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BIOGRAPHICAL MEMOIR

OF

GEORGE FILLMORE SWAIN

1857–1931

BY

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Foreword

In July 1935 the writer was asked by the President of the National Academy of Sciences to prepare a memoir of George Fillmore Swain who died on July 1, 1931. The writer did not feel well qualified for this task, having had but little contact with Professor Swain either professionally or socially. Having to rely on indirectly acquired information, he was afraid that he would be unable to do justice to the memory of this remarkable man. For this reason he decided to base this memoir chiefly on one prepared by Professor Emeritus C. Frank Allen and Professor Albert Haertlein and published in the Transactions of the American Society of Civil Engineers.* That memoir was written by men who had an intimate knowledge of Professor Swain and his work. It is so complete and so excellent in form that it was felt by the writer that any attempt to improve upon it would be presumptuous on his part. With the kind permission of the authors it is given here in full.

Biography

George Fillmore Swain was born on March 2, 1857, in San Francisco, Calif. His ancestors came from New England. He was eighth in direct descent from Richard Swain who came to America in 1635 and settled first in Hampton, N. H. A few years later, Richard Swain moved to Nantucket, Mass., and was one of nine who in 1659 purchased the English rights to the entire island from Thomas Mayhew who, however, retained a twentieth interest. The Indian rights were also promptly acquired. Nantucket, in its prime, was the leader in whale fishery, and this not only bred sturdiness of character, but also brought prosperity with its many advantages. George Swain could trace his ancestry among many of the best known

* Vol. 98, pp. 1476 to 1484, 1933.

families of Nantucket, the names of Coffin, Macy, Starbuck, and Bunker being prominent among others.

His father, Robert Bunker Swain, was a native of Nantucket who moved to California in 1855, where he was engaged in the shipping and commission business. He became one of the leading merchants of San Francisco, served as President of the Chamber of Commerce, and also of the Mercantile Library Association. He was appointed Superintendent of the Branch Mint during President Lincoln's administration, and this work brought into play an unusual facility in the use of mathematics; the son's success in this direction had some root both by inheritance and example. The father's business position and his tastes led him to entertain many notable people, among them Camella Urso, distinguished violinist, Dr. Bellows, the leading Unitarian clergyman, and Mark Twain, whose stories from "Innocents Abroad" quite convulsed young Swain, who was allowed to listen from a near-by room. The elder Swain was an intimate of Starr King, well known in New England, and a power in holding California loyal in the Civil War. It is interesting to note that Bret Harte was his Secretary at the Mint.

George Swain relates that he was shy, timid, and without much physical courage or aggressiveness, and that his father to cure this had him take lessons in boxing and later in fencing. Quick in movement and perception, he became for a little chap expert with foils. When a school bully tried to pick on him he got his father's consent to fight him, used his boxing science, and was troubled no further. He also had to ride horseback, with horses not always too gentle, and thus learned to manage an unruly horse without fear and was never unseated. His father showed rare wisdom in these matters. Further, in preparation for college, he sent him to a military school, conducted under strict discipline, which included guard mounting, inspection, and other military requirements. Young Swain became a good shot at target practice. He served as Adjutant as well as Captain of a company and was the Valedictorian of his class. He rated his military training as one of the best things that ever happened to him. All these furnished a background

and were elements which contributed to make George Swain the man he was; he had an unusual start, both by inheritance and environment, from his father's side.

His mother, Clara Fillmore, born in Lynn, Mass., was a woman of refined literary tastes. She died while George Swain was still young. His grandfather was the Rev. Daniel Fillmore, a Methodist minister, who was twice assigned to a pastorate in Nantucket. His grandmother, Susan French Clark, born in Plymouth, Vt., also was of fine literary tastes. A small collection of her poems was printed; one of these, "The House I Live in," written by her on the occasion of her eighty-fifth birthday, had real merit. She lived to be nearly ninety-eight years old. At one time, she had kept a private school in Boston, Mass. His uncle, Dr. Charles Wesley Fillmore, was graduated from the Harvard Medical School in 1856 and studied further in Europe—in Paris, Berlin, Vienna, and elsewhere—specializing in eye and ear; on his return he became a surgeon in the Army and, later, engaged in practice in Providence, R. I. While in Europe Dr. Fillmore studied the violin successfully under some of the best masters, and this as well as his studies and life abroad furnished elements which afterward contributed to Professor Swain's success.

