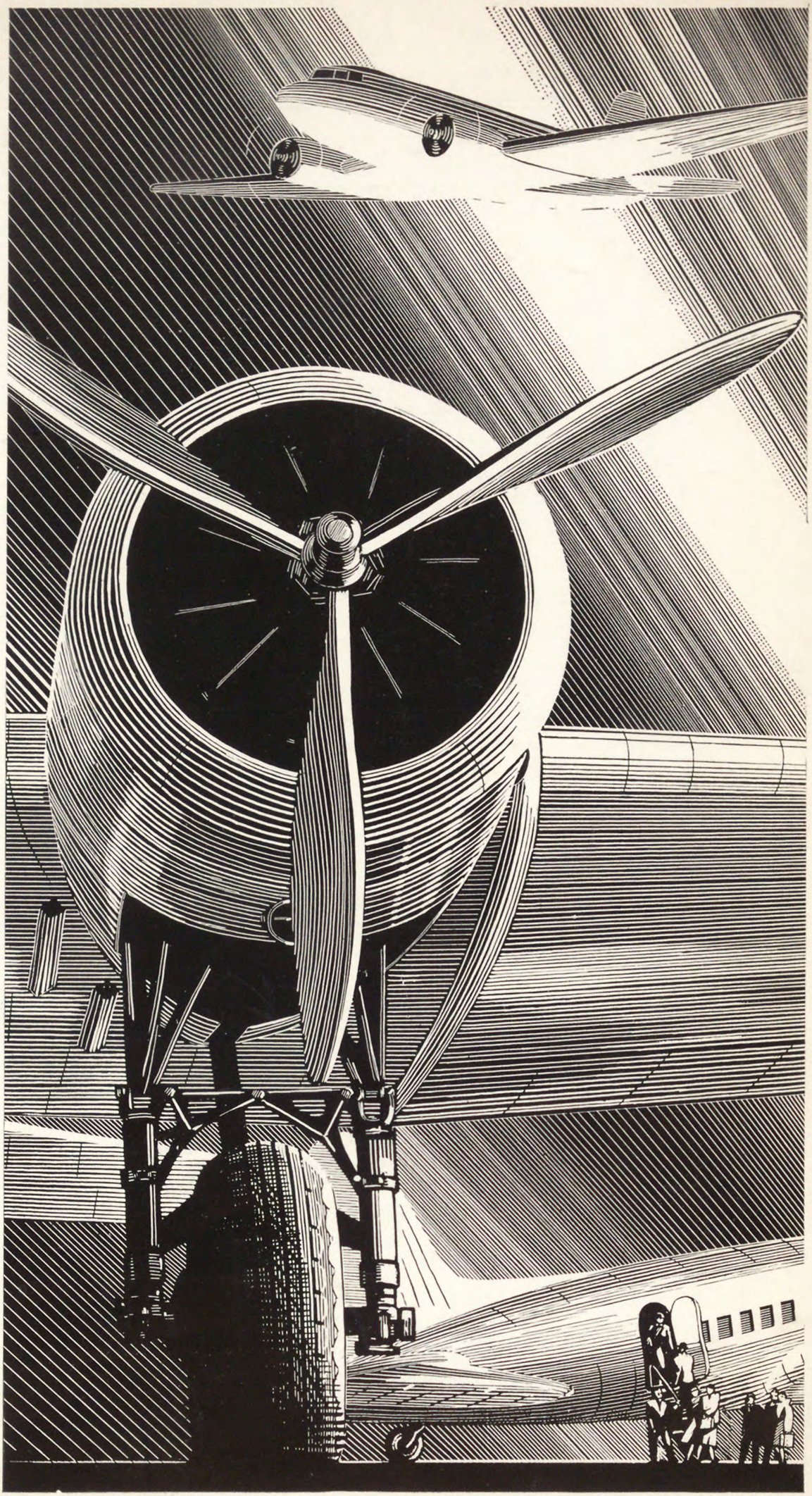
NEWARK ENGINEERING NOTES

Volume 2 Number 1

OCTOBER, 1938

What State Has the Largest Airport in the World?

NEW JERSEY — One of America's Great States



THE PRESIDENT'S DIARY

Enrollments — Education Must Be Democratic — The Development of Character — The Cost of Education

September 19th

The opening of the academic year always brings with it not only many problems but many satisfactions. It has been particularly interesting and satisfactory to note this year a very considerable increase in our applicants for admission which would seem to be explained at least in part by the good name and the spreading influence of the institution.

While figures are sometimes uninteresting, it would be perhaps well to call attention to the fact that we had considerably over four hundred applications for admittance. Of these palpably, on the basis of the high school records, many were unfit. Slightly over three hundred seemed to be academically satisfactory. They were given, at a considerable expense of time and effort, a personal interview and certain standard psychological and interest tests, and were further interviewed by the Department of Industrial Relations particularly with respect to their employability.

Some boys, on the basis of this interview, felt called upon of their own free will to withdraw. Others were so advised, and the deadline was set at one hundred and seventy-five students. This quota was met early in the summer. However, during the late weeks many more applicants put in an appearance, some of whose high school records were so outstanding, and who in addition were boys of such character and personality, that we felt it would be very much in the public interest as well as our own to take them in. The result was that an extra section has been provided and we officially registered two hundred and six freshmen.

This experience is not in any way unique, and it would be perhaps unfair to say that our own reputation and good standing alone were responsible, because educational institutions all over the United States and engineering institutions in particular are having an increased enrollment.

September 21st

In looking over this record which I have outlined in the previous paragraphs with some attempt at analysis, it would seem to suggest some very important problems in an institution supported as we are.

I think all the alumni and all the undergraduates understand that the institution is a public one supported in a very large measure by public funds. The great question then in enrolling students would seem to divide itself into two distinct parts. One, is the benefit to the students, and the other, the benefit to the community or the public at large. In many cases the benefit to the student by education is evident, but in all cases an institution founded and operating as we are, must consider the benefit to the public.

For this reason, and perhaps for this reason alone, an institution of this character should not take in all its applicants but should be perhaps more careful, keep its standards higher than institutions of any other type, and should in the main, I think, largely cater to those men of outstanding ability and capacity who through circumstances largely financial cannot afford to develop their capabilities in engineering.

This amounts to saying, as I have so often said, that in a democracy education must be democratic, must depend on ability, must depend on capacity, and must not depend on personal financial consideration alone.

September 26th

In reading this last paragraph and in connection with the international events which crowd in upon us so fast, I am almost forced to remark that in a democracy it is necessary as it is in any form of government to develop manpower and intellectual power just as definitely as it is to develop material resources. I do not remember whether it was Bismarck or Walter Rathenau who said that a nation would succeed which capitalized to the utmost the possibilities of its citizens. It seems to me that in industrial or technical education that this is particularly true and that one of our immediate and important practical duties is to assure that in a democracy our ideals and our practices remain truly democratic.

This means to me and to those interested in this institution that the institution must as a public institution concern itself primarily with the development of intellect and character among those who find it difficult or impossible to secure such development elsewhere under a prohibitive cost. This would seem to me not demagogic but simply downright sound common sense provided the basis of training and the basis of education rests on the capacity of the individual to personally profit by the education and his desire or willingness to pass on some of the benefits to the broader community who have made the training possible.

September 28th

Perhaps one further word should be said in this connection and that is we should not lose sight of the fact that money for tuition alone is not the determining factor in the education of young men at technical colleges. A great many colleges ask and require residence on the campus for which there are charges for room and board. Many colleges ask something in the way of recompense for an expensive athletic or social program.

