SCIENCE

VOL. LX OCTOBER 17, 1924 No. 1555

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SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. McKeen Cattell and published every Friday by

THE SCIENCE PRESS

Lancaster, Pa. Garrison, N. Y.

New York City: Grand Central Terminal.

Annual Subscription, $6.00. Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

Entered as second-class matter July 18, 1923, at the Post Office at Lancaster, Pa., under the Act of March 3, 1879.

ONE HUNDRED YEARS OF THE FRANKLIN INSTITUTE[1]

As honorary chairman of the centenary celebration committee of the Franklin Institute, I have been appointed—with no subject assigned—to address you, a circumstance which permits me to deal generally with the past period of one hundred years of the life of the institute. Before doing this, I should like to refer briefly to the significance of such an occasion as this, the bringing together of so much scientific talent and eminence in research as is evidenced in the names of the speakers who are to address the sections, according to the carefully prepared program. The institute is indeed fortunate in having on the list not only many of the most distinguished in our own land, but also exceptional representation from over the seas, the whole forming a body of scientists and engineers such as is seldom if ever brought together on like occasions. The impressive list of representatives of universities and colleges everywhere, the body of leaders in science who are listed as delegates from the learned and professional societies and the numerous company of those from the great industrial organizations together form a gathering of high standing in science, in research and in the technical work which characterizes the age in which we live.

One might wish to be able to add that the age is equally well characterized by the application, in all the activities of life, of at least a semblance of the scientific method of discerning truth from falsity. But there is a strong survival of prejudice, of bigotry and of medieval ignorance in relation to the simple facts of life and existence in this world of ours; a clouding of mind only to be removed by more universal teaching of scientific principles, not alone in physics and chemistry, but in such subjects as biology and its kindred branches, in economics and even in politics and government. The advanced medical investigator still has to deal with the unreasoning prejudice of the anti-vivisectionist, it may be, or vaccinationist, or other anti-what-not, and the usual quackery to be found in the fanciful names for fanciful practice. The naturalist is even at this day threatened, in his conclusions and teaching, by the anti-evolutionist and his kin.

Fortunately, the more fundamental studies of physics, chemistry and the mechanic arts are not so banned or obstructed. The beneficial results are more immediate or direct, and less likely to cast doubt on the

[1] Address at the Centenary Celebration of the Franklin Institute, Philadelphia, on September 17, 1924.

truth of dogma of any kind. Yet we have among us many who have blamed scientific developments for much of the terrible war we have so recently passed through, forgetting that a simple, short bar of that most useful of all metals, steel, can, by the simple act of sharpening one end thereof, be converted into a very dangerous weapon; but without the hand and mental resolve to wield it, how harmless! We will eliminate war, that horrible specter which menaces civilization, when we, through understanding, unite the souls of men in the conquest of nature by science, which holds out limitless possibilities in every direction and when we obliterate greed, dishonor and bitterness—even that of religious differences—from men's minds; and when we substitute for these evils candor and generous regard, with a passion for the real truth of things in our relations in life.

It is through the ideals and work of such organizations as the Franklin Institute that we may look for at least a part of this harmonizing process. Institutions of learning, and learned bodies in general, can legitimately have such ideals as a general object, though perhaps it may be necessary for some of them, a little hide-bound in ancient lore, to moult at least a portion of their long-worn integument and grow a new and more modern covering.

However all this may be, the ever-growing unity of science in all its departments, the interdependence of its advances and the mutual aid which one department can and must give to another, is of great significance for the future.

It has appeared to me that it would be well at this time briefly to review the origin of the institute one hundred years ago and its activities in the century past.

THE FRANKLIN INSTITUTE

In addressing this distinguished gathering on the subject of our Franklin Institute and the services it has rendered to scientific progress and public instruction during the past hundred years, I shall be unable to present more than a mere outline of the activities which it has sponsored; the researches which it has through so many years carried on or assisted; its influence upon education and the outgrowth thereof—its broad fostering of the mechanic and technical arts, including its drawing and architectural schools, its assistance to governmental work; its encouragement to invention and discovery, and to inventors themselves; its free library, of so great value for reference; its notable and successful exhibitions; its long established lecture courses, its valuable committee work; and the many other avenues of effort through which it has demonstrated its inestimable worth, not only to the immediate public in Philadelphia, but to the world at large.

