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WASHINGTON UNIVERSITY *Magazine*

WU

SUMMER 1964

Alumnus Lou Ames, director of programming for RCA's color television center at the New York World's Fair, confers with Watusi tribe members before a telecast from the African Village. For more about Lou's exciting job, see Page 36.

WASHINGTON UNIVERSITY *Magazine*

WU

SUMMER 1964

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COVER: Aimed at the sky, a 60-foot radio antenna tracks the first Gemini space craft launched from Cape Kennedy. See "Space Engineer," Page 2, and Sir Bernard Lovell's "Race to the Moon," Page 13.

Photo Credits: Page 8 (top right and bottom), National Aeronautics and Space Administration; Pages 13, 15, 17, U. S. Air Force Aeronautical Chart and Information Center; Page 22 (top left), 23 (bottom), inside back cover, Tom Stewart; all others, Herb Weitman.

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McDONNELL
NO STEP

One of 700 Washington University alumni at McDonnell Aircraft Corporation, John Yardley played a key role in the design of the Mercury space capsule and its successful flights; today he is the company's technical director for the Gemini space program.

SPACE ENGINEER

WHEN JOHN YARDLEY WAS AN undergraduate at Washington University, he raised the flag over Brookings Hall every morning. Today he is a key man in America's efforts to raise the flag on the moon.

It was back in 1942 that Yardley served as a member of the ROTC honor guard whose duty it was to raise and lower the campus flag. At that time, he was an engineering student with an avid interest in airplanes and a determination to become an aeronautical engineer. He achieved that ambition, but then went on to new and greater achievements in a field which could not even have been imagined in 1942.

Yardley was recently appointed technical director of the Gemini Program for the McDonnell Aircraft Corporation after having served as McDonnell's manager of Mercury flight operations at Cape Kennedy and after having played a major role in the design and development of both the Mercury and Gemini space craft. In his new position, Yardley is directing the work of some 3200 McDonnell employees in the project designed to launch a series of two-man Gemini space craft as the next giant step toward a manned landing on the moon.

A native of St. Louis, Yardley graduated from Kirkwood High School before first enrolling in Washington University in 1942. John spent his freshman and sophomore years studying engineering and then enlisted in the Navy's wartime V-12 program. The Navy sent him to Iowa State College, where he received a B.S. in aeronautical engineering in 1944.

He spent the rest of the war years as an aircraft maintenance officer at the Memphis and Seattle air Navy stations and as an engineer in the Bureau of Aeronautics in Washington, D.C., where he met his wife, the former Phyllis Steele, who was working then for the Bureau of Ordnance.

After the war, John returned to St. Louis and joined McDonnell as a structural engineer. At the same time he began his graduate engineering studies at the University. He received a master of science in applied mechanics degree in 1950.

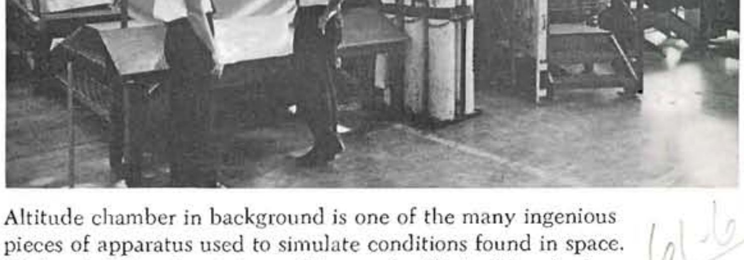
At McDonnell, Yardley's rise has been as rapid as the company's spectacular growth. When the young aeronautical engineer joined the McDonnell company, the firm had 2500 employees—less than one-tenth of the number the firm employs today. John started his career working as a structural engineer on the FH-1 Phantom, the first carrier-based jet fighter. He then worked on structural and stress engineering on the F2H Banshee, the F-101 Voodoo, and the Air Force's experimental XF-85 and XF-88.

John Yardley had achieved his lifelong ambition to become an aeronautical engineer. At McDonnell he had worked on a whole series of great military aircraft and was deeply involved in the planning of even more spectacular aircraft of the future. Then, in October, 1957, the Russians launched Sputnik I, the first artificial earth satellite. At

Alumnus John Yardley, technical director of the Gemini Program for McDonnell, and the first Gemini space craft.

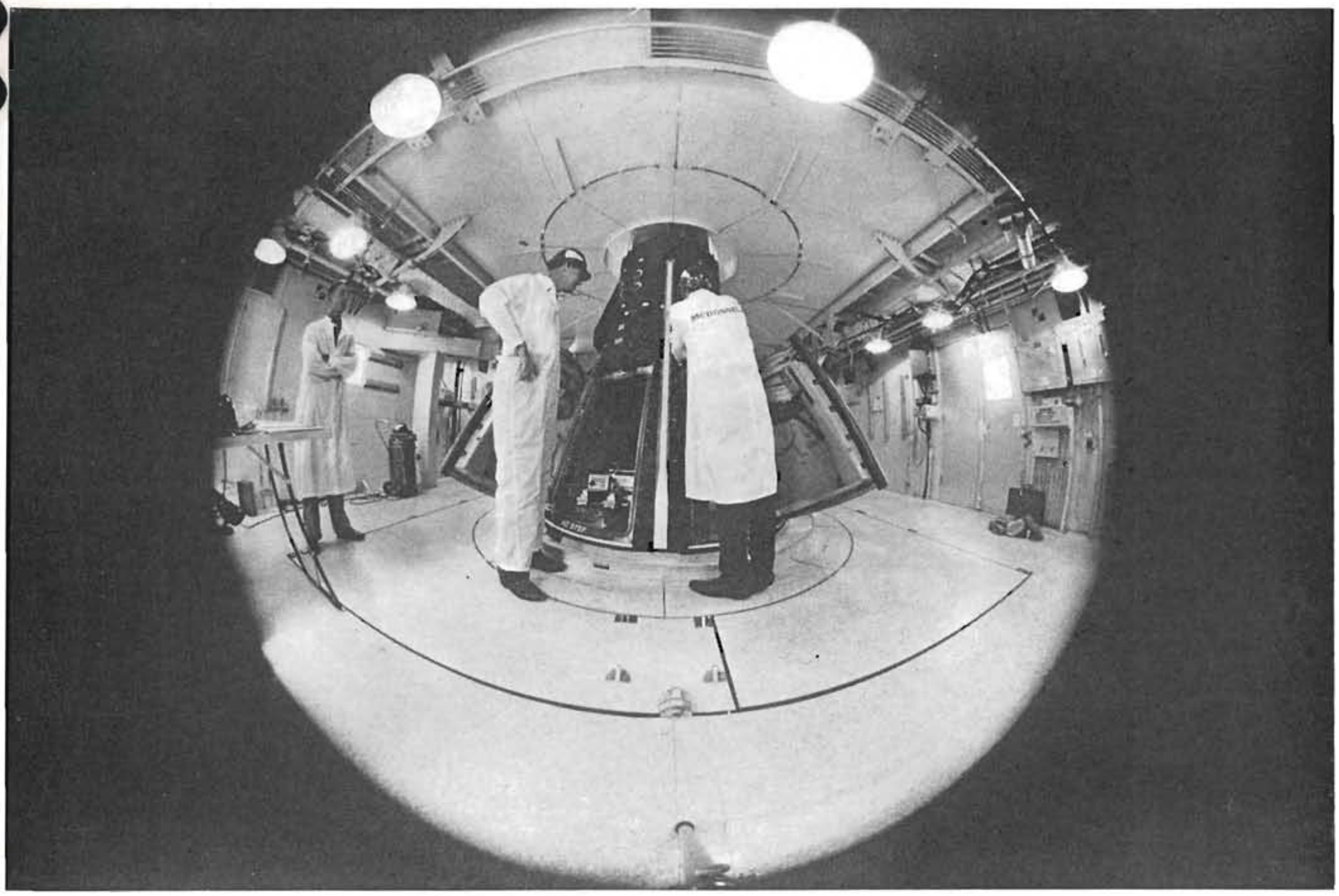
Yardley leaves the altitude-simulation chamber at Cape Kennedy. The chamber is used to test the astronauts and their equipment in conditions resembling those found at extreme altitudes above the earth.

Only a small part of Yardley's time is spent on the launching pad or in the control room. Most of it is devoted to plans and blueprints, conferences, discussions, and paperwork.



Altitude chamber in background is one of the many ingenious pieces of apparatus used to simulate conditions found in space. Within the chamber, it is possible to take "flights" hundreds of thousands of feet high.

Photographs by Herb Weitman



"White Room" at Cape Kennedy is employed to give space craft their final assembly and check under conditions of hospital cleanliness. Room is dust-proof, temperature- and humidity-controlled, and near-sterile.

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the same time, and almost as suddenly, John Yardley was launched into a new career.

Two months after Sputnik, Yardley was working full-time on what was to become the Mercury space capsule. He has been credited with masterminding the team that beat out other competing companies by coming up in record time with the space capsule design most similar to that envisioned by the National Aeronautics and Space Administration.

Because McDonnell had been working on the idea of a manned space capsule some eight or nine months before NASA was even formed, the company was able to launch a crash program that put the first vehicle into flight just eighteen months after the contract was awarded. The McDonnell team batted 1.000 in launching America's first six astronauts on successive space flights and returning them all safely to earth. The whole time span, from the selection of McDonnell as prime contractor to the final successful splashdown of the last flight in the series, was just four years, four months, and four days.

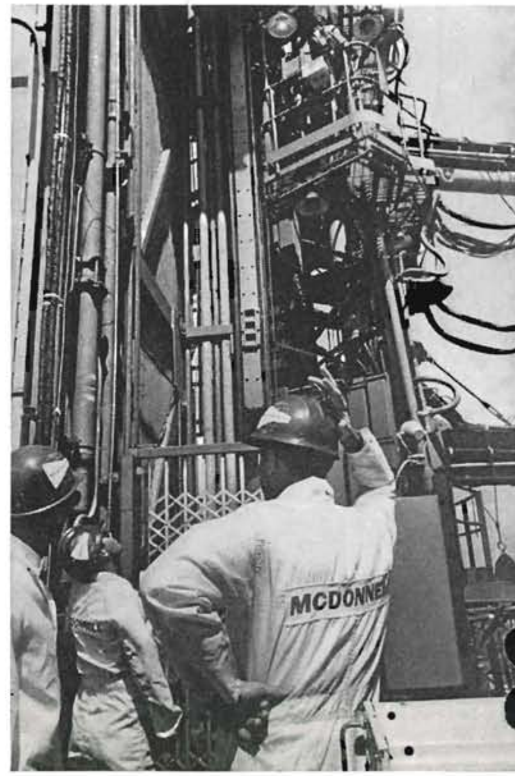
Among his many contributions to the Mercury capsule, Yardley designed its revolutionary safety system, which provided an alternate "backup" mechanism for each of the craft's basic functions. Following the design and construction every inch of the way, Yardley accompanied the space craft to Cape Kennedy (then Cape Canaveral), where he became manager of McDonnell flight operations.

As the Mercury was being designed and developed, Yardley worked closely with the astronauts who were to fly the space craft. Yardley and Lt. Col. John H. Glenn, Jr., who made the first manned orbital flight, became close friends. He worked closely with Glenn to perfect the craft, incorporating many of Glenn's suggestions and ideas as they went along.

Glenn's pioneering orbital flight provided what were probably the most dramatic moments in a business abounding in high drama. As most of the world learned at the time, listening to radio and television reports around the globe, the flight went smoothly until the start of the second orbit. Then, in the Mercury Control Center at

Yardley and Guenter Wendt, Cape Kennedy pad leader, don the white suits all personnel use when working in the "white room."

Wendt and Yardley discuss technical points about the Gemini space craft, on the launching pad at Cape Kennedy.



Space technicians are dwarfed by the huge launching tower, from which the first unmanned Gemini launching was made this past April.

the Cape, the instruments began to flash an ominous warning, indicating that the heat shield on Glenn's craft, the *Friendship* 7, had jarred loose.

It was a critical time. If Glenn began his re-entry into the earth's atmosphere and the shield broke loose, both he and the *Friendship* 7 would vanish in a flash of flame. The operations crew in the reinforced concrete blockhouse back at the Cape had little time to arrive at a decision. It was chiefly John Yardley's advice that led Walter C. Williams, Jr., the operations director, to advise Glenn to leave his retro-rocket pack attached during the descent. The retro-rockets were attached to the capsule with metal bands and it was Yardley's idea that the bands would help hold the shield in place during re-entry.

After Glenn was advised to retain the retro-rocket pack, the really tense period set in for Yardley and the other watchers and waiters in the control center. As soon as Glenn began his re-entry, ionization of the atmosphere from the heat generated by the capsule's passage blacked out all communications with the *Friendship* 7. For more than seven minutes, the ground controllers were cut off completely from Glenn and his craft. During those seven minutes, which seemed like seven centuries Yardley relates, the controllers could do nothing but sit and wait with the fearsome knowledge that loss of the heat shield could during those very moments be turning the *Friendship* 7 into a flaming meteor. The suspense was broken when Glenn's voice suddenly came through, loud and clear, exclaiming, "Boy, that was a real fireball!"

Recalling the experience later, Yardley relates that Glenn, despite a reputation among his colleagues for wanting to discuss and debate every point, replied to the unexpected and ominous instruction to retain his retro-rocket pack with a simple "Roger."

