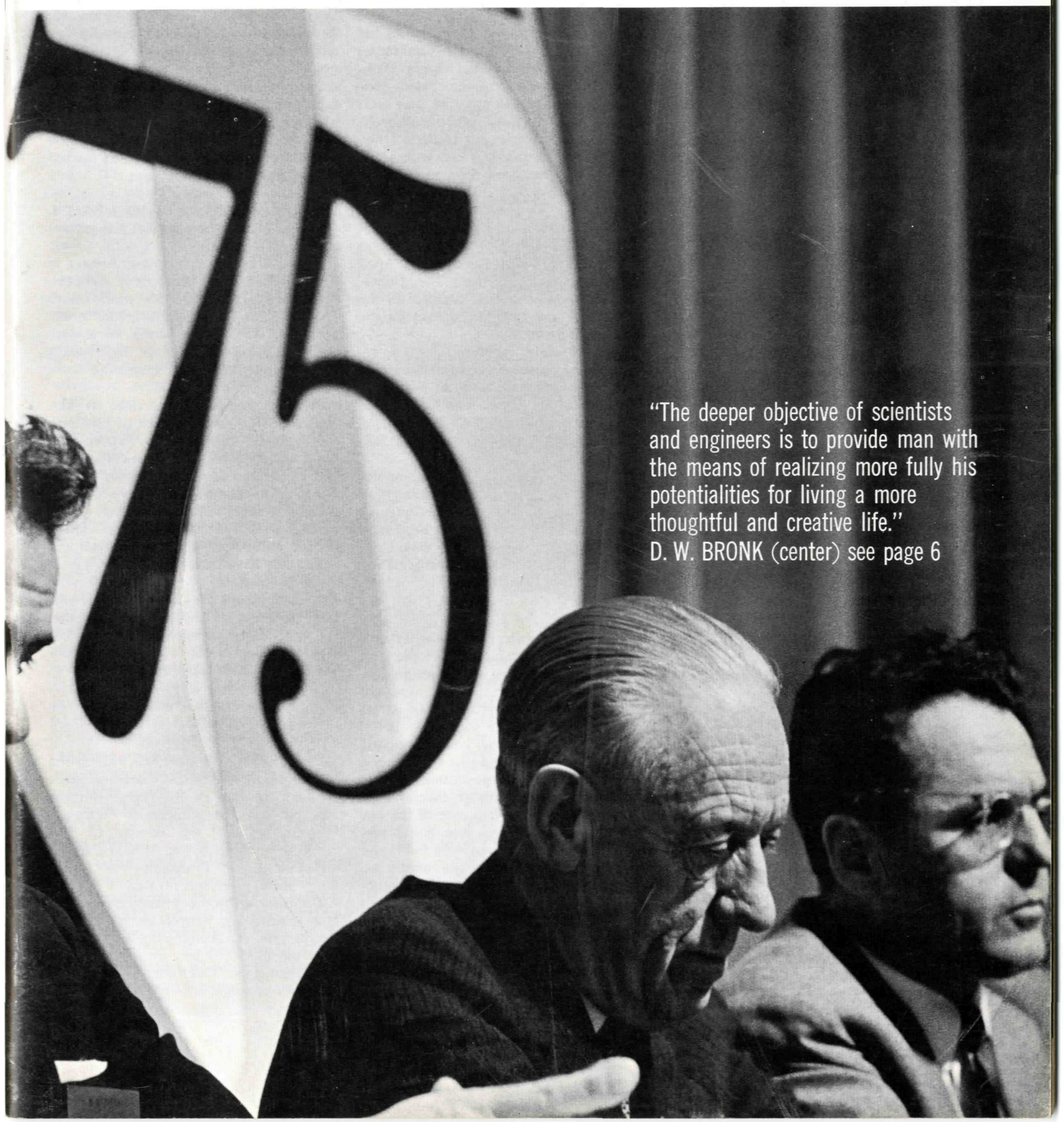
A special supplement on SCIENCE AND MAN complete in this issue

THE GEORGIA TECH ALUMNUS

MARCH 1963



"The deeper objective of scientists and engineers is to provide man with the means of realizing more fully his potentialities for living a more thoughtful and creative life."

D. W. BRONK (center) see page 6

Ramblin'— the editor's notes

▲ IN LIGHT OF THE SUCCESS of the first of a series of symposia (Engineering for Major Scientific Programs) celebrating the 75th Anniversary of Georgia Tech, the administration's announcement that the second scheduled program had been cancelled and the third postponed should come as a surprise to our readers. However, in one way it was the success of that first program that dictated both the cancellation and the postponement.

In a letter of February 8, two days after the first symposium, President Edwin D. Harrison informed the seven speakers already committed to the April 22 and 23 program on "The Consequences of Technological Change" of the cancellation and gave the reasons for the regrettable move:

"Unfortunately, we were unable to secure a complete roster of speakers of the caliber we felt necessary to present a program of significance and importance to the nation. Rather than sacrifice the quality of the program, we feel it advisable to cancel it.

"I wish to express to you my apologies for any inconvenience or disruption in your schedule which this action may cause you, but I know with the many responsibilities you have, you would not wish to sacrifice your time participating in a program which was not of top quality."

* * *

▲ AT THE TIME the letter was written, only ten weeks remained before the program dates. The point of no return had been reached and five speakers were still needed to fill out the program. In an attempt to fill these five vacancies, President Harrison and the committee had contacted by mail and even telephone over 30 top industrial, governmental, and educational leaders with no success.

To add to the problem, one of the key speakers, around whom one entire segment of the program had been built, had been forced by an out-of-the-country assignment to withdraw from the symposium.

To fill the remaining slots with lesser people would have meant watering down the program too much to suit Tech.

The International Symposium on Research Reactors has been rescheduled for October and details on the program will be released by May 1. The reason for this action was that the reactor at Tech is not expected to go critical in time for the original May date and the Institute felt it imperative that this magnificent new research and educational tool be in operation at the time of the visit to the campus of many of the world's leaders in this field.

* * *

▲ THE SYMPOSIUM of February 5 and 6, which produced the copy for the greater portion of this issue, was a solid artistic success. When the proceedings appear in print within the next three months, Georgia Tech should gain much more favorable publicity in the scientific press. Some of the biggest names in science were either on the stage or in the audience at the Electrical Engineering auditorium during those two days.

Also forming part of this issue on "Science and Man" is the speech of February 12 by Chief Justice Earl Warren. The Chief Justice, one of the most controversial men in America, brought the press out in droves and set a new Coliseum record for a Tech lecture when over 3,600 people (mainly students and faculty) turned out to hear him. If the crowd was expecting a controversial speech it was sadly disappointed. For the Chief Justice never mentioned the civil rights decisions or for that matter any decision by name. What he did say, however, was considered by many of the more-knowing observers to be a policy statement or at least as close to a policy statement as a Chief Justice will ever make.

* * *

▲ THE CHIEF JUSTICE'S first visit to the South since the 1954 decision that changed the face of the region brought out the expected number of "Impeach Warren" groups. But outside of two dozen or so signs posted around the city and great deal of threatening and gnashing of teeth, there was no sign of trouble.

Contrary to some press reports, the guards watching Warren on his visit to the campus numbered considerably less than the total assigned to a Tech home basketball game. The students—who have their own personal opinions of the man—treated the Chief Justice with the respect due the office. And that is the way it should be in this country.

* * *

▲ THE FINAL ARTICLE in this special issue was written by the Rev. Harwood (Woody) Bartlett, an honor graduate in Mathematics in 1956, who has since graduated from Virginia Theological Seminary. Bartlett, a top student leader in his days at Tech, is now college chaplain and an assistant on the clergy staff at All Saints (Episcopal) Church near the campus.

So this issue contains words on science by one of the most-respected scientists in America, by the Chief Justice of the United States, by a minister, and by a group of interested scientists and engineers. Whether or not you agree with any or all of the thoughts in this issue, we hope that you will find it interesting and challenging reading.

* * *

▲ THIS YEAR'S 11-man basketball squad was just as strong in the classroom as it was on the court. Led by Math major Jim Caldwell—the 6'9" sophomore center who was also the team's leading scorer and rebounder—the 1962-63 squad sported a scholastic average of 2.64 for the fall quarter and one of 2.47 for an overall average.

Caldwall—the SEC sophomore of the year—had a 3.8 fall quarter and a 3.2 overall average. He and senior center Alan Nass (3.4 fall quarter and 3.0 overall as an IE), sophomore guard-forward Ron Scharf (2.7 fall quarter and 3.0 overall as an IE), and junior reserve Bill Nigg (3.0 fall quarter and 2.8 overall as an IM) have all been frequent occupants of the Dean's List at Tech.

The team tied the Tech record set by the 1960 team for the most regular season wins (21) and certainly broke all existing records for the most heart-stopping ball games. During the season, Tech played six overtime games and won five of them, one in double overtime. It won four games by one point and lost one by the same margin. In ten games the point spread between Tech and its opponent was three points or less.

Coach John Whack Hyder was named SEC "Coach of the Year" by the United Press International in recognition of the outstanding job he did with a squad that included only four seniors. Despite the fact that the team finished in a second-place tie with Auburn in the conference race, Hyder received sixth place in the competition for "National Coach of the Year" for his work with this squad. It was a well-deserved honor. B.W.

Ramblin'—the editor's notes

▲ IN LIGHT OF THE SUCCESS of the first of a series of symposia (Engineering for Major Scientific Programs) celebrating the 75th Anniversary of Georgia Tech, the administration's announcement that the second scheduled program had been cancelled and the third postponed should come as a surprise to our readers. However, in one way it was the success of that first program that dictated both the cancellation and the postponement.

In a letter of February 8, two days after the first symposium, President Edwin D. Harrison informed the seven speakers already committed to the April 22 and 23 program on "The Consequences of Technological Change" of the cancellation and gave the reasons for the regrettable move:

"Unfortunately, we were unable to secure a complete roster of speakers of the caliber we felt necessary to present a program of significance and importance to the nation. Rather than sacrifice the quality of the program, we feel it advisable to cancel it.

"I wish to express to you my apologies for any inconvenience or disruption in your schedule which this action may cause you, but I know with the many responsibilities you have, you would not wish to sacrifice your time participating in a program which was not of top quality."

* * *

▲ AT THE TIME the letter was written, only ten weeks remained before the program dates. The point of no return had been reached and five speakers were still needed to fill out the program. In an attempt to fill these five vacancies, President Harrison and the committee had contacted by mail and even telephone over 30 top industrial, governmental, and educational leaders with no success.

To add to the problem, one of the key speakers, around whom one entire segment of the program had been built, had been forced by an out-of-the-country assignment to withdraw from the symposium.

To fill the remaining slots with lesser people would have meant watering down the program too much to suit Tech.

The International Symposium on Research Reactors has been rescheduled for October and details on the program will be released by May 1. The reason for this action was that the reactor at Tech is not expected to go critical in time for the original May date and the Institute felt it imperative that this magnificent new research and educational tool be in operation at the time of the visit to the campus of many of the world's leaders in this field.

* * *

▲ THE SYMPOSIUM of February 5 and 6, which produced the copy for the greater portion of this issue, was a solid artistic success. When the proceedings appear in print within the next three months, Georgia Tech should gain much more favorable publicity in the scientific press. Some of the biggest names in science were either on the stage or in the audience at the Electrical Engineering auditorium during those two days.

Also forming part of this issue on "Science and Man" is the speech of February 12 by Chief Justice Earl Warren. The Chief Justice, one of the most controversial men in America, brought the press out in droves and set a new Coliseum record for a Tech lecture when over 3,600 people (mainly students and faculty) turned out to hear him. If the crowd was expecting a controversial speech it was sadly disappointed. For the Chief Justice never mentioned the civil rights decisions or for that matter any decision by name. What he *did* say, however, was considered by many of the more-knowing observers to be a policy statement or at least as close to a policy statement as a Chief Justice will ever make.

* * *

▲ THE CHIEF JUSTICE'S first visit to the South since the 1954 decision that changed the face of the region brought out the expected number of "Impeach Warren" groups. But outside of two dozen or so signs posted around the city and great deal of threatening and gnashing of teeth, there was no sign of trouble.

Contrary to some press reports, the guards watching Warren on his visit to the campus numbered considerably less than the total assigned to a Tech home basketball game. The students—who have their own personal opinions of the man—treated the Chief Justice with the respect due the office. And that is the way it should be in this country.

* * *

▲ THE FINAL ARTICLE in this special issue was written by the Rev. Harwood (Woody) Bartlett, an honor graduate in Mathematics in 1956, who has since graduated from Virginia Theological Seminary. Bartlett, a top student leader in his days at Tech, is now college chaplain and an assistant on the clergy staff at All Saints (Episcopal) Church near the campus.

So this issue contains words on science by one of the most-respected scientists in America, by the Chief Justice of the United States, by a minister, and by a group of interested scientists and engineers. Whether or not you agree with any or all of the thoughts in this issue, we hope that you will find it interesting and challenging reading.

* * *

▲ THIS YEAR'S 11-man basketball squad was just as strong in the classroom as it was on the court. Led by Math major Jim Caldwell—the 6'9" sophomore center who was also the team's leading scorer and rebounder—the 1962-63 squad sported a scholastic average of 2.64 for the fall quarter and one of 2.47 for an overall average.

Caldwall—the SEC sophomore of the year—had a 3.8 fall quarter and a 3.2 overall average. He and senior center Alan Nass (3.4 fall quarter and 3.0 overall as an IE), sophomore guard-forward Ron Scharf (2.7 fall quarter and 3.0 overall as an IE), and junior reserve Bill Nigg (3.0 fall quarter and 2.8 overall as an IM) have all been frequent occupants of the Dean's List at Tech.

The team tied the Tech record set by the 1960 team for the most regular season wins (21) and certainly broke all existing records for the most heart-stopping ball games. During the season, Tech played six overtime games and won five of them, one in double overtime. It won four games by one point and lost one by the same margin. In ten games the point spread between Tech and its opponent was three points or less.

Coach John Whack Hyder was named SEC "Coach of the Year" by the United Press International in recognition of the outstanding job he did with a squad that included only four seniors. Despite the fact that the team finished in a second-place tie with Auburn in the conference race, Hyder received sixth place in the competition for "National Coach of the Year" for his work with this squad. It was a well-deserved honor.

B.W.

THE MARCH 1963
GEORGIA TECH
ALUMNUS
Volume 41 Number 6

CONTENTS

THE COVER

The man caught deep in thought by photographer Bill Diehl for this issue is one of the world's most distinguished scientists, D. W. Bronk, president of the Rockefeller Institute and immediate past president of the National Academy of Sciences. He and his colleagues brought Tech one of its finest hours in February as you can read by turning to page 11.

Cover Photo-Bill Diehl, Jr.

Published eight times a year—February, March, May, July, September, October, November and December*—by the Georgia Tech National Alumni Association, Georgia Institute of Technology; 225 North Avenue, Atlanta, Georgia. Subscription price (35c per copy) included in the membership dues. Second class postage paid at Atlanta, Georgia.

THE FACE OF GEORGIA TECH XI.

SELDOM IF EVER in the history of Georgia Tech has there been as many scientists and engineers of international reputation on the campus at one time as there were on February 5 and 6. The attraction for this distinguished gathering was a special symposium on "Engineering for Major Scientific Programs," designed by a faculty committee headed by Dr. Maurice Long of the Engineering Experiment Station. The over 250 delegates at the s
spected scientists such a
Rockefeller Institute ar
National Academy of Sc
of no-holds-barred pan
below. Part of this prog
the special supplement

Photographed fo

THE MARCH 1963
GEORGIA TECH
ALUMNUS
Volume 41 Number 6

CONTENTS

THE COVER

The man caught deep in thought by photographer Bill Diehl for this issue is one of the world's most distinguished scientists, D. W. Bronk, president of the Rockefeller Institute and immediate past president of the National Academy of Sciences. He and his colleagues brought Tech one of its finest hours in February as you can read by turning to page 11.

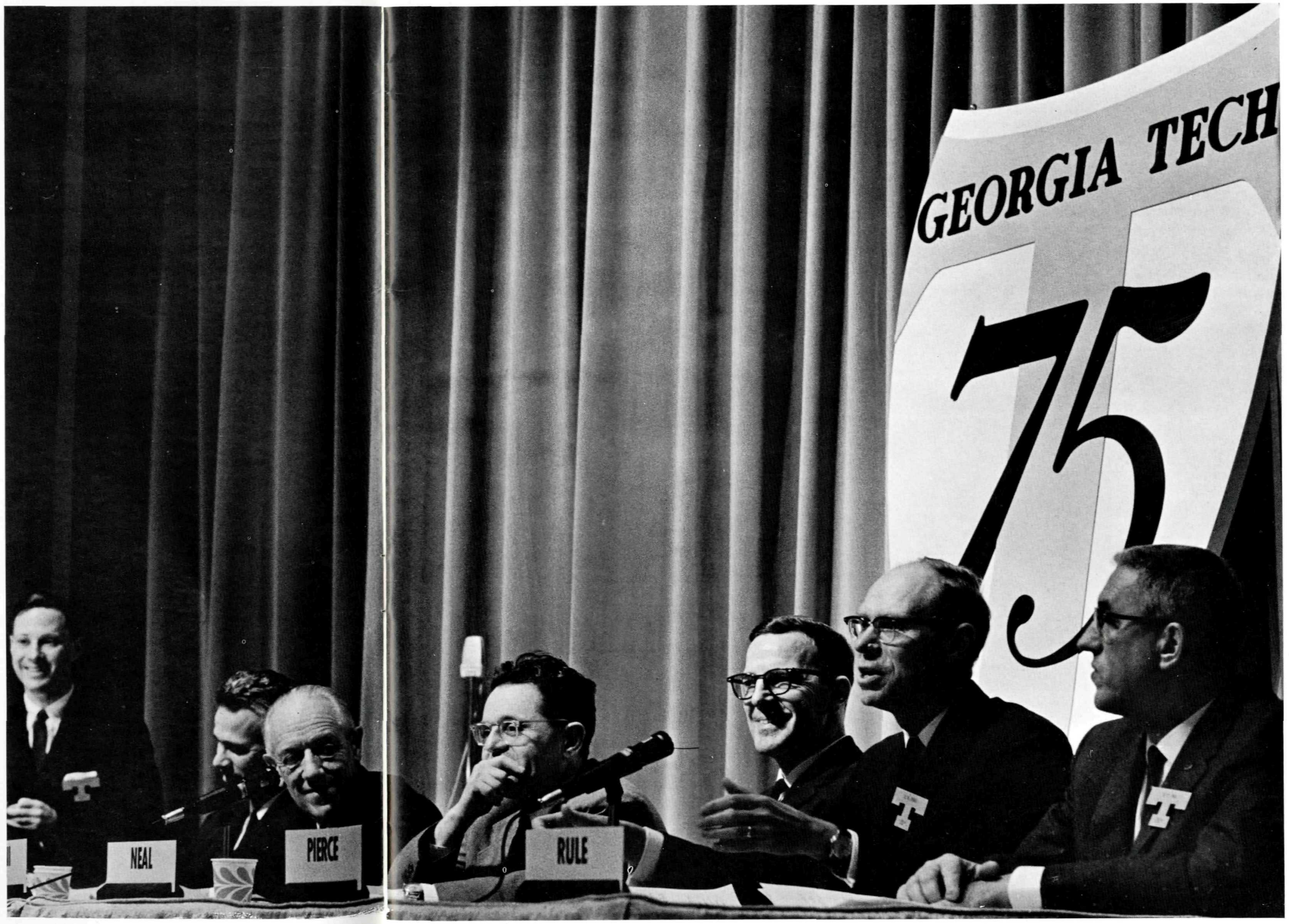
Cover Photo-Bill Diehl, Jr.

Published eight times a year—February, March, May, July, September, October, November and December*—by the Georgia Tech National Alumni Association, Georgia Institute of Technology; 225 North Avenue, Atlanta, Georgia. Subscription price (35c per copy) included in the membership dues. Second class postage paid at Atlanta, Georgia.

THE FACE OF GEORGIA TECH XI.

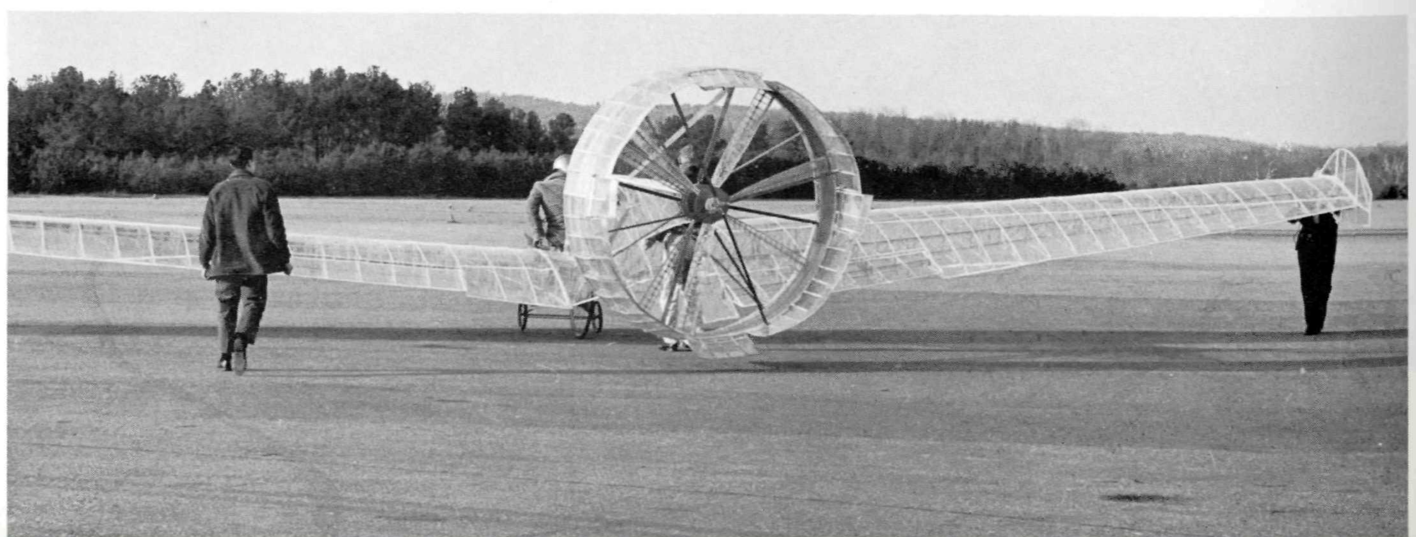
SELDOM IF EVER in the history of Georgia Tech has there been as many scientists and engineers of international reputation on the campus at one time as there were on February 5 and 6. The attraction for this distinguished gathering was a special symposium on "Engineering for Major Scientific Programs," designed by a faculty committee headed by Dr. Maurice Long of the Engineering Experiment Station. The over 250 delegates at the symposium heard speeches from respected scientists such as Dr. D. W. Bronk, president of the Rockefeller Institute and immediate past president of the National Academy of Sciences. And they also heard a couple of no-holds-barred panel sessions such as the one pictured below. Part of this program makes up the largest portion of the special supplement on "Science and Man" in this issue.

Photographed for the Alumnus by Bill Diehl, Jr.



Pilot Robert Richie (above) gets his gear ready for the final try at the first flight of the MPA-1. And, with the aid of his cohorts (below) Richie starts down the runway to run into grief as a wing collapses.

Photographs by Bob Dendy, The Atlanta Journal - Constitution



Staff writer Frank Bigger relates the inv
tribulations of an aircraft unique in the a

THE UNFINISHED FLIG

TO THE OUTSIDER, it seemed to be defeat. MPA-1 settled on the runway like a wounded, outsized dragon fly, her right wing crippled by a structural weakness. Her ground crew, pilot and builder, hovered around momentarily with faces set, examining the torn covering and broken spar cap. A handful of spectators, some declaring that the strange craft actually had become airborne, before the disaster, shook their heads and turned away.

It was a moment of heartbreak and frustration, as cold as the air of that late February afternoon when MPA-1, in a 50-yard runway dash, had attempted to break the bonds of earth. It was not, however, defeat.

Gently the crew lifted MPA-1 and carried her back to the protection of a Fulton County Airport hangar. Their touch was light, but their words were laced with invective, hurled at the months of planning, the struggle to secure money and supplies, the late hours spent assembling the craft, the efforts to obtain hangar space and a runway for tests, the endless details of transportation for MPA-1 to an airstrip, the countless weather delays, and the interminable questions from reporters and photographers for an inquisitive world audience.

When the heat of their disappointment passed, and it passed quickly, they began to tell each other that this was, after all, just another delay. MPA-1 could easily be repaired and strengthened and another flight attempt could be made, perhaps in June, when the air was less turbulent.

Soon a Lockheed van arrived and carried MPA-1 back to the model shop at Tech's School of Aerospace Engineering where she was born. This was the third time the truck had carried this cargo; first to Dobbins Air Force Base where weather delayed flight trials until MPA-1's hangar space was taken away for an Air National Guard training session, then to Fulton County Airport, and now back to Tech. The plane's builder "willed" the craft to his pilot and two other students and departed for his long-delayed job with Sikorsky Aircraft in Connecticut. So ended first phase of "Operation MPA-1."

The MPA-1 (muscle-powered aircraft) was conceived, designed and built by James M. McAvoy, 26, Washington, Ga., who expects to receive the master's degree in Aerospace Engineering in June, 1963. McAvoy has completed

all course
on MPA-
served as

McAvo
learning
firm is o
craft that
course. M
his idea w
of Aeros
in the sp
namic pr

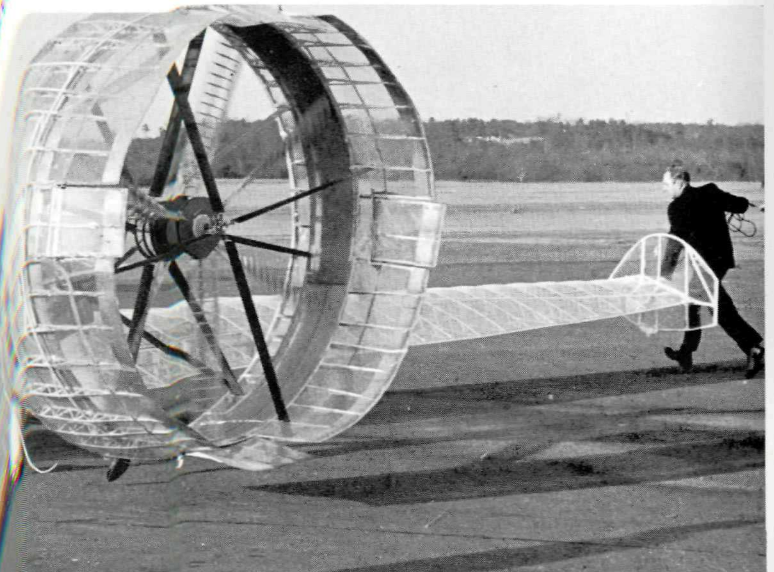
MPA-
a speed
an hour
possibly
MPA-1 h
picked b
C., a sop
158 pour
to 283 p
mometer,
duced on
possibly

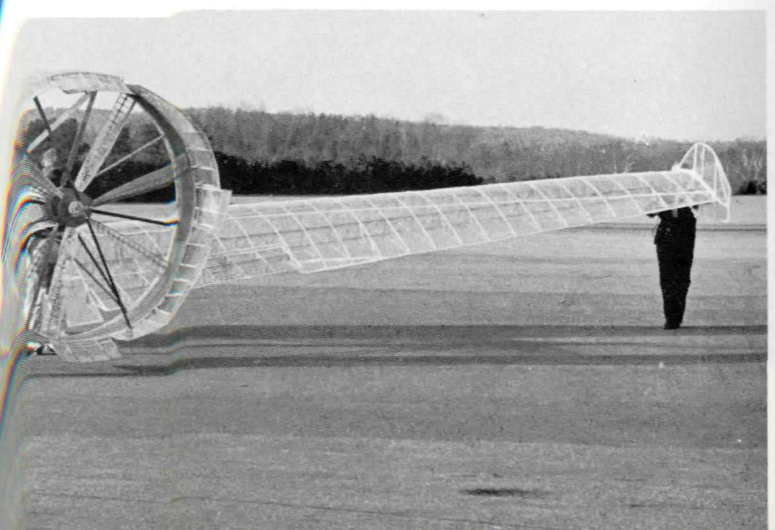
Resear
tually no
McAvoy
craft whi
Italian A
by a car.
ber of su
McAvoy.
also of i
not-too-s

Assisti
were Dav
their mas
ber, 1962
J. Bert W

MPA-

s by Bob Dendy, The Atlanta Journal-Constitution





Staff writer Frank Bigger relates the involved tale of the trials and tribulations of an aircraft unique in the annals of American aviation

THE UNFINISHED FLIGHT OF THE MPA-1

TO THE OUTSIDER, it seemed to be defeat. MPA-1 settled on the runway like a wounded, outsized dragon fly, her right wing crippled by a structural weakness. Her ground crew, pilot and builder, hovered around momentarily with faces set, examining the torn covering and broken spar cap. A handful of spectators, some declaring that the strange craft actually had become airborne, before the disaster, shook their heads and turned away.