When organized in 1824, chiefly through the effort and interest of Samuel Vaughn Merrick, assisted by Professor Wm. H. Keating, of the University of Pennsylvania, the main object of the institute was to combine the idea of the Mechanics Institute, a type of society of which many examples were then being formed, with that of a learned society, whose membership usually included only those who had been selected because of their possessing superior knowledge in the branches to which the society was devoted.

It was recognized, in those far off days, that there was a great fund of practical information in the possession of the skilled worker or mechanic, which ordinarily was unavailable to students in the arts and sciences; and that, on the other hand, it was desirable that the more advanced knowledge of the sciences should reach those engaged in practice of the arts. Thus, the professor, the layman, the master mechanic and the workman could be brought together to the mutual benefit of all. This idea, in a broad sense, has continued through the hundred years of the history of the institute, aptly named after Franklin, of whom great versatility and deep interest in scientific discovery and in the general knowledge of his time, as well as in the practice of the arts depending thereon, was so characteristic. We may recall that Franklin, the printer, the philosopher, the statesman, was a leading spirit in the founding, here in Philadelphia, of the American Philosophical Society, a learned body, the membership in which extends throughout this country and the world. That society celebrated its hundredth anniversary many years ago.

The charter of the Franklin Institute was granted by the legislature of the State of Pennsylvania, on March 23, 1824, with the title: "An Act to Incorporate the Franklin Institute of the State of Pennsylvania for the Promotion of the Mechanic Arts." Later the means whereby this promotion was to be attained were formally stated to be: First, by the delivery of lectures on the arts and the applications of science to them; second, by the formation of a library of books relating to science and the useful arts, and the opening of a reading room; third, by examinations of all new inventions and discoveries by a committee of learned and honorable men; fourth, by the publication of a journal to contain essays on science and art, specifications of English and American patents, etc.; fifth, by holding exhibitions of American manufacturers and awarding medals to worthy workmen; sixth, by building a hall for the meetings of the institute and the use of the members; seventh, by collecting machines, minerals, materials, etc., used in the mechanic arts; eighth, by the establishment of schools for the teaching of architecture and mechanical drawing, chemistry applied to the

arts and mechanics, and, if possible, of a high school for giving young men a liberal and practical education.

This was indeed an ambitious program, so comprehensive in its scope that little could be thought of as desirable to add to it. It was characteristic of the men to whom, as leaders, the institute owes its existence. It is related of Mr. S. V. Merrick that, as a young man of twenty-one, he found himself "owner of a workshop, without a mechanical education, and with scarcely a mechanical idea." To improve this condition, he applied for membership in a local mechanics institute and was *blackballed,* as lacking the qualifications for membership. He then apparently determined to found an organization after his own ideas.

I will not attempt to detail the steps in the formation of the society, as this is already part of the records and need not be repeated here. Suffice it to say that a well-attended meeting of citizens was called on February 5, 1824, and its proceedings were eminently successful. It was presided over by James Ronaldson, Esq., who was then the leading type founder in the United States, and who continued as president of the new institute until 1841, when Mr. Merrick, so prominent in the inception of the organization, succeeded him and held the office until 1854.

A few other names may be mentioned as among the first promoters of the new society. They are Mathias W. Baldwin, Peter A. Browne, Oram Colton, Thomas Fletcher, Robert E. Griffith, Wm. H. Kneass, David A. Mason, James Rush, George W. Smith, M. T. Wickham and Samuel R. Wood. Many of these men were prominent citizens of Philadelphia in the early years of the nineteenth century. Philadelphia has always been a great industrial center, with industries and arts covering the widest range from the most delicate instruments and machines to giant locomotives and ocean liners, a range so great that it has often been said that the city had industries that could supply every need of its people and most of their luxuries.

The hall of the institute, on Seventh Street, above Chestnut, is now 98 years old, and has been made to serve its purposes through the many years which have elapsed, but only by the most careful adaptation of means to ends. It has long since been outgrown, though its older members, like myself, will always cherish for it a sense of respect, due to the many and valuable activities of which it has been the scene.

