

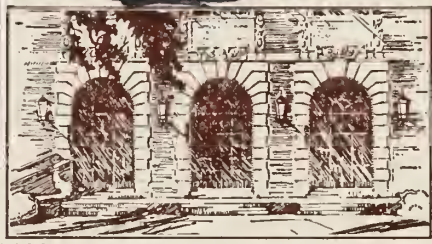


*GEORGE ALFRED
GOODENOUGH*

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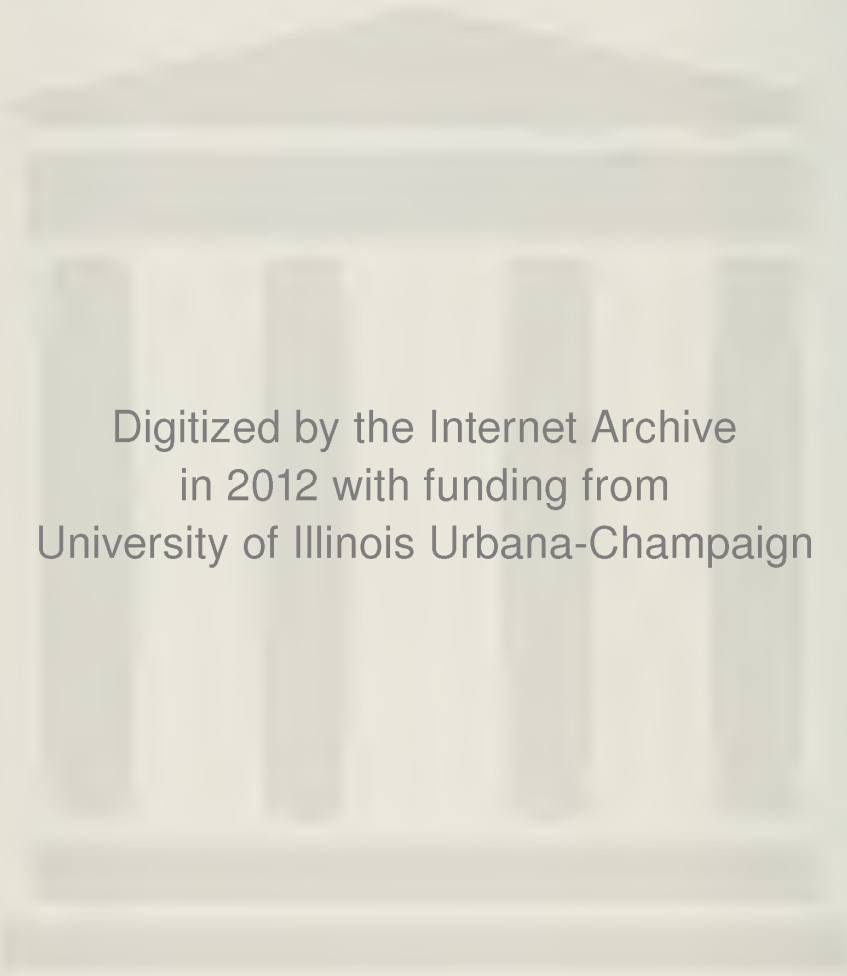
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Born in Davison, Michigan, May 3, 1868

Father, James Webster Goodenough was born October 1843 at
Niagara Falls, New York

Mother, Eliza Gifford Goodenough was born February 1844 in
Oshawa, Canada.

High School education at Flint, Michigan, High School

University education, B. S. from Michigan Agricultural Col-
lege, 1891 (later Michigan State University)
M. E. from University of Illinois, 1900

Married in Scranton, Pennsylvania September 27, 1894 to
Elizabeth C. Kitzmiller.

Important dates in his professional career.

1891-1893 Instructor in charge of shops at Michigan Agri-
culture College

1893-1895 with International Correspondence School as in-
structor

1895-1897 Instructor in Mechanical Engineering, University
of Illinois.

1897-1899 Editor for International Correspondence School

1899-1906 Assistant Professor, University of Illinois

1906-1911 Associate Professor of Mechanical Engineering

1909-1911 Acting Head of Department

1911-1929 Professor of Mechanical Engineering.

From 1906 until 1929 he was Illinois representative on the
Western Athletic Conference; from 1909-1910 he served as the
Secretary, and from 1910-1911 as Chairman.

Death occurred on September 29, 1929 at his home in a chair
before his desk, presumably from a heart attack.

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FOREWORD

When I was a student at the University of Illinois in the Department of Mechanical Engineering shortly after the turn of the century, it was my good fortune to come under the influence of an inspiring teacher, Professor George A. Goodenough. He possessed the rare faculty of motivating his students to master difficult engineering subjects with enthusiasm. His teaching was a major force in shaping my subsequent career.

His achievements in the field of thermodynamics in which he became an international authority brought great prestige to the University of Illinois. To honor and perpetuate the memory of this great teacher for ensuing generations of engineering students, I am establishing an endowment fund in his name for the College of Engineering which Professor George A. Goodenough served with such distinction.

ALWIN SCHALLER

Wellsville, New York
September 8, 1971

Out of the distant past came a voice that was faint but distinct. From a loyal alumnus of the class of 1907, who was a student more than two-thirds of a century ago, came a request that has brought a warm glow to those of us on the faculty in the Department of Mechanical Engineering, in this year of 1972.

Mr. Alwin Schaller asked a classmate of his (Mr. John C. Spittler of Urbana) to make an initial inquiry in the Department about the possibility of a memorial endowment fund in honor of his one-time preceptor, Professor George Alfred Goodenough. I embraced the opportunity to represent the Department since I was the only active member who had known Professor Goodenough.

