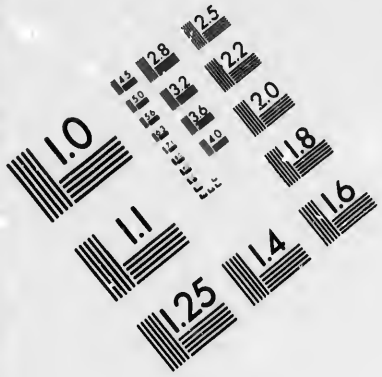
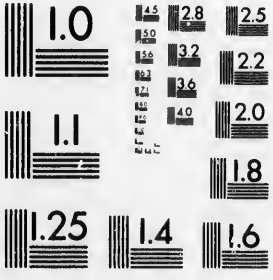
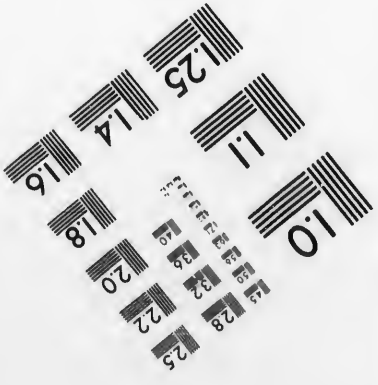


IMAGE EVALUATION TEST TARGET (MT-3)





Ca

CIHM/ICMH Microfiche Series.

CIHM/ICMH Collection de microfiches.

Canadian Institute for Historical Microreproductions

institut canadien de microreproductions histo-iques

1980

Technical Notes / Notes techniques

The Institute has attempted to obtain the best original copy available for filming. Physical features of this copy which may alter any of the images in the reproduction are checked below.

L'Institut a microfilmé le meilleur exemplaire qu'il lui a été possible de se procurer. Certains défauts susceptibles de nuire à la qualité de la reproduction sont notés ci-dessous.

- ☐ Coloured covers/ Couvertures de couleur
- ☐ Coloured maps/ Cartes géographiques en couleur
- ☑ Pages discoloured, stained or foxed/ Pages décolorées, tachetées ou piquées
- ☐ Tight binding (may cause shadows or distortion along interior margin)/ Reliure serré (peut causer de l'ombre ou de la distortion le long de la marge intérieure)
- ☐ Additional comments/ Commentaires supplémentaires

- ☐ Coloured pages/ Pages de couleur
- ☐ Coloured plates/ Planches en couleur
- ☐ Show through/ Transparence
- ☐ Pages damaged/ Pages endommagées

Bibliographic Notes / Notes bibliographiques

- ☐ Only edition available/ Seule édition disponible
- ☐ Bound with other material/ Relié avec d'autres documents
- ☐ Cover title missing/ Le titre de couverture manque
- ☐ Plates missing/ Des planches manquent
- ☐ Additional comments/ Commentaires supplémentaires

- ☐ Pagination incorrect/ Erreurs de pagination
- ☐ Pages missing/ Des pages manquent
- ☐ Maps missing/ Des cartes géographiques manquent

The images appearing here are the best quality possible considering the condition and legibility of the original copy and in keeping with the filming contract specifications.

The last recorded frame on each microfiche shall contain the symbol ⟶ (meaning "CONTINUED"), or the symbol ▽ (meaning "END"), whichever applies.

The original copy was borrowed from, and filmed with, the kind consent of the following institution:

National Library of Canada

Maps or plates too large to be entirely included in one exposure are filmed beginning in the upper left hand corner, left to right and top to bottom, as many frames as required. The following diagrams illustrate the method:

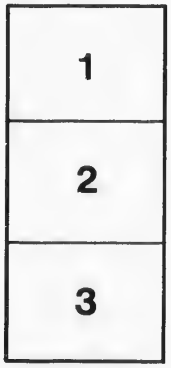
Les images suivantes ont été reproduites avec le plus grand soin, compte tenu de la condition et de la netteté de l'exemplaire filmé, et en conformité avec les conditions du contrat de filmage.

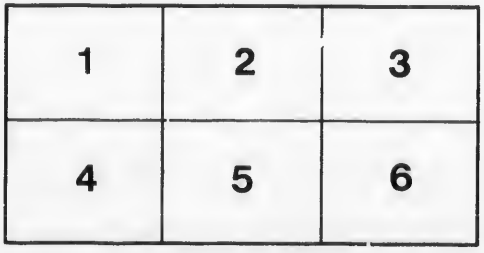
Un des symboles suivants apparaîtra sur la dernière image de chaque microfiche, selon le cas: le symbole ⟶ signifie "A SUIVRE", le symbole ▽ signifie "FIN".

L'exemplaire filmé fut reproduit grâce à la générosité do l'établissement prêteur suivant :