It was in that hall that I first listened to science lectures for the public, in which work without at the time suspecting it I was soon to take part. Becoming a member of the institute fifty years ago (in June, 1874, in fact), I was asked to give a course of five lectures on electricity during the season of 1876–7, which I somehow had the courage to undertake, though I was then only twenty-three. I confess that it was quite an undertaking. There was, incidentally, I was told, some shaking of older heads over the choice of one so young for such a serious task. I really think, looking back, that it was these very doubts that steeled me and filled me with a resolve to do my best to win success. With apparatus, much of which was new and most of which was constructed by myself, including a small arc light dynamo —then a rarity—I set out to show that electricities of any name, static, dynamic, voltaic, electro-magnetic, magneto-electric, thermo, animal or what not, were one and the same, not differing essentially in any respect. The text-books of the day really treated of several separate electricities as if they were distinct varieties almost unrelated, except under the general title of electricity. Not to discover any vacant seats at any of the five lectures was to me a great encouragement. For several years thereafter I was on the list of lecturers at the institute, until I became at last engrossed with electric developments and removed from Philadelphia to New England in 1880.

At the last of these lectures in 1877, in reversing a Ruhmkorff coil by sending a Leyden jar discharge through its fine wire secondary, thus making it a primary, the first clue to what afterward became the art of electric welding was obtained. It may have been the first time that such an experiment as reversing a Ruhmkorff was ever tried.

It was the practice from the start of the institute to lay stress on its educational objects, and to this end it established schools for teaching, under the control of its board of managers. Professor Keating, already mentioned, was appointed professor of chemistry; Professor Robert M. Patterson, of natural philosophy and mechanics, and William Strickland, of architecture. There were appointed also committees on instruction, on inventions, on premiums and exhibitions, on the library, on models and minerals, etc.

The committee on science and the arts, which has functioned so effectively for a long period in the past, is the outcome of these early committees, at least in so far as the examination of new inventions and machines, together with recommendations of awards of merit, medals, premiums and the like, are concerned.

The institute had from the start several types of membership, and this condition still exists, but in eligibility for membership, there has been no restriction. The membership has been open to men and women, without discrimination as to race, nationality or religion, all that was needed being good character

and friendly interest in the objects for which the society was organized. Election after proposal has been left to the board of managers, who were, with the other officers, elected by vote of the members in good standing.

It might at first be imagined that such democracy in the membership would not be desirable, and that the objects of the new society would have been better carried out if the membership had been more restricted. The instructional value of the society was, however, so great that its meeting rooms and lecture hall became, as it were, the city's scientific and technical rostrum for the discussion of new advances in those fields to which it had devoted itself. Always leaning toward the technical, it became a great force in the community, the activities of which were so largely given to arts and manufactures. This was and is Philadelphia. Some sixty years ago the secretary was made a salaried officer, charged with duties of a scientific nature combined with literary work. Even at its inception in 1824, the new society took steps to establish a school for the teaching of mechanical and architectural drawing, an experiment so successful from the start that the encouragement received led to the more ambitious project of providing a school in which should be taught "all the useful branches of English literature and the ancient and modern languages." Begun in 1826 the records for 1827 show that over three hundred students were enrolled. And now comes the significant thing. These Franklin Institute schools furnished a model leading to the extension of the public school system in a few years to include such a school, a people's college. In fact, it is said that the Boys' Central High School was itself patterned after the institute schools and that the high school of the institute was thereafter abandoned as unnecessary. The institute retained, however, its drawing school, which has been for many years an important part of its activities.

To me, the facts just presented are of unusual interest, as I was graduated from the Boys' Central High School in 1870, and taught in that school as assistant professor and full professor for ten years subsequently, while at the same time occupying lectureships in the Franklin Institute, serving on its board of managers and committees and taking part in its meetings and exhibitions.

It is proper to recall at this time that, although the institute was organized to devote special attention to the mechanic arts, it has at various times and in effectual ways assisted the efforts made to elevate standards of taste in the cultivation of the fine arts as applied to the industries. The School of Design for Women, founded by the institute in 1850, was conducted by its committee for several years, until it became self-supporting.

The institute also extended its friendly cooperation and shelter during infancy to the "Pennsylvania Museum and School of Industrial Art."

Mr. Frederick Fraley, well known to older Philadelphians, as one who filled with great honor many positions demanding talent and integrity, and to whose unselfish devotion as treasurer the success in considerable part of the Centennial Exhibition of 1876 was due, has recorded much of the early history of the institute.