Without going into the merits or demerits of these various factors in education, it might be remarked that if we have money enough to pay for things, we can afford to have many things, but in our whole economic structure as well as our educational structure it does not pay to acquire without limit things for which we cannot afford to pay. This means that a man on perhaps a twenty-five hundred dollars a year salary is foolish to attempt to duplicate the establishment of a man on a twenty-five thousand dollars a year salary—that is, keeping up with the Joneses is not the essence of democracy.

Of course I like to liken educational transportation to automotive transportation. There still is in this great democracy room for a dozen good cars in different priced fields of education without the feeling on the part of either the manufacturer or the driver of the car that the price field in which he purchased necessarily means poor transportation. All of which means that the fundamental criterion determining the enrollment in an institution of this kind is to choose men of ability and character and furnish them with a good education at as low a price as is consistent with quality instruction.

I cannot help but remark in closing this particular entry that once in a while I have heard some disparaging remarks toward the institution as a poor man's school and I would like to submit that it is a poor man's school in this great democracy of ours in exactly the same way that a Pontiac or a Plymouth or even a small Buick is a poor man's car. The fact that we can and do furnish instruction at a cost entirely reasonable is a source of great pride and great satisfaction to us.

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Do You Want to Be on Our Mailing List?

From time to time you will receive a copy of the Newark Engineering Notes. In case you wish to receive this magazine regularly, the only thing you have to do is to write us and say so. Address your letter to the Editor, Newark Engineering Notes, Newark College of Engineering, Newark, N. J.

IS THE DEAN IN?

Interesting Facts and Incidents Given from Fifteen Years' Experience

By JAMES A. BRADLEY, A.B., A.M.

Dean and Associate Professor in Chemistry, Newark College of Engineering

Some one has said that the function of the dean is to keep the rest of the faculty popular with the students. And certainly it seems in my own case that I spend more time than I like in having unpleasant interviews with students and their parents. Like the doctor and the lawyer, the dean seems to have much to do with the troubles of the human race, at least that small part of it that goes to college. He is the one who must finally persuade the boy with three F's that he must leave college, even though it is perfectly clear to the boy that he would make a brilliant record the following year if he were allowed to remain. The dean is the one who usually meets the parents of such boys and explains why it is that their son is very unlikely ever to become an engineer, even though his record in assembling radio sets and keeping the family car running smoothly proclaims him an engineer and nothing else. It is annoying to know, incidentally, how few people outside of the profession know what an engineer is and what he does. It makes it still harder for the dean when he realizes how heartbreaking it is for a parent to see a child suddenly left with no object in life by being dropped from college. He thinks of the months of adjustment that must be suffered before things begin to look right again. Such tragedies, for they often really are tragedies, happen in every college and in every grade of society in spite of our much publicized educational techniques with their strong psychological slant. We have not yet found a way to fit every student to his proper place in life. We have not even learned to judge whether a boy should be put through the educational process or not. The reason, possibly, is that each of us is an individual human being with his own complex pattern of reactions and idiosyncrasies, which, taken together, constitute a "special case." Psychologists may be able to predict with fair results the collective behavior of a group of one hundred thousand individuals, but the boy sitting in the chair in front of you is a problem all by himself. A doctor once told me that two people with a cold have two different diseases. I often think of this when dealing with students.

Writing of this, I have in mind a young man who entered college some years ago and did poorly the first year. The second year he fared even worse, and the scholarship committee decided that he should be dropped from college. He left without a struggle, as it seemed to me, and I felt that I had seen the last of him. But the following September he was back again.

"I've spent the summer working on a farm and thinking," he said when he came to see me. "When I entered this college I had queer and romantic ideas about engineering. I got it, I suppose, from the movies and from some of our popular magazines. But now I begin to see what an engineer's work is and I am not interested. But I have begun also to understand what chemistry is and I want to come back as a chemical. If you will let me try the evening school for a couple of years I think I can show you that I am a changed man."

I agreed that it might be worth trying "perhaps for a year." He worked days, of course. In the evening classes (he happened to be in one of mine) he went at his studies with such interest and vigor that I felt I was holding him back; it seemed to me that he should be allowed to range through the course ahead of the rest of us, without regard for schedule. He very clearly had found what he wanted to do. He graduated from the chemical engineering course, although his interest lay rather in pure chemistry, and he is now working for his doctor's degree.

I should like to write this article in a cheerful and amusing vein. As a matter of fact, I half promised the editor that I would. But it occurs to me that at the Newark College of Engineering others present the medals. My work is largely concerned with getting rid of the poorer students and by warnings and encouragement keeping the great middle class from slumping. This hardly permits a bowing acquaintance with our best men. And I am often chagrinned on the day of graduation to find that I hardly know the honor students, except those who are in the department in which I teach. So, instead of being cheerful and amusing about the whole matter, let us discuss some of the problems that come to the dean through his dealing with students.

It has been said that in order to produce a good man, you must start about three hundred years before his birth. We think heredity quite important. Most of us have heard of the mother who could not admit that her boy was at fault and yet was not able, on account of the evidence, to blame his teachers. So she said, "Well, his father's people were like that." It is not only in stories that such statements are made.

Whatever may be the influence of a student's heredity, it is clearly many years too late to do anything about it. People will marry, usually without regard to the teachings of eugenics. The environment, too, is a factor of importance but, except in romances, it seldom can be changed. We must take the material and the setting and do the best we can with it. And it sometimes amazes me to see how well we do with it.

This must not be taken to mean that the young man is merely clay in the hands of his teachers who form him into the intellectual shape which they think most desirable. Actually, I think, teachers have less to do with this process than they believe. The student himself is both the potter and the clay. He can look to his teachers and his books only for occasional direction. Even during the hours when he is under the eye of the professor in the lecture hall or the class room he is doing his own thinking. But the greater part of the time he is left to himself and must work out his problems alone. This condition is not always realized by the student or his parents. Yet I think it is one of the most important facts to be considered in college education. It involves the matter of responsibility. If you can cultivate in the student the understanding that he must depend on himself and, moreover, that he is in most ways accountable for the problems he undertakes in his own particular world, then you have solved one of the major problems of education. The transition from high school to college is very trying, chiefly because of this matter of responsibility. If the student feels from the very beginning that he will be thrown on his resources more and more as time goes on, and if he accepts his responsibilities with understanding, then he has made a great step in the development of his character. And, in general, he will accept, as *Ernest Dimnet** says, just about as much as his teachers expect him to accept. M. Dimnet does not believe that the American teacher is very well acquainted with this fact.

Character is the sum of the mental and moral traits which distinguishes an individual as a personality. Even a baby has a character as soon as it is born. This character is modified and added to hour

*Abbe Ernest Dimnet, a Frenchman, is best known as the author of "The Art of Thinking," but he has written many other books, among which I prefer his very sane and helpful, "What We Live By."

by hour by the thoughts, actions, and decisions of the baby, boy, man. We look on it as the most important attribute a man can have. It is the thing that every employer, every associate, every subordinate looks for in one, consciously or otherwise. It outweighs any other quality. Of what use is a high degree of technical knowledge or skill if the possessor cannot be depended upon? Does he have to be watched, or can his superior go to Europe or be out sick for a month with the feeling that he has left his affairs in the hands of one who can be relied on? Can he get along with others? This is the question that every prospective employer or associate asks.

I remember a man whom I met in the Navy during the war. He was trained as a chemist and, although young, was assigned to fairly important chemical duty. He was easily one of the most brilliant of our group, but erratic. Ten years later I met him in a New York theater. He was not exactly down and out, but he was doing rather unimportant work in a position that required little or no training. He was, as of old, quite voluble, and it did not take long to learn that his failure was due, not to lack of brains or to lack of training, but to the inability to get along with others and especially to the fact that he could not control a bitter tongue.