INTRODUCTION
BY
SEICHI
KONZO

The letters that came from Mr. Schaller, after our initial contact had been established, released a flood of memories of a fascinating teacher who captivated his students with his mastery of thermodynamics. My first interview with Professor Goodenough was a pleasant experience. I had been guided to Illinois after completing my undergraduate training at the University of Washington, not only by faculty advice in Seattle, but also because of the frequency of Illinois authors on the covers of textbooks and references used in our courses: Leutwiler's *Machine Design and Power Plant Notes*, Harding and Willard's *Mechanical Equipment of Buildings*, Macintyre's *Refrigeration*, H. F. Moore's *Engineering Materials*, Seely and Ensign's *Mechanics*, Ham and Crane's *Mechanisms*, and Goodenough's *Principles of Thermodynamics*.

In 1927 each of the few graduate students in Mechanical Engineering had registration interviews with Professor Goodenough. My interview started with a recital of the thermodynamics text that we had used and the topics covered in the course. When he found that I had just finished a summer work period with a lumber company near Mt. Rainier National Park, in which I fed endless feet of kiln-dried lumber into a raucous rip saw during the day, and then practiced baseball in the evening so that we could field a company-sponsored, semi-professional team in the Timber League, his eyes beamed and his conversation took off on an entirely different tangent. Professor Goodenough was not only Chairman of the Faculty Senate Committee on Athletics, but also Faculty Representative for Illinois on the Western Conference (now the Big Ten Conference) at a time when the Conference was new. He was a strong supporter of the ethics and principles of George Huff, the first Athletic Director at Illinois. Professor Goodenough emphasized that his decisions in Conference matters were based en-

tirely on what was good for the Conference, regardless of the effect on Illinois. It must be remembered that his interview was in 1927, only two years after Red Grange had skyrocketed to national prominence and the many problems of subsidized athletes, intensive recruiting of high school athletes, and amateurism vs. professionalism were beginning to swamp the faculty representatives on the Conference. And so a long discussion that ranged over several topics from thermodynamics to college athletic programs came to an end.

These memories made it easy to promise cooperation in preparing a memorial brochure to announce the establishment of an endowment fund in the name of Professor Goodenough. Initially, the establishment of a scholarship fund for Mechanical Engineering students was considered. However, those of us on the inside of the educational world recognize severe limitations of such funds.

Over the years a number of different approaches to subsidized education have been tried in the Department. In general, the least successful has been an outright grant of money to some selected student. All too frequently we have found that scholarships were not fully appreciated by the student; in some cases he was not even aware of the donor, and all too often he took the money as "owing to him" and not as a special privilege. By contrast, Professor W. F. Stoecker had established an "Air Conditioning Fund" to which several industrial firms in the field were contributing from \$500 to \$1000 annually as a discretionary fund under his care. Professor Stoecker "hired" undergraduates and graduate students on an hourly basis at prevailing student wages and assigned them to special projects that were related to research or development in the professor's field of interest. For example, the projects could involve computer programs on a problem involving optimization of a system, or the development of an apparatus for observing the liquid-gas interface of a refrigerant in an evaporator, or assisting a graduate student on a thesis project. Professor Stoecker wisely expended part of the discretionary fund in inviting the students to a special luncheon to meet with industry engineers, or hired a bus to transport a large number of students and staff to attend a technical society meeting of ASHRAE in Chicago each spring.

Our observation of this discretionary fund was that students seemed to appreciate money received for such work far more than money given to them as an outright grant in the form of scholarships. In the case of the scholarship grant, one student out of several hundred is selected for a cash award. The fac-

ulty member who has made the nomination of a qualified student does not become involved afterward, and his interest is only temporal. On the other hand, a discretionary grant to a faculty member gives him a source of funds that even the Dean cannot touch and which will promote the faculty member's research and instructional program. Each year Professor Stoecker presents a short financial report of receipts and expenditures to his donors. The benefit of the grant is extended to many students, and an entire class benefits from instrumentation and supplies purchased from the grant. The success of the Air Conditioning Fund has led to similar grants to other faculty members in other fields.

Mr. Schaller agreed to the idea of a non-restrictive clause in the endowment fund, and in order to provide for an orderly and business-like distribution of funds, we have suggested the following manner of handling the fund. The endowment fund is to be deposited with the University of Illinois Foundation, a non-profit corporation. The annual income from interests and dividends is to be transferred to the Business Office and deposited in an account entitled: Schaller Endowment, Mechanical Engineering, Memorial to Professor G. A. Goodenough. The Business Office will submit monthly statements showing the balance in the fund. The Department will manage the fund through a special committee, chaired by the Associate Head, and consisting of the Department Head, the four Division Heads, the Alumni Secretary, and the Business Manager. Requests for financial assistance are to be initiated by individual faculty members by a written proposal explaining the specific need and the approximate amount. These will be reviewed by the Committee and a decision will be made about funding. In general, diversity in the application of the funds and the greatest benefit to the department is to be sought.

In explaining our proposal to Mr. Schaller the following types of projects were considered as worthy of support, although the list is not all inclusive:

- a) To purchase instruments and equipment that will improve the quality of instruction and research,
- b) To purchase books, films, slides, microfilms, and other visual aids that will improve the quality of instruction.
- c) To provide financial aid to students, both undergraduate and graduate, in the form of work projects, loans, or assistantships.
- d) To provide funds for lecturers, visiting scholars, consultants, and chairs in specialized areas.
- e) To provide for equipment, machines, and tools that will

improve the machine shop, publication office, electronics shop, photographic shop, and other technical facilities that are operated by the Department.