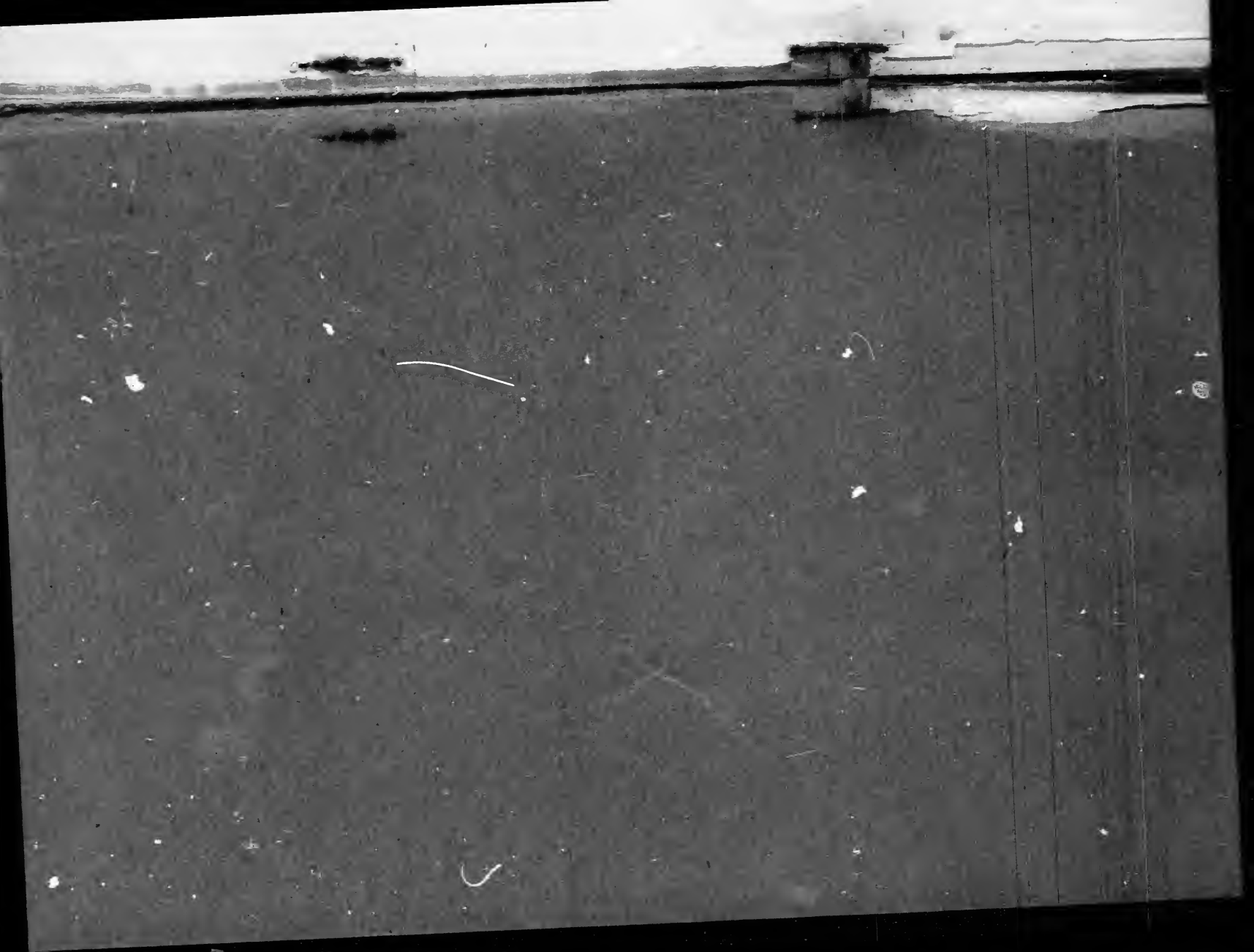
Bibliothèque nationale du Canada

Les cartes ou les planches trop grandes pour être reproduites en un seul cliché sont filmées à partir de l'angle supérieure gauche, de gauche à droite et de haut en bas, en prenant le nombre d'images nécessaire. Le diagramme suivant illustre la méthode :





The Conjunction of the Nineteenth and Twentieth Centuries from an Engineering Standpoint



P. Bell.

With Compliments of

Chas. T. Harvey.

CHARLES THOMPSON HARVEY, C.E.

From a photograph taken at or near the time referred to on pages 13 and 26, when the Water-way and the Elevated Railway first projected and promoted, and originally constructed by himself as Chief Engineer, surpassed all previous world-records of transit capacity in conveyance of freight by canal, and of passengers by railway; *both events occurring during the same year.*

TORONTO UNIVERSITY

SCHOOL OF PRACTICAL SCIENCE

ADDRESS

DELIVERED BEFORE ITS

ENGINEERING SOCIETY

BY

CHARLES THOMPSON HARVEY, C.E.

MARCH 8TH, 1899.

SUBJECT:

"The Conjunction of the Nineteenth and Twentieth Centuries from an Engineering Standpoint."

TORONTO:
THE CARSWELL CO., LIMITED, PRINTERS,
1899.

the term until the next general meeting of the Association, at which the officers are elected.

Article X.

Notice of Motion.--Permission to introduce any notice of amendment or amendments to this Constitution must be granted by a majority of two-thirds of the active members present. Permission being granted, notice may be given and the proposed amendment moved at any subsequent sitting. After discussion the amendment must be submitted to a Committee of five, named by the Chairman. The report of said Committee cannot be considered on the same day on which it is introduced. A two-thirds vote of all active members present shall be necessary for its adoption.

Article XI.

Notice of substantive motions is required, and no motion shall be discussed at the sitting at which the notice has been given, but this rule does not apply to merely formal motions, such as motions to adjourn. All reports of standing Committees are to be discussed at a sitting subsequent to the one at which such reports have been received. This rule may be suspended by a vote of two-thirds of the members present.

Article XII.

All motions must be duly proposed and seconded, and shall, except those of a purely routine character, be in writing.

Article XIII.

No member shall speak more than once, or at a greater length than five minutes, upon any question until all others have had an opportunity of doing so, nor more than twice on any one question without permission of the Chairman, or a majority of the members entitled to vote. The mover of a substantive motion has the additional right to reply.

Article XIV.

Questions may be re-considered upon a motion to re-consider being made by a person who voted with the majority, provided such motion is carried unanimously. No discussion of the said

NINETEENTH CENTURY EVOLUTION.

At the commencement of this century the civilized world's attention was mainly engrossed by those conducting military and naval warfare, Napoleon, Wellington and Nelson were then the most prominent directors of the world's energies in destructive operations.

But later on the functions of their class were eclipsed by those prominent in constructive undertakings, such as Fulton, Stephenson, Erickson and Roebling. All of these can be classed as Engineers, because they concentrated material qualities or forces for special objective purposes, whether in structural or mechanical development.

The extent to which Engineering has entered into the science of warfare is one of the marvels of this century. The fighting exploits of Kitchener on land, or of Dewey or of Sampson on the sea, is far more a record of engineering skill than of military courage.

What chance was there for the latter when facing machine guns?

Was not the engineering perfection of Dewey's ships and armament an essential element of his victory? Could Sampson have captured the escaping ships at Santiago if the engineers constructing or operating his cruisers had failed to do their part in a superior manner?

It is interesting to consider how the contestants in the famous sea-fights of antiquity would be surprised to learn that instead of encounters with battle axes and grappling hooks when their open war vessels clashed together, modern naval battles would be fought with miles of intervening space between the combatants, and the greatest endurance would be required of shovellers of coal into the engine furnaces (called "stokers"), who might not see a shot fired on either side until the victory was decided.

COMPARATIVE CENTENNIAL PROGRESS.

Have you ever considered that the century now closing has witnessed more improvement in the exterior conditions of human and social life than occurred in the sixty centuries preceding it?

Take the single but fundamental element of transit by land. There had been no essential change in that from the time that wheeled

conveyance by animal traction was first mentioned in the Bible, B.C. 1706, when Joseph, the Viceroy of Egypt, sent waggons to Palestine to move his father Jacob and all his family belongings, up to the year A.D. 1829, when the first public exhibition of steam traction was made by Stephenson, with the famous engine Rocket, near Manchester, England, and the first locomotive railway was there opened for use the following year.

Yet this radical improvement is now eclipsed by the utilization of electricity, which has come into use for transit purposes within the life of the youngest here present.

It is hard to realize that within this century the first steamship crossed the ocean, the first cablegram vibrated beneath its depths, the first public telegram, "What hath God wrought," flashed over conducting wires, or that wonders which would have paralyzed ancient wise men with awe, are now mere commonplace affairs with us, as for instance, that we can propel, illuminate, and heat a railway car by connection with a single minute wire, to say nothing of the horseless carriage which the last few months have seen introduced hereabouts.

An ingenious writer has recently undertaken to sum up the fundamentals of materialistic human progress in distinct centennial epochs.

He finds that the invention of alphabetic characters was the first, but the time of its introduction unknown. Next the system of numerals, also without date. With those exceptions he passes over fifty centuries failing to find any single improvement worthy of note, until he credits the fourteenth century of the Christian era with the discovery of the mariner's compass as its single achievement.

To the fifteenth he assigns the introduction of movable type by Guttenburg, although there is reason to infer that the Chinese had anticipated that by several centuries, but the European idea is the only one historically notable.

The seventeenth century he solely connects with the telescope, but it seems to me that magnifying lenses have not materially affected human conditions, and I would suggest that the introduction of explosives for engineering purposes was a greater event—the use of gunpowder for blasting rock dating from 1613.

With the eighteenth century he mentions only the steam engine, and in summing up says:

"We find only five inventions of the first rank in all preceding time, while in this nineteenth century alone we have 13, namely, (1) Railways, (2) Steamships, (3) Gas Lighting, (4) Friction Matches, (5) Telegraphs, (6) Telephones, (7) Electric Lighting, (8) Electric Railways, (9) Photographs, (10) Phonographs, (11) Antiseptics, (12) Anæsthetics, (13) Rontgen Rays."

ENGINEERING RETROSPECT.

