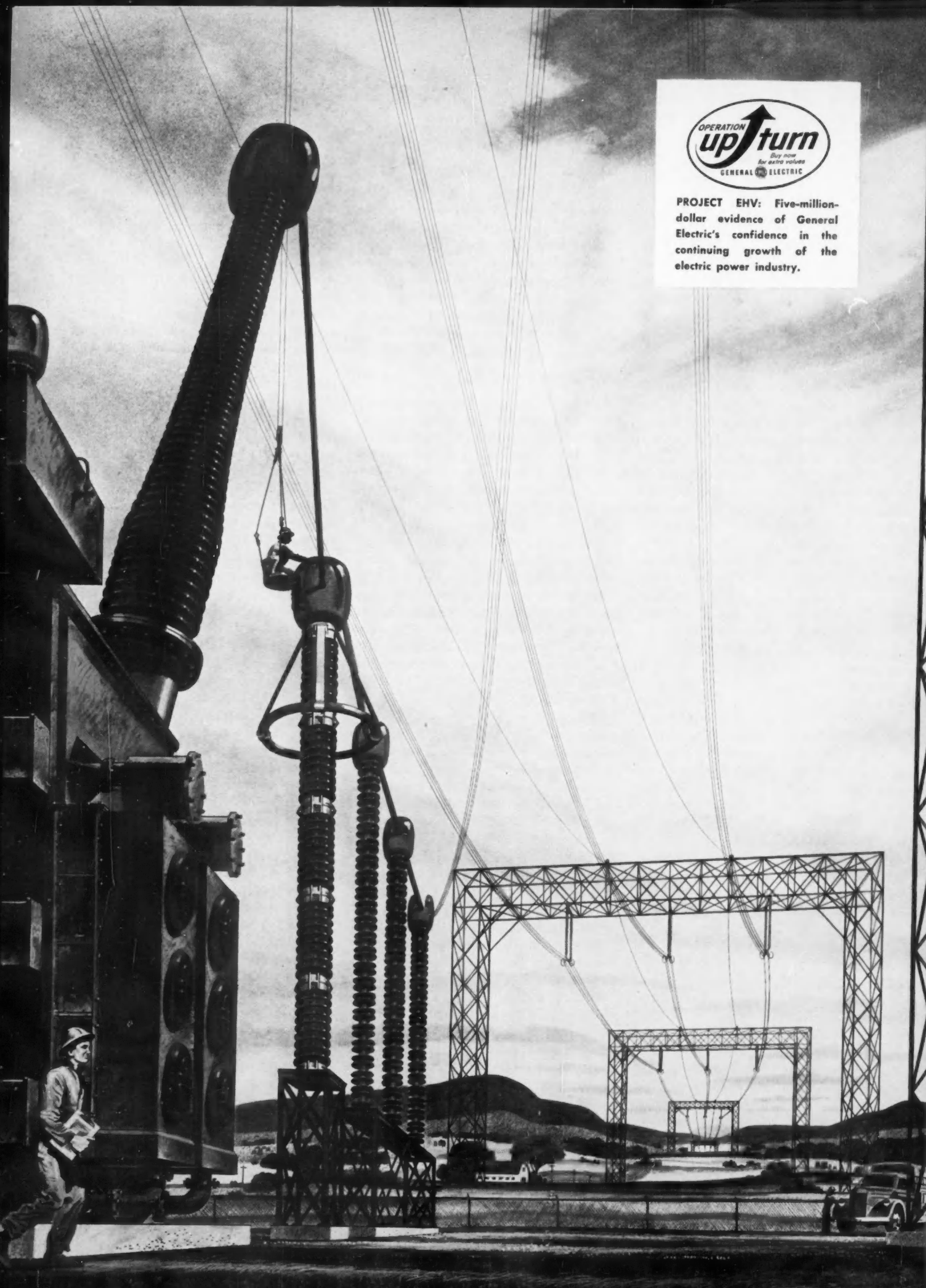
(Continued from page 37)

are still constitutionally at odds with the personal income tax. Our samples are no exceptions.