It was a moment of heartbreak and frustration, as cold as the air of that late February afternoon when MPA-1, in a 50-yard runway dash, had attempted to break the bonds of earth. It was not, however, defeat.

Gently the crew lifted MPA-1 and carried her back to the protection of a Fulton County Airport hangar. Their touch was light, but their words were laced with invective, hurled at the months of planning, the struggle to secure money and supplies, the late hours spent assembling the craft, the efforts to obtain hangar space and a runway for tests, the endless details of transportation for MPA-1 to an airstrip, the countless weather delays, and the interminable questions from reporters and photographers for an inquisitive world audience.

When the heat of their disappointment passed, and it passed quickly, they began to tell each other that this was, after all, just another delay. MPA-1 could easily be repaired and strengthened and another flight attempt could be made, perhaps in June, when the air was less turbulent.

Soon a Lockheed van arrived and carried MPA-1 back to the model shop at Tech's School of Aerospace Engineering where she was born. This was the third time the truck had carried this cargo; first to Dobbins Air Force Base where weather delayed flight trials until MPA-1's hangar space was taken away for an Air National Guard training session, then to Fulton County Airport, and now back to Tech. The plane's builder "willed" the craft to his pilot and two other students and departed for his long-delayed job with Sikorsky Aircraft in Connecticut. So ended first phase of "Operation MPA-1."

The MPA-1 (muscle-powered aircraft) was conceived, designed and built by James M. McAvoy, 26, Washington, Ga., who expects to receive the master's degree in Aerospace Engineering in June, 1963. McAvoy has completed all course work for the master's and has submitted his thesis on MPA-1. Prof. John J. Harper of Aerospace Engineering served as his thesis advisor.

McAvoy decided to try his hand at the project after learning of a "human flight" contest in England. A British firm is offering a $15,000 prize for the first man-powered craft that manages to fly a figure 8 pattern over a one-mile course. McAvoy did not plan to enter the contest, however, his idea was accepted for a master's thesis by Tech's School of Aerospace Engineering. He began work on the project in the spring of 1962, encountering many of the aerodynamic problems associated with a motor-driven craft.

MPA-1, weighing 125 pounds, is designed to take off at a speed of 17 miles an hour. Maximum speed is 20 miles an hour with maximum altitude set at 10 feet. It could possibly remain airborne for slightly over three minutes. MPA-1 has 287 square feet of total area. The pilot, hand-picked by McAvoy, is Robert W. Ritchie, 19, Hickory, N. C., a sophomore in Aerospace Engineering. Ritchie weighs 158 pounds, bringing the overall weight of craft and pilot to 283 pounds. Ritchie trained for flight trials on a dynamometer, a device for measuring force or power, and produced one-half a horsepower for six minutes. He could possibly exceed these figures in actual taxiing and flight.

Research for the project was especially difficult since virtually no data has been written for such low speed planes. McAvoy found one detailed account of a human-powered craft which was built and flown in 1937 by Enea Bossi, an Italian Aeronautical Engineer. This craft was towed aloft by a car. Bossi pedaled his "Aero-Cycle" through a number of successful flights and his calculations were helpful to McAvoy. The flights of another pedal craft, "Puffin," were also of interest to McAvoy. "Puffin" was put through its not-too-successful flights in England last May.

Assisting McAvoy with the research and the construction were David A. Shelton and John A. Ellis. Both received their master's degrees in Aerospace Engineering in December, 1962. Aerospace graduate students Asa K. Fulton and J. Bert Webb began working with McAvoy early in 1963.

MPA-1's wings have a span of 54 feet and a total weight

(Continued on page 10)

Richie inspects the damage to the wing at the end of the unfortunate flight of the MPA-1. Richie and other Tech undergraduates are now rebuilding for another try.

The Unfinished Flight—continued

of 50 pounds. They are gently rounded on the top surface with the bottom surface being nearly flat. These wings are fairly rigid and should be deflected upward only slightly when the craft becomes airborne. They are mounted near the under surface of the fuselage. McAvoy calculated these low-slung wings will give greater lifting power since more air will be crowded beneath them as the craft moves forward, and this condition should be effective even after the plane achieves maximum altitude. Measuring seven feet, six inches where they are attached to the fuselage, the wings taper gradually to a width of three feet at the tips where vertical plates are mounted to prevent air spillage. The internal structure is of balsa wood and aluminum and the covering is mylar, a thin, but relatively strong plastic material. Small wheels in wing plates give the craft stability on the ground. Wing loading is one pound per square foot. The fuselage, measuring 16 ft., is made of aluminum and covered with mylar.

Counter rotating propellers, seven feet in diameter, are mounted on the rear of the fuselage and enclosed in a shroud also of balsa-aluminum-mylar construction, which has a diameter of seven and a half feet. Two elevators are located at the top and bottom of the shroud to control pitch. The rudders are placed on the sides of the shroud and will be used in conjunction with differential flaps on the wings to control left and right banks. The differential flaps replace ailerons found on the wings of conventional planes. They can be lowered to give the craft more lift on takeoff.

Control surfaces are operated by means of a pivot stick in the open cockpit and by a handle device, much like that on a brief case, which is held in the pilot's left hand.

The craft's undercarriage is like a backward tricycle with the two small wheels mounted approximately two and a half feet forward of the larger center wheel. The small wheels are 30 inches apart.

The drive mechanism begins much like that of an ordinary bicycle. A bevel gear is secured to the side of the sprocket and transmits power to a torque tube which runs upward about three feet. At the end of this torque tube is a gear box which facilitates counter rotation of the propellers through another torque tube which passes through the fuselage for a distance of 11 feet to the shroud. The propellers turn at 240 rpm.

MPA-1 contains approximately $300 worth of materials. This represents a cash outlay of $175 with other materials being donated or already on hand in the School of Aerospace Engineering. The craft was built in the Aerospace Model Shop where George Cook, Model Shop head, and Dewey Ransom, model builder, helped with the construction.

McAvoy is a slow-talking, angular young man. So perfectly do his mannerisms and speech fit the Hollywood-built concept of a Georgia boy, farm-bred and farm-reared, that one almost decides he is really acting. That impression is quickly shattered when the conversation turns to aerodynamics. McAvoy knows the subject inside and out. His mental agility in dealing with news reporters is not often found among the inexperienced. For instance:

Reporter: "Mr. McAvoy, do you really think this plane will fly?"

McAvoy: "Well, if I didn't think so, I wouldn't have spent so many months working on it."

Reporter: "Jim, I imagine as a boy you built many model planes?"

McAvoy: "No, this is my first plane. I like to start big."

Applying the words of one of America's leading scientists, our universities need more students like Jim McAvoy in science and engineering; students whose minds can conceive a project, whose hands can build the necessary instruments, and whose hearts give them the desire to see the work through to the end unmindful of frustrations and sacrifice.

McAvoy's legacy to Ritchie, David Fern, and Royce Hall is far greater than the mere physical MPA-1. It is courage and determination. What happened on that wind-swept runway at Fulton County Airport last February was only a beginning for them.

The interest engendered throughout the world, from gigantic press agencies and from little old ladies as well, in the as yet unfinished story of MPA-1 brings to light a quality of human nature that appears often to fade in an age that seems to seek only after comfort and security. That fact is this. The spirit of adventure still lives in man.

Richie inspects the damage to the wing at the end of the unfortunate flight of the MPA-1. Richie and other Tech undergraduates are now rebuilding for another try.

The Unfinished Flight—continued

of 50 pounds. They are gently rounded on the top surface with the bottom surface being nearly flat. These wings are fairly rigid and should be deflected upward only slightly when the craft becomes airborne. They are mounted near the under surface of the fuselage. McAvoy calculated these low-slung wings will give greater lifting power since more air will be crowded beneath them as the craft moves forward, and this condition should be effective even after the plane achieves maximum altitude. Measuring seven feet, six inches where they are attached to the fuselage, the wings taper gradually to a width of three feet at the tips where vertical plates are mounted to prevent air spillage. The internal structure is of balsa wood and aluminum and the covering is mylar, a thin, but relatively strong plastic material. Small wheels in wing plates give the craft stability on the ground. Wing loading is one pound per square foot. The fuselage, measuring 16 ft., is made of aluminum and covered with mylar.

Counter rotating propellers, seven feet in diameter, are mounted on the rear of the fuselage and enclosed in a shroud also of balsa-aluminum-mylar construction, which has a diameter of seven and a half feet. Two elevators are located at the top and bottom of the shroud to control pitch. The rudders are placed on the sides of the shroud and will be used in conjunction with differential flaps on the wings to control left and right banks. The differential flaps replace ailerons found on the wings of conventional planes. They can be lowered to give the craft more lift on takeoff.

Control surfaces are operated by means of a pivot stick in the open cockpit and by a handle device, much like that on a brief case, which is held in the pilot's left hand.

The craft's undercarriage is like a backward tricycle with the two small wheels mounted approximately two and a half feet forward of the larger center wheel. The small wheels are 30 inches apart.

The drive mechanism begins much like that of an ordinary bicycle. A bevel gear is secured to the side of the sprocket and transmits power to a torque tube which runs upward about three feet. At the end of this torque tube is a gear box which facilitates counter rotation of the propellers through another torque tube which passes through the fuselage for a distance of 11 feet to the shroud. The propellers turn at 240 rpm.

MPA-1 contains approximately $300 worth of materials. This represents a cash outlay of $175 with other materials being donated or already on hand in the School of Aerospace Engineering. The craft was built in the Aerospace Model Shop where George Cook, Model Shop head, and Dewey Ransom, model builder, helped with the construction.

McAvoy is a slow-talking, angular young man. So perfectly do his mannerisms and speech fit the Hollywood-built concept of a Georgia boy, farm-bred and farm-reared, that one almost decides he is really acting. That impression is quickly shattered when the conversation turns to aerodynamics. McAvoy knows the subject inside and out. His mental agility in dealing with news reporters is not often found among the inexperienced. For instance:

Reporter: "Mr. McAvoy, do you really think this plane will fly?"

McAvoy: "Well, if I didn't think so, I wouldn't have spent so many months working on it."

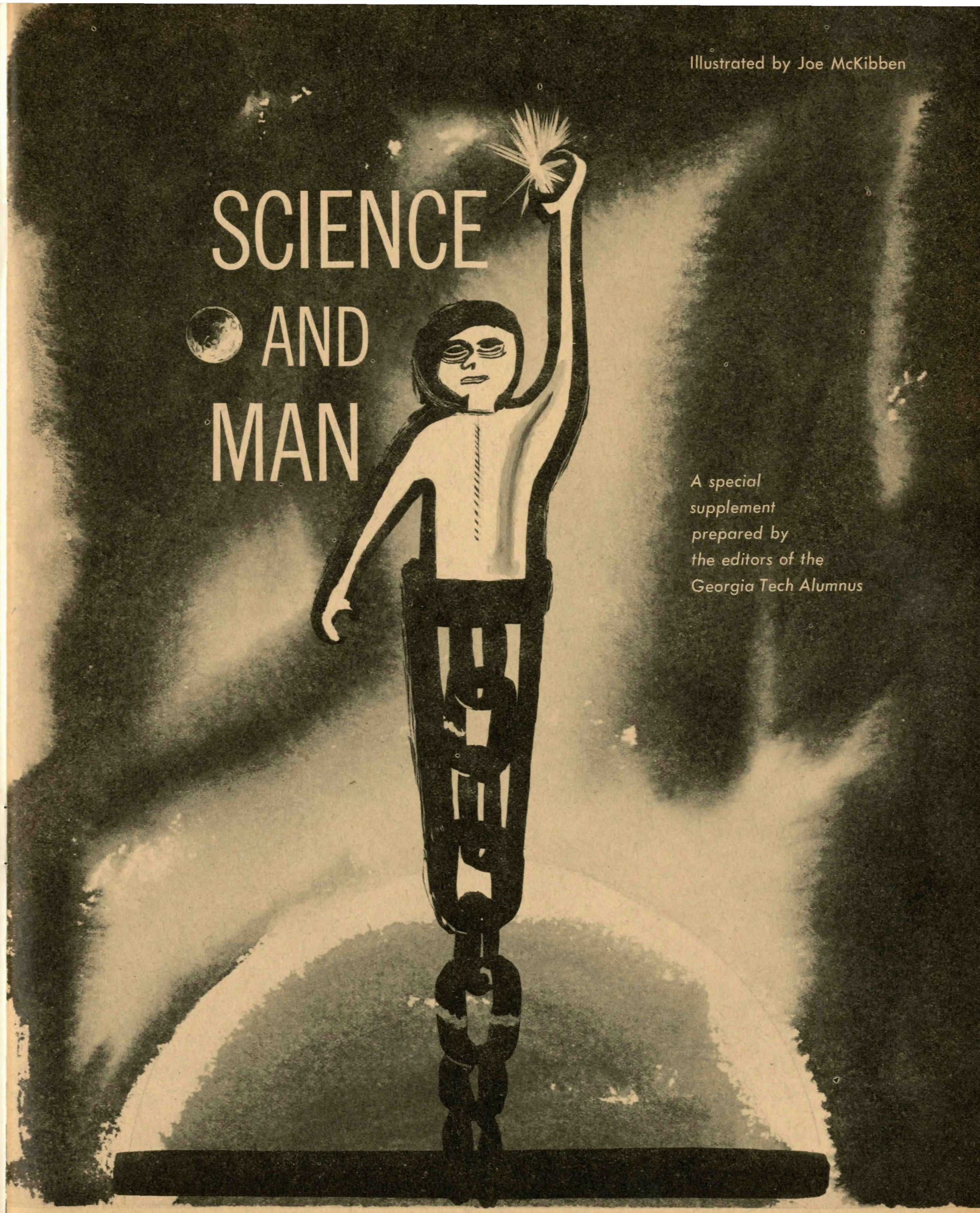
Reporter: "Jim, I imagine as a boy you built many model planes?"

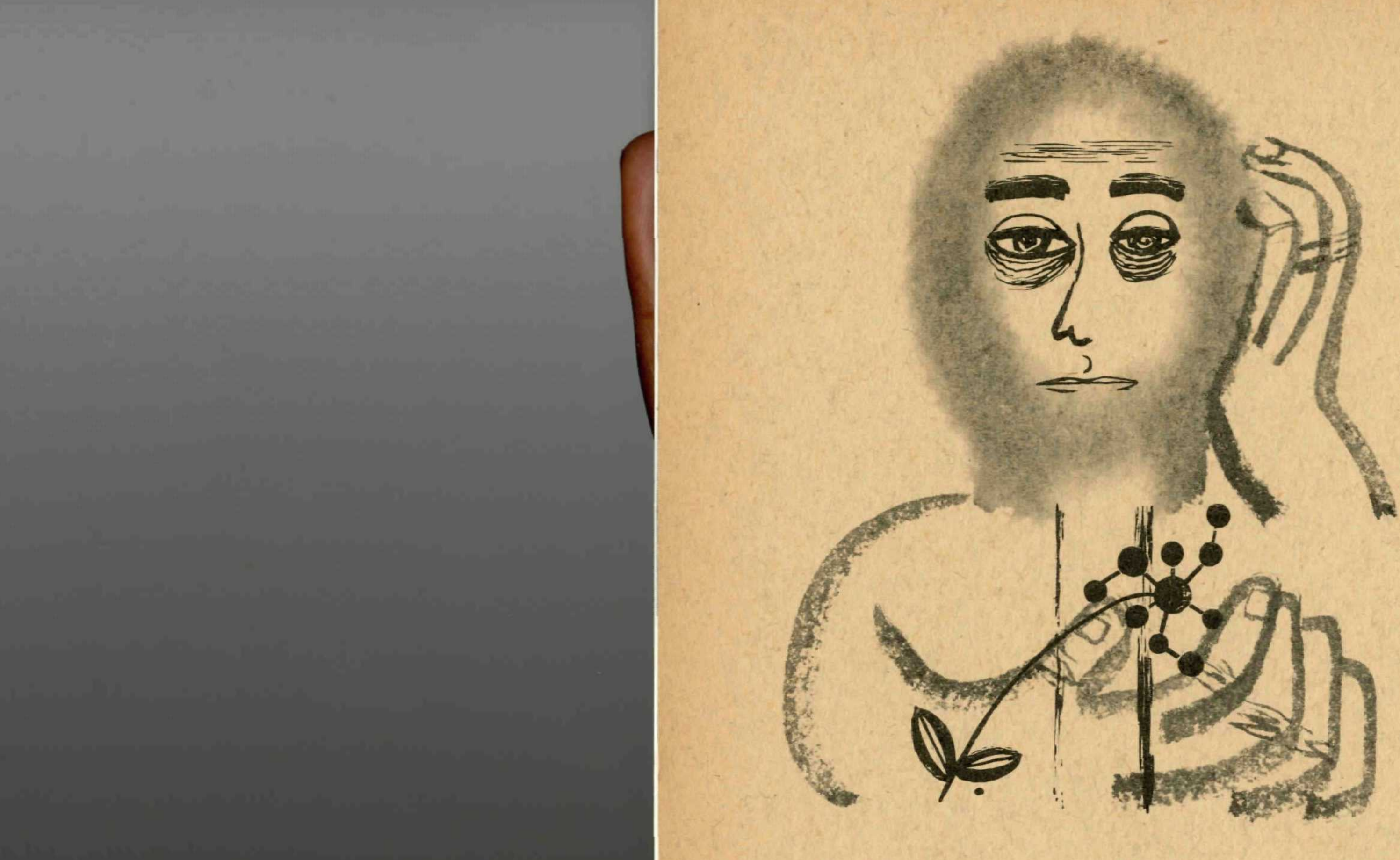
McAvoy: "No, this is my first plane. I like to start big."

Applying the words of one of America's leading scientists, our universities need more students like Jim McAvoy in science and engineering; students whose minds can conceive a project, whose hands can build the necessary instruments, and whose hearts give them the desire to see the work through to the end unmindful of frustrations and sacrifice.

McAvoy's legacy to Ritchie, David Fern, and Royce Hall is far greater than the mere physical MPA-1. It is courage and determination. What happened on that wind-swept runway at Fulton County Airport last February was only a beginning for them.

The interest engendered throughout the world, from gigantic press agencies and from little old ladies as well, in the as yet unfinished story of MPA-1 brings to light a quality of human nature that appears often to fade in an age that seems to seek only after comfort and security. That fact is this. The spirit of adventure still lives in man.





THE MATERIAL USES AND SPIRITUAL VALUES OF SCIENCE

D. W. Bronk, president of Rockefeller Institute and one of America's most distinguished scientists, presents his views on the values of science to man during the 75th anniversary symposium on "Engineering for Major Scientific Programs."

THE THEME of this symposium is a timely topic because searching questions are being asked in universities, industry and government regarding the relations between science and engineering. The questions should ultimately probe the purpose of individuals and society, the conditions necessary for personal and public happiness, the nature of human welfare, how to operate our materialistic civilization. Those are restless, uncomfortable questions that are usually left unasked. But they are relevant to questions we should ask ourselves during this symposium: Why is modern scientific research being undertaken and financed on so large a scale, what is the purpose of the research, how should it be conducted?

Our subject implies that there is a distinction between engineers and scientists. It is a distinction I find unclear, but perhaps that is because I was trained to be an engineer and have spent much of my life in scientific research. And so I have shunned the current controversies as to who is who and which is what. Nevertheless, I realize that mankind likes the mental security of classifications, society craves the hierarchies of ancient guilds which are now unions and professional societies, university faculties and administrations spawn schools and departments. And so, for our present purpose, I will reluctantly suggest that a scientist is one who seeks to discover the laws of nature; an engineer is one who applies scientific knowledge for useful, usable ends. If you tell me that my comparative definitions are inadequately definitive, I will agree and then refer you to those who debate the relative status and roles of scientists and engineers and the comparative nature and advantage of engineering and scientific education. By my definition, many engineers are scientists, and many scientists act from time to time as engineers.

There is a duality in the relations of engineering to scientific research. Those who support research expect materially useful results; to make the results of research useful is usually the function of engineers and physicians. To an increasing degree, engineers are required to design and operate the facilities used in modern research.

Among the changing conditions that affect the conduct of research and make desirable a partnership of engineers and research scientists, I would mention three.

The rapid increase of scientific knowledge and the difficult skills needed in many areas of research force specialization. Consequently, much research can be carried on successfully only by groups of investigators and supporting technicians under the direction of competent administrators. The supervision and coordination of such research teams is a more natural and traditional function of the engineer than of the individualistic scientist.

As the frontiers of space are pushed back and more of scientific research is concerned with the very small, the very large, and with larger numbers of living units, more complicated research facilities are required. I am thinking of linear accelerators, radio telescopes, oceanographic research vessels, devices for drilling the Mohole in the bottom of the sea, electron microscopes and electronic computers, to mention but a few of my examples. The design, construction and operation of these research facilities require the services of competent engineers.

The two characteristics of modern scientific research of which I have just spoken are due in part to a third new condition: the great increase in financial support of research that is provided by industry, private foundations and especially by the Federal government. I need not burden you with data to remind you that the funds available for the salaries of research scientists and the expenses of their research is today many-fold more than was available fifteen years ago. This is a consequence of the more widespread realization that knowledge of possible value for the furtherance of human welfare, for the vitality of industry and the international security of our nation can be derived from scientific research. The more abundant funds that are being provided make possible research on a larger scale than ever before.

Only during World War II was research done by such large, organized groups of scientists and engineers. Accordingly, we have little experience to guide the conduct of some of our major undertakings.

It is natural to think of universities as the appropriate sponsors of large as well as small research projects because universities comprise free scientists, and universities are the traditional homes of research. They have, indeed, been eminently successful in the conduct of some of our largest research programs, and the scientific faculties of universities have, in turn, been strengthened. But universities have also been harmed by some of their large scientific undertakings. University administrations have often been required to spend more time on the supervision of enormous research budgets than on more appropriate educational matters. Faculties, too, have been encouraged to spend so much time and effort on the conduct of large-scale research that they give little attention to the education of students. Even the graduate research student loses certain precious elements of his preparation for a career as a creative scholar if he is required to work as one directed cog in a large organization.

In order to protect universities against prostitution of their proper functions, and in order to secure certain qualities not readily provided by universities, various types of research organizations have been developed and still others have been proposed. Among the former are contractural relations with industrial corporations and their subsidiaries, non-profit institutions such as Rand and the Institute for Defense Analysis, and especially national laboratories such as Brookhaven, the Greenbank Radiotelescope, the Kitt Peak Optical Telescope, and the University Center for Atmospheric Research at Boulder. The National Laboratories have the unique advantages of being a continuing fiscal responsibility of the Federal government, under the scientific control or advice of able scientists chosen from universities as well as government, and of being available

THE MATERIAL USES AND SPIRITUAL VALUES OF SCIENCE

D. W. Bronk, president of Rockefeller Institute and one of America's most distinguished scientists, presents his views on the values of science to man during the 75th anniversary symposium on "Engineering for Major Scientific Programs."

THE THEME of this symposium is a timely topic because searching questions are being asked in universities, industry and government regarding the relations between science and engineering. The questions should ultimately probe the purpose of individuals and society, the conditions necessary for personal and public happiness, the nature of human welfare, how to operate our materialistic civilization. Those are restless, uncomfortable questions that are usually left unasked. But they are relevant to questions we should ask ourselves during this symposium: Why is modern scientific research being undertaken and financed on so large a scale, what is the purpose of the research, how should it be conducted?

Our subject implies that there is a distinction between engineers and scientists. It is a distinction I find unclear, but perhaps that is because I was trained to be an engineer and have spent much of my life in scientific research. And so I have shunned the current controversies as to who is who and which is what. Nevertheless, I realize that mankind likes the mental security of classifications, society craves the hierarchies of ancient guilds which are now unions and professional societies, university faculties and administrations spawn schools and departments. And so, for our present purpose, I will reluctantly suggest that a scientist is one who seeks to discover the laws of nature; an engineer is one who applies scientific knowledge for useful, usable ends. If you tell me that my comparative definitions are inadequately definitive, I will agree and then refer you to those who debate the relative status and roles of scientists and engineers and the comparative nature and advantage of engineering and scientific education. By my definition, many engineers are scientists, and many scientists act from time to time as engineers.

There is a duality in the relations of engineering to scientific research. Those who support research expect materially useful results; to make the results of research useful is usually the function of engineers and physicians. To an increasing degree, engineers are required to design and operate the facilities used in modern research.

Among the changing conditions that affect the conduct of research and make desirable a partnership of engineers and research scientists, I would mention three.

The rapid increase of scientific knowledge and the difficult skills needed in many areas of research force specialization. Consequently, much research can be carried on successfully only by groups of investigators and supporting technicians under the direction of competent administrators. The supervision and coordination of such research teams is a more natural and traditional function of the engineer than of the individualistic scientist.

As the frontiers of space are pushed back and more of scientific research is concerned with the very small, the very large, and with larger numbers of living units, more complicated research facilities are required. I am thinking of linear accelerators, radio telescopes, oceanographic research vessels, devices for drilling the Mohole in the bottom of the sea, electron microscopes and electronic computers, to mention but a few of my examples. The design, construction and operation of these research facilities require the services of competent engineers.

The two characteristics of modern scientific research of which I have just spoken are due in part to a third new condition: the great increase in financial support of research that is provided by industry, private foundations and especially by the Federal government. I need not burden you with data to remind you that the funds available for the salaries of research scientists and the expenses of their research is today many-fold more than was available fifteen years ago. This is a consequence of the more widespread realization that knowledge of possible value for the furtherance of human welfare, for the vitality of industry and the international security of our nation can be derived from scientific research. The more abundant funds that are being provided make possible research on a larger scale than ever before.

Only during World War II was research done by such large, organized groups of scientists and engineers. Accordingly, we have little experience to guide the conduct of some of our major undertakings.

It is natural to think of universities as the appropriate sponsors of large as well as small research projects because universities comprise free scientists, and universities are the traditional homes of research. They have, indeed, been eminently successful in the conduct of some of our largest research programs, and the scientific faculties of universities have, in turn, been strengthened. But universities have also been harmed by some of their large scientific undertakings. University administrations have often been required to spend more time on the supervision of enormous research budgets than on more appropriate educational matters. Faculties, too, have been encouraged to spend so much time and effort on the conduct of large-scale research that they give little attention to the education of students. Even the graduate research student loses certain precious elements of his preparation for a career as a creative scholar if he is required to work as one directed cog in a large organization.

In order to protect universities against prostitution of their proper functions, and in order to secure certain qualities not readily provided by universities, various types of research organizations have been developed and still others have been proposed. Among the former are contractural relations with industrial corporations and their subsidiaries, non-profit institutions such as Rand and the Institute for Defense Analysis, and especially national laboratories such as Brookhaven, the Greenbank Radiotelescope, the Kitt Peak Optical Telescope, and the University Center for Atmospheric Research at Boulder. The National Laboratories have the unique advantages of being a continuing fiscal responsibility of the Federal government, under the scientific control or advice of able scientists chosen from universities as well as government, and of being available to university faculties and students throughout the country. Furthermore, they are so large and extensive in scope that they can command the participation of competent engineers. In the papers that follow we shall probably hear how, in the organization and conduct of these different institutions for the conduct of research, we learn how we can better carry on our unprecedented scientific activities.

The brilliant success of the International Geophysical Year reminded us in a dramatic way that science is truly international in its scope and values, that science can be furthered best by international cooperation. Science is the great international partnership. For such cooperation, the international scientific unions and the International Council of Scientific Unions are suitable; they have the advantage that they are relatively free from governmental manipulations. But in the field of international science we must be prepared to work more intimately with governments. International scientific cooperation will to an increasing degree be dependent upon government policies. Inter-governmental policies will be influenced by scientific considerations to a greater or more obvious extent than ever before.

A reason for this inter-dependence of science and the international affairs of governments is the tremendous power scientists and engineers now possess to modify the environment of more than a single nation. Radio-active products of atomic explosions, control of sectors of the electro-magnetic spectrum, pollution of the atmosphere and sea, control of weather all have effects of possible significance to many nations. Can we and will we limit scientific undertakings to the control of international law?

This leads me to say that engineers need greater understanding of the biological foundations of engineering if they would use the powerful knowledge of modern science for the benefit rather than the harm of mankind.

An instrument is a device with which to increase the sensitivity, range or discrimination of man's senses. We thus gain much of our evidence of the universe in which we live. Through the medium of instruments we have wider social contacts.

A machine is a device which increases natural human powers, or gives to man powers he never possessed before.

The biological suitability of such technical achievements is limited by the characteristics of the human body, as well as by the research of scientists and the ingenuity of engineers. The healthy progress of our technological civilization requires that the human significance of machines be recognized, lest great powers be unwisely used. If instruments and machines and chemical products are to satisfy the needs of man, they should be designed to satisfy the biological requirements of the user.

During the course of centuries, man evolved gradually in an environment which changed slowly except in times of catastrophe. This is no longer true. By the use of scientific knowledge, men can now alter their surroundings rapidly and radically. They can move quickly from environments in which man has lived for countless centuries into environ-

SCIENCE AND MAN–continued

ments in which man has never lived before. Man can make his environment what he will. This has profound implications for man's future.

