THE NEW EPOCH AND THE UNIVERSITY

ORATION

DELIVERED BEFORE THE PHI BETA KAPPA SOCIETY
IN SANDERS THEATRE, CAMBRIDGE

Thursday, June 25, 1896

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Reprinted from the Harvard Graduates' Magazine, September, 1896

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A YEAR ago, on a very different occasion, I spoke of a subject which had impressed me deeply, and traced the effect which developments, amounting to the opening of a new epoch in civilization, are having on the profession to which I belong. I felt that my task was incomplete, and that the influence of these developments on education was equally important. An opportunity is now offered to consider this influence. Beginning with a review of the conditions which have so impressed me, as the only way by which I can emphasize the importance of the events through which we are now passing, I would give you an engineer's idea of the duties of a university in this new epoch.

The early development of the human race has been divided into ethnical periods, representing successive conditions of savagery and barbarism, which culminated in civilization. Students of this subject recognize three periods of savagery, followed by three periods of barbarism. With the use of fire man passed from his lowest condition into the second period and acquired a power the uses of which are not yet fully developed. With the invention of the primitive form of projectile, the bow and arrow, he entered the third period. With pottery, and the accessories which went with it, he passed from savagery to barbarism. By the domestication of animals he added the strength of the brute creation to that of his own body. With the manufacture of iron the last of the barbarous periods was entered. Finally, written language

made the work of one generation available for its successors and produced civilization; the subsequent developments of civilization make written history.

In every instance these changes are characterized by some distinct physical device by which man could either use his own strength better than before, or added another force to his own power. Man's capacity is measured by the power which it can control; this power has not only determined the ability of one tribe or nation to rule another, but it has given the opportunities for the intellectual improvement which is often confounded with the power which has made that improvement possible. The single event which makes possible the change from period to period can never come entirely alone; it is supported by a multitude of attendants, which collectively may be more important than the leader they surround.

And now, within a period so recent that we are practically in the midst of it, man has acquired a new capacity, which marks as distinct an epoch in civilization as the earlier achievements made in the savage and barbarous life of primitive society. Fire, animal strength, iron, and written language have in turn done their work, but the capacity of man has always been limited by his own strength and that of the animals he could control. His capacity is no longer so limited; he has learned to *manufacture power*, and with the manufacture of power a new epoch began. These words are chosen carefully; manufacture is not creation; the change of inert matter from one form to another, in such way that power is generated, is the manufacture of power.

The manufacture of power not only marks a new epoch in development, but it means greater changes than any which have preceded it; the others marked distinctions between successive stages of savagery and barbarism; this marks an advance in civilization as much greater than any of its predecessors as civilization is greater than barbarism.

The manufacture of power means practically unlimited power; whatever the measure of a single tool, that tool can be used to make a greater one. We are no longer limited by animal units, by locations of water-powers, nor by the force of wind and tide; power can be had where it is needed and when it is needed. The power generated in a modern steamship in a single voyage

across the Atlantic is more than enough to raise from the Nile and set in place every stone of the great Egyptian pyramid.

The substitution of inanimate manufactured power for the animal power on which our race was formerly dependent means a separation of the force which does the work from the intellect which directs it. The power which we make and use is absolutely without sense; all this must come from the human mind. The man who drives a horse has little to do, the horse finds the way and does the work; but the driver of a motor carriage has a senseless machine, and all direction must come from him. Manufactured power demands intelligence to supply the sense which the power lacks. The extreme logical development would be a condition where every kind of physical work is performed by machines, while human effort is reduced to design and care. Such a result will never be reached; so long as men have bodies, the forces placed in those bodies must be used, but the substitution of manufactured power for human labor is a promotion for man whose value becomes measured by skill in directing power and not by muscular strength.

Hitherto different races have existed simultaneously in every period of development, but the new epoch must from its very nature become universal. The manufacture of power has given the means of traversing the entire globe with a speed which brings all races together. It will gradually substitute the natural boundaries of convenient government for accidental tribal divisions. It will finally make the human race a single whole working for ends which we cannot yet understand.