Even before Glenn's flight, the McDonnell space team was working on the next step: Project Gemini. The Gemini project, to send a two-man vehicle on prolonged journeys in space, was a natural outgrowth of Project Mercury. The vehicle design was based on the successful Mercury pattern, and the experience gained in building twenty Mercury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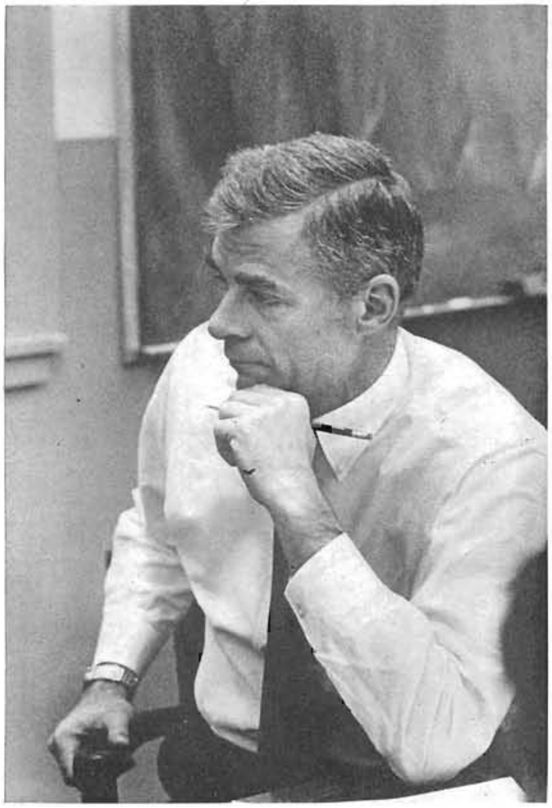
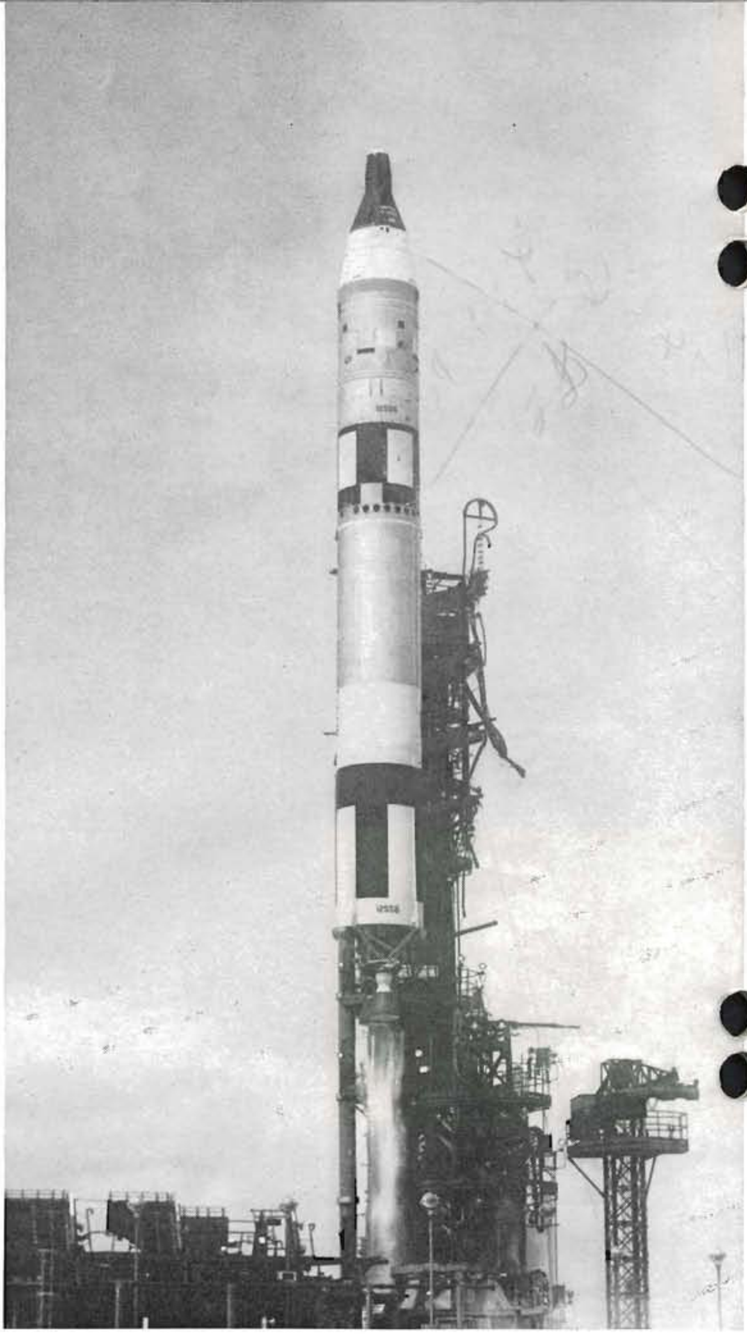
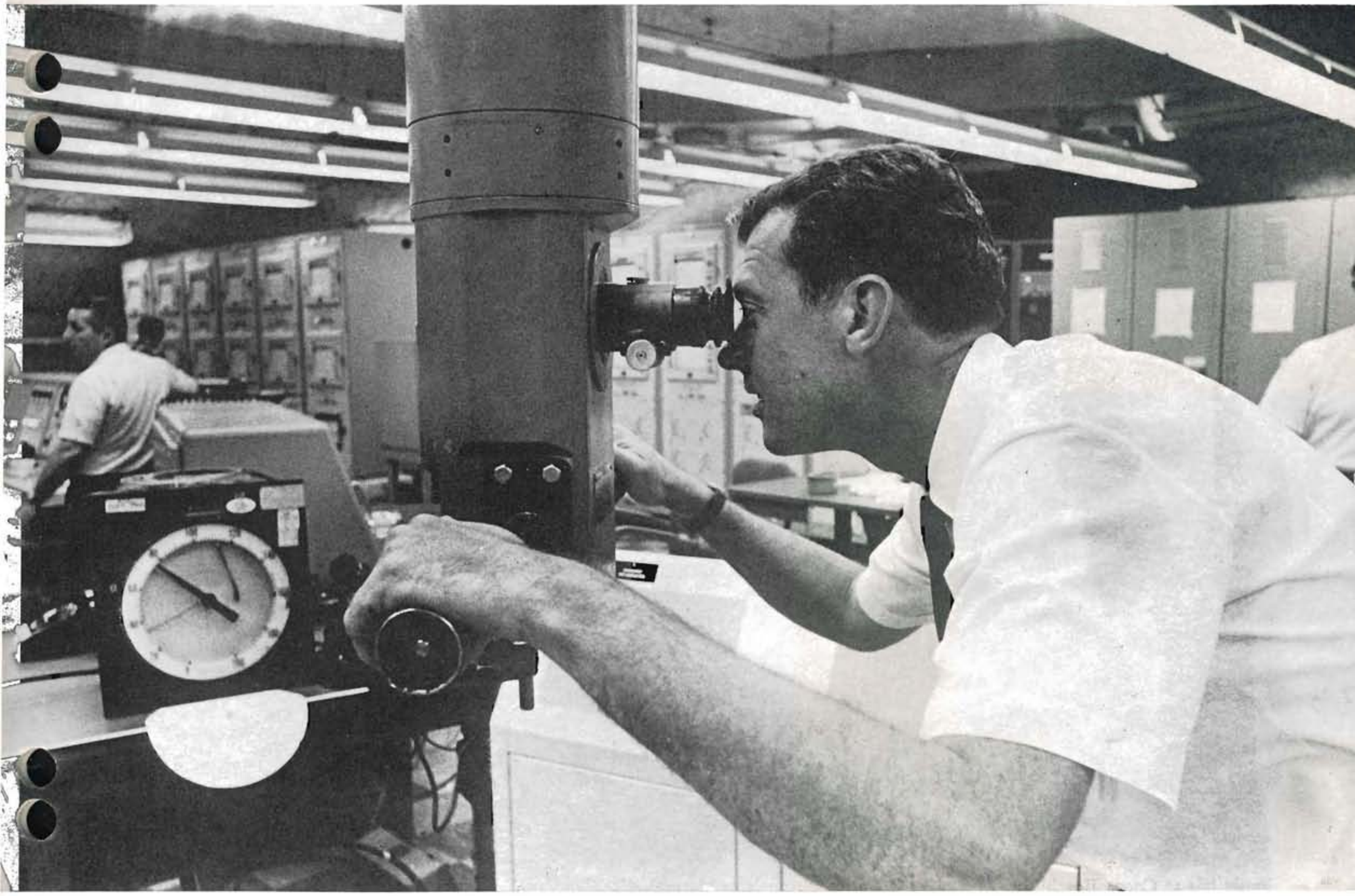


Another Washington University alumnus with a key job in the space program is Logan T. MacMillan (BSMechE42) company-wide project manager—Gemini-AGE.



The first Gemini launching takes off from the pad at Cape Kennedy. The space craft atop the giant rocket carried only instruments on this trial flight.

America's first astronaut, Comdr. Alan Shepard, comes out of the sea at the successful conclusion of the first manned flight in the Mercury series.



From the steel and concrete blockhouse sheltering the control center at Cape Kennedy John Yardley watches the first Gemini launching through a periscope.

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capsules and making seventeen Mercury flights was incorporated into the Gemini program. As the Mercury project drew near an end, the McDonnell team phased into Gemini. Yardley soon found himself in charge of the McDonnell Gemini operations at Cape Kennedy.

The first launching of a Gemini vehicle was made successfully from Cape Kennedy on April 8 of this year. An unmanned flight, the shot was designed as a structural test of the vehicle in the launch environment. From the test, Yardley and his group acquired valuable information about the vehicle's structural strength, the noise and vibration levels to be expected, and the techniques of launching, tracking, and recovering the craft.

After another unmanned flight, the Gemini craft will be shot into orbit with two astronauts aboard. The project will be a grand rehearsal for an American landing on the moon. It is designed to train astronauts to live and work in space for periods up to two weeks. Beginning late this year, about a dozen Gemini flights are planned. The Gemini astronauts will experiment with rendezvous and docking procedures in space and will even practice the uncanny skills involved in leaving the craft in space and working on its exterior, anchored only by a nylon cord.

One of the most important techniques to be explored will be the delicate precision maneuver of making a rendezvous with another vehicle in space, linking the two craft together, and moving from one vehicle to another. The Gemini astronauts will rendezvous and join in space with target space craft and will then operate both space craft as if they were a single vehicle.

Eventually, the Gemini project will lead to the development of a manned orbital laboratory, or "space platform" which will provide capability for several astronauts and for many experiments of crucial importance in both pure and applied science. It will also provide the vital experience necessary to build toward a manned lunar landing.

Yardley's promotion to his new position as technical director of the Gemini project presents a tremendous chal-

Family life at Cocoa Beach: In the Yardley Boat are, from left, Mary; Kathy, holding Betsy; Bobby, Phyllis, holding Susan; and John.

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lenge, but it also means the end of a way of life. He has sold his waterfront home at Cocoa Beach and has bought a handsome new house in St. Louis County. It will be quite a change for the Yardleys and their five children, especially when winter comes to St. Louis. Life at the Cape revolved around the space program, with space engineers and astronauts dropping in at all hours and with swimming, boating, and water-skiing available right off the back terrace. John will spend a great deal of time at the Cape, but life on the beach is over.

The position he held as McDonnell's base manager at Cape Kennedy has been taken over by another Washington University alumnus, Raymond D. Hill, who received his bachelor's degree in electrical engineering in 1943 and his master's in 1954. At the latest count, McDonnell Aircraft Corporation employs more than 700 Washington University graduates, in addition to many hundreds more who have taken courses at the University.

Among other key McDonnell personnel with degrees from Washington University are: Kendall Perkins, vice president—engineering; Garrett C. Covington, Jr., vice president—general engineering; Wayne Lowe, company-wide project manager, Asset Program; Raymond A. Pepping, manager—spacecraft advanced design; Harry L. McKee, Jr., defense, space, and missile sales manager; Paul T. Rafter, manager of plant-wide planning; Erwin F. Branahl, manager of space and missile engineering programs; Leo Mirowitz, chief structural dynamics engineer; Robert C. Goran, chief structural engineer; William J. Langton, patent attorney, Robert L. Harmon, assistant vice president and general manager—MAC automation center; Dr. George S. Lerman, group manager, aerospace medicine; Edward R. Jones, group manager, aerospace psychology; and Margaret Bernard, senior engineer—aerodynamics.

In his new position with the Gemini project, John Yardley is working at the very frontiers of man's assault on the secrets of the universe. It is a job where quite literally the sky's the limit.

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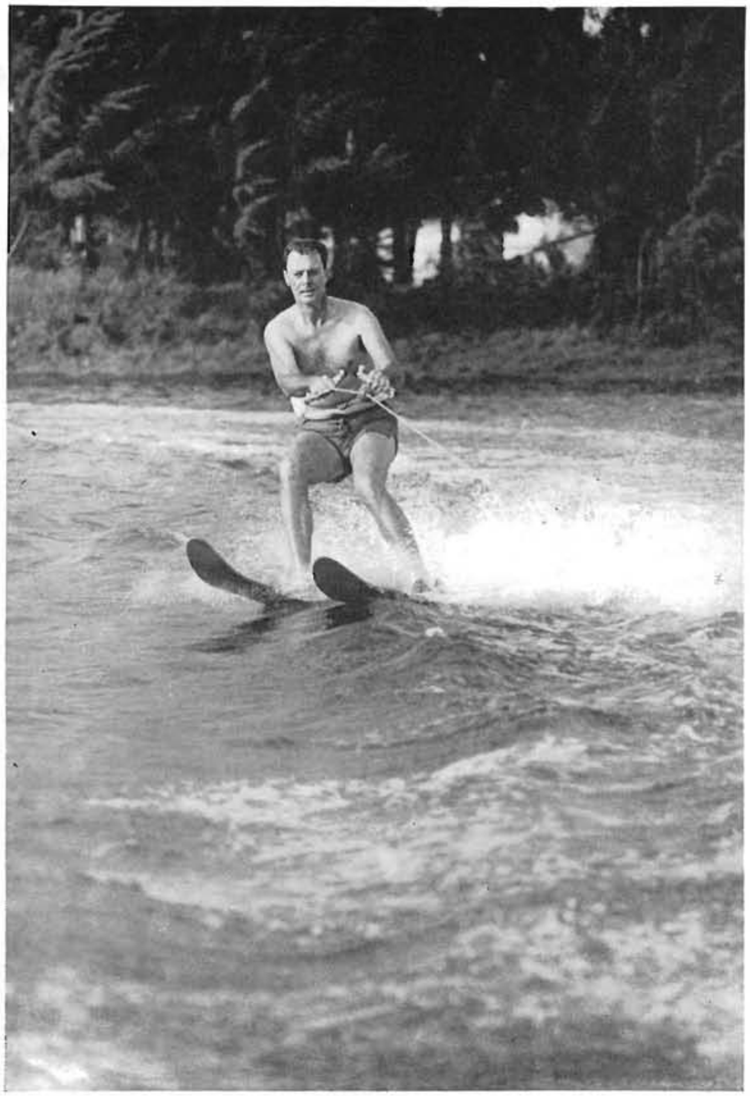


During his tour of duty at the Cape, Yardley became a proficient water-skier. One of his many water-ski companions was Lt. Col. John R. Glenn, who made America's first orbital flight.

View from the Yardley's back yard boat dock at sunset. Most Cape Kennedy personnel live on water near the Cape, enjoy boating, fishing, and water-skiing.

Not all launchings are successes. This one aborted a short distance from the pad. Those sinister objects surrounding Yardley are water-skis, not shark-fins.

With top down to catch ocean breezes, John Yardley drives home after an exciting day at Cape Kennedy.

Back to the drawing board. Mercury and Gemini successes to date are only milestones on the long voyage to the moon and the planets.

When Sir Bernard Lovell, director of England's great Jodrell Bank observatory, spoke at Washington University this spring, he stated that the moon race is still on and predicted that the Russians' next major space exploit would be the orbiting of a space platform, from which they would eventually get to the moon. As director of Jodrell Bank, Sir Bernard has been concerned primarily with the investigation of the most distant reaches of the universe. He has also played a major role in the satellite and space probe program by providing the facilities of the 250-foot radio telescope at Jodrell Bank to track both American and Soviet space vehicles. This article is a condensation of Sir Bernard's address.

THE RACE TO THE MOON

My authority for discussing the Race to the Moon arises in a rather peculiar way, because professionally I am an astronomer responsible for the radio telescope at Jodrell Bank. But by one of those rather strange twists of fate, just at the time the Jodrell telescope was coming into action, the Russians launched Sputnik I. I am awfully grateful to the Russians for launching Sputnik I, because it enabled us to recover from a large debt we had incurred during the construction of the telescope.

Both in the Soviet Union and the United States, for some time the ground base facilities could not match the accomplishment of the rocket engineers, and we became successively involved both in the Luniks and in the United States deep-space network.

It was the Jodrell telescope which sent out the signal which released Pioneer V from its carrier rocket and tracked it for over twenty million miles. However, since the Jodrell Observatory has been in operation, no more than five per cent of our time with the telescope has been spent on these space activities. Most of the time the telescope has been used for its real purpose of exploring the depths of the universe. Nevertheless, this five per cent spent in cooperation with the United States and in a stranger kind of cooperation with the U.S.S.R. has been extraordinarily interesting. From the point of view of international politics and international cooperation it could be said to be the most valuable five per cent.

Because of this rather strange relationship, which represents only five per cent of my activity, it has been my privilege to see a good deal of space activities in the United States and in the Soviet Union. Although I didn't realize that this was going to happen, I was invited to the Soviet Union last summer and spent several weeks there. Nominally, the invitation was to lecture at several Russian astronomical observatories, which I did; but to my great surprise, on my arrival I was summoned by the president of the Soviet Academy, Academician Keldysh, and informed that I was to be taken to their hitherto secret deep-space tracking network and that I was to have discussions with him again on my return. This was an extraordinary and somewhat frightening experience and gave me a new measure of assessment of the relative status of the U.S.S.R. and the U.S.A. in space activities.

After my visit, I was asked by Keldysh to convey certain information to the United States, which I did in the form of a memorandum to Dr. James E. Webb, the head of the National Aeronautics and Space Administration. This was intended to be a confidential memorandum, but because of the activities of some congressmen, it was eventually published. To my dismay, certain members of Congress used excerpts from my paper out of context to suit their political aims: either to urge that the United States should go on with its Apollo Program or, alternatively, to urge the United States to stop its Apollo Program. It was rather a strange experience to find that the same memorandum had been used for two completely contrasting purposes.

When it was suggested that the Jodrell Bank telescope be used for space activities, I refused to allow it at first.

But then I decided that many of the problems in which we were particularly interested at Jodrell Bank could be solved only by the development of space activities, particularly penetrations to the moon and the planets. As an astronomer, my outlook differs markedly from that of a politician seeking prestige for his country or a militarist who sees in these activities certain possibilities of military expediency. I acknowledge the importance of both of those other reasons for indulging in space activities, but as a scientist I believe that the sort of expenditure being made by the United States and the U.S.S.R. will be justified purely by scientific reasons.

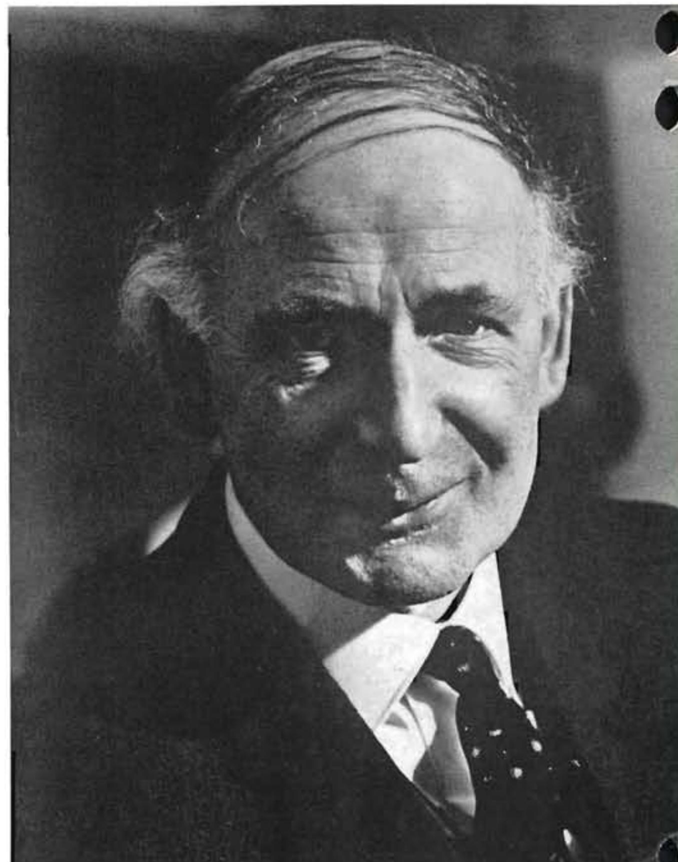
On a clear night, one can see the stars of the Milky Way. There are about a hundred thousand million stars like the sun in the Milky Way system. The Milky Way itself, our own galaxy, is so vast that it takes a ray of light about a hundred thousand years to traverse it. But this is only a very small part of the cosmos which is revealed by our optical and radio telescopes, because we know that the universe contains many trillions of these galaxies of stars. We now have records on our radio telescopes that there are clusters of galaxies so far away that the radio waves have been traveling from them through space for more than eight billion years. We are looking back into this remote epoch studying the universe as it was at that particular moment of time. These studies with the big optical and radio telescopes are of the utmost importance to the cosmological problem: how the universe came into existence and whether it began its life at a period of about ten billion years ago or whether it has always been in existence and has always had the same appearance.