> The general interest created by the existence and working of the institute caused more attention to be paid to technology and to science generally, and in the year 1837 [a panic year, by the way] gave rise to a movement for the establishment of a School of Arts. The institute headed this movement and applied to the Councils of the City for a grant of a large plot of ground in West Philadelphia as a site for the buildings of the proposed school. This was promptly and cheerfully granted and the legislature was appealed to by memorials from all parts of the state to endow the school by a liberal appropriation.

This project, we are told, failed of success, but was subsequently realized in the plans of the University of Pennsylvania.

That there was need of cultivation in design and in art work generally in the country was patent enough. I think this was particularly true in machine design. It was the period when steam engines, lathes, planers and the like were built on architectural designs, including moulded cornices, fluted pillars and such like ornamentation. Locomotives were painted in all the bright colors, scarlet, chrome yellow, grass-green, etc., as agricultural machinery was later and some of it is to-day.

Besides its educational influence and activities, a most important undertaking of the institute was the establishment of its library, which in time became of a distinctive character in our country as a scientific reference library, exceptional in its accessibility and completeness. It contains to-day a great collection of the publications of principal scientific and technical bodies here and abroad, as well as the leading periodicals dealing with science and the useful arts. It also became in 1887 a public depository for the congressional district in which it is located. In this way, it was the custodian of valuable pamphlets and books which rendered much assistance later in the completion of sets of the publications of the various scientific and technical bureaus of the government.

As a patent reference library, including United States and foreign patents, the institute library has been most valuable to inventors and to others desirous of finding readily the status of ideas or inventions or to those wishing to obtain a review of an art with the

object of its improvement. So valuable a library as that of the institute badly needs space for its growth, overcrowded as it long has been. Ample protection from fire is indeed a necessity, long ago recognized as most desirable.

As a member of the institute I was fifty years ago a frequent visitor to this library, which was of great value in my early studies in the sciences and their applications. Its very atmosphere and the method of its conduct were alike stimuli to one in search of knowledge. This was many years ago, but I have no reason to believe that any of this has changed in the lapse of time during which its collections have been much enriched.

I can not leave this subject of the library without expressing the hope that it may soon be securely housed in the new institute buildings long contemplated, and that ample measures may then be taken to facilitate the use of so valuable a collection of the literature of science and technology.

Not in small measure, indeed, has the institute itself contributed to this fund of the literature of science. It has, in the publication of the *Journal of the Franklin Institute,* extended its usefulness far beyond the confines of the city and state which is its home. Appearing originally in 1826, under the title, *The Franklin Journal and Mechanics Magazine,* it was published under the patronage of the institute, and its editor was Dr. Thomas P. Jones, professor of mechanics in the institute. With the January issue of 1828, however, it was renamed *The Journal of the Franklin Institute,* which name has been retained.

In this journal it was originally intended to publish a list of patented inventions with remarks on their utility and originality. In fact, this idea was definitely carried out and remained an especially prominent feature of the journal up to the close of 1859, though the remarks on utility and originality were discontinued in 1848 when Dr. Jones, who had continued as editor from the start, died. He had in the meantime been made superintendent of the U. S. Patent Office, which fact doubtless led him to call attention to the records of patents by making them a part of the text of the journal itself.

It happens that in the publications of the Government Patent Office, prior to 1843, there was no printed account of the claims of the patents as issued, and these were listed only in the institute journal, which for the period 1826 to 1859 gave the claims as well as abstracts of the specifications of the patents issued by the United States. Thus, the journal became and remained the only source available at any time for a record of the claims of patents issued between 1828 and 1842, inclusive.

This circumstance throws a curious sidelight on the comparative crudity and incompleteness of the patent system in the United States even eighty years ago, and within the early years of the formation of the institute. It is probable that we have now in the United States a patent system which has no superior anywhere. To its liberal patent system, with its encouragement of invention, we may perhaps trace in major part the reputation for inventiveness acquired by our people. To such a system, facility in determining what is new and what is old is second cousin. The library of the Franklin Institute, replete as always with patent publications, has provided just such facility. It has also provided for the earnest student access to scientific and technical journals and other publications, in a measure not easy to overestimate.

All this valuable work has been done with a relatively small endowment and with a similarly limited library force. It is a free public reference library, containing an exceptional collection of books, pamphlets, journals, maps, charts, photographs, etc., bearing on science and its applications.

I think that it can be said truly that the journal of the institute has steadily improved with the flight of years, so that the papers published therein, largely based on the lectures and discourses at the institute itself, have reflected the general advance in science in its latest and most recondite aspects. It has achieved a most enviable reputation, both here and abroad, for the standing and general excellence of the material which appears in its pages.