The unexampled progress made in engineering works during this century, such as the Lake Superior and Suez Canals, suspension bridges, elevated railways, mammoth steamers and others too numerous to mention, together with the fundamental discoveries just referred to, are the outcome of a dominant spirit of peace pervading the earth, fostered by international exhibition of the results of peaceful pursuits, commencing with the first one in London in 1851-2, and reaching a climax in Chicago in 1892-3, causing a commingling of races, and of ideas never before seen on this orb

The spectacle of the vast army of the Czar of Russia being now largely engaged in building of railways, excavating of canals, and drainage of marshes under engineering supervision is a most suggestive one as in the direct line of converting "swords into plough shares, and spears into pruning hooks." Right here I will remark that when universal peace does eventually reign among the nations it will be largely due to the engineering skill which has already made war so destructive *and unromantic*, that educated humanity shrinks from it as never before. The "hill tribes" about Manilla recently faced the American machine guns, relying on bows and arrows, but the ignorance of centuries was destroyed in an hour, and the few survivors will become teachers of new truths, which their kind will heed, as never before!

SEISMIC PHENOMENA.

The century just closing has an unique record of seismic disturbances.

It is stated that it has witnessed 52 volcanic islands rise out of the sea, nineteen have since disappeared, and ten are now inhabited.

The change in the earth's surface occurring at the Straits of Sunda nearly two decades since was the most serious yet recorded.*

When a high range of mountains for a length of eighty miles disappear in the sea, and the volcanic pumice evolved in one eruption can be detected in the atmosphere on the other side of the globe for months afterwards, a total destruction of the world in the form we now see it, seems to be quite possible on the same lines of unfathomed and unexplained energy.

TWENTIETH CENTURY PROBLEMS.

Turning towards the twentieth century we may eagerly enquire what can it bring to us as opportunities to add to the fundamentals of human progress so widely extended in the cycle now closing. Is the list exhausted? By no means. Two fields of prolific discovery can at once be named—Aerial navigation is one, which, permit me to predict, will become a practical factor in human conditions before many decades, and perhaps before one more has passed.

Utilizing tide energy is another of grand possibilities. The world is just waking up to the value of water powers in connection with electrical transmission, but compared with the aggregate energy of tides, they are quite overshadowed. The Province of Nova Scotia has few water powers owing to its topographical conditions, but its coast tides, particularly in the Bay of Fundy, could supply its own needs and leave a margin equal to all the steam power now used in the world ten times over.

And here let me say that no engineering prize, so far as fame is concerned, can excel that awaiting the discoverer of the best solution of either of these engineering problems, in which any of you can compete for success.

For your encouragement I will say that if other matters did not engross my own attention, and the means for experimenting were

*NOTE:—This catastrophe occurred in August, 1883. Scores of thousands of lives of the inhabitants in the vicinity were destroyed. The eminent scientist, Professor Newcomb referring to it said: "This eruption, the greatest cataclysm within the memory of man, was followed by extraordinary phenomena visible over the greater portion of the globe. It was attended by volcanic dust which was propelled in stupendous quantities for miles into the air and carried around the world by currents that were constantly moving in the upper atmosphere. It made the sunsets of that year unprecedented for beauty.

provided, I would unhesitatingly devote a few years to one of these topics, with full faith that a successful issue worthy of mention in marking a century's progress would result. If such sentiments can be entertained by one of my years, how much more by those endued with the fresh energies and the buoyant hopes of young men such as I see before me!

If any, however, prefer a purely mental and inductive line of investigation let them study seismic phenomena, and establish the data by which the energy producing earthquakes can be located, explained, estimated and forecasted, and the world will listen to any valuable deductions in that line because so directly interested. A seismometer is already provided in this vicinity to aid in such investigations.

Having thus glanced at these centuries from a world-wide standpoint, let us narrow our horizon to the country, or rather empire, in which we dwell.

BRITISH LIBERALITY.

You are to be congratulated upon coming forward into the arena of professional life under the protection of a Government the most just to the Engineering profession that the world has ever seen, and with a record in that respect of which you may well feel proud, for it is simply grand.

Let me relate one instance. In 1775 there was seen in London an awkward looking man about 40 years of age distributing cards in the seats of members of Parliament before the daily session commenced, which contained an appeal for the extension of his patent for the invention of steam engines, which was expiring just as he had it perfected sufficiently to secure a commercial success. The extension was opposed by manufacturers, who saw profit in using it, and they raised the cry of "No monopoly" When the members of Parliament understood the case, and that the distributor of those cards was the original inventor, James Watt by name, they promptly passed an Act extending the patent for twenty-four years, which insured the great inventor a competency for life, and when he died a monument was erected to his memory in Westminster Abbey, with an epitaph written by Lord Brougham, which denotes the highest level of national glory, and to which no other but England has yet attained, as the existence and uses of the famous Abbey attest.

The epitaph is worthy of your reverent attention, reading as follows:

NOT TO PERPETUATE A NAME
WHICH MUST ENDURE WHILE THE PEACEFUL ARTS FLOURISH,
BUT TO SHOW
THAT MANKIND HAVE LEARNED TO HONOUR THOSE
WHO BEST DESERVE THEIR GRATITUDE
THE KING,
HIS MINISTERS, AND MANY OF THE NOBLES
AND COMMONERS OF THE REALM,
RAISED THIS MONUMENT TO

James Watt,

WHO DIRECTING THE FORCE OF AN ORIGINAL GENIUS
EARLY EXERCISED IN PHILOSOPHIC RESEARCH
TO THE IMPROVEMENT OF
THE STEAM ENGINE
ENLARGED THE RESOURCES OF HIS COUNTRY,
INCREASED THE POWER OF MAN,
AND ROSE TO AN EMINENT PLACE
AMONG THE MOST ILLUSTRIOUS FOLLOWERS OF SCIENCE,
AND THE REAL BENEFACTORS OF THE WORLD,
BORN AT GREENOCK, 1736.
DIED AT HEATHFIELD, IN STAFFORDSHIRE, 1819.

This tribute you will notice was tendered during this century, so prolific in achievements worthy of like perpetuation, and discloses one cause of such glorious results.

Another instance is recorded in connection with Robert Fulton, the renowned American pioneer of steamboat navigation, who went

to London and submitted plans for torpedo boats to the British Government, for which it allowed liberally and paid promptly, in striking contrast with his own nation, which abused his confidence as to compensation for invaluable services later on. Its record in dealing with Erickson, whose genius greatly aided the re-union of the States by his invention of the first turreted warship, was still more discreditable.

Stephenson with his locomotive, Bessemer with his steel process, and many others with invaluable contributions to human progress, have found appreciation and protection under the "Union Jack," which you can rely upon for service of a similar kind when needed.

ONTARIO'S ENGINEERING CLIMAX.