I don't think that the penetration of the probes will assist us very much in the problems of the origin and evolution of the cosmos as a whole. Their activities must be reserved for an equally great and in some ways a more difficult problem: the origin and evolution of our own solar system.

In this great assemblage, where we see our own sun as just one star in the hundred thousand million stars in the Milky Way, and the Milky Way as just one galaxy in trillions and trillions of galaxies, this is the only planetary system to which we have immediate access, and the only one, indeed, for which we have observational evidence that it exists. We are an absolute microcosm as far as the cosmos as a whole is concerned: the earth is part of the sun's family of planets and we are ninety-three million miles from the sun; light from the sun takes eight minutes on its journey towards us; the whole dimensions of the solar system are included in the orbit of the planet Pluto, which is a few billion miles away, or about six light hours.

Although these distances are vast by terrestrial standards, the most distant penetration of a probe, so far, has been to the planet Venus with Mariner II—a distance of about thirty million miles.

The great problem, so far as the solar system is concerned, is how it came into existence. We know few facts for certain. It seems quite clear that the age of the solar system is about four and a half billion years, which is young compared to the universe's estimated age of at least ten billion years. When I was a student, the solar system was definitely regarded as unique. Its origin was considered to be a rare accident occasioned by the passage of another star close to our sun, which pulled out from the sun great streams of matter which subsequently condensed to form the planets and the earth. There were two important features of this theory. One was that the solar system was regarded for a long time as being unique in the universe. Secondly, this theory implied that the earth and the other planets were originally very hot and condensed in a molten state. Even if there had been any primeval life on the original dust, it could not have survived this formative process. The uniqueness of the solar system and the uniqueness of life was preserved in this theory. That theory of the origin of the solar system is now known to be entirely wrong. There are rather simple arguments connected with the distribution of the momentum—the rate of rotation of the planets around the sun—which make it impossible to maintain this theory of the tidal origin of the solar system.



Sir Bernard Lovell, director of the Nuffield Radio Astronomy Laboratories at Jodrell Bank, England.

Nowadays, we think we know, fairly generally at least if not in precise detail, how the planetary system did evolve. The theory which has grown up in various forms from the efforts of American, British, and Russian astronomers is, broadly speaking, as follows: The sun was at one stage a fairly ordinary star surrounded by a cloud of dust and gas; in the course of time the particles in this cloud collided and some of them stuck together and then there were more collisions and they broke apart again, but over the aeons of time the collisions gradually led to larger and larger accretions which eventually formed the planets we know today. The significant part of this theory compared with the tidal theory is two-fold. First of all, it is believed that the process by which the sun got this dust cloud must be very common in the universe. The other important change in this theory is that the process by which the dust aggregates and sticks together to form planets must take place in a cool state. The earth, according to this theory, was originally formed in a cold condition and it grew hot on the inside because of subsequent radioactive processes. The important problem here, from the biological point of view, is that since the earth was formed in a cold condition, any primeval organisms which existed on the original dust would have been preserved in the aggregation. Hence, from the astronomical point of view, there is nothing unique at all about the solar system and we believe that a high proportion of the stars in the cosmos must be accompanied by planetary systems.

As far as the existence of extraterrestrial life is concerned, there are two problems: astronomical and biological. The astronomical problem is whether there are many earth-like bodies in the universe, and I think that this can be cleared away with some degree of certainty. The formation of solar systems must be a frequent occurrence in the universe. However, this doesn't mean that all stars possess planets on which conditions are stable enough for evolution to occur. While the earth is four and a half billion years old, its organic evolution has taken about a billion years and, biologically, it seems that this is the kind of period of time needed. For life as we know it to evolve, it seems necessary to have a stable environment for at least a billion years. If one places this restriction on the number of planetary systems which may exist in the cosmos, the possible abodes of life have to be decreased considerably. Many of the stars which possibly may have planets are binary systems, subject to changes which would not give a long-term stable environment. When one does the calculations, one finds that something like one per cent of the possible planetary systems have at least one of their planets in a stable condition for the billion years needed to facilitate organic evolution. What that really means is that there is a possibility that one per cent of the stars in the cosmos have planetary systems on which extraterrestrial life could have evolved. This one per cent is an enormous number: one per cent of a hundred thousand million stars in the Milky Way multiplied by the trillion, trillion, trillion galaxies, each containing a hundred thousand million stars, which are within the observational range of our telescopes today.

You will have to put in the most enormous odds against biological evolution if you still wish to maintain that life in the universe is unique to the earth. This is one of many reasons why I think that the present situation in space is so dramatic. Nobody at the moment can give the biological answer to whether the life forms on earth arise from organisms which were uniquely here or whether they are distributed throughout the universe. Therefore, I base my arguments in favor of proceeding with the Russian and American deep-space probes on the grounds that they present us with a unique opportunity for testing the theories, not only of the origin of the solar system, but of the origins of life.

The new tools which we have in our generation to facilitate these studies are of two kinds: radio telescopes and space probes. The main contribution of the radio telescope is to the cosmological problems of the origin of the galaxies and the stars. Although radio telescopes play a vital part in the study of the sun, the planets, the moon, and the inter-solar medium, they do not possess the dramatic advantages inherent in man's ability to place working instruments outside the earth's environment or on the moon or planets. It is this technique of the space probe which is destined to give us the answers to the scientific problems concerning the origin of the solar system and of the uniqueness of life. While from the theoretical point of view the situation I have described about the origin of the planets is regarded as correct, there is at the moment very little hard observational evidence to support it. In order to obtain this observational evidence, we need to do two main things: sample the lunar surface and carry out biological investigations of Mars and Venus. In view of the findings of Mariner II, perhaps we should concentrate on the biological investigation of Mars.

But first of all we must deal with the problem of the moon. The moon has very little atmosphere. Its surface, throughout the whole four-and-a-half billion year history of the solar system, has been almost entirely untouched by the erosion of wind and weather which have completely determined the nature of the earth. It is true the moon's surface features must have been very largely altered by meteoric bombardment, but that is all part of the natural processes of formation. When we are able to obtain details about the nature of the lunar surface, the depth of the dust layer, the chemical constitution of the surface rocks, and the underlying features, a very large query will be removed from our present theories of the origin of the solar system. The investigation of the moon by space probes, either by unmanned instruments or by manned landings, is a key issue in the scientific problem of the origin and evolution of the solar system.

When we come to the biological problem, of course, the moon is of very little interest. It has a hostile environment, in which it is not likely that any organic evolution could have taken place. But the situation is undoubtedly quite different on Mars, whose environment may be hostile to life as we know it, but would certainly not be hostile to certain forms of organic evolution. Man is within a few years of achieving the ability to send biological instruments to penetrate the atmosphere of Mars and eventually to land on its surface, which will permit the biological assessment of whether any form of organic development has occurred on that planet. The key issue here is not that we expect to find any kind of intelligent life on Mars, but whether there is any degree of organic evolution. If success could be achieved in these two experiments, it would have a most dramatic impact on man's thinking. While we have been removed astronomically from our idea of being the center of the universe, it would remove another great question mark as to whether we, ourselves, are unique.

The question of the great expense of launching rockets to the moon and the planets has been the subject of much debate, certainly in the United States, and doubt has been cast on the value of the experiments. The space program seems to have been spurred on by a mixture of the sort of scientific arguments which I've tried to bring forth, by political and military needs, and by a great feeling that the United States is in competition with the Soviet Union. In spite of the denials which are made on both sides, I think it would be difficult to maintain that there is not a race in progress. So much of each nation's scientific, military, and political prestige is hanging on this question.

Russia got off to an extremely good start by launching Sputnik I. Its success surprised only those people who did not wish to believe in the power of Soviet science. The dramatic impact of Sputnik I in the United Kingdom, and even more so in the United States, caused a revolution in the funding of science and technology. My first contact with the United States space program came in the spring of 1958, when I received a message that a United States Air Force general wished to visit me at Jodrell Bank. When that visit was arranged, the general told me that the United States was intending to launch a rocket to the moon. Lacking the facilities to track the proposed moon rocket, the United States had sent the general over to ask for our assistance. I said that I was impressed and thrilled that the United States, after so much difficulty, could embark on such a program and that naturally we would be delighted to give all the assistance we could. That's how our association with the United States' deep-space program began.

Within a few months, large trailers of equipment and dozens of technical staff were flown over to Jodrell and we connected the trailers to the telescope and dealt with the successive series of the Pioneer space probes. Unfortunately the original Pioneers were not successful. Although they achieved very important data about the interplanetary medium, none of them succeeded in carrying out their mission of reaching the moon.

While these experiments were in progress, the Russians launched Lunik I in early January, 1959. Undoubtedly, it was intended to hit the moon but missed it. Then on September 12, 1959, while the Americans were still struggling with the Pioneer failures and while we were surrounded by American technicians, the Russians launched Lunik II. As is usual on these occasions, the first I heard about the launching was when people from the press started calling to say that the Russians had launched Lunik II and intended to reach the moon at 10 o'clock on Sunday night, and what was I going to do about it? I told the newsmen I did not intend to do anything about Lunik II because the Russians had given us no information whatsoever about Lunik I and cooperation would be very difficult.

That Saturday evening I called in at Jodrell Bank to find a message from Moscow which gave us the exact coordinates for Lunik II and asked us to track it to the moon. Immediate action was taken and within an hour we had located Lunik II exactly in the position indicated by the Russians. This was a dramatic situation. It was on Sunday evening that we followed Lunik II and measured its acceleration as it came under the gravitational attraction of the moon and made impact within half a minute of the predicted time.

Lunik II was followed two weeks later by Lunik III, which secured the photographs of the reverse side of the moon. That was in 1959 and, strangely, there has been no successful lunar exploit since. On Lunik III, the equipment failed about a day after taking the photographs and was not able to retransmit them as it returned close to earth. Lunik IV, launched last year, was widely acclaimed by the Russians to be a great success, but I have no doubt whatsoever that it was intended to be the first Russian attempt to land working instruments on the lunar surface and it certainly failed.

The American Ranger Series has not been successful either; the brilliant technological exploit of Ranger VI was obscured by the failure of its cameras. Therefore, we have this strange situation: despite Mariner II's brilliant success on Venus at a distance of 30 million miles, there is really extraordinarily little scientific information so far about the moon. The only real scientific information we have are the 1959 Russian photographs of the reverse side of the moon.

In 1960, the Russians launched a probe to the planet Venus. We made some attempts to pick it up, but weren't very enthusiastic because we had no information whatsoever from the Russians about it. After seven days, we did get signals from it and then it disappeared. A few weeks later, I had a telephone call from Moscow from a young lady who is a distinguished professor of astrophysics at the University of Moscow and is a familiar figure to British and American astronomers. She asked if I would send an invitation for her and the designer of the Venus probe to come over to Jodrell Bank to assist in the search for the lost Venus rocket. I said I would gladly do so and the two Soviet scientists arrived in May of that year and made what turned out to be a futile search for the Venus rocket. But, at that time, we actually had a line open from Jodrell Bank to the Soviet station which was sending out the command signals to the space probe.

I suspect that it was partially because of our good will in inviting the Russians over and letting them use the telescope for that short time that I received my invitation to the Soviet Union in 1963. It was my second visit as I had been there for an international astronomical meeting in 1958.

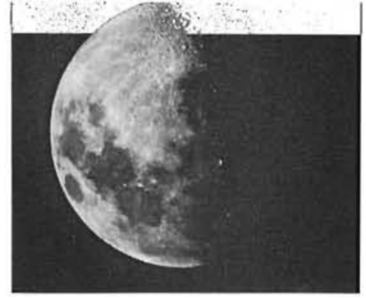
Although I didn't expect it, when I came back from Russia I had an entirely new outlook on the relative positions of the Americans and Russians in the deep-space exploits. In Russia I was a guest at the Crimean Astrophysics Observatory, beautifully situated on the mountains. The deep-space tracking station is on the coast a few hundred miles from the observatory. The day I was taken to the station is unforgettable. It was made clear to me that I was the only foreigner who had ever been allowed there.

The first matter of interest to me, of course, was what sort of radio telescopes the Russians were using in their lunar and deep-space program. We had had endless discussions among ourselves at Jodrell, on the basis of the sort of signal strength that we were getting, as to what we thought the Russians might have. We had come to the conclusion that they probably did not have a telescope as big as our 250-foot antenna at Jodrell. We thought they might have a telescope about half that size, but there were other estimates. When I arrived there, I learned that the Russians had a series of telescopes, not a single big bowl like ours at Jodrell, but a flat framework on which were mounted eight 80-foot telescopes. The American deep-space tracking network has an 80-foot dish at Johannesburg; the Russian radio telescope which deals with the space probe has eight dishes that big, mounted on a mattress or bedstead framework and phased together.

As accustomed as I was to quite big structures at Jodrell Bank, I was rather awed by the massiveness of this undertaking, particularly by the fact that there were three of these structures scattered on the station, which extended for about ten kilometers. The receiving equipment used with this telescope was really of the highest order and the transmitting side was vast and powerful. It is with this equipment that the Russians established radar contact with Mercury, Mars, Venus, and more recently, Jupiter. My general assessment of the Russian equipment is that as far as performance is concerned there is extremely little difference between it and the American. This is one minor but important index of the relative state of the two countries in the space field.

WHAT FRIGHTENED AND alarmed me about the Crimean station was that the investment there by our standards was about twenty million pounds, or sixty million dollars. I don't know how long it takes in America to put up an establishment costing sixty million dollars, but in Great Britain it would take us a very long time. It took us five years to build our radio telescope and about ten years from first thinking about it to bringing it into use. The whole Russian station was built in one year.

The information which Keldysh, the president of the Soviet Academy, gave me about the Russian program was quite precise and was brought back by me and conveyed to the head of N.A.S.A. Keldysh, after a very long discussion which took place in three different meetings with many of the senior academicians, said that at the moment, as a result of great arguments within the Academy, the Russians had decided that they could obtain 90 per cent of the scientific information they needed about the moon by continuing to concentrate on unmanned probes. Keldysh said that they were alarmed by the technical problem of protecting their astronauts from radiation damage for which at the moment they saw no economically feasible solution. He then went on to say that their program for the next few years would be based on instrumented investigation leading to soft landings of instruments on the moon, Mars, and Venus. He also said that as far as the manned part of their program was concerned, they were proposing in the near future to begin the erection of a very large space platform, which would orbit at a height of about 100 miles and would mount a 36-inch telescope for astronomical observation. The astronauts would have a duty cycle of about a week and then would be brought back to earth and a new team put on.

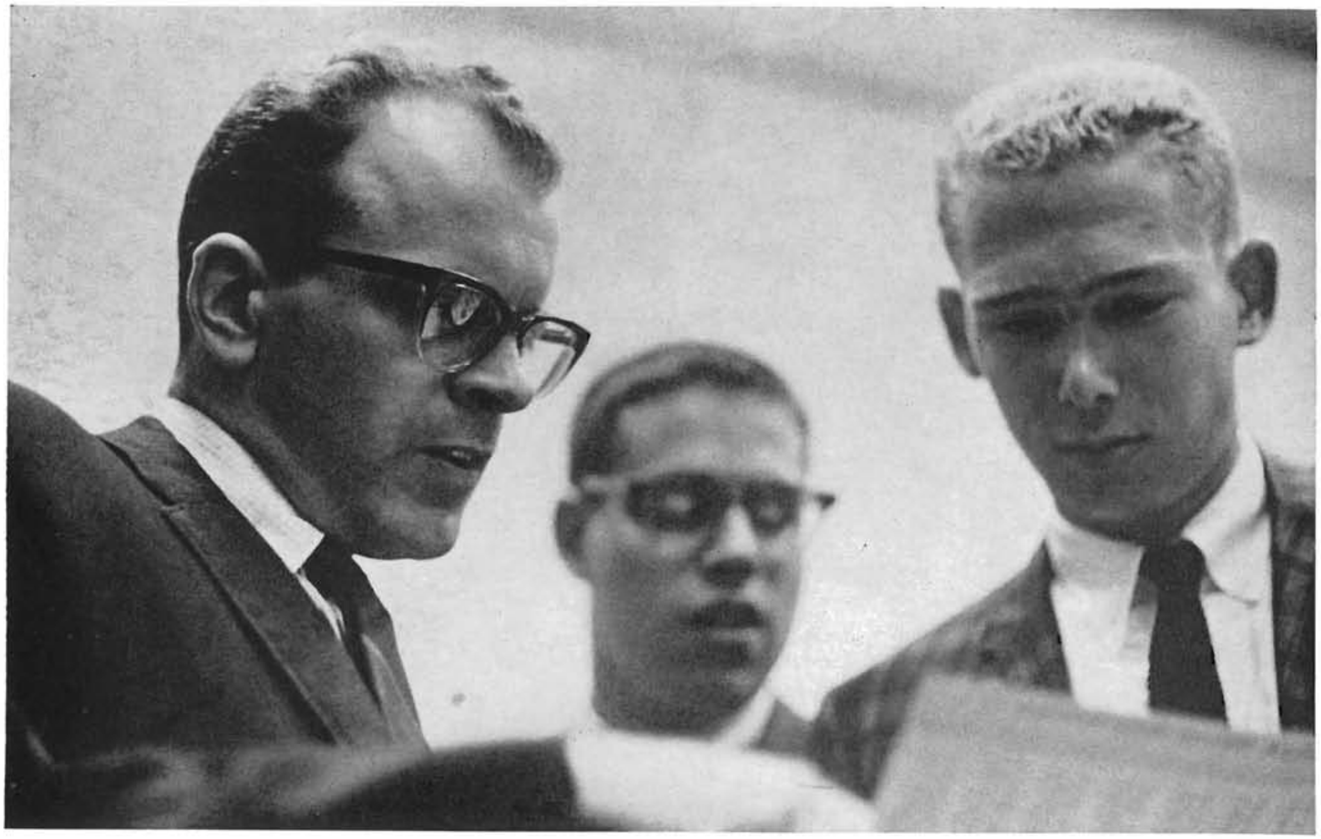


When I asked the Russians why they were worried about radiation dangers as far as the moon was concerned but not with an orbiting platform, the Soviets said that their scientists had great confidence that within two or three years they would be able to predict solar eruptions with a sufficient degree of certainty so that astronauts could be recovered if it was thought that there was going to be any damaging radiation from the sun.