The manufacture of power has barely begun. The steam-engine is almost the sole representative; the great advances in electricity have been in conveying power already manufactured, though transmutation and conveyance of power are closely allied to its manufacture. New forms of manufactured power may come at any time, but the great change came with the capacity to manufacture power at all; the method is a secondary thing. The manufacture of power has made the physical development of the nineteenth century exceed that of the whole previous life of the world. When future generations record the history of our times, they may select the date when man began to manufacture power as the division between the ancient and the modern, between the

ages of ignorance and of intelligence, between the early barbarous periods and the new civilization which has not yet received a name.

It is easy to understand that, when the new epoch is fully developed, all physical work may be dependent on inanimate power. It is easy to see that this means the concentration of enormous masses of power where power never could be had before; that it means the subdivision of power into units of a minuteness hard to conceive; that it means the unraveling of mysteries which have never been solved; that it means the construction of works of a magnitude before which the greatest monuments of antiquity become insignificant. The fighting ship of to-day is a floating machine-shop, though its crew of mechanics are confined as completely as the chained rowers of a Roman galley. The battles of the future will not be fought by men or by horses; the camels of Persia will never again confront the elephants of India; fortifications will be factories filled with power. It is easy to recognize that the discoveries already made may be slight in comparison with those which are to come. All this is a matter of physical possibility; it is interesting to speculate upon; it is foolish to prophesy about: these achievements are too close at hand for us to waste time in guessing what they will be.

Great changes impose new duties on the institutions which are charged with the intellectual development of the community. No changes have ever equaled those through which the world is passing now. No institution has greater responsibilities at this time of change than those which rest on a university. The manufacture of power has an intellectual as well as a physical effect; it has separated power from the mind which must manage it; it calls for intelligent design and direction of the multitude of works which it has rendered possible; it has equipped our generation with tools for study and investigation as well as for mechanical work.

A university is more than a school; it is not merely a college; still less should it be an eleemosynary institution for the benefit of young men to whom it can give an education. A university owes its duty to the community as a whole, not to individuals who live in that community. The endowment which a university may receive, whether it come from public appropriation or from private

gift, must come to it as to a public benefactor endowed and sustained in order that the whole community may have the benefit of its intellectual guidance; it must not train young men because those young men wish to be scholars, but because trained scholars are necessary for the good of the community. The individual must be sunk in the nation or state of which he is a part; the young men whom the university educates should know that they are educated to be useful members of a community, and not for their own ends. The real duties of a university are universal; it is the head of the educational system of the land, charged with the high responsibilities which this position implies; it must be the depository of the lore which former generations have accumulated, and the pilot of the community in every kind of intellectual life; it must preserve the records of the past, and it must train the men who are to make the records of the future; it must combine the work of a museum with that of a school.

A collection of physical objects, though those objects be most rare and curious, does not make a museum. A collection classified and arranged in the most systematic manner that has ever been devised would still be incomplete. It must be a collection of the records of the past, including that which can be stored only in the mind. A classified museum, though it include a library containing every book that has ever been written, would be of no value without the minds to use it; the museum which forms so important a part of a university must include among its collections a collection of educated men.

The school which is to train the men who are to make the records of the future must build its special courses on the foundation of an education which teaches how to use the mind; this is the real measure of a liberal education; without this, the men it educates will be of little value in the community.

The new epoch which the manufacture of power is bringing forth makes new demands upon a university; new demands upon it as a museum in the large sense which has been stated; new demands upon it as a school to train the young men whom the community needs, and who will make the records of the new epoch.

