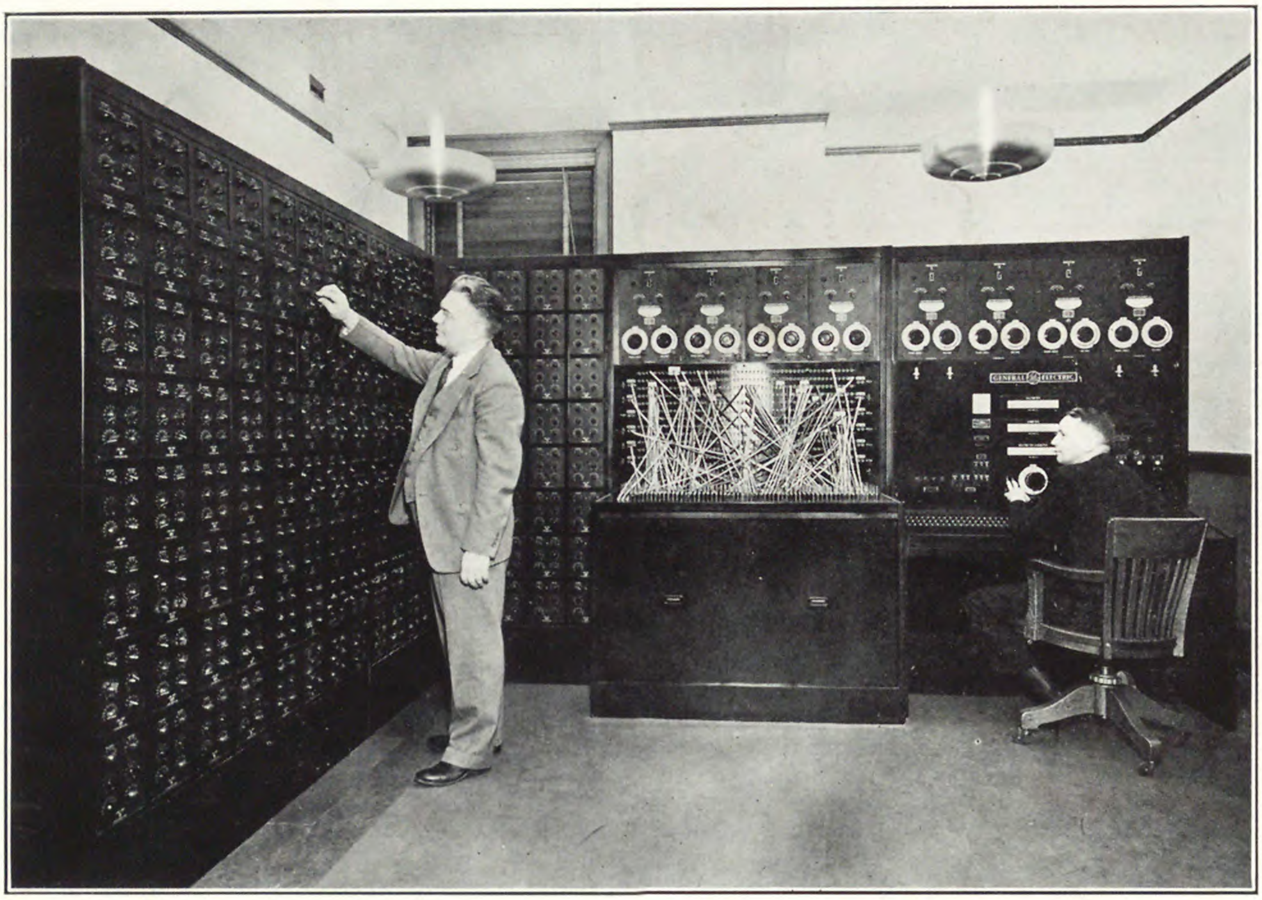
NEWARK ENGINEERING NOTES



Alternating-current Network Analyzer of the Public Service Electric and Gas Company, installed in the Public Service Terminal Building in Newark, N. J. At the left is Mr. Hollis K. Sels adjusting a load impedance; at the right, Mr. Raymond C. R. Schulze at the metering desk.

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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.

THE PRESIDENT'S DIARY

May 1st

Just at this time of year, when spring is in the air, it seems that there is just a little let-down from the winter's grind, a little general laxity, and a little feeling both in the faculty and the student body that it would be a pretty nice thing if we did not have to go to school when the golf is good and the fishing is good and there are many other things to do.

It is rather strange to see at this particular time just a little lapse in the general question of honesty with respect to the professional work of the college. My own theory on that is fairly simple. It would seem that about this time, when it is very much easier to spend hours outside of college doing what we want to do rather than doing what we have to do, it is a little easier to put off the writing of reports, the preparation for examinations, tests and things of that kind. The result is that when the test or the examination or the report is actually called for it is not ready, and rather than take a chance with a low mark there is a great temptation on the part of the average student to try to get his information from other sources. In fact, I am a little of the opinion that most of the dishonesty in college comes from the fact that a man is lazy or dilatory or procrastinates and puts off from day to day until the inevitable descends upon him, and then he tries to get his information or he "cribs" from somebody else.

In an analysis of our troubles in this regard in college, it would seem that in a great majority of cases this is what happens and it naturally happens a little more in the spring when study and application and hard work over books is not quite so easy.

May 10th

This question of honesty, ethics and morals among students is a very interesting question, and I very happily have changed my mind concerning such matters very definitely in the past few years.

I used to think that certain people were honest and certain people were dishonest; that we had certain honest students and certain dishonest students; then I unconsciously perhaps held that a man who was dishonest in one particular must, of necessity, be dishonest in most particulars; that there was a very definite general characteristic called honesty which affected all the acts of the man. Now I am very much inclined to doubt the soundness of this point of view; perhaps because in my thirty years or more of college work, I have never met but one student who it would seem to me was dishonest in every single particular in which I had any occasion to judge him. The other students to a very considerable extent formed a dishonest habit with respect to one single particular thing or set of things.

The truth seems to be that the average man who cheats in an examination will not necessarily write a dishonest report, and a man who writes a dishonest report is not necessarily expected to cheat in an examination. The facts seem to point out that we have a set of habits which are honest with respect to one thing and may have a set of habits which are dishonest with respect to something else; and that there is no general characteristic of honesty.

I have seen so many good men who are honest a great deal of the time and dishonest some of the time. I have even seen heads of institutions, and members of faculties who I thought were dishonest in some particular instance while they were honest in almost everything else. When we analyze the situation definitely with respect to ourselves I think that we all feel, no matter how much we try to be honest, that there are occasions when we perhaps unconsciously are swayed by habits and practices which have grown upon us and which may not perhaps originally have had a dishonest intention, but which in one particular field under a particular set of circumstances may properly be considered to be dishonest.

I used to wonder why Diogenes was pictured with a lantern . . . he was hunting for an honest man! But now I am almost at the point of believing that there is no such thing as general honesty as apart from specific honesty.

May 15th

To carry the thing just a step further, in our students, as perhaps in outside lives, these so-called dishonest manifestations spring primarily from selfishness, and in general, if we can generalize, we can say that if a man was inherently selfish in all his reactions he would be inherently dishonest; that is, that dishonesty arises largely out of giving too much weight to yourself . . . your wants and desires . . . aspirations . . . ambitions, and too little thought to the way they conflict with the same aspirations, desires, and ambitions on the part of other people. If these desires are so strong in you for yourself that you will consistently sacrifice the good of your neighbor or the good of society in order to put yourself forward, you are dishonest in that particular. It is rather easy to see then how extremely difficult general honesty would become. This will probably make us appreciate that in developing honesty in general it is perhaps the soundest course, not to preach at length on generalities that are non-existent in practice, but to give a well rounded series of experiences, showing that in each case the neglect of the point of view of the other fellow and of society led to trouble.

In cheating, for instance, a student wants something to benefit himself and if he can get it for nothing from a man who has paid dearly in time and effort, and if he takes it and uses it without any thought of the implications as to the fairness of the procedure toward the class, the other student, or the college, his selfishness has given rise definitely to his dishonesty.

It would seem in the end perhaps that a man who was sensitive only to his own wants and desires and ambitions would be criminal in the extreme, and a man who was entirely insensitive to his own wants, desires and ambitions and extremely sensitive to the wants of others would be a martyr in the Book of Saints; and between these two most of our students and friends fall; all of them dishonest in some particular and all of them honest in many. And, as I started out to say, perhaps their honesty is affected by this beautiful spring weather.