When asked, "If the Federal government gets short of money, do you think we should raise personal income tax rate?" only 25 percent of the businessmen, 30 percent of the professionals, and 34 percent of the engineers thought that we should. Significantly more of all three groups—39 percent of the businessmen, 48 percent of the professionals, and 48 percent of the engineers—think that we should increase excise taxes. On their last choice of tax proposals, the three groups clearly illustrate their basic differences. The businessmen (53 percent)—one would assume primarily the proprietors and managers of businesses that are not corporations—and the professionals (67 percent) feel that we should raise the rate on corporation income. The engineers—the majority are in the employment of corporations—have greater understanding of the consequences of increased corporate taxation and are in direct opposition, with 60 percent against the choice of an increase in the tax rate on corporation income.

Although the Russians' recent successes in science and technology have awakened national concern, their achievements have not brought about unanimity of opinion on possible corrective steps. As the data indicated, the sample of businessmen favor Federal control and direction of scientific research, and to a somewhat lesser degree so do the professionals. These two groups are also favorably disposed toward some government control of education. In direct contradiction are the sample of engineers who are strongly opposed to Federal control and direction of scientific research and education. However, they do agree with the businessmen and professionals that the Federal government should share with the local governments and the private sectors in providing any additional financial support that education might require.

Characteristic of so many approaches to the solution of national problems, many people, having taken sides in the Federal vs. local government and private sectors controversy, advocate their position as a total solution to all national problems, giving little thought to the nature of the problem. Ω


OPERATION
up turn
Buy now for extra values
GENERAL ELECTRIC
PROJECT EHV: Five-million-dollar evidence of General Electric's confidence in the continuing growth of the electric power industry.

General Electric announces...

PROJECT EHV

An operating system for study of all aspects of extra-high-voltage transmission 460 to 750 kv

General Electric, with counsel from the electric utility industry, will build and operate a prototype EHV transmission system. Objectives are to help extend the electrical industry's knowledge of high-voltage phenomena and to anticipate the equipment that will be needed when EHV transmission becomes standard practice.

The line, 4½ miles in length, will parallel and be made a part of the Pittsfield-Lee portion of the Western Massachusetts Electric Company's system. Initial operation in early 1960 will be at 460 to 500 kv a-c, rising later to the 600- to 750-kv range. In 1961, as tests proceed at the 650-kv level, power will be diverted from the adjacent segment of the WMECO line through the EHV system.

Others co-operating in the project, in addition to Western Massachusetts Electric Company, are Stone & Webster Engineering Corporation, Aluminum Company of America, and American Bridge Division of United States Steel.

An Advisory Council representing electric utilities, will help determine exact project parameters and the nature and scope of research.

Expected areas of study include:

- Economics of various a-c super-voltages
- Lightning and switching surge performance
- Effects of conductor size, bundle and phase configuration.
- Mechanical performance of line
- Effect of conductor temperature
- Corona loss, radio and television interference
- Reduced basic impulse insulation levels

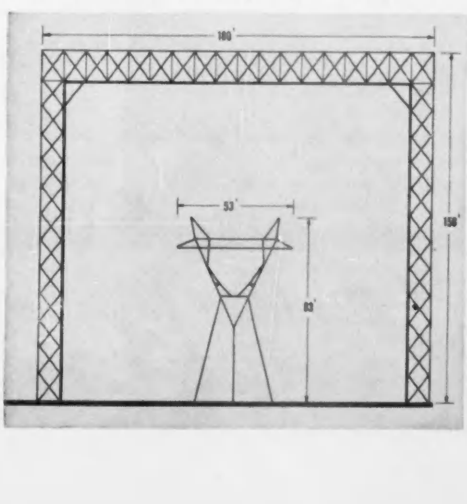
A wide variety of measurements with 200 instruments will be made at 15-minute intervals during all tests. Data will be processed through the 705 electronic data-processing machine at General Electric's Power Transformer Department, which is co-ordinating the project. Data will be correlated by analytical studies, model investigations and laboratory research in many G-E Departments.