- f) To provide funds for improving student welfare such as: recognition of outstanding performance, meetings for better faculty-student and alumni-student relationships, and travel assistance for students to industry or technical society meetings.
- g) To provide funds for increasing the technical competence of the faculty, such as: assistance in research projects, publications of reports and papers, travel to attend important technical society meetings or to visit industries, and assistance in class and laboratory.
- h) To provide funds for improvement in alumni relationships, including more frequent communications with the alumni, recognizing and honoring distinguished alumni, and maintaining up-to-date records of addresses and positions.
- i) To provide funds for the improvement of the College and the University, including: publicity on extension courses, short courses, and symposiums; promotion of required college facilities for the Library and Extension Center, and planning for the future development of the Department and College.
- j) And promotion of other activities that will provide for a more distinguished Department in teaching, research, and public service.

Mr. Alwin Schaller has agreed to these recommendations. This extended description is offered so that other alumni and friends may be informed of more imaginative ways of helping their school than merely establishing scholarships. The formula would be applicable to any school and the end result would be a much more satisfying grant that has the full support of the faculty and the administration. The plan is flexible and will meet the needs of the future, which are unknown today.

We believe that no better memorial can be established in honor of the late Professor George Alfred Goodenough.

Perhaps distance lends enchantment. But it does seem that the decades of 1900 to 1920 were times of romance and innocence, of May poles and demure damsels, of mandolins and banjos, of push-ball contests and literary societies. In far-away Urbana, the wary, sophisticated students from Chicago came in contact with the more naive students from the small towns of downstate Illinois. Champaign-Urbana was a sort of Shangri-La isolated from the rest of the world, and where the activities and interests of the student community were self-centered. As if to symbolize this isolation, more than 4500 huge American elm trees provided a protective canopy over the campus and towns.

In this self-sufficient community, a notable band of educators of mechanical engineering had been assembled. Every member of the faculty was a practicing engineer, possessed of great depth in his understanding of the field. Three titans, among these giants, seemed to be possessed with an overwhelming passion to seek and obtain some order out of the chaos of knowledge that abounded.

Professor Arthur Cutts Willard examined the state of art in the fields of heating, ventilating, refrigeration, and air conditioning, and, together with Professor Louis A. Harding, compiled the definitive volumes on "Mechanical Equipment of Buildings" that were in the offices of all architects and consulting mechanical engineers in this country. Professor Oscar Adolph Leutwiler selected from among the empirical, semi-empirical, and theoretical equations in the field of machine design and in 1917 issued his classic book *Machine Design* that was adopted by most of the engineering colleges of the day. His *Notes on Power Plant Design* was a similar assembly of practical assumptions and equations that was intended to codify the design processes for large power stations. The third member of this triumvirate, Professor George Alfred Goodenough (pronounced Good-uh-no), had a similar passion for orderliness, and he presented basic elements of thermodynamics in clear, concise, and logical form.

These three, together with an outstanding supporting staff that included such men as C. W. Ham in machine design, A. P. Kratz in experimental heat transfer, H. J. MacIntyre in refrigeration, J. A. Polson in internal combustion engines, B. W. Benedict in machine tools, and W. H. Severns in heating and ventilating, formed the backbone of an eminent team of mechanical engineering educators. The University was blessed with engineering faculty of equal prominence in allied fields: Herbert Fisher Moore in fatigue of metals, Hardy Cross in structures, Wilbur

THE
ACADEMIC
TIMES
OF
GEORGE
ALFRED
GOODENOUGH

M. Wilson in welded structures, Arthur Newell Talbot in concrete, Milo S. Ketchum in structures, and Fred B. Seely and Herald Malcolm Westergaard in theoretical mechanics.

The influence of these faculty members was perhaps more direct in the early 1900's than it would be today, because the curriculum at that time was more restrictive and every student had to endure the suspense and the agonies of the courses taught by each specialist. Alumni recall the head-shaking, emphatic Willard as he strode back and forth before the class expounding facts, theories, and personal contentions with much vigor and machine-gun like incisiveness. Alumni still quake when they remember the discipline and the head-shrinking process that occurred when they attended the classes of Leutwiler, a tyrant in class but a wonderfully human and considerate personality outside of the classroom. And alumni recall with delight the entirely different personality of Goodenough, whom they regarded with awe because of his computational skill, his prodigious memory, and his facile handling of higher mathematics.

One can only conclude that the conditions were right for the mechanical engineering students of the time. They were provided exposure to eminent men who were not only practicing engineers well-versed in theory, but in addition had the God-given ability to project their personalities on sensitive youth who were seeking guidance in professional careers. The influence of an educator of the caliber of Professor Goodenough is best summarized in the Memorial Resolution prepared by Professors O. A. Leutwiler, E. C. Schmidt, and A. C. Willard, and adopted by the College of Engineering faculty on October 31, 1929, as follows:

In the death of Professor George Alfred Goodenough, which occurred on September 29, 1929, the College of Engineering lost an inspiring teacher, an outstanding leader of scientific thought, and a man of broad sympathies and many interests.

Professor Goodenough was born in Davison, Michigan, May 3, 1868. He began his 36 years of teaching experience immediately after graduating from the Michigan Agricultural College in 1891. He was an instructor in Mechanics at his alma mater for two years, then instructor with the International Correspondence Schools for one year. Coming to the University of Illinois in 1895 as Instructor in Mechanical Engineering, his services to the University have been continuous, except for

a period of two years when he was called back to the International Correspondence Schools to edit their well known series of technical text books. Professor Goodenough received the professional degree of Mechanical Engineer from the University in 1900. He was Acting Head of the Department of Mechanical Engineering in 1909 and 1910, and was made Professor of Thermodynamics in 1911, at which time he became a member of the University Senate.

As a teacher, Professor Goodenough achieved such success as few men in engineering education have ever enjoyed. His wonderful technical knowledge and his sympathetic tolerance for others not familiar with his special field amazed and delighted students and faculty alike. Scores of graduates and former students of the College of Engineering enthusiastically proclaim him the greatest teacher of their experience. His sympathetic understanding of young men, coupled with an ability to command their respect and loyalty, secured for him the unstinted effort of each and every student who came under his tutelage. Professor Goodenough was an untiring worker; his students caught the spirit of their teacher and gave their best thought and energy to the master of a difficult subject.