Our early ancestor gradually moved from caves to crude huts to cold houses of rough hewn stone. For centuries he warmed himself before open fires. The building industry has not been the most notable example of the application of science in the satisfaction of human desires, but within a century man has learned to build for himself towering structures in which he is surrounded by the humidity and temperature and light he chooses.

Throughout recorded history and until a century ago, men moved on their own legs. They gradually learned to travel a little faster and more easily by harnessing animals to carts on skids or wheels; boats were ultimately propelled by the force of wind on sails. In the short space of a century and a half, man has increased his speed of travel from no more than he could run to greater than the velocity of sound. Each present day, countless thousands fly faster than birds, at altitudes where oxygen for life is lacking.

Man of the past suited his life to his natural surroundings and lived in close association with other living creatures. Only slowly did he change the world as he found it: laboriously he cleared the forests with his axe, drained the swamps with shovel-dug ditches, hunted wild beasts, and endured the insects. Within the last few years, chain-saws fell trees across denuded acres, bulldozers change the earth's configuration, chemical pesticides quickly alter the pattern of the fauna and the flora.

These achievements of the human mind have added greatly to the security and material welfare of mankind. But there is no evidence that more material possessions beyond certain necessities provide a happier, more satisfying life. On the contrary, a surfeit of material goods and an excess of busyness often create boredom that leads to unhappiness and worse. Security and suppressed curiosity inhibit the intellectual and spiritual development of man.

The deeper objective of scientists and engineers is to provide man with the means for realizing more fully his potentialities for living a more thoughtful and creative life.

The national space program is criticized by some who say that the billions could be better spent on supplying the material wants of an earth-bound population. This is not the place, nor am I the one to debate priorities in our national budget. But this I know: our adventures into space are best defended because they keep alive curiosity and the spirit of adventure in countless men and women. Curiosity and the spirit of adventure were qualities of our ancestors that made their nation great. They are still vital elements of our national spirit.

The greatest contributions of science and engineering to human welfare are the material means they provide, and the will they foster, to adventure beyond the frontiers of knowledge and there seek understanding.

SCIENCE AND THE LAW

In an address to the Tech students and faculty in February, Chief Justice Earl Warren discusses the problems that science and technology will bring to all of the courts of the future

IT MUST BE A great satisfaction for you to look back upon seventy-five years of accomplishment in the fields of science and technology. No other comparable period in history has made such contributions to the sum total of human knowledge in these areas. And your University has been a dynamic force in all such developments. You have contributed greatly to the national effort in these days when we must all run as fast as we can just to keep from being overrun. The entire nation is in your debt as it is to the other great institutions of higher learning for your scientific discoveries and for the application of technology to their practical uses in a mixed-up and embroiled world. These are the advances that have made it possible for America to give leadership to the world and to keep the major part of the world free. I am sure that as you take inventory of the accomplishments of the past seventy-five years, you also look forward with enthusiasm to the possibilities for science and technology in the future.

I wish that we had made comparable advances in my profession of the law, because if science is to serve the peaceful purposes of mankind it must be given a peaceful setting in both domestic and world law.

There are people who are distrustful of science and who believe that its awesome discoveries threaten our civilization.

In fact during the nineteen thirties there were proposals to declare a moratorium on the application of technology to scientific discoveries in order to enable us to solve our unemployment and related problems. But our problems and our approach have changed since then. Now we are searching everywhere for youngsters who show an aptitude for the physical sciences, to a point where many people are concerned lest there will not be a sufficient number of first-rate minds for the other professions and the social sciences which they fear are already being outstripped. As a result the professional schools of the country are now starting to recruit some of the best students in the country as avidly as many universities recruit athletes.

But scientists are not the ogres of society. They are more concerned with laws than the rest of us. By the study of facts and their systematic application to known truths, they demonstrate the operation of general laws. Society itself determines to what use these discoveries are to be put. A society that is governed by law will not permit these great discoveries to be used for destructive purposes. A world without law is hell-bent for destruction with or without scientific discoveries.

When the chemists of the last century worked out by careful experiment the nature and properties of chlorine, I do not believe they had in mind
nate massed soldiers as
Europe in World War I. V
the century worked out
equating mass with energ
uses of atomic energy in m

When Ernest Lawrence
back of Berkeley at my u
explosions like that at Hir

And I would be surpri
and Marconi and all the
electricity and communic
radar and guided missiles
their experiments.

The simple fact is that l
It is not that science is ru
zation. The real danger lie
the absence of a world or
the pressures to use sci
rather than for peaceful p

In all countries and fro
traditional to express our
of knowledge and progres
sun and to the mysteries o

Perhaps such analogies
the physical scientists ha
invention which will pro
"coherent" light, a kind
never before seen in the w
Maser." The principle wa
the word "Maser" derives
"Microwave amplification
tion."

In this fascinating devi
power, atoms are reflect
within a tube reaching a
photons emerges in a bea
step with its predecesso
power of the wave whic
waves are all in step, eac
a beam of light of incred
Optical Maser has actuall
surface of the moon which
on earth. At present, not
potential usefulness of thi

Certainly it would be b
selves about the danger in
gave more consideration
that make science so pow
of Law and to the contro
the wartime applications

How much better the w
a kind of Maser for the Ru
ples of law and justice co
and re-reflected, striking
under law, and if the m

SCIENCE AND MAN-continued

ments in which man has never lived before. Man can make his environment what he will. This has profound implications for man's future.

Our early ancestor gradually moved from caves to crude huts to cold houses of rough hewn stone. For centuries he warmed himself before open fires. The building industry has not been the most notable example of the application of science in the satisfaction of human desires, but within a century man has learned to build for himself towering structures in which he is surrounded by the humidity and temperature and light he chooses.

Throughout recorded history and until a century ago, men moved on their own legs. They gradually learned to travel a little faster and more easily by harnessing animals to carts on skids or wheels; boats were ultimately propelled by the force of wind on sails. In the short space of a century and a half, man has increased his speed of travel from no more than he could run to greater than the velocity of sound. Each present day, countless thousands fly faster than birds, at altitudes where oxygen for life is lacking.

Man of the past suited his life to his natural surroundings and lived in close association with other living creatures. Only slowly did he change the world as he found it: laboriously he cleared the forests with his axe, drained the swamps with shovel-dug ditches, hunted wild beasts, and endured the insects. Within the last few years, chain-saws fell trees across denuded acres, bulldozers change the earth's configuration, chemical pesticides quickly alter the pattern of the fauna and the flora.

These achievements of the human mind have added greatly to the security and material welfare of mankind. But there is no evidence that more material possessions beyond certain necessities provide a happier, more satisfying life. On the contrary, a surfeit of material goods and an excess of busyness often create boredom that leads to unhappiness and worse. Security and suppressed curiosity inhibit the intellectual and spiritual development of man.

The deeper objective of scientists and engineers is to provide man with the means for realizing more fully his potentialities for living a more thoughtful and creative life.

The national space program is criticized by some who say that the billions could be better spent on supplying the material wants of an earth-bound population. This is not the place, nor am I the one to debate priorities in our national budget. But this I know: our adventures into space are best defended because they keep alive curiosity and the spirit of adventure in countless men and women. Curiosity and the spirit of adventure were qualities of our ancestors that made their nation great. They are still vital elements of our national spirit.

The greatest contributions of science and engineering to human welfare are the material means they provide, and the will they foster, to adventure beyond the frontiers of knowledge and there seek understanding.

SCIENCE AND THE LAW

In an address to the Tech students and faculty in February, Chief Justice Earl Warren discusses the problems that science and technology will bring to all of the courts of the future

IT MUST BE A great satisfaction for you to look back upon seventy-five years of accomplishment in the fields of science and technology. No other comparable period in history has made such contributions to the sum total of human knowledge in these areas. And your University has been a dynamic force in all such developments. You have contributed greatly to the national effort in these days when we must all run as fast as we can just to keep from being overrun. The entire nation is in your debt as it is to the other great institutions of higher learning for your scientific discoveries and for the application of technology to their practical uses in a mixed-up and embroiled world. These are the advances that have made it possible for America to give leadership to the world and to keep the major part of the world free. I am sure that as you take inventory of the accomplishments of the past seventy-five years, you also look forward with enthusiasm to the possibilities for science and technology in the future.

I wish that we had made comparable advances in my profession of the law, because if science is to serve the peaceful purposes of mankind it must be given a peaceful setting in both domestic and world law.

There are people who are distrustful of science and who believe that its awesome discoveries threaten our civilization. In fact during the nineteen thirties there were proposals to declare a moratorium on the application of technology to scientific discoveries in order to enable us to solve our unemployment and related problems. But our problems and our approach have changed since then. Now we are searching everywhere for youngsters who show an aptitude for the physical sciences, to a point where many people are concerned lest there will not be a sufficient number of first-rate minds for the other professions and the social sciences which they fear are already being outstripped. As a result the professional schools of the country are now starting to recruit some of the best students in the country as avidly as many universities recruit athletes.

But scientists are not the ogres of society. They are more concerned with laws than the rest of us. By the study of facts and their systematic application to known truths, they demonstrate the operation of general laws. Society itself determines to what use these discoveries are to be put. A society that is governed by law will not permit these great discoveries to be used for destructive purposes. A world without law is hell-bent for destruction with or without scientific discoveries.

When the chemists of the last century worked out by careful experiment the nature and properties of chlorine, I do not believe they had in mind the use of chlorine gas to exterminate massed soldiers as happened on the battlefields of Europe in World War I. When Albert Einstein at the turn of the century worked out his famous mathematical formula equating mass with energy, I do not believe he had military uses of atomic energy in mind.

When Ernest Lawrence built his first cyclotron on the hill back of Berkeley at my university, I am positive that atomic explosions like that at Hiroshima were not in his mind.

And I would be surprised if Edison and Morse and Bell and Marconi and all the others who made contributions in electricity and communications were thinking in terms of radar and guided missiles to destroy civilization as they made their experiments.

The simple fact is that law has not kept abreast of science. It is not that science is running away and endangering civilization. The real danger lies in the lack of a lawful world, and the absence of a world ordered under law which will negate the pressures to use scientific knowledge for destructive rather than for peaceful purposes.

In all countries and from the beginning of literature, it is traditional to express our ideas about education, the pursuit of knowledge and progress towards ideals by analogy to the sun and to the mysteries of light.

Perhaps such analogies are no less useful today. Recently the physical scientists have produced a most extraordinary invention which will produce a beam of what they call "coherent" light, a kind of light never found in nature and never before seen in the world. The device is called "Optical Maser." The principle was discovered here in America and the word "Maser" derives from the key letters in the phrase "Microwave amplification by stimulated emission of radiation."

In this fascinating device, by the application of electrical power, atoms are reflected and bounced back and forth within a tube reaching a crescendo from which a cascade of photons emerges in a beam of light in which each wave is in step with its predecessor, each wave thus adding to the power of the wave which has gone before. Because these waves are all in step, each adding to the force of the other, a beam of light of incredible power can be produced. The Optical Maser has actually flashed a spot of red light on the surface of the moon which could be observed with telescopes on earth. At present, not even the scientists can estimate the potential usefulness of this device.

Certainly it would be better if, instead of concerning ourselves about the danger involved in scientific discoveries, we gave more consideration to applying some of the techniques that make science so powerful to the furtherance of the Rule of Law and to the controls and self-restraint that will make the wartime applications of scientific knowledge obsolete.

How much better the world would be if we could develop a kind of Maser for the Rule of Law—if the elemental principles of law and justice could be broken down and reflected and re-reflected, striking sparks from all who want freedom under law, and if the mixture could produce a beam of

SCIENCE AND MAN–continued

coherent legal light of immense power capable of revealing the Rule of Law in its full glory to any and every part of the earth. I wonder if Abraham Lincoln did not have some kind of a legal Maser in mind when he uttered these challenging words:

"Let reverence for the laws be breathed by every American mother to the lisping babe that prattles on her lap; let it be taught in schools, in seminaries, and in colleges; let it be written in primers, spelling-books, and in almanacs; let it be preached from the pulpit, proclaimed in legislative halls, and enforced in courts of justice. And, in short, let it become the political religion of the nation; and let the old and the young, the rich and the poor, the grave and the gay of all sexes and tongues and colors and conditions, sacrifice unceasingly upon its altars."

But the law is slow to move. In the past, seldom has it anticipated conditions and evolved methods to remedy them. It has waited for problems to develop and then belatedly sought to make rules for solving them. There is no reason, however, why we cannot make legal research accomplish the same function as scientific research. We know that a new world order is in the making. There are over a hundred nations in the United Nations where there were but half that number ten years ago. We know we do not have either the world law or the machinery to cope with the problems these changes bring about.

We know that there must be a law of space if men are to fly to the moon and the planets. We know there is a world-wide population explosion, and that mass migrations will change life in many ways. All of these foreshadow tremendous problems. Notwithstanding, we give little concentrated attention to the law that is necessary to solve them. Yet they lend themselves to laboratory techniques as clearly as do the splitting of the atom, the refraction of light and heat, the desalting of water and all the other problems that are the daily preoccupation of institutions like your own.

The development of science and technology on the one hand and law and the other social sciences do not advance hand-in-hand as do the protons in coherent light. The law lags behind until crisis stirs it into action.

In 1962 in Massachusetts, only a few miles from Cambridge where Harvard University had been advancing the sciences for more than a half century, they were burning innocent women at the stake for witchcraft under the law in Salem.

Such is the lag of the law behind technology and the resulting social changes. But the order in which changes occur in the various aspects of our social structure is controlled by laws of logic and nature as immutable as any rule of mathematics or any law of the physical universe.

Chronologically, technological change always comes first. This has been true from the beginning of history and most probably in prehistoric times. In the wake of technological development, which has always involved changes in the economic and social structure, come changes in jurisprudence, in man-made laws. What is conceived to be just when human beings are engaged in one sort of activity may become unjust when they are engaged in another. And moreover, legal problems arising in a new society may differ totally from those of a simpler society. When hunters became nomads; when nomads became shepherds; when shepherds settled down to agriculture; when farmers invented cities; when cities began to serve as bases for states and nations; new problems arose of which the earlier generations were unaware.

Like problems are being catapulted upon us with such great rapidity that only by prodigious and concentrated study can we meet them. We are confronted at once with a whole series of discoveries, each of which demands adjustment of established law in the light of new situations. We are in the age in which rapidity of communication makes every one of us on the globe a neighbor of the other. We are in an age when, for the first time, the power is given to at least two nations to destroy all life in resort to atomic war. We are finally in the Age of Space. How high into space over his property does the right of an individual go? Does flight over national territory violate the right of a nation to the space above it? If so, to how many miles does this right extend? One hundred miles? One thousand? Ten thousand? To what extent may the air we breathe be polluted by industrial development and the increasing number of internal combustion machines? Can the privacy of our homes and offices be invaded by the use of electronic instruments that are far removed from the property?

These are only a few of the problems which you, men of science, pursuing your calling with such devotion and indefatigability, pose to us whose vocation it is to protect human life, human rights and human property. You are doing your duty. Each year brings its wealth of scientific discovery and invention. And each year requires an equal wealth of legislative inventiveness and judicial insight to make sure that human life can continue at least as happy and satisfactory as it was before the discovery or invention;—to make sure that human dignity is preserved and that throughout our broad land there will be "liberty and justice for all."

As I mentioned earlier, when Einstein discovered the formula for the equation describing the relation between matter and energy, probably the last thing he had in mind was its translation into practical use, through the creation of atomic weapons. His discovery was in the great tradition of the pursuit of knowledge. Whether this discovery would help man or lead to his destruction in thermo-nuclear war, Einstein had to leave for the decision of those whose business it is to make the Law catch up with inventions and discoveries.

If the latter fail in their duty, the blame is not that of the scientist. As he followed in the tradition of his great calling, those whose preoccupation is the law must follow in the best tradition of their professions. New powers, entrusted to man, require new regulations by the Legislatures, new decisions by the courts, new interpretations by theoretical philosophers and ethicists.

We are probably at the beginning of even greater developments in science than any of those we know.

Such immense strides in the development of science and technology necessarily will involve application of well-established principles to problems not anticipated by the philosophers who formulated those principles or the Legislatures that enacted them into law. In any such interpretation of ancient principles, there will necessarily be differences of judgment. But it seems clear that without advancing law to meet the challenges of science, science could do immense harm as well as immense good.

It would be foolhardy and impossible to declare a moratorium on science as was proposed in the nineteen-thirties to cure the problems we then faced. It would be equally foolhardy and likewise impossible to declare a moratorium on emerging jurisprudence, as it struggles to meet the challenges of our time, which are so different from those of even our immediate ancestors, and even of our youth.

Man must go on to ever-increasing knowledge and action in all fields. He wants to know more about the Universe, about himself, and about life. He wants scientific knowledge to be used for the advancement of civilization rather than for its destruction. He wants life to be better for his children than it has been for him. And this can be done. It can be done better in America than in any other place on earth—

AUTOMATION AND THE SPIRIT OF MAN

Harwood Bartlett, an honor graduate of Tech and now a college chaplain, voices concern for the effects of science and technology on people

first, becai
ment; sec
written co
and, lastly
genius of
ments, th
nately for
brush. Int
the averag
ernmental
tended to
to the co
under con
today and
And perha
to the peo
language
purpose. T
not want c
Medes an
eventually

This gr
175 years
if we nurtu
ing organi
upon the
wonderful

I FOR O
society
on th
human be
we are beg
than a ma
huge cities
buildings,
fare, peop
most impo
of man.

One phe
our under
netics is a
Dr. Norbe
means the
communic
machines.
readily in
cybernetic
plant, the
people in t
be designe
quicker an

At the

coherent legal light of immense power capable of revealing the Rule of Law in its full glory to any and every part of the earth. I wonder if Abraham Lincoln did not have some kind of a legal Maser in mind when he uttered these challenging words:

"Let reverence for the laws be breathed by every American mother to the lisping babe that prattles on her lap; let it be taught in schools, in seminaries, and in colleges; let it be written in primers, spelling-books, and in almanacs; let it be preached from the pulpit, proclaimed in legislative halls, and enforced in courts of justice. And, in short, let it become the political religion of the nation; and let the old and the young, the rich and the poor, the grave and the gay of all sexes and tongues and colors and conditions, sacrifice unceasingly upon its altars."

But the law is slow to move. In the past, seldom has it anticipated conditions and evolved methods to remedy them. It has waited for problems to develop and then belatedly sought to make rules for solving them. There is no reason, however, why we cannot make legal research accomplish the same function as scientific research. We know that a new world order is in the making. There are over a hundred nations in the United Nations where there were but half that number ten years ago. We know we do not have either the world law or the machinery to cope with the problems these changes bring about.

We know that there must be a law of space if men are to fly to the moon and the planets. We know there is a world-wide population explosion, and that mass migrations will change life in many ways. All of these foreshadow tremendous problems. Notwithstanding, we give little concentrated attention to the law that is necessary to solve them. Yet they lend themselves to laboratory techniques as clearly as do the splitting of the atom, the refraction of light and heat, the desalting of water and all the other problems that are the daily preoccupation of institutions like your own.

The development of science and technology on the one hand and law and the other social sciences do not advance hand-in-hand as do the protons in coherent light. The law lags behind until crisis stirs it into action.

In 1962 in Massachusetts, only a few miles from Cambridge where Harvard University had been advancing the sciences for more than a half century, they were burning innocent women at the stake for witchcraft under the law in Salem.

Such is the lag of the law behind technology and the resulting social changes. But the order in which changes occur in the various aspects of our social structure is controlled by laws of logic and nature as immutable as any rule of mathematics or any law of the physical universe.

Chronologically, technological change always comes first. This has been true from the beginning of history and most probably in prehistoric times. In the wake of technological development, which has always involved changes in the economic and social structure, come changes in jurisprudence, in man-made laws. What is conceived to be just when human beings are engaged in one sort of activity may become unjust when they are engaged in another. And moreover, legal problems arising in a new society may differ totally from those of a simpler society. When hunters became nomads; when nomads became shepherds; when shepherds settled down to agriculture; when farmers invented cities; when cities began to serve as bases for states and nations; new problems arose of which the earlier generations were unaware.

Like problems are being catapulted upon us with such great rapidity that only by prodigious and concentrated study can we meet them. We are confronted at once with a whole series of discoveries, each of which demands adjustment of established law in the light of new situations. We are in the age in which rapidity of communication makes every one of us on the globe a neighbor of the other. We are in an age when, for the first time, the power is given to at least two nations to destroy all life in resort to atomic war. We are finally in the Age of Space. How high into space over his property does the right of an individual go? Does flight over national territory violate the right of a nation to the space above it? If so, to how many miles does this right extend? One hundred miles? One thousand? Ten thousand? To what extent may the air we breathe be polluted by industrial development and the increasing number of internal combustion machines? Can the privacy of our homes and offices be invaded by the use of electronic instruments that are far removed from the property?

These are only a few of the problems which you, men of science, pursuing your calling with such devotion and indefatigability, pose to us whose vocation it is to protect human life, human rights and human property. You are doing your duty. Each year brings its wealth of scientific discovery and invention. And each year requires an equal wealth of legislative inventiveness and judicial insight to make sure that human life can continue at least as happy and satisfactory as it was before the discovery or invention;—to make sure that human dignity is preserved and that throughout our broad land there will be "liberty and justice for all."

As I mentioned earlier, when Einstein discovered the formula for the equation describing the relation between matter and energy, probably the last thing he had in mind was its translation into practical use, through the creation of atomic weapons. His discovery was in the great tradition of the pursuit of knowledge. Whether this discovery would help man or lead to his destruction in thermo-nuclear war, Einstein had to leave for the decision of those whose business it is to make the Law catch up with inventions and discoveries.

If the latter fail in their duty, the blame is not that of the scientist. As he followed in the tradition of his great calling, those whose preoccupation is the law must follow in the best tradition of their professions. New powers, entrusted to man, require new regulations by the Legislatures, new decisions by the courts, new interpretations by theoretical philosophers and ethicists.

We are probably at the beginning of even greater developments in science than any of those we know.

Such immense strides in the development of science and technology necessarily will involve application of well-established principles to problems not anticipated by the philosophers who formulated those principles or the Legislatures that enacted them into law. In any such interpretation of ancient principles, there will necessarily be differences of judgment. But it seems clear that without advancing law to meet the challenges of science, science could do immense harm as well as immense good.

It would be foolhardy and impossible to declare a moratorium on science as was proposed in the nineteen-thirties to cure the problems we then faced. It would be equally foolhardy and likewise impossible to declare a moratorium on emerging jurisprudence, as it struggles to meet the challenges of our time, which are so different from those of even our immediate ancestors, and even of our youth.

Man must go on to ever-increasing knowledge and action in all fields. He wants to know more about the Universe, about himself, and about life. He wants scientific knowledge to be used for the advancement of civilization rather than for its destruction. He wants life to be better for his children than it has been for him. And this can be done. It can be done better in America than in any other place on earth—first, because we know and understand constitutional government; second, because we have remained dedicated to a written constitution longer than any other nation in existence; and, lastly, because that constitution represents not only the genius of the Founding Fathers but, through its Amendments, the sovereign will of the American people. Fortunately for us, the Founding Fathers painted with a broad brush. Into a document of 4373 words, which is shorter than the average magazine article of today, they distilled the governmental wisdom of the ages. They wrote what they intended to be a living document, not one committed merely to the conditions of that day but one that could function under constantly changing conditions—even those we have today and those we will have in the generations to come. And perhaps the greatest wisdom they showed was in leaving to the people the right to change it by amendment when its language or its interpretation no longer served the national purpose. They knew that change is a law of life, and they did not want our charter of government to be like the laws of the Medes and the Persians which never changed and which eventually became a symbol only of the dead past.

This great Constitution serves our needs today as it did 175 years ago. It will serve as well 175 years in the future, if we nurture it as a living document—as a constantly growing organism—by bringing "coherent" legal light to bear upon the ever-changing conditions of life wrought by the wonderful age of science.

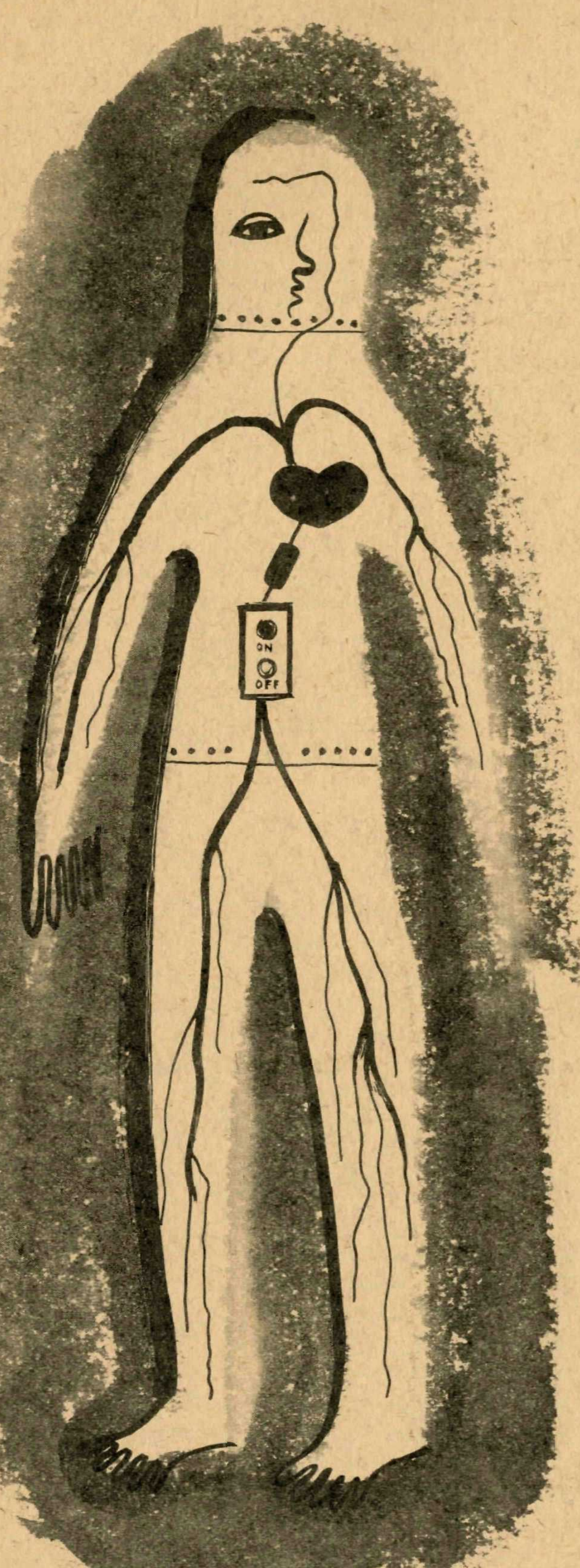
AUTOMATION AND THE SPIRIT OF MAN

Harwood Bartlett, an honor graduate of Tech and now a college chaplain, voices concern for the effects of science and technology on people

I FOR ONE, am troubled about an undercurrent in our society, an undercurrent in the way we think. We are on the verge of losing our understanding of what a human being is. Surrounded by machines and automation, we are beginning to think of a human being as nothing more than a machine. And so I am troubled. For in this world of huge cities, mass transportation and communication, soaring buildings, 18,000 mph satellites and threatened nuclear warfare, people or should I say the individual still remains our most important asset. We must not loose our understanding of man.

One phenomenon which is subtly but determinedly eroding our understanding of the individual is cybernetics. Cybernetics is a new and exciting field. The word was coined by Dr. Norbert Wiener, professor of mathematics at M.I.T., and means the scientific study of the processes of control and communication which are common to living organisms and machines. Cybernetics is seen by the average man most readily in automation and computers. The practitioner of cybernetics studies the functions of workmen in the industrial plant, the tasks of women in the home, the problems of people in their daily lives and tries to see how machines can be designed to relieve people of the tasks that can be done quicker and more accurately by an automated machine.