At the age of fifteen George Swain had decided to become an engineer, and not long after his father's death in 1872, he came East to his grandmother and his uncle, Dr. Fillmore, in Providence. He finally decided to enter the Massachusetts Institute of Technology at Boston, largely on account of its proximity to Providence. In some doubt as to adequate preparation in mathematics for the entrance examinations, he secured as a tutor a senior in Brown University, Benjamin Ide Wheeler, who later became President of the University of California. A letter from Dr. Fillmore was sent to Edward Everett Hale, who secured young Swain's boarding place in Boston. He was fortunate in the kind of people who became interested in him.

Not quite sixteen when he entered the Massachusetts Institute of Technology, he had a fine record of scholarship and was the ranking student of his class. He served as Adjutant of the

Military Battalion for which his earlier training well fitted him.

Among the studies pursued, the course in logic taught by Professor George H. Howison appealed to him, and he took this course as an extra subject. The taste for study along this line and the reading done in this direction he had always valued highly as an important part of his training. He was an omnivorous reader. Bryant's poetry specially appealed to him, as it had also to his mother, and Emerson did much for his philosophy. He developed a fondness for Shakespeare, and this, in connection with his logic, certainly was conducive not only to clear thought, but also to habits of clear expression, which a training in mathematics and science sometimes fails to secure.

His teacher in civil engineering was Professor John B. Henck, a fine mathematician, a strict and effective teacher who demanded and received good work from his pupils and did more than any other member of the early faculty to fix the high standards of this institution. His influence on Professor Swain's later teaching must have been very great.

In 1877, young Swain received the degree of Bachelor of Science in the Course of Civil and Topographical Engineering. Not satisfied with this, he spent three years abroad, primarily for the study of civil engineering, in which he did fine work, but with the added advantage to him of acquiring a breadth of view and experience in life, a wide acquaintance with men of various training, and an opportunity to travel, which together formed a most valuable feature of his life abroad. He thus secured something which cannot be acquired from travel alone. Among the acquaintances he formed while abroad the late Dr. Arthur T. Hadley is worthy of mention. He acquired also an almost perfect knowledge of German, and in his travels often registered from Berlin rather than from America, to his material advantage.

He studied at the Royal Polytechnicum, in Berlin, under such able masters as Winkler, Goering, and Hagen, specializing in bridges and other structures, railroads, and hydraulics, subjects valuable quite as much for training as for understanding of the work covered. With superior natural and demonstrated

ability, combined with an excellent foundation secured at the Massachusetts Institute of Technology, he was in a position to benefit well-nigh to the limit from the opportunities offered at the Royal Polytechnicum. At the close, he had substantially mastered the subjects of structural, hydraulic, and railroad engineering, and reached this country probably more highly trained in these subjects than any of his contemporaries.

Advanced degrees were then restricted to those who were to enter governmental service, so that he received no degrees; but the substance he secured. He did, however, bring away flattering recommendations from Winkler and Goering. While in Germany he visited many engineering works with his professors. He attributed much of his later success to his years abroad, and not solely to his training in engineering or his mastery of German. He took advantage of his opportunity to hear music by great masters. He played the piano with skill and taste, and on his return to America spent many evenings playing such music as Beethoven sonatas with his uncle, the violinist. It is probable that his uncle, who had been trained abroad, was responsible for young Swain's going to Germany to study.

On his return in 1880, he was appointed Expert Special Agent of the Tenth Census of the United States, investigating water power in connection with manufacturing interests. He presented reports on the Middle Atlantic and on the South Atlantic water-sheds, and, later, on the water powers of New England.