THE IN-AND-OUT RESERVOIR PROBLEM

By H. N. Cummings, *Professor of Civil Engineering, and*

B. S. Koshkarian, *Professor of Theoretical and Applied Mechanics, Newark College of Engineering*

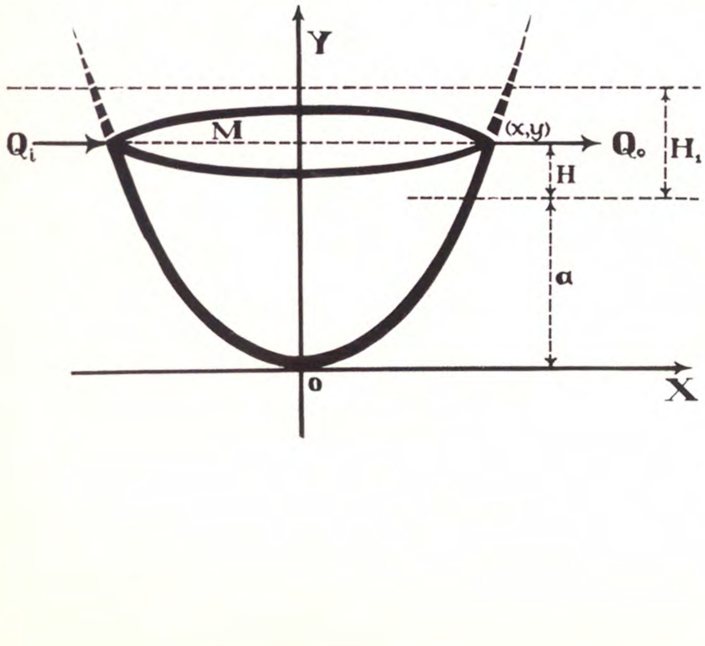
An interesting problem in our course of Elementary Hydraulics is that of a reservoir into which water is flowing at a known rate and out of which water is at the same time flowing at a known rate. If the dimensions of the reservoir were completely known, the rate of change in surface level could easily be expressed in terms of the surface area and the rates of inflow and outflow, provided the inflowing water were instantly spread over the entire surface of the reservoir so as to contribute its effect to the change in head at the outlet and provided the water discharged were instantly withdrawn from the entire cross-section of the reservoir so that it also would be reflected in the change of the discharge head. Actually, of course, the time-lag between the changes of level caused solely by the inflow and by the outflow respectively complicate the problem, so far as any precise mathematical statement of the rate of change of surface level is concerned. However, if it actually becomes necessary to determine the total time required to produce a predetermined change in surface level, the lack of precision obtainable in the rates of inflow and outflow, and in the dimensions of the reservoir, are so great as to justify neglecting this time-lag, as a practical problem of this type cannot be solved with any high degree of precision.

In this paper we shall set up an expression based on the assumption that the rates of inflow and of outflow at any given instant affect the surface level as though there were no time-lag. In practice, the rates of inflow from natural streams are variable, particularly during and immediately following storms on the water-shed, and these rates of inflow are functions of such variables as intensities of rainfall, conditions of the ground surface, dry or moist conditions below the surface, height of the water-table, etc.

The conditions of the reservoir vary very irregularly, with varying elevations, and therefore reservoir surface areas are practically impossible of expression as even moderately simple functions of elevation. The rates of outflow, if controlled by artificial discharge devices such as spillways or waste-gates, can be expressed with a fair degree of precision (say, within a few per cent) as functions of surface elevation.

We have found that if the rates of inflow, reservoir dimensions, and rates of outflow can be set up under the assumption of some simple mathematical relation, the problem admits a solution. For a particular case, we shall present such a solution as at least interesting from the mathematical standpoint.

Let us consider a reservoir, fed by a stream having a varying rate of discharge into the reservoir. A spillway is discharging



water from the reservoir at a rate depending upon the head, H, on the crest. The usual weir formula can be used for this outflow rate. We assume that a study of the surface area of the reservoir, in the elevation range covered by this study, shows that it varies as though the entire reservoir were a paraboloid of revolution. Let the sketch, then, indicate a reservoir of this geometric type.

Let b = rate of inflow at time $t=0$,

$Q_i = b + ct$, rate of inflow at time t, c a constant,

$Q_o = kH^{3/2}$, rate of outflow at time t, k a constant,

H = height of reservoir surface above spillway at time t,

M = area of reservoir surface at elevation H above spillway at time t,

a = height of spillway crest above vertex of paraboloid,

H_1 = height of reservoir surface above crest of spillway at time $t=0$.

Now, the equation of the meridian section, by the xy-plane, of the paraboloid is

$y = Ax^2$, A a constant, and

$M = \pi x^2$.

$$\text{Hence } M = \frac{\pi}{A}\, y = \frac{\pi}{A}\,(a+H)$$

$= B(a+H)$, B being a constant.

Under the assumptions set up of instantaneous effects of Q_i and Q_o, we have

$-M\,dH = (Q_o - Q_i)\,dt$, H in feet, t in seconds, M in sq. ft.

$$\text{Hence } dt = -\frac{B(a+H)\,dH}{kH^{3/2} - b - ct}$$

$$\text{or } B(a+H)\frac{dH}{dt} = -kH^{3/2} + b + ct$$

which is a differential equation of the first order and the first degree.

Taking the following set of numerical values $b = 250$, $c = -0.002$, $k = 100$, $B = 10{,}000$, $a = 100$, $H_1 = 4$ ft., the differential equation becomes

$$10{,}000(100+H)\frac{dH}{dt} = -100H^{3/2} - 0.002t + 250 \quad (1)$$

with the initial conditions $t=0$, $H=4$.

We shall give an approximate solution for (1) by five different methods, obtaining the time required for H to change from $H_1 = 4.0$ ft. to $H_2 = 3.5$ ft.

I. *Approximate solution by "finite intervals"*

This is a practical method, capable of a high degree of numerical precision—higher, in fact, than the obtainable precision in the field warrants. Briefly, the method is to obtain increments in "t" by assuming increments of "H" and solving equation (1), in the form

$$\Delta t = \frac{10{,}000(100 + H_{mean})\,\Delta H}{-100H^{3/2}_{mean} - 0.002t_{mean} + 250}$$

after assuming mean values of "H" and "t" for the corresponding increment ΔH. If the Δt obtained indicates serious error in the assumed "t_{mean}", revise the assumed value of "t_{mean}", and recompute, continuing until Δt and "t_{mean}" are consistent. This is, of course, merely "successive approximation."

The solution is as follows:

Assumed $\triangle H$	Change in H	Mean H	Assumed t_{mean}	$\triangle t$ See equation	$\Sigma\triangle t$
—0.1	4.0 to 3.9	3.95	0	194	194
—0.1	4.0 to 3.9	3.95	100	194	194
—0.1	3.9 to 3.8	3.85	300	205	399
—0.1	3.8 to 3.7	3.75	500	217	616
—0.1	3.7 to 3.6	3.65	700	230	846
—0.1	3.6 to 3.5	3.55	960	246	1,092

This indicates that approximately 1,100 seconds are required, *under the conditions assumed*, for the reservoir surface level to fall from "H_1"=4 to "H_2"=3.5.

II. *Approximate solution in infinite series*

This method is based on the

Existence Theorem. Let $\frac{dy}{dx} = F(x, y)$ be a differential equation of the first order. If F(x, y) is finite, continuous, and single-valued, and has a finite partial derivative with respect to y (see Picard's Traité d'Analyse, vol. II, p. 292), as long as x and y are restricted to certain regions, then if x_0 and y_0 are a pair of values lying in these regions, we can find one integral y, and only one, which will take the value y_0 when x takes the value x_0.

In the proof of this theorem, y is found in the form of an infinite series

$y_0 + c_1(x-x_0) + c_2(x-x_0)^2 + \text{———} + c_n(x-x_0)^n + \ldots,$

which satisfies the differential equation when substituted in it for y, and is convergent for values of x sufficiently near to x_0.

Now let us set H=4—h, then (1) becomes

$$[800(1-\frac{h}{4})^{3/2}+0.002t-250]\frac{dt}{dh}$$

$$=10,000(104-h) \qquad (2)$$

with the initial conditions h=0, t=0, which satisfies the conditions of the existence theorem.

Let the solution of (2) be

$$t=a_1h+a_2h^2+a_3h^3+\ldots+a_nh^n+\ldots, \qquad (3)$$

Then we have

$$\frac{dt}{dh}=a_1+2a_2h+3a_3h^2+4a_4h^3+5a_5h^4+\ldots \qquad (4)$$

and by the Binomial Theorem

$$800(1-\frac{h}{4})^{3/2}=800-300\,h+\frac{75}{4}h^2+\frac{25}{32}h^3$$

$$+\frac{75}{1024}h^4+\ldots \qquad (5)$$

which is convergent for $\frac{h}{4} < 1$.