As a scientific investigator and engineer in the special field of thermodynamics, as well as in the broader field of mechanical engineering, Professor Goodenough's conspicuous achievements are well known both in this country and abroad. His writings in the fields of thermodynamics are taken as authoritative the world over. Several bulletins of the Engineering Experiment Station are the products of his labor and genius. Textbooks in mathematics, thermodynamics, and steam engineering attest the scope of his scholastic interest. He was an active participant in the work done at the University in solving the difficult problem of ventilation of the Holland Vehicular Tunnel under the Hudson River at New York City. At the time of his death and for more than three years prior thereto, Professor Goodenough held the distinguished position of consulting engineer to the General Electric Company.

As a member of the faculty of the College and the University, Professor Goodenough gave generously and effectively of his time and energy. Because of the soundness of his judgment, his keen perception, and his

breadth of vision, he was a valued member of both College and University committees. As Chairman of the Faculty Committee on Athletics and as the Illinois representative on the Intercollegiate Conference for many years, he rendered service of great worth to intercollegiate athletics not only in the University but in the Middle West.

Professor Goodenough was a member of the American Society of Mechanical Engineers, the Society for the Promotion of Engineering Education, Sigma Xi, Tau Beta Pi, Pi Tau Sigma, and Phi Gamma Delta.

The College of Engineering desires to extend its sincere and heartfelt sympathy to the family of Professor Goodenough, and herewith records its great appreciation of the services and character of an honored and cherished colleague.

Tributes to the memory of Professor Goodenough came also from the men with whom he served during the 23 years he represented the University on the Western Intercollegiate Conference (now the Big Ten Conference.)

George Alfred Goodenough was an esteemed and honored member of the Conference for 23 years. During that period the major portion of its legislation was enacted. The Conference Code reflects his fair mindedness, his reflective temperament, and his wide experience in athletic matters. He was a close student of athletic problems. He was always seeking for the right solution, but never forgetting that it must be a practical one. His mathematically trained mind permitted only the use of clear, terse, and unambiguous language.

Professor Goodenough's greatest and lasting service to the Conference is found in his interpretation of its rules, handed down as chairman of the eligibility committee for more than a decade. This service he rendered painstakingly. These rulings were so fair, so just, and rendered with such candor and grace of manner as to win the respect and confidence of all members.

He was wise in his counsellings. He was courageous in his positions. He was fair in his judgments. He was kindly in his bearing. The qualities of mind caused us to repose in his confidence and trust.

His hearty, jovial nature, so friendly, so interested in the enjoyable side of life, made him a most companionable man, and drew us to him in strong bonds of affection. We miss our wise counsellor. We mourn our friend. The Conference has sustained a great loss.

The respect accorded Professor Goodenough in his service in this extra-curricular labor of love is best epitomized by the statement made by the late "G" Huff:

Perhaps the greatest tribute I can pay to him is to say that in all Conference legislation he never raised the question of how it would affect Illinois and I am sure he never thought of that. He considered it solely from the viewpoint as to whether or not the legislation was for the best interest of athletics.

The personal side of Professor Goodenough is difficult to recall at this late date, but here Mr. Lester G. Leutwiler, the son of the late Professor Oscar A. Leutwiler, provides a glimpse of long, long ago.

"Professor and Mrs. Goodenough lived on Lincoln Avenue three to four houses south of Green Street, on the west side of the street (309 S. Lincoln). Their house was of stucco construction and always well maintained as long as he was living there.

Mrs. Goodenough always called him 'Alfie'. They were both of English background, as near as I can remember. They had many friends in the East, as a result of their living in eastern Pennsylvania at one time. I am not certain as to just where they became acquainted with my parents, but I know that many of their friends were mutual. As you know, my father taught at Lehigh University for the first two years after he was married and then returned to the University of Illinois.

"In the early days, I recall my father and Professor Goodenough going to play golf on their bicycles. Professor Goodenough was not as much of a golfer as my dad and did not keep up the sport.

"Professor Goodenough enjoyed sitting in an old, well-worn, black leather upholstered chair and was completely relaxed with his slippers on in the evening after returning from the office. He enjoyed good music and had an Edison machine with hundreds of records, particularly symphonies and band music. As the records played, he would pick out various instruments

in concert and vocally sound out the various parts. It would appear that this was one of his ways of relaxing.

“He enjoyed good art. In fact his son, Arthur, enjoyed painting and did considerable with his talents in this area. As you know, he has a grandson, Bradford, and I believe Mrs. Arthur Goodenough is still living.

“Probably one of the best memories I have of my parents and the Goodenoughs was their Saturday evening games of Whist. They usually started playing around 7:30, going on to 11:30, alternating their games at each other’s homes. They kept score for the entire year and partners were some years between the Goodenoughs and my parents, and other years between alternate spouses. In the game of Whist, four players take part with a regular deck of cards and one point is given for each trick over six. They kept individual scores during the evening with poker chips and I can recall many heated games. The losers treated with dinner at the end of the year.

“I neglected to comment on one of my early experiences with Professor Goodenough. As a child, we always exchanged Christmas gifts with the Goodenoughs and celebrated at each other’s homes on alternate years. Our recognition of Christmas was on Christmas Eve, at which time Professor Goodenough and my father would alternate as Santa Claus. As you know, one was tall and slender and the other was short and stocky. My sister commented several times—in the period before she got wise to the symbol of Santa Claus—that Santa Claus was fat one year and slim the next year.

(From notes supplied by Mr. Lester G. Leutwiler, Class of 1929, and now Vice President Production, Grocery products Division of Pet, Incorporated, of St. Louis, Missouri. Mr. Leutwiler obtained his Bachelor of Science degree in Mechanical Engineering.)