In 1881, he was appointed Instructor in Civil Engineering at the Massachusetts Institute of Technology. Gen. Francis A. Walker who had been Superintendent of the Census, was in the same year appointed President of the Institute. George Swain had served under him while engaged on the census, and the natural outcome was General Walker's early recognition of his abilities by his promotions to Assistant Professor in 1883 and to Associate Professor in 1886. He spent one summer with the Essex Company, at Lawrence, Mass., and another at Lowell, Mass., in the office of Locks and Canals under the late

James B. Francis, Past-President and Honorary Member American Society of Civil Engineers.

Early in 1887, occurred the widely known Bussey Bridge disaster. This furnished the first opportunity for Professor Swain to distinguish himself in the engineering field. At the investigation which followed, the quality of his training and his ability to analyze the causes of the accident so impressed the Railroad Commission of Massachusetts that he was appointed the first Expert Engineer of the Commission under a law newly passed, an office for which he was well fitted—one which he filled continuously and satisfactorily for many years, and which yielded him a rare experience. He examined and became responsible for more than 2000 railroad and electric railway bridges—a tremendous burden. He steadily and unostentatiously brought them into condition, securing the confidence of railroad officials, and thereafter no accident happened for which he could be held responsible in the slightest degree. He served in this position for twenty-seven years.

Although Professor Swain had been told that he was too young to become the head of the department of the Institute then vacant, the prestige of his railroad appointment led to his selection as Hayward Professor of Civil Engineering and head of the department at the age of thirty (an early age for conservative Boston); however, his success more than justified his appointment. A remarkable development followed. At the time when he became Acting Head of the department in 1887, he was the only full professor; there were three instructors and one assistant. In 1909, there were twenty members of the department, of whom ten were members of the faculty. In 1887, there was no department library worthy of the name; in 1909, it had become probably the best working library of civil engineering in the country, and it was due to his enthusiasm and judgment that this was accomplished.

While at the Massachusetts Institute of Technology he served for a time as Secretary of the Society of Arts connected with it, and for two years was Secretary of the Technology Alumni Association.

In 1909, Professor Swain was offered and accepted the Gordon McKay Professorship of Civil Engineering at what was then and for a time afterward the Graduate School of Applied Science, Harvard University. An important consideration in his acceptance was his expressed belief that this Graduate School marked an advance in the status of engineering, putting it on the same basis as law and medicine, the schools of which for some time had been on a graduate basis at Harvard. He held the Gordon McKay Professorship at Harvard until his death, becoming Emeritus in 1929 when impaired health prevented his active participation in the class-room.

As a teacher, Professor Swain's standards were high. He demanded from his students not only diligence and attention but, beyond that, insisted upon clear thinking on their part. His work was very thorough, of a high grade, and enforced by a steady drill in the principles of the subject. Mere acquirement of an understanding of the subject in hand was secondary to clear thinking along the line of work. He was a drillmaster *par excellence* in a subject which especially lent itself to such treatment. Perhaps no other man has contributed so much, so consistently, and for so long a period, to the development of correct methods of thought and high standards of scholarship in the field of engineering education.

He taught many subjects at the Massachusetts Institute of Technology in the early days, the important course in hydraulics being for several years in his direct charge. Later, he confined his attention almost exclusively to structures, which he taught not only to undergraduate students, but also to graduate students. Fate, in part through the Railroad Commission, seems to have decreed that both his teaching and his engineering activity should be largely in the field of structural work.

In 1893, men engaged in teaching engineering in the United States and Canada organized the Society for the Promotion of Engineering Education. Professor Swain was an early president of this Society, in which he took for many years an active part. His attitude toward the work of teaching was well defined in his presidential address on "The Profession of En-

gineering Teaching," in which he called attention to the necessity that professors of engineering should cultivate the teaching side, however attractive the engineering side might be. In his annual address * as President of the American Society of Civil Engineers, he said:

"Our teachers are generally, I think, chosen upon an incorrect principle; they are appointed by reason of what they know; it seems to me they should be selected for what they are—for their ability to teach, and their power of enforcing scientific discipline."

