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DR. ROBERT HENRY THURSTON'S EIGHTEEN YEARS AT CORNELL[1]

By Dr. WILLIAM F. DURAND

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To me has been allotted the pleasant task of giving you some account of the life and work of Dr. Thurston during his eighteen years as director of the Sibley College of Cornell University. To compress into a period of some twenty-five or thirty minutes' time any adequate account of the activities over a period of eighteen years of a man such as was Dr. Robert Henry Thurston will be, I am sure you will agree, quite out of the question; and I can only hope to give some account of what appear to be the more important features of this story.

The initial point in the sequence of events which led to Dr. Thurston's call to Cornell appears to have been a gradually growing conviction in the minds of the then president, Dr. Andrew D. White, and members of his board of trustees, that the Sibley College, as representing the School of Mechanic Arts of Cornell, was hardly realizing, in its condition during the middle eighties of the last century, the full measure of its potential standing in the domain of higher technical education.

This is evidenced by the appointment by the trustees, on June 18, 1884, of a special committee known as the "Committee on Revision of Sibley College." This committee comprised the president of the university, Dr. Andrew D. White, Honorable Hiram Sibley (the founder of Sibley College), the chairman of the Board of Trustees, and one graduate of the Department of Mechanic Arts to be selected by the trustees. The resolution calling for the appointment of this committee prescribed its duty as that of considering "all

[1] Address at the celebration at Cornell University of the hundredth anniversary of the birth of Robert Henry Thurston, October 25, 1939.

questions relating to the Mechanic Arts Department," and the resolution itself was accompanied by a declaration of purpose reading as follows:

Resolved: that it is the wish and purpose of the Trustees of Cornell University to establish and maintain an Engineering and Mechanical Department either by union under one head or by division into two departments—a complete system of instruction in all that belongs to this important branch of a thorough university education.

The members of this committee approached their study with a sense of its serious importance. They early reached the conclusion that in order to realize the purposes in view some new form of organization was needed, with a new directive head with enlarged authority and responsibility. The crux of the situation was obviously the man to be called as head of the reorganized college. The field was surveyed with care and several eminent engineers were considered and their qualifications passed in review. Finally, almost exactly a year later, on June 17, 1885, this committee submitted a written report from which some extracts may be given:

. . . They have met various gentlemen eminent in the profession, and several of these gentlemen on the invitation of the president of the University, and the chairman of the board of trustees, have visited the University, looked carefully into the affairs of Sibley College, and discussed them freely with resident members of the committee. After such full consideration, the committee unanimously report in favor of establishing a professorship of mechanical engineering to be called the Sibley professorship, . . . and that there be attached to the same the directorship of Sibley College, in the duties of which shall be included the chairmanship of the faculty of mechanical engineering or mechanic arts with large powers as to the laying out of the course or courses in the department, the assignment of duties to the various professors especially connected with it, the decision as to the character and amount of various kinds of instruction, including drafting and shop work, subject to this board, the executive committee, and the president of the University so far as their spheres include his own, and having the special faculty of Sibley College as his advisory council. . . . They also recommend that the professor be immediately called and asked at once during the summer vacation to begin a careful study of the various questions involved and to prepare and have ready for this board at the coming annual meeting in October a full report on these subjects and all others which he deems best to bring before the board, and especially to include any plan that occurs to him in regard to any possible consolidation of instruction in his own and kindred departments.

Your committee, in looking about among candidates, have found various distinguished gentlemen, many of whom would do high honor to their profession and to the University. But they have unanimously concluded to recommend Professor Robert H. Thurston, LL.D., a graduate of Brown University, at present professor of mechanical engineering in the Stevens Institute at Hoboken, N. J. Professor Thurston is a gentleman of about forty-four years of age, has taken the highest rank in his profession, has published reports and various documents showing a wide range of knowledge and great depth of thought, has built up a high reputation as a teacher, has held the position of president of the American Association of Mechanical Engineers, as well as consulting engineer of the United States Navy, has been intrusted with some of the most important theoretical and practical tests by the Government of the United States and by large private corporations, and has thus gained an experience and a knowledge which cannot fail to enure to the benefit and the reputation of the Sibley College of our University. He has also proved his teaching ability by sending forth for several years past a number of graduates from the Stevens Institute who have taken high positions. And as to his standing among his associates in his profession, your committee would submit herewith certain letters from eminent mechanical engineers and others, sent directly to the members of the committee, which show that Professor Thurston is all that we could desire him to be.

