

INTO NEW LANDS:
THE PRINCIPLES OF NAVIGATION*

DR. HOUSTON, Members of the Class of 1957, Ladies and Gentlemen:

I am truly honored to be your guest on this occasion. Because of its high ideals, the Rice Institute has long enjoyed the respect of the entire academic world. Because, too, of my own warm affection and great esteem for your President, I responded with pleasure to his invitation to join you this evening.

Dr. Houston and I met first in the winter of 1927-28 as postdoctoral students of physics in Munich, Leipzig and Berlin. To you who are about to graduate from college, a span of thirty years must seem to have its roots buried in antiquity. To Dr. Houston and me, and to the older members of this audience, 1927 was only yesterday. And something of a case may be made for each of these points of view.

Certainly it is true that in the long perspective of history, thirty years is an almost imperceptible interval. But events have transpired in these *particular* years which have changed the tempo of time and the very meaning of its measure. The great river of human affairs seems suddenly to have come upon a stretch of steep falls and cataracts, and is now rushing on towards a new world unlike anything man has known before. Never before our time has the character of our globe as a habitation for man been altered so much in so short a span. From this point of view, 1927 was indeed a long time ago.

The year 1927 stood almost midway between the two most devastating wars of history. I am not competent to analyze

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the factors that have contributed to these terrible conflicts of our century, nor to assess the responsibility. The immediate causes clearly have been economic and political.

But underlying these convulsive movements of our time has been the striving of great peoples to adjust to a new existence made possible by the onrushing development of science and technology. Within this single century man's power to direct the forces of nature both to useful and to destructive purposes has multiplied a thousandfold. Within the lifetime of you who are graduating here this evening there has been an almost explosive growth in the technology at our command. So swift indeed has been the rise of science and engineering as mighty shapers of our society, and of all civilization, that many still fail to comprehend the breadth and strength of their influence. Let me give some substance to this point.

By its triumphs over disease, science has notably increased the normal expectancy of life and thereby affected the balance of populations. It is estimated, for example, that one person out of every twenty who have ever lived is alive today. The effective dimensions of the globe have been shrunk by the ease and rapidity of transportation and communications. Our generation has seen a truly stupendous expansion of industry, both in the volume of business and even more spectacularly in the variety of products. These in turn have contributed enormously to the material comforts of life. Science in agriculture has multiplied the fertility of our land and is effecting a major readjustment between town and country. City planners, in fact, are predicting that by 1975 the population of our metropolitan regions may be 70% again as large as it is today, in fact, with a resulting total urbanized area three times its present extent. It is difficult at this

moment, consequently, to foresee the ultimate form of the American city; we can be sure only that it will differ vastly from the city of today.

Finally, I would remind you of profound changes that have begun to affect the processes of industry and commerce. Indeed, we are on the verge of a second industrial revolution far more dramatic than the first. Old trades will disappear, of course; but for every job lost a dozen new ones may emerge, in service as well as production, challenging human skill and imparting variety and new interest to human labor.

In these few words I have hoped to convey to you only a suggestion of the magnitude of the revolution that is being wrought through progress in science. I well realize that it has become almost a commonplace to speak of technological innovation in this way. But despite all that has been written and said, I am obsessed by the thought that there is to this day still too little comprehension of the total extent of the changes in which the world is engaged.

There are, of course, in all this history of change, fearful implications for our future. The other evening at dinner I heard a distinguished diplomat remark with deep emotion and sincerity that the world would have been a better place had the atom never been discovered. He thought it now most unlikely that his children would live out their natural lives. But the atom does exist, has always existed, and by manifest destiny man was bound to discover it. The atom of itself is not evil. Neither is it good, although science—in everything it has given us—has increased man's opportunities for good. But the power of good lies with man himself and with his capacity for wisdom and moral judgment, his will to exploit his intellectual and spiritual resources for the welfare of mankind.