For further information on PROJECT EHV, contact your G-E Representative or write for bulletin GED-3262, General Electric Co., Section 421-56, Schenectady 5, N. Y.

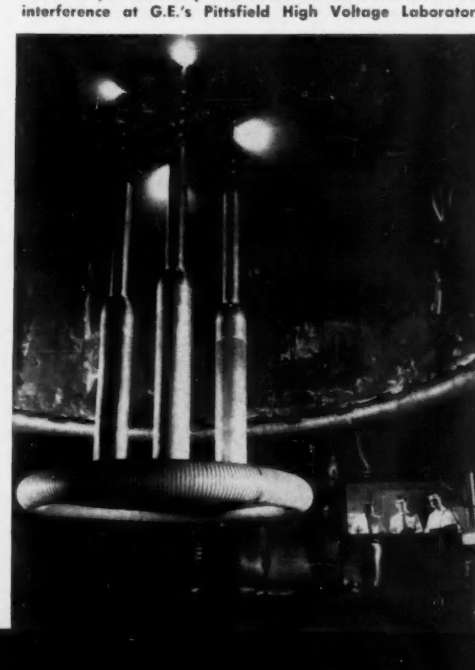
Progress Is Our Most Important Product

GENERAL ELECTRIC

PROJECT EHV portal-type towers, 158 feet high, 180 feet wide (here contrasted with typical present 230-kv towers), will allow varied conductor spacings and clearances.



PRELIMINARY STUDIES of apparatus and system are now under way. Here sample conductor bundle is tested for radio interference at G.E.'s Pittsfield High Voltage Laboratory.



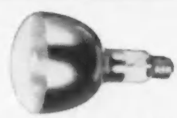
CONTRIBUTIONS TO LIGHTING FROM GENERAL ELECTRIC

FIRST FLUORESCENT Exactly 20 years ago, 1938, General Electric contributed the first fluorescent—a revolutionary increase in lighting efficiency.

ISN'T IT AMAZING? Each of these lamp types, and improvements in lamps, for commercial and industrial lighting, were developed and introduced into public use by General Electric to give you more value for all your lighting costs. Here are fifteen outstanding, but by no means *all*, of General Electric's contributions. The proud histories of General Electric and the lamp industry have gone side-by-side since the basic contributions of Mr. Light himself—Thomas A. Edison.

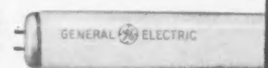
ISN'T IT LOGICAL? The company that gives you more value in new lamps and new improvements—and has been making both for a longer time—is also the company that makes the lamps that will be your best bet for day-in, day-out service and lowest operating cost. If you'd like more value for *all* your lighting costs, call your local General Electric Lamp representative, or write: General Electric Co., Large Lamp Dept. C-842, Nela Park, Cleveland 12, Ohio.

1950



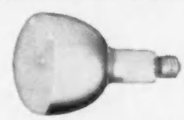
R-52 Reflector Lamp—sealed-in reflector never needs cleaning, 500- and 750-watt sizes.

1952



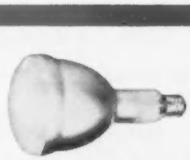
Rapid Start fluorescent brought faster, flickerless starting *without* starters . . . cut maintenance, too.

1952



R-1 Reflector Mercury gave maintenance advantages of inside reflector, plus mercury lamp efficiency.

1955



RB-52—This design improvement made practical a regular glass, 1000-watt reflector lamp for high bay use.

1955

Bonus Line of filament lamps increased light output up to 15% by G-E stand-up filament design.