The hope and belief of your committee is that if this nomination be ratified by the board, we shall have a professor and director of the fullest competence and of the highest standing, one who will at once by his counsels, his teachings, his influence upon the students, and the weight of his opinion on the country at large give to Sibley College a standing among the foremost institutions of the kind in existence.

The board of trustees lost no time in acting on this report with approval and among the minutes of this meeting it is recorded that:

Upon ballot duly had, Robert H. Thurston was unanimously elected Professor of Mechanical Engineering and Director of Sibley College.

There is also extant an account written by President White, thirty years later in 1915, and giving his recollection of the circumstances which led to the selection of Dr. Thurston out of the field of possible choice of presumably available material. Only a small part of this account can be quoted here. Speaking of conditions in Sibley College at that earlier period, he says:

. . . There were differences of opinion, some of them very acute, in the Sibley faculty, and, to the great regret and even dismay of those interested in the department, Professor Sweet left it. It was clear that a thorough reorganization was needed, and it fell to my lot to seek a professor who should take the post of director of the College, who could speak as one having authority, and who should have both theoretical and practical acquaintance with all the departments and, at the same time, a position among mechanical engineers throughout the whole country which would command respect and justify authority. But the question was where to find him.

Then, further speaking of Dr. Thurston, he says:

. . . His position was one of great eminence. He had certainly, in an astonishing degree, the qualities I sought,

but his reputation as a professor at Hoboken and his distinction as a consulting engineer at New York City were such that it seemed impossible to dislodge him. All I had hoped to do was to secure from him information regarding various candidates throughout the country. A whole morning was spent by me in obtaining from him opinions regarding the work of different men who seemed promising, and at last I departed, more than ever impressed with the difficulties of the situation. Taking leave of Professor Thurston, I walked slowly down the pathway from his door, when it suddenly occurred to me to make one more attempt, such as, thus far, I had not dared. It was a sudden thought, and returning to the door, I asked Professor Thurston one more question, simply whether, under any circumstances, he could come to Cornell. He answered that he had no desire to change his surroundings at Hoboken, but he gradually confided to me that he and Mrs. Thurston had sometimes agreed that, for their children's sake and, indeed, for their own tastes, they would have preferred a life more remote from a great city and with more rural surroundings. A new hope sprang up within me. I presented the attractions of Cornell and its neighborhood, dwelt upon the possibilities of a great work under his direction, and, before leaving the house, had secured his promise to come to us.

It is well known that the qualifications of other engineers of high standing in those days were also canvassed carefully by this committee on the "Revision of Sibley College." Among these was the late William Kent, between whom and Dr. Thurston there had existed for many years a warm personal friendship. Correspondence between these two men shows that they discussed the situation frankly regarding Cornell. Up to the very last, it was generally assumed, certainly by Dr. Thurston himself, that his role was that of an adviser rather than an active candidate himself. Finally, however, in a letter from Thurston to Kent under date of June 16, 1885, he refers to a telegram from Dr. White accepting the conditions which he, Thurston, had proposed as essential to his consideration of their offer to himself of the position; he then expressed to Kent the feeling that, "had I not been in the way, you would, perhaps have gone there, and that causes me regret."

Between the accounts given in copies of Dr. Thurston's letters to Kent and Dr. White's account written some thirty years after the event, there is some uncertainty as to just when and where Thurston first received the suggestion of considering the appointment for himself. It is clear, however, that he did not give his final acceptance of the offer until certain conditions had been met, conditions which he considered essential to the proper realization of the major purposes in view.

Thus there is extant a letter written by Dr. Thurston to President White under date of May 26, 1885, setting forth his views and understanding regarding the authority and responsibility to be vested in the position to which he had been invited. This letter apparently served as the basis of a final and definite understanding regarding these matters, as evidenced by the telegram from White to Thurston, referred to in the letter from Thurston to Kent, noted above.

The attitude of the committee regarding the choice of Dr. Thurston for the position is clear from correspondence between the late Walter C. Kerr, the alumnus member of the committee, and Dr. White, showing clearly that Thurston was the choice of the committee from the start, and if there was delay in making a direct approach to him regarding the matter, it was doubtless due to a fear that with his connections in and about New York City, it would not be easy to interest him in taking up the work at Ithaca.

So in 1885 began the new era for Sibley College. In the article by Dr. White previously quoted from, and speaking of the period immediately following 1885, he says:

> So began a new era for Sibley College, for Cornell University, and indeed, for the country. . . . Professor Thurston's coming put an end to all divided counsels and began a new and better order of things.