Hence,

$$800(1-\frac{h}{4})^{3/2}+0.002t-250=550+Ah+Bh^2$$

$$+Ch^3+Dh^4+\ldots \qquad (6)$$

where

$$A=-300+0.002a_1, \quad B=\frac{75}{4}+0.002a_2,$$

$$C=\frac{25}{32}+0.002a_3, \quad D=\frac{75}{1024}+0.002a_4, \qquad (7)$$

Multiplying (6) by (4), we get an expression which is identically equal to 10,000(104—h). The coefficients of like powers of this identity are, therefore, equal. Thus we get

$$550a_1=1,040,000,$$
$$Aa_1+1,100a_2=-10,000,$$
$$Ba_1+2Aa_2+1,750a_3=0,$$
$$Ca_1+2Ba_2+3Aa_3+2,200a_4=0,$$
$$Da_1+2Ca_2+3Ba_3+4Aa_4+2,750a_5=0 \qquad (8)$$

Solving (8) and (7), we get approximately

$a_1 = 1,891,$
$a_2 = 500, \quad A=-296,$
$a_3 = 147, \quad B= 20,$
$a_4 = 49, \quad C= 1,$
$a_5 = 17, \quad D= .17 \qquad (9)$

putting (9) in (3), we get the solution

$$t=1,891h+500h^2+147h^3+49h^4+17h^5+\ldots$$

If we take h=½ ft., the solution is, t=1,091 sec.

III. *Approximate solution by the first derivative method*

The theory underlying this method is given by Morris and Brown (Differential Equations, p. 167). The method of procedure is shown in the following table. Our differential equation is

$$\frac{dt}{dh}=t'=\frac{10,000(104-h)}{800(1-\frac{h}{4})^{3/2}+0.002t-250}, \quad h_0=0,\ t_0=0.$$

Let us find the value of t when h=0.5 ft.

Taking q=0.1, we have

h	*t*	*t'*	*dh=q*	*dt=qt'*	*h+dh*	*t+dt*
0	0	1891	.1	189	.1	189
.1	189	1998	.1	200	.2	389
.2	389	2112	.1	211	.3	600
.3	600	2240	.1	224	.4	824
.4	824	2381	.1	238	.5	1062

Thus, when h=0.5 ft., this method gives t=1,062 sec., which nearly agrees with the result obtained by method (I).

IV. *Approximate solution by Runge's method*

A very effective single formula for the approximate solution of our equation is that of Runge (Mathematische Annalen, t, XLVI, 1895, pp. 167-178). The object of this formula is to produce an approximation to the desired value in the form $h=h_0+k$. The formula involves the following quantities:

$$\triangle'=pf_0,\quad \triangle''=pf(x_0+\frac{p}{2},\ y_0+\tfrac{1}{2}\triangle')$$

$$\triangle'''=pf(x_0+p,\ y_0+\triangle'),\quad \triangle''''=pf(x_0+p,\ y_0+\triangle''')$$

$$k=\tfrac{1}{6}(\triangle'+4\triangle''+\triangle'''')$$

To make this method applicable, we must put our differential equation in the form

$$\frac{dh}{dt}=\frac{100(4-h)^{3/2}+0.002t-250}{10,000(104-h)}=f(t,h), \qquad (10)$$

which is $<$ 1, as required by this method.

Here $x_0 = t_0$, $y_0 = h_0$,

Let us take t=1,090 sec., as found by method (I) and find the corresponding value for h.

Now, p=1,090, $(t_0, h_0)=(0, 0)$, $f_0=.00053$,

$\triangle'=pf_0=.58$, $t_0+\frac{1}{2}p=545$, $h_0+\frac{1}{2}\triangle'=.29$,

$$f(t_0+\tfrac{1}{2}p,\ h_0+\tfrac{1}{2}\triangle')=\frac{100(4-.29)^{3/2}+.002\text{x}545-250}{10,000(104-.29)}$$

$=.00045,$

$\triangle''=1,090\text{x}.00045=.49,$

$t_0+p=1,090$, $h_0+\triangle'=.58$,

$$f(t_0+p,\ h_0+\triangle')=\frac{100(4-.58)^{3/2}+.002\text{x}1,090-250}{10,000(104-.58)}$$

$=.00037,$

$\triangle'''=1,090\text{x}.00037=.40$, $h_0+\triangle'''=.40$,

$$f(t_0+p,\ h_0+\triangle''')=\frac{100(4-.4)^{3/2}+.002\text{x}1,090-250}{10,000(104-.4)}$$

$=.00042,$

(Please turn to page 12)

SCIENTIFIC MANAGEMENT IN THE SMALL BUSINESS

Reprinted with permission from *Mechanical Engineering* for May, 1939

By J. ANSEL BROOKS

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A business does not have to be big to be efficient or progressive, yet many small businesses are not taking full advantage of the economies of modern management. This article deals primarily with the application of scientific-management principles to small business, the business that employs a few workers or a few hundred workers. It includes comments on some management tools and mechanisms, but it does not explain the technique of management operation.

Scientific management, often spoken of as modern management, is defined as "the scientific selection, control, and disposition of methods, money, men, manufacturing, marketing, and measurement."[1] This definition includes a broad field of management activities, yet an industrial plant, having a good cost-accounting system, or a wage-incentive system, or a motion-and-time-study department, is often referred to as a plant with scientific management. That is, the mechanisms of scientific management are often confused with the principles.

The four basic principles of scientific management are: (*a*) Continual research for the purpose of determining policies and procedures; (*b*) the establishment of standards of policies and procedures, based on the results of research; (*c*) control of all operations in terms of the established standards; (*d*) coöperation or the stabilization of human relationships.

RESEARCH AS A FUNCTION OF MANAGEMENT

Research in finance, production, and sales is an important function of management. It makes possible the substitution of facts for guesses and rule-of-thumb methods. Many small businesses, however, cannot finance an extensive research program. This fact should not prevent the small business from applying this principle of scientific management at least to a few of management's mechanisms, later extending the program, when and as finances permit. If this method is adopted as a standard policy and if the first mechanisms to be investigated and studied are those which show promise of the greatest financial returns, then later, research may pay its own way.

[1] "Modern Management," by J. E. Walters, John Wiley & Sons, Inc., New York, N. Y., 1937.

Presented at a meeting in New York, N. Y., Feb. 8, 1939, of the Management Division, Metropolitan Section, of The American Society of Mechanical Engineers.

Any business, particularly the small business, should take advantage of the results of prior research by others. Many of these results may be obtained from the periodical, *Factory Management and Maintenance*, the publications of The Society for the Advancement of Management, The American Society of Mechanical Engineers, The American Management Association, The American Standards Association, The United States Department of Commerce, and others.

Research should be a continuing function of management in any business and should be established as a standard policy. In the small business, the methods used in research and the standards resulting from research may differ from those in the large business. Nevertheless, the purpose is the same, namely, the elimination of unnecessary wastes.

This article does not include all the management problems to which this principle of scientific management might be applied. It does, however, comment on some of the management mechanisms which the small business now using rule-of-thumb methods might investigate for the purpose of establishing scientifically determined standards.

MAINTENANCE OF EQUIPMENT

Maintenance is a function of management and, if a plant is looked upon as a machine, maintenance can be considered as a tool or a mechanism which can be used to make the plant more efficient. Maintenance is an indirect expense and for this reason, or others, its cost is often kept too low. Hence, unit cost of production is not decreased but increased. This increase is due to one or more of the following: Too rapid depreciation of equipment; inferior quality of products caused by faulty equipment; decreased output caused by inefficient equipment; interruptions in plant operation resulting from breakdowns; costly repairs. Therefore, the purpose of maintenance is, in so far as practicable, to prevent too rapid depreciation of equipment, to prevent equipment from becoming inefficient or faulty in action, to prevent breakdowns, to prevent repairs.

Before a maintenance program is set up, the general policy might be established that maintenance will be preplanned, scheduled, and controlled in terms of established standards.

Preplanning involves a study of past records and experiences, standard practice, and perhaps tests for the purpose of determining what is to be done, how it is to be done, when it is to be done (time intervals), and by whom. From this study standards will be determined and control methods devised.

What is to be done will include such items as cleaning, painting, oiling, calibrating, adjusting, replacing, dismantling (in anticipation of trouble), and minor repairs. How it is to be done and when it is to be done should be recorded and should become standard procedures. By whom it is to be done will depend upon the plant organization. However, the best results should be obtained when authority and responsibility are centralized.

The purpose of maintenance, which is prevention, can be attained only by periodic inspection. Therefore, inspection should be scheduled and standard methods of inspection should be used.

The maintenance program should fit the requirements of the business. The maintenance work may be done by a department or as the part-time duty of one man. Nevertheless, maintenance in the small business can be and should be preplanned and controlled.

CLASSIFICATION AND SYMBOLS

Classification is the grouping together of items that have similar characteristics; symbols are the abbreviations of items of the classification. Every business has some method of classification and most businesses use symbols. Yet groupings, terminology, and symbols are often confusing and cause delays and mistakes. Classifying material things and activities is helpful in visualizing and understanding them. It is essential for proper comparison, filing, recording, and identification. Good classification tends to prevent mistakes in purchasing, storing, fabricating, cost finding, general accounting, etc. Symbols are the characters representing the items of classification. Mnemonic symbols assist the memory and are, therefore, preferable to others. Classification is essential to the orderly arrangement of facts.