This attitude toward teaching, shared by his colleagues in the department, meant much to the success of his administration. His reputation among the teachers of the country placed him in the first rank. This is attested by the fact that the Society for the Promotion of Engineering Education in 1928 made him its choice as the first recipient of the Lamme Medal, awarded yearly for "accomplishment in technical teaching or actual advancement in the art of technical training." This medal, Professor Swain valued most highly.

As an engineer and as an official in connection with engineering work, he had a large and successful experience. Aside from his duties with the Railroad Commission, he served as consulting or designing engineer for a number of bridges, movable as well as fixed, an unusual case being the reconstruction of the old chain suspension bridge at Newburyport, Mass., as a stiffened cable suspension bridge with a hinge at the center and with reinforced concrete towers.

In 1894, the Boston Transit Commission was organized to construct the Boston subways. Professor Swain was one of the first commissioners appointed. He served on it for twenty-four years and was its chairman for five years. The work was without precedent in this country, was well carried out, and within the original estimates. The Tremont Street Subway

* "Some Tendencies and Problems of the Present Day and the Relation of the Engineer Thereto": Address at the annual convention, Ottawa, Ont., Canada, June 18, 1913, by George Fillmore Swain, President, American Society of Civil Engineers, *Transactions*, Am. Soc. C. E., Vol. LXXVI (1913), p. 1112.

was the first under-street subway in the United States. The tunnel under Boston Harbor to East Boston was a part of the work of this Commission, as was also the Charlestown Bridge. The expenditure by the Commission during Professor Swain's years of service was in excess of $30,000,000.

He served upon approximately twenty commissions in Massachusetts to fix the method of eliminating grade crossings of highways with steam railroads, those of Worcester, Taunton, Newton, and Waltham, being among the most important. He was a member of the Commission to revise the Building Laws of Boston. He was also frequently called upon as an expert in court cases, not only in Massachusetts, but elsewhere.

Professor Swain served as expert for the State Commission on the valuation of the assets and liabilities of the New York, New Haven and Hartford Railroad Company. This involved appraisals of properties and securities held by the railroads, a physical valuation, a consideration of economic problems, and a critical examination of books. He was in charge of the Royal Commission on Railways and Transportation of Canada, involving 13,000 miles of Canadian railways. He directed similar valuations of other railroads, both large and small, among which were the Chicago Elevated Railways as well as the New York Central Railroad. Altogether, these valuations ran up to many hundreds of millions of dollars.

In 1908, he was appointed by President Theodore Roosevelt a member of the Inland Waterways Commission and also of the Conservation Commission. This followed the hearings of a Congressional Committee upon the proposed Appalachian Forest Reserve, at which Professor Swain took an important part.

In 1918, he was one of the representatives of the American Society of Civil Engineers, as part of a delegation of nine from the four Founder Engineering Societies of the United States, to confer with French engineers regarding the adoption of a program for the rehabilitation of France. He served as secretary of the delegation as well as chairman of two of the sub-committees during a stay in France of about one month.

He was also a member of the Franco-American Engineering Commission organized in 1919.

For a number of years he was a member of the Board of Judges to select names for the Hall of Fame, at New York University, and this University, in 1906, conferred upon him the honorary degree of Doctor of Laws.

During the celebration of the fiftieth anniversary of the founding of the University of California in 1918, he delivered the Hitchcock Lectures. There was then conferred on him the honorary degree of Doctor of Laws by President Benjamin Ide Wheeler, his former tutor in Providence, who must have had great satisfaction in conferring the degree upon his former pupil. Professor Swain was much gratified at receiving this honor from the State University of his native State.

In 1914, he delivered the Charles S. Lyman Lecture, at Yale University. He chose for his title "The Conservation of Water by Storage." This was published in book form by the Yale University Press.