The new epoch has an inheritance from older times; it increases the work of a university in its capacity of museum. In the mere

collection and preservation of records, the work is greater in a period of change than at any other time. Generally, in passing from one ethnical period to another, the records of the past have been lost. The students of the earliest life of man have to grope among prehistoric remains, deciphering marks which seem almost as inanimate as geological strata, and tracing their uncertain way by analogies drawn from races living to-day. The new epoch must destroy as well as build; the new civilization will wipe out the conditions which precede it. The savage and barbarous tribes which now live simultaneously in different parts of the world must disappear; if their habits, customs, and mental conditions are to be recorded, the work must be done soon; in one or two centuries it will be too late. The structures which represent the achievements of many generations cannot be preserved; a few may be kept as beautiful relics, specimens in a universal museum; but the manufacture of power has made the demands of the new epoch so different from those of the old that nearly everything which has to be used must be built anew. The old and the new cannot exist together. It is hard to realize how rapidly the appearance of the whole earth may change; greater care of life is a feature of the new epoch; an increase of population at the rate of one per cent. annually, which is less than that in European Russia, would cover the entire land surface of the globe, including deserts, mountains and snow-capped plains, with a population as dense as that of Belgium, in about three centuries. In the change through which we are now passing, a change which will leave no isolated tribes for the future, it is one of the duties of the university to see that the museums of the future are stored with the full history of the past.

The new epoch is characterized by great material changes; in such a time there is danger that natural science and physical study will overpower all other thought; the treasures of philosophy, of music in the broad Greek meaning, and of religion in the noblest sense, must be a special charge of the university.

Around the museum, of which they will form a part, must be gathered the men who will collect, study and care for what it contains. The university must train and educate these men to be the curators and scholars who will see that record precedes destruction; who will take care that, when physical existence ends, the facts

which scholars need are preserved, and who will themselves be the scholars who are to use these records. The education of these men must include the intelligent study of the delicate accomplishments and refinements of the past; the new epoch may not have the grace and taste which have marked some inferior conditions; in the creation of beauty, Europe and America are to-day far below the nations which dwelt around the Mediterranean two thousand years ago, or the older races which still inhabit Asia. The study of history belongs to this department. The training for those professions which are based on history and precedent will find a place here. But few of the young men so educated will remain to form the body of educated men which is an essential part of the university museum; the majority will seek other lives and callings. The general body of educated men, as education was once understood, the men who are students rather than workers, readers rather than originators, who are guided by what others have done rather than by what they themselves would do, will be educated in this museum.

This work is much like what the university has always been doing. In this department the effect of the new epoch is to develop rather than to change; it makes the old work greater and more important than before: greater because there will be more workers, more to do and more tools to work with; more important because much which cannot be done soon may be lost forever, and because the life of a community busied with material development needs a double leaven from the educated past.

But the community has needs for the future as well as for the past. The records of the past must be preserved and studied by that body of educated men who make the society of a university town the most refined and intelligent that is anywhere found, and who give to the precincts of a university a peculiar attraction which exists in no other place. The records of the future must be made by men of different types and different habits, who are educated to fit them for active work, who will exchange the pleasures and quiet of the university for the roar of the rolling-mill, the buzz of the machine-shop, the obscurity of the mine, the bustle of the railroad, and the harsh surroundings of many other duties. These men must be prepared to sacrifice the pleasures of educa-

tion as such, and the delights of study for mental development, and spend their lives where their work calls them.

Seventy years ago Civil Engineering was defined as the art of directing the Great Sources of Power in Nature for the use and convenience of man.[1] This definition was embodied in the charter of the institution which has done more than any other to unite the profession and to give it the standing it is now attaining; it was made in the very infancy of the new epoch, within sixty years of the time when Watt developed his first steam-engine. Had the profession remained unnamed till the end of the century, it is possible that its various departments might have been classed separately, and that what is now called by a single name would have been divided into several professions. The definition was followed by a list of objects and applications; but it was expressly stated that its real extent was limited only by the progress of science, and that its scope and utility would be increased with every discovery and its resources with every invention, since its bounds were unlimited, as must also be the researches of its professors. This definition is broad enough to embrace every department of education or work which undertakes the study, development, and use of all those physical powers through which the new epoch is now subjecting all varieties of matter to the dominion of mind. A university may accept the same definition as measuring the duties of the new education which is to train young men for active work in the new epoch; this education must qualify them to handle all the great sources of power in nature, whether those sources be animate or inanimate, whether the direction be mechanical or physiological, whether the work be investigation, construction, management, or invention; it must be prepared to deal with every kind of matter of which the world is composed, with the power associated with such matter, and with the laws, simple and complicated, which govern it; the object must be to direct such matter and power for the improvement of mankind; this must be the work of the new education. The civil engineer claims that all this work belongs to his profession, which should include every educated man who, with a clear knowledge of the laws which govern his work, is handling the powers of nature, be that work in a harbor, a machine-shop,