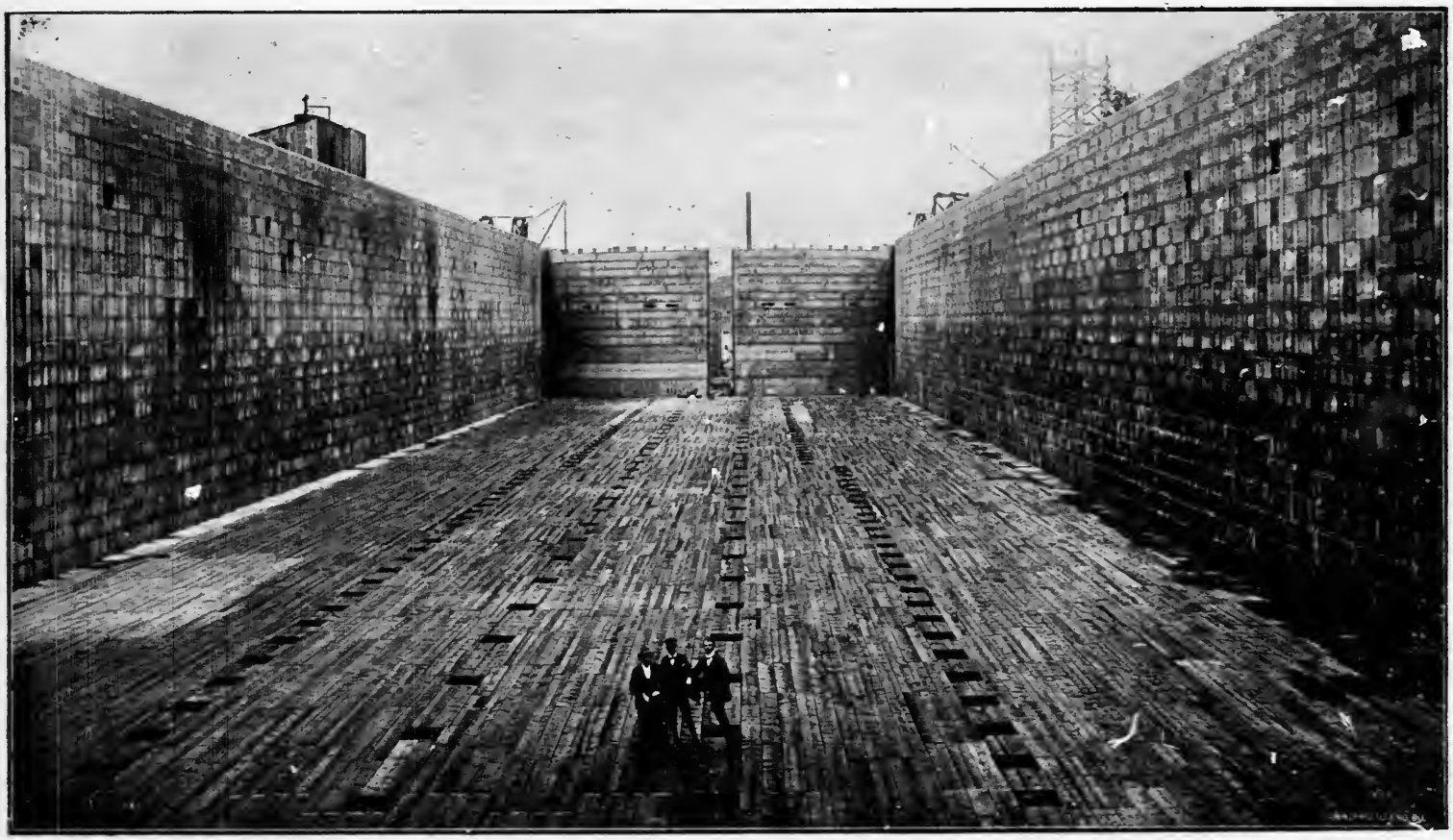
Concentrating our attention on Canada as the eldest daughter of the Empire, and on Ontario as the Empire Province of the Dominion, with its great lake frontage on the south, and its salt sea coast on the north, constituting it a keystone of the trans-continental arch of confederated provinces, we find it has already within its borders the greatest engineering wonder of the world, and perhaps the most perfect example of national comity yet recorded.

I refer to the Dominion Canal at the outlet of Lake Superior in the District of Algoma and Province of Ontario. Its single lock is 900 feet long, 60 feet wide, and 20 feet deep. The lock gate machinery is operated by electricity which the attendant manipulates by a button arrangement which controls the valves and gates, and fills or empties the lock with perfect exactness. Here we have the spectacle of one person, whether man, woman or child, by a simple finger pressure causing the displacement of 1,080,000 cubic feet of water, weighing 32,690 net tons in less than five minutes!

This minimum of energy and maximum of effect stands unequalled in the world's history as an engineering triumph, and of it as an achievement of your chosen profession, within your own inheritance, you may well be proud.

The United States canal on the opposite side of the river is still larger in dimensions, but it is operated by water power controlled by hand leverage requiring more manipulating force, and hence, while equally efficient, does not furnish as perfect an example of the minimum of energy to obtain certain results as the other.

DOMINION LAKE SUPERIOR CANAL LOCK—(900 feet long, 60 feet wide, 20 feet deep and 18 feet lift).
View of rush of intake of water caused by touching the Electrical Button Arrangement for operating the lock mentioned on page 10.



Photographic View NEW LOCK UNITED STATES LAKE SUPERIOR CANAL. 800 feet long; 100 feet wide, 20 feet deep, 18 feet lift, opened for use 1896-7. This unrivalled Canal Lock occupies the site of the original Locks built 1853-5.

But another most charming feature is that both canals are free to the adjoining nations, and steamers sailing under either flag pass on one side or the other without question, as best suits the captain's convenience. It can be truly said that at this point the two greatest and richest nations of the earth come in closest, and yet freest, touch with each other, and that they severally owe their greatness and their wealth more to the engineering profession than to any other.

In singular contrast with this glorious engineering achievement is the condition of affairs on the northern boundary of this Province. There it possesses a coast line of several hundred miles on the second largest sea of the world, but without having instituted any improved means of access thereto, since possession was acquired in the seventeenth century.

Immense wealth in fish, minerals and forest products have remained unexplored and unutilized for centuries, when only separated from the central water-way of the great lakes of the continent by a zone of less than 300 miles wide. That vacant space is now reduced to 250 miles by the advent of east and west railway facilities.

It is safe to say that a similar waste of natural resources is without precedent in the history of civilization. Various theories are advanced as to the cause, but perhaps the most plausible is that it has become the custom of the Government to rely for its revenue upon the sale of forestry products in the northern districts, the proceeds of which are expended at the seat of government, and in sustaining public institutions in the southern section of the Province, and that the northern region is regarded in Toronto as a farmer does his wood lot, which is left to the slow process of natures reproduction to offset limited use for special purposes.

But there are serious discounts in this policy. Desirable settlers avoid the unopened timber districts, and pass on to the western prairies, while fires devastate more or less territory every year.

NEW FORESTRY FOES.

A new element of destruction has lately appeared in two varieties of insect life, one of which attacks the tamarack timber, and the other the spruce, and threatens to ruin both, in latitudes where the more valuable pine does not grow, and there is less danger from fires.

Professor Bell reports that the tamarack groves in the vicinity of James' Bay, on the south-eastern side, have recently been largely

killed by a species of worm, spreading over wide areas, and causing incalculable damage and waste, for which there is no remedy save speedy utilization. Your president, Mr. Carter, informs me that he noticed the devastation caused by this pest in large sections of the Moose River basin in his official explorations for the Provincial Government last season, and that the worm's scientific name is "Nematus'erichsonii."

NEW ENGINEERING OPPORTUNITIES.

The introduction of improved transit into these northern regions, and access to the Great Sea, will open up a sphere for engineering talent, which you may reasonably expect will give a wide range for the exercise of your professional abilities. Especially is such the case with regard to its being the natural highway to the great Mackenzie and Yukon valleys, where extensive demand must rapidly spring up for your services. This century ought not to pass without a commencement being made in that direction.

With this brief glance at your political and professional environment a few closing words will be devoted to your status as individuals, and to personal reminiscences connected with your profession.

PERSONAL SUGGESTIONS AND ILLUSTRATIONS.

The most wonderful feature of human life is what we term the human will. It can neither be seen, weighed or measured. Its existence can only be proven by its effects, which are as multiplied and varied as are the units of human existence. How any one who has considered its phenomena can doubt the existence and power of an origin for it in a creating will on a higher plane, where Deity itself, which we style God, dwells, I cannot comprehend, and hope that all of you will consider this subject with the attention which it deserves.