In the world external to "Shangri-La," the industrial revolution was in full sway. Activity was centered in heavy industry; the products of mills and factories ended in heavy hardware, such as locomotives, freight cars, ships and large steam engines. Henry Ford and the mass-produced automobile were making positive strides; interchangeability of machined parts was introduced in New England metal fabricating factories; the Wright Brothers at Kitty Hawk were initiating a new dimension in man's conquest of nature; transcontinental railroads were being completed across the Rockies; steam engines of tremendous dimensions were turning wheels which moved the belts which finally moved the pulleys and axles of industry. The equipment produced in these decades was slow-moving, massive, rugged, reliable, and most impressive.

*THE
PUBLICATIONS
OF
GEORGE
ALFRED
GOODENOUGH*

One always wonders: What would the fertile mind of Goodenough be concentrating upon if he were alive in the 1970's? With the knowledge now available, where would his inquiries lead? Of one thing we can be certain: a searching mind as agile as that of Goodenough would never be idle.

Living as he did at the turn of the twentieth century, Professor Goodenough turned to the problems that were of importance at the time, and one of these was the accurate delineation of the properties of saturated and superheated steam. The transition from slow-moving steam engines to high-speed steam turbines occurred during the career of Professor Goodenough, who encountered many of the problems relating to steam turbines in his capacity as a consultant to the Turbine Research Department of General Electric Company. He brought many of his basic problems back to the campus, and when a logical solution was developed he exposed them to his students. Just a year before his death he was fascinated with the conditions leading to supersaturated steam and the resulting impact of droplets on turbine blades. His interest in power included the intricate processes occurring in the internal combustion engine—again, his analysis and problem solving were far ahead of the simplified stoichiometric analysis of the day.

His tools of trade were few—a book of logarithms, sheets of paper, pencil, blackboard, and chalk. He conducted no experiments, he directed no laboratory projects. His was a thinking game in which he utilized the best experimental data of scientists over the world, and then applied logic and analysis to evolve a rational solution. He did, it is true, encourage students and faculty colleagues to conduct experiments and research to provide accurate data upon which theories could be built.

Most of his contributions were published under the format of the Engineering Experiment Station, which was established during the early days of the Twentieth century. His preference to this source instead of national technical publications was probably from a sense of loyalty to a newly developing organization. Certainly the contributions of Professors Goodenough and L. P. Breckenridge in Mechanical Engineering, Professor A. N. Talbot in Theoretical and Applied Mechanics, and Professor W. M. Wilson in Civil Engineering did much to establish the reputation of the Engineering Experiment Station bulletins. A distinct advantage that the Station bulletins had over other publications forms was that sufficient space was provided for a complete exposition of a subject. In this respect the writings of Professor Goodenough are a model for any technical writer. Each bulletin is a self-contained unit containing historical review, analysis of experimental evidence, establishment of theory consistent with laws of physics, complete tabular data, and numerous example problems. Each of these publications is an engineering text that can be extrapolated for practical applications to the field.

The assistance of Mr. Maynard Jay Brichford, University Archivist, is gratefully acknowledged.

Bringing order out of chaos seems to have been a passion for Professor Goodenough. In this extension of the Dewey Decimal System, the classification was applied to mechanical engineering and a first edition of six pages was printed. This was followed by second, third and fourth printings, each an elaboration of the first printing. The 1906 edition included electrical engineering and railway engineering.

L. P. Breckenridge and G. A. Goodenough, University of Illinois Engineering Experiment Station Bulletin 9, 71 pages, 1905 (revised 1912).

AN
EXTENSION
OF THE
DEWEY
DECIMAL
SYSTEM
OF
CLASSIFICATION
APPLIED
TO THE
ENGINEERING
INDUSTRIES

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The foreword states: "Experiments have been made, it is true, but these have been for the purpose of determining the ultimate strength of the chain when tested to destruction and are thus purely empirical.—the results are not satisfactory, chains break, often with disastrous consequences, and the only reason that more do not break is that a chain is seldom subjected to its rated load.—The present analysis assumes a distribution of pressure over a definite area" (as contrasted with earlier assumptions of concentration at a point).

THE
STRENGTH
OF
CHAIN LINKS

Notes from Mr. Schaller: "The stress analysis of chain links lay dormant from 1900 until experimentally verified in 1907. Some, if not all, of the steam shovels that dug the Panama Canal used chains. The chain lost its importance as a vital machine component, due to the introduction of wire rope.—My first employment (in 1907) was with a construction company that was engaged in building a cement plant. We erected a large tonnage of structural steel and had four steam hoisting engines on the job. All were equipped with wire ropes."

G. A. Goodenough and L. E. Moore, University of Illinois Engineering Experiment Station Bulletin 18, 73 pages, 1907.

FIRST
COURSE
IN
CALCULUS

ESSENTIALS
OF
CALCULUS

The authors stated: "Much emphasis is placed upon the applications of the calculus to practical problems. Some problems are introduced that show the use of calculus in discussing well-known applications to physical and engineering phenomena.— Functions of two or more variables, because of their importance in physics, have been discussed more fully than usual.— Attention is called to the treatment of exact and inexact differentials; a subject of first importance in the physical applications of calculus."

Notes from Mr. Schaller: "In my time many young men began the study of engineering inadequately prepared in mathematics. This handicap still persisted when they enrolled in such subjects as Theoretical and Applied Mechanics or Thermodynamics. The result was that so much time had to be spent on the mathematics of the problems that little remained to think about the laws of physics involved."

1908, Henry Holt and Co.

E. J. Townsend and G. A. Goodenough, 355 pages, Henry Holt and Company, 1910.

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ENTROPY

We must look upon entropy merely as a function of the state of the system—one of many such functions that can be found. It is a function that, applied to an isolated system, gives us information regarding the possibility of change and the direction of the change. It further gives a measure of the degree of the degradation of energy due to change."