[1] Thomas Tredgold, 1828, subsequently embodied in charter of the Institution of Civil Engineers.

a railroad, a mine, an edifice, or a laboratory; the fundamental condition being that the work shall be that of an educated man, who knows how to design and to direct, in accordance with nature's laws of construction, strength and power.

There is one profession whose age and history have given it a rank by itself. Medicine had an old and honored name when civil engineering was still unrecognized. But it belongs with the new profession rather than with the older ones; its work deals with the powers in nature for the use of man. It differs from engineering in that it deals with organic life, and not with inanimate power. Its recent developments have been rendered possible by the same conditions which have developed engineering. Its place in a university is with the other branches of physical science in the new education, rather than in the historical museum.

The time is not far behind us when none of the occupations which strove to direct and use the sources of power in inanimate nature required any high degree of education. Practice and experience seemed to be enough. Good sense, guided by precedents, accomplished what was necessary. While in some ways a man specially educated had an advantage, it was not enough to give his work the marked position which belongs to an educated profession. This is no longer so. Within the last half century the whole conditions have changed.

It is not the educated character of the man, but the educational needs of the work which make an educated profession. The work must be such that it can only be done by those whose education has specially qualified them for it. Natural ability combined with education will always be greater than either of the two alone; but no occupation can become an educated profession until education gives the men who follow it a distinct advantage over those who have not received such education; and no profession will ever be composed entirely of educated men until the advantages of education outweigh those of mere natural ability.

The manufacture and use of power, though in its crude beginning easily understood and handled, has already reached a point where accurate knowledge and thorough training are needed for the best results. There is not a single department in the manufacture or use of power in which the advantage of a thorough education is not felt.

The study of the strength of materials and the mathematical laws involved is required in all structural work. The older structures were the gradual development of experience, each builder inheriting the work of his predecessors. So long as dimensions were small and the material generally excessive, this worked well, but modern engineering asks for the least material which can be used to produce safe results; the strains in every part of the structure must be calculated and unnecessary material removed; the rule that nothing is stronger than its weakest part must be applied by eliminating the material which gives useless strength.

The development of iron manufacture shows what science has already done. Twenty years ago nothing typified the strain of human labor more than the row of furnaces in which the puddlers, by muscular effort and in glaring heat, slowly drew together the particles of soft metal into the spongy puddle-ball from which wrought iron was forged and rolled. To-day the Bessemer converter and the open-hearth furnace have spoken the doom of wrought iron, which is disappearing before the less costly steel; and there is nothing more striking about a great steel-plant than the absence of men; ingots, blooms, billets, and finished product appear to make themselves, the few men who stand around seeming to police the machinery rather than to labor.

Metallurgy has become in all its details a matter of refined investigation. A minute variation in the amount of phosphorus it contains will make the difference between a bar of steel which is perfectly safe for structural purposes and one which is treacherous and may break without warning. A large portion of the steel product of the world is now made in furnaces with basic linings which absorb the excess of phosphorus, and which were introduced, not by a practical iron-master, but by a chemist, who made dephosphorization his special study and sacrificed his life to the ardor of his researches.[1]

The ordinary high-pressure slide-valve steam-engine, such as is used for a sawmill in the woods or for a straw-burning harvest outfit on a Dakota prairie, is a simple thing which anybody can understand, but its use is only justified because temporary convenience is more important than economical results. The marine engine, where power is limited by capacity to carry fuel, is very

[1] Sidney Gilchrist Thomas.

different; scientific study and design have reduced the coal consumption of the best marine engines to less than a pound and a half per horse-power per hour; this has rendered possible the speed of the modern Atlantic liner and the extremely cheap carriage of the tramp freight steamer.

Electrical engineering and the other professional branches which are multiplying rapidly, require a like scientific training.