This ability to coöperate is one of the good things that make up character and is as important as technical skill or special knowledge or any of the other qualities that we usually think of as salable in the industrial world. At the Newark College of Engineering we train men in the engineering sciences but our chief concern is this matter of the development of character.

The question of money is as troublesome to college men as it is to most other people, and it is an excellent lesson in personal economics to watch how some students make their way, lacking a father to pay the bills. Often, of course, they are helped by relatives, by scholarships, or by the college through an arrangement for deferred payment of tuition. But I marvel at the man who is alone in the world, who finds and keeps a job in or out of a depression, who always looks as if he had just stepped out of a band box, and who does at the same time enough college work to graduate in six years instead of the usual four. I think we should not fail to give part of the credit for these miracles to a small, but growing, class of modern employers who have a heart as well as an intelligence and who make it possible for such men as I am writing about to arrange their working hours so as to allow time for attendance at college and for study.

Some of what I have written may seem more like thoughts and considerations than problems. But I feel that they may be legitimately included since they are concerned with the solution of the problems. These last we have with us always in great variety; from simple ones, such as, "Whom shall I have to see about running a fraternity dance?" to questions which, one realizes, may influence the whole life and happiness of some one. The problems are not all solved to everybody's satisfaction, least of all to my own.

Editor's Note: Dean James A. Bradley was born in Boston. He graduated from Boston Latin School and entered Harvard College, receiving the A.B. degree in 1914 and the A.M. degree in 1920. From 1914 to 1916 he did research and biological chemical work at the Massachusetts State Infirmary, and from 1916 to 1918 he was instructor in biological chemistry at Tufts College Medical and Dental School in Boston. The following year he was in the U. S. Navy doing work on explosives at the Naval Proving Grounds at Indian Head, Maryland. In 1919 and 1920 he did research work in organic chemistry in the Harvard Graduate School of Arts and Sciences under Professor J. B. Conant who is now president of the university. After two more years of industrial research work on dyestuff intermediates with the Grasselli Chemical Company, he came as an instructor to the Newark College of Engineering where he has been ever since.

AMERICAN SOCIETY OF CIVIL ENGINEERS

The Newark College of Engineering student chapter of the American Society of Civil Engineers will hold meetings this year on the following dates: October 10, November 14, December 12. Next year meetings will be held on January 9, February 6, March 6, April 3 and May 1.

At the November 14th meeting Mr. Cullimore, President of the Newark College of Engineering, will tell of his observations and experiences from a recent trip to Italy. A suitable title to his talk might be "Some Disadvantages of a Dictatorship."

Professor William S. La Londe is Faculty Advisor.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

President Waldau and his newly elected officers of the student branch of the A. I. E. E. look forward to presenting a particularly active and interesting series of meetings. The tentative schedule for the year includes talks and trips designed to cross section the engineering field. "Electrical Developments in the Aviation Field" dealing with unique power supplies used in ship communication is the subject for the first meeting on October 24th. This group with the other student branches of the college is arranging a trip to the World's Fair Grounds in late November. An inspection of the television broadcasting equipment and a talk on some of the problems involved features the meeting for December. The latter half of the school year will be taken up with a joint meeting with the branch of one of our neighboring colleges. A meeting of interest to the radio enthusiasts and the convention to be held next year at Cooper Union complete the program.

Clarence H. Stephans is Student Counselor.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Our Student Branch will open its 1938-1939 with a discussion of "Modern Air Conditioning," by Mr. Robert Ward of the Delco Division, General Motors Corporation. The meeting will be held on Monday evening, October 3rd, at 8 P. M. in the Gymnasium.

This year's schedule calls for a series of eight meetings on various topics, the meetings to be held on the first Monday of each month. The Chapter is laying plans to attend the annual meeting of the A.S.M.E. in New York in December and also to have a large delegation represent the School at the Eastern Conference of Student Chapters at New York University in April. Graduate members of the Chapter are invited to attend the meetings and take an active part in our program.

Professor Frank D. Carvin is Honorary Chairman.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS

The first meeting of the Student Chapter of the American Institute of Chemical Engineers was held on October 7 in the gymnasium of the college. The speaker was Mr. A. L. Stern who talked on "Commercial Pulverizing."

A number of other meetings are to be held during the year at which the students will have an opportunity to hear talks by chemists and chemical engineers practicing in the metropolitan area. Other talks planned for the near future are one by Dr. A. E. Edel of Newark, who will discuss his experiences as a toxicologist, and one by Mr. F. J. Van Antwerpen, who will speak on chemical publications.

The Faculty Chairman is Professor V. T. Stewart.

MOTION OF A CHAIN WITHIN A SMOOTH FIXED TUBE

By Bedross Koshkarian, A.B., A.M.

Professor in Theoretical and Applied Mechanics, Newark College of Engineering

In his Traité de Mecanique Rationelle M. Paul Appell solves this problem for a *homogeneous* inextensible chain, assuming that the equation of the curve (tube) and the density of the chain are given. We propose to solve the same problem for a *heterogeneous* chain.

In a subsequent paper we propose to discuss the inverse problem: To determine the law of distribution of density so that the chain shall move in a manner given in advance. The solution of this problem leads to *integral equations*, as shown by Myller (Nouvelles Annales de Mathématiques), of the Volterra type, or that of Fredholm, according to the given conditions. By means of this simple problem we wish to introduce to our readers the very interesting subject of integral equations. We meet this type of equations in mathematical physics and in mathematical theory of economics.

To derive the differential equation of motion of the chain, let, in Fig. 1, DN represent the chain of length $2a$ moving in

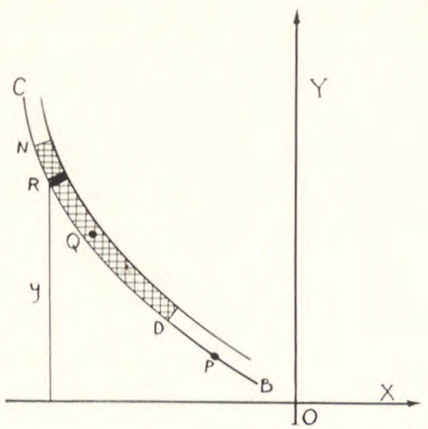


Fig. 1

the tube in the direction BC. Let Q be the middle point of the chain and p denote the arc PQ, P being a fixed point on the tube. The position of the chain will be known if p is known.

We shall use the work-energy equation

$$d\,\frac{\Sigma mv^2}{2} = dU.$$

The external forces acting on the chain are the weights of its particles and the normal reactions of the tube. The latter forces do no work. To calculate the work done by the weights of the particles we assume that the density of the element du of the chain at R is given by

$$\rho = f(u)$$

where u denotes the arc QR of the chain, R being any point on the chain. Then, since the arc PR of the tube $= p + u = s$, measured from P, the ordinate of du is given by

$$y = F(p + u).$$

Let us suppose that the chain slides a length dp. The element of work done by the weight of $du = -[gf(u)\,du]dy = -gf(u)F'(p+u)\,du\,dp$. Hence, the work done by the weights of all the elements $= -gdp\int_{-a}^{a} f(u)F'(p + u)\,du = dU$. The kinetic energy of the system is

$$\tfrac{1}{2}\Sigma mv^2 = \tfrac{1}{2}\Sigma m \left(\frac{dp}{dt}\right)^2.$$

Hence, the work-energy equation becomes

$$d\tfrac{1}{2}M\left(\frac{dp}{dt}\right)^2 = -gdp\int_{-a}^{a} f(u)F'(p + u)\,du.$$

Dividing both members of this equation by dt, and performing the indicated differentiation, we get

$$M\,\frac{dp}{dt}\,\frac{d^2p}{dt^2} = -g\,\frac{dp}{dt}\int_{-a}^{a} f(u)F'(p + u)\,du,$$

where M = mass of the chain $= \int_{-a}^{a} f(u)\,du$.