There were early publications on hydraulics and on structures for the use of his classes; they were highly regarded, but were not given general circulation. The *Journal* of the Franklin Institute for 1882 and 1883 contains articles by him on "Mohr's Graphical Theory of Earth Pressure" and on the "Application of the Principle of Virtual Velocities to the Determination of the Deflection and Stresses of Frames"; in 1887 he contributed a paper to the American Society of Civil Engineers, "On the Calculation of Stresses in Bridges for the Actual Concentrated Loads," * a feature of which was the use of "influence lines," and in March, 1919, a paper, "On a New Principle in the Theory of Structures." ** The three last-mentioned papers have had a very material effect upon present practice in structural computations and investigations. He was active in contributing papers to various societies, and many official reports were made by him, sometimes individually, sometimes as a member of a board.

Late in life, he brought to the point of publication three

* *Transactions*, Am. Soc. C. E., Vol. XVII (1887), p. 21.
** *Loc cit.*, Vol. LXXXIII (1919-20), p. 622.

volumes of a treatise upon which he had worked intermittently for thirty years. The first volume on "Strength of Materials" was published in 1924, as was also the second volume, "Fundamental Properties of Materials." The third volume, "Stresses, Graphical Statistics and Masonry," was published in 1927. His sudden illness delayed and perhaps prevented the completion of the remaining volumes, which, in manuscript, are nearly finished. As might be expected, these books were of monumental character, and of great value to the profession. His book on "How to Study" (1917), has had a wide and continuing circulation, being required as a part of the engineering course in a number of colleges. A somewhat later book, "The Young Man and Civil Engineering," was one of a series touching various occupations or professions, and was well received.

Professor Swain was a member of many engineering or allied societies, including: Boston Society of Civil Engineers, of which he was President and Honorary Member; New England Water Works Association; American Society of Mechanical Engineers; American Institute of Consulting Engineers; American Society for Testing Materials; Canadian Institute of Engineers; Institution of Civil Engineers of Great Britain; Society of Engineers of Hanover, Germany; American Railway Engineering Association; New England Railroad Club; National Academy of Sciences; American Association for the Advancement of Science, of which he had been a Vice-President; American Academy of Arts and Sciences; American Forestry Association; and Society for the Promotion of Engineering Education, of which he was Senior Past-President.

Perhaps the highest honor to which a civil engineer may aspire is the presidency of the Society, and to this post Professor Swain was elected in 1913, the first professor of engineering to be so honored. This qualification was doubtless a factor in his selection, although this was justified either by his standing as an engineer or because of faithful and efficient work within the Society.

He had long been of the opinion that activity in the Society

should precede rather than follow election. By this standard, he qualified well. He had contributed papers to the Society, had served on its important committees, had been an influential member of its Board of Direction, and a Vice-President. Additional distinctions came from his elevation to Honorary Membership in 1929. At this ceremony, which occurred at the annual meeting, in New York, N. Y., on January 15, 1930, he was introduced by Hardy Cross, Member American Society of Civil Engineers, with the following remarks:

"Bred of stock which made New England famous, educated in that school of great engineers, the Massachusetts Institute of Technology, he brought to his life work a firm foundation of training and of character. I need not itemize his long career of service to his profession, to his Alma Mater, to Harvard University, to the City of Boston, to the Commonwealth of Massachusetts, and to our nation. His record is well known to you. You know especially of his services to this Society, through its publications, on its committees, and in administrative work. As an author he has given us a model of clear, precise, and forceful style. As a scholar he has been honest and accurate in detail and broad in vision. As an engineer he has shown discrimination in the choice of appropriate tools of thought and resourcefulness in application to engineering work. As a teacher he has been preeminent in his ability to inspire men and to train them.

"This man, this teacher, is no mere academic pedagogue. He was a man who never permitted mazes of mathematics and mazes of statistics to befog the vision of the men who studied under him. He was a prophet, a priest of clear individual thought and aggressive individual judgment."