PLANT LAYOUT A MATTER OF RESEARCH

Many small plants can be found in which very little or no study has been given to plant layout. The layout in these plants has often been based on opinions and not on the results of investigation. A scientific investigation of these layouts would reveal many things contrary to good management. It is, therefore, a subject to which small business could profitably apply the research principle of scientific management.

Plant layout is the arrangement of departments and equipment. A good layout is one which secures a smooth and rapid flow of work. Therefore, most problems which concern a change in the flow of work are problems in plant layout. In the small plant there are, as in the large plant, several types of layout problems: (*a*) A general change (plant or departmental) in the method of manufacturing, that is, from the departmental method to the continuous, or from continuous to the departmental; (*b*) a rearrangement throughout the plant or a department; (*c*) a change at one workplace. If the problem is one of making a change at one workplace, a study should be made of the effect this change may have at other workplaces. That is, changing the flow of work at one workplace may, to obtain the best results, necessitate changes at others.

Before making any change in layout it is advisable to make a process chart and a flow chart. These charts should form the basis for the study. From them some of the following changes in the flow of work may be suggested: The elimination of backtracking, storage between operations and bottlenecks; elimination of some handling, or a change in handling methods; elimination and combination of operations, or a change in operation methods or sequence; relocation of machines and workplaces. A template layout of the plant or of a department should be made when a relocation of equipment is contemplated. Also, before making some of these suggested changes, time-and-motion studies should be made.

A poor plant layout results in inefficiency. Small business has the opportunity, by means of scientific investigation, to secure a better flow of work, thereby increasing plant capacity and decreasing unit costs.

MOTION-AND-TIME STUDY

Of the numerous management mechanisms, motion study and time study have probably received the greatest amount of attention, favorable and unfavorable. Much of the unfavorable criticism of time study and of motion-and-time study is due to a misunderstanding of the real purpose of these studies and to fear of the misuse of results obtained from them. Much of this misunderstanding can be overcome by education.

A motion-and-time study, as the words indicate, includes a study of motions and times, yet time studies are made without a study of the motions, and motion studies are made which are not followed by accurate time studies. In certain instances these studies have value. However, for the best results motions and times should be included in the study.

Motion-and-time study is a scientific method of analyzing (*a*) the motions employed in performing an operation, (*b*) the equipment used, (*c*) the surrounding conditions which might affect the results of the study, (*d*) the time required to perform the operation.

The ultimate aim of this analysis is job standardization, that is, the setting up of standard specifications for the performance of an operation or job. A standard specification should embody those items which, at the time, are the best under the conditions. Thus, items which result in waste of time, energy, and material are altered or eliminated.

Job standardization, through the medium of motion-and-time study together with a system for controlling the work in terms of the standards, should result in determining the best manner of performing the work (including better working conditions), a fairer measure of work for rate setting, fewer delays (dependent upon the production - control system), increased wages, and decreased unit costs.

Motion - and - time study is another mechanism of management which can be used advantageously in a business of any size. It offers the small business an opportunity to eliminate much waste which has crept in due to the lack of a scientific analysis of operations.

RAW-MATERIAL STOREROOM

Three basic principles of scientific management are the principle of research, the principle of standards, and the principle of control. A good illustration of the non-application of these principles can be found in the storerooms of many small plants.

In these storerooms the absence of research can be noted by an examination of storeroom layout, stores classification and marking, raw-material specifications, simplification of raw materials, safekeeping and correct issuing of materials, and inventory method. Standards may exist but, if there has been no research, they are probably based on habit or guesswork. Control may exist for some of the functions of storekeeping, but seldom for all of them.

Much waste can be eliminated if these three principles of scientific management are applied to the operation of the storeroom. The benefits that can be obtained by means of a well-organized and controlled storeroom are a more orderly storeroom, less floor space, material easily found and moved, less obsolete material, less misuse and diversion of material to improper use, more uniform quality of material, greater certainty of adequate supply of material, and less money tied up in inventories.

The mechanisms for controlling inventories are simple and effective. One of them, the balance-of-stores ledger, can do much to eliminate wastes and should be used in every business.

Due to the great loss that can and does occur through improperly organized and controlled storerooms, much of which can be eliminated easily, it is surprising that there is not a more general application of scientific management to storerooms.

SMALL BUSINESS SHOULD ADOPT STANDARDS

The importance of standards has already been mentioned. One of the principles of scientific management is that of standards, yet in many plants, large and small, variations exist in methods, times, procedures, and policies. A successful system of management requires standards. The purpose of research should be to establish standards. Small business should start or continue to establish standards based on research.

These management mechanisms and others, such as simplification, standard costs, budgetary control, etc., can be used by small business. In some instances it may be possible and practicable to install one or two of them at the start and perhaps others later; for example, a good system of classification and a maintenance program based on research, standards, and control. It is not necessary that small business use the same techniques, policies, forms, etc., which might be used in large business, but it can apply the principles of good management, namely, research, standards, control, and coöperation.

TECHNICAL ARTICLE BY PROFESSOR NIMS

"*Electronics*" for June carries an article by A. A. Nims of the Department of Electrical Engineering of Newark College of Engineering on "Circle Diagrams for Tube Circuits." Circle diagrams are familiar graphs for illustrating quantitative relationships in synchronous and induction motors and transmission lines as well as in elementary circuits. The expressions for relative voltage gain and power output in electron tube amplifier circuits, operated under such conditions that the tube characteristics are substantially linear, take the form of equations which represent circles.

The article describes a method of plotting families of these circles (using separate diagrams for voltage gain circles and for power output circles) on co-ordinates which also carry loci of constant phase difference between signal and output voltages, minimum voltage gain, maximum power output, and maximum undistorted power output. The curves are made absolutely general for any tube by expressing the resistance and reactance of the load in the plate circuit of the tube as a decimal fraction of the plate resistance of the tube.

THE ALTERNATING-CURRENT NETWORK ANALYZER OF THE PUBLIC SERVICE ELECTRIC AND GAS COMPANY

By HOLLIS K. SELS, *Transmission and Substation Engineer, and*
RAYMOND C. R. SCHULZE, *Assistant Engineer, Electric Distribution Department*

Every spring, the senior electricals of Newark College of Engineering pay a visit to the Public Service Electric and Gas Company. This visit includes a substation, the Load Dispatcher's office, and the two calculating tables installed in the office of the Transmission and Substation Engineer in the Electric Distribution Department.

One calculating table is the direct-current calculating table, installed in 1928. A new voltmeter has been added which increases the usefulness of this table. Although over ten years old, it can still be considered to be of a modern design.

The latest improvement of which the Company is justly proud, however, is the Alternating-current Network Analyzer installed in January, 1938. This alternating-current calculating table is the second one built by the General Electric Company, and is the seventh A-C table in the United States. Being the most recent one built by the General Electric Company, and having some minor improvements over their own table, this one represents the latest ideas in A-C table design.

Before going too far into the complexities of the A-C Network Analyzer, it may be well to give some idea of the need for it, and the uses to which it is put.

As any power system grows, it becomes increasingly complex, and the natural result of this complexity is greater difficulty in making accurate calculations of the electrical conditions in the system. In fact, the system may become so complex that it will be almost impossible to make accurate calculations by longhand. Furthermore, calculations by longhand require so much time that it is possible to work out only a few of the cases necessary for a complete answer to the problem. Therefore, some method of doing the work electrically is of great value.

The A-C Network Analyzer provides the solution to this difficulty. On it, it is possible to represent any desired system condition—past, present, or future—and obtain readings of the various electrical quantities occurring under that condition.

Description of Analyzer

The Network Analyzer itself contains the following equipment:

Type	*Range*	
Power Supply		
Metering Equipment		
Generator units	0-360°, 0-250%-v	8
Line units	51+j81% impedance	85
Load units	1610+j1605% impedance	30
Condensers	0 to 110% Susceptance	18
Mutual transformers		12
Auto-transformers	100/85 to 115%	10
Double-end cords		9

The present installation represents about two-thirds of the ultimate equipment.

It should be noted that everything is calibrated in percent, rather than ohms or actual volts, etc. This use of percent values may be confusing at first, but the percent method results in some simplification of the set-up, and in an easier understanding of the relative values of the electrical quantities in the network being studied.

The power supply for the Network Anaylzer is a separate motor generator set on the tenth floor of the Public Service Terminal Building. The driving motor is a 5 horsepower synchronous induction unit taking power from the 3-phase, 208-volt supply in the building. The generator is a 3-kva, 440-volt, 480-cycle machine. On the same base are two other machines, one an exciter and the other a phase balancer. This phase balancer is necessary because the load drawn by the Network Analyzer itself is a single-phase load. Three-phase supply to the Analyzer is necessary, however, in order to obtain voltages at different phase angles from the individual analyzer generator units.