At the same time the cybernetics people are progressing



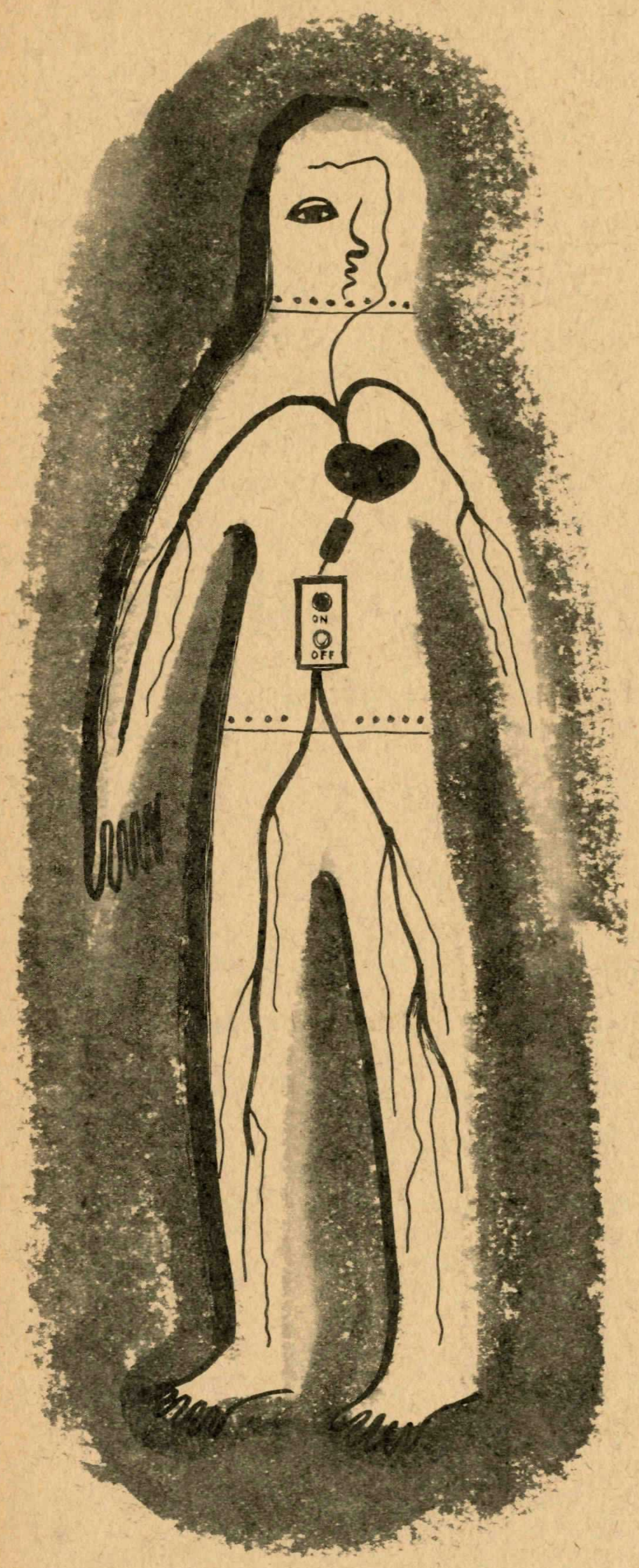
rapidly toward understanding the way the human mental, emotional, muscular and organic systems work, so that machines can be produced to replace or simulate these. As an example, take the following quotation from a recent article in the Dec. 22, 1961 issue of *Science* magazine. The article on "Computer Stimulation of Human Thinking" is about a computer program that can reproduce human problem solving processes.

> *A digital computer is a general purpose symbol-manipulating device. If appropriate programs are written for it, it can be made to produce symbolic output that can be compared with the stream of verbalizations of a human being who is thinking aloud while solving problems. The General Problem Solver is a computer program that is capable of simulating, in first approximation, human behavior in a narrow but significant problem domain.*

This result and other results of cybernation are very worthy and quite exciting. They have produced great improvements in our society. But is not cybernetics taking its toll also? Where is the dividing line between man and machine? If we make machines to do human tasks and then study men to see how they are like machines, where is the difference?

There was a cartoon in the *New Yorker* recently. Two men were standing in front of the output printer on one of those monstrous computers that cartoonists have immortalized. The two men were in a greatly agitated state for the computer had just declared its independence by printing out the historic words of Descartes, "I THINK; THEREFORE I AM." Now there's not much reason for concern that the machines will suddenly march on Washington, London and Moscow and take over the world as the science-fiction writers dream about. But there is cause for concern that our infatuation for machines and automation will dupe us into thinking that men are no more than very complex machines and that a man can, at least in principle, be duplicated by a machine.

But let us look into the field of cybernetics with a bit more care. Cybernetics is a child of the machine age and the industrial revolution. It has come into its own in just the last 15 or 20 years. One of the first of the modern high-speed computers was invented to solve the complex problems that came with the splitting of the atom and the development of the atomic bomb. That wasn't too long ago. Since then computers have been perfected until they are now doing such complicated tasks as designing and "flying" rockets and airplanes before they are built; designing our modern expressways by computing the optimum cuts and fills so that a minimum of earth will have to be moved as well as designing optimum angle and grade for interchange ramps to fit budget, traffic flow and safety requirements; "fighting" thermonuclear wars, taking into account the resources and strategy of each side as an aid to military planning; and doing fairly accurate translations of foreign languages. They do these things and many more and yet the builders of computers say that they are just in their infancy as far as possibilities go.



rapidly toward understanding the way the human mental, emotional, muscular and organic systems work, so that machines can be produced to replace or simulate these. As an example, take the following quotation from a recent article in the Dec. 22, 1961 issue of *Science* magazine. The article on "Computer Stimulation of Human Thinking" is about a computer program that can reproduce human problem solving processes.

> *A digital computer is a general purpose symbol-manipulating device. If appropriate programs are written for it, it can be made to produce symbolic output that can be compared with the stream of verbalizations of a human being who is thinking aloud while solving problems. The General Problem Solver is a computer program that is capable of simulating, in first approximation, human behavior in a narrow but significant problem domain.*

This result and other results of cybernation are very worthy and quite exciting. They have produced great improvements in our society. But is not cybernetics taking its toll also? Where is the dividing line between man and machine? If we make machines to do human tasks and then study men to see how they are like machines, where is the difference?

There was a cartoon in the *New Yorker* recently. Two men were standing in front of the output printer on one of those monstrous computers that cartoonists have immortalized. The two men were in a greatly agitated state for the computer had just declared its independence by printing out the historic words of Descartes, "I THINK; THEREFORE I AM." Now there's not much reason for concern that the machines will suddenly march on Washington, London and Moscow and take over the world as the science-fiction writers dream about. But there is cause for concern that our infatuation for machines and automation will dupe us into thinking that men are no more than very complex machines and that a man can, at least in principle, be duplicated by a machine.

But let us look into the field of cybernetics with a bit more care. Cybernetics is a child of the machine age and the industrial revolution. It has come into its own in just the last 15 or 20 years. One of the first of the modern high-speed computers was invented to solve the complex problems that came with the splitting of the atom and the development of the atomic bomb. That wasn't too long ago. Since then computers have been perfected until they are now doing such complicated tasks as designing and "flying" rockets and airplanes before they are built; designing our modern expressways by computing the optimum cuts and fills so that a minimum of earth will have to be moved as well as designing optimum angle and grade for interchange ramps to fit budget, traffic flow and safety requirements; "fighting" thermonuclear wars, taking into account the resources and strategy of each side as an aid to military planning; and doing fairly accurate translations of foreign languages. They do these things and many more and yet the builders of computers say that they are just in their infancy as far as possibilities go.

Automation is a bit older as an art. And it has come up with amazing accomplishments. Take the following article from the June 23, 1961, *New York Times* as an example:

> *U.S. Industries announced . . . that it had developed what was termed the first general-purpose automation machine available to manufacturers as standard "off-the-shelf" hardware . . . The new machine, called a TransfeRobot, sells for $2,500 . . . The Westclox Company of LaSalle, Ill., has been using a TransfeRobot to oil clock assemblies as they pass on a conveyor belt. The machine oils eight precision bearings simultaneously in a second. At the Underwood Corporation typewriter plant in Hartford, the robot picks up, transfers and places a small typewriter component into a close-fitting nest for an automatic machine operation. In an automobile plant, the device feeds partly fabricated parts of a steering assembly to a trimming press and controls the press. The device consists basically of an arm and actuator that can be fitted with many types of fingers and jaws. All are controlled by a self-contained electronic brain.*

In addition automated systems now control complex oil refineries and steel mills. They do the work and make adjustments in the process on the basis of feed-back data obtained from automatic checks in the process. They can store information in vast memories. They can 'learn' from previous operations and modify future operations according to this experience. They can perceive and recognize in more different modes and with almost the same ability as men. In short, cybernetics is developing machines and computers that can do the same things that men can, but with much more speed and accuracy.

All of these advances have brought great benefits to mankind. They have relieved many people of much of the drudgery of life. They have allowed our country to have the highest wage level and standard of living in the world and still remain competitive on the world market. They have shortened the work week so that men have more leisure time than they have ever had. These are positive and valued contributions to society.

But at the same time, these machines have brought some problems. They have replaced workers in factories and have given us a problem of what seems like cronic unemployment. They have opened up jobs at a significantly higher training level so that replaced workers must be retrained for new skills by the thousands. The high speed computers have concentrated decision-making power into the hands of a few by virtue of the fact that data needed to make policy decisions within corporations or government is now often incorporated into machines and controlled by those who control the machines. This could present a real problem as we become more dependent on high-speed computers.

But these are problems that are recognized and are being dealt with to some degree at this time.

There is a more insidious problem that machines and cybernetics have raised. The problem is insidious because it is generally unrecognized. This problem concerns the way we think about life and people. We are becoming so entranced by automation and the way it has delivered us into such a full life, that we are starting to look at life itself as automated, mechanistic and machine-like. And when we look at life as mechanistic, we look at people as mechanistic, a very dangerous practice that could prove to be our undoing.

The following quotation from *Automation, Cybernetics and Society* by F. H. George illustrates the way we think of life as mechanistic:

> *The reason we think of human beings, either alone or in collections, as machines, is that scientific theory makes no distinction between the two. This fact being accepted, we go to work with all our available mathematical, logical, and psychological knowledge, to discover the conditions that are best suited to different machines. The reasons underlying that are human; matters of human value. We believe that humans are now doing the jobs of machines, we believe that humans are now living in the worst sort of slavery, and the only way to make their lot better is to establish the facts by the rigorous methods of science. Then we have to build the machines that will release human beings for human tasks.* (p. 245)

This line of reasoning is probably very agreeable to most people in our society. I raise a question, however. Is the result of looking on humans as machines a release of humans from their machine-like tasks? Or does this kind of thinking have the destructive effect of lowering humans to the level of machines and lowering human values to machine values? Does this free humans from their slavery or does this kind of thinking make man into another very complex machine? I am all too fearful that it has the latter effect.

It is difficult to prove that this is the effect. Statistics and facts don't seem to be able to support this argument one way or the other. An individual must answer it in his heart. And so many individuals seem to be saying in their hearts, "Yes, I am a machine and no more than that." Just look at the large amount of conformity in our country. Even the nonconformists conform in their non-conformity. Conformity is so machine-like. Something is wrong with a machine that doesn't operate like the identical machine next to it. And just look at the way the masses of people understand psychology. They say that a person does something because of his environment or because of something that happened to him in his youth. A person operates by cause and effect; just like a machine. And if you want to change a person you just give him a certain treatment; just as you would adjust a machine. And just look at the way people complain about being numbers on the roles of the government or the school or their employers. They complain because numbers are impersonal and machine-like. And people don't want to be machines. But they are afraid that they are.

John Steinbeck in his powerful novel, *The Grapes of Wrath,* speaks of what happens when vast, machine-run farms drive the small, dirt farmer off his land. And he speaks of the deprivation that machines bring.

SCIENCE AND MAN–continued

> *. . . when a horse stops work and goes into the barn there is a life and vitality left, there is a breathing and a warmth and the feet shift on the straw, and the jaws champ on the hay, and the ears and eyes are alive. There is a warmth of life in the barn, and the heat and smell of life. But when the motor of a tractor stops, it is as dead as the ore it came from. The heat goes out of it like the living heat that leaves a corpse . . . And in the tractor man there grows the contempt that comes only to a stranger who has little understanding and no relation. For nitrates are not the land, nor phosphates; and the length of fibre in the cotton is not the land. Carbon is not a man, nor salt nor water nor calcium. He is all these, but he is much more, much more; and the land is so much more than its analysis. The man who is more than his chemistry, walking on the earth, turning his plow point for a stone, dropping his handles to slide over an outcropping, kneeling in the earth to eat his lunch; that man who is more than his elements knows the land that is more than its analysis. But the machine man, driving a dead tractor on land that he does not know and love understands only chemistry; and he is contemptuous of the land and of himself.* (pp. 157-8)

The machine man is contemptuous. He is contemptuous of the land and of himself. Somehow when machines enter our lives they drain from life that which is personal, that which loves, that which is warm, that which is human. And the result is life that is impersonal, unlovable, cold and inhuman—like a machine.

But what is a man? Certainly, one can look at a person on one level and describe him in machine language. We can explain how a finger can move as the result of an electrical impulse coming from the brain and activating the proper muscle. We can explain how light waves enter the eye, strike the retina and are transformed into electrical impulses which go to the brain via the optic nerve. We can understand the way a heart works and we can even build an artificial heart that can do the work of the human heart. In time and with much research it does seem that we can reproduce most of the organs in the human body. And we can describe most of the workings of a person in some cause-and-effect, mechanistic manner.

There does seem to be some question about whether the human emotional and creative functions can ever be simulated mechanically. Can we ever explain human emotions? (Of course, there are some who would try to suppress all human emotions because they are not mechanical enough.) And can we ever describe the creative functions of the human brain? Does not the brain have some originating power in and of itself? Must everything it does be a reaction to a response—like a machine?

I am not really in a position to argue these two points—emotions and creativity. I am not a scientist. I *am* a human being, however. And I do know one thing. You cannot know a person by describing how he works. As Steinbeck says, "Carbon is not a man, nor salt nor water nor calcium. He is all of these, but he is much more, much more. . ." A human is an organism that can be described on one level as a system of causes and effects, as a machine. But he is much more.

The difference is in the meaning and value of a man. There is an intrinsic meaning to everything in the world. Some things are more meaningful than others. Some things are more meaningful than other things that are made of the same stuff. A marble statue has more meaning than a chunk of uncut marble. They can be scientifically described as of exactly the same complex of atoms and molecules. But they are different. In a like manner, some machines have more meaning than other machines. An automobile means much more than a cold chisel. They are both made of steel but they have different meanings. So it is that a human being might be made of carbon and salt and water and calcium, but a human being has much more meaning than any of these.

One doesn't just arbitrarily assign different meanings to different things either. These meanings are discovered as we relate to the different objects. In enjoying a statue we discover its greater meaning. In driving a car we discover that it means more than the chisel. In knowing and loving a person we discover that he or she has more meaning than any of these. Meaning does not come from analysis but from relationship. One does not discover the meaning of a chocolate eclair by doing a chemical analysis of it. One discovers its meaning by relating to it in the way it is meant to be related to—by eating it. If it is an especially good eclair, then it really does have meaning.

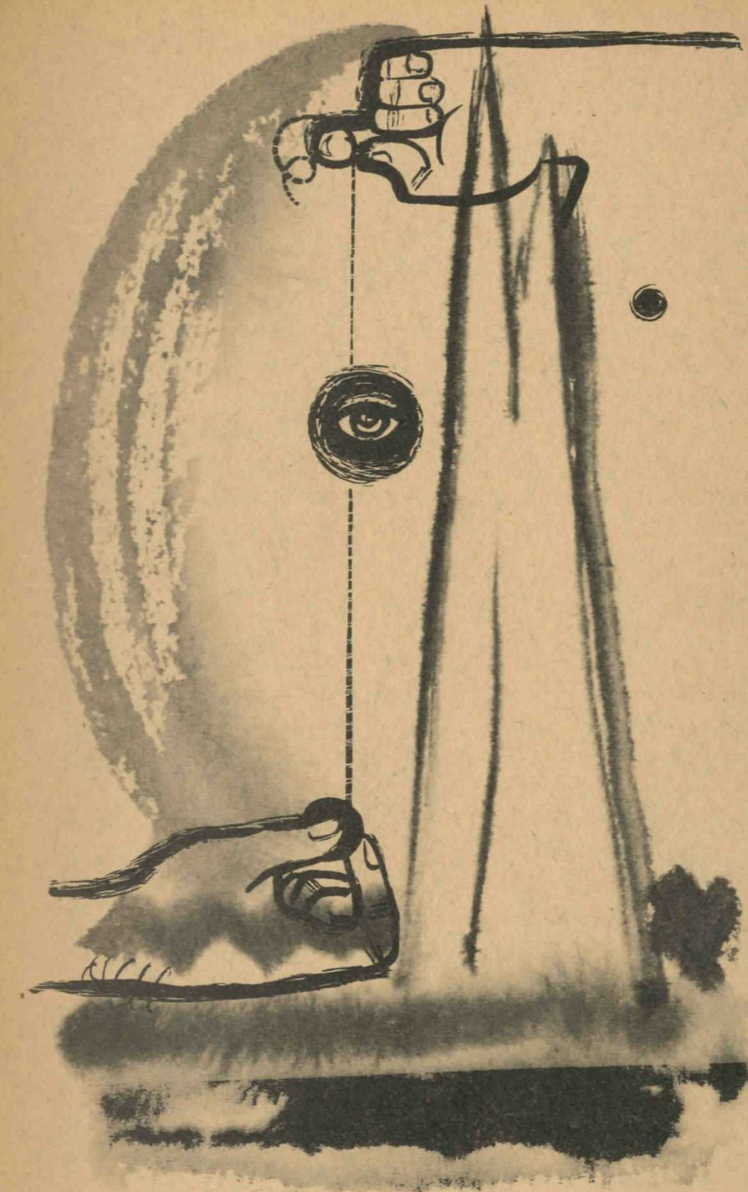
We have been dealing with one of the dangers in our age of automation and cybernetics. We are in danger of being so infatuated with machines that we start to see humans as nothing more than very complex machines. And we thus devaluate the meaning of human beings so that they are on a par with machines. It is crucial to us as humans that we realize the much greater meaning that humans have—a meaning that is intrinsically human.

Our civilization, and indeed, the scientific revolution, was founded on the value and meaning of men and the dominion of these men over nature.

> *And God blessed them (man and woman), and God said unto them, Be fruitful and multiply, and replenish the earth, and subdue it: and have domination over the fish of the sea, and over the fowl of the air, and over every living thing that moveth upon the earth.* (Genesis 1:28)

It strikes me as being a tragic irony that the men of this civilization who set out to claim their dominion over the earth by way of the scientific revolution might in the end be sucked down onto an equal footing with the things of the earth—subdued by the very thing that they had tried to subdue.

Men are much more than machines, much more. A man has much more value and meaning than any machine—because he is a man. Our country must understand this before it is too late—before we lose the dignity and meaning that is ours as men.



THE FUTURE CHALLENGES OF SCIENCE

During the 75th Anniversary symposium of February 5 and 6, many of this country's top scientists and engineers entered into an open discussion of science — here is the transcription of one of these sessions

WINDING
for M
panel
"Recommende
ment to facilita
with large-scal
moderated by
demic affairs o
be one of the
posium. Here, a
that discussion:

Hrones: Ladies
session: I think
I will repeat t
left, Dr. D. W.
Mr. J. J. Harw
of Ford Motor
of Union Carb
Office of Space
ciate Director
Dr. Ernst Webe
lyn; and Dr. W.
Biophysics, MI

I remember
the pieces of in
of my memory
Georgia Tech a
said or sung it
amount of und
celebrating its 7
of us participat
them in their ta
is "a hell of an

In doing this
of what engine
think it is, an
sharpening of
I think that one
neering and wh
not the same,
engineering wo
Similarly, peop
represents the f
doing engineeri
themselves in s
mountain peaks
to define where
valleys begin, s
the same thing
science. Statem
and I would re
of engineering i
ing into being
may be a mach
The aim of the

) MAN-continued

rse stops work and goes into the barn nd vitality left, there is a breathing and he feet shift on the straw, and the jaws hay, and the ears and eyes are alive. mth of life in the barn, and the heat ife. But when the motor of a tractor ead as the ore it came from. The heat ike the living heat that leaves a corpse tractor man there grows the contempt ly to a stranger who has little under- relation. For nitrates are not the land, ; and the length of fibre in the cotton is arbon is not a man, nor salt nor water He is all these, but he is much more, nd the land is so much more than its man who is more than his chemistry, e earth, turning his plow point for a g his handles to slide over an outcrop- in the earth to eat his lunch; that man an his elements knows the land that is analysis. But the machine man, driving on land that he does not know and love ly chemistry; and he is contemptuous d of himself. (pp. 157-8)

n is contemptuous. He is contemptuous of nself. Somehow when machines enter our om life that which is personal, that which is warm, that which is human. And the impersonal, unlovable, cold and inhuman

nan? Certainly, one can look at a person lescribe him in machine language. We can ger can move as the result of an electrical rom the brain and activating the proper plain how light waves enter the eye, strike transformed into electrical impulses which a the optic nerve. We can understand the s and we can even build an artificial heart ork of the human heart. In time and with does seem that we can reproduce most of human body. And we can describe most of person in some cause-and-effect, mechanis-

m to be some question about whether the and creative functions can ever be simu- y. Can we ever explain human emotions? are some who would try to suppress all because they are not mechanical enough.) lescribe the creative functions of the human the brain have some originating power in ist everything it does be a reaction to a machine?

in a position to argue these two points— tivity. I am not a scientist. I *am* a human nd I do know one thing. You cannot know ribing how he works. As Steinbeck says, man, nor salt nor water nor calcium. He is all of these, but he is much more, much more. . ." A human is an organism that can be described on one level as a system of causes and effects, as a machine. But he is much more.

The difference is in the meaning and value of a man. There is an intrinsic meaning to everything in the world. Some things are more meaningful than others. Some things are more meaningful than other things that are made of the same stuff. A marble statue has more meaning than a chunk of uncut marble. They can be scientifically described as of exactly the same complex of atoms and molecules. But they are different. In a like manner, some machines have more meaning than other machines. An automobile means much more than a cold chisel. They are both made of steel but they have different meanings. So it is that a human being might be made of carbon and salt and water and calcium, but a human being has much more meaning than any of these.

One doesn't just arbitrarily assign different meanings to different things either. These meanings are discovered as we relate to the different objects. In enjoying a statue we discover its greater meaning. In driving a car we discover that it means more than the chisel. In knowing and loving a person we discover that he or she has more meaning than any of these. Meaning does not come from analysis but from relationship. One does not discover the meaning of a chocolate eclair by doing a chemical analysis of it. One discovers its meaning by relating to it in the way it is meant to be related to—by eating it. If it is an especially good eclair, then it really does have meaning.

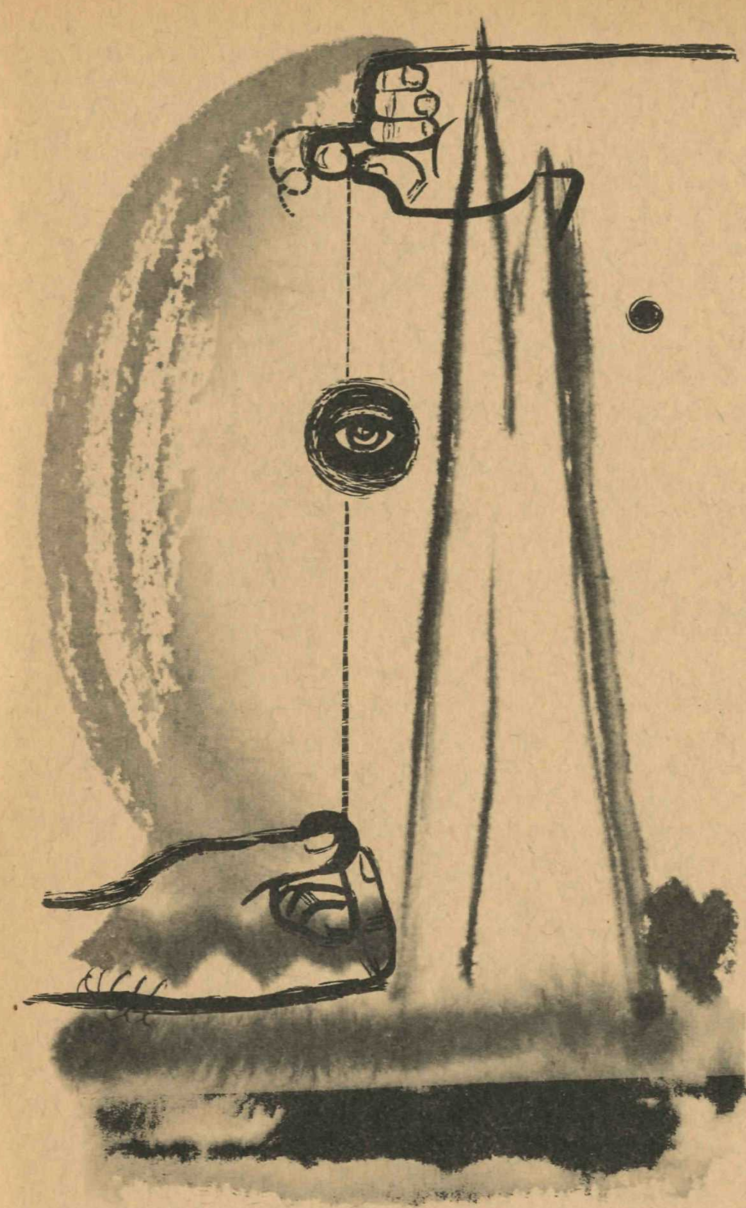
We have been dealing with one of the dangers in our age of automation and cybernetics. We are in danger of being so infatuated with machines that we start to see humans as nothing more than very complex machines. And we thus devaluate the meaning of human beings so that they are on a par with machines. It is crucial to us as humans that we realize the much greater meaning that humans have—a meaning that is intrinsically human.

Our civilization, and indeed, the scientific revolution, was founded on the value and meaning of men and the dominion of these men over nature.

> *And God blessed them (man and woman), and God said unto them, Be fruitful and multiply, and replenish the earth, and subdue it: and have domination over the fish of the sea, and over the fowl of the air, and over every living thing that moveth upon the earth.* (Genesis 1:28)

It strikes me as being a tragic irony that the men of this civilization who set out to claim their dominion over the earth by way of the scientific revolution might in the end be sucked down onto an equal footing with the things of the earth—subdued by the very thing that they had tried to subdue.

Men are much more than machines, much more. A man has much more value and meaning than any machine—because he is a man. Our country must understand this before it is too late—before we lose the dignity and meaning that is ours as men.



During the 75th Anniversary symposium of February 5 and 6, many of this country's top scientists and engineers entered into an open discussion of science — here is the transcription of one of these sessions

THE FUTURE CHALLENGES OF SCIENCE

WINDING UP the two-day symposium on "Engineering for Major Scientific Programs" was a challenging panel discussion on the rather involved topic of "Recommended steps for universities, industry, and government to facilitate the solving of future problems associated with large-scale scientific pursuits." This panel discussion, moderated by Dr. John A. Hrones, vice president for academic affairs of Case Institute of Technology, turned out to be one of the most exciting two hours of the entire symposium. Here, as transcribed from the tapes sans applause, is that discussion:

Hrones: Ladies and gentlemen, we are ready to start the panel session: I think you have all met the members of the panel. I will repeat their names and positions. Proceeding to my left, Dr. D. W. Bronk, President of the Rockefeller Institute; Mr. J. J. Harwood, Manager of the Metallurgy Department of Ford Motor Company; Dr. C. E. Larson, Vice President of Union Carbide Nuclear Company; Mr. Jesse Mitchell, Office of Space Sciences, NASA; Dr. R. M. Robertson, Associate Director (Research), National Science Foundation; Dr. Ernst Weber, President of Polytechnic Institute of Brooklyn; and Dr. W. A. Rosenblith, Professor of Communications Biophysics, MIT.

I remember as a boy deep in Yankee territory that one of the pieces of information stored in the rapid access element of my memory was the sentence "I'm a ramblin' reck from Georgia Tech and a hell of an engineer." When I heard that said or sung it came through without question with a certain amount of undisguised decisiveness. And I suspect that in celebrating its 75th Anniversary, Georgia Tech would like all of us participating in the affairs of these two days to help them in their task of decisively preparing each one of which is "a hell of an engineer."

In doing this, it seems to me that there is need for clarity of what engineering is or at least what Georgia Tech may think it is, and I was particularly pleased to see some sharpening of that focus by the speakers this afternoon. I think that one can state what constitutes the focus of engineering and what constitutes the focus of science. They are not the same, although people who actually concentrate in engineering work with and at times operate as scientists. Similarly, people who are stretching toward the peak that represents the focus of science, many times are involved in doing engineering work in reaching for goals they set for themselves in science. So just as one can clearly see two mountain peaks and that one runs into trouble when one tries to define where the mountain stops and where the plains and valleys begin, so one runs into endless discussion if one does the same thing with peaks and valleys of engineering and science. Statements have been made that define engineering, and I would rephrase the definition. I think the single focus of engineering is design, where design is defined as the bringing into being of something that did not exist before. This may be a machine, it may be a device, it may be a system. The aim of the scientist is to search for new knowledge. The engineer designs and builds and gets his great satisfaction in having been able to build something that is new and different and didn't exist before.

We've talked about the kinds of problems that engineers and scientists deal with. We have been impressed by the growth in the magnitude of those problems and in the understanding that whether they are engineering problems or whether they are problems in science, that many of the most important problems to our society require joint effort by people who consider themselves engineers or scientists. It seems to me that as I listened to the distinguished speakers I could detect perhaps two kinds of problems, and again I don't want to get into an argument about the gray area between these two. I suppose I may violate certain definitions in mathematics by dividing these problems into two categories—those I would call stationary problems and those I would call non-stationary problems. The stationary problems being those where in essence the problem remains essentially the same over a relatively long period of time. The solution of such problems can often await the development of the necessary knowledge to understand all phases of that problem. There are many such problems of enormous importance and great difficulty. A number of these were discussed in the last two days. Then there is the case of the non-stationary problem. The problem that faces us at a given time in space. If we fail to solve it at that time, the problem changes and in a way the limitations on the possible solutions are narrowed down. Thus the failure to appropriately solve an integrated transportation system in the United States at whatever time you might want to suggest in the 1930's was a failure that cannot be ever fully recouped. The chance for solving that problem with the same limitations will never come again. The problem of solving the integrated transportation problems that face this country today and will face it 25 years from now can and must be solved differently today than they can 25 years from now. This is true in two respects: First, we will know more 25 years from now about the problem than we do now. On the other hand, the additional serious limitations which will be imposed on the possible solutions with the growth of urban areas, the solidification of social boundaries. All of these things change the very nature of the problem. Yet both kinds of problems are ones that institutions such as Georgia Tech hope to train engineers and scientists to provide the leadership in meeting and solving them when they must be solved.