Journal of the Western Society of Engineers, v.XVI, March 1911, pp. 193-207. Discussion covers 33 additional pages.

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THE
PROPERTIES
OF
SATURATED
AND
SUPERHEATED
AMMONIA
VAPOR

This bulletin is an excellent example of a thorough bibliographical survey, an engineering analysis based on the best available experimental evidence, and presentation of numerous examples for users of the data. Cross comparisons are made of experimental data and the "fit" of the Goodenough theoretical equations with the best of the experimental evidence is convincing.

G. A. Goodenough and William Earl Mosher, 94 pages, 1913, University of Illinois Engineering Experiment Station Bulletin 66.

The classic researches of Regnault in 1847 formed the basis of all tabulations of thermal properties of Steam. Within the ten years preceding 1914 a number of experimenters in Germany and England presented data of a high degree of accuracy, and these were incorporated by Professor Goodenough in equations that expressed the variations of these properties through well-known thermodynamic laws. In this work he acknowledges the work by Mr. Alwin Schaller and Mr. John A. Dent. The bulletins presents a complete analysis of available data.

*THERMAL
PROPERTIES
OF
STEAM*

Notes from Mr. Schaller: "In the summer of 1904, I visited the World's Fair in St. Louis. The center of attraction in Machinery Hall was an angle-compound steam engine, which carried the entire load of the fair. The steam turbine was represented by only one small motor, a Parsons turbine exhibited by Westinghouse. Every time I went to view this machine, it was down for repairs and I never did see it in operation.

"The picture changed almost overnight. By 1907 the march away from the steam engine as a prime-mover to the turbo generator was in full stride. The Commonwealth Edison Company had placed into operation its Fisk Street Station, the first central station in the United States designed for steam turbines. It contained ten 12,000 KW vertical-shaft General Electric units.

"As facilities were lacking to test this size unit at the point of manufacture, arrangements were made for an exhaustive test of one unit while in operation. To secure the personnel required to take all of the required simultaneous readings, senior students in Mechanical Engineering at the University of Wisconsin and Illinois were permitted to volunteer. I accepted two weeks assignment and was detailed to weigh the condensate. Being informed of the load, I quickly obtained the approximate water rate and could see how much this was influenced by the degree of vacuum.

"Before the advent of the steam turbine there was little interest in superheated steam. We were taught that the specific heat was constant and equal to 0.48. The only time we came in contact with this figure was in the use of the Peabody calorimeter for determining the quality of saturated steam.

"The findings of Knoblauch and Jakob which became available in the early part of 1907, proved conclusively that the specific heat of superheated steam was not a constant but a function of both the pressure and temperature. It was then apparent that previous concepts were fallacious.

"A new set of tables for both saturated and superheated steam were published by Marks and Davis of Harvard University in 1908. These embodied the latest and most accurate researches on steam, both in the saturated and superheated region. However, there was no mathematical formulation for computing the heat content of superheated steam. These values were obtained as follows: In Table 3, the total heat and entropy increments from saturation at a number of standard pressures were computed by a step-by-step numerical integrations of the C_p curves and the results plotted on a large scale. Smooth curves were then drawn for each of the superheats required and the increments read off for the intermediate pressures.

"In the fall of 1910, part of my duties were to assist Professor Goodenough in his work of teaching Thermodynamics. My responsibilities were shared with Mr. John Dent who was born in Potter County, Pennsylvania, about 25 miles from Wellsville, New York, and graduated from Lehigh University. He was blessed with a brilliant mind and had a successful career as a teacher at Illinois and later in Pittsburgh, Pennsylvania. I mention these details because he played an important role in the events which follow.

"In the Preface of the first edition of *The Principles of Thermodynamics*, 1911, Professor Goodenough wrote to Mr. John Dent, I am indebted for assistance in the construction of the tables and in the revision of the proof sheets.

"The school year, 1910-1911, was entering its final phase when Professor Goodenough asked John Dent and myself to an afternoon conference. Neither of us had the faintest idea about what was to transpire. At the appointed time he entered the deserted classroom with a sheaf of papers, and placed on the blackboard the empirical equation (No. 1, page 203) which Linde had deduced to represent the results of the Munich experiments on the pressure, temperature, volume relation of superheated steam conducted by Knoblauch, Linde and Klebe. He pointed out that this equation did not lend itself to working out a general theory.

"Professor Goodenough made many attempts to modify this equation into a more useful form and his repeated efforts were finally crowned with success and he put equation No. 3 (page 203) on the board. This equation passed its first test because it represented the results of the Munich experiments. Next, Professor Goodenough placed on the board much of the material covered in pages 204 to 223 inclusive in an abbreviated form.

He showed us how the superheated steam tables could be calculated from the characteristic equation 3.

“To assist in proving the validity of these equations John Dent and I each took a series of different conditions and carried through the necessary computations by means of logarithms. These were then compared with the figures in the Marks and Davis Tables. No serious discrepancies were found.

“John and I were the first to know that Professor Goodenough had succeeded where many others had failed. He deduced a characteristic equation for superheated steam which readily lends itself to calculating changes of state or computing the values required for a steam table. To me this was a monumental achievement.”

G. A. Goodenough, University of Illinois Engineering Experiment Station Bulletin 75, 69 pages, 1914.

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The Preface to the third edition (1920) states that the subject matter of the first edition was entirely rewritten and rearranged. The first half of the text deals with the presentation of fundamental laws. The treatment of available energy and entropy was worked out with special care. The latter half of the book deals with heat engines and applications, and covers such topics as: flow of fluids, flow of compressible fluids, throttling, steam engine, steam turbine, compressed air, refrigeration, combustion, internal combustion engines, and mixtures of gases and vapors.