Dividing both members of this equation by $\frac{dp}{dt}$, we finally get

$$M\,\frac{d^2p}{dt^2} = -g\int_{-a}^{a} f(u)F'(p + u)\,du, \qquad \text{(A)}$$

which is the differential equation of motion of the chain.

To find the tension at any point of the chain, we apply the work-energy equation to the motion of the part DR of the chain, Fig. 2. The external forces acting on the system are the weights of the particles, the normal reactions of the tube, and the tension T at the point R. Let the chain slide a length dp. Then

Work done by the normal reactions = 0,
Work done by the tension T = Tdp,
Work done by the weights of the particles =

$$-gdp\int_{-a}^{u} f(u)F'(p + u)\,du.$$

The kinetic energy of the system is

$$\tfrac{1}{2}\Sigma m\left(\frac{dp}{dt}\right)^2 = \tfrac{1}{2}\left(\frac{dp}{dt}\right)^2\int_{-a}^{u} f(u)\,du.$$

The work-energy equation becomes

$$d\tfrac{1}{2}\left(\frac{dp}{dt}\right)^2\int_{-a}^{u} f(u)\,du = Tdp - gdp\int_{-a}^{u} f(u)F'(p + u)\,du.$$

Dividing both members of this equation by dt, and remembering that

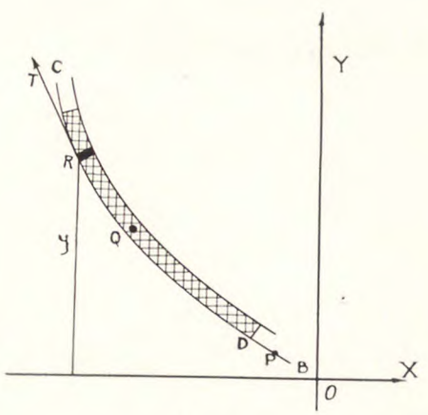


Fig. 2

$\int_{-a}^{u} f(u)\,du$ = mass of the part DR = M, we obtain

$$M\frac{dp}{dt}\frac{d^2p}{dt^2} = -g\frac{dp}{dt} - \int_{-a}^{u} f(u)F'(p+u)\,du + T\frac{dp}{dt}.$$

Putting the value of $\frac{d^2p}{dt^2}$, as given by (A), in this equation, we finally get

$$T = -\frac{Mg}{M}\int_{-a}^{a} f(u)F'(p+u)\,du + g\int_{-a}^{u} f(u)F'(p+u)\,du, \quad (B)$$

which is the general expression for the tension. For a homogeneous chain $\rho = f(u) =$ constant, and (A) becomes

$$M\frac{d^2p}{dt^2} = -gf(u)\int_{-a}^{a} F'(p+u)\,du, \qquad M = 2a\rho.$$

Hence

$$2a\rho\frac{d^2p}{dt^2} = -g\rho\left[F(p+u)\right]_{-a}^{a}$$

or

$$\frac{d^2p}{dt^2} = -\frac{g}{2a}\left[F(p+a) - F(p-a)\right], \quad (C)$$

For a homogeneous chain (B) becomes

$$T = -\frac{Mg}{M}f(u)\int_{-a}^{a} F'(p+u)\,du + gf(u)\int_{-a}^{u} F'(p+u)\,du.$$

Since, in this case, $M = (a+u)\rho$, we obtain

$$T = -\frac{(a+u)\rho g}{2a}\left[F(p+a) - F(p-a)\right] +$$

$$g\rho\left[F(p+u) - F(p-a)\right] =$$

$$\frac{g\rho}{2a}\left[2aF(p+u) - (a+u)F(p+a) - (a-u)F(p-a)\right]. \quad (D)$$

The results (C) and (D) are derived directly, by M. Appell.

To illustrate the foregoing work, it will perhaps be interesting to take a few examples.

Example 1. Chain homogeneous, tube cycloidal.

The cycloid will be taken as in Fig. 3, in which case its equation is

$$x = r \operatorname{arc\,vers}\frac{y}{r} + \sqrt{2ry - y^2}.$$

We have

$$\frac{dx}{dy} = \sqrt{\frac{2r-y}{y}}$$

Measuring the arc s from the lowest point O, we get

$$s = \int_0^y \sqrt{1 + \left(\frac{dx}{dy}\right)^2}\,dy = 2\sqrt{2ry}$$

Hence

$$y = F(s) = \frac{s^2}{8r}$$

and $M = 2a\rho$.

Equation (C) becomes

$$\frac{d^2p}{dt^2} = -\frac{g}{2a}\left[\frac{(p+a)^2}{8r} - \frac{(p-a)^2}{8r}\right]$$

Simplifying, we get

$$\frac{d^2p}{dt^2} = -\frac{g}{4r}p.$$

It appears that the chain performs *harmonic curvilinear oscillation* about O, with the period $4\pi\sqrt{\frac{r}{g}}$.

The expression (D) for the tension becomes

$$T = \frac{g\rho}{2a}\left[2a\frac{(p+u)^2}{8r} - (a+u)\frac{(p+a)^2}{8r} - (a-u)\frac{(p-a)^2}{8r}\right].$$

Simplifying this expression, we get

$$T = -\frac{g\rho}{8r}(a^2 - u^2).$$

Since $a \geq u$, the tension is either zero, or always negative. It appears that the stress in the chain is compression, not tension.

Example 2. Chain homogeneous, tube rectilinear; motion up the tube.

From Fig. 4 we get s measured from O.

$y = F(s) = \sin\theta\, s.$

Equation (C) becomes

$$\frac{d^2p}{dt^2} = -\frac{g}{2a}\left[\sin\theta(p+a) - \sin\theta(p-a)\right]$$

which gives

$$\frac{d^2p}{dt^2} = -g\sin\theta = \text{constant}.$$

In this case the chain moves with constant deceleration.

The expression (D) for the tension becomes

$$T = \frac{g\rho\sin\theta}{2a}\left[2a(p+u) - (a+u)(p+a) - (p-a)(a-u)\right] = 0,$$

which shows that there is no stress in the chain.

Example 3. Chain heterogeneous, tube cycloidal.

Since $y = F(s) = \frac{s^2}{8r} = \frac{(p+u)^2}{8r}$,

and $F'(p+u) = \frac{p+u}{4r}$,

the differential equation (A) becomes

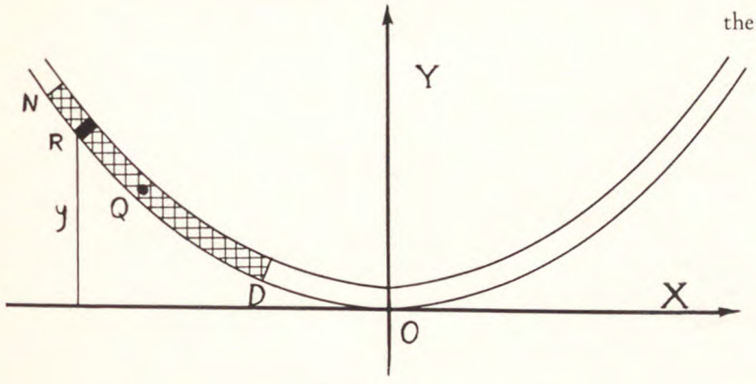


Fig. 3

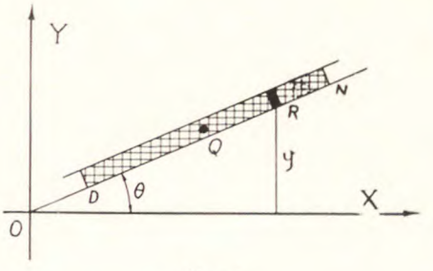


Fig. 4

(Continued on page 15)

COLLEGE GUIDANCE FOR ENGINEERS

By ROBERT WIDDOP, B.S.