I know that my position is not to make statements of this kind, but I can't resist them, and with that I would also just make a few statements concerning the tasks of education. Education, as a number of the speakers have pointed out, is a life-long task. A number of social institutions enter into this job of educating men. The family, the primary and the secondary school divide up something like 16 to 18 years of a man's life in trying to do something here. The college or university take something like 4 to 7 or 8 years to do their task, and then government and industry have by all lots the greatest opportunity. They have a period of something like 40 years in which a man spends his life continuing education. So the task of my institution, the task of Dr. Weber's institution and the task of Georgia Tech is to most effectively make use of the smallest time that any social institution has to carry out our business of learning. It was clearly pointed out by Dr. Rosenblith and some others that we know little about the learning process. So we are trying to develop the kind of program that's stimulating and will prepare talented people to be leaders in the world 15, 20 or 25 years from now. The basic process we are dealing with is learning: learning ourselves and encouraging our younger colleagues to learn. Well, that is the task that we are faced with, and I hope that some of the questions you will address to the panel will help Georgia Tech face up to what they can do to meet this problem: the problem of tomorrow, which they must meet today.

Goeffrey Keller, National Science Foundation: I am, of course, very much interested in the remarks just made and those that have been made all along about the close intimacy between the task of the engineer and scientist as well as those initiating the clear differentiation between the interests and goals of the two individuals. The topic for this symposium deals with how we can get on with large scientific projects. It seems to me that this implicatively means how we can use these diverse, different abilities together to achieve a goal which requires the abilities of these groups. Now, this, of course, leads to problems in management, because you have men of different talents, and no one man can easily acquire today all of the knowledge and all of the information that the individual members of his team have. Yet, on the other hand, if it is going to be a complex system, the kind that has never been built before, some one individual, or some one computing machine, or some one device must somehow or other keep in mind all of the imputs from the various members of the team and make sure that the end product utilizes those inputs properly. The question I would like to ask Dr. Robertson is: Suppose that one is embarking on a major scientific program involving major engineering, what precautions should be taken, what things should we keep in mind in assembling the team of men and if necessary machines, possibly industrial firms, and organizing them into an operating group, in order to assure that the ultimate system developed will indeed be a well integrated one, utilizing the talents of the various component inputs?

Robertson: Well, I can start out by saying that this, of course, is the real problem that we are wrestling with, stated in almost its most general form. In my talk when I emphasized the need for improving our design capabilities, I was really challenging the engineers to come up with a solution that included an answer to the problem of how we organize one of these efforts in order to assure ourselves that we will get optimum results. I can't help feel that one component must be the project engineer or manager with his own abilities amplified

and deepened by some "attachment" to a computer, whic
will not replace him but intensify his ability to cope with th
problem. It is to a certain extent the same problem wit
which the military people have been wrestling. How can w
help the task force or area commander—how can we deepe
his ability to manipulate his forces? This has been in pa
solved by various kinds of data systems which bring th
information into cleared form and present him with just thos
elements of the information which enable him to make th
right strategic or tactical decision. And by some analogy wit
this, we must try to enable the team attacking one of thes
problems to have the information before them better an
more systematically than is possible today. There will alway
be a certain amount of confusion either in a battle or
scientific project, but hopefully not as much as we have see
in some of the ones that I have observed.

W. W. Pleasants, Green Bank: I'll make the statement first th
I am a newcomer at Green Bank and, therefore, I ha
nothing to do with the design of the 140 foot telescope. Th
problem is one that I am directly concerned with. To m
there is a third leg missing in the support and that is the are
of contracting. And speaking as an engineer who has t
marshal these forces and get the work done, we only get
done through contracting it to engineering firms, materi
suppliers, construction firms, and so forth. We are faced wit
a dilemma. Do we wrap the thing up in a tight package s
that we can get the best price, and know in advance what it
going to cost. If we do this, then when the scientist wants t
make a change along the line, we say "no" we have a contra
and if you put any extras in, we'll run over on the cost. The
the other way is to leave it open—cost plus or CPFF, som
thing like that, in which case your financial picture gets out c
balance. Now, maybe there is somebody at Georgia Tech c
elsewhere who could help us with this aspect of the proble

Robertson: In part, of course, this is a matter of thinking th
thing through as far as possible to begin with, and of achie
ing a flexible management system so that the inevitab
scientific changes that occur in dealing with scientists can b
brought into the design without adding too much to the cos
You have hinted at the very, very difficult problem of relatin
a major project of a scientific nature to the federal budg
process. In other words, we bureaucrats have to go and g
the money for it. We have to make certain commitments th
it is going to be built within so many dollars. We have to d
that without full knowledge, and sometimes we have to g
crawling back and explain that it really is going to cost mor
This is an added dimension of difficulty to any project th
involves funding by the federal government. I don't have
solution for that one either.

Hrones: Dr. Weber, I think, implicit in both of those que
tions was the need for at least some of our engineers t
assume major leadership responsibility in the manageme
of relatively large groups of people working on large syste

ıgineer designs and builds and gets his great satisfaction in aving been able to build something that is new and different ıd didn't exist before.

We've talked about the kinds of problems that engineers ıd scientists deal with. We have been impressed by the rowth in the magnitude of those problems and in the underanding that whether they are engineering problems or hether they are problems in science, that many of the most nportant problems to our society require joint effort by eople who consider themselves engineers or scientists. : seems to me that as I listened to the distinguished speakers could detect perhaps two kinds of problems, and again I on't want to get into an argument about the gray area beveen these two. I suppose I may violate certain definitions ı mathematics by dividing these problems into two cateories—those I would call stationary problems and those I 'ould call non-stationary problems. The stationary problems eing those where in essence the problem remains essentially ıe same over a relatively long period of time. The solution f such problems can often await the development of the ecessary knowledge to understand all phases of that prob-ːm. There are many such problems of enormous importance nd great difficulty. A number of these were discussed in the ıst two days. Then there is the case of the non-stationary roblem. The problem that faces us at a given time in space. f we fail to solve it at that time, the problem changes and in way the limitations on the possible solutions are narrowed own. Thus the failure to appropriately solve an integrated ransportation system in the United States at whatever time ou might want to suggest in the 1930's was a failure that annot be ever fully recouped. The chance for solving that roblem with the same limitations will never come again. 'he problem of solving the integrated transportation prob-ːms that face this country today and will face it 25 years rom now can and must be solved differently today than they an 25 years from now. This is true in two respects: First, /e will know more 25 years from now about the problem ıan we do now. On the other hand, the additional serious imitations which will be imposed on the possible solutions /ith the growth of urban areas, the solidification of social oundaries. All of these things change the very nature of the roblem. Yet both kinds of problems are ones that institu-ions such as Georgia Tech hope to train engineers and cientists to provide the leadership in meeting and solving hem when they must be solved.

I know that my position is not to make statements of this ind, but I can't resist them, and with that I would also just nake a few statements concerning the tasks of education. Education, as a number of the speakers have pointed out, is a ife-long task. A number of social institutions enter into this ob of educating men. The family, the primary and the sec-ndary school divide up something like 16 to 18 years of a nan's life in trying to do something here. The college or uni-ersity take something like 4 to 7 or 8 years to do their task, and then government and industry have by all lots the greatest opportunity. They have a period of something like 40 years in which a man spends his life continuing education. So the task of my institution, the task of Dr. Weber's institution and the task of Georgia Tech is to most effectively make use of the smallest time that any social institution has to carry out our business of learning. It was clearly pointed out by Dr. Rosenblith and some others that we know little about the learning process. So we are trying to develop the kind of program that's stimulating and will prepare talented people to be leaders in the world 15, 20 or 25 years from now. The basic process we are dealing with is learning: learning ourselves and encouraging our younger colleagues to learn. Well, that is the task that we are faced with, and I hope that some of the questions you will address to the panel will help Georgia Tech face up to what they can do to meet this problem: the problem of tomorrow, which they must meet today.

Goeffrey Keller, National Science Foundation: I am, of course, very much interested in the remarks just made and those that have been made all along about the close intimacy between the task of the engineer and scientist as well as those initiating the clear differentiation between the interests and goals of the two individuals. The topic for this symposium deals with how we can get on with large scientific projects. It seems to me that this implicatively means how we can use these diverse, different abilities together to achieve a goal which requires the abilities of these groups. Now, this, of course, leads to problems in management, because you have men of different talents, and no one man can easily acquire today all of the knowledge and all of the information that the individual members of his team have. Yet, on the other hand, if it is going to be a complex system, the kind that has never been built before, some one individual, or some one computing machine, or some one device must somehow or other keep in mind all of the imputs from the various members of the team and make sure that the end product utilizes those inputs properly. The question I would like to ask Dr. Robertson is: Suppose that one is embarking on a major scientific program involving major engineering, what precautions should be taken, what things should we keep in mind in assembling the team of men and if necessary machines, possibly industrial firms, and organizing them into an operating group, in order to assure that the ultimate system developed will indeed be a well integrated one, utilizing the talents of the various component inputs?

Robertson: Well, I can start out by saying that this, of course, is the real problem that we are wrestling with, stated in almost its most general form. In my talk when I emphasized the need for improving our design capabilities, I was really challenging the engineers to come up with a solution that included an answer to the problem of how we organize one of these efforts in order to assure ourselves that we will get optimum results. I can't help feel that one component must be the project engineer or manager with his own abilities amplified

and deepened by some "attachment" to a computer, which will not replace him but intensify his ability to cope with the problem. It is to a certain extent the same problem with which the military people have been wrestling. How can we help the task force or area commander—how can we deepen his ability to manipulate his forces? This has been in part solved by various kinds of data systems which bring the information into cleared form and present him with just those elements of the information which enable him to make the right strategic or tactical decision. And by some analogy with this, we must try to enable the team attacking one of these problems to have the information before them better and more systematically than is possible today. There will always be a certain amount of confusion either in a battle or a scientific project, but hopefully not as much as we have seen in some of the ones that I have observed.

W. W. Pleasants, Green Bank: I'll make the statement first that I am a newcomer at Green Bank and, therefore, I had nothing to do with the design of the 140 foot telescope. This problem is one that I am directly concerned with. To me there is a third leg missing in the support and that is the area of contracting. And speaking as an engineer who has to marshal these forces and get the work done, we only get it done through contracting it to engineering firms, material suppliers, construction firms, and so forth. We are faced with a dilemma. Do we wrap the thing up in a tight package so that we can get the best price, and know in advance what it's going to cost. If we do this, then when the scientist wants to make a change along the line, we say "no" we have a contract and if you put any extras in, we'll run over on the cost. Then the other way is to leave it open—cost plus or CPFF, something like that, in which case your financial picture gets out of balance. Now, maybe there is somebody at Georgia Tech or elsewhere who could help us with this aspect of the problem.

Robertson: In part, of course, this is a matter of thinking the thing through as far as possible to begin with, and of achieving a flexible management system so that the inevitable scientific changes that occur in dealing with scientists can be brought into the design without adding too much to the cost. You have hinted at the very, very difficult problem of relating a major project of a scientific nature to the federal budget process. In other words, we bureaucrats have to go and get the money for it. We have to make certain commitments that it is going to be built within so many dollars. We have to do that without full knowledge, and sometimes we have to go crawling back and explain that it really is going to cost more. This is an added dimension of difficulty to any project that involves funding by the federal government. I don't have a solution for that one either.

Hrones: Dr. Weber, I think, implicit in both of those questions was the need for at least some of our engineers to assume major leadership responsibility in the management of relatively large groups of people working on large system problems. Would you speak to the question of what engineering schools can do with respect to increasing the output of talented people competent and willing to assume such responsibility.

Weber: I don't think I can at this moment say what engineering colleges will do. In my own talk, I pointed out the need to start with the introduction of programs along the lines of systems thinking. We have had illustrations of the need for systems concepts for quite some while, but none of our institutions, in fact, none of our industries has fully developed a method for dealing with a really complicated system. The whole procedure is in its infancy. I have here a note that Jack Norton of Bell Telephone Laboratories penned out, and it indicates the relative scope of what we are dealing with. He doesn't define systems engineering. There is no such definition available. It has been effected, but everybody criticizes it so much that it is always withdrawn. So this definition is not a definition of systems engineering but methods. The systems engineering method recognizes each system has an integrated whole, even though composed of batteries, specialized structures, and sub-functions. It further recognizes that every system has a number of objectives. The methods balance may vary widely from system to system. The methods seek to optimize the overall system functions according to the weighted objectives and to achieve maximum capability of its parts. This is an academic definition, but it indicates the real complexity of the problem. I don't think that we can hope within a short period of time to furnish trained systems engineers. We can rely upon some of the people to grow up to these responsibilities and hope that they will become our teachers.

Howard D. Edwards, Georgia Tech: In seeking a greater supply of trained engineers and scientists, one of the problems that the university faces certainly is whether or not it should increase the length of time that you spend in college for a bachelor's degree. In giving the students training in many of these areas we discussed, we are running out of time. I would like, since we have quite a mixture of academic and industrial people on the panel, to get some discussion going among them on this idea of increasing the curriculum to say a 5-year program instead of four, which would, of course, temporarily cut back the supply, but this would only be temporary because the system would eventually be turning them out at the same rate.

Bronk: It has been suggested that I answer this, I suppose because I began my career as an educator, and I am back in education again. I am reminded of a question that was asked me, essentially the same, at this noon time. I commented then that because of the influence of industry and commercial leaders rather than engineering leaders, the retirement age is being reduced. And, because there is an increasing body of knowledge which it is assumed must somehow be pumped into our students, the curves representing age of graduation and age of retirement may ultimately cross.

I am concerned by the fact that many of our students are being trained to solve the problems of the immediate future or the present. There is little thought being given to the fact that the pinnacles of our young people's careers will be reached 25 and 30 and 40 years from now, provided the retirement age doesn't keep on going down. We should be concerned with fitting these young men and women to grow with changing times and to be able to deal with problems 25 and 30 years from now. The reason we so frequently concentrate on training people to deal with problems of the immediate present is in part because faculty members don't have vision enough to see that what they know is not the limit of all that is to be known. That's an extreme statement. Another reason is that our graduate students are too often used as helpers for those who are already trained. In other words, they are the assistants of the professors. I think that because we should always be looking to the future, a senior professor should never be a director of a young man's research. He should be an advisor, a counsellor, a guide, an exacting examiner, but he should never impose the limits of his imagination upon the more vital imagination of young people. And so I would say, take as long as necessary to give young people the basic foundations upon which they can grow. I think this could be done in a much shorter time than we generally require if we would not endeavor to pump knowledge into the student, but would train him to use his mind.

Hrones: I only have one comment in response to the question. In a school such as a number of our schools of engineering and science, there are strong resident graduate programs, and therefore, a program which provides a 4-year undergraduate with the opportunity to continue with either that institution or another institution for one, two, three or four or more years—thus there is provision for flexibility with respect to the length of time a man can spend on the campus.

Harwood: On the subject of education, we would like to make a plea that the interdisciplinary spirit, particularly on the undergraduate level, not be converted entirely into a completely non-disciplinary one. In other words, it doesn't do any of us much good to have students come out who are essentially trained with a smattering of ignorance. You can see this particularly in the growing fields of materials sciences where a man comes out of some schools not quite sure whether he is a metallurgist or a physicist. And he is neither a good solid state physicist nor a good metallurgist. Interdisciplinariness is a wonderful thing when you actually get into research or get into engineering or into industry or anywhere, in which you interact with people of other disciplines. In other words, interdisciplinariness itself carries the connotation of other disciplines mixing with one another, and the plea we want to make is that the student at least have a depth of knowledge in a field, as well as a breadth of knowledge.

Bronk: Might I, in support of what Mr. Harwood has said, remind you of the very old phrase that is as applicable to the present as it was when first uttered, "It is desirable to know something about everything, and everything about something." Unless you know everything about something, in the sense which Mr. Harwood has spoken, it is relatively futile to know something about everything, because then you become superficial.

Robert M. Page, U.S. Naval Research Lab: Rather than increase the time the student must spend in college to become proficient, is there something to be gained by calling upon these devices which when specialized to a particular function, can out-perform the human. I am wondering if Dr. Rosenblith would like to say something about the self-pacing of teaching machines.

Rosenblith: I don't feel that I am particularly expert in this area. Experimentation in education is one of the hardest tasks to carry out in a controlled manner. Changing curricula may seem a good way to keep the faculty awake in faculty meetings, but success can not always be documented in terms of increased efficiency. The point I was trying to make this morning is that we need to experiment with a broad spectrum of novel learning and teaching techniques. Such experimentation must be carried on a sufficiently comprehensive basis so that one can get at least a "seat-of-the-pants" feeling of whether one is getting anywhere. Industrial concerns, such as the Bell Telephone System, have made use of teaching machines rather successfully on a limited scale. There is some discussion of whether—to cite an example—a teaching machine program for neuroanatomy is just what the doctor ordered. Carnegie Tech is at present experimenting with programs in which the computer assists the student in the task of self pacing. Thus we may do more than simply recognize that there are individual differences in learning speed and power. (Only too often do we fail to challenge the very best pupils and make no contact with members of a class who haven't acquired the necessary background.)

How this growing technology is going to be used in the next decades is a crucial issue for both academic institutions and the whole engineering profession. The Ford Foundation has financed an experimental program at Michigan in which computers are being used in design problems in many courses in engineering subjects. This is a useful start, but it hardly limits the scope of this technological device whose potential value depends whether or not we can learn to use it.

What can these teaching or learning machines do for people who have not yet retired but left college? Maybe they can constitute the key invention of a novel self-paced system of adult education. No one knows at this time the limits of the usefulness, but unless we experiment on a significant scale we may never know them. Maybe the new Commissioner of Education in Washington can in this area of contemporary educational techniques provide the impetus that seems as yet lacking.

W. P. Bebbington, DuPont: A number of years ago when I was on a university faculty as an instructor, we had what I suppose is still a common problem. We looked at where the graduates of the University's engineering school of 15 or 20 years previously were working, and many of these graduates were in pretty high administrative positions. Then the question came up whether or not we should have taught those graduates what they were taught 15 or 20 years previously, and there was a considerable feeling that the answer to this might be "no" that they should have been taught more administrative skills, economics, etc. rather than mechanical, electrical, chemical engineering. Now, then we have before us eight men who have become rather eminent in the fields of administration, academic life, industrial activities and governmental affairs. I wonder if any of them would care to say what, if they could have known at the time they were in college where they were going to be now, would they have taken that they did not take. I would like to put it that way—what would they have sacrificed in order to have taken something different which would have helped them now.

Mitchell: Well, if I'd known then that I would be here, I probably would have taken public speaking. Seriously though I have thought about the same question as to whether engineering, which is my background, is suitable for management or administration or being a bureaucrat, as Dr. Robertson says.

I think there is a need in administration for people with a background in the sciences and engineering. Being in Washington and having not been there too long, I feel very strongly that unless there are people that have a background of sciences and engineering and maybe basic experience, that we sort of lose sense of the reality of life. The problems that Dr. Weber mentioned—I am sympathetic with the problem of having to tell the government what you are going to do 18 months from now. In order to clarify this statement, I might add that right now we are working on fiscal year '63 programs, we have fiscal year '64 programs in Congress, and we are just starting on fiscal year '65. Specifically, in my own case, I think that I would if I knew that I was going to be in this area that I am now in, I would have taken more science. I think this points up the sort of general theme that has been discussed.

I was particularly interested in what Professor Weber had to say with regard to this. As I understand his thesis, he would say that for engineering training he would propose that the first four years should concentrate on the fundamentals. I believe he mentioned a better understanding of physics rather than getting off on the drawing board and some of the mechanics. I would take more physics. I would also take more English, public speaking, and the humanities.

Weber: I would like to underline this emphasis upon fundamentals certainly in the first four years. There is not time enough in any one's life to learn everything that he would ever want to do within any reasonable amount of time.

and age of retirement may ultimately cross.

I am concerned by the fact that many of our students are being trained to solve the problems of the immediate future or the present. There is little thought being given to the fact that the pinnacles of our young people's careers will be reached 25 and 30 and 40 years from now, provided the retirement age doesn't keep on going down. We should be concerned with fitting these young men and women to grow with changing times and to be able to deal with problems 25 and 30 years from now. The reason we so frequently concentrate on training people to deal with problems of the immediate present is in part because faculty members don't have vision enough to see that what they know is not the limit of all that is to be known. That's an extreme statement. Another reason is that our graduate students are too often used as helpers for those who are already trained. In other words, they are the assistants of the professors. I think that because we should always be looking to the future, a senior professor should never be a director of a young man's research. He should be an advisor, a counsellor, a guide, an exacting examiner, but he should never impose the limits of his imagination upon the more vital imagination of young people. And so I would say, take as long as necessary to give young people the basic foundations upon which they can grow. I think this could be done in a much shorter time than we generally require if we would not endeavor to pump knowledge into the student, but would train him to use his mind.

Hrones: I only have one comment in response to the question. In a school such as a number of our schools of engineering and science, there are strong resident graduate programs, and therefore, a program which provides a 4-year undergraduate with the opportunity to continue with either that institution or another institution for one, two, three or four or more years—thus there is provision for flexibility with respect to the length of time a man can spend on the campus.

Harwood: On the subject of education, we would like to make a plea that the interdisciplinary spirit, particularly on the undergraduate level, not be converted entirely into a completely non-disciplinary one. In other words, it doesn't do any of us much good to have students come out who are essentially trained with a smattering of ignorance. You can see this particularly in the growing fields of materials sciences where a man comes out of some schools not quite sure whether he is a metallurgist or a physicist. And he is neither a good solid state physicist nor a good metallurgist. Interdisciplinariness is a wonderful thing when you actually get into research or get into engineering or into industry or anywhere, in which you interact with people of other disciplines. In other words, interdisciplinariness itself carries the connotation of other disciplines mixing with one another, and the plea we want to make is that the student at least have a depth of knowledge in a field, as well as a breadth of knowledge.

Bronk: Might I, in support of what Mr. Harwood has said, remind you of the very old phrase that is as applicable to the present as it was when first uttered, "It is desirable to know something about everything, and everything about something." Unless you know everything about something, in the sense which Mr. Harwood has spoken, it is relatively futile to know something about everything, because then you become superficial.

Robert M. Page, U.S. Naval Research Lab: Rather than increase the time the student must spend in college to become proficient, is there something to be gained by calling upon these devices which when specialized to a particular function, can out-perform the human. I am wondering if Dr. Rosenblith would like to say something about the self-pacing of teaching machines.

Rosenblith: I don't feel that I am particularly expert in this area. Experimentation in education is one of the hardest tasks to carry out in a controlled manner. Changing curricula may seem a good way to keep the faculty awake in faculty meetings, but success can not always be documented in terms of increased efficiency. The point I was trying to make this morning is that we need to experiment with a broad spectrum of novel learning and teaching techniques. Such experimentation must be carried on a sufficiently comprehensive basis so that one can get at least a "seat-of-the-pants" feeling of whether one is getting anywhere. Industrial concerns, such as the Bell Telephone System, have made use of teaching machines rather successfully on a limited scale. There is some discussion of whether—to cite an example—a teaching machine program for neuroanatomy is just what the doctor ordered. Carnegie Tech is at present experimenting with programs in which the computer assists the student in the task of self pacing. Thus we may do more than simply recognize that there are individual differences in learning speed and power. (Only too often do we fail to challenge the very best pupils and make no contact with members of a class who haven't acquired the necessary background.)

How this growing technology is going to be used in the next decades is a crucial issue for both academic institutions and the whole engineering profession. The Ford Foundation has financed an experimental program at Michigan in which computers are being used in design problems in many courses in engineering subjects. This is a useful start, but it hardly limits the scope of this technological device whose potential value depends whether or not we can learn to use it.

What can these teaching or learning machines do for people who have not yet retired but left college? Maybe they can constitute the key invention of a novel self-paced system of adult education. No one knows at this time the limits of the usefulness, but unless we experiment on a significant scale we may never know them. Maybe the new Commissioner of Education in Washington can in this area of contemporary educational techniques provide the impetus that seems as yet lacking.

W. P. Bebbington, DuPont: A number of years ago when I was on a university faculty as an instructor, we had what I suppose is still a common problem. We looked at where the graduates of the University's engineering school of 15 or 20 years previously were working, and many of these graduates were in pretty high administrative positions. Then the question came up whether or not we should have taught those graduates what they were taught 15 or 20 years previously, and there was a considerable feeling that the answer to this might be "no" that they should have been taught more administrative skills, economics, etc. rather than mechanical, electrical, chemical engineering. Now, then we have before us eight men who have become rather eminent in the fields of administration, academic life, industrial activities and governmental affairs. I wonder if any of them would care to say what, if they could have known at the time they were in college where they were going to be now, would they have taken that they did not take. I would like to put it that way—what would they have sacrificed in order to have taken something different which would have helped them now.

Mitchell: Well, if I'd known then that I would be here, I probably would have taken public speaking. Seriously though I have thought about the same question as to whether engineering, which is my background, is suitable for management or administration or being a bureaucrat, as Dr. Robertson says.

I think there is a need in administration for people with a background in the sciences and engineering. Being in Washington and having not been there too long, I feel very strongly that unless there are people that have a background of sciences and engineering and maybe basic experience, that we sort of lose sense of the reality of life. The problems that Dr. Weber mentioned—I am sympathetic with the problem of having to tell the government what you are going to do 18 months from now. In order to clarify this statement, I might add that right now we are working on fiscal year '63 programs, we have fiscal year '64 programs in Congress, and we are just starting on fiscal year '65. Specifically, in my own case, I think that I would if I knew that I was going to be in this area that I am now in, I would have taken more science. I think this points up the sort of general theme that has been discussed.

I was particularly interested in what Professor Weber had to say with regard to this. As I understand his thesis, he would say that for engineering training he would propose that the first four years should concentrate on the fundamentals. I believe he mentioned a better understanding of physics rather than getting off on the drawing board and some of the mechanics. I would take more physics. I would also take more English, public speaking, and the humanities.

Weber: I would like to underline this emphasis upon fundamentals certainly in the first four years. There is not time enough in any one's life to learn everything that he would ever want to do within any reasonable amount of time. There have been serious suggestions towards lengthening the four years of college to five, six or seven. It doesn't make sense. We are not training people to do whatever they do in their lives at any time. We are trying to put down fundamentals so that they can learn for themselves to adapt to the changing requirements of their environment or their life. If we are successful, then I think we have successfully educated. We can never train for everything that we will ever do.

Harwood: It always upsets my friends who make a fetish of operations research and management philosophy, when I use the type of language that Dr. Robertson used this afternoon in saying that all they can say, all that they are doing is building up a particular jargon in methodology about the principles of common sense, and this is really what administration and management consists of. It turns out that a Harvard Business School graduate cannot step in and run a scientific or engineering laboratory, not unless he knows about science and engineering, so it is a very difficult question to ask what should you have learned to help you in what you are doing now. What you are doing now, of course, is the net consequence and result of all the experiences and education which you have accumulated during your lifetime. As a matter of fact, one of the evils which industry tends to perpetuate and now universities have joined in as a result of the large-scale government supported program, is essentially to convert good creative scientists and engineers much too early into administrators and managers. As Parkinson says in his recent article in the *Bulletin of Atomic Sciences,* if you are a successful scientist you soon become an administrator and those who don't become administrators become editors of journals.

Larson: I would like to point out that the answer to this question probably would be different depending on what day of the week the question was asked. One day you would probably wish you had taken more personnel training, another day you certainly might wish you had taken some labor relations training, etc. I think the most important thing is a grounding in the fundamentals such as mathematics, physics, chemistry and, perhaps most importantly, the basic skills of the English language.

Robertson: I would like to put in my bit on this. We will be going up on February 26 to face the House Appropriations Subcommittee, which is concerned with the NSF appropriations, and I'll be backing up Dr. Waterman there that day. Looking back at my education, I can't think of anything that I should or shouldn't have taken that will help me much on that occasion. I do feel very definitely that for a job such as I have, an administrator responsible for a large federal basic research program, an education which included training for basic research is essential. This kind of program should be in the hands of people who have lived through some of the real problems that the research scientist faces

SCIENCE AND MAN-continued

and have not just read about them in a book or heard about them in a conference.