I am reminded of the old legend of Gutenberg and the invention of printing. It is told that one day as Gutenberg stood looking down upon his type with pride in his great discovery, the devil appeared before him and in a vision revealed to him all the evil that was to befall man in ages to come through the printed page—the slander and calumny, lies and obscenity, incitement to riot and war. In a fury of remorse Gutenberg caught up a hammer and was about to destroy his precious type. But there came to him at that moment an angel, and in another vision he saw the greatness of books as the record of all that man has said and thought and done that is noble or true or beautiful. Each man might now turn to his own Bible to seek consolation and hope in times of trouble; in history he might read the lessons of the past; in the rhythm and imagery of poetry his spirit would be stirred by the beauty of this world; and in philosophy he might discover the deeper meanings of life.

As it has been with printing, so may it also be with the atom and with the multitude of momentous discoveries that science is now showering upon us. You of this Class of 1957 should view the prospect not in a dark mood of alarm and despair but in optimistic terms of opportunity and challenge. There are gargantuan problems to be resolved, it is true, before the world can achieve political, economic and social equilibrium; but I, for one, am confident that they will be resolved, and that the difficulties and complexities of your existence will be more than offset by the challenge of new powers. Indeed, I envy you the intellectual adventures that lie ahead. We need waste no time in regretting an age that is now gone forever, but must look rather to the future.

Whether this future is to prove better or worse than the

past will depend wholly on our own efforts. We can only be sure that it will be different. We have been caught up in a great stream of technological development and are being swept forward into new lands. We cannot stem that tide. I do believe that we can navigate. Indeed I have faith that we *can* direct the forces of destiny and in significant measure determine the shape of things to come. Without that faith and confidence, your outlook on this Commencement Day would be most somber.

Now the basic resource that must sustain us in this adventure into the future is the common education of our people. In fact it has been said that civilization is a race between education and catastrophe. This week from schools and colleges all over the land, the Class of 1957 moves out to take its place in the line. The success with which *you* deal with the problems ahead will be governed in large measure by whatever wisdom my generation has exercised in the planning of your education. You in turn must shortly assume responsibility for those who come after. The welfare of this nation—and indeed the peace of the world—will be profoundly influenced by your concern for the importance of higher learning.

At every level of the American school system we are confronted today by perplexing and difficult problems. There is a shortage of buildings to accommodate the surging growth of population. There is an appalling shortage of teachers qualified to meet our more exacting demands. Among educators themselves there are deep differences of opinion as to the function of the common public school, differences as to the appropriate nature of the curriculum or the process of teaching.

At the root of all our concern, moreover, is the funda-

mental dilemma of numbers—of how to reconcile our dream of universal opportunity in education with a pressing need to cultivate excellence. It is imperative that we learn to take better account of the enormous spectrum of human ability, interests and initiative. Truly democratic education imposes upon us the duty to help each individual make the most of his abilities. We must recognize, therefore, the obligation of a democratic people in the interest of its own survival to seek out and educate the notably gifted, the industrious and the ambitious, the most promising of its human resources for spiritual and intellectual leadership.

These are among the most meaningful and difficult questions of our day, and with this Commencement they become your problems too. Since you cannot escape them, I trust you will seek to resolve them with all the intelligence at your command.

And so from these allusions to broad issues let me turn to comment briefly on engineering and the arts in the context of a liberal education for our time.

Engineering education as it commonly exists today is a product of the mid-nineteenth century. It was designed for a more elementary technology and a simpler society. As such it has provided a rather rudimentary training in mathematics and the physical sciences, a meager amount of general education, and the essentials of some specialized branch of engineering. At its best the curriculum has been fundamental and thorough; at worst, heavily vocational. While this plan has been basically sound for the years gone by, the complexities of modern technology and the complete transfiguration of modern society confront us with an entirely new range of requirements. The traditional patterns of engineering education are in large measure outmoded and inadequate.

Our first task, as it seems to me, is to take better stock of the vast variety of activities encompassed under the title of engineer. When we refer to the alarming shortage of engineers, we have in mind a wide range of occupations that begins with research and development and extends through design and production, into sales and service, and on to the highest levels of industrial management. Every part of this spectrum can have dignity and importance and each contributes in a particular way to the national good. I do not believe, however, that one and the same plan of engineering education can serve both the aims of immediate utility and the highest aspirations of the profession.