Associate Professor and Director of Industrial Relations, Newark College of Engineering

The Administration at Newark College, sensitive to its obligation in the guidance of its students in the non-technical as well as the technical phases of professional development, offers this information. The President served as Chairman of the S. P. E. E. Committee on Orientation and reported for his Committee at Cambridge, July, 1937. In the introduction of this Report is a statement significant to the problem: . . . "that life in general seems to be a series of more or less important orientations, and that it would be idle to present any single paper on the broad subject."

The material which follows is part of a paper given at a S. P. E. E. Conference on Orientation at Texas A. & M., June, 1938. Other phases of orientation and guidance, pre-college and post-college, were treated by other papers. The purpose of the Conference was to develop a philosophy, and in deference to that purpose and to the representatives of other institutions it was deemed advisable not to discuss in detail the techniques developed at a particular college. The material may appear, therefore, to be wholly diagnostic of the problem, and so that our local people may know of the efforts made at Newark there is added at the end of this paper material describing our attack on the problems suggested.

Pre-College Factors

Some of the factors bearing on guidance come from the condition that our young people live and have lived in an engineered world. A boy's first touch is with toys, carefully designed, geared, and streamlined—replicas of our machines. His association with the products of science, with the radio and the automobile broadens as he grows. Unconsciously, perhaps, when he makes his decisions as to college training, he reaches into this background and his whole viewpoint and outlook is colored by these associations.

Before he reaches any maturity of thought or interest these things immediately at hand must be significant to him and we may expect a considerable portion of our youth to have engineering interests and aptitudes at early college ages. Added to this normal exposure are the unthinking and sometimes perverted versions of the profession, popularized, and, to a degree, misleading.

From this combination much of the choice as to profession and as to course is made before the boy enters college. It is true that the choice is largely on an emotional basis, but it is, nevertheless, definite at the time.

What will happen to this interest in the normal changes of the period, as the boy matures, as his skills develop in one direction or another, as the process of education takes hold, is another thing. In some boys it will be intensified; in others it will lessen or disappear. We certainly cannot obviate change in the interest pattern.

If we look at some factors, other than interest, that bear on achievement, on motivation, physical, emotional and intellectual equipment, we see a wide gradation and variation, and, inevitably, we see the prospect of change.

We may recognize also that the anticipation of longer school years, and the lack of employment opportunity has delayed, to a degree, the transfer of responsibility from the parent to the youth with a result that maturity is retarded. If by maturity we mean the acceptance of responsibility by the individual, and the ability and disposition of the individual to do well unpleasant things in the line of duty, the net effect to us is that we are faced with more of the maturing process and with more obligation in orientation and guidance than were our predecessors.

These matters of interest and of maturity need to be more thoroughly considered and appreciated. First, interest is continually changing. Next it is important in younger or more immature people because a child will characteristically do those things which immediately interest or appeal to him and neglect the more difficult tasks. Maturity and chronological age do not seem to be closely tied together.

Post College Factors

So far as the post-college experience for a group taking engineering training is concerned it seems improbable that we can predict with any precision the conditions ahead. About all we know is that conditions will probably be different as to the opportunities for them and as to the social conditions under which they will live.

It is particularly true in times of industrial slackness that many of the men we train do not go into, or at least do not continue at, work of an engineering nature. It is true that many with design or research aptitudes and opportunities do continue in such activity, but it is equally true that there is a definite and noticeable filtration into other occupations.

Our direction and their interests and skills seem to play a secondary part to opportunity and economic pressure.

The Nature of the Problem

These matters of pre-college interests and the variety of post-college occupations were not introduced to show complexity in the problem, but to suggest that whatever we may do in orientation or in guidance must be done with an understanding that we deal with a constantly changing boy in preparation for a condition which is changing while he is with us. This would seem to limit the possibility that we might give exact, precise direction, and to indicate that our stress should be on the factors common to all professions and to all courses.

Perhaps, we should recognize also that the whole purpose of education is to effect change, to promote growth and development. There is no need to establish here that each individual with whom we deal is unique. The work of the psychologist becomes much more valuable to us when the study of similar factors and qualities is supplemented by the study of individual differences. These differences, perhaps, are the really significant factors.

An approach to orientation and guidance may be based on the idea that the student will need to make at least three major adjustments in which we can be of assistance to him. The first adjustment is to the job of getting through college, the second an adjustment to the business world, that is, to the job of making a living; followed later by an adjustment to a place in the social order. These are not necessarily separate or distinct adjustments, nor do they necessarily occur in the order mentioned. We may break it down in this way and in this order simply because its appears to parallel the natural sequence of experience.

The boy will need immediately to become familiar with the college environment. Later he will be confronted with the necessity of making a living, of seeing the relationships between ideas and principles which were separated for him to study, and of learning from direct experience. Eventually, he may be confronted with a consideration of his life in the community, of his ability and obligation to contribute to his profession and to the society in which he lives.

Orientation and guidance are terms whose meanings are hard to separate; they seem to be part and parcel of the same thing.

Orientation and Guidance

Possibly orientation may be attacked as the general problem touching all of the student body, and designed, if there is a design, to sensitize the group to the fact that these adjustments will be necessary, and to pass on to them some general phil-

osophy and some techniques which we have found in our experience to be helpful.

Guidance may treat more specifically of individual adjustment, concerning itself with the progress that each student is making in reacting to the general philosophy and in acquiring some mastery of the techniques.

Orientation and guidance are continuous processes. There is little likelihood that we can in any short time make our contribution once and for all. There seems to be an endless variation in the necessity for helping in this matter as there is an endless variation in the ease or difficulty of individual adjustment.

As to orientation, thus defined, undoubtedly the most powerful direction in attitude and viewpoint comes from the general tone of the college. This has to do with the emphasis, given by the administration and faculty, with broader perspectives, which are likely to be more concerned with basic unity in the engineering courses than with the points of differences in the individual courses.

Approach to the Problem

It might be well to consider the possibility of a continuous thread for orientation purposes running throughout a four-year program.

We might treat the problem of adjustment to college life in a course extending throughout the Freshman year, in which we try to give the young man some idea of our objectives, of course structure, the sequence and value of the individual courses, some idea of the techniques of study and mastery of subject matter, of the part that extra-curricular activities may play in his development, of local emphasis and procedures.

The orientation work in the Sophomore year might deal more definitely with sensitizing the young man to work outside of college. It might be designed to familiarize him with the differences between academic and industrial procedures, with the demands of industry, with the possibility of continuing his education from direct experiences, and with his adjustment to professional work.

As part of this guidance it might be well to have a series of discussions centering about personal problems having for their object the preparation of the student for an industrial experience to follow his Sophomore year.

Then, too, a serious attempt should be made to induce the student to undertake some constructive program of personality and character development, to meet the standards required of those who can successfully live and work together.

As a continuation of this plan, and looking somewhat to the first step in actual professional orientation, it might seem wise to offer summer work to those men who have given indication of professional attitudes and abilities.

There would seem to be a common ground here for the colleges and for industry. They would have, by this sort of an arrangement, an opportunity to judge the worth of the men and to make a real contribution to education. The boy should get an excellent chance to broaden his experience, to study the possibilities along engineering and other lines, and to gain some understanding of the conditions which the practice of engineering places on its theory. These industrial experiences would seem to be of particular value in sensitizing the young man to human relation problems.

Perhaps, our Junior and Senior orientation work should afford the opportunity for the integration of these industrial experiences and place emphasis on the adjustment to a professional environment in the economic, social, emotional, and moral phases of this correlation. It might be well to present to our students the mature viewpoints of men of the community, leaders in law, medicine, politics, banking, and the various divisions of the engineering profession. This would be valuable in sensitizing the young men to factors which are common in all professions and to all courses.