There seemed to be a very great desire on the part of Keldysh to cooperate with the Americans in the moon program and he asked me to convey this message to the head of N.A.S.A., which I did in my memorandum. These messages have been interpreted by some people in America as indicating that the Russians have abandoned the race to the moon. That is absolute nonsense. Anybody who willfully misinterprets not only my message, but who likes to misinterpret for political reasons anything which the Russians have since said about the moon program, will be doing a very serious disservice to the cause of both science and strength in the West.

The Russians, as usual, are being awfully clever. The Apollo configuration for getting to the moon is only one of at least four different configurations which have been discussed exhaustively in the United States. As a result of these discussions, the United States program is committed to the idea of the lunar rendezvous. One possibility which was discussed but not adopted was the earth orbit rendezvous. My interpretation of the Russian situation is that they are going to get to the moon by the earth orbit rendezvous. They are proposing to build up a big space platform, for they see no great technical difficulties in the solution of the rendezvous problem. It is from this platform that they will succeed in launching their manned lunar missile as and when they decide to do so and without a great deal of publicity.

In other words, there *is* a severe race to the moon and the situation as far as the Russians are concerned is camouflaged in an extremely clever way. They have taken out an option on the moon race. At the moment they see, as everybody does, a large number of difficulties with radiation and they have not committed themselves to a twenty-billion-dollar program, as has the United States, because they've chosen a mode of procedure which doesn't require them to commit themselves at this moment. But I think it would be a very serious error to think that because they haven't taken the sort of definite steps which have been taken in the United States that they have abandoned the moon race. On the contrary, I think they are in it in a big way but they have got themselves into a very pleasant situation whereby they can retain their option for at least two or three years, until it is possible to send a man around the moon and get him back again.



Organizer of the educational Cruiser Patrol program at the University, Law Professor Jules Gerard (left), discusses his idea with two students before a Friday session.

CRUISER PATROL

Last summer, Washington University Law Professor Jules Gerard spent a weekend riding around Chicago in a squad car. That brief experience, part of a criminal law seminar in which he participated at the University of Wisconsin, Gerard describes as "the most interesting forty-eight hours of my life."

Because of that weekend, 100 Washington University students, men and women, had a comparable experience this spring in St. Louis—and their reactions were nearly as enthusiastic as their professor's.

At the instigation of Gerard, in his role as a faculty fellow in the Forsyth Residence Halls, groups of students from the Forsyth area and from Metropolitan St. Louis prowled St. Louis' high-crime districts until midnight on five Friday nights in unmarked, radio-equipped police cruisers. Their chauffeurs were armed members of the St. Louis police force, most of them in plain clothes.

Friday night was chosen for the short short-course because more criminal activity takes place then than on most other nights, but a few of the more cynically eager students still were disappointed by the lack of "action" they encountered.

Even those expressing disappointment on that score learned from the experience: such things as what it must be like for respectable families to have to live in neighborhoods where violence is common; how a detective, with a badge in one hand and a flashlight in the other, must be prepared to draw his revolver if necessary when stopping a suspect; and what a cop thinks of his job and the people he deals with.

Gerard's reason for organizing the cruiser patrol program at WU was to hasten the eradication of the students' stereotypes of policemen and of residents in high-crime areas. He points out that WU students come increasingly from upper-middle class backgrounds, and that their knowledge of life in the "inner city" and of the policeman's role is not very extensive.

If knowledge leads to understanding, and if understanding is requisite to maturity, then these 100 undergraduates did some growing up this spring.

Friday nights with police began at headquarters, included stop at the holdover. This cell, no longer used, has mural of Christ on wall, artist and medium unknown.

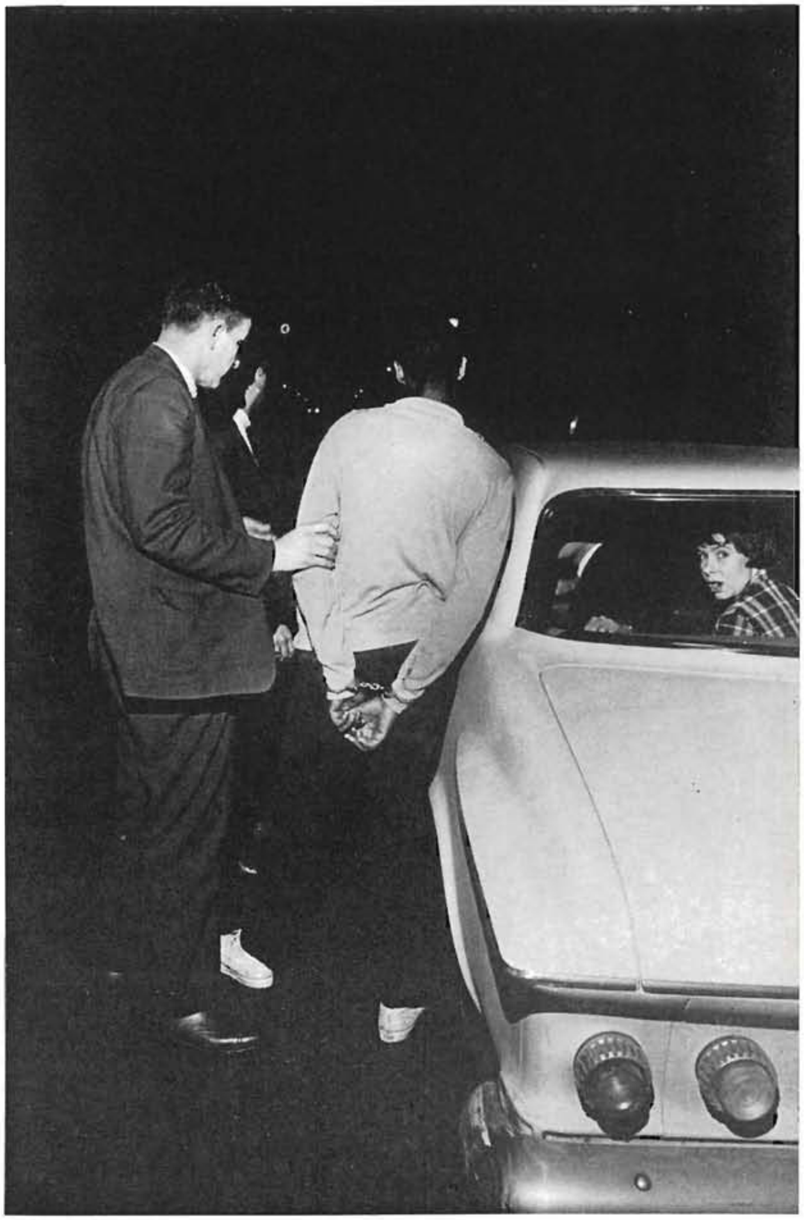
A visit to the Police Academy and its target range was included in a Friday night tour.

Speed with which records of suspects can be located at headquarters and relayed to officer waiting in squad car impressed sophomores Ed Sacks (left) of Rock Island, Ill., and Dave Saunders of Shaker Heights, Ohio.

Alex Candylis, freshman student from Paris, listens intently as officers get their orders during 11 p.m. precinct roll call.

Elaborate dispatching network at headquarters includes tape recordings of every call received. Said one student: "I was impressed by how seriously the St. Louis Police take every complaint. In the town where I live, I was run off the road and beaten up, and the cops said 'Too bad.' "

Out on the street, one stop was at emergency entrance at Homer G. Phillips Hospital. Another was at the city morgue.



Sophomore Jane McKinstry of Potosi, Mo., was in a cruiser whose driver (left) apprehended suspect in soft drink company burglary.

Students found it easy to be amused by demonstration of viciousness of Canine Corps member during demonstration. Chances are their reaction to the real thing, which they didn't encounter, would have been considerably different.

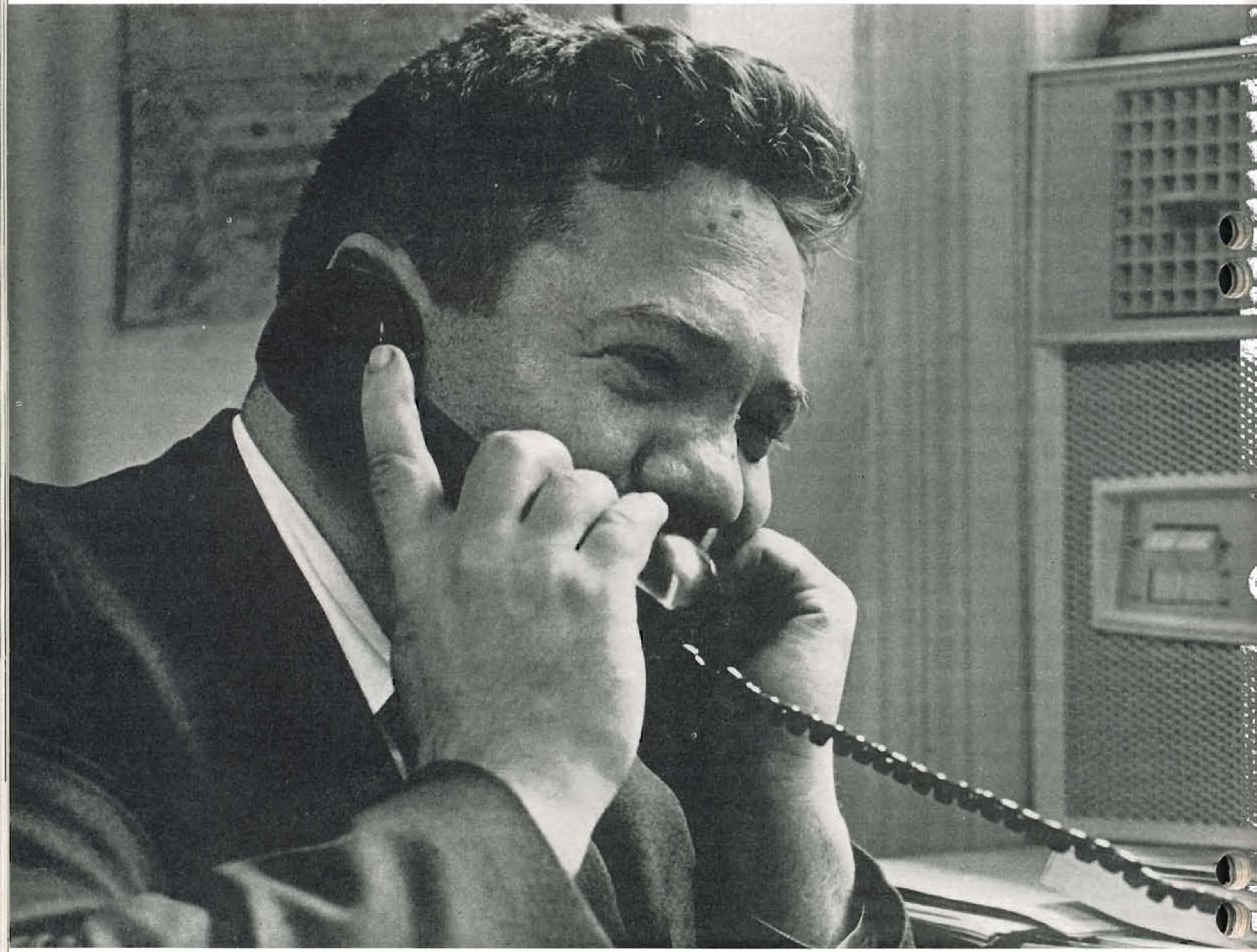
When a suspect tried to run, the arresting officer grabbed him by the seat of his pants, with this result.

Participants discovered how varied are the calls police answer in a single evening. Here an accident victim is carried by officers to waiting ambulance.

WU students observed the ultimate in big-city violence: administration of last rites by priest in a hospital emergency room.

"The Fail-Safe/Strangelove phenomenon, whatever its artistic merits or demerits, suffers from a major political blindspot," Professor Horowitz maintains in this article based on a paper he presented at the 17th Conference on International Relations in Colorado this spring. "The problem of World War III has little to do with accidental wars," he declares. "It has a great deal to do with designed, anticipated, and perhaps even desired wars."

Dr. Horowitz is the author of a number of works on social policy and theory, including The War Game, The Idea of War and Peace in Contemporary Policy, The New Sociology, *and* Revolution in Brazil, *and is the editor of* Power, Politics, and People: The Collected Essays of C. Wright Mills. *He is presently at work on a book about the emergent nations, tentatively called* The Third World, *to be published by Oxford University Press.*



By IRVING L. HOROWITZ

Associate Professor of Sociology

Historical Optimism and the Game of War

TODAY MEN MAY HOLD THE power to prevent history from exercising its vagaries by the simple device of programming Doomsday. But as long as anything short of total annihilation is contemplated, or acted upon, the historical muse will be with us: The relationship of historical judgment, of estimates of where "we" are in relation to the generalized "they," has never been more important in the mapping of military strategy. In the following propositions, I shall try to show how this is the case, and why historical judgment largely invalidates policies derived exclusively from pseudomilitary gamesmanship.

A great deal of new civilian-military thinking is based on a disguised appeal to historical pessimism. "Thinking about the unthinkable," the designing of scenarios predicated on negative events, and the simulation of post-World War III conditions, while clearly postulating future contingencies, does so in such a style as to prohibit the serious scientific study of political events. Originally an attempt to convey an optimistic view about the potentialities of a post-nuclear war environment, war game theorizing underestimates the fact that historical pessimism does not value survival but rather victory. Annihilation is its possible vengeance. For to define how men will behave under conditions of maximum tension and severity is not to take seriously the capacity of men to shift definitions of minimal tension and severity.

One very interesting example of pessimism, particularly in the United States, has been the spate of literature, and now films, concerned with accidental war. The Fail-Safe/Strangelove phenomenon, whatever its artistic merits or demerits, suffers from a major political blind spot. It tends to see the world in apocalyptic terms of a technological apparatus run wild, and of generals gone mad in relation to technical innovation. But while such "new look" books and films make us aware of the dangers of the all-out use of thermonuclear weapons, they do not provide any corresponding awareness of the political and historical conditions in which the use of such military hardware is contemplated. To be blunt: the problem of World War III has little to do with accidental wars; it has a great deal to do with designed, anticipated, and perhaps even desired wars. From this point of view, while the magnitude of destruction is enormously increased in the thermonuclear age, the content of warmaking still is rooted in such conventional problems as diplomacy, nationalism, democracy, capitalism, and socialism.

Technological "accidents" have occurred, and will occur again. But the likelihood of their leading to all-out Armageddon is slim indeed. Not simply because padlocking devices are constantly improving (which is so), and not simply because generals are much more knowing and rational than the outsider sometimes imagines, but because the traditional problems confronting mankind are being dealt with more seriously than ever before. The political world is undergoing a steady redefinition of "reality"—old "enemies" are becoming new "friends"; the definition of political and social systems is undergoing a process of sophistication thought unlikely a decade ago; modalities of trust, cooperation, and agreement are being entered into now—precisely because both sides to the Cold War see themselves as potential long-range victors.

To the very degree that the United States and the Soviet Union continue to define the future in optimistic terms, the possibility of "accidental war" diminishes, and the technological means of destruction become subject to mutual agreement. The Test-Ban Agreement of 1963 and the Uranium-Production Control Agreement of 1964 are the strongest evidence available that international control systems are possible. The problem of World War III has never been accidental warfare. Never has this been made plainer than now. The problem was and remains that of designed warfare. I should like to take up the role of historical judgment in minimizing this severe hazard.

EVEN THOUGH THERE IS AT PRESENT a high degree of military symmetry between the NATO powers and the members of the Warsaw pact, it is not the delicate balance of terror which defines the present situation, so much as the mutual definition of long-range victory. There are several powerful reasons for asserting that the peace of the world can never rest on a terror balance. First, any sort of small-scale military action can be quickly escalated into a general conflict. A serious deterioration of the situation in Southeast Asia could bring into play major nuclear powers on both sides. Second, the absence of a satisfactory nuclear control system, the heavy emphasis on big-power control in the face of a widening nuclear-spread, signifies that even if there exists a symmetry in weapons systems there is no corresponding symmetry in control or dispersion systems. Third, the more we emphasize a peace based on mutual deterrence, the more we must expect a mutual hardening of positions and postures, even when political factors leading to a potential softening of the lines of hostility are present. In other words, the concept of a terror balance, if and when rigorously pursued, moves in opposition to those polycentric and eclectic tendencies in both military encampments which could promote a long range peace. Fourth, as long as deterrence through maximum weapons systems remains the basis of peace there is the danger of war, either through misinterpretation of motives or political miscalculation. Thus, the model of the world derived from and built upon war game analogies is bound to run afoul of an essentially asymmetrical world situation.