Professor Swain had been a pronounced believer in the advantage to engineers of associating more largely with business and professional men not engineers. His presidential address to the Boston Society of Civil Engineers dealt with this subject; and, consistently, he had been a member in Boston of the Union Club, a general social organization; the St. Botolph Club, where literary or similar qualification is necessary; the Boston Art Club, for which he could qualify as a musician; the Commercial Club, whose name indicates its business character; and the Bos-

ton City Club, very cosmopolitan in character. He was also a member of the Harvard Club, the University Club, and the Unitarian Club, a denominational dining club that meets monthly.

Neither was he averse to recreation. He enjoyed whist and billiards, at both of which he played a good game. He was also, as has been stated, fond of music, and played the piano with skill and taste. It was his habit to do things well.

Professor Swain had a fine library, not only of scientific and professional books, but also along varied lines, including economics as well as general literature which appealed to him. His library contained many books in German and French, and he read freely in both languages, both as literature and as scientific treatises.

He was thrice married; to Katherine Kendrick Wheeler, who died in 1901; to Mary Hayden Lord, who died in 1914; and to Mary Augusta Rand, who survives him, as do also his daughters, Barbara and Clara, and a stepdaughter, Alice Rand.

Professor Swain's success may be attributed in part to inherited ability and fine environment at home and at school, both here and abroad; a training extended beyond that secured by most of his fellows; an orderly habit in his work and economy of effort, avoiding waste; a faculty for clear thought and clear expression; a remarkable capacity for hard, rapid, and concentrated work, together with an appreciation of "short-cuts" and effective methods. He possessed the valuable faculty of taking advantage of his opportunities, the lack of which talent has spelled failure to many otherwise able men.

It is not easy to record the sense of personal loss felt by his many friends who held him in high esteem. Many who visited him in his last sickness will rejoice that the honors so much appreciated by him, the Lamme Award and the Honorary Membership in the Society, happily came to him as a meed of cheer as the sun was slowly setting upon an active, well-spent, and useful life. He died July 1, 1931, at his summer home in New Hampshire.

Professor Swain was elected an Affiliate of the American

Society of Civil Engineers on September 5, 1883; a Member on March 2, 1892; and an Honorary Member on October 7, 1929. He was elected and served as a Director from 1901 to 1903; Vice-President, in 1908 and 1909; and President, in 1913.

While the writer of the present memoir is unable to add anything of his own knowledge to Professor Allen's and Professor Haertlein's account, he has thought it proper to add a few characteristic notes extracted from letters received from another of Professor Swain's former colleagues and from one of his former students.

FROM A FORMER COLLEAGUE *

"I knew Professor Swain as intimately, perhaps, as anyone outside his family circle, from my student days up to the time he died, a period of about thirty-five years. Together we worked on many problems connected with consulting and general engineering. I also knew him in his home and when, toward the close of his life, he was confined to his bed, I saw much of him and learned more about the man than I had known before.

"I was always much impressed and fascinated by his brilliancy, by his keen analytical observations, and his logical methods of deduction. These qualities he constantly endeavored to inculcate in his students, and his whole method of teaching was centered on this aim. Logical reasoning was constantly emphasized, and I well remember his earnest recommendation that we procure copies of Jevon's 'Logic' and master its contents.

"His mental processes were made in seven league boots compared with the slow, painful steps of the average man. His mind seemed to grasp the whole without having to assimilate the parts. His brilliant mental flashes in the classroom often dismayed the plodding student, but they succeeded in awakening his dormant faculties and aroused the pupil to greater efforts.

* Professor Geo. E. Russell, Massachusetts Institute of Technology, Cambridge, Massachusetts.

His mind was quite mathematical and his mental arithmetic was often most entertaining. I have seen him square numbers of three or four figures in as short a time as I would obtain the result on a slide rule. In fact, he had little use for a slide rule, claiming that it robbed him of just so much mental exercise.