This necessarily brief account of the objects and services of the Franklin Institute would be very imperfect if some allusion were not made to its function of investigation, examination and award accomplished through its committees during the century of its life.

Early in its history, a special committee of the institute made a careful investigation of water-wheel efficiency, examining the various types then known, and the results appeared in the journal. This was followed by a committee investigation of the cause of steam boiler explosions, not very uncommon in those early days. In this investigation, the committee secured the cooperation of the government, with an appropriation therefrom to defray the cost of the experiments, without, however, allowing any compensation to the members conducting them. It was volunteer work through many months and resulted in great public benefit. Allied to these boiler tests was an examination of the strength of materials used in construction, the results of which were also published fully in the journal.

A notable page in the history of the institute's activity and service is the interest elicited in the study of meteorology by lectures and essays of Professor Jas. P. Espy, leading to the appropriation by the

state of $4,000 in 1843 for the acquisition of instruments and the establishment of observing stations throughout the state of Pennsylvania. The committee on meteorology of the institute, in conjunction with a like committee of the American Philosophical Society, conducted the observations for the study of weather conditions and storms.

This early meteorological work gave rise to a theory of storms which foreshadowed in large measure the views subsequently adopted. It was a work carried on before the days of telegraphy, and was later followed by the establishment of weather bureaus in this and other countries. There is no need to speak of their value in agriculture and in commercial enterprises. In 1887, following the lead of the Franklin Institute, there was begun the Pennsylvania State Weather Service, which has been so successful in more recent years.

To mechanical engineers and machine manufacturers, the results of the work of the special committee for studying the shapes and proportions of screw threads are well known. As far back as 1865, its report was adopted by the institute. It proposed for adoption a simplified system of screw threads which shortly thereafter was adopted by the government and called "The United States or Franklin Institute Standard Thread." This system was adopted throughout the country. The records show that the same system, modified only in dimensions to suit the metric system, was reported favorably by the Associated Engineering Societies of Germany in 1887.

In 1875, an expert body nominated by the institute cooperated with the Philadelphia Water Department in considering the then present and the future water supply of the city, making an elaborate report, published in abstract in the journal at that time.

Reference should also be made to the investigation of the 1877–78 committee on dynamo electric machines, then rare; machines used in operating single arc lights. It was probably the earliest inquiry of the kind, and served to bring out much important data, as well as to reveal certain facts, before unknown, concerning the electric arc itself, and the relation of internal and external resistance of the circuits, voltage, etc., to efficiency in the utilization of driving power.

It was demonstrated for the first time that the greater the external or work resistance was, in relation to the internal resistance, of a dynamo, the higher was the efficiency, other things being equal. I had some years before this been constructing small dynamos and studying them. They were indeed rare machines in those days. Serving as I did on the committee as one of those in charge of electrical determinations, the work was to me most inspiring and valuable as a foundation for my future efforts in the field. The work of the committee preceded the appearance of the carbon filament lamp of Edison by nearly two years. The report of the committee is to be found in the May and June numbers of the journal of 1878.

About six years afterward, at the time of the institute's international electrical exhibition in the fall of 1884, the first electrical exhibition held in America, this earlier work in the electrical field was supplemented by more elaborate reports of similar scope, but the great growth of the electric lighting industry, which had taken place in the intervening years, furnished an abundance of material which only emphasized the paucity of that to which the early work was restricted. A notable feature of the work at the exhibition of 1884 was the report on the "Life, duration and efficiency of incandescent lamps."

The institute published in its journal of December, 1881, a report on "The conditions of safety in electric lighting." It is probably true that it was a first exposition of a number of conditions to be followed in the wiring of buildings and in the installation of circuits, afterward incorporated in underwriters' rules.

In the foregoing brief outlines of the long past work of some of its committees, an account which could, if there were need, be greatly extended, no mention has been made of the practically perpetual committee on science and the arts. Continued in one or another form from the very start of the institute, this committee has, up to the present, been an important factor in carrying out the original objects of the founders in 1824. At first it was a standing committee of five members, called a Board of Examiners, the duty of which was to examine and report on new and useful machines, inventions and discoveries which were submitted to them. Later the name was changed to the "Committee on Inventions." Continuing in this form and enlisting the voluntary services of members notable for their attainments in mechanics until 1834, it was then replaced by the "Committee on Science and the Arts," and at the same time its scope was enlarged. The records disclose a rather ambitious set of functions, continued for more than fifty years, the journal being much enriched by the labors of the body. This committee had been, prior to 1886, a voluntary association of members, but was reformed in that year on the elective basis, consisting of forty-five members, fifteen being elected each year. The condition of their choice was that they "shall pledge themselves to perform such duties as may devolve upon them, and to sustain by their labors the scientific character of the institute."