The 440 volts from the motor-generator are fed into a 3-phase auto-transformer mounted in the back of the Analyzer cabinet; this auto-transformer has taps at 55, 110, and 220 volts (corresponding to 25, 50, and 100%), and a voltage selector switch on the right side of the metering panel allows the selection of any of these voltages for use on the Analyzer. Usually, 100% volts (220-v) are used for load studies; lower voltages are used when starting work on a new problem (while checking to make sure the connections and settings are right), and occasionally on a short circuit study, where the currents with 100% volts may exceed the design limits of certain units.

The generator units are continuously adjustable in phase angle and magnitude, and the dials are graduated in degrees and percent volts. Each generator unit has an on-off switch, fuse, and a watt-varmeter with voltage and current switches for the selection of different scales. The watt-varmeter is used during the setting-up process and is cut out when the generators are almost adjusted. The load units can be connected in series or parallel; the parallel connection is easier to adjust. The series connection is used for light loads. The condensers are calibrated in percent susceptance; for instance, on a 100,000 kva base, a 30,000 kva condenser is set at 30. The mutual transformers are 1/1 ratio, 2-winding transformers, used to represent mutual impedance. The auto-transformers are used where it is necessary to represent a transformer tap setting above or below the normal one.

Connections are made by inserting one plug of each impedance which represents a line, transformer, load, etc., connected to the same bus, into adjacent jacks in the same horizontal row. Different buses can be set up in the same row of jacks by leaving one or more vacant jacks between the groups of plugs. The bottom row of jacks is connected together solidly to represent a neutral bus, which can be connected to ground through the switch in the lower right corner. The leads from each generator unit come to two jacks (for each) on the sides of the jack panel; the one on the inside is the "phase" lead, the other is the "neutral" end of the generator winding, which can be connected to ground through the switch adjacent to it.

The unit values on the Network Analyzer are 1% impedance=10 ohms, 100% current=0.050 ampere, and 100% volts =50 volts (these 50 volts are the output voltage of each generator unit, and correspond to the 220-volt 3-phase input to the generator unit). With these small quantities, it is obvious that something special in the way of metering is required. Therefore, the master meters (voltmeter, ammeter, and watt-varmeter — "var" meaning reactive volt-amperes) are light-beam instruments, supplied by separate current and voltage amplifiers (two stages each) with check-back circuits to insure accuracy. These light-beam meters are very fast, are much easier on the eyes than the usual pointer-type, and can be read from almost any part of the room. This permits one-man operation of this Network Analyzer. The meter burden on the network is negligible. The meters can read network amperes, total fault amperes (through red cord, used to represent a short circuit), or reference current. Voltage readings are from the yellow cord of an impedance to ground, green cord to ground, yellow to green, yellow to white, green to white, or reference volts. Watt-var and plus-minus switches are to left and below the master meters. The large dial below the master meters is for the selection of current and voltage scales. Non-locking switch to right is for changing voltage multiplier to read low voltages. The dial to right of that is instrument phase shifter—used to supply "reference" volts and amperes for reading angles. Above the instrument phase shifter is a voltmeter to read the actual volts supplied to the table, and the 3-position table voltage selector switch.

A "white" cord was mentioned above. It is used where voltage readings are wanted between two widely separated points in the network being studied.

The instrument phase shifter mentioned above is used for the measurement of angles. Suppose the angle between two voltages is wanted. One voltage is placed on the potential coil of the wattmeter, and reference current from the instrument phase shifter is placed on the current coil of the wattmeter. The angle of the reference current is adjusted by moving the dial of the instrument phase shifter until the wattmeter reads zero; the setting of the dial is noted. The other voltage is placed on the potential coil of the wattmeter, the process repeated, and the angular difference between the settings of the instrument phase shifter dial for the two conditions is the angle between the two voltages.

Reasonably good solutions to a large number of power system problems can be obtained on the D-C calculating table. However, better solutions are obtained on the A-C Network Analyzer, and furthermore, where phase angles must be considered, the Network Analyzer is necessary. This means that problems of power flow, voltage regulation, and especially system stability on any large power system must be done on the Network Analyzer.

The time required to make a set-up on the Analyzer and adjust it for the first set of readings is usually about three hours. After one set-up has been made, each minor change in a network with its set of readings will require approximately an hour. This is a very small amount of time when compared with the number of days which would be necessary to solve each case by longhand, if such means of solution were possible.

This Network Analyzer has been used on a variety of problems since its installation. The solutions obtained have helped to explain past occurrences, they have shown how the operation of the system may be improved, how suggested system changes will perform, and the proper ratings for new equipment.

Specifically, these studies include the need for high speed relays on the 132-kv system, system stability under fault conditions, the ratings of the windings in a new 132/26/13-kv transformer, system performance with a 100,000-kw generator added to the system, operation of a two-winding generator, and studies of load and fault currents on the trolley-bus system.

In the solution of the complicated problems of system operation and design, the A-C Network Analyzer has been an invaluable tool. If further justification for its use were needed, it undoubtedly can be shown that it has paid for itself several times already, in reduced expenditures for new equipment.

The history of the use of calculating tables by the Public Service Electric and Gas Company shows that the Company has always utilized the most up-to-date means for solving its engineering problems to attain the best possible grade of service at the minimum of net expense.

Comments by Professor James C. Peet, in charge of the Electrical Engineering Department:

The article by Messrs. Sels and Schulze is a very valuable contribution to this issue of the NEWARK ENGINEERING NOTES. I am hoping we can arrange to obtain reprints of this material for our Seniors before our next annual visit to the Public Service.

We have had some very fine help from Mr. Schulze during the many trips our students have made to the plant. He has been most generous of his time and very patient in explaining the operation and use of this board to our group. Some of the results he obtained from the board are almost unbelievable.

We congratulate the authors of the article—it is a very worth while effort.

WHAT OUR PROFESSORS ARE DOING

Mr. Daniel C. Frost of the Department of Civil Engineering has been elected to membership in the Rutgers University Chapter of Phi Delta Kappa fraternity. This fraternity is a national, honorary, graduate fraternity in education.

Professor William S. LaLonde, Jr., who for the last three summers has attended the graduate school in engineering at the University of Michigan where he received his Master's degree, will be working this summer for the firm of Ash-Howard-Needles and Tammen, New York, consultants in bridge engineering.

Professor Robert Widdop is scheduled to present a short paper on "The Integration of Coöperative Experiences with Management and Staff Control" at the annual meeting of the Society for the Promotion of Engineering Education. This meeting will be held June 19 to 23, 1939, at the Pennsylvania State College, State College, Pa.

Dean James A. Bradley has been re-appointed to serve on the Membership Committee of the American Chemical Society, North Jersey Section, for 1939-40.

Dr. Frank D. Carvin has been elected a member of the Executive Committee of the A. S. M. E. and made Chairman of the Program Committee. He is also Secretary of the Heat Power Committee of the S. P. E. E. and will be chairman of that group next year.

Recently Doctor Carvin was elected President of the Summit Civic Association.

Mr. David E. Zeliff of the Mechanical Engineering Department has been granted one year's leave of absence to complete his work for the Ph.D. degree at Columbia University.

Professor J. Ansel Brooks has recently been appointed a member of the Editorial Committee of the Society for the Advancement of Management.

Professor Paul Miller Giesy, of the department of Chemistry and English, has again been appointed a member of the Consulting Board of the Institute of Cancer Research of Columbia University, having held this appointment for thirteen years.

MECHANICALLY MINDED

By Frank N. Entwisle, C.E.

Professor of Physics, Newark College of Engineering

A visitor to Newark Museum during a certain week last winter might have been mildly amused at the sight of an unusual number of young men carefully examining the small but excellent collection of paintings housed in the entrance hall and court. And if he proceeded to the basement where the Clark Collection of Mechanical Motions is exhibited he might have found a similar scene of a more intensive aspect. The visitor might have noticed perchance that the earnest young men were not taking any notes despite the evident fact that they were engaged in a high powered job of observation.

What this interested bystander had happened upon was the first part of a somewhat unique test conducted last year with the two hundred members of the Freshman class as voluntary guinea pigs. The second part took place in a College lecture room shortly thereafter, when the Freshmen were formally asked to disclose their ability to retain the impressions which they had gathered at the Museum. They were asked to sketch bits of apparatus, allowed to hint at past acquaintance with this or that item, hazard opinions as to its probable usefulness, confess emotional reactions, and otherwise furnish material for the subsequent operations of the examiner.