The picture which Dr. Thurston had formed in his own mind of a college of mechanical engineering was far removed from the relatively simple plan which had so far been followed. As set forth in his first annual report, he visualized a comprehensive system of schools of engineering and of the underlying mechanic arts. In the lower or fundamental departments, these schools would offer instruction in the principal departments of industry, and then, built upon these, schools of the industries in which, to quote his own words, "the use of the apparatus of the several industries as well as the scientific and statistical facts and principles underlying them should be exhibited and illustrated by learned and expert teachers." And then, finally, schools of the constructive professions of engineering, architecture and industrial art, conducted by men distinguished in their respective professions; and then, in immediate contact with all of this splendid picture, he visualized a department of experimental research in which, again to quote his words:

> . . . men who have earned their spurs in the earlier struggles of previous years, and who have acquired a right to liberty to continue their work of solution of the great problems of the unknown, shall give themselves wholly, with all their time, talent, strength and genius, to the work which attracts them. . . .

And then he closes with the words: "All this is now and here a possibility—given capital."

As we know, not all of this splendid picture was realized. Limitations arose in time, in funds and in

human effort. Graduate schools in naval architecture and marine engineering and in railway engineering were organized and carried on for some years, but the experience with these schools showed that the idea as expressed wholly in terms of *graduate* study was somewhat ahead of the temper and demands of the time.

Just as Dr. Thurston was transferring to Cornell, the newly organizing field of electrical engineering was beginning clearly to show its importance, though few of its foremost protagonists could, at that time, have imagined the brilliant future which lay just ahead of this newly developing domain of engineering work.

A few years earlier, in 1883, a course of instruction in electrical engineering at Cornell had been organized and announced. The work was wholly in the department of physics under Professor Anthony. Dr. Thurston in 1886 took steps, through a cooperative arrangement with the department of physics, to supplement and round out the work in the department of physics with courses of instruction and training in the more directly professional phases of the subject.

Thus in the late years of the decade 1880–90, Sibley College became a college of mechanical and electrical engineering, with courses substantially the same for the first three years, but diverging each along its special line for the senior and graduate years.

Another cardinal feature in Dr. Thurston's picture of a great school of engineering—the Department of Experimental Research—was promptly organized and carried along vigorously in the lines of both mechanical and electrical engineering.

The growth of Sibley College both in numbers and in prestige was continuous and notable throughout the period of his work at Cornell. In 1885, there were seven members on the teaching staff and about sixty students. At the time of his death in 1903, the respective numbers were forty-three and nine hundred and sixty.

If the attempt be made to sum up in a single sentence the results of Dr. Thurston's work at Cornell, it may be said that they were manifest in a broadening and strengthening of the courses of instruction, and in an infusion into the work, especially of the junior, senior and graduate years, of a more distinctly professional atmosphere; in giving to the college front rank prestige and standing among the engineering schools of the country and of the world, and finally in putting the imprint of his spirit and fine idealism on some sixteen hundred graduates who passed into and through the college during the years of his life as its directing head.

In the paper by President White previously quoted from, he says further, in speaking of Dr. Thurston's work as a whole:

He brought the institution immediately into touch with the leading men in the profession, not only in this country but in other lands. It became my duty later, at various places and institutions, in company with him, to perfect our relations with leading establishments for mechanical engineering, at home and abroad, and everywhere he was received as an authority and treated as a full equal among the leaders in the profession. At home, in his class room, in his business office, in his study, he was a center toward which students in ever increasing numbers were attracted; his books, his lectures, his talks were an inspiration. Various men prepared by him, who were destined to carry on his work, will, everyone of them, testify to his influence upon his students, upon the institution at large and upon the whole field of its activity. How Sibley College, in those days, was increased in its numbers, improved in its work, and altogether, how a new epoch began, not only for itself, but for the University, is known especially by all those who had the great privilege and honor of graduating under him.

Again in a different connection but referring to these same years, President White says:

Few days in the history of Cornell University have been so fraught with good as that on which Thurston accepted my call to the headship of Sibley College. At the very outset he gained the confidence and gratitude of trustees, professors, students, and indeed, of his profession throughout the country, by his amazing success as professor, as author, as an organizer and administrator of that department, which he made not only one of the largest, but one of the best of its kind in the world. The rapidity and wisdom of his decisions, the extent and excellence of his work, his skill in attracting the best men, his ability in quieting rivalries and animosities, and the kindly firmness of his whole policy were a source of wonder to all who knew him.

As a writer, during these years, Dr. Thurston maintained a steady pace, both in the production of books and of papers on technical subjects.