An important duty of the committee, calling for care and discretion, is in the awards of medals, certificates of merit and diplomas. The Elliot Cresson gold medal, named after its founder, is awarded as a

mark of recognition for inventions and discoveries of unusual or permanent value. The committee is empowered to award the "Medal of Merit" (made possible by the bequest of Edward Longstreth, at one time vice-president of the institute), also the "Certificate of Merit" and the "Diploma," according to its judgment. The "John Scott Legacy Medal and Premium" is awarded by the city of Philadelphia on the recommendation of the Committee on Science and the Arts, the action of the committee having been followed in making this award by the Board of City Trusts. It was established by John Scott, of Edinburgh, Scotland, as a recompense to ingenious men and women who make useful inventions.

This medal is not now awarded as formerly on the recommendation of the committee. Ten years ago there was established the Franklin Medal by Samuel Insull, president of the Commonwealth Edison Company, of Chicago, and the award of this medal is now esteemed the highest honor which the institute has in its power to bestow. The first Franklin Medal was awarded to Thomas A. Edison in 1915—and a later award has been made to Heike Kamerlingh Onnes, the great leader in low temperature research.

The fact that throughout a century such work has been carried on by this committee with so satisfactory results and with unwavering honesty of purpose is in itself a testimonial to the fidelity with which it has performed the tasks set for it, while the services of its members have at all times been rendered without compensation. It is most unlikely that such a record can be matched anywhere. All the members of the committee have been chosen by the institute as far as possible because of expert ability in professions or trades, eminent in their attainments and reputation. This prestige has been of the greatest value to the standing of the institute at large before the public.

In the early conception of the organization of our institute, the holding of exhibitions for showing to the public the products of industries and the advance in the mechanic arts and in technical science was made an important aim. It was thought that thereby encouragement might be given, and healthy rivalry among the exhibitors stimulated, which would result in lasting benefit to them and to the public. This was at a period when American manufacturers were in their infancy and needed encouragement to enable them to compete effectually with foreign productions. The early exhibitions appear to have been successful, and the records of them disclose interesting facts concerning the inception and growth of manufacturing in the United States. Premiums were awarded for meritorious accomplishment. To this end and to gain the confidence of the exhibitors, skilled examiners or judges were chosen for weighing the merits of the exhibits themselves. There can be no question that the conduct of these exhibitions served to increase the influence of the institute very greatly, and to inspire confidence in the public mind, as well as to stimulate a sense of loyalty and pride in the members.

These exhibitions were held either yearly or biennially up to the year 1858, and in various places available at the time. Naturally the reports and awards of premiums and medals were much prized by the recipients, while the exhibitions themselves served to nurture and encourage young and growing industries and to improve those already firmly established. In the records of the exhibitions the historian finds a rich mine of information in the accumulation of data thus brought together concerning the origin and progress of the industrial arts.

The two most notable exhibitions held by the institute were those of 1874 and 1884, the former commemorating the fiftieth anniversary of the founding of the society, and that of 1884 being distinctive in that it was the first international electrical exhibition held in America. It may be said to have commemorated the establishment of the early electric industries soon after to become of the greatest importance, not only to progress in the arts themselves, but in the development of our social system. As I have pointed out before, the great structures such as the tall and multifariously cellular buildings called skyscrapers, characteristic particularly of New York City, could not exist without three electric agencies: the electric light (gas would have made furnaces of them), the telephone, the absence of which would have been fatal in itself, and the electric elevator, a high speed vertical railway for quick passenger traffic between floors from top to street and even below street level.

I remember well the 1874 exhibition, held in the Old Pennsylvania Railroad Station at 13th and Market Streets, where the Wanamaker stores, well known to every Philadelphian, were erected soon after. It was in every sense a well-planned industrial exhibition, worthy of the institute, and served much to increase the prestige of the society. I had myself been elected to membership in June of 1874, and my first duty as a member was to serve on a committee of judges of exhibits in the field of scientific apparatus, chiefly optical and electrical. It was my first experience of the kind, and being but twenty-one years old at the time, the sense of responsibility engendered is a lasting remembrance.