A continuous program of this sort will need to be timed as closely as possible to the natural experiences of the group.

Individual Guidance

We must realize that ultimately we are dealing with individual adjustments. Of course, our job is not to find the answers so much as it is to show our clients how to look for solutions. We know that the ability to adapt is a natural function, and that much of it goes along normally and without trouble.

Much of our individual guidance is done casually, informally. It is at any institution, however, the main job. There is a question as to whether this can best be done by means of an advisor system or by some central agency. We are inclined to favor the central agency so as to insure some unity of purpose, some familiarity with the whole problem.

Perhaps the guidance can be initiated before admission by personal interview, examination, and tests. These should give some estimate as to whether an individual has the physical, emotional, and intellectual equipment necessary to give him a reasonable chance of doing the college work and of fitting later into professional work. Some simple record should be kept of the general developments of the individual including his scholastic record. Regularly scheduled interviews may be worth while in observing this development.

I believe that the whole purpose of this record should be to indicate changes in the factors that make for achievement, and to determine whether the changes are going along normally and with reasonable smoothness.

As we go along we shall be able to see some of the individual traits and make a definite effort to institute new habits. We should realize, I think, that we cannot effect rapid changes in long-established habits or viewpoints.

We should proceed, I believe, on the basis that long observation is necessary to study the individual, to determine his strengths and weaknesses, and to effect any change in direction.

Use of Tests

Always in these matters of orientation and guidance there comes the question as to the use of tests. To some, tests appear to be the very heart of the problem.

This is somewhat in line with the theory that every human being has certain innate qualities and abilities, and he can gain happiness, satisfaction, and success only when he is able to fit these factors exactly into the scheme of things. This seems to be contrary to observation in many cases. Undoubtedly, there are some occupations which a young man should avoid. To determine definitely the one that he should follow is, perhaps, a somewhat different matter.

There seems to be some question, philosophically, as to whether tests may be widely applied to changing individuals, particularly if they are intended for long-term prognostication. It would seem that there is no question as to the value of tests when they are used for group prediction and it would seem entirely possible to use them in helping to segregate the extremes of fitness to profit from an engineering college experience whether this training leads to engineering as a career or whether it serves ultimately as a background for some other activity.

It seems also that tests are definite, usable aids in obtaining evidence to fit into a picture otherwise determined, to help in the diagnosis of a change which seems to be going along not as normally or smoothly as it should. How far we can go away from consideration of the factors which are essentially subjective and which vary themselves and in their combinations with each individual is a matter for a good deal of thought.

Summary

In summing up I should like to suggest that we recognize that change in the boy and in his external world are essential facts, and that our educational processes are designed to promote change and growth in individuals. Our purpose is not so much to direct a young man to a specific vocational objective as it is to prepare him to meet conditions, as he finds

them, with a professional attack and viewpoint, with courage and resourcefulness. As orientation and guidance and tests contribute to this end they are worth while. We make our contribution by developing techniques that will assist the boy in making an intelligent, well-informed attack on his personal and professional problems. We should defeat our purpose if we try to solve his problems completely for him.

Procedures at Newark College of Engineering

The procedure at Newark is to interview each applicant and to form a preliminary estimate from his history as to his ability to profit from engineering training. Established tests and similar methods are used for additional information in the event that this ability is not reasonably evident.

A Course (Ind. E. 11) Principles of Engineering (The College) two hours per week extends through the Freshman year in which the factors affecting the relation of a young man to his college are discussed. Men of the staff particularly fitted by interest and experience conduct these classes.

In the second year two hours per week are devoted to a course (Ind. E. 12) treating of the relation of a young man to his work covering particularly the emotional and personality factors involved in that relationship. Men from industry and business contribute viewpoints and experience in talks to the group and in the discussions which follow.

During the pre-Junior and pre-Senior summers industrial placement is offered to selected groups who have demonstrated ability and have given some indication that they will capitalize the experience. This work appears in the catalog as Ind. E. 60 and is designed to furnish the laboratory for the subsequent courses in Staff Control, Management and Economics and to provide general motivation for the professional courses.

A Junior course Ind. E. 13 "Staff Control" extends Ind. E. 12 with more advanced treatment of those factors which have to do with human behavior and with human relations problems. It deals with the coördination of the young engineer with his environment and supplemented by treatment of the "Obligations of Citizenship," "Techniques of Good Manners," etc.

The final in the series of courses is Industrial Engineering 14 Staff Control Senior Year. The course is designed to integrate the work experiences of the pre-Junior and pre-Senior summers and adds material on such subjects as Law, Banking, and Advertising.

By these courses a continuous thread of orientation is maintained for the group.

In addition a continuous record of each individual indicates his growth in scholarship and personal development. Each student is interviewed each year as a scheduled procedure, and all facilities are placed at his disposal for his personal and professional development. This is, of course, in addition to the usual contacts ordinarily made in college.

Editor's Note: Professor Robert Widdop . . . Director of Industrial Relations . . . was born in Philadelphia in 1899 . . . graduated in 1924 from the Newark College of Engineering with B.S. in M.E. He continued working for his coöperative concern: the Edison Portland Cement Company on plant construction and operation until in 1926 he became operator of a sand and gravel plant at Hackettstown, N. J., to be followed by a position as engineer for Pennsylvania Dixie Cement Corporation. He returned to Newark College of Engineering in 1928 as Superintendent of Plant and Equipment to receive the successive appointments of: 1930, Assistant Professor in M.E. . . . 1932, charge of Engineering Drawing Department . . . 1935, Associate Director of Industrial Relations . . . 1936, Director of Industrial Relations and Associate Professor in Industrial Engineering.

ALUMNI PERSONALITIES

Marcus Mainardi, graduate in Civil Engineering Class of 1935, has left his position with the Public Service Company of Newark to enter the Columbia University School of Education, where he will do work towards a Master's degree.

F. J. Van Antwerpen has joined the staff of Industrial and Engineering Chemistry as associate editor. Mr. Van Antwerpen received his B.S. in chemical engineering last June from the Newark College of Engineering. He left high school after two years to enter the laboratories of the American Zeolite Co., now consolidated with the Permutit Co., but later finished high school by attending evening classes. He accepted a position with the United Piece Dye Works as water analyst in 1930 and the following year, upon enrollment in the evening chemical engineering course of Newark Technical School, was placed in the company's dyestuff laboratory. The last two years he was in technical school he served as assistant editor of the school magazine, editor in 1934-35, chairman and editor of the 1935 yearbook, and president of the student council in 1934-35. Since 1933 he has been manager of the Munitex Corp., which position he has just resigned to cast his lot with Industrial and Engineering Chemistry.

CHANGES IN THE STAFF AT NEWARK COLLEGE OF ENGINEERING

Professor Henry H. Metzenheim was appointed Comptroller and Associate Professor of the Newark College of Engineering on September 1, 1938. In his new position he will be interested principally in the financial aspects of the operation of the Institution.

Professor Robert W. Van Houten was appointed Assistant to the President on September 1, 1938. In addition to the duties connected with his new position, he will also continue his affiliation with the Department of Civil Engineering as Assistant Professor.

Francis J. Burns, formerly an Instructor in Mechanical Engineering, has been appointed Assistant Professor in Mechanical Engineering.

Frank A. Grammer, formerly an Instructor in English, has been appointed Assistant Professor in English.

Charles J. Kiernan, formerly an Instructor in Civil Engineering, has been appointed Assistant Professor in Civil Engineering.

Sidney Baum has been appointed Assistant Instructor.

Frederick C. Burt, Jr., formerly a Departmental Assistant, has been appointed Assistant Instructor.