ANY POSSIBILITY FOR PROLONGED peace has to be grounded in an optimistic definition of present relations and future possibilities of victory. That is to say, both sides in the Cold War must perceive the situation in optimistic terms to make peace "worthwhile." If either major force in the Cold War perceived the situation otherwise, and thought that "things were going badly," and would continue in the same negative direction, then the restraints against an all-out military confrontation would be sharply lessened. Thus, the maintenance of international peace requires a theory of history in which long-run tendencies were deemed favorable to the "victory of democracy" (for the United States) and favorable to the "victory of communism" (for the Soviet Union).

The Soviet Union, operating as it does within the Marxian doctrine of the historical inevitability of socialism, has optimism built into its calculations irrespective of short-run defeats. It can always re-translate objective defeats into temporary setbacks, due to the weakness of revolutionary factions or the strength of reactionary elements, both of which can be rectified given a long range in which historical imbalances can be righted. The United States, lacking a State ideology, cannot proceed with quite the same degree of historical assurance. Indeed, the constant assaults on infallibilistic philosophies of history have made the direct appeal to historical optimism not only politically risky but intellectually disreputable. Nonetheless, it is clear that the underpinnings of "the New Frontier" or "the war on poverty" do rest on an optimistic reading of future history. American foreign policy has increasingly focused on supporting the rising tide of revolutionary expectations, and on the inevitability of the victory of freedom over tyranny, democracy over totalitarianism, and, with ever more insistence in recent years, the victory of a capitalist economy over a socialist economy.

But perceptions of the situation have to be based, solidly or otherwise, upon "real" indices of victory, and these are present in increasing abundance. The United States can claim that the cultural exchange program with the Soviet Union has proven the superiority of the American Way by the tremendous positive reactions of Soviet audiences to everything Western—from Leonard Bernstein to Benny Goodman. From the American point of view, continued culture contacts work to its advantage in the long run. The Soviets, for their part, can perceive the same sort of cultural contacts as a victory of socialist culture over decadence. The huge receptions to the Moisseyev Dancers or the Bolshoi Ballet can be interpreted as a hunger on the part of Americans for something different and better than commercialized culture—which only a socialist society can provide.

The same sort of "peaceful competition" can be seen at work in terms of the achievements of science and technology in the United States and the Soviet Union. Indeed, the frequent resort to phrases such as "Soviet science" and "American ingenuity" are strong indications that there is a convergent optimism regarding the future of everything from space technology to experimental psychology.

In answer to the question: What kind of a man is American man (or Soviet man), the responses are remarkably similar: free thinking, unrestrained in the uses of imagination, cooperative in the style of work, dedicated to the victory of abundance over poverty, etc. Both sides have made powerful claims that the organization of science and technology in their respective countries proves, beyond a shadow of a doubt, the superiority of one system over another. The Soviets may emphasize different features: the rational planning of industrial activities, the absence of waste in production, and the coordination of managerial functions. The Americans may emphasize with equal sincerity their distinctive features: high rates of pay for scientific and technological work, the experimental attitudes of scientific workers, the self-imposed dedication to hard work of the American scientist. But again, what is clear is that whether or not there is an actual functional convergence of living styles and work styles between the

United States and the Soviet Union, there is a convergence at the level of history; both sides claim to have produced a superior human product no less than a superior scientific technology.

This kind of historical optimism is not restricted to areas of peaceful competition, but extends very clearly into areas of military confrontation. The Cuban missile crisis of October, 1962, witnessed the astonishing upshot of both the United States and the Soviet Union claiming undiluted victory. Nor ought we to imagine that these claimed victories are conjurers' tricks, devices ordered by propaganda chiefs who know better. Both sides could perceive real victory, simply by the relative weighting given to various factors in the Cuban crisis. The United States, perceiving the danger to lie in the hardened missile launching pads in Cuba, derived its victory by the removal of long-range ICBM missiles and medium-range IRBM missiles, and in the minimization of the military encampment of Soviet advisers in Cuba. The Soviets, for their part, could perceive things quite as positively. They could (and did) view the missile sites as incidental to the support of the territorial integrity of Castro's Cuba. And the removal of the missiles sites was made possible by the reaffirmation, informally at least, that the United States had no designs upon Cuban territory and no desire to upset the Communist regime of Castro. The "showdown" over Cuba was possible in symbolic terms, by a "show of force" without an actual use of force, because the same situation was perceived as advantageous to both sides.

SIMILAR ILLUSTRATIONS can be given for crisis-ridden situations elsewhere—in Berlin, South Viet Nam, etc. Indeed, the entire rise of the Third World, of revolution in Algeria, Egypt, Zanzibar, Ghana, etc., is considered by the Soviet Union as part and parcel of the coming victory of the Marxian prophecy. For the United States, these same national liberation movements are viewed as potential if not positive buffers against Soviet expansionism. Again, it must be emphasized that these definitions of the situation, however they differ one from the other, are not simply delusions, but are a consequence of differentially weighing factors involved. More profoundly, what this shows is that historical optimism is not the special preserve of any one side or any single ideological posture.

It must be emphasized that historical optimism is not Panglossian. It is quite capable of being rendered within a realistic political perspective. President Kennedy could stimulate optimism despite his blanket acknowledgment of the Bay of Pigs disaster, and Premier Khrushchev need not fear a collapse of his personal leadership despite his candid admissions concerning the bankruptcy of Soviet agricultural policies. This point might be generalized as follows: charisma is the ability of leadership to snatch victory out of defeat by the capacity candidly to admit failures and shortcomings, while at the same time generating the sort of optimistic vision of the future which prevents any major internal catastrophe. Put in more conventional terms, political "realism" is consonant with either an optimistic or pessimistic reading of events. And because this is the case, the function of optimism (or pessimism) as a guide to policy is not necessarily impaired by the actual trajectory of events.

In a gaming situation, we assume a finite number of possibilities and a stipulated number of plays—let us call this simply finite capital (or fixed capital). Thus, in a game of blackjack, both players know exactly what constitutes victory or defeat (the player holding a total number of points adding up to 21 defeats the player holding 20 points, and in turn, 20 points defeats 19 points), and in the event of a tie in points, the player designated banker by the rules or by mutual consent is declared the winner. Further, each player comes with a fixed capital investment in the game. If we assume investment parity, with each player entering the game with 100 dollars, then the winner is that player (or those players) emerging from the game with 100 dollars plus, while the loser is that player emerging with less than the amount of fixed capital he started with. But in a political contest, we cannot assume a finite number of possibilities, or a stipulated number of maneuvers. We are confronted by an infinite expansion or retraction of capital. Let us call this variable capital. In a game of politics, neither player really knows exactly what constitutes victory or defeat (unless the situation is as clear cut as enemy soldiers storming the gates of the capital city—and even then, as in Vichy France, there is enough elasticity in the situation to claim some sort of victory, or perhaps in an extreme situation, a stalemate). Further, each player can emerge from a military situation with more capital than he entered it. For example, the "defeated" Germans and Japanese emerged from their war-torn economies as major economic powers after World War II, while the recovery rates of a victorious England continue to lag seriously behind the defeated powers. Because of this near-infinite elasticity in political and economic relations, the concept of a human universe divided into a non-zero, two-player game is, to say the very least, misanthropic. It offers neither a correct diagnosis nor a significant basis of strategy formations.

Where then does the immediate threat of war come from? In great part, the answer seems to lie in the self-definition of the situation as negative, in the perception of the world as going "bad for us" in the event something drastic is not achieved. Stalinism carried the disease of the conspiratorial theory to new heights by perceiving the Soviet Union as surrounded by a ring of enemy bases poised to strike at Soviet soil the minute Soviet military vigilance was minimized. On this basis, all sorts of internal repression was justified and rationalized, and on this basis, the Soviet Union accelerated its arms production far beyond the comparable buildup on the part of the Western powers during the period from 1945 to 1955. McCarthyism and now Birchism rest in part on defining the world exactly in terms of the Soviet image of things. Every national liberation effort in Africa, Asia, or Latin America came to be interpreted in terms of historical pessimism—as a defeat for the United States and its interests. The policies of "roll-back" (in the late forties), of "brinksmanship" (in the fifties), and now of "Fortress Americana" all rest on a perception of historical events in pessimistic terms. Things are going badly for us, and therefore "something must be done."

Extremism is defined not simply by a willingness to take whatever risks are necessary to secure an all-out victory over the enemy, but more profoundly by a pessimistic reading of historical events, that is, by a belief that only by military actions at a nuclear level will it be possible to prevent the "communist conspiracy" from gaining the day. If any situation in which there is a shared perception of historical optimism is conducive to world peace, then it can be said, with an equal measure of meaning, that any situation in which there is a mutual perception of historical pessimism is conducive to world war. Examining those pressure points around the globe where there is a maximum confrontation, either on-going, or in the offing, we can see how relevant historical judgment is to policy-making.

When the Soviet Union launched the first earth satellite, this provoked an incredible reaction in the United States—not simply because of the shock of recognition that Soviet science and Soviet society was open enough and resilient enough to permit such advances, but because it provoked a pessimistic response on the part of the American population. The similar advances of the United States in manned fighter-bombers has provoked a dangerous pessimism on the part of the Soviet Union. But thus far, the upsetting of the balance of nuclear terror has led one side to reinforce its optimism, and the other to become pessimistic.

Where pessimism seems joined, as in the Berlin Crisis, with both sides absolutely determined to maintain their respective positions at all costs—the Soviets insistent on their dominion over Berlin and the access-ways to the city, while the Americans are equally insistent over the free status of the city and the rights of unimpeded access—any deterioration in the situation would be measured by a departure from the status quo, and hence would cause anxiety-producing pessimism. It is this, rather than any imaginary nuclear advantage, which could easily trigger the third world war. The optimism generated over even a temporary edge in military hardware or delivery systems has not, and probably will not, of itself generate any military adventurism. But given an untractable political context, such as Berlin, even the power having less "overkill" can easily be provoked into a precipitous military action. What this points to is the continuing relevance of politics based on historical judgment in the study of the Cold War. Modern technology may have radically altered the character of international political relations and scientific calculations of survival potentials, but the alteration only points up that much more sharply the need for mature political behavior.

OF COURSE, MUTUAL PESSIMISM may generate peace through an inverse process of mutual fear. There may, for example, be an increasing and shared fear on the part of the United States and the Soviet Union that a military threat equal to that of the contracting partners may actually be imminent, for example, the case of French *Force de Frappe* and the Chinese drive for an independent nuclear weapons system, and hence this will generate a spirit of cooperation between the major powers not possible at an earlier historical stage. But such a mutual pessimism about the Nth power problem, or an increasing fear of unacceptable forms of mass destruction (such as bacteriological or chemical warfare, or thermonuclear devices beyond a certain megatonnage), while offering the possibilities of freezing present military postures, or even of a limited arms agreement, cannot be effectively pursued until and unless the United States and the Soviet Union can perceive the definite advantages to themselves by so doing. In turn, this tosses the problem right back into the lap of historical judgment, and out of the wargamers' range. It is clear, therefore, that while history no longer exists as the mischievous thief operating behind the backs of men, for the simple reason that men can stop history in its tracks by massive nuclear detonations, insofar as such self destruction is not relied upon, history still is an operational factor in the lives of men and in the judgment of nations. And historical optimism could become a viable

instrument in transforming sentiments of mutual fear into those of shared victory.

It is difficult to deny that the sort of mechanical and contrived strategic thinking we have grown accustomed to has led us into grotesque decisions of major importance. For example, we continue to behave as if the Chinese Communists are rapacious beasts intent upon swallowing up enemy shores, as if the second largest land mass on this earth is thirsting for more land. Conveniently forgotten is Chinese Communist military caution in the face of all sorts of opportunities—from Viet Nam to Formosa. The India border disputes never became more than that, despite the overwhelming superiority of Chinese arms and manpower. Since "thinking about the unthinkable" is now on the agenda, is it not an entertainable hypothesis that the traditional Chinese virtue of patience combines with the communist Chinese faith in "history is on our side" to forestall any precipitous behavior on their part—whether or not they have developed their own nuclear deterrent?

Likewise, might not the present French posture be grounded in something considerably more substantive than the dreams of a gallant old soldier? Is it not possible that the French position too is based on an optimistic reading of the immediate future? The great speed with which France has become the leader of the European Economic Community, the revitalization of trade with former colonial nations such as Algeria within so short a time after the conclusion of military hostilities, the reopening of the Southeast Asia trade market to French business interests, the schisms between the major communist powers, the development of a potent, if minimal, nuclear striking force, are not these plugged into a form of historical optimism which does justice rather than violence to objective circumstances?

In a sense, whether or not historical optimism is perfectly warranted or not, its very presence in the policy-making apparatus of France and China is a cause for cautious optimism. It demands a serious re-evaluation of the present international division of political alignments.

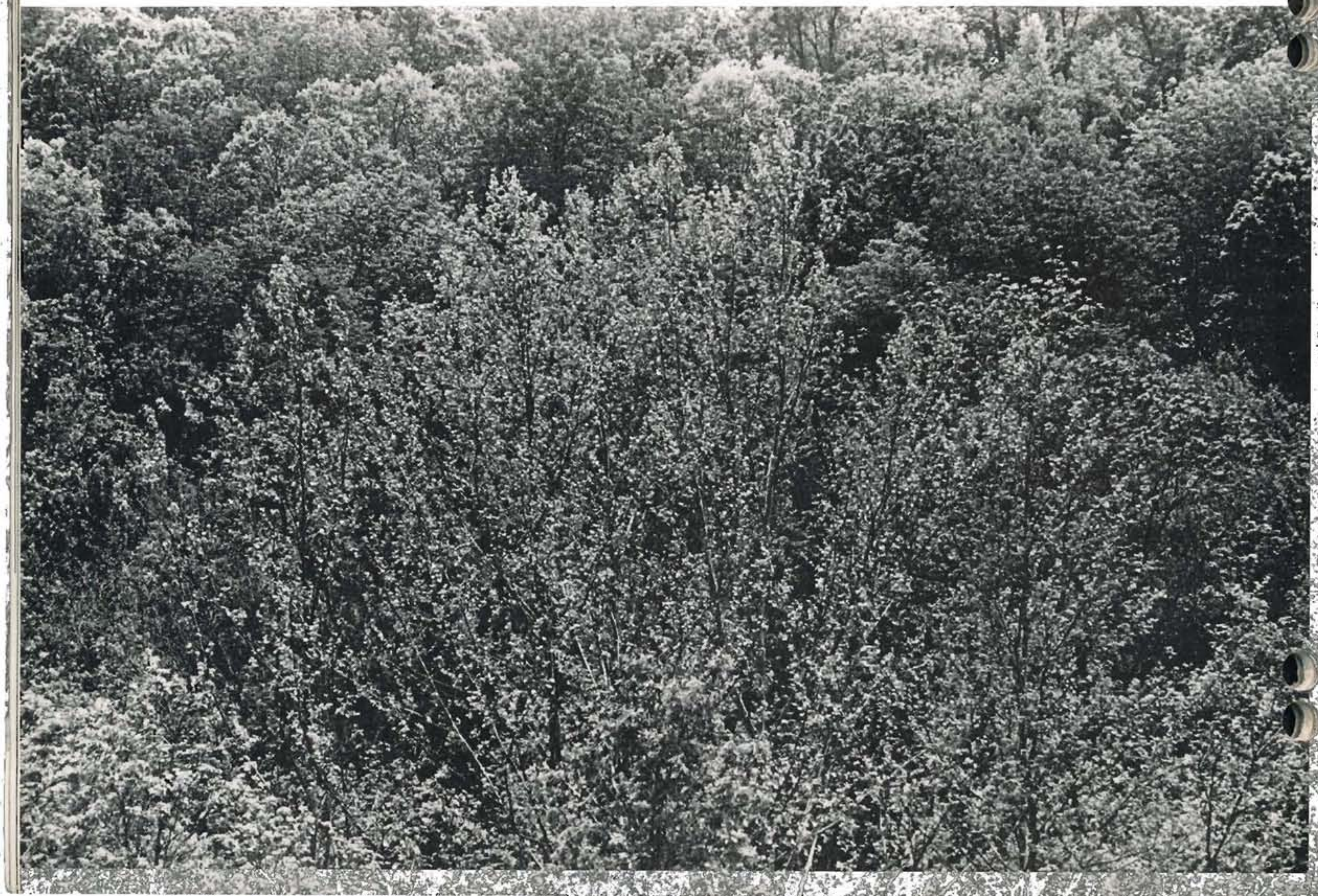
It is not being suggested that historical optimism can continue to inform policy decisions of great powers (or near-great powers) without some corresponding set of objective circumstances. But given the common denominator of superordinate goals which are shared by the contracting powers, there is sufficient elasticity in historical judgment for each side to claim long-run victories. The very ambiguity in the concept of "long-run" is itself a central feature enabling both sides in the Cold War to claim victory as inevitable. It cannot be repeated often enough that unlike a game of chance, the game of war contains such a wide ranging latitude of ambiguities—in defining the situation no less than in defining the consequences of a conflict—that the possibility of both sides being right inhere in the competing definitions of just what the goals of conflict are. So few situations are clear-cut that the demand for clear-cut decision-making has become in itself a mark of extremist thinking, of thinking which is impatient with the greyish course of the world, of thinking which insists on a Faustian struggle between good and evil, black and white, that is indeed more like a game of blackjack than like a game of politics.

THE DANGER OF AN ACCIDENTAL war, arising more from political than technological defects or from a mis-reading of the maneuvering of one party of the contracting nations, decreases in proportion to the judgment that a non-military solution is advantageous for "our side"—whichever side that may be in a particular situation. High gambling, in contrast, is stimulated by a belief that the gamble, or the bluff, is all that is left, and that win or lose, it is better to play than not to play. But when such a pattern of behavior is manifested by an individual, we tend to term such behavior pathological. The gambler prepared to "shoot the load" is a potential suicide (or homicide). His reading of objective events has compelled him, probably erroneously, to conclude that no other alternative for survival exists than an all-out, all-or-nothing, approach. The high-risk-taker is not a prudent man. But such prudent behavior is possible, in a utilitarian world at least, when judgments about the future victory outweigh judgments about a future defeat. And in the intervening time-span, in the breathing space which prudent behavior makes possible, the contracting nations or players have the time to redefine just what their goals and aims are.