Bronk: Before we end the comments on the question that was asked, and because I, too, will be before that congressional committee, may I say I don't agree with Mr. Robertson. I value the fact that I was trained as a naval pilot, as an engineer, as a physicist, a physiologist, and a journalist, even as a dean and a college president; I find that all of those backgrounds contribute to my being able to understand the points of view of politicians. The reason I made the remark I've just made is because I think diversity of experience is important; too many of us let ourselves get trapped into a narrow groove of activity. Every time I hear a factory whistle blow I think of the ten long weeks I spent as a workman at $5.08 per week working 56 hours a week sorting collars at a Cluett-Peabody collar factory. I think of the days when I worked as a shipfitter's helper in the Sun Shipbuilding Yards at Chester, Pennsylvania. I think of the days when I worked as a steamfitter's helper in the Delaware and Hudson Railroad yards. I know what it means to be trapped in narrow grooves of activity, which erode the spirit of adventure of people. I would like to see more individuals fired with a curiosity, fired with a willingness of adventure, willing to give up security. I think that all of us have greater capacities for adventure than any of us have ever used. This comes back to the question of what should be the objects of education. I would say that we should encourage the ability to learn, the desire for intellectual adventure. I recall an experience of the President of a great university. For years he tried to get his faculty to reduce the number of required courses from 5 to 4. Ultimately he succeeded. There was this significant result of that action: the number of books used, the number of hours spent by students in the library in that first year after reduction in the number of required courses increased 60%. Sixty percent more use of the library means to me just one thing. The students had more time to learn; they had more time to learn because they were being taught less. If we can give all of our students the zest for adventure, the desire to learn, the will to understand, I think we will best solve the problem "How can universities facilitate the solving of future problems?".

Hrones: I would venture a few comments in answer to the question. As I think back to my own education which came, I guess, at the end of one era and the beginning of a new era, (I also think every era is the ending of an old era and the beginning of a new one). I did have a unique experience as an undergraduate. One, that in the courses regarded as basic and far-reaching at that time and taught by people who are still making contributions to the field, I also came under the influence of a group of people who had made contributions earlier in their lives, and these early contributions completely dominated their complete outlook on life. They were dealing with problems that were no longer the serious problems of the society in which they lived. Also as a senior, I had the unique experience of working with Dr. Bush on one of his research projects. And I would say that one of the great excitements was first of all to think that Dr. Bush would actually believe that I, a student, an undergraduate student, could make a contribution to a new scientific undertaking. I suspect that the fact that he expected this out of me made me resolve that I would try to make such a contribution. Secondly, that we had on the group working on this project some undergraduates and graduates from physics, and I recall one from chemistry, and we worked together as undergraduates on a problem that was clearly a problem of the future, a problem that we regarded of importance to the society. We were given a clear understanding that we were expected to make a contribution, and this was not a student problem. I would suggest that this is an important element in not only graduate education but undergraduate education. Somehow, at least a fraction of the students in a school of this kind should be directly involved with a problem that has meaning and is important in the society of their time or of the future. They should be looked upon not really as students but as colleagues who are expected to make a contribution to this problem. I suppose that if we could have more of our professors who involve students in this kind of problem, that we would have a greater motivation, and a greater sense of excitement and involvement on the part of the student that would make the basic discipline have more meaning than otherwise.

Richard L. Doan, Phillips Petroleum: I think the last few remarks have highlighted a very important problem. All of us had our spark of interest lighted by some outstanding teacher. Now, with the ratio of students to teachers going up by a factor of ten, and with many of our outstanding teachers off on government jobs or advising the government in some contract or other, how do you light the spark?

Weber: I'm not quite certain that I can answer, but in the schools that I have observed the ratio of students per teacher has not changed markedly. It is only in certain liberal arts and some public institutions that the ratio has gone up considerably. Television, closed television, etc. will increase that, but then teachers will have assistance to pay individual attention to the students—the small student groups. It is a problem of experimentation. We don't have the answer yet for that, but I think in the progressive schools that you normally want to evaluate, for example in this school, the number of students per teacher does not change radically.

Phil Leroy, Georgia Department of Labor: We've talked about this question of graduating and finishing your education and retirement curves getting closer and closer. Could this education start earlier? I'm thinking partly in my own case. I graduated with an eight-course diploma from the Baltimore Polytechnic Institute, which allowed me to enter Georgia Tech as a sophomore. There are some similar high schools, Brooklyn Polytechnic and one of the science high schools in New York City. Could there be more of this type high school around the country where if a student were interested he could start earlier to be an engineer?

Hrones: One attempt to meet this problem is the advance placement program that is rapidly growing in the country. Students in an increasing number of secondary schools have the opportunity of undertaking courses that are of a college freshman level and are so accepted by the best institutions in the country. Perhaps there are others here though who would want to comment on that question.

Robertson: I am convinced that it is possible to have much more mathematics and science absorbed during the high school years than we now realize, and that one way to cope with the vast increase of knowledge that has to be absorbed is to have more absorbed at the high school level.

Mitchell: I guess this goes back to the other question, but with regard to the teacher-pupil ratio, it seems that there is a one-way street here with teachers going to industry and government, as consultants. Is there a need, and I think there is some indication of this, for a trend to go back the other way. That is, for industry and government to be unselfish enough to allow their people to go to the schools, as it were, to teach in the schools. This is, I think, a possibility. There are people in industry, there are people in government that could challenge young people, if the opportunities were made available for them to teach.

Bronk: The Bell Telephone Laboratories provide examples of this. Jim Fisk, the President of the Bell Telephone Laboratories, went from the academic world, to industry, to the academic world, and back again. John Bardeen went from the Bell Laboratories to the University of Illinois. William Baker, the present Vice-President in charge of Research, is actively engaged in various educational programs, as a trustee and as a lecturer; he strongly emphasizes the desirability of what you have just suggested. It has the advantage of providing assistance to educational institutions, by way of giving service; it brings into the academic world a sense of realism and contacts with the applications of science for human use, and conversely it brings industry into contact with the educational trends.

R. J. J. Lockatel, Architect: When Dr. Weber was speaking he made a comment that, particularly at the graduate level, many of the polytechnic institutes, being the logical schools to generate instruction at the increasing numbers of engineering disciplines, apparently would be unable to do so simply for the lack of funds. He indicated that it would be necessary to rely on the federal government for such assistıd have not just read about them in a book or heard about em in a conference.

onk: Before we end the comments on the question that as asked, and because I, too, will be before that congres- ɔnal committee, may I say I don't agree with Mr. Robert- n. I value the fact that I was trained as a naval pilot, as ı engineer, as a physicist, a physiologist, and a journalist, 'en as a dean and a college president; I find that all of ose backgrounds contribute to my being able to under- and the points of view of politicians. The reason I made e remark I've just made is because I think diversity of ;perience is important; too many of us let ourselves get apped into a narrow groove of activity. Every time I :ar a factory whistle blow I think of the ten long weeks spent as a workman at $5.08 per week working 56 hours week sorting collars at a Cluett-Peabody collar factory. think of the days when I worked as a shipfitter's helper in e Sun Shipbuilding Yards at Chester, Pennsylvania. I ink of the days when I worked as a steamfitter's helper the Delaware and Hudson Railroad yards. I know what means to be trapped in narrow grooves of activity, which ode the spirit of adventure of people. I would like to see ore individuals fired with a curiosity, fired with a willing- ɛss of adventure, willing to give up security. I think that l of us have greater capacities for adventure than any of ; have ever used. This comes back to the question of what ıould be the objects of education. I would say that we ıould encourage the ability to learn, the desire for intellec- ıal adventure. I recall an experience of the President of a 'eat university. For years he tried to get his faculty to :duce the number of required courses from 5 to 4. Ulti- ıately he succeeded. There was this significant result of that :tion: the number of books used, the number of hours ɔent by students in the library in that first year after reduc- on in the number of required courses increased 60%. ixty percent more use of the library means to me just one ıing. The students had more time to learn; they had more me to learn because they were being taught less. If we can ve all of our students the zest for adventure, the desire to arn, the will to understand, I think we will best solve the roblem "How can universities facilitate the solving of ıture problems?".

rones: I would venture a few comments in answer to the uestion. As I think back to my own education which came, guess, at the end of one era and the beginning of a new 'a, (I also think every era is the ending of an old era and ıe beginning of a new one). I did have a unique experi- ıce as an undergraduate. One, that in the courses regarded ; basic and far-reaching at that time and taught by people ho are still making contributions to the field, I also came nder the influence of a group of people who had made ɔntributions earlier in their lives, and these early contributions completely dominated their complete outlook on life. They were dealing with problems that were no longer the serious problems of the society in which they lived. Also as a senior, I had the unique experience of working with Dr. Bush on one of his research projects. And I would say that one of the great excitements was first of all to think that Dr. Bush would actually believe that I, a student, an undergraduate student, could make a contribution to a new scientific undertaking. I suspect that the fact that he expected this out of me made me resolve that I would try to make such a contribution. Secondly, that we had on the group working on this project some undergraduates and graduates from physics, and I recall one from chemistry, and we worked together as undergraduates on a problem that was clearly a problem of the future, a problem that we regarded of importance to the society. We were given a clear understanding that we were expected to make a contribution, and this was not a student problem. I would suggest that this is an important element in not only graduate education but undergraduate education. Somehow, at least a fraction of the students in a school of this kind should be directly involved with a problem that has meaning and is important in the society of their time or of the future. They should be looked upon not really as students but as colleagues who are expected to make a contribution to this problem. I suppose that if we could have more of our professors who involve students in this kind of problem, that we would have a greater motivation, and a greater sense of excitement and involvement on the part of the student that would make the basic discipline have more meaning than otherwise.

Richard L. Doan, Phillips Petroleum: I think the last few remarks have highlighted a very important problem. All of us had our spark of interest lighted by some outstanding teacher. Now, with the ratio of students to teachers going up by a factor of ten, and with many of our outstanding teachers off on government jobs or advising the government in some contract or other, how do you light the spark?

Weber: I'm not quite certain that I can answer, but in the schools that I have observed the ratio of students per teacher has not changed markedly. It is only in certain liberal arts and some public institutions that the ratio has gone up considerably. Television, closed television, etc. will increase that, but then teachers will have assistance to pay individual attention to the students—the small student groups. It is a problem of experimentation. We don't have the answer yet for that, but I think in the progressive schools that you normally want to evaluate, for example in this school, the number of students per teacher does not change radically.

Phil Leroy, Georgia Department of Labor: We've talked about this question of graduating and finishing your education and retirement curves getting closer and closer. Could this education start earlier? I'm thinking partly in my own case.

I graduated with an eight-course diploma from the Baltimore Polytechnic Institute, which allowed me to enter Georgia Tech as a sophomore. There are some similar high schools, Brooklyn Polytechnic and one of the science high schools in New York City. Could there be more of this type high school around the country where if a student were interested he could start earlier to be an engineer?

Hrones: One attempt to meet this problem is the advance placement program that is rapidly growing in the country. Students in an increasing number of secondary schools have the opportunity of undertaking courses that are of a college freshman level and are so accepted by the best institutions in the country. Perhaps there are others here though who would want to comment on that question.

Robertson: I am convinced that it is possible to have much more mathematics and science absorbed during the high school years than we now realize, and that one way to cope with the vast increase of knowledge that has to be absorbed is to have more absorbed at the high school level.

Mitchell: I guess this goes back to the other question, but with regard to the teacher-pupil ratio, it seems that there is a one-way street here with teachers going to industry and government, as consultants. Is there a need, and I think there is some indication of this, for a trend to go back the other way. That is, for industry and government to be unselfish enough to allow their people to go to the schools, as it were, to teach in the schools. This is, I think, a possibility. There are people in industry, there are people in government that could challenge young people, if the opportunities were made available for them to teach.

Bronk: The Bell Telephone Laboratories provide examples of this. Jim Fisk, the President of the Bell Telephone Laboratories, went from the academic world, to industry, to the academic world, and back again. John Bardeen went from the Bell Laboratories to the University of Illinois. William Baker, the present Vice-President in charge of Research, is actively engaged in various educational programs, as a trustee and as a lecturer; he strongly emphasizes the desirability of what you have just suggested. It has the advantage of providing assistance to educational institutions, by way of giving service; it brings into the academic world a sense of realism and contacts with the applications of science for human use, and conversely it brings industry into contact with the educational trends.

R. J. J. Lockatel, Architect: When Dr. Weber was speaking he made a comment that, particularly at the graduate level, many of the polytechnic institutes, being the logical schools to generate instruction at the increasing numbers of engineering disciplines, apparently would be unable to do so simply for the lack of funds. He indicated that it would be necessary to rely on the federal government for such assistance. I would like to ask Mr. Harwood and Mr. Larson, who are representatives of two large corporations this question. Since the large corporations are the benefactors of the universities' output, hiring some 70% of the engineers, why are not more corporations subsidizing these universities so that they can teach these new disciplines?

Larson: Well, I would like to address myself specifically to that question, and I would like to try to use the trite expression "I'm glad you asked me that." I think if you follow the statistics you will find that practically every major corporation does actually have grants, fellowships and other aids to education which are rather sizeable. For our own corporation, I think the amount is something over $1 million per year, and I suppose that other corporations are proportionately about the same. I think it is purely a question of the relative size of contributions and duty to the stockholders plus a few other factors. I am sure that almost all major corporations recognize the obligation and are allocating a proportional amount such as this for aid to education.

Harwood: I am sure you are familiar with the Ford Foundation and many other foundations of similar nature. Dr. Larson was certainly correct. At Ford, for example, if any individual gives a contribution to a university, the Ford Foundation matches it. If it happens to be a university of which the individual is an alumnus, they give twice the amount. So there are all sorts of techniques and gimmicks by which industry, at least responsible industry, and large industry, does provide support to educational institutions. However, I think when you add it all up, it falls far short of satisfying the education needs in this country. If I may continue for just a moment, it has also become obvious that it is no longer possible to solve the general purpose educational needs of universities through the government research contract system. Now it is obvious to me, and to other people I understand, that the only solution lies in direct federal subsidy to higher education.

Bronk: I would like to add that through the tax support of our federal government by our corporations, industry is supporting universities.

Kenneth Picha, Georgia Tech: I would like to address this question to Mr. Larson and Mr. Harwood. Some of my friends are criticizing me when they are talking about the engineer in a scientific program in a tax-consuming industry vs. the engineer in a scientific program in a tax-producing industry. You gentlemen are representatives of tax-producing industries, I guess, and I would like to get your reaction—and particularly Mr. Harwood, since you have both experience in government working with projects there and now with the Ford Foundation—is there a difference in the responsibilities, and the education, of people who will devote their lives in science in tax-producing institutions as opposed to tax-consuming institutions?

Harwood: I think the answer is NO, if I understand what you mean. I think the first lesson I learned, and I had to learn it pretty quickly was that the problems of large industry are no different than the problems of large government. The same situation prevails. The laboratories such as we have at Ford and the other large industrial companies are little different than those such as the Naval Research Laboratory. I would like to say that if a company is to exploit research, it must contribute to research. There is a responsibility over and above the individual responsibility you have as a scientist to a scientific development of interest to your company. You have a responsibility to the scientific community. And in that sense, a fundamental scientist is just what the name implies, and he is not overly concerned with the ultimate exploitation of his research. Many good scientists work in industry, because it happens to turn out that this is a good place to work in terms of the environment that's created for him to do research without the administrative burdens that go along in universities or other research institutions. So really there is no difference, both have the same responsibilities to contribute to research, to explore the implications of research and to study the social responsibilities of you and your organization in the scientific community.

Larson: I would like to add one more point to this. We happen to have a very sizeable responsibility both in the field of government contracts and, of course, our own private operations, and at no time are we ever for a second permitted to think of using two different standards insofar as the operations are concerned. There are different problems to be sure, but the responsibility is as far as the expenditures, the same in both types of operations, and the other point which I wanted to raise with regard to the expenditures of funds for research. The research, of course, and expenditure for that is a very profound responsibility both so far as the government is concerned and as far as the stockholder is concerned. One of the most amazing calculations which I've made with respect to this is that for every research worker whom we hire we commit over $1 million so far as his lifetime is concerned to support that man in the field of research or development. Research today costs anywhere from $30,000 to $40,000 a year, whether it be in government or in private research, and I think a quick calculation in the lifetime of a research worker will indicate that over $1 million is expended. So far as the stockholder is concerned, it's necessary for that man to develop about $10 million worth of new products business, in order to just pay for himself. These are sobering facts, and the same thing, I think, is true insofar as government expenditures. Each individual research member does have to essentially be worth $10 million worth of new business, if he is to pay for himself during his lifetime.

Dr. Chilton, Georgia Tech: I want to address a question to people that are not on the panel, and perhaps not even represented here at all. Perhaps some of the faculty members would have a comment to make on it. It concerns the question of the fundamentals. I couldn't be more heartily in support of Dr. Weber's proposal that the undergraduate education be concentrated on the fundamentals. On the other hand, I hope we can persuade our colleagues in these fundamental sciences to give the instruction in those sciences in terms of a continuing education and an open mind. I think back to what I learned as an undergraduate: The chemistry I learned then certainly did not prepare me for understanding the modern theories of the chemical bond. The physics that I learned 40 years ago had no application in the field of nuclear science. The mathematics that I learned 40 years ago was not applicable to modern computer technology. What can we do to keep our future educators alerted to the possibilities that even the basic sciences may change and the demands may change in the course of 25-30 years?

Rosenblith: There is, of course, no "real" answer to this question but one of Dr. Bronk's earlier comments may furnish the chief ingredient to an answer. Educational institutions have one foremost responsibility: not to kill but to nurture what is entrusted to them for a few years. Of all the "fundamentals" the desire to learn is most fundamental, most irreplaceable. Bury it, stunt it or bring about its premature death in a man and he ceases to be a scientifically or technically productive person. That sounds pretty convincing and trite but is hard to translate into realities. You may have the best core curriculum in the country, you may expose your students to more math, physics, chemistry and even biology than they have ever been exposed before and yet you will fail to make good scientists and especially engineers out of them if they remain students-in-waiting. They need to get involved: in the lab, in industry, in government, or elsewhere. This is why the NSF's attempt to make undergraduates legitimate inhabitants of our research labs is so important. This is why we need adequate facilities so that these students can derive a sense of achievement from grappling (experimentally or with the aid of computers) with meaningful problems, instead of hoping that their desire to learn will be kept alive by good grades on frequent tests.

Maybe our state governments and municipalities could on a large scale make use of the talents of these young people during their vacations or during work terms, very much in the manner in which certain federal agencies have provided student employment. What more exciting perspective for a young engineer than to find opportunities for socially useful and technically challenging tasks throughout the whole fabric of our society. What better guarantee that industries, public utilities and a technologically oriented civil service will remain closely coupled to new learning.

Robertson: I would like to comment briefly here. I think we have a problem here for our entire society. The problem is keeping everyone learning, keeping everyone intellectually

alive. There is too much feeling that education stops when you get a degree or graduate from high school, or go through some formal course work. I think that our whole social system needs a feeling that everyone should keep on learning. Everyone should set aside some part of his life for learning. Everyone should keep an open mind. I don't believe that our society as it is now organized is very receptive in this particular respect. It is a problem for all of us to try to do something about that. People get so busy; they take on so many activities which call on their resources but don't contribute to their growth. We have to set aside some time for that purpose.

Mitchell: One of the fundamentals I think that we need to teach engineers, and this is one of the subjects that I wish I had taken more of when I was in school, is history. Dr. James Conant, I believe, pointed out that a good way to learn about a science is through the historical approach. In reviewing what I would say here today, and I said it rather badly this morning, concerning the history of space sciences, just one little area, I was impressed by the fact that we are always on a growth curve that goes like this, and then it does this, it does this. You can't anticipate where this curve is going to jump. The point of jump is going to take place, but it is going to be there, so that we need to piece from a historical viewpoint one of the fundamentals is that you don't know it will be there. Here's where we are in chemistry today. Here's where we are in physics today, or any other subject. Ten years from now at a date that I can't predict, there will be a quantum jump. This is the way it will look historically, so I think one of the fundamentals that we can improve in our teaching is history.

Archie Corriher, Georgia Tech: We've had the comment that we now have more scientists and engineers in administration, but we have two members of the panel who also made comments that they are to appear before a congressional committee. I wonder if being an attorney in this particular age we are living will necessarily fit a man to make decisions on scientific programs. I would like to ask Dr. Bronk and Dr. Robertson if we need more scientists and engineers in the legislative branch of the government.

Bronk: It is a lawyer's function to study, to create and administer the laws which relate man to man in our social system, whereas engineers or scientists are concerned with the study and discovery of natural laws and their application. Therefore, when we go into politics or government, we usually get pretty far away from science and engineering. Therefore, we become less and less competent in our own field of science. It is natural, therefore, that scientists and engineers do not desire to go into politics, because they move away from their chosen field; a lawyer on the other hand continues in his proper realm of activity. So while it may be desirable to have more engineers and scientists in government, I doubt whether it would be a natural activity for many who are devoted to science and engineering.

: I think the answer is NO, if I understand what you hink the first lesson I learned, and I had to learn it ickly was that the problems of large industry are no than the problems of large government. The same prevails. The laboratories such as we have at Ford other large industrial companies are little different se such as the Naval Research Laboratory. I ce to say that if a company is to exploit research, ontribute to research. There is a responsibility over e the individual responsibility you have as a scientist itific development of interest to your company. You sponsibility to the scientific community. And in that 'undamental scientist is just what the name implies, not overly concerned with the ultimate exploitation search. Many good scientists work in industry, be- iappens to turn out that this is a good place to work of the environment that's created for him to do without the administrative burdens that go along in ies or other research institutions. So really there is ence, both have the same responsibilities to con- research, to explore the implications of research tudy the social responsibilities of you and your ion in the scientific community.

would like to add one more point to this. We o have a very sizeable responsibility both in the field nment contracts and, of course, our own private is, and at no time are we ever for a second permitted of using two different standards insofar as the opera- concerned. There are different problems to be sure, esponsibility is as far as the expenditures, the same types of operations, and the other point which I o raise with regard to the expenditures of funds for The research, of course, and expenditure for that profound responsibility both so far as the govern- oncerned and as far as the stockholder is concerned. ne most amazing calculations which I've made with o this is that for every research worker whom we commit over $1 million so far as his lifetime is con- support that man in the field of research or develop- esearch today costs anywhere from $30,000 to a year, whether it be in government or in private and I think a quick calculation in the lifetime of a worker will indicate that over $1 million is ex- So far as the stockholder is concerned, it's necessary man to develop about $10 million worth of new business, in order to just pay for himself. These ing facts, and the same thing, I think, is true insofar ment expenditures. Each individual research mem- have to essentially be worth $10 million worth of ness, if he is to pay for himself during his lifetime.

n, Georgia Tech: I want to address a question to people that are not on the panel, and perhaps not even represented here at all. Perhaps some of the faculty members would have a comment to make on it. It concerns the question of the fundamentals. I couldn't be more heartily in support of Dr. Weber's proposal that the undergraduate education be concentrated on the fundamentals. On the other hand, I hope we can persuade our colleagues in these fundamental sciences to give the instruction in those sciences in terms of a continuing education and an open mind. I think back to what I learned as an undergraduate: The chemistry I learned then certainly did not prepare me for understanding the modern theories of the chemical bond. The physics that I learned 40 years ago had no application in the field of nuclear science. The mathematics that I learned 40 years ago was not applicable to modern computer technology. What can we do to keep our future educators alerted to the possibilities that even the basic sciences may change and the demands may change in the course of 25-30 years?

Rosenblith: There is, of course, no "real" answer to this question but one of Dr. Bronk's earlier comments may furnish the chief ingredient to an answer. Educational institutions have one foremost responsibility: not to kill but to nurture what is entrusted to them for a few years. Of all the "fundamentals" the desire to learn is most fundamental, most irreplaceable. Bury it, stunt it or bring about its premature death in a man and he ceases to be a scientifically or technically productive person. That sounds pretty convincing and trite but is hard to translate into realities. You may have the best core curriculum in the country, you may expose your students to more math, physics, chemistry and even biology than they have ever been exposed before and yet you will fail to make good scientists and especially engineers out of them if they remain students-in-waiting. They need to get involved: in the lab, in industry, in government, or elsewhere. This is why the NSF's attempt to make undergraduates legitimate inhabitants of our research labs is so important. This is why we need adequate facilities so that these students can derive a sense of achievement from grappling (experimentally or with the aid of computers) with meaningful problems, instead of hoping that their desire to learn will be kept alive by good grades on frequent tests.

Maybe our state governments and municipalities could on a large scale make use of the talents of these young people during their vacations or during work terms, very much in the manner in which certain federal agencies have provided student employment. What more exciting perspective for a young engineer than to find opportunities for socially useful and technically challenging tasks throughout the whole fabric of our society. What better guarantee that industries, public utilities and a technologically oriented civil service will remain closely coupled to new learning.

Robertson: I would like to comment briefly here. I think we have a problem here for our entire society. The problem is keeping everyone learning, keeping everyone intellectually

alive. There is too much feeling that education stops when you get a degree or graduate from high school, or go through some formal course work. I think that our whole social system needs a feeling that everyone should keep on learning. Everyone should set aside some part of his life for learning. Everyone should keep an open mind. I don't believe that our society as it is now organized is very receptive in this particular respect. It is a problem for all of us to try to do something about that. People get so busy; they take on so many activities which call on their resources but don't contribute to their growth. We have to set aside some time for that purpose.

Mitchell: One of the fundamentals I think that we need to teach engineers, and this is one of the subjects that I wish I had taken more of when I was in school, is history. Dr. James Conant, I believe, pointed out that a good way to learn about a science is through the historical approach. In reviewing what I would say here today, and I said it rather badly this morning, concerning the history of space sciences, just one little area, I was impressed by the fact that we are always on a growth curve that goes like this, and then it does this, it does this. You can't anticipate where this curve is going to jump. The point of jump is going to take place, but it is going to be there, so that we need to piece from a historical viewpoint one of the fundamentals is that you don't know it will be there. Here's where we are in chemistry today. Here's where we are in physics today, or any other subject. Ten years from now at a date that I can't predict, there will be a quantum jump. This is the way it will look historically, so I think one of the fundamentals that we can improve in our teaching is history.

Archie Corriher, Georgia Tech: We've had the comment that we now have more scientists and engineers in administration, but we have two members of the panel who also made comments that they are to appear before a congressional committee. I wonder if being an attorney in this particular age we are living will necessarily fit a man to make decisions on scientific programs. I would like to ask Dr. Bronk and Dr. Robertson if we need more scientists and engineers in the legislative branch of the government.

Bronk: It is a lawyer's function to study, to create and administer the laws which relate man to man in our social system, whereas engineers or scientists are concerned with the study and discovery of natural laws and their application. Therefore, when we go into politics or government, we usually get pretty far away from science and engineering. Therefore, we become less and less competent in our own field of science. It is natural, therefore, that scientists and engineers do not desire to go into politics, because they move away from their chosen field; a lawyer on the other hand continues in his proper realm of activity. So while it may be desirable to have more engineers and scientists in government, I doubt whether it would be a natural activity for many who are devoted to science and engineering. Furthermore, I do not think that science and engineering is a training that qualifies men for the broad reaches of politics, unless they carry into that sphere of activity wisdom as well as knowledge. One of the great problems of modern society is how we can more wisely deal with the increasing knowledge we have.

Robertson: I agree with Dr. Bronk. I do think that a few scientists turned politicians might be valuable in our congress, but I would hate to see the entire body filled with scientific colleagues who had decided it was necessary to go into politics.

Stevenson, Georgia Tech: I tend to agree with the panel on their philosophy in education, but sometimes I become a little bit worried as to whether or not our thinking is a little bit narrow. In particular, where do you relegate the training of "conventional" engineers? It seems to me that there is a need in our society, and especially in a world society of underdeveloped countries, for the technology of 25 years ago rather than that of 25 years hence. It's not quite clear as to who should share the responsibility of training these people; whether or not the universities should perform some sort of bilateral training, in which they have a program for gifted students and an additional one for conventional engineers; or whether there should be set up trade schools or something of this nature.

Hrones: Since my alumni and some of my board of trustees ask me this question periodically, I can't resist being the first one to attempt an opinion on the matter. First of all, I am not sure that I would agree that the best thing for underdeveloped countries to do would be to rely upon the technology of 25 years ago to face their future with. I am sure they have some opportunities to use the technology and understanding of the future that we do not have because of our more advanced society and our more committed developments. So I would answer, I think it would be a great mistake for us to undertake the education of people of this kind for the purpose you suggest. I somehow feel that there is no room to specifically design an education to meet the past. I think that the kind of environment we have been talking about, an environment that stimulates all members of it to learn and to continue to learn after they leave a campus, is the kind of education that will allow people to make the best contribution in any situation that they may find themselves. I know this is a very unsatisfactory answer for many people, and I would rapidly turn to other members of the panel at this point.

Bronk: Well, I'm going to refer the question to Geneva. At the present time, there is a UN conference on the use of science and technology in the development of less developed areas that will run through this week and next week, and ultimately many volumes will be published containing the 1600 papers that will be given there.

Hrones: I knew I shouldn't have tried to answer that.