But to enable you to most advantageously use the will power with which you are severally endowed is what you, as students, are here for, and the ultimate value of your several existences will be determined by your use of such endowment.

The sublimest effects of which we can conceive, are caused by it, and the highest happiness we can know, is to look back at the close of life upon its having been used to the best advantage in the elevation of ourselves and our species towards the highest possibilities, in

the material and spiritual world, for ascend as we may, there will be altitudes yet above us.

You have chosen a profession which calls for intense exercise of trained will power, as its functions are to re-arrange the material features of the earth to serve human purposes to a higher degree. The embankment of a railway, the prism of a canal, or the mechanism of a steam or electrical engine are triumphs of educated will power over matter.

ENGINEERING PROCLIVITIES.

Engineers of the highest class are born, not made. Technical education is helpful, but not determinative of the quality or strength of the will power which you need to best succeed in your profession. If I were to estimate your chances for eminence in it, I might not ask what technical works your are studying, but would enquire what class of books you liked best for reading, and what your amusements were.

These indicate the tendency of your will power, which may commence its development in boyhood, or even in childhood, on some fundamental principle of your profession, or of any other. Happy is the person who cultivates such manifestation of Deity in his nature, before he gets to technique.

About fifty years ago you might have seen a lad left to choose his own amusements, who selected a small watercourse, and without suggestion or attention from any one, proceeded to build over it a bridge made of laths placed in a new form of construction, and when after days of working in the muck he had it built on a good foundation, proceeded to cover it with an earth embankment, and not satisfied with its sustaining that, loaded a wheel-barrow with stones and set it on the centre of the span. The satisfaction of finding no deflection in the structure under extra pressure he deemed abundant compensation for days of hard work. Less than forty years later he had attained the unique engineering distinction of having a canal built by him out-classing all others on the globe, not only in lock dimensions but eventually in volume of transit tonnage, which occurred the same year—in the 80's—that a railway also originated by him, exceeded any other in number of passengers per mile transported over it. If you were to ask him how this distinction (probably never to

be duplicated) was attained, he would tell you that he attributed it not to technical education, in which his opportunities were few, but to the choice he made in his amusements and reading.

Aside from scientific books, those of history and selected biography will prove the most useful to you. History shows you the effect of will power focused by, in, or on communities or nations. The first record in the series should be the Holy Scripture, as reaching to the remotest recorded time, and commencing with the sublimest sentence ever written, namely, "In the beginning God created the heavens and the earth."

As to biography, the first should be of the Nazarine carpenter's son, as the person who exercised will power to the highest degree ever attained in this life, and then the lives of those who developed it in your chosen profession in its widest application, afterwards, of those eminent in other spheres of life.

The facts thus to be learned are most salutory, as showing how others have surmounted difficulties far greater than any opposing your progress, and that the rewards of diligence, perseverance and discrimination generally come in due time.

NOTABLE BIOGRAPHIES.

Were I to name a few useful biographies I should begin with the life of James Watt, and continue with George and Robert Stephenson, Robert Fulton's Arkwright's, Telford's, Brassey's, Clinton's Morse's, Cornell's, Cooper's, Erickson's, Bessemer's, and so on to Edison, who is the latest marvel of will power, of whom it is probable that I bought newspapers as I passed over the railway where he as a lad was then selling the same. Of the influence of books and of observation on the will power, I will pause to mention two instances which greatly impressed me.

One was that of Hall, the Arctic explorer, who, when a journeyman engraver in Cincinnati, Ohio, read accounts of the mysterious fate of Sir John Franklin and determined to try to find traces of him.

Without money and without prestige to start with, his will power carried him to the wastes which Franklin traversed, and he brought back relics picked up where dropped by the great explorer, but his enthusiasm—which is but one name for will power—in Arctic explorations was communicated to the American Congress and to

President Grant to such an extent that they made him a naval commander and placed a national vessel under his control by unprecedented special legislation. His name is indelibly connected with those Northern seas on the shores of which now reposes his body, in which his will performed feats that unless they were well attested would be deemed incredible.

He who now addresses you could tell about the influence of reading one of the biographies just mentioned which permeated his life and led to results hardly less improbable than those referred to.

The other instance is that of Bernard Pallissy, the Potter of France, who when following the profession of land surveyor, was so impressed by the sight of a specimen of glazed pottery that he devoted the best part of a lifetime to learning the secret of making it. He succeeded most marvellously. Read his life if you wish to be doubly impressed with the possibilities of will power, which in his case led one who started into active life without the advantages of early education to practically become the founder of the famous "French Academy," which ranks as the most learned organization in the world.

But why multiply mention when every eminently useful life—living as well as dead—is an illustration of this principle. Colonel Sir Casimir Gzowski, who departed this life from this City during the last year was an eminent example. Sir William Van Horne is another, while the Nova Scotia farmer boy of 1870, who is now President Schurman of Cornell University, and representing the United States in an extraordinary mission at Manilla is in the same line of eminent examples.

THREE EPOCH MAKERS.

It has been my good fortune to be on terms of intimacy with three epoch makers in the world's history. One was Thaddeus Fairbanks who established the first innovation in methods of weighing prevailing for over 5,000 years, by introducing the platform scale as an improvement upon the even balances, solely used before this century.

Another was Peter Cooper who built and operated the first locomotive on the Western hemisphere, and the third, Ezra Cornell, the founder of the famous University, who built the first telegraph line in the world, in connection with Congressional aid to Professor Morse.

I have heard the stories of these men's experiences from their own lips, and in every case their will power was exercised to the utmost before reaching success.

Thus far as to individuality. Now for a few remarks as to your profession and its environments.

THE IDEAL ENGINEER.

The ideal Engineer, the highest type of your profession, stands for stability of character in his work, which must be a reflection of like characteristics in himself. He will be tempted by shifty contractors or capitalists, but he must use the plumb line of integrity, and the square of equity in laying the foundation and rearing the superstructure of a bridge, or in making up the estimates of work done, or to be done.

If he attempts great achievements, he must expect great opposition, especially in innovations of a public nature.

Ezra Cornell spent an entire winter in endeavoring to gain consent in New York City to his erecting a telegraph line through it to Boston, and found opposition so strong that he had to go elsewhere, or starve. He then slept on chairs in his room because he could not spare money enough to pay for a bed. Read the speeches of those who opposed the introduction of railways into England, where you will find that the solicitor for a canal assured a Parliamentary Committee that he would prove that a canal boat could go faster with a load than Stephenson's "smoking machines." No more interesting bit of history can be found than the record of overcoming opposition to the introduction of the locomotive in England or the telegraph in the United States. It was in the former connection that the elder Stephenson, when a witness before a Parliamentary Committee was asked by an opposing lawyer, what would be the effect if his engine should encounter a cow on the track? "Bad for the "coo" was his reply.

THE ENGINEER AND CAPITAL.

Money is to the Engineer what air is to the lungs, and happy is he who has ample capital to back up his undertakings from start to finish.

The success of Watt was hardly more due to his inventive genius than to the financial ability and faith of Boulton his financier and partner.

The fame of Stephenson is shared by the capitalist known as the Quaker Pease, to whom a well-deserved statute was erected in Darlington, England, to commemorate his assistance as the financier of the great Engineer's railway enterprise. Other Engineers for the want of such financial aid have failed to attain possible success, as the speaker can testify.