The time has now come, in fact, when the engineering educator must differentiate more clearly and firmly between the engineer and the technologist. Because the great problems of engineering can no longer be dealt with in isolation from the needs and affairs of people and human institutions, I am moved by the vision of a new and higher role for the engineer in the changing world I have portrayed for you. But if the engineers of the future are to provide the leadership that we shall desperately need, then technical competence is not enough; they must also be educated men. At the same time, it has become manifestly impossible within the brief undergraduate span both to train for technical competence and to educate young men and women for the grave responsibilities of leadership.

Education is a costly investment in time and money and we must not lightly add to that burden. But for the engineer of the future there seems to be no alternative course. No longer can we afford to substitute mere mastery of techniques for professional competence.

And now, finally, to these comments on engineering edu-

cation I would add that our need to strike a new balance in the teaching of the liberal arts is, if anything, even more acute. As we have come to require the scientist and engineer to understand the social and cultural forces he affects and is influenced by, so must we expect the liberal arts student to understand the spirit and meaning of science. Science has become an intimate and influential part of our culture, and no one born into today's world can escape its impact on the changing pattern of civilization.

The health of our national economy is bound up tightly with new products of research. Our national security is almost wholly dependent upon them. The books and journals of the day are preoccupied with the political and ethical consequences of an expanding wealth of power through technology. Even art and architecture are affected by the new ideas and new materials that flow from scientific and technical progress. These are the conditions that exist and we had best learn to live with them.

After all, if we are to contribute constructively to the preservation of peace and the dignity of human existence, then we must be prepared to deal intelligently with the world as it is. If we are to be effective in life we must comprehend the great issues of *our* time and the forces that are shaping *our* destiny. While we may draw upon religion for codes of conduct and upon history for principles of action, every liberally educated man or woman must know something of the laws that govern our material universe.

This is not to ask that the doctor, the lawyer, or the banker should learn and retain the details of science. But it does seem to me vital that at some period every educated man and woman should have gained an insight of certain principles, certain methods, certain great modes of thinking that lie be-

neath all science. It is not necessary that a man be able to discuss the gravity of the fall-out problem in terms of roentgens. But it *is* important that he should have a feeling about how we have arrived where we are. He should have explored some science far enough to have gained confidence—confidence that in this great domain there are no mysteries accessible only to the few—confidence that he himself might have pursued science to its farthest frontiers. Out of such confidence and familiarity may develop judgment, an intuitive sense of the critical factors entering into great issues.

Out of confidence, too, and through this basic understanding must come freedom from the fear of science, the dispelling of that mistrust and dormant hostility that threatens to cut off the community of scientists and engineers from the general body of educated people.

This growing chasm in our culture has come about in part because educated men have failed to communicate adequately with one another. Too often the scientist and engineer have been content to lead parochial lives; too often they have been too little concerned that others should understand the meaning and implications of their work. But this spirit of separatism has arisen too because we live in an age, as one physicist has put it, "in which poets and historians and men of affairs are proud they wouldn't begin to consider thinking about learning anything of science, regarding it as the far end of a tunnel too long for any wise man to put his head into." Such a tunnel philosophy, which is more common than many suspect, should lie heavy on the conscience of American education.

We need desperately a new and healthy fusion of learning and knowledge in our American colleges—a fusion which the educational programs I have outlined in such sketchy

terms this evening could help achieve. Happily, I believe such programs are coming. Already we have taken steps to give science and engineering students more opportunities for study in the social sciences and the arts. Happily, some schools—and you may be proud that Rice is among them—are also wisely requiring that the liberal arts student acquire a basic understanding of mathematics and science. But such forward-looking programs as yours are still too few in number to give American education the significance and relevancy it needs to create a climate of mutual understanding and respect among educated men. Such a climate, and such a greater unity of purpose in our educational programs, can contribute immeasurably toward the attainment of our highest national aspirations. The challenge of attainment is yours.

Having presented this challenge to your future, may I close with a word of congratulations on what you have already accomplished. I am privileged to have had the opportunity to share in this joyous occasion with you. I wish you Godspeed.

J. A. STRATTON