*PRINCIPLES
OF
THERMO-
DYNAMICS*

Notes from Mr. Schaller: “The treatment of Dalton’s Law of partial pressures was very superficial in all of the textbooks on Thermodynamics then in use in American colleges and universities. At the end of Chapter XI there are only three references. We must conclude therefore that the investigation and equations on this subject are largely original with Professor Goodenough.

“Back in 1910 a certain man gained considerable attention for his idea that the economy of a steam engine could be materially improved by using a mixture of steam and compressed air. In

paragraph 147, page 236, the author states: "The suggestion has been made that a mixture of air at relatively high temperature and pressure can be mixed with steam either superheated, saturated or with a slight amount of moisture be used as a medium for a heat engine."

"This proposal aroused Professor Goodenough's interest with the results stated in the concluding paragraph of Chapter XII. 'The discussion of Articles 146 and 147 furnished the necessary equations for the analysis of the action of a motor that uses a mixture of air and steam as its working fluid.' At this late date (1972) it is interesting to recall that the man who first proposed this idea not only received attention but also some financial backing. Such an engine was actually built using a standard Corliss engine frame.

"About eight years ago, I decided to make a serious study of Chapter XII. By a strange coincidence at that time, the Turbine Division of the Worthington Corporation, located in Wellsville, received an order from the Sanitary Commission of Chicago for a 12000 KW turbo-generator to operate on a mixture of saturated steam and sewer gas. The Commission had contracted to install a plant at Stickney, Illinois using the Zimmerman process for the flameless combustion of sewage sludge, the by-product of which is the mixture referred to. This process requires the use of reactors under a pressure of 2500 psi.

"In order to design a multi-stage turbine or gas expander, it is first necessary to construct a Mollier chart for the medium to be used. The senior engineers of the Turbine Division supplied me with their original data on the state of the mixture and the analysis of the sewer gas.

"To secure the coordinates of a line on a Mollier chart, a series of changes of state at constant pressure must be computed. While this procedure is not outlined in Articles 145 and 147, I was able to set up such an equation and carried through the computations for one change going from saturation to a condition of 2% moisture. In a conference with the engineer who had constructed the required chart, with the aid of a computer, he approved my analysis. In other words, the reasoning and equations of Chapter XII are still valid. A motor using a mixed medium has been built and put into operation, the design of which was based on the principles laid down by Professor Goodenough a half century earlier."

G. A. Goodenough, 353 pages, Henry Holt and Company, 1911, revised 1920.

Fifty prominent engineers were contributors to this handbook, including Professor Edward C. Schmidt (Railway), and Clarence W. Ham, (at the time Assistant Professor at Cornell, and later to become a colleague of Professor Goodenough).

*MECHANICAL
ENGINEER'S
HANDBOOK*

The compression and condensation of material includes three distinct subject areas: the first area of physical phenomena covers mixtures, freezing, boiling, heats of fusion and latent heats, as well as heat transfer. The second area covers gas mixtures, ideal cycles, engineering fluids, humidity, evaporation, and drying. The third area covers engineering applications to engines, refrigerating processes, liquefaction, flow, combustion, and gas producers.

by G. A. Goodenough, pages 290-373.
edited by Lionel S. Marks, McGraw-Hill Book Co., First edition, 1916.

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“A Table is thermodynamically consistent when the tabular values are obtained from equations that are properly connected by the necessary thermodynamic relations, such as the Clausius and Clapeyron relations; it may be considered accurate if the calculated values show satisfactory agreement with trustworthy experimental data.”

*PROPERTIES
OF
STEAM
AND
AMMONIA*

So opens the preface to this monumental work, based on the theoretical formulation described in Engineering Experiment Station Bulletins 66 and 75.

G. A. Goodenough, 126 pages, 1917, John Wiley & Sons.

AMERICAN
CIVIL
ENGINEER'S
POCKET BOOK

The contributions were by 15 Associate Editors, including Ira O. Baker of the Civil Engineering Department.

Section 14 was entitled *Steam and Electrical Engineering*. Professor Goodenough contributed articles 1-9, pages 1286-1309. The second half of the section on Electrical Engineering was written by Malcolm Farmer.

Articles 1 through 9 covered such topics as: Fundamental laws of thermodynamics, properties of gases, saturated and superheated vapors, flow of elastic fluids, and practical applications to steam boilers, steam engines, steam turbines, and internal combustion engines.

edited by Mansfield Merriman, Third edition, 1916.

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A
DISCUSSION
OF
CERTAIN
THERMAL
PROPERTIES
OF
STEAM

The paper introduces the topic with a quotation from a previous paper of Dr. A. N. Davis: "The reconciliation through Clausius thermodynamics relation of the accepted volume and specific heat measurements in the superheated region is impossible. It is probably the most important of the outstanding problems in the field."

The author states that: "It is the purpose of this paper to present an attack on the problem thus suggested."

G. A. Goodenough, Journal ASME, pp. 465-491, 1919.

The contribution of Prof. Goodenough to the analytical phase of research on the ventilation of the Holland Tunnel, connecting New Jersey to Manhattan, was acknowledged by Professor Arthur Cutts Willard in an article in the Technograph (an engineering publication edited by students, but containing many articles by faculty members in the early years). The model studies on ventilation ducts for the tunnel were conducted at Illinois under the direction of Prof. Willard. The research team included: Prof. Alonzo P. Kratz (in charge of operations), Prof. G. A. Goodenough (mathematical analyst), and Prof. Vincent S. Day (test engineer). The results from this model study provided a completely successful ventilation system for a vehicular tunnel, in which carbon monoxide concentrations of not more than 1 part per 10,000 were considered as design values. As a result of the success of this tunnel, numerous others throughout the world have been constructed.