The test has been given to gather information upon a debated subject. A very well defined belief exists in the minds of a great many people to the effect that we can divide mankind into two classes: those who "work with their heads," and those who "work with their hands." This idea is easily expanded to the point where separate types of education are proposed for the separate classes. The youth who displays evidence of being "mechanically minded," as shown by his propensity to work with his hands, is advised from that fact alone to turn to Engineering as his most likely avenue to satisfaction and success. Likewise, the boy not so constituted is urged to seek his training along other lines.

The fact that a grave fallacy can be shown to exist in this viewpoint does not prevent its reaffirmation on many occasions. There is no evidence to show that the boy who is adept with his hands is weak above the shoulders or that a lack of manual dexterity necessarily implies an agile brain. There is much evidence to the contrary. No list which can be compiled of those men to whom manual dexterity is a necessity could fail to include surgeons, sculptors, painters, musicians, inventors, and research workers in the sciences, and to imply that these men lack adequate intelligence is to court derision. And yet the ghost will not down.

It was thought, then, that it might be an interesting experiment to ask the Freshman class to subject themselves to a concentrated dose of mechanical gadgets in such a way that latent interest might be stirred for the time being, at least, and to draw out by suitable questioning, some indication of the depth of that interest. If a comparison of the results with subsequent standing in scholastic work showed any definite tendency toward a correlation, then it might be said that the ghost had earned a reprieve.

The Clark Collection of Mechanical Motions seemed to promise a setting which was ideal for the purpose. Here are gathered together some two hundred and sixty examples of mechanical devices of all sorts, from "simple machines" to complicated link, gear, chain driven, water driven machines, attractively presented, and arranged with back stage power, so that the observer may operate them at will. The Freshmen were asked to submit themselves to the influence of this exhibit with no stipulations as to time. And since the proposed examinations depended to a considerable extent upon the ability to remember observed objects in detail arrangements were made to have the candidates spend some time in viewing another exhibit—the paintings in the Museum.

The thought here was that a high score in the Mechanical Motions section of the test might mean, not interest, but an acute memory, and this individual should therefore, in a general way, reveal himself by making a good score on paintings also. The paintings therefore should act as a sort of control. Obviously, other exhibits in the Museum, such as the collection of Japanese art objects, would have been just as effective in this duty.

The formal examination revealed a wide range in quality and number of responses. The test seemed to be a frank bore to some, highly absorbing to others. Scores varied between marks which indicated little appreciation of the opportunities presented to those which showed a good percentage of the possible maximum. The "array" of marks seemed to indicate a reasonably good distribution. So far, so good.

Attempts were made to connect these results with the subsequent work of the men in College, as occasion permitted, but nothing startling has resulted, unless the fact that no connection seems to exist may be so viewed. "Correlations" have been worked out between the tests and the scholastic records of the students in the first and second semesters of 1937-38 and no definite direct correlation can be seen. The boy who knew all the answers at the Museum does not always seem to be equally at home in the College. High scorers in Mechanical Motions tend, to some slight extent, to be high scorers in the test on Paintings. This is understandable, and not particularly significant.

Of course it is not possible to say that the men making high scores in the Mechanical Motions tests are always those whose mechanical interests are the most lively. That would require biographical data to an extent not possible to procure. What has been done, it is believed, is to use the Museum Exhibit as a focus for latent interests and it seems reasonable to assume that some direct general relation exists between depth of interest and number of responses. Apparently, this interest is distributed at random through any group of varying intelligence, and even when allowance is made for the roughness of the measurement, presents no evidence of being a requisite for success in the Freshman year of an Engineering College.

The Student Chapter of the American Institute of Chemical Engineers at its meeting on April 3 heard a talk on RARE GASES AND THEIR APPLICATIONS by Mr. E. Dietz, Jr., of the Linde Air Products Company. Mr. Dietz discussed particularly the more recent developments in the industry.

At the May meeting, Mr. George B. Hogaboom, consultant on electroplating and co-author with William Blum of PRINCIPLES OF ELECTROPLATING AND ELECTROFORMING, spoke on the history and development of electroplating. Mr. Hogaboom is electroplating adviser to the United States Bureau of Standards.

On April 13 the Student Chapter and guests made a trip of inspection through the Tide Water Oil Company's plant at Bayonne, N. J. On May 26 the last inspection trip of the year was made to the plant of the Christian Feigenspan Brewing Company.

(Reported by Dean James A. Bradley)

A. I. E. E. HOLDS THIRTEENTH ANNUAL CONVENTION

J. McGrath of Newark College of Engineering Wins Second Prize

By Elliot Godman, *Senior, N. C. E.*

The thirteenth annual Student Convention of the American Institute of Electrical Engineers was sponsored by student members at Cooper Union on Thursday, April 27.

After Prof. George F. Bateman welcomed the students and graciously extended to them free passage throughout the college, a technical session was held in Cooper Hall.

The first of the six men to present their papers was our own John McGrath, who was awarded the second prize of $15. His feat is a particularly noteworthy one and should serve as an inspiration to all of us. The subject of his paper was the "Electron-Ray Tube Comparator," which is an original piece of apparatus designed for use in comparing d-c and a-c voltages. McGrath explained its wide range of applications and stated that it could be permanently installed in circuits so that a constant check-up could be maintained.

Mr. Paul J. Reifselneider from Brooklyn Polytech then presented his paper on the "Electronic Voltage Regulator for an Alternator." Its operation depends on a negatively biased Thyratron situated in a critical voltage sensitive circuit. Its high sensitivity and low cost were listed among its advantages.

Cooper Union's representative, who won the first prize of $25, Mr. B. D. Laughlin, completed the first half of the session with his paper on "The Vector Response Indicator." His apparatus is used to give direct readings of magnitude and phase angle of currents or voltages. He demonstrated, by using oscillograms, how easily faults in high frequency circuits could be detected.

A fine educational film, "The River," was shown before continuing with the second half of the program; Mr. G. Doxely from Pratt Institute, who spoke on "Recent Power Developments." He outlined the increases in national capacity, the existing power networks, and their improvement, suggesting d-c transmission and artificially cooled lines (to reduce resistance).

Mr. Javna, of the City College of New York, then presented his paper on a very cleverly conceived "Electric Guitar." Fundamentally, it was based on electric currents, resulting from the cutting of magnetic fluxes by steel strings and amplified by a high gain amplifier. Its tonal qualities were excellent.

The last speaker of the session, Mr. E. A. Dolbert, of New York University, discussed "The Fundamentals of Fluorescent Lamps." He first explained fluorescence and then demonstrated the new type of fluorescent lamp, which he said would soon be used more extensively, in spite of higher cost, because of the quantity and quality of light emitted per watt.

Let us hope that next year's convention will be as successful, and that we may again have, as we have had for two years, a man from our College to represent us successfully.

It might be recalled that Henry Jasik, a senior of Newark College of Engineering last year, won the first prize with his article on "A High Speed Electronic Circuit Breaker."

THE FIXED POINT THEORY

A very recent contribution to the text books on Reinforced-Concrete Bridges has been written by Taylor, Thompson, and Smulski. It is interesting for us to note that the authors have devoted more than one hundred and thirty pages in this work which is just off the press to a discussion of the Fixed Point Theory.

This theory was included this year in the course on Structures at the Newark College of Engineering and the students readily absorbed the theory and applied it remarkably well to their design problems in reinforced-concrete.

THE IN-AND-OUT RESERVOIR PROBLEM

(Continued from page 6)

$\triangle'''' = 1{,}090 \times .00042 = .45$,

Hence

$h = h_0 + k = \frac{1}{6}(.58 + 4 \times .49 + .45) = .49$ ft.

V. *Approximate solution by Picard's method*

This method is more of theoretical than of practical value as the integrals involved may become quite formidable. To solve our differential equation (10), we calculate the successive approximations:

$$h_1 = h_0 + \int_{t_0}^{t} f(t, h_0)\,dt,$$

$$h_2 = h_0 + \int_{t_0}^{t} f(t, h_1)\,dt,$$

$$h_3 = h_0 + \int_{t_0}^{t} f(t, h_2)\,dt,$$

Now, since $t_0 = 0$, $h_0 = 0$, we have for a first approximation

$$h_1 = \int_0^t \frac{0.002t + 550}{1{,}040{,}000}\,dt = \frac{.001t^2 + 550t}{1{,}040{,}000} \quad (11)$$

The work involved even in finding the next approximation h_2 is tremendous; we shall, therefore, be satisfied here with the first approximation (11), which for $t = 1{,}090$ sec., gives $h = .58$ ft.

The limit of Picard's method is the exact solution of the differential equation.

Exact solution of the differential equation

If the conditions of the existence theorem are satisfied, every differential equation of the first order and degree admits a solution obtainable through a quadrature, although this integral is not always expressible in terms of elementary functions. This exact solution is obtained either by means of an integrating factor or by a change of variables so as to produce an equation in which the variables are separable. Now it is easy to prove that if the conditions of the existence theorem are satisfied, every such equation admits an integrating factor (in fact, an infinite number of them). Moreover, Sophus Lie has proved (Differentialgleichungen, Chapter 6, § 5) that by a proper change of variables every equation of this type can be transformed into one in which the variables are separable.