This education is not a simple one. A smattering of knowledge may enable a man to understand what is going on, but to design and perfect the structures and machines which will give the best results requires a thorough knowledge of laws whose complications increase as their applications are extended. The strength of materials, the chemical composition of substances, the laws of heat and of dynamic energy, with other equally important principles, enter into almost every operation of modern life. Every design must be worked out in accordance with the laws which govern it. There was a time when Yankee ingenuity was thought to be equal to anything, and the memory of that time still exerts its baneful influence in Massachusetts; works which required educated engineers have been intrusted to ignorant men, and terrible disasters have followed this perversion of trust. The laws which govern the problems of mechanical and material devices are complete, and require trained minds for their solution; they are exact; they can be demonstrated absolutely, and a mistake may be followed at once by a disaster. There is no place among them for the strange theories which, when without the corrective influence of physical facts, seem to prove intellectual depravity; the man engaged either in the manufacture of power or the utilization of its sources in nature, can find no refuge behind unproved theories or questionable practices.

This work is the creation of an epoch differing from the past to such a degree that it may itself be considered new; the education which will fit men to perform this work must also differ from the old education. The old education teaches facts; it is based on a knowledge of what has been done. The new education cares little what has been done, provided no one ever wants to do it again. The men who are to adapt the great powers of nature to the use of man, who are to make the records of the future, must understand the laws by which they are to do this, must know how to

investigate, and how to work themselves, rather than know what work other people have done. No work is good unless made on correct principles, and education must equip the worker with these principles. The education of the engineer is intended to fit him to construct and use tools which serve some specific purpose; they must be adapted to their purpose and nothing else; he must be prepared to see them thrown away when their work is done. The machine must be properly proportioned; the heavy, clumsy tool which requires unnecessary power must be avoided as much as the weak tool which fails under its work. Furthermore, this education must be applied to every class of work; to all that great variety of tools by which the engineer utilizes the powers of nature; to those more permanent constructions by which the architect would build monuments for future ages.

As this education becomes more general, it will be realized that the basis of all true beauty is adaptation to its purpose; that the decorations of the so-called fine arts must be made subservient to correct and simple lines of construction, which they would emphasize rather than conceal. The false motto *Ars celare artem*, which really means it is good to lie, must give place to the *Veritas* of this university. The incongruous absurdities of the present day must disappear. The engine frames of the first Cunard steamers were decorated with Gothic arches; beside the engines of a modern steamer these old machines have a strange, fantastic look. Architecture, which as a fine art would consign itself to the museum, and sometimes, following the rapid changes of fashion, seems to differ from millinery chiefly in the want of a beautiful object on which to place its novelties, will find its highest development in correct construction.

The engineering of the new epoch must be thoroughly good. This means the development of the true professional idea and demands professional education. The best work has never been done by separate men; it is only accomplished when professional knowledge so permeates the whole body of workers that each member has the benefit of what all are doing. The first steps in invention and in new developments are taken by individuals; the best work is done later when the path into which the bold inventor ventured alone is trodden by the crowd who find it their usual course. The name of Watt was immortalized by his successful

introduction of the steam-engine, but there are thousands of men to-day who can build better engines than James Watt could. Marine construction owes its present high condition to the fact that shipbuilding has become a profession in which each builder has the real benefit of what all are doing. There lived in one of our great cities an engineer of marvelous inventive skill and world-wide reputation, who in a variety of ways has left his mark on the developments of the century; his history was a mixture of great accomplishments and strange disappointments; but the saddest part of the whole was the work of the last years of his long life, when alone, having little intercourse with other men, he set himself the task of devising means by which future generations might manufacture their power when the supplies of fuel now in use should be exhausted.[1] Perhaps no engineer who has ever lived was as well qualified to solve this problem as he was; but no man, however great, can do good work alone and before its time. When the problem on which he toiled for years becomes a real issue, there will be many men, of far less ability than he, who, sharing the professional experience which will come meanwhile, will have little difficulty in providing the needed power.