At Stevens Institute he had outlined, in mind, a great series of engineering texts. Of these, his treatise on "Friction and Lost Work in Machinery and Millwork" was completed at Stevens Institute in 1885, just as he was transferring to Cornell. He had projected two great works, one on the steam boiler and another on the steam engine. Some work had been done on these books, but they were unfinished, and to their completion and publication he gave much time and energy during his earlier years at Cornell. The "Manual of Steam Boilers" was published in 1888 and that on the steam engine in 1891–92. In addition to this, there was, during the entire period of his life at Cornell, continued work on revision of books already published as well as a continued output of papers on technical and more general subjects, astonishing in their number and in the wide variety of topics treated.

In addition to the work of organization, administration and instruction in Sibley College and to his tre-

mendous output of technical writing, Dr. Thurston found time for much service of a public character. Only a few illustrations need be given. Thus: service as a member of the New York State Commission on Voting Machines; service as a member of a New York State Commission to report on a Modern Rifle for the National Guard; service on the United States Industrial Commission on Improvements in Manufacturing Methods and on the United States Commission on Safe and Vault Construction for the U. S. Treasury.

In 1889 he attended the French Exposition in Paris and took a prominent part as vice-president of one of the juries. Again in 1893 he served as a member of the Jury of Awards at the World's Columbian Exposition in Chicago. Again and in widely different lines Dr. Thurston served for six years as a member of the board of aldermen for the city of Ithaca, for most of the time as chairman of the finance committee and at a later time as a member of its board of water commissioners.

Dr. Thurston was always ready and willing, within the limits of his obligations otherwise, to undertake service for the public good or where he believed that his training and experience might be of specific and definite value. He was, furthermore, sufficiently human to distinctly enjoy public service of an important character and where the work was such as to bring him into contact with other men of note.

The family life of Dr. Thurston was most fortunate and happy. His family comprised his wife, three daughters and, for portions of the time, Mrs. Thurston's mother and sister, Mrs. and Miss Boughton.

Soon after coming to Cornell he built a comfortable house on East Avenue, and I can not refrain from adding here the source of the funds for the construction of this house. In connection with the capture of the blockage runner *Princess Royal* during the Civil War, and to which reference has been made by Admiral Brown, Thurston received as prize money the sum of $2,291.99. This was first invested in government bonds and later in real estate, first in Providence, R. I., and later in Hoboken. As a result of the advances in value realized in these various transactions, he was able, selling out these holdings, to build his house at Cornell; and it was always a matter of much satisfaction to him that, through the judicious use of this prize money, he had been able to furnish the major part of the funds necessary for the provision of comfortable housing for himself and his family for the remainder of his days.

I have spoken thus far chiefly of Dr. Thurston as an educator; somewhat incidentally as an engineer, as a public servant and as a writer. I can not bear to close my tribute, however, without a word regarding him as a man among men, as a friend and neighbor, as a social unit in the delightful atmosphere of the Cornell campus. If I were to attempt the briefest possible specification of the character of Dr. Thurston, I would say that the controlling elements in this complex were an abiding faith in himself, unwavering persistence toward his objectives and a steadfast optimism, all combined with generous and kindly human impulses toward those about him, with a serene, cheerful and confident outlook regarding both present and future. He was always ready to accept responsibility and to undertake any task which seemed to fall in the line of his duty, which seemed worth while and for which the means were at hand. These characteristics are illustrated throughout his entire life.

I would not imply, however, that his faith in himself was such as to lead to reckless and ill-considered measures. It was tempered with a wise restraint. In the face of important steps his strategy included not only a most careful survey and analysis of the matter by himself, but the taking of counsel with those in whose opinion he had confidence. In the end he might or might not follow advice given, but if not, it was always after a careful and generous weighing of such counsel given. He was ready at the last to accept responsibility for the final judgment and to make it in the light of all the assembled evidence which he could bring to bear on the problem.

No characteristic was perhaps more marked than his persistence in following through in the face of discouraging obstacles. Repeated return to the attack, again and again, always with the same cherry optimism, gives the secret of the successful outcome of some of his undertakings carried forward against obstacles which might well have discouraged a soul less persistent, less hopeful and less assured of the righteousness of the ends for which he was working.

Members of the board of trustees of those days have told in later years of the cheerful and unruffled manner in which he would accept unfavorable action with regard to the grant of funds or regarding some other measure which they might not find themselves in a position to forward as rapidly as he might wish. With no exhibition of impatience or disappointment, he would bid them a cheery and courteous good day, with the assurance that in due time he would venture to present the matter again in the hope that it might then commend itself to their more favorable consideration. One of the trustees of that period, speaking of these matters, once remarked that "it was no wonder that a man like that got what he wanted in the end."