The central chore for the social scientist in such a situation would then be to define the terms of any particular contest or conflict, evaluate the possibilities of settlement in such a way as to continue the historical optimism of the contracting players, and examine the conflict for possible areas of commonalities over-riding the specific conflict situation. Seen in such a light, the descriptions provided by the social scientist could be informed by historical judgment, without doing violence to the empirical character of social science. Otherwise, it may be that the wargamers will not so much inherit the world, as commit themselves, and all the rest of humanity, to collective suicide.

The blue haze over forests which interested Leonardo da Vinci is caused by submicroscopic particles given off by trees and other plants. Dr. Went estimates that a billion tons of these particles are released into the atmosphere each year and maintains that they are a major cause of air pollution, a potent factor in human allergies, and the possible source of the earth's petroleum deposits. In this article, he describes the work being done in this field with the University's mobile laboratory.

Professor Went came to St. Louis as director of the Missouri Botanical Garden and professor of botany after more than twenty-five years at the California Institute of Technology. A native of the Netherlands, he is a graduate of the University of Utrecht and holds honorary degrees from the University of Paris and McGill University. He has served as president of both the Society of Plant Physiologists and the American Institute of Biological Sciences and is the creator of the Missouri Botanical Garden's world-famed "Climatron," the geodesic dome structure in which plants are displayed and studied under complete climate control. Dr. Went recently resigned his position at the Garden to devote full time to research and teaching.



By FRITS WENT

Professor of Botany

THE BLUE HAZE OF SUMMER

IT ALL STARTED ALMOST five centuries ago, when that arch-inquisitive mind of Leonardo da Vinci tried to explain why distant mountains appear blue even if their rocks are grey or brown and their vegetation green. Leonardo showed that the mountains take their blue color from the air, which in turn gets it from the sun. He also argued that the ultimate source of whatever reflected the blue light was trees growing along rivers in valleys. Five hundred years later, at Washington University, we are using a new laboratory equipped with the latest gadgets and mounted on wheels, to chase Leonardo's tree effluents right where they were supposed to emerge.

But it would be wrong to suppose that there was so simple and direct a connection between those first imaginings and their ultimate verification. It was not until I was wondering myself about the blue haze, which spreads like a mile-thick blanket over such a large part of the land area on this earth, that I came across the notebooks of Leonardo, which are such a source of pure delight in intellectual exercise. They teach two important lessons: one, that the mind can be sharpened to such keenness that no computers or electronic instruments are needed to solve significant problems; the other, that without experiments and apparatus, the workings of the mind remain intellectual exercises and cannot be applied to improving man's condition.

I do not claim that the work now being carried out in the mobile gas chromatography laboratory of Washington University will lead to a more comfortable world. It may tell us only things which will make certain problems more understandable and it may produce a concrete basis for speculations like Leonardo's. And yet, there are some remarkable parallels between the blue heat hazes of the countryside and the blue city smog. Perhaps if we learn what nature does with these hazes, man may be able to manage his smog problem more intelligently.

The Los Angeles smog became a danger for my plant experiments in Pasadena when it drifted daily from the center of the metropolitan area to engulf our pleasant community in an acrid, tear-jerking, plant-damaging, and health-threatening blue blanket. Therefore, almost out of a sense of self-preservation, we research workers at the scientific institutions in the Los Angeles area took up work on smog. The California Institute of Technology, especially through the work of chemist A. J. Haagen-Smit, took a strong lead. Haagen-Smit showed that the blue smog haze was a photochemical product of olefins, or unsaturated petroleum products, which were released in great abandon by industry and public alike; by oil refineries, combustion engines, filling stations, the paint industry, and dry cleaners. Further contributions to this smog were made by smoke-belching back-yard incinerators as well as by the apparently efficient oil-fired boilers of electric power stations.

When we showed that this man-made smog did physical damage to plants, and when we could express this damage in millions of dollars in market value to vegetables and fodder plants, financial support for a study of this plant damage was made available. Within one year of the start of the research work, it was proved in my laboratory that ozonides of gasoline vapors were respon-

Deep within 2000 acres of woods at the University's Research Center, Dr. Went takes a reading on the level of plant terpenes in the atmosphere.

sible for this smog damage. Shortly after, Haagen-Smit produced typical smog by irradiating gasoline vapors with strong light in the presence of small amounts of nitrogen oxide.

THE PROOF THAT CITY smog was so toxic to plants stimulated research on the effects of smog on animals and man. As a result of this medical research, we now know that smog contains small amounts of cancer-producing substances, and that it affects people adversely in many different ways.

In the early 1950's, the Los Angeles smog problem was viewed hypocritically by people in other metropolitan areas, who felt that this could not happen to them. But later I found evidence of plant damage, identical with that caused by Los Angeles smog, in most metropolitan areas from Sydney and Melbourne to London and Paris, with many American cities on the list. Further studies proved that in New York or San Francisco exactly the same photochemical air pollution occurs, because of partially oxidized gasoline vapors. Curiously enough, in spite of my six-year experience in St. Louis, I have never found typical smog damage on leaves of vegetables or other sensitive plants here, which makes St. Louis the largest metropolitan area in the United States without plant smog damage. Perhaps this shows that general air sanitation, in which St. Louis took such a decisive and effective lead under the guidance of Mayor Raymond Tucker, not only eliminates smoke, but also delays the development of other forms of air pollution.

Washington University's mobile laboratory, however, was not set up to study man-made air pollution. It was designed to get information about a phenomenon which resembles smog in some respects, but which has nothing to do with human activities. It was designed to investigate the age-old problem of summer haze, first examined by Leonardo da Vinci. This blue haze looks remarkably like city smog, only it remains more dilute, and rarely leads to eye irritation or plant damage. It had formerly been attributed to air humidity, to a very dilute fog of microscopic water droplets. But we know now that the moment a fog or mist forms it appears white because the smallest stable water droplets reflect all colors equally. It is not until particles are smaller than the wave length of light (one-tenth the diameter of the smallest stable water droplet) that they appear blue. Therefore, to understand these blue hazes, we had to look for a source of such submicroscopic particles, invisible even under the most powerful light microscopes.

John Aitken in the 1880's succeeded in counting these particles with a method as elegant as it was simple. He had observed that in completely pure air devoid of any specks of dust, steam would not condense to microscopic water droplets, or mist, but would remain suspended in the air as supersaturated water vapor. But any dust or other particles present could cause the condensation of a water droplet on its surface. Therefore, when a small mass of air was cooled by expansion, to produce super-saturation, a mist formed, whose density was a measure of the number of particles, or condensation nuclei, in the air. Aitken found that the number was very great: in the purest country air there were still millions of particles per cubic foot; in city air there were billions of such particles per cubic foot. He also found that smoke and flames were the greatest producers of nuclei condensation.

If we relate these findings of the Scot Aitken with those of the Irishman John Tyndall, we start to see the outline of a working hypothesis of the origin of these condensation nuclei in the atmosphere. Almost a hundred years ago Tyndall found that when a beam of strong light was passed through a tube filled with the vapors of certain organic substances, a delicate blue haze, or "blue cloud" as he called it, developed in the course of seconds or minutes. Repeating Tyndall's experiment and Aitken's measurements, I found that all organic vapors tried would produce blue hazes, if they were irradiated with strong light in the presence of small amounts of nitrogen oxides or other light-absorbing material, such as iodine vapor. At low concentrations no blue haze was formed, but a high concentration of condensation nuclei could be counted in the reaction mixture. This was confirmed in a dramatic way under natural conditions.

In the thermal areas of Yellowstone Park, geysers, warm springs, and hot pools abound. In summer they send up dense columns of steam, when the air above them becomes supersaturated. Curiously enough, in winter these steam columns are less spectacular, or sometimes they are altogether lacking, even though in the cold crisp air a high

Using a syringe, Dr. Went takes a sample of air near a growing plant. Even the five cubic centimeter sample will show plant terpenes present.

degree of water vapor supersaturation occurs above the hot pools, which are virtually boiling. But that same cold air is so pure that it lacks the necessary condensation nuclei. Therefore Yellowstone Park in winter becomes a vast laboratory in which the formation of these nuclei can be studied. Whenever they are present, hot pools disappear in a shroud of mist.

This past January, I joined the many scientists from different fields who journey to Yellowstone Park each winter to use the remarkable conditions which nature offers in the Old Faithful geyser area. To reach this area we had to travel the last thirty miles by snowmobile over two to four feet of snow. The water vapor produced by the hundreds of geysers and pools added to the pristine beauty of the northern winter. Each morning the pines in the geyser basin were covered with hoarfrost, because the surface of their needles provided the atmosphere with a means to precipitate its excess water vapor, which it could not get rid of by mist formation because of the lack of condensation nuclei.

MY EXPERIMENTS WERE SIMPLE but convincing. I tried to establish under what conditions volatile substances given off by plants could produce condensation nuclei. Just working around the hot pools, I did not really need any instruments other than my eyes. When I saw the water vapor above these pools condense to thick clouds of mist I knew that I had produced nuclei, and the denser the mist the greater the number of nuclei. As an ever-skeptical scientist, I occasionally checked these visual tests with an Aitken condensation nuclei meter; but whenever I could measure an increase in nuclei with my instrument I first had observed it visually.

I found that four factors had to cooperate before condensation nuclei were formed:

1. There had to be organic volatile substances in the air, e.g. alpha-pinene (the substance which makes pines smell piney), or other terpenes such as turpentine.

2. The presence of catalysts, such as nitrogen oxides or iodine vapors, was absolutely essential, although by themselves they were unable to produce nuclei.

3. Strong light. This had to be of the intensity of full sunlight. On cloudy days a mixture of alpha-pinene and nitrogen oxides was ineffective, but in full sunlight splendid mist clouds formed over hot pools or above geysers. When I was producing condensation nuclei in the vicinity of the Giantess geyser, which erupts very seldom, the National Park rangers mistook the dense condensation cloud I produced for an eruption.

4. Time. Upon mixing terpene vapors with a catalyst nothing measurable happens during the first few seconds or minutes. But given enough time and light, nuclei start to form and mist clouds are produced. When I worked too close to a hot pool or geyser nothing happened, but when I produced my vapors at some distance from them, dense flumes of mist arose, if the wind wafted my vapors towards them.

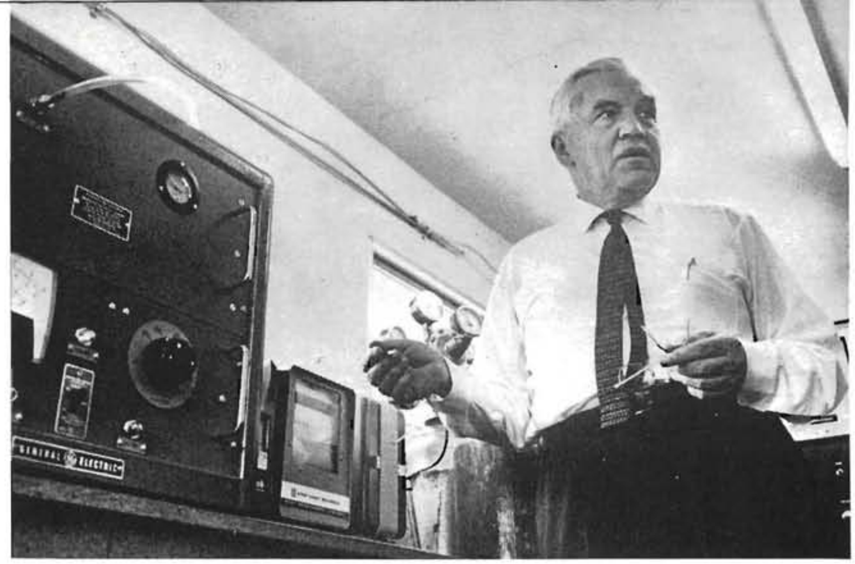
From all these observations we can draw two main conclusions:

1. Organic vapors can produce condensation nuclei in sunlight;

2. Such nuclei can be the basis for the blue hazes hanging over the countryside.

It now becomes a problem whether plants or other organisms produce enough organic vapors to account for the summer or heat haze. How can this problem be solved? For this we should know the quantity of organic vapors produced by plants. This was done in the laboratory by Haagen-Smit, but does it actually happen in nature? On the basis of theoretical considerations I had concluded that plants might be the source of these volatile materials. Reinhold Rasmussen, a graduate student at Washington University, proposed to undertake a test of this hypothesis. During the last few years, a new experimental technique, the gas chromatograph, had been developed and Rasmussen suggested that he try this instrument to measure what volatile substances were given off by plants. There were several major difficulties to solve in this problem. One was that there are a few dozen chromatographs commercially available, each with different properties and advantages. Another difficulty is their price, usually several thousand dollars; so that we could not afford to make a mistake in our selection.

Our problem was neatly solved by help from the Research Division of the Monsanto Chemical Company. In Monsanto's chromatography laboratory, they use a number of different gas chromatographs, which were made available for our research. Rasmussen soon found that there



Inside the air-conditioned portable laboratory, Dr. Went explains the operation of the cloud chamber device at left, which records the number of particles present in the air.

is no time when the concentration of volatile organic matter in the atmosphere is so low that the most sensitive gas chromatograph does not register it, even in a volume of only five cubic centimeters of air. This means that it is not necessary to concentrate this volatile matter before analysis, and that it is possible to measure the quantity of the various organic gases in the air by injecting five-cubic-centimeter air samples into such a sensitive machine. At its most sensitive this instrument can detect at little as one million-millionth of a gram of a substance. Even more remarkable, it can detect such amounts of a substance in a mixture, separate the substances in this mixture, and record their presence individually. Most remarkable of all, from the chromatogram the specialist can deduce with a fair degree of accuracy which specific substances were present.

ESSENTIALLY the gas chromatograph does two things: it separates the different components of a gas mixture, and it then measures each component separately. Many different sensing devices exist and the various gas chromatographs use different detectors. By sheer good luck there is one sensor, the hydrogen flame detector, which responds *only* to reduced carbon compounds and consequently to the organic volatile materials given off by plants, and which, molecule for molecule, is equally sensitive to all plant terpenes. Thus, equal deflections of the needle of the indicator mean approximately equal amounts of different substances.

Through financial help from the National Science Foundation we were able to buy a gas chromatograph, which we mounted in a specially designed trailer-laboratory. In this way we could move the instrument towards the air we wanted to analyze instead of bringing our air samples to the instrument. This is important, because the ultra-small quantities of substances we have to measure can become lost easily, or absorbed in the container in which we would have to transport air to the laboratory. As it is, we locate the trailer-laboratory in a forest or next to the plants from which we want to measure the emanations. We then simply take a 5 cc air sample with a hypodermic syringe and inject this air into the gas chromatograph before its components have a chance to change or disappear.

About one year's experience analyzing the air in many parts of the United States, from Connecticut to Colorado, including the Smoky Mountains, the Ozarks, and the Rocky Mountains, has told us something about what organic substances are present in the air, in what concentrations, and at what times. These quantities change from hour to hour, from day to day, and from season to season. Each day the highest concentration occurs in the afternoon. It decreases during the night to about half and then increases again the next morning. On warm sunny days the concentration goes up much higher than on cloudy or rainy days. In summer and autumn the concentration goes up to ten or twenty parts per billion, while in winter it decreases to one or two parts per billion. When the air is fragrant with the odors of newly cut hay, the gas chromatograph registers as much as fifty parts per billion or more. The aroma of the air on Indian Summer days, when the foliage turns to brilliant colors, is also due to volatile materials. All this comes from plants, as can be shown by putting a plastic bag around plant branches, or over a plot of grass. The concentration of the volatile organic substances immediately starts to rise in these bags, showing that plants actually are their source.

When we try to identify these organic materials, we find that most of them are terpenes commonly found in plants. But there also are gasoline vapors, and during winter these predominate, not only in the city, but even in country air. We can see how man's activities gradually change his environment, even the air he breathes. People are prone to blame all untoward changes in their environment on atomic bombs, for which most of us disdain direct responsibility. But we ignore the fact that our cars continuously put exhaust products into the air, and that appreciable amounts of gasoline vapors escape through leakage and when gas tanks are filled. It is high time that we find out how much you and I contribute to the deterioration of our air, and what can and should be done about it. The gas chromatograph will play an important role in assessing the degree of air pollution due to human activities.

Now that we have measured the emanations of plants into the air, can we estimate how much this amounts to for the whole world? In this estimate we have to take

A sample of air is injected into a gas chromatograph, which will give an exact quantitative analysis of all volatile gases present.

into consideration that plants continuously produce terpenes, and that these substances disappear again, as the decrease during the night indicates. Although we have no measurements for the tropics and other parts of the world, an estimate of one billion tons of volatile organic substances produced annually over the whole world seems to be reasonable. This is more than the world production of cement and it would be appalling to think of this much cement dust dispersed into the air daily. Therefore: what happens to all this volatile plant material?

For an answer to this question we return to the experiments of Tyndall and the observations in Yellowstone. Volatile organic matter can be transformed, under the influence of sunlight and in the presence of catalysts, into submicroscopic particles, or Aitken condensation nuclei. Do the observations on these nuclei support this explanation? Very definitely so. When we take measurements throughout the day and night, we find a daily fluctuation, provided we are far enough away from cities.