In a coming issue of the Engineering Notes, we shall give the exact solution of our differential equation although it may prove inconvenient for computation in practice.

PROFESSIONALITIES

Mr. Theodore E. Starrs, graduate of the Class of 1930 in Electrical Engineering, has been employed with the Public Service Electric & Gas Company since 1936. He was recently appointed Assistant Engineer in charge of engineering, operation, and maintenance of the Essex-Bayway line. He previously had worked as Engineering Assistant in the design of this cable system which was the Company's first 132 kv oil-filled cable. It is nine and one-half miles long and extends between the Essex Generating Station and the Bayway Switching Station.

Immediately upon his graduation in 1930 Mr. Starrs was employed by the Western Electric Company as an Engineer in the development of lead-covered telephone cable.

In 1934 he was engaged as an Assistant Engineer with the Jensen, Bowen and Farrel Company on the inventory and evaluation of utility properties, and just before his employment by Public Service Company he had been with the Wright Aeronautical Corporation in Paterson for one year.

Marshall C. Bassford, '29 in Chemical Engineering, has been with the Alco Products Division of the American Locomotive Company since 1931. He is now in charge of the heat exchanger division of the Engineering Department. Shortly after his graduation, Mr. Bassford entered the employ of the Standard Oil Development Company in Elizabeth, N. J., as an engineer in the Process Design Division and remained with this organization until 1931 when he went with the Alco Company.

Paul J. DuMont, '30 in Electrical Engineering, is Assistant Port Engineer for the Grace Lines, Inc., in New York. He has been with the Grace Lines since 1933 when he served first as chief electrician on shipboard, and later as a steam and diesel engineer. He has been in his present position since 1938.

Stanley Farrow, '36 in Mechanical Engineering, is an Associate Ordnance Engineer with the U. S. War Department in Washington, D. C.

John B. Opdyke, '30 in Civil Engineering, has been a field engineer with the Lago Oil and Transport Company, Ltd., in Aruba, Netherlands West Indies, since 1937. Previously he had been an instructor at the College and a field engineer for a firm of consulting engineers.

THE ENGINEER AS A CITIZEN

By Professor Charles J. Kiernan

Dr. Roy V. Wright, Past President of the American Society of Mechanical Engineers, who for a number of years has been lecturer on Citizenship at the Newark College of Engineering, is the author of a feature article appearing in the May number of the *Wisconsin Engineer*, published monthly at the University of Wisconsin.

"The Engineer as a Citizen" is the title of the article. In his ever-convincing and interesting style, Dr. Wright sketches the progress of the movement started in 1931 to increase the participation and interest of engineers in various civic affairs. He cites the important contributions to community betterment that have been made by young engineers working in groups on a non-partisan basis. He points out that an individual engineer, holding membership in a club or society of a non-professional nature, can be of great help in assisting the community and its people in making wise decisions. The peculiar training and abilities of the engineer have always been most helpful and productive when the engineer is associated with other types of business and professional men interested in public affairs.

Dr. Wright refers to the Newark College of Engineering and the pioneer work it has been doing in its course in Citizenship. He speaks of the pamphlet which has been in use for a number of years in the College, "The Engineer's Duty as a Citizen." He mentions several instances in which students of this institution have contributed definitely to a high standard of citizenship on the part of engineers by taking active interest in movements designed for civic betterment.

MOTION STUDY COURSE TO BE GIVEN AGAIN

STARTS SEPTEMBER 19, 1939

The evening course in Motion Study closed on Monday, May 8, after a very successful term. The twenty-one students enrolled in the course represented sixteen industrial firms and held a wide variety of positions, including supervisors, foremen, time study men, rate setters, and draftsmen.

The course during the next college year will be offered in the first semester. It will open on September 19 and run for seventeen weeks, three hours each Tuesday evening. Professor George D. Wilkinson, Jr., and Mr. Clifton H. Cox will again give the lectures and conduct the laboratory work. Much of the time in the course will be devoted to the laboratory work. Students will study problems brought in from plants where they are employed. Micro motion analyses will be made of these problems, and each student, at the completion of the course, will receive a reel of motion pictures showing the results of his study.

Enrollment in the course will be limited. Registrations may be made after July 1st. The tuition, $45, includes registration and laboratory fees.

COMING ISSUES

Articles to appear in some of the next issues of the Newark Engineering Notes are as follows: *Integral Equations*, by Professor Bedross Koshkarian; *Some Problems in Moisture Measurements*, by William B. Wible; *We Cast Out 9's or 3's*, by E. C. Easton; *Repulsion Motor Calculations*, by Professor Paul C. Shedd; *The General Conic, or Quadratic, Angle and Its Functions*, by Professor Albert A. Nims; *Trigonometry by Vectors*, by Edward Baker; *The Vector Idea in Trigonometry*, by Edward Baker; *Cellophane*, by Donald A. Waterfield; *Isotopes as a Tool in Chemical Research*, by Professor Joseph Joffe.

WHAT OUR READERS SAY

Throughout the year over three hundred written comments have been received by the Editor. Most of the letters were interesting enough to deserve publication, but obviously only a small number could be used.

COLLEGE GUIDANCE FOR ENGINEERS

To the Editor:

This is in answer to your letter of March 13th, in which you ask for my comments on Professor Widdop's article, "College Guidance for Engineers." My answer has been delayed because of my absence from the office on sick leave.

But I want you to know that I enjoy receiving copies of your Engineering Notes, and I appreciate your kindness in sending the magazine to me. It is one of the best college magazines which has come to my notice.

Professor Widdop has presented a complete and concise summary of the problem of which all engineering educators are aware. In my opinion, the heart of the problem is in the paragraph in which he discussed the lack of responsibility. Many examples substantiate this statement.

Mr. Widdop suggests that an orientation program should start with the student when he enters college. Since there are so many failures in the engineering colleges, it would seem logical that such a program begin in the early high school years.

An effective co-operative program between the colleges and high schools would make the college program less difficult. The unfitted would be steered away and the qualified ones would have better training since definite high school programs could be worked out for these students. Our own co-ordinator, working with a faculty member, is working with this long range objective in mind, when they present the problem of college guidance to the high schools.

After reading the section entitled "Approach to the Problem," it seems that an effective co-operative system coupled with a good system of personnel guidance would be ideal for achieving the objectives.

Individual guidance is the only effective procedure. The central agency is the most efficient if it does not divorce its work from that of the faculty. Our school of engineering is of the co-operative type.

Our experience with tests has demonstrated the predictive value of the tests. Of course the results must be used with judgment. It is my opinion that such tests should be given about the junior year of high school.

I enjoyed meeting Professor Widdop at the Texas meeting of the S. P. E. E. last June. I had looked forward to the meeting this year at Penn State, but it will be impossible for me to attend.

Please remember me kindly to Professor Widdop. Should the opportunity present itself, I hope that some one of your faculty will drop in and visit our school.

Again expressing my appreciation for being on the mailing list of ENGINEERING NOTES, and with my warmest personal regards,

Very truly yours,
W. B. WENDT,
Professor of Civil Engineering,
University of Louisville.

P.S.: I discussed Professor Widdop's paper with Professor John M. Houchens, our co-ordinator, and many of his ideas are incorporated in this letter.
Louisville, Kentucky, May 5, 1939.

THE ORDEAL OF THE FRESHMAN

This article by Dean James A. Bradley appeared in the March issue of NEWARK ENGINEERING NOTES. Among comments received, we quote:

To the Editor:

It is an exceedingly attractive publication, with contents which match, in point of interest, its excellent and dignified physical appearance.

The article by Dean Bradley entitled "The Ordeal of the Freshman" seems to me to be the product of a true educator because it does what Dean Bradley probably intended it should do when he prepared it; namely, provoke thought. The topics he used are very important and deserve serious consideration by those interested in youth, in education and in better citizenship. As yet we have had no well considered answer to the question as to "who should go to college," whether the opportunity of college education should be open only to those who are able to meet the expense of it, and what the high schools should do in order best to discharge their responsibilities to the youth within their doors and to the communities which support them, in many instances at mounting costs.

The changes and reactions which either accompany or follow the transition from high school to college, the course of the study which should be undertaken, and the choice of the professions to be made, all dealt with in the Dean's article, are very important problems not only for those whose plans include preparation for life's work through the educational advantages which the colleges offer, but also for the families of the college minded boys and girls.

I have the distinct feeling that the solution of these problems, in many individual cases, would be much facilitated were this excellent article of Dean Bradley available, early in the high schools, to those who are at all considering for themselves the benefits of college training.

Very truly yours,
S. WARZALA
The Calco Chemical Co., Inc.

Bound Brook, N. J., April 14, 1939.