Luigi Pollara has been appointed Assistant Instructor.

Edmund M. Squire has been appointed Instructor.

THE STAFF OF NEWARK COLLEGE OF ENGINEERING

The faculty and instructing staff of the Newark College of Engineering now numbers 75 members. Included in the staff is the President, 32 professors, 26 instructors, 5 special lecturers, and 11 departmental assistants.

FEATURES TO COME

For coming issues of NEWARK ENGINEERING NOTES many interesting articles on various topics have been received or are now being prepared:

"Duplicating the Cube by Ruler and Compass." Newark resident obtains remarkable close approximate solution to this famous problem, which is analyzed by Professor James H. Fithian.

"Evolution of the Electrical Courses" by Professor James C. Peet, that gives the history and development of the electrical courses at Newark College of Engineering.

"The Department of Mechanical Engineering" is described in a lengthy article by Professor Frank D. Carvin.

"Designing the Rim Under Gear Teeth" is an original treatise by Waldemar F. Larsen, Stress Analyst at Wright Aeronautical Corporation.

WHAT OUR READERS SAY

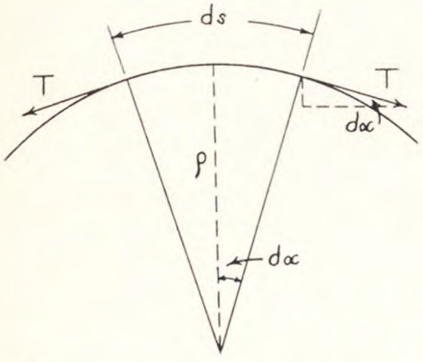
PROFESSOR JOFFE'S INTEGRAL

To the Editor:

In connection with Dr. Joffe's article, "The Equilibrium of a Rectangular, Horizontal Piece of Canvas under Water Pressure" (NEWARK ENGINEERING NOTES, April, 1938), I should like to make the following comments:

(1) In the second paragraph occurs the statement: "Our present problems leads us practically to a cable under a load which is everywhere normal to the cable." From this we can deduce Equation (3) from purely physical considerations. By its very nature a tension is directed along the tangent to the curve. The only way in which its magnitude can change in passing along the arc is to have some external *tangential* forces acting. However, by hypothesis the forces are everywhere normal to the curve. Hence there can be no increment in T in passing along the curve. This at once implies T = constant.

From the relation T = a constant we get Equation (4) at once from the following diagram:



Resultant (normal) force acting on ds = $2T \sin d\alpha$

F (normal load) = wy

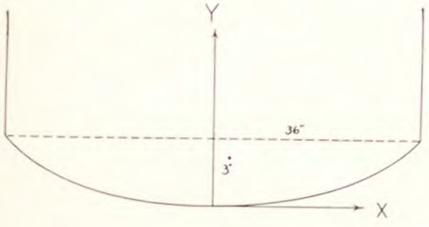
Normal load on ds = $w\,y\,ds = 2\rho\,w\,y\,d\alpha$

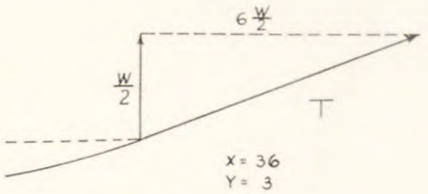
For equilibrium: $2\rho\,w\,y\,d\alpha = 2\,T \sin d\alpha$

$y = T/w\rho$

(2) An approximate solution of the problem of tension in the canvas in the case of the three-inch sag can be obtained from elementary considerations quite apart from those discussed in the article.

If, as is done in the article, we assume the sag so small that y can be considered constant, we have the problem of a flexible cable with uniform horizontal loading. In this case the curve is a parabola. Consider the following diagram:





The equation of the curve is $y = ax^2 = 3/36^2 x^2$

Then $dy/dx = 6/36^2 x$ $\quad (dy/dx)_{x=36} = 1/6$

If W is the total weight of water in unit length of tank, we see at once from diagram (c) above that T is given by:

$T = W/2\sqrt{37} = 12 \times 62.5 \times \sqrt{37} =$ 4560 lb./ft.

Since both methods are approximate, the agreement can be considered good.

(3) In considering the general solution and the special example I do not see that the problem stated is the problem solved. If the canvas is horizontal originally, and then sags under load, it must stretch. In this case the problem is statically indeterminate and the elastic properties of the canvas must be taken into consideration. If the canvas does not stretch appreciably, it must have slack, and hence could not have been horizontal. The problem discussed above seems quite clearly to be a question of the tension set up in a slack canvas by a given load.

Sincerely yours,
CHARLES S. CUMMINGS, 2ND.
Princeton, N. J., June 3, 1938.

Editor's Note: Mr. Charles Cummings is a graduate of Princeton, Class of 1936, member of Phi Beta Kappa and of Sigma Xi, holds an M.A. degree from Princeton, and is now working on his doctorate in the Physics Department at the Princeton Graduate School.

AUTHOR'S REPLY:

I have read Mr. Charles Cummings' letter and should like to make the following remarks:

(1) Mr. Cummings' derivation of the differential equation $y = T/w\rho$ has the great merit of brevity but lacks in mathematical rigor. Thus, he assumes in his proof that the element of arc may be replaced by the arc of a circle and also that the resultant hydrostatic pressure acts at the center of the element of arc.

(2) In my discussion of the equilibrium shape of the canvas I was not concerned with the manner in which this equilibrium was attained. Hence, my discussion is equally applicable to a canvas which stretches under load into its final equilibrium shape and to an inextensible canvas which was slack before the load was applied.

However, Mr. Cummings' remarks lead to two new and interesting problems:

(a) Given an inextensible slack canvas of known span and circumference, to determine the sag and tension produced by any given hydrostatic load.

(b) Given an elastic canvas without sag initially, but with a known modulus of elasticity, to determine the sag and tension produced by any given hydrostatic load.

JOSEPH JOFFE, Ph.D.,
Asst. Professor in Mechanics and Chemistry, Newark College of Engineering.
Newark, N. J., Sept. 26, 1938.

PORTABLE VIBRATION INSTRUMENTS

To the Editor:

In a previous issue of the NEWARK ENGINEERING NOTES, which I was glad to receive, Professor Smith's article on *Great Range Portable Vibration Instruments* came with especial interest, since I have had an opportunity to view these instruments in Cambridge. They are excellently planned to fill a present wide gap in the art of vibration measurement.

One suggestion, perhaps I should make (which is along the lines of our own work at M. I. T.) and in regard to all portable recording instruments, is that exact interpretation of vibration records requires an extended mathematical analysis.

Yours very truly,
ARTHUR C. RUGE,
Assistant Professor of Engineering Seismology. Massachusetts Institute of Technology.
Cambridge, Mass., June 4, 1938.

AUTHOR'S REPLY:

Professor Ruge—whom the author considers one of our best authorities—makes a timely suggestion. After having listened to one of Professor Ruge's pioneer lecture courses on Vibration, we share the feeling that Instrument Design has only begun.

FROM THE MAIL BAG

To the Editor:

My general impression on reading this paper is similar to that I received on my inspection of Newark College last Vistors' Day—one of surprise and satisfaction in the very considerable progress made in equipment and arrangement these last few years. To me, your paper is an outward indication of the internal growth of Newark College—and is to be commended.

As a general suggestion, if space permit, I think it might be most satisfactory to have in each issue of the NOTES one or more technical articles on each of the four main branches of engineering . . .

Yours very truly,
GEORGE S. MILLS.
Little Falls, N. J., May 14, 1938.

To the Editor:

I was very pleased to receive a copy of the first issue. It is just the thing to keep us graduates informed of developments at the college and also provides valuable and worth-while publicity.