In St. Louis the number of condensation nuclei varies according to the amount of automobile traffic, rising sharply at 7 a.m. and at 4 p.m. Twenty miles west of St. Louis, at Washington University's Research Center in Tyson Valley, an eastern wind will cause a fourfold increase in nuclei when city air is blown over the area. When the wind is from the north, slight increase occurs a few minutes after each train has passed over the nearby Missouri-Pacific tracks. Southern winds produce irregularities because of traffic on Highway 66, a mile away. The arrival of individual cars at the mobile laboratory site causes an increase in nuclei lasting half a minute, until local winds dissipate them again.

In the middle of the Ozarks, we found a consistent daily fluctuation. Every day the number of condensation nuclei increased, particularly the small ones, indicating that new ones were being produced. At night there was a decrease, and the small ones disappeared. Where did these nuclei go? For an answer to this question I took the Aitken nuclei counter up in airplanes and sampled the air during whole flights. This does not do any good in a commercial plane, where the cabin air is heavily contaminated with smoke and shows a very high particle count. But the air coming from the fresh air jets above the seats is equally unsuitable; although it is fresh outside air, it has been filtered through glass fiber bags which remove all nuclei. But when flying in planes chartered by cloud physicists of the University of Chicago, or by the State of Illinois Water Survey, I could take in fresh air for my nuclei counter through a tube extending beyond the fuselage from the cabin. Then I found that the nuclei gradually decreased in number from ground level to cloud level; above the first temperature-inversion layer the number hardly decreased any further. This seemed to indicate that there was a mechanism by which these nuclei disappeared in the inversion layer.

Actually I found that fair weather cumulus clouds are sinks for condensation nuclei, which accumulate on their surfaces. I found a lot of particles, other than dust and pollen, in rainwater. Therefore I have come to the conclusion that there is a typical cycle in the atmosphere for the volatile organic matter given off by plants. This is continually released, particularly during the day. It then is partly carried away by air currents and partly becomes particularized to condensation nuclei. These nuclei are captured by clouds and are concentrated on their surfaces (did you ever wonder why clouds often have much darker surfaces than their cottony white interiors?), and are then returned to earth by rain and snow. When you collect rainwater and are careful not to contaminate it with surface dirt, you will find that it is definitely not as pure as usually asserted. It carries a great deal of solid material, and since the atomic bomb, radioactive fallout.

We do not have much information about the chemical constitution of this solid material in the air and in rain. The best guess, supported by a few analyses, is that it is organic in nature, oily, and sticky, and consists mainly of high molecular, asphaltic material. I have ventured the guess that this material ultimately becomes the parent material for petroleum formation.

The work carried out in the University's mobile laboratory gives us much new information which helps to illuminate problems in botany, geology, and meteorology. It provides a key to the understanding of air pollution. And it furnished the proof for Leonardo's contention that trees are responsible for the blue haze of summer.


RCA
OFFICIAL COLOR TV
CENTER

As director of programming for the RCA Color Television Center at the New York World's Fair, Alumnus Lou Ames will be responsible for the creation of 8,000 hours of color television shows.

THE COLORFUL WORLD OF LOU AMES

AT THE NEW YORK WORLD'S FAIR of 1939, the miracle of television was unveiled. David Sarnoff, then president of Radio Corporation of America, inaugurated the first regular commercial television service with the dramatic message: "We now add sight to sound."

Twenty-five years later on the same site, the 1964-65 World's Fair features some 300 color television receivers scattered throughout the Fair's 650 acres over which continuous full-color programs are being broadcast twelve hours a day and seven days a week.

The man in charge of creating and producing the programs for this colorful television marathon is a Washington University alumnus, Louis Ames. In 1939, Lou was an undergraduate at Washington and he remembers well making a trip to the Fair and seeing his first television then. In his present job, he sees it everywhere he looks—and in full color at that.

Lou Ames was active in Quad Show on the campus and he also managed to obtain an after-school job as an announcer, writer, and producer with an experimental radio station just being organized by the old *St. Louis Star-Times* newspaper. The combination of show business and broadcasting proved irresistable. Immediately after his graduation in 1940, with a liberal arts degree and a major in English and journalism, he went to New York to try to break into the broadcasting world. His first job was that of a pageboy at the National Broadcasting Company studio. He has been in the business ever since in a variety of exciting positions, including stints as co-founder and program manager of the *New York Daily News* station WPIX, producer of fellow-alumnus Dave Garroway's Today Show and the Arlene Francis Home Show, and administrator of the NBC Opera Company and its television series.

Lou got into the world's fair business by way of Rome and Brussels. When plans were being made for the Brussels World's Fair, Lou was asked to produce a Menotti opera for the Fair. He put the opera together in Rome and then took it to the Fair in Belgium, where he spent the year.

He is now on a three-year leave of absence from NBC to the New York World's Fair. Last year, he was director of cultural programs for the Fair and planned and developed many of the Fair's cultural attractions. After working on the plans for the RCA color television communications center, he became its program director. During the two summers of the Fair's operation, he will be responsible for producing some 8,000 hours of color television.

The RCA Building is just inside the front gate of the Fair. There, in a building resembling a collection of gigantic and colorful hatboxes, is an ultramodern color television studio in which visitors can see all phases of producing and transmitting color programs. From the Center, a continuous flow of news, weather reports, entertainment, and special information programs is transmitted on a closed-circuit network to the 300 color television receivers in exhibits, restaurants, lounges, and waiting rooms throughout the Fair grounds.

Every day, Ames is responsible for twelve hours of pro-

Lou Ames is responsible for planning programs, conferring with other Fair exhibitors and visiting celebrities. He also directs many of the shows from the floor of the RCA World's Fair studio.

grams. Programs include regular newscasts hourly of both world news and fair activities, hourly weathercasts, children's participation shows, fashion displays, sports events, visiting entertainers and celebrities of all kinds, and live pickups of events throughout the Fair by means of a color mobile TV unit. The color TV system is also used to help restore lost children to their parents—a most useful service on a square-mile site thronged with millions of visitors, a large proportion of them children.

The continuous color telecast is also building an unparalleled library of color television tapes, to be used on local and network shows and to provide a living record of the Fair. The project has two main objectives: to inform and entertain visitors and to provide them with a behind-the-scenes view of color television in action.

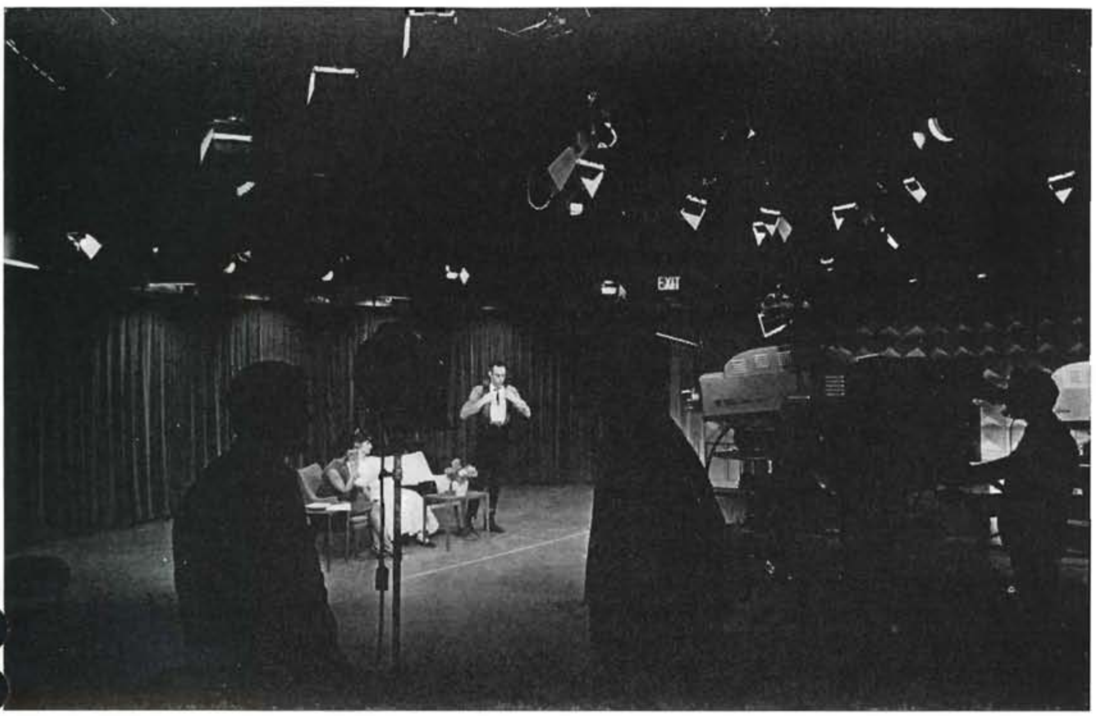
Visitors to the building, and already they're coming through at the rate of about 8,000 a day, follow a gentle sloping ramp through the building which enables them to see into the studios and watch color television in actual production and to observe the control room and its engineers in action. A special feature, already proving one of the most popular attractions at the Fair, is the opportunity the Center gives each visitor to see himself on color television. Every visitor passes before color television cameras and then sees himself twice on monitor sets—once "live" and once in a delayed playback on tape.

Planning and producing the continuous parade of programs for the Center's color cameras is a hectic job, even for someone with all the experience of Lou Ames in the world of radio and television. Every show that appears on the screen must first be planned and scheduled in conference with other Fair exhibitors or visiting entertainers and celebrities. The programs must be timed, dovetailed into the overall schedule, and given professional direction. Ames serves first as the general program director, but he also directs many shows personally from the floor of the studio and occasionally interviews guests himself. Ames made a special point of handling one recent interview personally. It was with an old friend and colleague of Lou's days with the NBC Opera: Soprano Anna Moffa. Other visiting celebrities who have made guest appearances on the Fair's color network have ranged from kings and other heads of state to movie stars and sports figures.

Throughout the two summers of the Fair, the RCA mobile color television unit is visiting the other Fair exhibits, doing live shows of glassblowers at the West Virginia exhibit, Watusi dancers in the African Village, Jordanian bagpipers, exhibits of great Spanish art, and other widely varied attractions.

Lou lives today in nearby Norwood, New Jersey, with his wife, actress Jetti Preminger, and their two sons. While his job keeps him away from his family for long stretches at a time, there are compensations: his two boys get to go to the Fair regularly and have an entree to the behind-the-scenes activities that is the envy of their friends whose fathers work in more prosaic jobs.

When the Fair closes, Lou will go back to NBC and continue his work in the television business—richer by the experience of producing some 8,000 hours of varied and unusual color television.

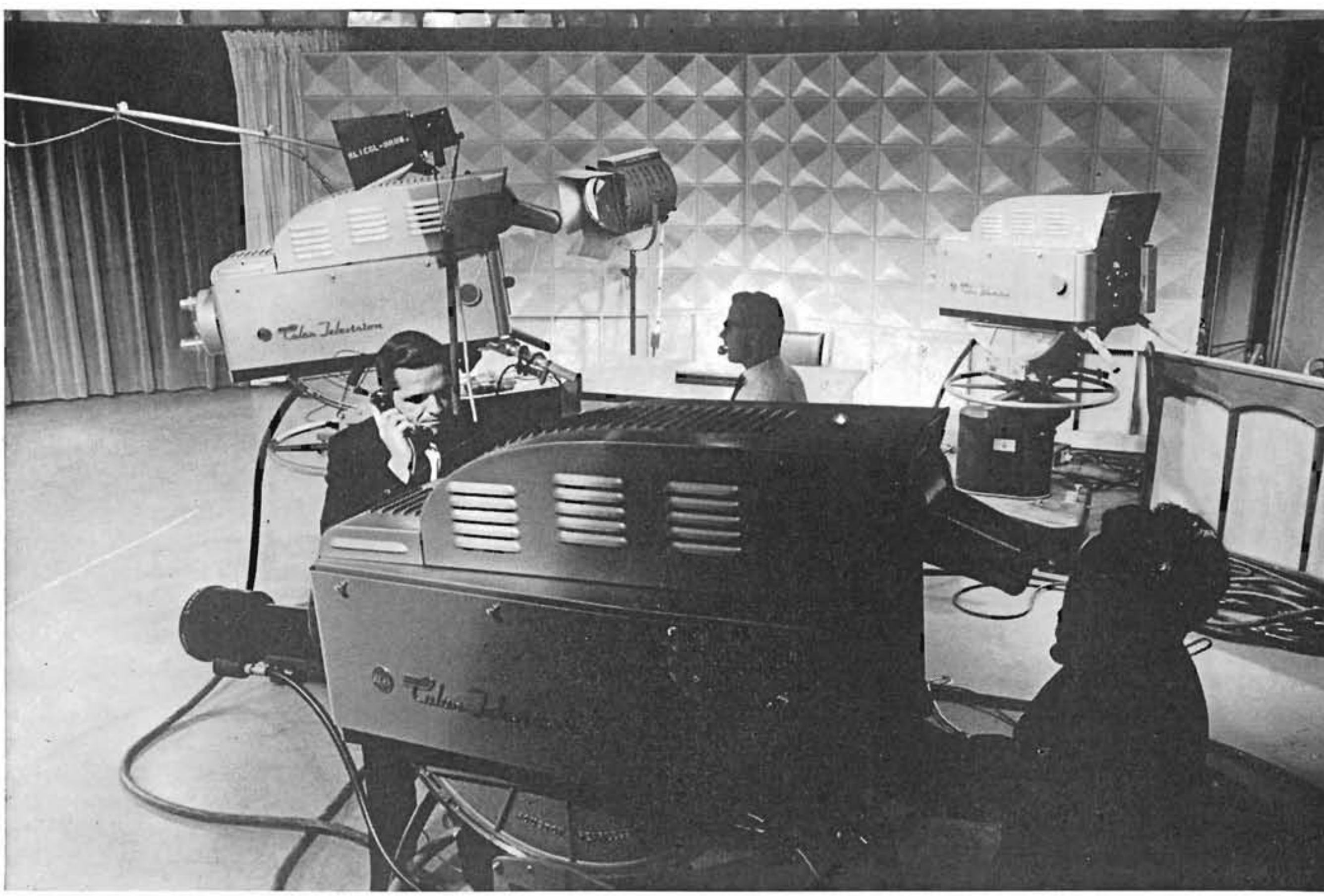


Actors from the Illinois Pavilion present a scene from "Abe Lincoln in Illinois" for the color television cameras. Visitors to Fair can watch the program in progress from balconies.

Lou Ames confers with Sonny Fox, director of a popular New York children's television show. Sonny was known to St. Louis audiences as "The Finder" on a KETC children's program.

Ames gives a cue to a performer during a World's Fair telecast. Programs are telecast from the RCA Pavilion twelve hours a day and seven days a week.

It's always fair weather at the Fair. Ames poses with the three "Weather Girls" who give hourly weathercasts from the RCA studios. Girls were chosen for role in national competition.



The World's Fair studio is one of the most modern and completely equipped in existence. It has elaborate facilities for both live and taped programs, and a complete sound stage.

By RICHARD P. WILBUR

In his address at Washington University's 103rd Commencement, Poet Richard Wilbur described the role of ceremony in society as serving "to punctuate our lives with what look like significant choices and deliberate changes."

Wilbur first gained prominence in 1957 when his book of poetry Things of This World *received a Pulitzer Prize and the National Book Award. He attended Amherst College and received a master's degree from Harvard, where he taught for seven years. He is now professor of English at Wesleyan University in Connecticut.*

A SPEECH AT A CEREMONY

SOME PEOPLE ARE VERY FOND of ceremony. I think, for instance, of Benjamin Disraeli. Someone asked him, when he was a young man, what he thought life should be, and he unhesitatingly replied, "A continuous grand procession from the cradle to the grave." He required of life that the prose of every day be incessantly redeemed by pomp and drama, and anyone who reads his biography must marvel at how close he came to having his way. Disraeli always seemed an odd and flamboyant bird among the English, and I suppose he would have seemed even odder over here, in our unceremonious country. Pomp has never wholly caught on with us. Try as he might, John Adams never succeeded in setting a monarchical style for our republican way of life, and Americans ever since have been a little disrespectful of ceremonial grandeur. We recall the scandalous inaugural of Andrew Jackson and all that spilt whiskey on the White House carpets with a certain horror but also with a certain glee; and we like to hear stories, true or false, about Will Rogers calling the King of England "George," and Harry Truman addressing Princess Elizabeth as "dear."

To be sure, there *are* ceremonious Americans, and we have all encountered a few. I recall one in particular. Toward the end of World War II, the U. S. Army established a number of temporary universities in Europe, in order to keep some of our troops out of trouble until it was time to go home. I was furloughed from Germany as a member of the first cycle at Shrivenham American University, which was housed in the buildings of a military school near London. Our university made a somewhat ragged start, because there was no library to speak of, because our textbooks were late in arriving, and because our classes consisted of men of all ages and degrees of culture; but once we got going, it was a splendid school, and I have never seen elsewhere such hunger for learning or such pleasure in teaching.

WHAT I WANTED TO TELL you, however, was this: before our university was two weeks old it possessed, by order of the general, a uniformed football squad, a football schedule, a corps of cheerleaders, a set of Shrivenham American University cheers, a glee club, and a nostalgic alma mater which the glee club had already broadcast over the BBC. I think you'll agree that we had a truly ceremonious general: before we had a present, he gave us a tradition and a beloved past; in a time of confusion he offered his displaced charges, by means of songs and cheers and scheduled occasions, a certain sureness as to where we were, who we were, and what we were to feel.