To the Editor:

Dean Bradley's article is very pointed and timely. It states the situation quite clearly and it is a situation which should be forcibly impressed upon every pre-freshman and the parents of a pre-freshman. I might add another common cause of failure, it being the unwillingness to spend more than four years in college, feeling the spending of a fifth year to get a degree is a sign of incompetence.

Dean Bradley might well write another article on "The Ordeal of the Graduate." This, too, is a pertinent problem.

Yours very truly,
R. C. STRATTON,
Supervising Chemical Engineer,
The Travelers.

Hartford, Conn., April 13, 1939.

MOLECULAR SPECTRA

Professor Carvin's article in the March issue of NEWARK ENGINEERING NOTES on "Molecular Spectra" has had many comments:

To the Editor:

Thank you for the copy of NEWARK ENGINEERING NOTES containing the article by Dr. Carvin on "Molecular Spectra." While Dr. Carvin and I meet frequently at national meetings, not being a molecular spectroscopist, I do not feel I should comment on this article, except to say I am sure it is characterized by the high degree of excellence which one might expect from his pen.

Very truly yours,
D. S. ELLIOT,
Professor of Physics,
The Tulane University of Louisiana

New Orleans, April 25, 1939.

To the Editor:

This is to acknowledge your letter of April 5th, enclosing a copy of NEWARK ENGINEERING NOTES which I have found to be a very interesting publication.

I have not had the opportunity to read Professor Carvin's article on "Molecular Spectra" but I am taking this home with me to read at the first opportunity.

This publication seems to be extremely scholarly and you are to be congratulated upon the high order of subject matter.

Cordially yours,
HUBER O. CROFT,
Professor in charge of Mechanical Dept.,
The State University of Iowa.

Iowa City, April 12, 1939.

To the Editor:

Thank you for sending me a copy of NEWARK ENGINEERING NOTES. I enjoyed examining this issue very much and hope that you will make all subsequent numbers as interesting. Naturally, I was most fascinated by the article of my former associate, Professor Carvin; may I ask that you extend my congratulations to him.

Very truly yours,
ERICH HANSMANN, *Dean*
Polytechnic Institute of Brooklyn

Brooklyn, N. Y., April 19, 1939.

GYURIS STORAGE BATTERY

Professor Stewart's article on "The Gyuris Storage Battery" appeared in the November issue of the NEWARK ENGINEERING NOTES. Here we quote extracts from some of the letters received to show the apparent commercial value of the NOTES.

A storage battery specialist writes:

"Is this particular type of battery now on the market for sale to the commercial classes that you mention? If so, I would very much appreciate knowing where the main headquarters are to follow up."

The vice-president of a yacht-building concern says:

"We have read with interest your article on the Gyuris storage battery. We wish to know if you can inform us where we may obtain further information on this battery and where we may purchase them."

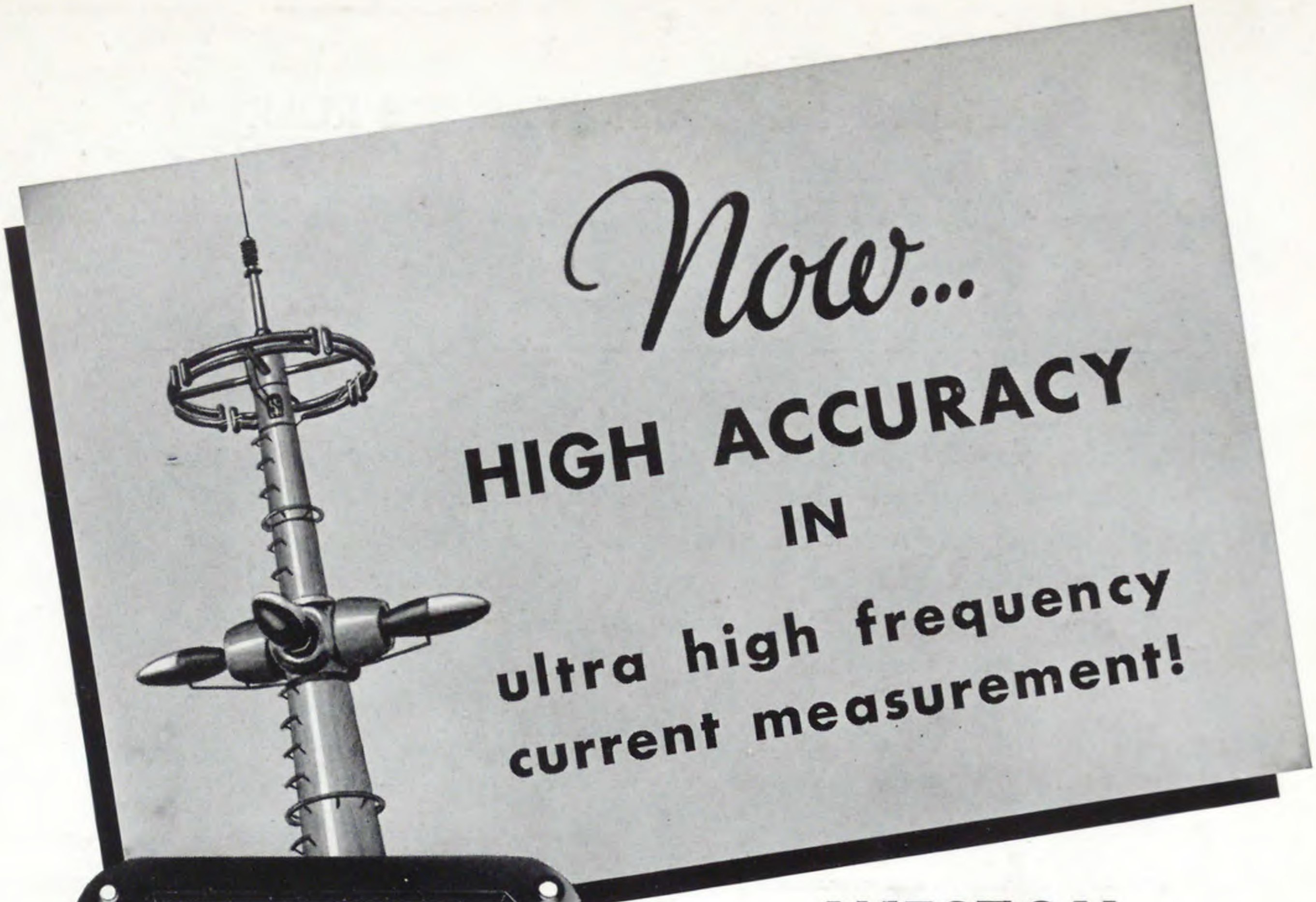
The purchasing engineer of a photographic film-manufacturing concern writes:

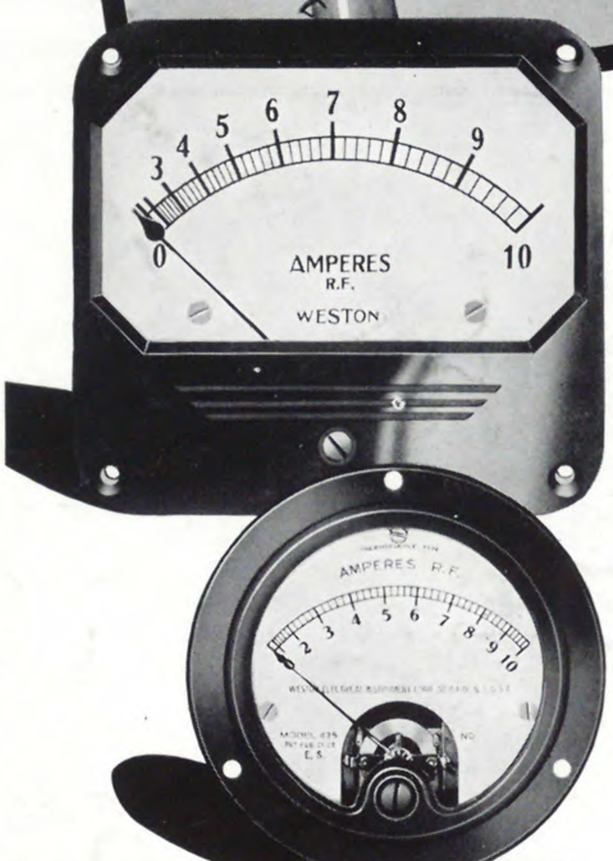
"We have read with interest your article on page 11 of the NEWARK ENGINEERING NOTES for November, 1938, with reference to the Gyuris storage battery. We would like to know whether this battery is being used commercially and if so, the cost, etc."

One leading industrial concern writes:

"We are especially interested in storage batteries of the lead-acid type, since we manufacture the oxides and grid metal used in this type of battery, but the unique construction of the Gyuris storage battery has aroused my curiosity, particularly in its lighter weight and greater output.

ABBEY PRINTING COMPANY, EAST ORANGE, N. J.





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