Not many in this room have, perhaps, seen Dr. Thurston in the flesh. I wish that I might give some adequate picture of him, for example, in his daily walk across the campus from his home to the Sibley buildings. The late Dr. W. A. Hammond, of the department of philosophy at Cornell, who will be remembered by many in this audience, once told me

that in going to classes in the morning, his path often crossed that of Dr. Thurston and that he grew to look forward to these meetings with anticipation; that Dr. Thurston's manner of saying "Good morning" would always make the day seem brighter and fairer for him.

In physical frame, Dr. Thurston was moderate in stature, rather spare of build, erect in carriage and mien. His hair with full beard and moustache were in early and middle life black, becoming gray with the passing years. His eyes were dark and piercing, often with something kind and quizzical shining through. His gait was rapid and firm, with figure trim and erect, a characteristic tracing back, perhaps, to his naval training, but none the less a natural expression of his personal energy and normal outlook on the world about him. This daily walk between his house and office, with black portfolio of lecture notes under his arm, body erect, shoulders back, head up and eyes to the front, formed a picture of personal dignity and of purpose toward an intended goal which will surely long be remembered by those who saw this as a familiar sight during the years of his life at Cornell.

I wish that there were time for some of the anecdotes which illustrate his kindly nature, his intense human sympathy, his resourcefulness in adapting himself to the unexpected, all combined with his optimistic outlook on his environment, his abiding faith in the ultimate working out of the great enterprise in which he was embarked, but time presses and I must close.

The fall of 1903 found Dr. Thurston in seeming good health, in the midst of interesting and important work and apparently with many years of fruitful activity before him. On the occasion of his birthday, thirty-six years ago to-day, Mrs. Thurston had arranged for a small dinner party of intimate friends. Sitting quietly in his home waiting for the arrival of these friends, the final summons came—apparently through an aneurism of the heart. Peacefully and with hardly a movement he passed on, and so out of the busy life in which he had wrought so long, so courageously and so well.

In the shuffling of human characteristics by the Fates, only too rarely do the combinations give us a man such as was Dr. Robert Henry Thurston. We shall not soon look upon his like again.

PHOTOPERIODIC ASPECTS OF PHASIC DEVELOPMENT

By Professor W. F. LOEHWING

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THE concept of phasic development of plants has, in less than a decade, profoundly influenced the fundamental philosophy of plant growth as well as theory and practice in plant physiology, ecology, agronomy and genetics. This theory emphasizes especially the differences between the thermo- and photo-phases of plant growth. In view of the fact that recent advances in our knowledge of photoperiodism show variable effects of a given light period upon the different processes involved in sexual reproduction, it now seems desirable to evaluate this evidence to determine the possible desirability of subdividing the photophase of plant development into (*a*) an initial flowering phase as distinguished from a subsequent (*b*) gametogenic phase concerned with the formation of viable gametes.

When the photoperiodic concept was first clearly enunciated by Garner and Allard (1920), formation of macroscopic flowers in known periods of diurnal illumination was taken as a criterion of photoperiodic response. It was soon learned, however, that plants receiving minimal periods of photo-induction frequently produce flowers of anomalous shape and marked sterility. *Xanthium* of one short photoperiod, for example, exhibits marked pollen sterility (Hamner and Bonner, 1938; Neidle, 1939). Kirichenko and his associates (1934–36) had also previously observed that though flowers developed in *Triticum erythrospermum* when exposed for several weeks to a daily two-hour photoperiod, pollen when present was invariably sterile. The data of Kirichenko and other investigators indicate that the development of viable pollen requires (*a*) a longer period (6 hours or over) of photo-induction, consisting both of more days and longer daily light periods than necessary for the differentiation of pistil and ear. In conformity with other light-induced, formative processes, once the requisite period of photo-induction has been supplied, *Triticum erythrospermum* then continues to produce viable pollen indefinitely in all ranges of illumination from continuous day to continuous night. Oleson (1938) observed similar conditions in *Fuchsia* and *Begonia*.

The work of Rosenbaum (1937) on 18 varieties of soybean indicates that not only stamen but also perianth and ovule development can be suppressed by extremely short day length (8 hours or less), thus reducing the fruits to parthenocarpic, seedless pods. A 13-hour day, on the other hand, results in normal flowers producing pods with the usual complement of viable seeds (Hamner, 1938). Earlier still, Schaffner (1927–30), Richey and Sprague (1932) noted the absence of tassels in corn grown during very short