I knew of a case where an Engineer had plans of vast utility which he needed $50,000 to launch in proper shape. He went to a certain financial magnate to solicit his aid. This individual then had exceeding ten millions in marketable assets of which over one million was cash in bank. He looked the matter over and took advice of third parties who discouraged the idea. He declined. The Engineer saw others occupy the field with capital that he could not obtain in time and clear many millions by the transaction. The next time they met was in a lawyer's office where the magnate referred to was engaged in passing through bankruptcy, his ten millions having disappeared in stock speculations when the withheld $50,000 might have made him famous as well as doubled his fortune.

This kind of disappointment is the rule rather than the exception in Engineering experience, because the number of aspirants to a prize must bear a relative proportion to the losers in the contest for it.

GOVERNMENTS, *in re* ENGINEERING TALENTS.

This is a theme which includes a large part of the progress of modern civilization, because it relates not only to governments directly, but to corporations which are the creations of governments, and can only exercise functions delegated by the latter.

Every country has its own methods of dealing with Engineers and their works, some of which are wise, and some otherwise. I will only select two examples. One is that of the Dominion of Canada with reference to railways, the other that of the State of New York in connection with its canal system.

Canada has more miles of railway per capita than any other people, and to this feature is due the fact that it has more influence in the world at large per capita than any other commonwealth.

It inaugurated at an early day a system of railway aid, municipal, provincial and federal, more liberal per capita than instanced elsewhere. While the same evolved abuses in some minor cases the total result was largely beneficial. The history of its great trans-continental (C. P. R.) railway is one of intense interest.

Commenced as a political necessity by the Government itself, as a composite system of part water-way and part railway, with a view to economy rather than comprehensiveness, it was a predestined commercial failure like the expenditures which from political influences are now being made upon the Trent Canal in Ontario. No administrative integrity or professional ability, could change the results when following out such lines.

Suddenly the Government policy was changed, and through the corporate agency of the Canadian Pacific Railway Company, the executive and engineering ability of Sir William Van Horne and Sir Sanford Fleming and their staffs were brought into full swing, with marvellous results which I need not describe. To secure these the Government acted with great liberality, turning over large sections of railway work it had already done, with twenty-five million acres of land, and as many dollars in money, as bonuses. That it was a master stroke of statesmanship is beyond question, and the statues of the master spirit then Premier at Ottawa, to be seen at the capitals and large cities of so many Provinces, is a proof of final popular approbation.

The money that the Dominion voted was expended in its own territory, the values thereby created are subject to control and taxation under its sovereign powers, and its gain irrespective of larger commercial advantages is positive and permanent.

THE CANALS OF NEW YORK.

The reverse of this policy is illustrated in the history of the Canal system of the State of New York.

This system at one time the most successful in the world, owed its existence to the will power of DeWitt Clinton, who met fierce opposition, but with the support of Peter Cooper, and others, he overcame all obstructions and saw the work completed in 1825 with an ovation, when for want of a telegraph line, intermediate placed cannon boomed the news of its opening from Buffalo to New York

within an hour. He was elected Governor and was holding that office when he died in 1828.

The Canal from the Great Lakes to tide water proved a success beyond all anticipations. Its revenues soon paid back its cost, and in 1868 it was yielding a net income of over two millions annually. Some 15,000 boats were employed in its carrying trade, earning over nine millions of annual freight money, while it was an effective guard against railway combinations to raise freight rates unduly.

But there was one drawback, the use of steam power was not made available upon it, and this was a fundamental defect which impaired its usefulness from the start. Governor Clinton and Peter Cooper jointly endeavoured at an early date to solve the problem of the practical application of steam traction thereon, but without success.

CABLE TRACTION PROPOSED.

In 1868 an Engineer came forward with a new plan for that purpose which Peter Cooper at once said supplied the long-desired want. He signed and circulated a petition to the State Government asking that a speedy trial be made of it.

He said that if it had been shown to Governor Clinton or himself when the Canal was being built, it would have been made an adjunct of the same from the start.

The inventor was an Engineer of experience who offered to demonstrate its utility on a section of the Canal and establish a towage system which would double the boat speed and reduce the cost at least 33 per cent., without compelling any to use it, or interfere with the use of animal power in any respect. This practically doubled the capacity of the canal without costing the State one dollar of additional outlay and benefited the owners of boats in the same ratio by economy in time of transit. The Engineer asked the State to authorize the trial of a ten-mile section of the Canal equipped with the new method at private expense, but providing for an extension of the same for the entire length, if proposed savings were proven to result from its use.

The principle of the new method was cable traction but applied in a novel and peculiar manner upon which hinged entire success. Governor Clinton and Peter Cooper had themselves experimented with the same power but in a different form of application, which

proved so objectionable that they gave up the idea and fell back on horse power. Hence when Mr. Cooper 40 years later endorsed the new method he spoke from experience in that line of engineering.

A SHORT-SIGHTED GOVERNOR.

Had DeWitt Clinton been Governor the new system would have been adopted at once, but one of different mould was Governor (Fenton) in his place, who, although of unimpeachable private character was without mental grasp of large issues, lacking in will power, and quite out of touch with engineering problems. Under these conditions the opposition of the horse-towage combinations and other adverse influences blinded his mental vision from seeing the immense advantages for the State then within reach.

Mr. Cooper could not induce him to come out in favor of the Canal Improvement and the Legislative sessions of '68-9 passed by without action in that direction. The next election brought in the opposing party under the lead of the infamous Tweed, when no public measure stood any chance of State action except with corrupt influences behind it.

The Engineer withdrew his proposal, his improved plans were lost sight of, and the old system was continued. Thirty years have since passed and a review of results can now be made with relative accuracy.

On the new plan 75 stationary engines of suitable power with five men in attendance at a time, or ten each per day would have dispensed with the horses used by 15,000 boats averaging three each, and the same number of extra hands, with the result of 750 doing the work of 45,000 men and 45,000 horses, doubling the transit speed of the boats, at once reducing the cost to the boat owners 33 per cent., and then leaving abundant profit to the State and to private capital doing the towing. Distinguished citizens of the State took special interest in this subject, and one of them occupying the prominent position and life office of Clerk to the Court of Appeals (the highest in the State), published a pamphlet on the subject from which my data as to the number of Canal boats etcetera is obtained, a copy of which I have brought with me. He estimates that the saving to the State would at once amount to $2,666,000 per annum, as you can see on page 26—but events proved that his estimate was far too small.

The facilities on the Canal gradually became so poor that the State abolished its tolls in order to prevent disuse altogether.

The two millions of income was thus wiped out. Then the State resorted to direct taxation to maintain the Canal, the expense of which in the hands of politicians amounted to about two millions annually.

A few years since the statement was made, that prosperity would return to the Canal if it was enlarged at an expense of $9,000,000.

On a vote of the electors being taken, the measure was adopted, and the money spent with the result that the work is not completed, leaving the Canal it is publicly stated in worse condition than before, and $6,000,000 more is asked for. The usual charges of corruption and fraud are being bandied about, and general disgust engendered which it is not supposed that the Railway Corporations dislike to see approaching a crisis where the State may sell or give away the Canal which has so long stood as a bulwark against greedy combinations.

Meanwhile the boat owners have lost most of their capital and largely retired from the business. The alliance which the State might have had with the Steam Towing Company would have enabled it to manage the Canal very profitably and to have maintained its two millions of annual net income to this date. In a recent issue of a New York City paper (Mail & Express), several columns are devoted to a review of the Canal situation. It states that the number of boats is reduced to 2,300, of which only 1,117 are fit to carry grain, the majority of the remainder are old and rotten, few new ones are being built and tonnage has fallen off to such an extent that the outlook is extremely gloomy. The writer says that the system is fifty years behind the times, and hardly improved since the days of DeWitt Clinton. As matters now stand the State, has lost the difference between two millions net income and two millions outgo, or four millions per annum for thirty years, a total loss of 120 millions. Add loss of interest and of private boat equipment, also the $9,000,000 recently expended and the total easily foots up to $150,000,000 as the resulting loss to the State and its citizens from the want of will power in one of its Governors.