Articles, such as that by Prof. Eastman Smith, should be encouraged. Prof. Smith's article shows us that there is a human interest side to our usually cut-and-dried engineering work and that we should

not take ourselves too seriously.

Very truly yours,

ROBERT B. HENDERSON, '37.

Matawan, N. J., May 13, 1938.

To the Editor:

The publication of such a paper is a real sign of growth, as well as a means of keeping us informed as to progress in the school and in our respective fields.

. . . With best wishes for more and still better NOTES, I am,

Yours truly,

CARMAN D. STROHL, '33.

Elizabeth, N. J., May 9, 1938.

To the Editor:

I take this opportunity to offer my appreciation and sincerest wishes for continued success to the new college publication, NEWARK ENGINEERING NOTES.

No graduate of N. C. E. can help but be interested in published news of his college dealing with information such as college participation in educational, engineering, and industrial activities; college construction and additions; and faculty, alumni, and student notes. In general I would like to see the paper maintain its present form of being fundamentally a technical publication.

I offer my thanks and ask to be placed on the mailing list for further issues of the NEWARK ENGINEERING NOTES.

Sincerely yours,

FRANK S. STANILEWICZ, '37.

Kearny, N. J., May 24, 1938.

Dear Sir:

When your publication was called to my attention, it gave me a great deal of pleasure. Newark and the vicinity has a great many diversified industries and their products can be best called to the attention of the users by a paper of this nature.

Often local and neighboring town manufacturers, looking for certain products, will write all over the country, and will finally receive a reply saying that this very article is made in Newark or vicinity. I am sure that Newark manufacturers as well as others in the State of New Jersey will support your paper, and I feel that it has a great future in this city and can be of outstanding service to the community.

Many of Newark's products are known throughout the world and not known to local or neighboring consumers. By keeping this information before its readers, this paper will render a valuable service.

Wishing you success, I remain,

Very truly yours,

CHARLES EISLER.

Newark, N. J., September 22, 1938.

To the Editor:

. . . Being very firmly convinced that our instruction at Newark College of Engineering is as good as the better known and more highly acknowledged engineering colleges, I think your magazine is a definite step to instructing others of the merits of our college . . .

Yours truly,

E. F. TEN BROEKE, '35.

Secaucus, N. J., August 3, 1938.

To the Editor:

Congratulations on your first issue. In my opinion this publication should fill a long-felt need . . . In regard to your comment on "Who's Who in Engineering," it would be interesting to know how many graduates of N. C. E. are listed.

With best wishes for continued success of your publication, I remain

Very truly yours,

GRANGER DAVENPORT, '25,

Research Engineer, Gould & Eberhardt.

Newark, N. J., May 2, 1938.

OPPORTUNITIES UTILIZED

Good examples of what happens to former graduates of our College may be shown by the experiences related in letters recently received from Opdyke and Hind.

John Opdyke, B.S. in C.E., 1930, is now a field engineer with an oil company on the island of Aruba, in the West Indies, and is engaged in harbor work there, which includes making surveys, steel detailing, and checking the dredging of the new channel and harbor.

John Hind, B.S. in M.E., 1938, is an assistant engineer in a pineapple cannery on the island of Kauai, Territory of Hawaii. He has been called on to design framework and girders for heavy mills, in which all joints are welded. Besides he has done some surveying and has found much need for chemistry.

Those letters show the need of a sound basic training in engineering fundamentals. The engineer of today must be ready to attack any problem presented to him.

MOTION OF A CHAIN WITHIN A SMOOTH FIXED TUBE

(Continued from page 9)

$$M\frac{d^2p}{dt^2} = -g\int_{-a}^{a} f(u)\,\frac{p+u}{4r}\,du.$$

$$= -g\int_{-a}^{a}\frac{pf(u)\,du}{4r} - g\int_{-a}^{a}\frac{f(u)\,udu}{4r}.$$

But

$$-g\int_{-a}^{a}\frac{pf(u)\,du}{4r} = -\frac{gpM}{4r}, \text{ and}$$

$$-g\int_{-a}^{a}\frac{f(u)\,udu}{4r} = \text{constant}.$$

Hence

$$\frac{d^2p}{dt^2} = -\frac{g}{4r}\,p + \text{constant}.$$

It appears that the heterogeneous chain will perform *harmonic curvilinear oscillation* with the same period as that of the homogeneous chain.

By (B) the tension is

$$T = -\frac{Mg}{M}\int_{-a}^{a}\frac{f(u)\,(p+u)}{4r}\,du + g\int_{-a}^{u}\frac{f(u)\,(p+u)}{4r}\,du$$

$$= -\frac{Mg}{4rM}\left[\int_{-a}^{a}(p+u)f(u)\,du - \frac{M}{M}\int_{-a}^{u}(p+u)f(u)\,du\right]$$

$$\text{If } \frac{M}{M}\int_{-a}^{u}(p+u)f(u)\,du < \int_{-a}^{a}(p+u)f(u)\,du$$

the second member of the above expression is negative and the stress in the chain is compression.

$$\text{If } \frac{M}{M}\int_{-a}^{u}(p+u)f(u)\,du > \int_{-a}^{a}(p+u)f(u)\,du$$

the second member of the above expression is positive and the stress in the chain is tension.

In view of the property of tautochronism of the cycloid one would suspect that the stress in the heterogeneous chain would still be one of compression, in which case the first of the inequalities would hold.

We shall leave the analytical proof of the last remark to one of our enterprising readers.

Example 4. Chain heterogeneous, tube rectilinear; motion up the tube.

As in example (2), $y = F(s) = (p+u)\sin\theta$, and $F'(p+u) = \sin\theta$.

Equation (A) becomes

$$M\frac{d^2p}{dt^2} = -g\int_{-a}^{a} f(u)\,\sin\theta\,du = -gM\sin\theta.$$

Hence

$$\frac{d^2p}{dt^2} = -g\sin\theta = \text{constant}.$$

In this case the chain moves up the tube with constant deceleration as in example (2).

The expression (B) for the tension becomes

$$T = -\frac{Mg}{M}\int_{-a}^{a} f(u)\sin\theta\,du + g\int_{-a}^{u} f(u)\sin\theta\,du$$

$$= (-Mg + Mg)\sin\theta = 0.$$

It appears that in this case also there is no stress in the chain, and the particles move as if they were isolated.

Our readers may consider the motion of a chain in other tubes, e.g., circular, parabolic, helical, etc., and obtain results which might be interesting.

Editor's Note: Professor B. S. Koshkarian specialized in pure and applied mathematics at Yale University, receiving his master's degree in 1912. He also studied celestial mechanics in the University of Chicago. Subsequently he took a position in the mathematical department of the Prudential Life Insurance Company. During the World War Professor Koshkarian enlisted in the Ordnance Department, and after fourteen months of military service he received his honorable discharge and returned to his work with the Prudential in Newark. A short time later the opportunity presented itself to him to teach vocational mathematics to disabled ex-service men at the Newark Technical School. Professor Koshkarian accepted, and when the Newark College of Engineering was established in 1919 he was appointed to the faculty, in which he has since remained.

Mr. George P. Slockbower, Advertising Manager of L. Bamberger & Co., courteously supplied the drawing used for the front cover of this issue.

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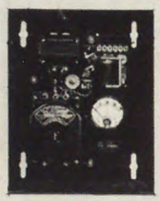

✓ **Illumination Meters and Controllers**—Foot-candle meters . . . the standard instruments for illumination level tests in industry and the home. Special high-sensitivity instruments for photometric research . . . Photronic Controllers which turn lights on and off at predetermined levels.

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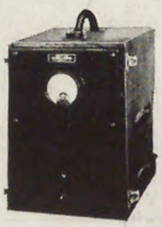

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