But the best professional spirit demands more than this. The university, in educating men to do the work of the new epoch, will fail in its duty if it stops here. To the training and instruction which it will impart, it must add the spirit which alone makes men worthy of the power education gives them. They must not only know how to work, but they must do it in the spirit which the best good of the community demands. The advance of mankind through the savage and barbarous periods was not continuous. Increased powers are susceptible of abuse as well as use, and the evil of the abuse has sometimes exceeded the good of the use. The new epoch will be no exception; its universality has only substituted other dangers for the barbarian invasions which destroyed older civilizations. The men who would sacrifice their friends and their country for their own selfish selves still live; the greater their capacities the greater the danger. Never before have the opportunities for selfishness been so great, whether that selfishness be devoted to acquisition of useless wealth, to indulgence in degrading luxuries, or to the general disregard of the

[1] John Ericsson.

rights of others which may characterize poor and rich alike. In communities where everything is organized on the selfish basis of commercial life, these influences may transform the great forces of the new epoch into powers of destruction from which the world will never recover.

There is a capacity in the mind which can be developed to meet these dangers. The antidote for these evils which selfishness begets is that power which, working in many ways and for many objects, takes a man out of himself and is called love, whether that love be for human beings, for animal life, for inanimate objects, or for laws and principles which are as real as anything else. The education of the men who are to do the work of the new epoch must not only train them and teach them, but must fill them with that interest and enthusiasm which engenders love. This can be done; the more complicated the work and the higher the education, the more interest the worker finds to make him love his work. Every man who has entered earnestly into the study of the powers of nature, into the design of works which are to utilize those powers, or the execution of the plans which the world is profiting by, knows that this is true. The ordinary workman who works for wages only, does not feel this love; the professional man whose profession is simply a source of income, is little better; but education can be so directed that no man can really enter into the spirit of the work for which this education has trained him, without caring more for the work than for the profit, without an interest which is really love. The men who are to save the new civilization from business trickery, commercial cruelty, and selfish indulgence must feel this interest in the work they do; they must seek the best results because they love the best; they must do their work because they love it, not perhaps with all their heart and soul, but with the full strength of their intellectual capacity. This love for their work has characterized the best students and investigators in all ages. With the change which the manufacture of power has introduced, it should exist in every branch of work which deals with the utilization of the great sources of power in nature. The university will fail in its duty to the community if it does not inspire young men with a love for their work.

The new epoch will be an age of specialists; the complications of both study and work make this necessary. It is only by train-

ing a multitude of specialists that the duty for which a university is created can be done. Only specialists working in their special callings, as part of a community which has the benefit of the general work and knowledge which embraces all specialties, can do the work which the new epoch demands. The best scholars in the museum and the best workers in the field must individually submit to the limitations of their own departments, to secure for the community as a whole the highest possible development. Each man must accept his position, consoling himself with the thought that, as a member of the community, he owns a share in what every member of it does and what every member enjoys; but the work of the new epoch is too varied for any one man to hold the position which many scholars and workers held less than a century ago.

But though the new education in those courses with which a university is supposed to be specially charged will be an education of specialties, not every man who receives such an education will become a specialist. In every occupation, a natural selection of men takes place; some follow the close lines of the work for which they are trained, while to others this training is but an incident in the early part of their careers, and does little more than point the general direction of their lives. The ability to deal with men and to direct the minds of other men is a matter of natural gift more than of education; it is so important that when possessed in a high degree, all other accomplishments yield to it, and its possessor, realizing that the ability to use several minds gives him the same advantage among his fellows that the control of additional power has given among races, will use his capacity. But the positive training of an education has its value for men whose paths of life may lie far from the special work for which they were trained; it will at least teach them the importance of accurate knowledge; too many men are contented to guess rather than to know, relying on personal tact to relieve themselves from difficulties when their guesses are wrong.