"He continually exhorted his students to keep their minds 'fluid'. 'When you meet a seeming obstacle in analysis,' he would say, 'let your minds flow around the problem, viewing it from all sides. Don't let it be thick like molasses.' He practiced this preachment and it was interesting to see him attack a knotty problem. He would follow a line of reasoning leading to no solution, and then quickly abandon it for a wholly new approach. He never allowed his mathematical processes to blind his judgment. Constantly was he warning that common sense must sit as judge upon all mathematical conclusions. He was very fond of saying that 'common sense' should be called 'uncommon sense.'

"He was an avid reader and performed the difficult feat of keeping abreast with current events, sifting the contents of professional journals and, at the same time, dipping deep into history, biography and fiction. During his last sickness he could do nothing else but read and it was amazing to see the volumes that he devoured. I think he told me that he had read one hundred and twenty-five volumes during a period of three months.

"Some idea of him as a teacher may be gained from his little book on 'How to Study' which appeared in 1917 from the press of the McGraw-Hill Book Company. Crammed into less than seventy pages are many of the fundamental ideas he held on the art of studying. He was a very able writer and his books are models of careful arrangement and exposition.

"Before me, as I write, is the open page of a set of notes on structures written by him and used as a textbook. On the margins of the pages I find penciled notes of his last talk to the class. They refer to the essential things entering into the making of a successful engineer.

" 'Four things are necessary for success

1. Knowledge
2. Experience
3. Judgment
4. Character

" 'To get the first two, read transactions of engineering societies and professional papers; listen to experiences of others; keep notes; accumulate data; keep studying. —all branches.

" 'Train judgment by watching others. Have no opinion without a base to rest it on.

" 'Character,—most depends upon character. Persevere, —it is very important. Obey orders; keep your mouth shut; be reliable and truthful.

" 'Be careful of personal appearance and personal address.

" 'Success is to make the most out of life possible. It does not mean money.

" 'Never doubt your ultimate success.

" 'If you ask a favor, make it easy to answer it.

" 'Don't be over-confident.'

"Truly a great sermon in a few words."

FROM A FORMER STUDENT *

"Professor Swain was an unusual man. He was the finest teacher that I ever had, whether at Johns Hopkins, at Massachusetts Institute of Technology or at Harvard. I had already studied logic at Hopkins, but Professor Swain taught me how to use it, so far as I am capable of doing.

"He was always rigorous; he had little use for a student who came to class unprepared. His notes were mimeographed, and all of the mistakes were left in them, uncorrected, to catch the boy who did not use his mind when studying them. He was never content that his students should merely learn from notes or from books, but required individual thinking. His examination questions always contained some problem which had not been touched upon, either in the notes or in class, and which required thought.

* W. Watters Pagon, Member American Society of Civil Engineers, Consulting Engineer, Baltimore, Maryland.

"I thought so well of him that, when I had been out of college two years and had found how little I really knew, I followed him to Harvard. His methods were original, and he taught me something of originality.

"His most valuable instruction to his students was, I believe, his inculcation of the single idea that when one knows thoroughly the fundamental principles of a subject, he stands on a rock foundation. Many times when I have been giving expert testimony this teaching has given me the courage and sureness to stand up under heavy assaults. Further, having been imbued at Johns Hopkins with the spirit of research and having been persuaded by eminent scientists of the truth of its motto, 'Veritas vos liberabit', I was fertile ground for the sowing of his fearless spirit of adventure and pioneering from a known country of principles to a wilderness of fascinatingly unknown facts and ideas.

"Not many, I believe, of his students knew the more tender side of his nature. He permitted me to see some of it. He always showed some interest in me personally, and I can bear witness to the fact that he possessed a very warm heart. No one of course can overrate this high degree of personality.

"In my fifty years I have known few men of whom I can speak so highly and so fondly as of Professor Swain. His death was a sad loss to the professions of teaching and of civil engineering."

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