Rosenblith: It seems rather obvious that mechanical translation of the needs of the developing countries into a phrase such as "oh, sure, we had these problems in our pioneering era," is simply not good enough. It is also often not very wise to import some of their young people into an environment in which they lose contact with the socially motivating forces which to an engineer are so important. Hence the attempts of designing on the spot training programs. However, problems of this type exist not only in the underdeveloped areas of the world: They exist in our own country. There exist in our own country scientific and technological problems of considerable social import that do not attract the young. We are at a stage in which the mobile technological reserve is enormously powerful; there are very few programs that are out of our reach. The question is rather, what are the problems to which we want to allocate the highest priorities. The scientific, educational and technological community must make it clear what our resources are so that all of us can decide where and how they are to be used. But unless young people are interested enough to make a career in these problem areas we shall fail not only with respect to the underdeveloped countries but also with regard to our homegrown needs.

W. W. Pleasants, Green Bank: I'm a little bit surprised that this question came from a man from Georgia Tech, because at lunch yesterday I learned that they have established a new school at Marietta, Southern Tech, that has a 2-year course that develops technicians. It seems to me that this may provide the solution, that the 4-year engineering course would be more devoted to administration, science, fundamentals and the things that Mr. Mitchell mentioned, history and English, public speaking, and the humanities. The engineer would be a much more rounded individual. This matter of training underdeveloped people and doing the mechanical details, that type of thing would be relegated to a new class of individuals, namely, a technician who has received two years training and qualify for those type of things.

Bronk: The Pennsylvania State University, under the leadership of President Eric Walker is also actively engaged in such 2-year schools of technology. For example, when I took electrical engineering, I spent two afternoons a week for a whole term learning to survey. I understand that there are very few engineering schools at the present time that give practical courses in surveying; this is left to other individuals who have a less broad training. Such individuals are being trained in schools such as those of which you speak.

Rosenblith: Could I, at the risk of raising too complex a question, say a few words about the very title of this symposium. We have been talking here about the engineering for large scientific programs. Dr. Bronk mentioned in his keynote address the problem of the graduate student, who ought to have personal contact with something that is important, with something that resembles "the building of our cathedrals." (Let me hope that we develop reasonable ways of making these enterprises self-liquidating; but this is not the point I'm trying to make.) The point I'm trying to make is as follows: Science, and to some extent engineering, in spite of differences in motivation, used to attract people who by temperament were not part of a massive army that was advancing on an enemy, even if this "enemy" be nature. Scientists and engineers were often lone wolves at a frontier, operating not in hierarchial groups, but willing to think and work things through on their own.

Does the very necessary contemporary emphasis upon facilities, upon large resources, not change the character of the people who flock into science? Is it not changing the nature of science itself? There is probably little we can do about it. But when one hears so many questions on managerial responsibilities and things of that nature, I can only hope that such questions do not determine the motivation of *all* the young people who will be tomorrow's scientists and engineers.

Bronk: Because I have just heard very wise words come from President Weber, and because I saw in the *Atlanta Constitution* this morning an appealing advertisement which reads, "you will receive free career tests for the right career for you at college," I am reminded of the important elements of motivation. I find it very difficult to refrain from criticizing our method of selecting students. Yet, I hasten to add that I don't know of any better way to do it than the way it is being done because we must deal with large numbers. But I am concerned lest we exclude from universities those who are not effective sponges, capable of soaking up information and squeezing it back into the examination bucket at the end of the course. There are other more desirable characteristics. Darwin would never have got into a modern university on the basis of grades, and no one knows what would have happened to Newton. Let us not forget that there are many people worth educating because as President Weber has pointed out, motivation is important. I am thankful that Stanford University accepted Russell Varian who had a good deal to do with devising many of the large scale instrumentalities with which we have been dealing these last two days. He would never have gotten in on the basis of any normal selection procedure.

Hrones: We have problems. That's one of the most difficult. Our time is about up. I would say for myself personally, and I think I speak for the panel in saying this has been an extremely exciting and exhilerating experience for me. I hope it has been for you. I am sure that I take back to my own institution things of value, and I hope that Georgia Tech's expectations with regard to the past two days have been met.

s: I knew I shouldn't have tried to answer that.

blith: It seems rather obvious that mechanical transla- f the needs of the developing countries into a phrase as "oh, sure, we had these problems in our pioneering is simply not good enough. It is also often not very wise port some of their young people into an environment in they lose contact with the socially motivating forces to an engineer are so important. Hence the attempts signing on the spot training programs. However, prob- of this type exist not only in the underdeveloped areas world: They exist in our own country. There exist in wn country scientific and technological problems of lerable social import that do not attract the young. e at a stage in which the mobile technological reserve rmously powerful; there are very few programs that are our reach. The question is rather, what are the prob- o which we want to allocate the highest priorities. The ific, educational and technological community must it clear what our resources are so that all of us can where and how they are to be used. But unless young are interested enough to make a career in these prob- reas we shall fail not only with respect to the under- ped countries but also with regard to our homegrown

Pleasants, Green Bank: I'm a little bit surprised that this on came from a man from Georgia Tech, because at yesterday I learned that they have established a new at Marietta, Southern Tech, that has a 2-year course evelops technicians. It seems to me that this may pro- he solution, that the 4-year engineering course would be devoted to administration, science, fundamentals and ings that Mr. Mitchell mentioned, history and English, speaking, and the humanities. The engineer would be h more rounded individual. This matter of training developed people and doing the mechanical details, ype of thing would be relegated to a new class of luals, namely, a technician who has received two years g and qualify for those type of things.

The Pennsylvania State University, under the leader- f President Eric Walker is also actively engaged in 2-year schools of technology. For example, when I lectrical engineering, I spent two afternoons a week whole term learning to survey. I understand that there ry few engineering schools at the present time that give al courses in surveying; this is left to other individuals ave a less broad training. Such individuals are being l in schools such as those of which you speak.

lith: Could I, at the risk of raising too complex a ques- ay a few words about the very title of this symposium.

We have been talking here about the engineering for large scientific programs. Dr. Bronk mentioned in his keynote address the problem of the graduate student, who ought to have personal contact with something that is important, with something that resembles "the building of our cathedrals." (Let me hope that we develop reasonable ways of making these enterprises self-liquidating; but this is not the point I'm trying to make.) The point I'm trying to make is as follows: Science, and to some extent engineering, in spite of differences in motivation, used to attract people who by temperament were not part of a massive army that was advancing on an enemy, even if this "enemy" be nature. Scientists and engineers were often lone wolves at a frontier, operating not in hierarchial groups, but willing to think and work things through on their own.

Does the very necessary contemporary emphasis upon facilities, upon large resources, not change the character of the people who flock into science? Is it not changing the nature of science itself? There is probably little we can do about it. But when one hears so many questions on managerial responsibilities and things of that nature, I can only hope that such questions do not determine the motivation of *all* the young people who will be tomorrow's scientists and engineers.

Bronk: Because I have just heard very wise words come from President Weber, and because I saw in the *Atlanta Constitution* this morning an appealing advertisement which reads, "you will receive free career tests for the right career for you at college," I am reminded of the important elements of motivation. I find it very difficult to refrain from criticizing our method of selecting students. Yet, I hasten to add that I don't know of any better way to do it than the way it is being done because we must deal with large numbers. But I am concerned lest we exclude from universities those who are not effective sponges, capable of soaking up information and squeezing it back into the examination bucket at the end of the course. There are other more desirable characteristics. Darwin would never have got into a modern university on the basis of grades, and no one knows what would have happened to Newton. Let us not forget that there are many people worth educating because as President Weber has pointed out, motivation is important. I am thankful that Stanford University accepted Russell Varian who had a good deal to do with devising many of the large scale instrumentalities with which we have been dealing these last two days. He would never have gotten in on the basis of any normal selection procedure.

Hrones: We have problems. That's one of the most difficult. Our time is about up. I would say for myself personally, and I think I speak for the panel in saying this has been an extremely exciting and exhilerating experience for me. I hope it has been for you. I am sure that I take back to my own institution things of value, and I hope that Georgia Tech's expectations with regard to the past two days have been met.

THE MARCH 1963

GEORGIA TECH Journal

A digest of information about Georgia Tech and its alumni

Tech graduate student receives top award

IAN A. NIMMO, ChE '62, now a graduate student in Tech's School of Industrial Management, was recently awarded the $1,000 Mitchell Market Research Fellowship. The award is named for William F. Mitchell, ME '33, vice president in charge of chemical and international activities for General Mills, who won the 1962 Chemical Market Research Association Memorial Award. This memorial award consists of a plaque and a $1,000 grant, the latter to be given to an educational institution of the recipient's choice.

Mitchell selected Tech for the award and requested that the Tech committee select a student who would fulfill the qualifications of a market research man: "competent, imaginative . . . in order to anticipate and wherever possible lead the change in the market."

Tech's annual T-game set for April 26

THE 1963 Tech football team will again close out spring practice with the traditional T-game between the White and the Black squads. The game—sponsored by the Greater Atlanta Georgia Tech Club—has been set for Friday, April 26, at 8:00 P.M. Last year's game was played on Saturday afternoon because the lights on the East Stands were down for the construction of the new double-deck stands.

Proceeds from the T-game go to the scholarship fund of the local alumni group. This fund finances the extensive academic scholarship program for outstanding students (not athletes) from the Atlanta area. To date, over 95 students have got their start at Tech under this scholarship plan. Last year, the club awarded 13 freshman scholarships and eight upperclassman scholarships under the program. Tech alumni may purchase tickets from The Greater Atlanta Georgia Tech Club, c/o The Georgia Tech National Alumni Association, Atlanta 13. The cost per ticket in advance is $1.00. If you purchase tickets at the gate, the cost goes up to $1.50.

Coach Dodd and his staff begin what promises to be one of the most challenging spring practices in years on March 25. The biggest problem facing the coaching staff will be finding replacements for the five starting interior linemen who helped make the 1962 Tech forward wall, "the best I have ever had," according to Dodd.

Only ends Billy Martin and Ted Davis return from that line that started every game last fall. Gone are tackles Ed Griffin and Larry Stallings; guards Rufus Guthrie and Dave Watson; and center Bobby Caldwell. Tech will also be searching for a fullback to replace Mike McNames and halfbacks to fill the gaps left by the graduation of Tom Winingder, Don Toner, and Zollie Sircy.

The 1963 edition will be different in one way from its predecessors—a captain will be named before each game, a move endorsed by the Tech squad in January.

THE SCHEDULES

Football

Sept. 21 *Florida	Atlanta
Sept. 28 Clemson	Atlanta
Oct. 5 †*Louisiana State	Baton Rouge
Oct. 12 *Tennessee	Knoxville
Oct. 19 *Auburn	Atlanta
Oct. 26 *Tulane	New Orleans
Nov. 2 Duke	Atlanta
Nov. 9 Florida State	Atlanta
Nov. 16 *Alabama	Birmingham
Nov. 30 *Georgia	Atlanta

**Southeastern Conference opponent.*
†Night game.

Baseball

Mar. 18 Florida Southern	Lakeland
Mar. 19 Ohio State	Winter Park
Mar. 20 †Ohio State	Winter Park
Mar. 21 †Rollins	Winter Park
Mar. 22 *Florida	Gainesville
Mar. 23 *Florida	Gainesville
Mar. 27 Clemson	Atlanta
Mar. 29 *Auburn	Atlanta
Mar. 30 *Auburn	Atlanta
Apr. 2 Clemson	Clemson
Apr. 5 *Vanderbilt	Atlanta
Apr. 6 *Vanderbilt	Atlanta
Apr. 9 *Auburn	Auburn
Apr. 10 *Auburn	Auburn
Apr. 12 North Carolina	Atlanta
Apr. 13 *Georgia	Atlanta
Apr. 16 *Georgia	Athens
Apr. 19 *Florida	Atlanta
Apr. 20 *Florida	Atlanta
Apr. 24 *Kentucky	Lexington
Apr. 25 *Kentucky	Lexington
Apr. 26 *Tennessee	Knoxville
Apr. 27 *Tennessee	Knoxville
May 3 *Georgia	Atlanta
May 4 *Georgia	Athens
May 14 Mercer	Atlanta
May 16 §Florida State	Atlanta
May 16 §Florida State	Atlanta

†Morning Game.
**SEC Game.*
§Double header.

Golf

Mar. 18 ‡Florida State	Tallahassee
Georgia	Tallahassee
Springfield	Tallahassee
Mar. 19 ‡Florida	Gainesville
Rollins	Gainesville
Mar. 21-23 ‡Fla. Intercoll.	Ocala
Mar. 26 Alabama	Atlanta
Mar. 29 ‡Florida	Atlanta
Duke	Atlanta
Apr. 2 Georgia State	Atlanta
Apr. 5 Vanderbilt	Nashville
Apr. 9 ‡Auburn	Atlanta
Apr. 12 ‡Tennessee	Atlanta
Apr. 15 ‡Auburn	Auburn
Apr. 23 Georgia State	Atlanta
Apr. 27 ‡Georgia	Athens
May 2-4 SEC Tournament	Athens
SIC Tournament	Athens
May 10 ‡Tennessee	Knoxville
May 14 ‡Georgia	Atlanta

‡Freshman teams will also compete.

Tennis

Mar. 18 ‡Florida State	Tallahassee
Mar. 19 ‡Florida	Gainesville
Mar. 21 Stetson	DeLand
Mar. 22 Florida Southern	Lakeland
Mar. 27 Amherst	Atlanta
Mar. 30 ‡Florida	Atlanta
Apr. 6 Vanderbilt	Atlanta
Apr. 9 ‡Mississippi State	Atlanta
Apr. 10 Kentucky	Atlanta
Apr. 11 Sewanee	Atlanta

THE MARCH 1963

GEORGIA TECH Journal

A digest of information about Georgia Tech and its alumni

udent receives top award

), ChE '62, now a graduate
ı's School of Industrial Man-
recently awarded the $1,000
et Research Fellowship. The
l for William F. Mitchell, ME
ent in charge of chemical and
ctivities for General Mills,
1962 Chemical Market Re-
tion Memorial Award. This
d consists of a plaque and a
the latter to be given to an
stitution of the recipient's

cted Tech for the award and
the Tech committee select a
ould fulfill the qualifications
research man: "competent,
. in order to anticipate and
ble lead the change in the

ame set for April 26

h football team will again
practice with the traditional
n the White and the Black
ne—sponsored by the Greater
a Tech Club—has been set
il 26, at 8:00 P.M. Last year's
d on Saturday afternoon be-
s on the East Stands were
nstruction of the new double-

n the T-game go to the schol-
the local alumni group. This
e extensive academic scholar-
or outstanding students (not
the Atlanta area. To date,
s have got their start at Tech
olarship plan. Last year, the
3 freshman scholarships and
sman scholarships under the
alumni may purchase tickets
ater Atlanta Georgia Tech
e Georgia Tech National
tion, Atlanta 13. The cost per
ce is $1.00. If you purchase
te, the cost goes up to $1.50.
l and his staff begin what
one of the most challenging
in years on March 25. The

biggest problem facing the coaching staff will be finding replacements for the five starting interior linemen who helped make the 1962 Tech forward wall, "the best I have ever had," according to Dodd.

Only ends Billy Martin and Ted Davis return from that line that started every game last fall. Gone are tackles Ed Griffin and Larry Stallings; guards Rufus Guthrie and Dave Watson; and center Bobby Caldwell. Tech will also be searching for a fullback to replace Mike McNames and halfbacks to fill the gaps left by the graduation of Tom Winingder, Don Toner, and Zollie Sircy.

The 1963 edition will be different in one way from its predecessors—a captain will be named before each game, a move endorsed by the Tech squad in January.

THE SCHEDULES

Football

Sept. 21 *Florida	Atlanta
Sept. 28 Clemson	Atlanta
Oct. 5 †*Louisiana State	Baton Rouge
Oct. 12 *Tennessee	Knoxville
Oct. 19 *Auburn	Atlanta
Oct. 26 *Tulane	New Orleans
Nov. 2 Duke	Atlanta
Nov. 9 Florida State	Atlanta
Nov. 16 *Alabama	Birmingham
Nov. 30 *Georgia	Atlanta

*Southeastern Conference opponent.
†Night game.*

Baseball

Mar. 18 Florida Southern	Lakeland
Mar. 19 Ohio State	Winter Park
Mar. 20 †Ohio State	Winter Park
Mar. 21 †Rollins	Winter Park
Mar. 22 *Florida	Gainesville
Mar. 23 *Florida	Gainesville
Mar. 27 Clemson	Atlanta
Mar. 29 *Auburn	Atlanta
Mar. 30 *Auburn	Atlanta
Apr. 2 Clemson	Clemson
Apr. 5 *Vanderbilt	Atlanta
Apr. 6 *Vanderbilt	Atlanta
Apr. 9 *Auburn	Auburn
Apr. 10 *Auburn	Auburn
Apr. 12 North Carolina	Atlanta
Apr. 13 *Georgia	Atlanta
Apr. 16 *Georgia	Athens
Apr. 19 *Florida	Atlanta
Apr. 20 *Florida	Atlanta
Apr. 24 *Kentucky	Lexington
Apr. 25 *Kentucky	Lexington
Apr. 26 *Tennessee	Knoxville
Apr. 27 *Tennessee	Knoxville
May 3 *Georgia	Atlanta
May 4 *Georgia	Athens
May 14 Mercer	Atlanta
May 16 §Florida State	Atlanta
May 16 §Florida State	Atlanta

*†Morning Game.
*SEC Game.
§Double header.*

Golf

Mar. 18 ‡Florida State	Tallahassee
Georgia	Tallahassee
Springfield	Tallahassee
Mar. 19 ‡Florida	Gainesville
Rollins	Gainesville
Mar. 21-23 ‡Fla. Intercoll.	Ocala
Mar. 26 Alabama	Atlanta
Mar. 29 ‡Florida	Atlanta
Duke	Atlanta
Apr. 2 Georgia State	Atlanta
Apr. 5 Vanderbilt	Nashville
Apr. 9 ‡Auburn	Atlanta
Apr. 12 ‡Tennessee	Atlanta
Apr. 15 ‡Auburn	Auburn
Apr. 23 Georgia State	Atlanta
Apr. 27 ‡Georgia	Athens
May 2-4 SEC Tournament	Athens
SIC Tournament	Athens
May 10 ‡Tennessee	Knoxville
May 14 ‡Georgia	Atlanta

‡Freshman teams will also compete.

Tennis

Mar. 18 ‡Florida State	Tallahassee
Mar. 19 ‡Florida	Gainesville
Mar. 21 Stetson	DeLand
Mar. 22 Florida Southern	Lakeland
Mar. 27 Amherst	Atlanta
Mar. 30 ‡Florida	Atlanta
Apr. 6 Vanderbilt	Atlanta
Apr. 9 ‡Mississippi State	Atlanta
Apr. 10 Kentucky	Atlanta
Apr. 11 Sewanee	Atlanta
Apr. 12 ‡Auburn	Auburn
Apr. 13 ‡Alabama	Tuscaloosa
Apr. 15 Tulane	Atlanta
Apr. 20 ‡Cincinnati	Atlanta
Apr. 22 ‡Florida State	Atlanta
Apr. 23 ‡Tennessee	Atlanta
Apr. 24 ‡Georgia	Athens
Apr. 26 & 27 Georgia Collegiate	Athens
May 1 ‡Georgia	Atlanta
May 2 Miami	Atlanta
May 4 ‡Tennessee	Knoxville
May 9-11 ‡SEC Tournament	Tuscaloosa

‡Freshman teams will also compete.

Track

Mar. 30 ‡Florida Relays	Gainesville
Apr. 6 ‡Florida	Atlanta
Apr. 13 ‡Vanderbilt	Nashville
Apr. 20 ‡Georgia	Atlanta
May 4 ‡Auburn	Auburn
May 11 ‡Alabama	Atlanta
May 17 & 18 ‡SEC Championships	Birmingham

‡Freshman teams will also compete.

Tech staff members win top award

THE DIVISION of Water and Waste Chemistry of the American Chemical Society has awarded the Edward Bartow Award for 1962 to a paper on "Biodegradation of the Chlorine Carbon Bond" authored by Robert S. Ingols, director, Applied Biology, and Paula Stevenson, research assistant. Miss Stevenson was one of Tech's first female graduates. The Bartow Award is given "in recognition of the most outstanding paper for material content and for manner of presentation given before the Division of Water and Waste Chemistry for both National Meetings for the year 1962." The award will be presented at the Divisional Dinner in Los Angeles on April 3.

Tech all-American to run boys' camp

ROGER KAISER, IM '61, Tech's only all-American basketball player, will run a sports camp for boys of 10 through 16 near Clarksville, Georgia, this summer. Kaiser and his assistant director, Bob Reinhart, former

More news on page 34

Indiana University basketball captain, will have a complete staff for the four regular two-week sessions which begin June 16 and for the one-week post session beginning August 11. For information on the camp write: Roger Kaiser, 2777 Drew Valley Road, Atlanta 19.

The Clubs

KNOXVILLE, TENNESSEE — Georgia Tech alumni in Knoxville gathered at the UT Student Center for supper and a brief meeting prior to the Tech-Tennessee basketball game on February 19. There were 24 alumni and nine wives present. The purpose of the meeting was to discuss the formation of an alumni club. Everyone was in favor, and a committee of five was appointed to present a slate of officers and select a spring meeting date. Rufus Camp was selected as chairman of the committee. Harold (Buddy) Woods instigated the meeting with the help of two other young alumni. Roane Beard, Secretary of the National Association, was guest speaker.

NEW ORLEANS, LOUISIANA — The Georgia Tech Club of New Orleans held a luncheon meeting at Arnauds on February 8 with 45 alumni and several guests present. Nesbitt Hagood presided over the meeting. Coach Whack Hyder was presented the key to the city following his talk to the group. Bob Eskew, athletic business manager, and Buck Andel, athletic trainer, were recognized. Mel Leavitt, local commentator, was a guest of the club and interviewed Hyder after the meeting. A nominating committee was appointed to submit a slate of officers at the next meeting. The committee consists of Henry H. Bush, Frederick Fuchs, and Jim C. Ryan.

NEW YORK, NEW YORK—The New York Georgia Tech Club held its winter meeting on December 12 at Reeves Sound Studio. Over 125 alumni turned out to hear Fred Ajax, director of public relations at Tech, speak on the real necessity of a return to the pioneering spirit that built America. Mrs. Dorothy Crosland, director of libraries, was a special guest of the club and spoke briefly on the growth of Tech's library program. Coach "Bulldog" Turner of the New York Titans closed out the meeting with anecdotes on the life of a professional football coach.

PITTSBURGH, PENNSYLVANIA—It was snowing and ice was on the river when 20 alumni met for their February 12 Pittsburgh Alumni Club dinner meeting at the Harvard-Yale-Princeton Club. Featured guest for the occasion was Tom Hall, associate alumni secretary of the National Alumni Association. Hall spoke to the gathering concerning the current 75th Anniversary Celebration. Special attractions for the evening were the '62 Highlight Football Film and a taped message to the club members from President Harrison, Dean George Griffin and Coach Hyder. Newly elected officers are: Robert S. Holmes, '38, president; and Frank Alexander, '43, vice president.

RICHMOND, VIRGINIA—Over 30 alumni of the Richmond area met in the Richmond West Hotel on February 11 to enjoy a social hour and dinner. Featured speaker for the occasion was Tom Hall, who discussed the events of the 75th Anniversary and brought the club a special taped message from President Harrison, Dean Griffin and Coach Hyder. Following the meeting the alumni viewed the "'62 Highlight Football Film."

News of the Alumni by Classes

'13 *S. A. Flemister,* EE, died February 4. He retired in 1956 after 43 years with Southern Bell. His widow lives at 1704 Homestead Ave., N.E., Atlanta 6, Georgia.

'19 *Sam O. Fitzgerald,* of Montgomery, Alabama died recently in Montgomery. He was manager of the Southern Cotton Oil Company prior to his retirement.

'21 *G. Paul Jones* has been named president of the Cornell-Young Company, Macon, Georgia succeeding the late William A. Young, '02. Mr. Jones has been with the Macon construction company for a number of years.

Deloney Sledge, CE, has completed 30 years of service with the Coca-Cola Company. He is vice president, Advertising, in Atlanta, Georgia.

'23 *George P. Bartlett,* ChE, has completed 40 years of service with the Coca-Cola Company. He is in the Fountain Sales Department, Atlanta, Georgia.

'26 *Web C. Brown,* Com, Chattanooga, Tennessee realtor and civic leader, died January 4. He was owner and senior partner in Chattanooga's oldest real estate firm, C. V. Brown & Brother. He was active in civic affairs and was a past trustee of the Georgia Tech National Alumni Association. Mr. Brown's widow lives at 501 W. Brow Road, Lookout Mountain, Tennessee.

'27 *James H. Groves* died February 10 at his home, 691 Upton Road, N.W., Atlanta, Georgia. He was assistant director of Industrial Education at Georgia Tech. His widow lives at the above address.

'28 *Harry B. McCash,* Com, has completed 35 years of service with the Coca-Cola Company. He is in the Tax Department, Atlanta, Georgia.

Herndon Thomas died in February at his office in Atlanta. He was president of Herndon Electronics. Earlier in his career he was vice president of Steel City Supply Company in Birmingham, Alabama and was later a founder of the Georgia Appliance Company in Atlanta. His widow and two daughters survive him.

'31 *C. Eugene Stephenson,* EE, died January 11 of a heart attack. He was superintendent of the construction and maintenance division of the engineering department of R. J. Reynolds Tobacco Company. He had been with the company since graduating from Georgia Tech. His widow lives at 757 Roslyn Road, Winston-Salem, North Carolina.

'32 *James T. Hanie,* field supervisor of construction and civil engineer for the Georgia Power Company, has been named project superintendent of Plant Harllee Branch near Eatonton, Georgia.

'33 *James H. Franklin,* president of Federal Express Money Order, Inc. in Atlanta, died February 17 at his home. He is survived by two brothers.

Kyle H. Turner, Com, has been named assistant treasurer and secretary of the Atlanta Gas Light Company. He was formerly head of the customer accounting department. His home address is 1102 Lanier Boulevard, N.E., Atlanta, Georgia.

'37 *Ashworth N. Stull* is now Executive Vice President of the Linatex Corporation of America with offices in Stafford Springs, Connecticut. He was formerly assistant vice president of The Borden Chemical Company.

'39 *Lt. Col. Paul Reynolds, Jr.,* IM, retired from the U.S. Air Force January 31 after 22 years of service. He is now manager of the Georgia Tech Book Store.

'40 *Russell Bobbitt,* IM, vice president of Citizens & Southern Bank, has been named officer in charge of the Peachtree-Baker office in Atlanta, Georgia. Russell was formerly with C&S in the Chicago Service Office.

'41 *W. L. Sullivan,* EE, is now General Products Planning Engineer with Southern Bell in Atlanta, Georgia.

'42 *Harry B. Arthur,* USN, IM, has been promoted to the rank of full captain in an exercise at Pearl Harbor. He is now assigned to the Naval Headquarters in Washington, D.C.

L. B. Barnes, TE, has been promoted to vice president and controller with Fulton Cotton Mills in Atlanta, Georgia.

Joseph J. Tribble, ME, was elected state senator from Chatham County in a run-off held February 13. The new Republican senator is an engineer with Union Bag Camp Paper Company in Savannah, Georgia.

'43 *Charles W. Bastedo* has been elected vice president and plant manager of Dixisteel Buildings, Inc., Tallapoosa, Ga.

W. C. Phillips, ChE, has been appointed manager, development laboratory, of Kaiser Chemicals, Division of Kaiser Aluminum and Chemical Corporation.

More news on page 36

INSTITUTE—*continued*

University basketball captain, will complete staff for the four regular :k sessions which begin June 16 and one-week post session beginning 11. For information on the camp Roger Kaiser, 2777 Drew Valley Atlanta 19.

The Clubs

LLE, TENNESSEE — Georgia Tech in Knoxville gathered at the UT Stu- enter for supper and a brief meeting the Tech-Tennessee basketball game ruary 19. There were 24 alumni and ves present. The purpose of the meet- to discuss the formation of an alumni veryone was in favor, and a commit- ve was appointed to present a slate of and select a spring meeting date. Camp was selected as chairman of the tee. Harold (Buddy) Woods insti- e meeting with the help of two other lumni. Roane Beard, Secretary of the l Association, was guest speaker.

ORLEANS, LOUISIANA — The Georgia lub of New Orleans held a luncheon at Arnauds on February 8 with 45 and several guests present. Nesbitt presided over the meeting. Coach Hyder was presented the key to the llowing his talk to the group. Bob athletic business manager, and Buck athletic trainer, were recognized. Mel local commentator, was a guest of b and interviewed Hyder after the . A nominating committee was ap- to submit a slate of officers at the eeting. The committee consists of H. Bush, Frederick Fuchs, and Jim C.

YORK, NEW YORK—The New York Tech Club held its winter meeting ember 12 at Reeves Sound Studio. 25 alumni turned out to hear Fred director of public relations at Tech, n the real necessity of a return to the ing spirit that built America. Mrs. Crosland, director of libraries, was l guest of the club and spoke briefly growth of Tech's library program. "Bulldog" Turner of the New York closed out the meeting with anecdotes life of a professional football coach.