The military profession is no doubt peculiarly aware

Richard P. Wilbur

of some of the uses of ceremony: our generals know how ceremony can convert bare discipline into a felt ritual, how it can dramatize routine, how it can promote that prompt simplicity of emotion which belongs to the soldierly nature. Yet in all professions some disposition toward ceremony can be found—even in my own calling of letters. Writers are thought to be impatient of pompous formalities, but I know some who are never so happy as at banquets, testimonials, and assemblies, where they can put on looks of simple greatness and bestow honors on each other.

Still, as I've said, we Americans are more skeptical than other peoples when it comes to the highfalutin, and it is common among us to feel that the thing to do about forms and observances is to see through them. If here and now we were to set about seeing through some formal occasion—a funeral, an inauguration, a confirmation, a commencement, a rally—I suppose we might say first that the function of any ceremony is to enable one to feel some appropriate emotion decisively—to feel it rightly and get it over with. In each man's private history, and in that part of public history which touches him, there occurs a number of moments or events to which he feels bound to respond. Very often he cannot, on his own hook, respond with any intensity, or with what seems to him a proper emotion, and this he finds troubling. He feels as if he were missing out on life; he feels as one might feel who had not looked up from the racing form as Man o' War went by, or who, at a New Year's Eve party, had dropped off to sleep in a chair and not awakened until 12:35. When we miss out on our emotional opportunities, we are upset at the moment of failure; and we are also nagged ever after by a sense of not having measured up, a sense of unfinished and unfinishable business.

It is from such remorse and regret that ceremony preserves us. The girl who awakens on her wedding day, and finds that it seems like any other day; the shoe clerk who, after fifty years with the same store, can manage nothing but a dull wonder at the swiftness of time; the guilty man who wants to pray and cannot: for people like these—that is, for people like us—there are ceremonies which can demand and release a suitable emotion, persuade us that we are adequate to life, and so assist us to live some more. A prudent heart will not despise such aids.

AND SUCH AIDS are the more painfully needed the more our lives are formless, mannerless, traditionless, placeless, and private. There have been times and places in which men had ceremonious hearts and could respond unassisted to any circumstance, in a manner both fervent and orthodox. There are still such places and such men; but in most of our Western world, as the novelists have been telling us for decades, the ceremonious heart is rare. When Hans Castorp, in *The Magic Mountain,* is told of the manner in which the dead are brought down for burial from the higher sanatoria, he bursts into wild, uncontrollable laughter; it is a laugh, as the critic Eric Heller said the other day, which was never heard in ancient Greece. And think of the blank, intransitive hearts of the heroes of Albert Camus; think of the child in a Virginia Woolf novel who learns that her mother is dying and learns, too, that she does not care. There's no need to go on with such examples: in novel after novel of our times, we have been shown this peculiarily modern form of sickness or suffering: the inability to feel, or the inability to feel other than perversely.

Nor is it the novel alone which purveys this revelation about our times; surely the so-called "sick" humor which is now so popular in our night clubs and elsewhere tells the same story. With its cruelty, its callousness, its universal irreverence, sick comedy shocks us into laughter; it shocks us, however, not so much because we are conventional as because it exposes and caricatures the miserable indecorum of our own hearts. We have need, at times, of the benign coercion of ceremony.

THERE IS ANOTHER manner, I think, in which ceremony might be seen through and accounted for, and perhaps I can best approach the idea by quoting a much-anthologized poem of Carl Sandburg's. It is called *Limited,* and it goes as follows:

> I am riding on a limited express, one of the crack trains of the nation.
>
> Hurtling across the prairie into blue haze and dark air go fifteen all-steel coaches holding a thousand people.
>
> (All the coaches shall be scrap and rust and all the men and women laughing in the diners and sleepers shall pass to ashes.)
>
> I ask a man in the smoker where he is going and he answers: "Omaha."

The poet is a little patronizing, it seems to me, toward the man in the smoker. Mr. Sandburg regards "Omaha" as a limited sort of answer, and it is. But surely Mr. Sandburg's jaw would have dropped if the man in the smoker had said, "I am hurtling into blue haze and dark air; I am passing to ashes; I am rushing toward death and infinite mystery." The fact is that the man answered naturally; we all prefer Omaha to death; we all prefer to move toward the unknown by short stages; and even monks and nuns, who have a special professional concern with last things, pass toward them by way of each day's duties, each day's canonical hours, and the feasts of the church year.

There are many pleasures and exhilarations in travel, but one of the greatest is the illusion that we are taking time and space into our own hands. We get on the train for Omaha, and soon by our own choice we are losing or gaining an hour; we are passing time, rather than being passed by it; no longer are we wholly subject to the earth's motion; we move purposively with or against it. And when we get down at Omaha, we feel that we have got somewhere. In our deepest consciousness we know that it is not true; that we have not mastered space and time; that the heart has gone on wearing out at the same rate; and that we are scarcely better or wiser than when we started out on the journey. We suppress that knowledge, however, because it is difficult to bear.

There is a great deal of knowledge which one would like to avoid. How unpleasant it is, for example, to be told in a statistical article how many glasses of milk one is expected to consume in a lifetime. Confronted with such a statistic, one sees oneself as a prisoner of appetite, helplessly consuming from birth until death, a creature wholly passive and repetitious. At such a moment the landscape of our life's journey lies before us like the desolate perspectives of De Chirico; we envision a desert prospect of unrelieved sameness, traversed only by a long line of milk glasses, dwindling toward a vanishing point which is also our own. Or consider a related kind of unpleasant awareness, the kind that comes when one realizes that for the fifth straight time one has failed to keep one's New Year's resolution to give up smoking. Much of the dignity of man consists, we think, in his power to choose, to decide, to exert his free will; yet every now and then one is forced to confess that, even in trifling matters, one doesn't have much volition.

"Once to every man and nation," says James Russell Lowell, "comes the moment to decide." One sometimes wonders whether, in the average life, a clear and crucial need to decide presents itself so much as once. We go to some school of other, we enter this line of work or that, we marry and beget, we vote and discuss, we move from one place to another place, we join this organization or that, and for all our striving after what Roy Fuller calls "the appearance of choice," there is always the secret suspicion that we have chosen nothing, but only drifted. There is a whole class of ceremonies which can be seen as allaying that suspicion, sustaining the appearance of choice, and nursing the illusion that each of us makes a purposive and decisive progress through life. All initiations are of that character, involving as they do a commitment to reshape one's life, to change oneself, or the supposition that one has already done so. A regular communicant of the church asks more than fifty times a year that the past be forgiven and resolves henceforward to lead a new life. But we do not change so often; indeed, if we had to show proof, on our birthdays, of having matured as well as aged, we would seldom clearly deserve the cake and candles.

It might be one function of ceremony, then, to punctuate our lives with what look like significant choices and deliberate changes, and to hide from us the extent to which we are aimless and passive. And now let me venture a third and last explanation of the human weakness for the making of occasions. It has to do with the fact that, despite what the salesmen of easy chairs and annuities would have us believe, man is not capable of contentment. We are creatures of infinite hankering, and therefore we are never satisfied, although we may dream of reaching such a condition. I think of a poem of Stephen Spender's, the opening lines of which are these:

> What I expected was
> Thunder, fighting,
> Long struggles with men
> And climbing.
> After continual straining
> I should grow strong;
> Then the rocks would shake
> And I should rest long.

But it doesn't work out that way; the long rest never comes this side of the grave. To be sure, men sometimes do arrive at their objectives; the point is that the achievement never satisfies. A man who solves a crossword puzzle, or fills the last gap in his stamp collection, may feel a fleeting complacency, but then there will be a letdown, and he will ask himself why he has given such time and thought to so slight a thing. Or if the goal achieved does not disappoint us by its triviality, it is likely to appall us by the revelation that we have not understood our own desires. That is what happens in all those fairy stories where the hero is given three wishes, and it happens in life as well. Robert Penn Warren, in his essay on Sam Houston, tells an astonishing thing; he tells how Houston, at the battle of San Jacinto, saw his officers riding up with 400 prisoners; how he knew by that that Santa Anna was utterly beaten, and that he, Sam Houston, would soon realize his ambition to be president of a vast southwestern republic; and how, at that moment of victory, instead of rejoicing, Houston cried out, "Have I a friend in this world?" It is a strange story and an enigmatic cry, but I think that we would all explain it in the same way; we would guess that Houston, in the hour of his triumph, was suddenly free to know how his bitter ambition had estranged him from other men, and how the gaining of his goal would mean a lifetime of lonely eminence.

Some goals, when achieved, disappoint us because they turn out to be trivial; others, because the gain is attended by unforeseen loss. And even when the goal we reach is worthy and wholly to be desired, we are still not content. One evening, some twelve years ago, I fell into a deep depression because it occurred to me that I might very well die without having read Dante in the original. Shortly thereafter, by a stroke of luck, I found myself able to spend a year in Rome, and it was not long before I felt able to go beyond menus and billboards and newspapers and make an attempt on Italian poetry. On the day when I managed to get through a passage of the *Inferno* without consulting the dictionary, I was delighted both with the poem and with myself; and yet, remembering how I had once focused all my despair on the thought that I should never read Dante in his own tongue, I wondered a little at the moderation of my pleasure. Why did

I not feel that I had arrived, once and for all? Why did I not cry *Nunc dimittis*, and die happy? The answer is simple: the self which desires a thing is not the self which at last possesses that thing. As one approaches any goal, it seems more and more reasonable that one should reach it, and desire commences to look beyond. Even as I delighted in my beginner's acquaintance with the *Inferno*, I was revising my despair and saying to myself, "You may very well die without ever having read Dante *properly;* and what's more, you know nothing about grand opera."

We are all like that, as Yeats said over and over in his poems. Some of you may know the little poem called *The Wheel* in which he says it most plainly:

> Through winter-time we call on spring,
> And through the spring on summer call,
> And when abounding hedges ring
> Declare that winter's best of all;
> And after that there's nothing good
> Because the springtime has not come—
> Nor know that what disturbs our blood
> Is but its longing for the tomb.

Yeats does not mean that men long to die, any more than Goethe's Faust, when he reaches for the poison goblet, longs to die. What Yeats and Goethe are talking about is the human craving for more life, for new life, for the compassing of all possibilities—for "life piled on life," as Tennyson's Ulysses said. We are all moved by that craving, even the laziest of us, and we value human discontent because of what it has driven men to accomplish; nevertheless there are times when we weary of the fact that there is no such thing as a finished man, and wish that it were in us to rest and be satisfied. Perhaps it is a function of certain ceremonies to distract us for a moment from our own insatiable restlessness by saying to us: "Relax, you've made it; you've got what you wanted; you're a Nobel Prize chemist; you're a senior lifesaver; you're a Phi Beta Kappa; you're a bachelor of arts."

Which brings us to the present occasion. To hear me talk, as I've been doing for too long, you'd think that a ceremony was nothing but a magical means of allaying individual anxieties. That's part of the truth, I think; but I don't think we are gathered here merely to enable the individual to discharge a timely and proper emotion or to furnish him with a charmed moment in which to feel purposive and realized. Nor have we come here in such numbers and such panoply to congratulate the individual on having made a good beginning of his personal career. For such a private happiness, private congratulations would suffice.

Insofar as this event is more than a sort of gaudy mail call, in which diplomas are delivered to their addressees, we are engaged in something corporate, something collective; for ceremonies are always of that character. Our corporate self is here to say something which, since commencements have persisted for so long, must seem to us true and important. And I think it is this: that learning and developed sensibility are real and excellent things, and vital to the society which it is their obligation to serve.

In order to feel entitled to make that affirmation and promise we need not believe that all members of this graduating class have done famously as scholars and sensibilities. Some, I'm sure, have inwardly or outwardly more than fulfilled the requirements for the bachelor's degree; others, who graduate today by the skin of their teeth, may some day surprise us; still others, perhaps, will forever be scholars by imputation only. It doesn't matter; for the truth is that people and ceremonies are always more or less out of phase. Who knows when a man and a woman are truly married? Some, I think, are married before they ever come to the altar, while some, though pronounced man and wife, arrive at that condition late or never. But this does not invalidate the marriage ceremony. Ceremony becomes invalid only when it bears *no* relation to the facts; then it is dead and will not be tolerated, as Richard the Second learned to his sorrow. A ceremony is valid so long as the idea it celebrates is sometimes and in some measure achieved and embodied. What we celebrate in the marriage ceremony is marriage, and we can do so because Alcestis, St. Joseph, and even some of our friends have managed to be married in fact. What we celebrate here today is the learned mind and the articulate spirit, and we can do so because, at this great university and elsewhere, such things have more than once been brought about.

I feel like a bit of an imposter this morning, because it is conventional nowadays for the commencement speaker to be a public man—a congressman, a general, an ambassador. And there is good reason for that convention. Sometimes these public men give addresses which are strangely wide of the mark: one will make a foreign policy statement; another will take the occasion to run for office; and I have heard a Prime Minister of Canada inform a graduating class about the price of wheat. But whatever such public men may say, their mere presence on the platform is a dramatic reminder that our skills are prized and requisitioned by the community. We need that reminder, because the life of the mind is separate and lonely, and it is all too easy to come to feel that we do what we do merely for its own sake, or for career's sake, or for curiosity's sake, or for the pleasure of exercising a competence.

Belonging as I do to the world of the academy, I cannot polarize this occasion as a public man would do in my place; but the ritual will be accomplished if we all, as members both of the academy and of larger communities, remind ourselves that our gifts and skills are finally not our own. I need not elaborate on that idea because, as you will have noticed, I am now saying what hundreds and thousands of commencement speakers have said. And this should not surprise or dismay us. It is characteristic of ceremonies that they can afford to mean the same thing again and again.

Comment / On Mending Snow-Fences

THE "TWO-CULTURE" GAP existed long before C. P. Snow gave the phenomenon its definitive label, and it is likely not only to continue to exist but to widen as knowledge becomes more and more specialized. There are some who maintain that the social sciences provide a bridge between the two cultures of science and the humanities; others may feel that the rise of the social sciences has merely created a third and equally distinct culture.

While we feel sure that most members of this University are familiar with *both* the Second Law of Thermodynamics and *Hamlet,* there is no question but that the explosion in research is making it extremely difficult for a scholar in one field to keep up with advances in areas outside of his specialty.

A modest attempt to cope with this problem was made this spring by several members of the Department of Physics. A series of four programs was presented in an attempt to bring to non-science students and faculty some idea of the newest discoveries and theories of modern physical science. Provost George Pake opened the discussion with a general survey of the problem and a non-technical (or nearly non-technical) description of the work being done in his special field of magnetic resonance. Dr. Michael Friedlander presented a program on cosmic rays and space science, Dr. Joseph Dreitlein discussed particle theory, and Professor Edward Jaynes covered lasers and masers.

Attendance at all of the lectures was good, although there was a feeling that most of the students present were science majors and that the non-science students for whom the program was designed did not respond to the opportunity with much enthusiasm. Many of the non-science faculty were on hand, however. We spotted Leigh Gerdine, chairman of the Department of Music; Kenneth Hudson, dean of the School of Fine Arts; Leon Gottfried of the Department of English, and many other scholars from the other side of the Snow-fence.

At one lecture, we sat next to Dr. Isidore Silver, the eminent Renaissance literature scholar. Dr. Silver seemed most interested in everything being presented, but he really brightened when the name Galileo was mentioned. *There* was a familiar friend.

In his program, Professor Dreitlein attempted to give the lay audience some idea of the latest work in particle physics and of the directions in which particle theory is moving. He discussed the prediction and discovery of the omega minus particle, the "Eightfold Way" theory, the "bootstrap universe," and other new and exotic concepts. There was a ripple of recognition when Dreitlein employed James Joyce's term "quarks" to describe a new family of particles, but the general reaction, judging from the comment afterward, was that the subject was a little too technical for an untrained audience.

In attempting to present a program of this sort, the specialist gets caught in a dilemma. If he makes the presentation simple enough for a popular audience, he runs the risk of giving a distorted and inaccurate picture; if he gives an accurate and rigorous presentation, it may go over the heads of the audience.

However, the series did represent a commendable effort to offer the rest of the scholarly community a chance to discover some of the exciting things going on in modern physics. Maybe one of these days the people in the humanities will offer a similar program for the physical scientists. After all, both groups have "quarks" and the "Eightfold Way" in common.

A FIRST-RATE JOB in attempting to get the substance of social science research to the educated layman is being done by the University's Community Leadership Project, organized recently under a grant from the Fund for Adult Education. Its most effective activity to date has been a new kind of magazine in the social sciences: *Trans-action: Social Science and the Community.* Covering significant work in the fields of anthropology, sociology, political science, economics, and psychology, this new bimonthly publication is written in clear, simple, non-jargon English. The physical sciences have long had popular, yet responsible publications, of which *The Scientific American* is perhaps the best known. *Trans-action* is a similar and most welcome development in the social sciences.

ONE DAY THIS SPRING we accompanied Botanist Frits Went to the Washington University Research Center at Tyson Valley, where he was doing some of the work described in his article "The Blue Haze of Summer" in this issue. Because he wanted to remove his instruments as far as possible from automobiles and other man-made air pollution sources, Dr. Went had parked his mobile laboratory in the very heart of the 2000-acre Tyson tract.

It was an incredibly quiet and unspoiled spot to exist today just twenty miles from St. Louis. The only sounds were the songs of birds, the drone of insects, and the faint hum of Dr. Went's apparatus. We couldn't help reflecting on how this quiet woods is destined to change when the preliminary studies now going on are concluded and the many major research projects get underway. U. S. Interstate Highway 70, bordering the tract, will seem quiet by comparison. *—FO'B*

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