ENGINEERING ABILITY AS AN ELEMENT OF GOVERNMENTAL SUCCESS.

We are now in a position to draw a comparison between the management of affairs in the State of New York and the Dominion of Canada on certain engineering problems.

The State thirty years ago had a most valuable property earning four per cent. net on fifty millions. By neglect of Engineering talent when offered, it has lost a money equivalent for the canal or capital and one hundred millions with it.

Within that period the Dominion found itself with an uncompleted rail and water system on hand, in which it could easily have expended fifty millions and then had only a miserable failure, but invoking engineering talent, offering liberal inducements to private capital to become associated with it in transit affairs, a grand success has been achieved. It has a trans-continental railway system of over 4,000 miles, the stock of which (exceeding $120,000,000) is nearly at par, with four per cent. dividends being paid regularly thereon.

Young men when you pass a statue of Sir John A. Macdonald you can well afford to raise your hats to it, for his will power and appreciation of engineering ability averted a great disaster to Canada and its transit interests, while achieving a grand success in lieu thereof.

The State of New York under a low grade of Executive ability started with a success, and ended with an enormous loss and scandalous failure from opposite Executive management.

ONTARIO'S PROBLEM.

Will Ontario profit by these examples?

Eminent citizens have memorialized her Government on the subject of opening up early access to Hudson's Bay. Will it respond? When such leading minds as Principal Grant of Queen's University, and Principal Parkin of Upper Canada College join with many foremost bankers, merchants and manufacturers of the Province in expressing the opinion that access to the great Northern Sea is the most important subject now before the Government, do they not in effect ask it to invite the Engineering profession to lead the way? Am I not right in assuming that it will respond to the full capacity of the opportunity?

I shall deem it a great honor to be associated with you in professional labors which will beyond doubt inaugurate a new era of prosperity for this Province and greatly benefit the entire Dominion. By taking the initiative in calling attention to the possibilities of easy transit between the waters forming Ontario's northern sea coast and

the great Mackenzie and Yukon Basins I feel assured of being more or less identified with Canadian progress in a field where your profession will achieve some of its highest glories in the twentieth century.

Do not expect that so great an opportunity will open up without opposition. That would be contrary to all precedents in history.

The old game of starting rival routes to befog choice as to the best one, will be sure to come to the front. Sectional jealousies will be appealed to, and if these do not hold back the tide of progress, the bug-bear of increasing Provincial indebtedness will be borne aloft to frighten weak minds to the end that a prompt and liberal policy may be deferred, and the present opportunity lie buried or "laid up in a napkin" because of evil reports.

It is an interesting bit of history that when Governor Clinton had secured the approval of the New York Legislature to his plan of building the Erie Canal, the law which it passed was not effective until approved by a third power, since abolished, styled "The Council of Revision," composed mostly of Court Judges. The majority were opposed to the Canal Act, but when one of them in giving his reasons said that the State should hoard its money, and other resources to be ready for another war with England and invasion of Canada, Chancellor Kent said, "if that is what the money is wanted for I prefer to have it used for building a canal, and change my vote," which carried the measure. By such a narrow margin was opposition to that grand enterprise overcome, and based on objections which now appear as puerile as will some of those which you will hear in favor of letting Northern Ontario remain in a state of nature.

GREAT PRIZES AHEAD.

This Province has in extending transit facilities to Hudson Bay as great a prize in view as Governor Clinton foresaw in building the Erie Canal, only a railway instead of water transit is now called for.

With improved transit to those waters, avenues to remoter regions will soon need opening, and, in those beyond, splendid prizes are awaiting the engineering talent that I may be now addressing, of which I will name but two.

The wonderful Peace River upon which a full-sized Erie Canal boat loaded to six feet draught can pass for nearly 900 miles without artificial improvement, comes through the Rocky Mountains on a level,

but with cliffs a mile high on either side. At the eastern "foot hills" it plunges downwards 1,000 feet within ten miles.

That tremendous water power will be curbed and utilized ere long. Next barges of, say 500 tons burden will be taken by canal or inclined plane around it to and from the upper level. Is the young man now sitting before me who is to engineer these noble undertakings?

Within a short distance of Hudson Bay waters are those of the Gulf of Bothnia, four times as large as Lake Ontario, with abundance of fish life in its depths, but what of value along its shores no one knows. Some one will pioneer its exploration, and no doubt devise a method of utilization if marketable values exist thereabouts. Is the young man before me who will lead the way there?

A hundred other engineering problems of more or less magnitude in the great North and North-West wait upon coming educated "will powers" to search them out, and solve them during the near by century.

With the belief that your chosen profession will maintain its advanced position in the progress of human achievements in the twentieth century as in the nineteenth, and with the hope that those here present may be in the front ranks of its glorious phalanx I bid you *farewell!*

RIES.

foot hills"

ıtilized ere
by canal or
the young
ble under-

hose of the
abundance
res no one
oubt devise
abouts. Is

magnitude
cated "will
he near by

naintain its
ents in the
e that those
alanx I bid

Eastern Gate of Upper Lock of the Original Lake Superior Canal.

Western Gate of Upper Lock and Lock Chamber in continuous use, 1855 to 1889.

These views were taken in 1889 with C. T. Harvey, C. E., standing in the centre of each gate. On the 19th of April, 1855 he opened the coffer dam sluice gates, which permitted the waters of the greatest of lakes to flow into them for the first time. The gates were operated by the beams shown in upper foreground, attached to hand lever power. Each of the two locks were 350 feet long, 70 feet wide and 12 feet deep, with 9 feet lift. They were by far the largest locks in the world. General Poe in a report to the U. S. Government, said. "they were magnificent constructions in their day and would still be useful if the commerce had not entirely outgrown them." In 1875 a supplementary lock 515 feet long, 60 feet wide, 17 feet deep and 17 feet lift was added. In 1889 the work of removing the original locks commenced, and their site is now occupied by the new lock shown upon another page.

19th of April,
o them for the
wer. Each of
t locks in the
IONS IN THEIR
supplementary
original locks

EDITORIAL NOTICES.

The following Editorial Comments are added because they are valuable as explanatory of conditions connected with the address which might not otherwise become known to the reader, but will no doubt add to the interest of this contribution to professional literature.

The "World" published the lecture in full, its reporter being present at its delivery.

The "Mail and Empire" selected portions of the same for print.

A REMARKABLE ADDRESS.

Toronto World, March 19, 1899.

The address to the University Society, which is to be found upon another page, has circumstances connected with it which are quite unique, especially in respect to the speaker on that occasion. His topic, as a review of engineering progress during the century now closing, was cheeringly optimistic, while his estimate of the prospects of further progress during the century so soon to greet the students of the profession, was one to encourage and stimulate them.

Although on the sunny side of "three score and ten," he evidently was nearing that period which is considered as the border line of active life, and no doubt looked venerable to the scores of young men whom he was addressing, and who cheered him to the echo at various climaxes in his statements and illustrations. It is probable that, had they searched the globe for one to represent the achievements of their profession during the last half of the 19th century, they could not have found another better, if as well, qualified, so far as records can determine.