It was at this exhibition that the Tilghman sand blast process, which in later years became of signal importance in several arts, was shown as a novel development. I can not remember that a single dynamo generator of electricity formed part of this exhibition, excellent as the showing was in many

departments of manufacture, machinery and the inventions of the time. Yet, in less than ten years from 1874, there had come into existence systems of arc and incandescent electric lighting, destined to revolutionize the whole art of illumination.

At the Centennial Exhibition of 1876, there were, as I remember, only two types of dynamos displayed, the Gramme and Wallace-Farmer, the latter of which soon disappeared after the Franklin Institute Committee's tests of 1877–8 had shown its very low efficiency as compared with the Gramme dynamo, and after the causes of that inefficiency had been pointed out by the committee. In less than two years, or in 1879, there appeared the series arc lighting systems of Brush, of Cleveland, the Thomson-Houston series system, with its automatic regulation, in Philadelphia, the Weston system in Newark, N. J., and others, and these several systems were in use that year in a number of places for the lighting of spaces to which the arc lamp was best adapted. The principles of dynamo construction and operation began to be fairly well understood by those who were connected with their design.

At the very close of 1879, Edison announced the incandescent lamp with its carbon filament, sealed bulb and high vacuum, and made the first showing of a few such lamps at Menlo Park, N. J. Central stations for arc lamp distribution in cities were beginning to be established, and a year or two later, the Pearl Street Station, the first for the distribution of incandescents on the Edison plan, was established in New York. This was followed a year later by the improvement known as three wire distribution, which was first installed in a lighting station in the city of Brockton, Mass., in 1883. This brings us close to the important institute exhibition, entirely electrical in character and international in scope, which was opened in the fall of 1884. This exhibition was not only an excellent display of the latest developments in the larger electrical applications, but it served to bring together the scientific men here and abroad in a notable congress, their meetings and discussions adding greatly to the knowledge of the principles of the new industry. My own first meeting with Sir William Thomson, afterward Lord Kelvin, the centenary of whose birth was celebrated in London in July last, occurred at these meetings in 1884. Along with Sir William Thomson were scientific men of international reputation such as Lord Rayleigh, Professor Silvanus P. Thompson, Wm. H. Preece, Professor Geo. Forbes, Professor W. A. Ayrton, and others. Professor Forbes I had the pleasure of meeting in London lately, and he is the only survivor of these named. Of our own country, there may be mentioned such names as Professor Henry A. Rowland, Professor Geo. F. Barker, Simon Newcomb, Professor C. F. Brackett, of Princeton, Professor F. Willard Gibbs, Professor John Trowbridge, Professor Charles A. Young, and others of high standing in science at that time. None of these now survive.

The several international electrical congresses, which have generally been held in connection with the larger international exhibitions, have had for their principal end the establishment of uniform definitions, designations and values for the fundamental units, such as the ohm, the volt, the ampere, the henry, etc., and it is owing to these bodies that not only the names, but the values and methods of determining such values have become uniform throughout the world. At the International Electrical Exhibition of 1884, there was organized an Electrical Congress, the first of its kind in America, followed later by the important gathering of international delegates at the World's Fair in Chicago, in 1893, and still later by the Chamber of Official Delegates at St. Louis, in 1904. Following this international gathering, there was established the International Electrotechnical Commission, the work of which has continued uninterruptedly to the present time.

The educational value of the exhibitions has unquestionably been very great, yet such has been the advance in technology since the beginning of the present century and before, that an exhibition, even restricted in its scope, would at once become too vast and beyond the power of such a body as the institute properly to finance and organize. Hence, exhibitions of the character of those of 1874 and 1884, to be at all adequate in representation, must necessarily, it seems, be held in the future, if at all, under the auspices of governments which also furnish the financial support as in constructing suitable buildings, in installing exhibits and in providing for the many activities which are necessarily involved. The British Empire Exhibition, held in London this year, is an example of the type which must survive in the future.