RGH, PENNSYLVANIA—It was snowing was on the river when 20 alumni met ir February 12 Pittsburgh Alumni inner meeting at the Harvard-Yale- on Club. Featured guest for the occa- s Tom Hall, associate alumni secre- the National Alumni Association. oke to the gathering concerning the 75th Anniversary Celebration. Spe- ractions for the evening were the '62 ht Football Film and a taped message club members from President Harri- an George Griffin and Coach Hyder. elected officers are: Robert S. Holmes, '38, president; and Frank Alexander, '43, vice president.

RICHMOND, VIRGINIA—Over 30 alumni of the Richmond area met in the Richmond West Hotel on February 11 to enjoy a social hour and dinner. Featured speaker for the occasion was Tom Hall, who discussed the events of the 75th Anniversary and brought the club a special taped message from President Harrison, Dean Griffin and Coach Hyder. Following the meeting the alumni viewed the "'62 Highlight Football Film."

News of the Alumni by Classes

'13 *S. A. Flemister,* EE, died February 4. He retired in 1956 after 43 years with Southern Bell. His widow lives at 1704 Homestead Ave., N.E., Atlanta 6, Georgia.

'19 *Sam O. Fitzgerald,* of Montgomery, Alabama died recently in Montgomery. He was manager of the Southern Cotton Oil Company prior to his retirement.

'21 *G. Paul Jones* has been named president of the Cornell-Young Company, Macon, Georgia succeeding the late William A. Young, '02. Mr. Jones has been with the Macon construction company for a number of years.

Deloney Sledge, CE, has completed 30 years of service with the Coca-Cola Company. He is vice president, Advertising, in Atlanta, Georgia.

'23 *George P. Bartlett,* ChE, has completed 40 years of service with the Coca-Cola Company. He is in the Fountain Sales Department, Atlanta, Georgia.

'26 *Web C. Brown,* Com, Chattanooga, Tennessee realtor and civic leader, died January 4. He was owner and senior partner in Chattanooga's oldest real estate firm, C. V. Brown & Brother. He was active in civic affairs and was a past trustee of the Georgia Tech National Alumni Association. Mr. Brown's widow lives at 501 W. Brow Road, Lookout Mountain, Tennessee.

'27 *James H. Groves* died February 10 at his home, 691 Upton Road, N.W., Atlanta, Georgia. He was assistant director of Industrial Education at Georgia Tech. His widow lives at the above address.

'28 *Harry B. McCash,* Com, has completed 35 years of service with the Coca-Cola Company. He is in the Tax Department, Atlanta, Georgia.

Herndon Thomas died in February at his office in Atlanta. He was president of Herndon Electronics. Earlier in his career he was vice president of Steel City Supply Company in Birmingham, Alabama and was later a founder of the Georgia Appliance Company in Atlanta. His widow and two daughters survive him.

'31 *C. Eugene Stephenson,* EE, died January 11 of a heart attack. He was superintendent of the construction and maintenance division of the engineering department of R. J. Reynolds Tobacco Company. He had been with the company since graduating from Georgia Tech. His widow lives at 757 Roslyn Road, Winston-Salem, North Carolina.

'32 *James T. Hanie,* field supervisor of construction and civil engineer for the Georgia Power Company, has been named project superintendent of Plant Harllee Branch near Eatonton, Georgia.

'33 *James H. Franklin,* president of Federal Express Money Order, Inc. in Atlanta, died February 17 at his home. He is survived by two brothers.

Kyle H. Turner, Com, has been named assistant treasurer and secretary of the Atlanta Gas Light Company. He was formerly head of the customer accounting department. His home address is 1102 Lanier Boulevard, N.E., Atlanta, Georgia.

'37 *Ashworth N. Stull* is now Executive Vice President of the Linatex Corporation of America with offices in Stafford Springs, Connecticut. He was formerly assistant vice president of The Borden Chemical Company.

'39 *Lt. Col. Paul Reynolds, Jr.,* IM, retired from the U.S. Air Force January 31 after 22 years of service. He is now manager of the Georgia Tech Book Store.

'40 *Russell Bobbitt,* IM, vice president of Citizens & Southern Bank, has been named officer in charge of the Peachtree-Baker office in Atlanta, Georgia. Russell was formerly with C&S in the Chicago Service Office.

'41 *W. L. Sullivan,* EE, is now General Products Planning Engineer with Southern Bell in Atlanta, Georgia.

'42 *Harry B. Arthur,* USN, IM, has been promoted to the rank of full captain in an exercise at Pearl Harbor. He is now assigned to the Naval Headquarters in Washington, D.C.

L. B. Barnes, TE, has been promoted to vice president and controller with Fulton Cotton Mills in Atlanta, Georgia.

Joseph J. Tribble, ME, was elected state senator from Chatham County in a run-off held February 13. The new Republican senator is an engineer with Union Bag Camp Paper Company in Savannah, Georgia.

'43 *Charles W. Bastedo* has been elected vice president and plant manager of Dixisteel Buildings, Inc., Tallapoosa, Ga.

W. C. Phillips, ChE, has been appointed manager, development laboratory, of Kaiser Chemicals, Division of Kaiser Aluminum and Chemical Corporation.

More news on page 36

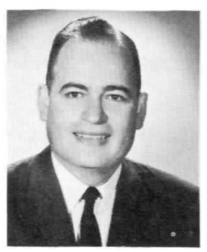
Faces in the News

Col. Morgan W. Pirkle, '34, retired from the U.S. Air Force after more than 28 years of service. Special ceremonies honoring Col. Pirkle were held at Robbins Air Force Base, Georgia, where Pirkle had been serving as director of industrial production equipment.

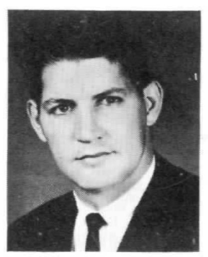
Robert C. Elder, '43, has been appointed sales manager of A.M. Lockett and Co., Limited. Elder joined the company in 1946 after completing his studies at the Wharton Graduate Business School. He was named sales engineer in Houston office in 1951.

Eugene Miller, '45, has been appointed vice president—public affairs and communications of the McGraw-Hill Publishing Co. Miller, Tech's 1962 commencement speaker, joined the company in 1952 as manager of the Southwest news bureau of *Business Week* magazine in Houston.

Richard C. Atchley, '48, has been named manager of The Vendo Company's Kansas City plant. He joined the company three years ago after serving as production manager of the hydraulic valve division of the New York Air Brake Co. He moves up from supervisor of systems.



J. Frederick Medford, '49, has recently been promoted to chief, reliability engineering section of advance missile technology in the missile and space division of Douglas Aircraft Co. Medford, who also received an MS degree from Tech in 1956, has been supervisor, advance programs.



M. D. Ellis, '58, has been appointed salesman representing Union Bag-Camp Paper Corporation's new multi-million dollar corrugated box plant in Greater Atlanta. Ellis, who joined the company five years ago, will have his new headquarters at the Atlanta plant.

NEWS BY CLASSES—*continued*

'45 *Charles R. Minors,* EE, division commercial sales engineer for the Georgia Power Company, Atlanta, Georgia, has been named assistant to the vice president and general manager.

'47 Married: *Thomas Walker Gilmer Richardson Jr.,* EE, to Miss Carolyn Roy, December 8. They live at 823 South Plymouth Boulevard, Los Angeles, California.

'48 *Richard C. Atchley,* IE, has been named manager of materials of the Vendo Company's Kansas City plant. He was formerly supervisor of systems. He lives at 5314 Williamsburg Court, Kansas City, Missouri.

Grover N. Meinert, IE, has been appointed director of industrial relations for Atlantic Steel Company, Atlanta, Georgia.

B. F. Smith, ChE, is a co-patentee of a recently issued patent assigned to Texaco, Inc. covering improvements in hydrocarbon conversion process. He is supervisor of fuels and research with Texaco in Port Arthur, Texas. Mr. Smith lives at 3147 Allison, Groves, Texas.

'49 Married: *Clinton B. Newton,* IE, to Miss Patsy Fowler, March 2. Mr. Newton is with American Insurance Company, Atlanta, Georgia.

Born to: *Mr. & Mrs. Joseph Spector,* ME, a daughter, Alina Beth, December 17. Mr. Spector is chief of the Computing and Analysis Branch at Picatinny Arsenal. They live at 14 Lake Shore Drive, RD 2, Dover, New Jersey.

'50 Born to: *Mr. & Mrs. Harry W. DeMille, III,* IM, a son, Donald Morgan, January 19. They live at 2553 Shetland Drive, Decatur, Georgia.

Born to: *Mr. & Mrs. Carl H. Fulton,* a daughter, Gloria Jane, January 22. They live at 2325 Burnt Creek Road, Decatur, Georgia.

'51 *Dr. Robert Fulton Dye,* ChE, is the new director of the Mississippi Industrial and Technological Research Commission at McComb, Mississippi. He holds 23 U.S. patents and patents pending and 62 patents and patent applications in 18 foreign countries.

'53 Born to: *Mr. & Mrs. Adrian D. Bolch, Jr.,* ME, a daughter, Laurie, November 12. Adrian was recently promoted from a staff position of evaluation engineer to a management position of Head of Forecasts Group in Headquarters Crude Oil with Humble Oil. They live at 5723 Portal Drive, Houston 35, Texas.

Born to: *Mr. & Mrs. Robert G. McClellan,* ME, a son, Robert, Jr., July 26, 1962. They live at 5 Roxbury Court, Newark, Delaware.

Stanley E. Tisdale, EE, has been promoted to principal engineer in the Communications Systems Engineering Department, Bendix Radio Division of the Bendix Corporation. He lives at 3119 Summit Avenue, Baltimore 34, Maryland.

'54 *Hansell P. Enloe,* Atlanta architect, has been installed as Second Vice President of the Georgia Engineering Society.

James E. Feltham, ChE, has been appointed manufacturing superintendent-phosphorus, at the Columbia, Tennessee plant of Monsanto Chemical Company's Inorganic Division. He lives at 1209 Whitney Drive, Columbia, Tennessee.

'55 Born to: *Mr. & Mrs. Ben T. Daugherty,* IM, a son, Christopher Shawn, January 27. They live at 34 The Prado, N. E., Atlanta 9, Georgia.

Born to: *Mr. & Mrs. John H. Fyfe, Jr.,* a son, John Hamilton, II, January 18. Mr. Fyfe is with Signode Steel Strapping Company. They live at 1018 Greenwood, Wheaton, Illinois.

Maj. Arthur J. Lochrie, Jr., USA, ME, has completed a course in coordinating and combined operations among the Armed Services and civilian agencies at The Armed Forces Staff College, Norfolk, Virginia.

Capt. Thomas N. Daniel, USAF, IM, is undergoing specialized training as a Strategic Air Command KC-135 Stratotanker co-pilot at Castle AFB, California.

'57 *Robert B. Church, III,* Atlanta architect, was designer of the new building of the Arkansas State Hospital at Little Rock. For this design, he won the health citation award in the 10th annual design awards program sponsored by Progressive Architect, a national architectural magazine. Mr. Church is with the Atlanta firm of Finch, Alexander, Barnes, Rothschild and Paschal.

'58 Married: *C. A. Freck,* ME, to Miss Harriet Ann Peterman last May. Mr. Freck is an engineer in the Apollo Support Department of General Electric. They live at 419 No. Peninsula Drive, Daytona Beach, Florida.

Benjamin Hirsch, Arch, has opened an architectural firm at 1064 West Peachtree, N. W., Atlanta, Georgia.

Married: *Robert Harbin Ledbetter,* IM, to Miss Betty Dandridge, January 19 in Rome, Georgia.

Married: *Frederick Earl Smith, Jr.,* IE, to Miss Constance Delores Lewis, February 16 in Richmond, Virginia.

'59 Born to: *Mr. & Mrs. Joseph F. Cornelius,* ChE, a daughter, Janine Kay, February 2. Mr. Cornelius is a project engineer for Firestone Synthetic Company. They live at 2608 Overbrook Drive, Cayahoga Falls, Ohio.

Engaged: *Horace Emmon Shelton,* ME, to Miss Joyce Davenport. The wedding will take place March 16. Mr. Shelton is with the General Services Administration in Atlanta, Georgia.

'60 Engaged: *Rev. Charles Burney Humphreys,* Tex, to Miss Glenda Reinhardt. The wedding will take place April 20 in Atlanta. Rev. Humphreys will graduate

More news on page 38

NEWS BY CLASSES—continued

'45 ... , EE, division commercial sales engineer for the Georgia ... Atlanta, Georgia, has been ... to the vice president and ...

'47 ... Thomas Walker Gilmer, Jr., EE, to Miss Carolyn ... They live at 823 South ... Los Angeles, California.

'48 ... Atchley, IE, has been ... manager of materials of the ... Kansas City plant. He ... supervisor of systems. He lives ... Court, Kansas City, ...

... IE, has been appointed ... relations for Atlantic ... Atlanta, Georgia.

... ChE, is a co-patentee of a ... patent assigned to Texaco, ... improvements in hydrocarbon ... He is supervisor of fuels ... Texaco in Port Arthur, ... lives at 3147 Allison, ...

'49 ... Clinton B. Newton, IE, to ... Fowler, March 2. Mr. ... American Insurance Com- ...

... Joseph Spector, ME, ... December 17. Mr. ... the Computing and Analy- ... Arsenal. They live ... RD 2, Dover, New ...

'50 ... Mr. & Mrs. Harry W. De- ... a son, Donald Morgan, ... They live at 2553 Shetland ... Georgia.

... Mrs. Carl H. Fulton, a ... January 22. They live ... Road, Decatur, Geor- ...

'51 ... Fulton Dye, ChE, is the ... of the Mississippi Indus- ... Technological Research Commis- ... Mississippi. He holds 23 ... patents pending and 62 ... applications in 18 foreign ...

'53 ... Mr. & Mrs. Adrian D. ... ME, a daughter, Laurie, ... Adrian was recently pro- ... position of evaluation ... management position of Head ... Headquarters Crude ... They live at 5723 ... 35, Texas.

... Mrs. Robert G. McClel- ... Jr., July 26, 1962. ... Court, Newark, Del.

... EE, has been promoted ... the Communications ... Department, Bendix ... Bendix Corporation.

He lives at 3119 Summit Avenue, Baltimore 34, Maryland.

'54 *Hansell P. Enloe,* Atlanta architect, has been installed as Second Vice President of the Georgia Engineering Society.

James E. Feltham, ChE, has been appointed manufacturing superintendent-phosphorus, at the Columbia, Tennessee plant of Monsanto Chemical Company's Inorganic Division. He lives at 1209 Whitney Drive, Columbia, Tennessee.

'55 Born to: *Mr. & Mrs. Ben T. Daugherty,* IM, a son, Christopher Shawn, January 27. They live at 34 The Prado, N. E., Atlanta 9, Georgia.

Born to: *Mr. & Mrs. John H. Fyfe, Jr.,* a son, John Hamilton, II, January 18. Mr. Fyfe is with Sigmode Steel Strapping Company. They live at 1018 Greenwood, Wheaton, Illinois.

Maj. Arthur J. Lochrie, Jr., USA, ME, has completed a course in coordinating and combined operations among the Armed Services and civilian agencies at The Armed Forces Staff College, Norfolk, Virginia.

Capt. Thomas N. Daniel, USAF, IM, is undergoing specialized training as a Strategic Air Command KC-135 Stratotanker co-pilot at Castle AFB, California.

'57 *Robert B. Church, III,* Atlanta architect, was designer of the new building of the Arkansas State Hospital at Little Rock. For this design, he won the health citation award in the 10th annual design awards program sponsored by Progressive Architect, a national architectural magazine. Mr. Church is with the Atlanta firm of Finch, Alexander, Barnes, Rothschild and Paschal.

'58 Married: *C. A. Freck,* ME, to Miss Harriet Ann Peterman last May. Mr. Freck is an engineer in the Apollo Support Department of General Electric. They live at 419 No. Peninsula Drive, Daytona Beach, Florida.

Benjamin Hirsch, Arch, has opened an architectural firm at 1064 West Peachtree, N. W., Atlanta, Georgia.

Married: *Robert Harbin Ledbetter,* IM, to Miss Betty Dandridge, January 19 in Rome, Georgia.

Married: *Frederick Earl Smith, Jr.,* IE, to Miss Constance Delores Lewis, February 16 in Richmond, Virginia.

'59 Born to: *Mr. & Mrs. Joseph F. Cornelius,* ChE, a daughter, Janine Kay, February 2. Mr. Cornelius is a project engineer for Firestone Synthetic Company. They live at 2608 Overbrook Drive, Cayahoga Falls, Ohio.

Engaged: *Horace Emmon Shelton,* ME, to Miss Joyce Davenport. The wedding will take place March 16. Mr. Shelton is with the General Services Administration in Atlanta, Georgia.

'60 Engaged: *Rev. Charles Burney Humphreys,* Tex, to Miss Glenda Reinhardt. The wedding will take place April 20 in Atlanta. Rev. Humphreys will graduate

More news on page 38

Facts in the News

NEWS BY CLASSES—*continued*

in June from the Candler School of Theology of Emory University.

Born to: *Lt. & Mrs. James A. Rosser, Jr.*, USAF, CE, a son, James A., III, May 3. Lt. Rosser is Control Center Director of the 328th Civil Engineering Squadron at Richards-Gebaur AFB, Missouri. They live at 5359 B Steward Avenue, Richards-Gabaur AFB, Missouri.

Frank R. Speer, IM, has been named 1963 Man of the Year by the Penn Mutual Life Insurance Company for his outstanding service to policyholders and his underwriting achievements. Mr. Speer is with the James M. Thurman Agency, 986 W. Peachtree, N.W., Atlanta 9, Georgia.

Dr. W. H. Starnes, Jr. conducted a seminar at Rice University in February on "The Effects of Metal Ions on Free Radical Reactions." He is a senior research chemist at Humble Oil, Baytown, Texas.

Engaged: *Harry Bruckner Thompson, III*, IE, to Miss Eleanor Ashcraft. The wedding will take place in June. Mr. Thompson is associated with the Conklin Tin Plate and Metal Company in Atlanta, Georgia.

'61 Married: *Allen A. Beech, Jr.*, IE, to Miss Monte Ann McKenzie. Mr. Beech is with Mead Packaging, Inc. They live at 2255 Lenox Road, N. E., Apartment B-6, Atlanta 5, Georgia.

Born to: *Lt. & Mrs. Robert F. Belote*, USAF, IE, a son, Robert Franklin, Jr., January 13. They live at 307 Rockwood Drive, Wichita Falls, Texas.

Married: *Roger Allen Camp* to Miss Marilyn Rives Bird, February 2. Mr. Camp is with the Navy and is stationed at Memphis, Tennessee.

Engaged: *Robert Edward Cheshire, III* to Miss Julianna Webb. The wedding will take place March 31. Mr. Cheshire is attending the Harvard Graduate School of Design.

Richard Coway, ME, has been transferred by the Georgia Power Company to their general office in Atlanta. He and his family live at 2888 Belvedere Lane, Decatur, Georgia.

Lt. Charles F. Cooper, USAF, IM, is being reassigned to Key West Naval Air Station, Florida following graduation from the U. S. Air Force technical training course for supply officers at Amarillo AFB, Texas.

Lt. Juddson A. Dewar, USA, is stationed at Dyess AFB, Texas. He is assigned to Battery B of the 517th Artillery's 5th Missile Bn.

Lt. Clark B. Dorsey, USAF, IM, has been reassigned to Turner AFB, Georgia following graduation from the U. S. Air Force technical training school for communications officers at Keesler AFB, Mississippi.

Alan W. Douglas, Chem, has received his masters degree in chemistry from Emory University.

Lt. Fred A. Reimers, USAF, IM, has completed the US Air Force advanced training course for F-102 Delta Dagger pilots at Perrin AFB, Texas.

Engaged: *Mark Herbert Rosen*, ChE, to Miss Joan Kaufmann. The wedding will take place April 13. Mr. Rosen is with DuPont in Wilmington, Delaware.

Lt. James H. Tucker, USA, IM, is the aide de camp to Brig. Gen. H. P. Persons at the Army Missile Command, Redstone Arsenal, Alabama.

Born to: *Lt. & Mrs. Jack Wilson*, IM, a son, Brooks Slaton, January 18. Lt. Wilson is a supply officer with the Navy in Sasebo, Japan.

'62 Engaged: *John Adolphus Coolik*, BC, to Miss Eileen Taratoot. The wedding will take place in June. Mr. Coolik is with Frontier, Inc., Montgomery, Alabama.

Lt. Kenneth C. Akins, USA, IE, has completed the infantry officer orientation course at The Infantry School, Fort Benning, Georgia.

Lt. John W. Anderson, USAR, IE, is stationed with Battery B, 6th Missile Battalion in Germany. His address is Battery B, 517th Artillery, APO 39, New York, New York.

William L. Ashe, CE, has been promoted to Division Construction Engineer with Texaco, Inc. He lives with ~~his~~ wife and son at 2167 Dresden Drive, Chamblee, Georgia.

Lt. Roger K. Borkenhagen, USA, IE, attended the Installation Stock Control Course #3 at Fort Lee, Virginia from November 25 through December 18. His permanent mailing address is 1226 Springdale Road, N. E., Atlanta 6, Georgia.

Lt. John P. Decker, USA, AE, has completed the officer orientation course at The Ordnance School, Aberdeen Proving Ground, Maryland.

John H. Harms, USN, IM, graduated in December from the Naval Officer Candidate School, Newport, Rhode Island and was commissioned an Ensign in the U. S. Naval Reserve. He is serving aboard the USS Henley. His mailing address is USS Henley (DD-762), c/o FPO, New York, New York.

Lt. Edward L. Harney, Jr., USA, IM, has been assigned to the U. S. Army Biological Laboratories at Fort Detrick, Maryland.

Monte W. Hartsell, USAF, IM, has been commissioned a second lieutenant in the U. S. Air Force following graduation from Officer Training School at Lackland AFB, Texas. He is now assigned to James Connally AFB, Texas for training as a navigator.

W. Zachary Hayman III, IM, graduated from Officer Candidate School at Yorktown, Virginia in January and was commissioned Ensign in the U. S. Coast Guard. He has been assigned to the Coast Guard Base Office, Sand Island, Hawaii.

Lt. Charles D. McWhorter, USA, EE, has completed the officer orientation course at Aberdeen Proving Ground, Maryland.

James F. Morris, IM, recently completed six months of active duty with the U. S. Army at Fort Jackson and is now associated with Courts and Company in Atlanta. He lives at 3806 Vermont Road, Atlanta 19, Georgia.

Lt. Russell B. Sorrells, III, USA, AE, has completed the officer orientation course at The Ordnance School, Aberdeen Proving Ground, Maryland.

Lt. Herbert W. Stewart, USAF, IM, is assigned to the Air Force Logistics Command Unit at Brookley AFB, Alabama.

Lt. Ralph E. Vick, USAF, AE, is in pilot training at Webb Air Force Base, Texas.

Ensign Rhodes Waller, USN, IM, recently graduated from Officer Candidate School at Newport, Rhode Island and is now enrolled in the Officers course in Naval Communications at Newport. Upon completion of this course he will be assigned to the USS Boxer (LPH-4) in Norfolk, Virginia.

WS BY CLASSES—*continued*

ıne from the Candler School of Theology ımory University.

ırn to: *Lt. & Mrs. James A. Rosser, Jr.,* F, CE, a son, James A., III, May 3. Rosser is Control Center Director of 328th Civil Engineering Squadron at ırds-Gebaur AFB, Missouri. They live 59 B Steward Avenue, Richards-Gabaur Missouri.

ınk R. Speer, IM, has been named 1963 of the Year by the Penn Mutual Life ınce Company for his outstanding serv- policyholders and his underwriting ıements. Mr. Speer is with the James hurman Agency, 986 W. Peachtree, Atlanta 9, Georgia.

W. H. Starnes, Jr. conducted a semi- Rice University in February on "The of Metal Ions on Free Radical Reac- He is a senior research chemist at ıle Oil, Baytown, Texas.

ıaged: *Harry Bruckner Thompson,* to Miss Eleanor Ashcraft. The wed- ıill take place in June. Mr. Thompson ıciated with the Conklin Tin Plate and Company in Atlanta, Georgia.

Married: *Allen A. Beech, Jr.,* IE, to Miss Monte Ann McKenzie. Mr. is with Mead Packaging, Inc. They 2255 Lenox Road, N. E., Apartment ıtlanta 5, Georgia.

ı to: *Lt. & Mrs. Robert F. Belote,* IE, a son, Robert Franklin, Jr., Jan- 3. They live at 307 Rockwood Drive, a Falls, Texas.

ıied: *Roger Allen Camp* to Miss ı Rives Bird, February 2. Mr. Camp the Navy and is stationed at Mem- ennessee.

Engaged: *Robert Edward Cheshire, III* to Miss Julianna Webb. The wedding will take place March 31. Mr. Cheshire is attending the Harvard Graduate School of Design.

Richard Coway, ME, has been transferred by the Georgia Power Company to their general office in Atlanta. He and his family live at 2888 Belvedere Lane, Decatur, Georgia.

Lt. Charles F. Cooper, USAF, IM, is being reassigned to Key West Naval Air Station, Florida following graduation from the U. S. Air Force technical training course for supply officers at Amarillo AFB, Texas.

Lt. Juddson A. Dewar, USA, is stationed at Dyess AFB, Texas. He is assigned to Battery B of the 517th Artillery's 5th Missile Bn.

Lt. Clark B. Dorsey, USAF, IM, has been reassigned to Turner AFB, Georgia following graduation from the U. S. Air Force technical training school for communications officers at Keesler AFB, Mississippi.

Alan W. Douglas, Chem, has received his masters degree in chemistry from Emory University.

Lt. Fred A. Reimers, USAF, IM, has completed the US Air Force advanced training course for F-102 Delta Dagger pilots at Perrin AFB, Texas.

Engaged: *Mark Herbert Rosen,* ChE, to Miss Joan Kaufmann. The wedding will take place April 13. Mr. Rosen is with DuPont in Wilmington, Delaware.

Lt. James H. Tucker, USA, IM, is the aide de camp to Brig. Gen. H. P. Persons at the Army Missile Command, Redstone Arsenal, Alabama.

Born to: *Lt. & Mrs. Jack Wilson,* IM, a son, Brooks Slaton, January 18. Lt. Wilson is a supply officer with the Navy in Sasebo, Japan.

'62 Engaged: *John Adolphus Coolik,* BC, to Miss Eileen Taratoot. The wedding will take place in June. Mr. Coolik is with Frontier, Inc., Montgomery, Alabama.

Lt. Kenneth C. Akins, USA, IE, has completed the infantry officer orientation course at The Infantry School, Fort Benning, Georgia.

Lt. John W. Anderson, USAR, IE, is stationed with Battery B, 6th Missile Battalion in Germany. His address is Battery B, 517th Artillery, APO 39, New York, New York.

William L. Ashe, CE, has been promoted to Division Construction Engineer with Texaco, Inc. He lives with ~~his~~ wife and son at 2167 Dresden Drive, Chamblee, Georgia.

Lt. Roger K. Borkenhagen, USA, IE, attended the Installation Stock Control Course #3 at Fort Lee, Virginia from November 25 through December 18. His permanent mailing address is 1226 Springdale Road, N. E., Atlanta 6, Georgia.

Lt. John P. Decker, USA, AE, has completed the officer orientation course at The Ordnance School, Aberdeen Proving Ground, Maryland.

John H. Harms, USN, IM, graduated in December from the Naval Officer Candidate School, Newport, Rhode Island and was commissioned an Ensign in the U. S. Naval Reserve. He is serving aboard the USS Henley. His mailing address is USS Henley (DD-762), c/o FPO, New York, New York.

Lt. Edward L. Harney, Jr., USA, IM, has been assigned to the U. S. Army Biological Laboratories at Fort Detrick, Maryland.

Monte W. Hartsell, USAF, IM, has been commissioned a second lieutenant in the U. S. Air Force following graduation from Officer Training School at Lackland AFB, Texas. He is now assigned to James Connally AFB, Texas for training as a navigator.

W. Zachary Hayman III, IM, graduated from Officer Candidate School at Yorktown, Virginia in January and was commissioned Ensign in the U. S. Coast Guard. He has been assigned to the Coast Guard Base Office, Sand Island, Hawaii.

Lt. Charles D. McWhorter, USA, EE, has completed the officer orientation course at Aberdeen Proving Ground, Maryland.

James F. Morris, IM, recently completed six months of active duty with the U. S. Army at Fort Jackson and is now associated with Courts and Company in Atlanta. He lives at 3806 Vermont Road, Atlanta 19, Georgia.

Lt. Russell B. Sorrells, III, USA, AE, has completed the officer orientation course at The Ordnance School, Aberdeen Proving Ground, Maryland.

Lt. Herbert W. Stewart, USAF, IM, is assigned to the Air Force Logistics Command Unit at Brookley AFB, Alabama.

Lt. Ralph E. Vick, USAF, AE, is in pilot training at Webb Air Force Base, Texas.

Ensign Rhodes Waller, USN, IM, recently graduated from Officer Candidate School at Newport, Rhode Island and is now enrolled in the Officers course in Naval Communications at Newport. Upon completion of this course he will be assigned to the USS Boxer (LPH-4) in Norfolk, Virginia.


DRINK
Coca-Cola