Mr. Harvey's professional career commenced in 1853, when he took charge of the construction of the original "Soo" Canal, then by far the greatest work of its kind ever undertaken. He formally broke ground with the first barrow load of excavation on June 4 of that year, and opened the sluice gates of the coffer dam to the waters of Lake Superior on the 19th of April, 1855, when the work was practically completed. This stands at the head of the engineering achievements in the world's record for water-way construction, both as to time and economy, the time being less than 22½

months, and the cost less than one million of dollars. With all the improvements in labor saving machinery of later years the Dominion Canal on the opposite side of the river recently opened for use, consumed eight years in building and about four millions in cost, although of less than double the capacity of the first one.

Mr. Harvey not only supervised the engineering department, but all others included in the management and care of several thousands of men employed on the work. A vote of thanks engrossed on parchment signed on behalf of the construction corporation by its president, who was then the first president of the New York Central Railroad, and by the Chancellor of the University of New York, as secretary, can be seen at Mr. Harvey's office in Toronto, and was tendered to him before he had passed his 26th year.

In that work intricate engineering problems arose in which plans of the most eminent officers in the United States Army Topographical Corps, as its selected engineers were then styled, were pitted against his, but when tests were applied his methods proved the best, and as the work progressed his engineering opinions were accepted as final without question, with the result as stated.

Mr. Harvey's next work was opening the first overland stage route to Lake Superior, followed shortly after by the first railroad to those shores, of which he was the first projector and engineer, and which proved to be the most profitable line of its mileage in the United States.

In 1865-6 the State of New York, by a special commission, created for the purpose of affording relief for the terrible evils of overcrowding of population in the City of New York, which exceeded in density, that of any other city on the globe, advertised in the chief cities of the civilized world inviting engineers of all nations to send competitive plants for a system of urban transit to suit the wants of the great city and allowing a year's time for so doing.

When the time for inspection came, scores of plans were submitted from many countries, and the engineering profession of the world was engaged on the problem where but one won the prize of a practical solution.

The plan selected had for its author the one making the address The World now prints for the benefit of its readers. It was the first inception of the elevated railroad system, and Mr. Harvey was its first engineer and constructor who won success for it in the face of unreasonable opposition which now seems incredible.

In the same room with the parchment first mentioned, hangs a photograph of Mr. Harvey making the first trial trip as inspecting engineer over the initial structure which has proved the greatest boon New York ever received from any individual service. [For photographic copies of both see opposite page.]

PHOTO-LITHOGRAPH OF ENGROSSED VOTE OF THANKS PRESENTED TO
CHARLES T. HARVEY,
1855.

Referred to on Page 26.

PORTRAITS OF THE
DIRECTORS OF THE CANAL COMPANY,
Surrounding the above Engrossed Vote of Thanks.

PRESIDENT:
HON. ERASTUS CORNING, ALBANY, N.Y.
First President of New York Central Railway Company.

JOHN W. BROOKS, ESQ., BOSTON, MASS.,
President of Michigan Central Railroad Company

HON. JOHN M. FORBES, BOSTON, MASS.,
Of Chicago, Burlington & Quiney Railroad Company

CHARLES T. HARVEY, SAULT STE. MARIE, MICH.
GENERAL AGENT and CHIEF ENGINEER.
(In place of 7th Director, who was absent).

HON. ERASTUS FAIRBANKS, ST. JOHNSBURY, VT.
Governor of State of Vermont.

HON. JOHN V. L. PRUYN,
Chancellor University State of New York, SEC'Y-TREAS.

JOHN F. SEYMOUR, ESQ., UTICA, N.Y.

PHOTO-LITHOGRAPHIC COPY OF PHOTOGRAPHIC VIEW
TAKEN OF THE FIRST STEAM-POWER PASSAGE OVER
THE FIRST ELEVATED URBAN TRANSIT STRUCTURE IN THE WORLD, MADE BY

CHARLES T. HARVEY,

AS ITS CHIEF ENGINEER, IN A HAND CAR PROPELLED
WITH A TRACTION CABLE IN 1868.

This view was taken of the Experimental Section of Elevated Railway erected in Greennich Street, New York City, under a provision of State law that it should be removed at the expense of the constructors, with payment by them of all damages to private property if it did not obtain the official approval of the Governor after it had been exhibited in practical operation. A bond in the penal sum of $500,000 to secure removal and liquidate damages were required as a condition precedent to the experimental illustration. The first name on the bond is that of Charles T. Harvey. The Governor, Hon. Reuben E. Fenton, made a personal visit of inspection and rode over it July 2nd, 1868. He fyled his certificate of approval with the Secretary of State as required by law on the following day. From this beginning the elevated railway system in New York and all other cities originated.

The climax of these two achievements was reached when in 1884-5 the "Soo" Canal, built by the speaker, showed the greatest tonnage transit of any artificial water-way in the world, first exceeding the Suez, at that time, and now showing more than double the annual traffic passing the latter. During the same year the elevated railway system of New York City carried more passengers than any other railroad of whatever length in the world, having then or since exceeded two hundred millions a year and three-fourths of a million in a single day.

Now this same engineer proposes to crown his record by developing the longest system of inland water-ways in the world, for which he finds that Canada offers the opportunity, and he publicly states that if reasonably supported by the Provincial and Federal Governments, he will within five years bring into operation a combined system of railway and water-ways the equal of which will not exist on the globe. He holds the position of chief engineer for 400 miles of the trunk line which crosses the Province of Ontario and for which a provincial charter is being utilized. He is also chief engineer for a corporation chartered by the Dominion Government which is to connect over 10,000 miles of rail and water-ways in North-Western Canada with the St. Lawrence Basin, and the railway system of the continent.

It is in relation to this new departure that in his address Mr. Harvey invited the students of the profession to be ready for great opportunities in their line while the 20th century is yet young, and before his active life may terminate.

The Ontario Government has published a very able report upon the section of the route in this province, made by its special commissioner, W. A. Charlton, M.L.A., and as an annex to it, is attached a map showing the proposed inland water and rail transit to connect with three oceans and designated as the "Harvey route."

We will add that Mr. Harvey was the engineer referred to in his address, the neglect of whose plans has already cost the State of New York over one hundred and fifty millions of dollars, with the end of loss not yet in sight.

CANADA'S ENGINEERING PROGRESS.

Mail and Empire, March 18, 1899.

A few days ago an extremely interesting paper on "The Conjunction of the Nineteenth and Twentieth Centuries from an Engineering Standpoint" was read before the Engineering Society of the School of Practical Science by Mr. Charles T. Harvey, C.E. The high place Mr. Harvey holds in his profession gives his paper a rightful claim to more than passing notice, and, if space permitted, we should gladly reproduce it. Upon his young hearers,

for whose special benefit it was prepared, it must have had an inspiring effect. The lecturer might very well have been pardoned if he had lingered with some fondness on two of the most notable engineering achievements belonging to the period under review—namely, the first Sault Canal and the elevated railway system of New York—for of both these great works he was the constructor. But though the canal immediately became the greatest channel of water traffic in the world, the tonnage passing through it much exceeding that of the Suez Canal, and though the Manhattan railway started in by doing the largest transportation business of its kind in the world. Mr. Harvey modestly refrains from referring to either. It is true he mentions the American Sault canal, but he means the new one. Of Canada's progress in the field of engineering he gives a survey which, though brief, is appreciative enough to make us proud. . . With the splendid national enterprise shown in the building of our water-ways and our great transcontinental railway, Mr. Harvey compares the supineness shown in respect to bringing the northern part of this province, on the shores of Hudson's Bay, into connection with the centres of business.