These facts can not, however, dim the fame of the institute resulting from the successful conduct of the exhibitions which have characterized its past. Abundantly useful as the institute has been in the past century in furthering scientific knowledge, particularly as applied to the arts, and numerous as have been the instances of brilliant work accomplished, can we doubt that, under proper guidance and with the firm policies which have become characteristic of it, the future holds equal promise of accomplishment? It is for the public to realize the true value of the possible services it can render and accord to it proper support. Endowments such as the Bartol Research Foundation are needed, and will be more needed in

the future than in the past. The ramifications of applied science naturally increase, and the delicacy and cost of research grows, the deeper we penetrate nature's secrets. There must be an increasing corps of workers, with the increasing extent and variety of the problems presented for solution. It is to be hoped that the institute may receive generous support in the coming years, and that its usefulness in carrying out the original objects for which it was founded may not be restricted by inadequate means of provision. Those among us who are of the older generation can hardly hope to see much of its future growth, but the heritage which the younger generation has received from the past should be the stimulus to continue and increase the good work which so far has characterized the work of the institute in its various forms. While the associations which have grown up around the old hall on Seventh Street stir many emotions in many of the older members, yet it is to be assumed that not many more years will elapse before the proposed new hall and library on the new site may become a reality.

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QUETELET'S SCIENTIFIC WORK

FIFTY years have passed since the death of one of the most remarkable men to whom Belgium has given birth, Quetelet. It is very much to be regretted that this important anniversary should have been forgotten officially. Yet we have here a fine and universally appreciated scientific reputation. Besides, it would have been an opportunity to recall the example of a life entirely devoted to science and animated by a glowing and strengthening enthusiasm.

At seventeen Quetelet took up teaching at a private college of Audenarde, a small town in Flanders. Six years after that, he took the degree of doctor of science at the University of Ghent, with a remarkable dissertation in the field of geometry. The following year he was received as a member of the Royal Academy. From 1823 on, he suggested that the secretary of public instruction should create an observatory in the southern provinces, Belgium forming at that time part of the Netherlands. This happy project was realized a few years later after much patience, perseverance and energetic effort. Quetelet, having been appointed head of the new institution, organized completely its scientific function. The attention and the appreciation of the learned world had been especially attracted to him by his statistical work. His first paper on demography: "Sur les lois des naissances et de la mortalité â Bruxelles" ("On the laws of birth and mortality in Brussels") was published in 1825. Ten years later his fundamental work: "Essai de physique sociale (sur l'homme et le développement de ses facultés)" ("Essay on social physics, concerning man and the development of his faculties") saw the light in Paris. It is a synthesis of Quetelet's statistical works. In that book, the author studies the average man, in his physical and moral aspects. This audacious theory was taken up again and completed in another work: "Du système social et des lois qui le régissent," ("Of the social system and the laws that govern it," 1848). In 1841, Quetelet was called to direct the activities of the Central Commission for statistics, of which body he soon made a highly famous institution. The last years of his life were devoted to an active and fruitful participation in the work of the international meetings for statistics, and to several works of a general character, namely to the preparation of a second edition of his "Social Physics" (1869). He died on the 17th of February, 1874.

Without being transcendental, Quetelet's mathematical work is interesting and original. His researches concerning the theory of caustics have opened the way for important work. Thanks to him the first Belgian periodical devoted to exact science was created, *La correspondance mathématique et physique* (1825). Finally, he is the author of a documentary work that is worthy of notice: "Histoire des sciences physiques et mathématiques chez les Belges" ("History of Physical and Mathematical Science in Belgium," 1864). Quetelet's activities in the field of astronomy have consisted in a particularly rich work along various lines, such as descriptive astronomy, magnetism, meteorology and terrestrial physics. It is necessary to mention especially his great work on the climate of Belgium. But his universal reputation rests, without doubt, on his statistical work. His name is closely linked to the history and the development of the science of statistics. His numerous papers on demography and his remarkable analytical and synthetical studies of statistics are important in many respects.

Quetelet was a master of statistical method. He also was its apostle. The work he accomplished in statistics is extensive and fundamental. Therein lies his real scientific merit. In a general way Quetelet's statistical doctrine can be thus characterized: to a monographical description of facts, to a systematical census of elements, he substitutes a scientific observation of the masses, a methodical survey of the groups, founded on the principles of the theory of probabilities. Thence one easily admits the fundamental idea that rules all Quetelet's statistical investigations: the statistical method is the application of the calculus of probabilities to the observation of facts. Sixty years ago this was an audacious and original doctrine. It