The special training of the new education will become the best training for many who are to enter public life. When ability to rule meant ability to defend against invasion, government was in the hands of soldiers. As society became more complicated and a permanent administration of civil matters more necessary, the

administration passed largely into the hands of lawyers; the legal profession was long the only educated profession whose members were available for public work. The functions of government are changing; the demands of the new epoch are not like those of the past: safety from foreign invasion is needed less than safety from dangers which lurk within, from the poisons, both moral and physical, which endanger concentrated population; from bad air, bad water, and bad construction; from corrupt administration, and from bacteria. In cities and in many communities, the duties of the government rest more on good engineering than on legal skill. The whole life of the community depends on appliances and conveniences which the manufacture of power alone has made possible. For all this work the government needs neither soldiers nor lawyers, but men educated in the various departments which come within the broad definition of the work of the civil engineer. The rulers and governors who at first were soldiers, who subsequently were selected from men trained as lawyers, must in the future be taken, at least in part, from those who are educated in the utilization of the powers in nature, from civil engineers and the men who are equipped with the new education for the benefit of their country.

The new education and that which a university must give in its capacity of museum are to train men whose whole lives are to be different. Though the claim of one class to be better than another may disappear, social distinctions, based on differences of occupation and taste, are real, and no life can be satisfactory in which the association of work and companionship are widely separated. The young man who will do the best work must enter into his profession with his whole soul, prepared to cast his life as well as his labor into the field where his associates dwell.

Teachers in the new education must be in touch with the active work which the young men whom they train are to do; there must be opportunities for interchange of ideas between professors and workers, between students and their future employers, between the young men and the old men whom they expect to succeed. The workers who are to control and direct other men will be held responsible for other people's time; they must have the accurate methods which belong to business life; their education must include systematic habits, respect for authority, promptness and

discipline; no one is fit to handle and discipline other men unless he is first well disciplined himself; an education which does not teach the value of time and system will never fit a man to handle the time of others. Increase of power means large establishments which must have intelligent heads; they must be controlled by men who are superior to their workmen. Concentration of power means concentration of capital; managers must be few in proportion to owners; this means an extension of corporate work, with all the responsibilities which go with the care of other people's property. The new education must fit them for all this work. The workshop might give part of it; the technical school would give much of it; but nothing less than the union of these with high professional standards and with a love for the work can give the whole.

I have wished to emphasize the fact that the new conditions which the manufacture of power have brought into the world have extended the needs of higher education to a great variety of occupations for which the engineering profession must stand as sponsor. The educated men engaged in these occupations must before long equal in numbers and in intellectual capacity all other educated men. But these occupations, which make so high demands on the mind and on the university, are not substitutes for, but additions to, the older educated callings. Did time permit, something might be said to show the magnitude of the work already accomplished; the civil engineer recognizes no limit to the capacities of the tools he would provide, nor to the size of the works he would construct, except the limits of cost and time.

I have spoken of the general bearing of the new epoch upon the duties of a university. I have not intended to refer specially to Harvard University, nor particularly to my own *Alma Mater*. Speaking as a member of a profession which, with all its breadth and variety, has had few votaries among the sons of Harvard, my words are intended as general suggestions rather than more. The large provisions now being made for physical science and engineering courses in many of the newer universities of the country are evidences of the demands of the new epoch. But when there are many universities, not every one need occupy the full field of both the museum and the school. The management of each uni-

versity must decide what it is best to do. The new epoch makes more work for a university in the function of museum alone than all it could have done in any earlier period. For this work of a museum Harvard University is preëminently well qualified; it is in the oldest educated community on the continent; its endowments and equipment, both of tools and men, are adapted to this work; there is no place in America better fitted for the old education.

Perhaps this university should be content with its old work; traditions place its duties with the past; it need not train young men to be active workers in the new epoch; the old work is complete in itself and the scope of this university need be no broader: the new epoch may have increased its capacity without changing its duties. Other universities may be better situated for the new education. This university may stop here, if it would perform a part only of the universal duties; if it is willing to stop with the work of a museum; if it is content to busy itself with the past and have little to do with the future; if it is ready to bear no part in the great changes which we are already in the midst of; if it would keep aloof from the achievements which the new epoch has made possible. It should stop here, if it would only preserve the work of our ancestors, and would leave to others the care of those who are to be the ancestors of the future.

George S. Morison, '63.