1956

Power Groove—This revolutionary lamp gives 2½ times the light of slimline; saves 5 to 20% on initial cost.

GENERAL ELECTRIC

IT'S A FACT: **Over the past 3 years, General Electric has averaged a new lamp *every other working day!***

Dr. L. T. Rader—educator, engineer, and General Manager of General Electric's Specialty Control Department—provides a new slant on a key industrial-management topic:

"Flexible automation"... ready now for low-volume operations

For more than a decade, "automation" has held out to industrial management the shining promise of lower costs. And, in fact, many high-volume, repetitive production processes have been successfully automated.

Today, there is a new direction to automation. The really exciting automation advances are taking place in the field of small-lot production of many different parts. This new concept—which brings the benefits of automation within the reach of hundreds of new industries—we in General Electric term "flexible automation."

Flexible automation is achieved by equipping individual standard or custom production machines with proved, low-cost electronic controls, to automate virtually any production process. Machine "programs"—for drilling, bending, milling, punching, shearing, turning, boring, or welding operations—can be quickly and easily set up or modified to produce different parts.

The result: producers of a variety of parts with low production runs can now realize the lower costs and higher quality inherent in automatic production.

Flexible automation at work

General Electric program controls are already bringing the benefits of low-cost flexible automation to many new industries. Here are typical examples:

Step shafts for machine tools are being machined on an automatically controlled turning lathe, with production-time savings ranging up to 83%. Tests run on varying job-lot quantities of 20 different shafts show that preparation time with program controls is 90% *less* than with templates.

Base plates, mounting feet, covers, castings, and other "every-day" jobs are done on a small general-purpose six-spindle drilling machine. Production time savings range from 32% to 95%. And, a prototype part—formerly an eight-hour operation—was turned out in exactly 56 minutes.

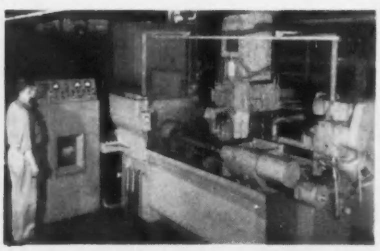
Close-tolerance parts for a new supersonic jet fighter are machined on a profile milling machine which is automatically directed by General Electric program control. Production has been boosted by 75%, unit costs have been cut from $69.50 to $15.70.

Precision tracks for tailpipe liners of jet engines are welded by the nation's first automatically programmed resistance-welding machine. With this machine, production time has been reduced by 81%, and man-hours cut from 16 to 1-1/3 per liner.

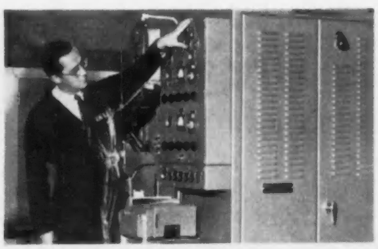
What can you do?

With such spectacular results, it is little wonder that many manufacturers are now profiting from flexible automation with G-E program-controlled machines. You can keep pace by planning now for optimum use of program controls in your company.

Once opportunities in your plant have been pinpointed, let General Electric help technically. As the only control manufacturer with a complete line of program controls—with more experience in the field than any other company—we're well equipped to help you achieve the full benefits of flexible automation. G-E sales engineers in our Apparatus Sales Offices across the country are ready now to work with your manufacturing - engineering people and machinery suppliers. Specialty Control Dept., General Electric Company, Waynesboro, Va. 795-3A



Automatic lathe has cut machining time of 20 different parts an average of 51%... with time savings ranging to 83% on some parts.



Automatic drill is now delivering production-time savings of from 32% to 95% on such parts as mounting feet and base plates.

Progress Is Our Most Important Product

GENERAL ELECTRIC

For a copy of a management-directed booklet, "Planning for Flexible Automation," write on your letterhead to Dr. Rader at our Waynesboro, Virginia, plant.