*HOLLAND
TUNNEL
NOTES*

1921-1923

“It is possible to calculate the total head for an air duct with open ports by deriving from fundamental equations of flow an expression for total head—available for overcoming friction in the duct. Since the velocity at any section varies inversely with the distance from the (tunnel) entrance, it is possible to write a differential equation, which, integrated, gives directly an expression by Prof. Goodenough. The resulting expression has been applied to the results obtained on the experimental model with complete success.”

October 1921, Technograph, Pages 4-7, by A. C. Willard

In this article the author applied the energy equation to the Tunnel flow problem. An interesting conclusion from these studies was that: “Considerably more power is required to exhaust a given volume (of air) from a tunnel with ports than to blow the same amount of air throughout the tunnel—the loss due to turbulence is much greater.

January 1922, Technograph, Pages 51-52, by G. A. Goodenough

“I am enclosing a new and final discussion of the tunnel problem. When I got into the exhaust case with 45-degree ports, I speedily found that the original theory must be defective. For about two days I sweat blood: for I thought perhaps both cases were in error. However, the blowing case is OK and I was able to drop out one term in the other expression, which made things

check better. In the final exposition this discussion should replace all the others, as it is rigorous, and, I am quite sure, correct."

August 11, 1922, Letter from Prof. Goodenough to Prof. Willard

These and the following notes were distributed to the research team and later included in the report to the New York Tunnel Commission.

October 18, 1922, Technical notes relating to the "Calculation of N. E. 5 Section"

The author states that the coefficient of friction, f , is a function of four variables (Reynold's Number) and not of velocity alone.

November 22, 1922, Technical Notes

Consideration is given to:

Blowing—end enclosed. Air passes through ports

Exhausting—end closed. Air passes through ports

November 29, 1922, Technical Notes on "Flow of Air in Ducts"

Case 1.—Blowing system—uniform escape—no turbulence.

Case 3.—Exhaust system—no turbulence.

Case 4.—Exhaust system—with turbulence.

The Holland Tunnel investigation was an outstanding example of experimental and analytical work. Unfortunately, Professors Willard, Goodenough, and Kratz were busy men who carried on this special assignment in addition to normal university duties. Hence, the work performed was not adequately reported to the Engineering profession. The report to the Tunnel Commission was not in a form that was suitable for reporting by the Engineering Experiment Station. Furthermore, Prof. Kratz felt that the technical material was of limited interest—little realizing that the Holland Tunnel would be a forerunner of other vehicular tunnels. In any case, this consulting work of Prof. Goodenough was a diversion that occupied much of his time between 1920 and 1923.

July 9, 1923, Technical Notes

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The essence of this paper lies in the following statements: "In a mixture of gases in which chemical action is possible, for example, a mixture of CO, O₂, N₂, H₂O, reactions may proceed with an accompanying change of temperature; but at some definite state of the mixture, a state determined by the temperature and the partial pressures of the constituents of the mixture, chemical action ceases, and the mixture is said to be in equilibrium.

"The determination of the conditions under which a gas mixture attains the equilibrium state is a fundamental problem in the investigation of temperatures and pressures due to combustion. The equations giving these conditions are deduced by various methods, all of which, however, are essentially identical with the analysis of Prof. J. Willard Gibbs, who first developed the general theory of chemical equilibrium.—The method of thermodynamic potentials (which is the original method of Gibbs) is used because it is peculiarly applicable when several simultaneous equilibrium equations are to be established."

G. A. Goodenough and G. T. Felbeck, University of Illinois Engineering Experiment Station Bulletin 139, 160 pages, 1924.

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The analysis was applied to the Otto and Diesel cycles. In contrast to theoretical analyses using so-called "air standard" or properties of actual gas mixtures, this third system of analysis took into account the fact that combustion is not complete and that through the dissociation of the product of CO₂ and H₂O as the temperature rises above 2500 deg. F., there will be unburned CO and H₂ in the mixture at the beginning of adiabatic expansion. As the temperature falls during expansion the combustion continues until at the end of expansion it is practically complete. An interesting chapter is presented by the late Dr. Albert Eby Hershey showing that a more complete expansion engine with throttle control would show a higher thermal efficiency and fuel economy than a similar engine operating on the standard Otto cycle.

G. A. Goodenough and J. B. Baker, of University of Illinois Engineering Experiment Station Bulletin 160, 67 pages, 1927.

AN
INVESTIGATION
OF THE
MAXIMUM
TEMPERATURES
AND
PRESSURES
ATTAINABLE
IN THE
COMBUSTION
OF
GASEOUS
AND
LIQUID
FUELS

A
THERMO-
DYNAMIC
ANALYSIS
OF
INTERNAL-
COMBUSTION
ENGINE
CYCLES

*SUPER-
SATURATION
AND THE
FLOW
OF
WET STEAM*

This early treatment of two-phase flow was the result of Prof. Goodenough's consulting work with the Turbine Dept., of General Electric Co., where he met J. H. Keenan, who was to establish his eminence at Massachusetts Institute of Technology in later years.

"Supersaturation is a phenomena that may occur in the flow of steam through nozzles when the steam is initially wet, saturated or only slightly superheated. In the case of flow through a turbine, the steam at some stage passes from the superheated to the wet condition. At this stage, and presumably in all succeeding stages, a greater or lesser degree of saturation may be present." The presentation is unusually compact and complete, with the usually thorough welding of theory, experiment, and practical application. In the short paper the author presents such items as:

- a) two-phase flow at an initial common temperature,
- b) theoretical equations of gas flow,
- c) experiments of Wilson and Stodola,
- d) Kelvin-Helmholtz equations of drop dimensions,
- e) Surface tension, or capillary energy of water,
- f) Upton's data on size of rain drops,
- g) J. H. Keenan's analysis involving inelastic impact,
- h) Experiments at the G. E. Laboratory on steam flow through steam nozzles, and
- i) Turbine and bucket losses.

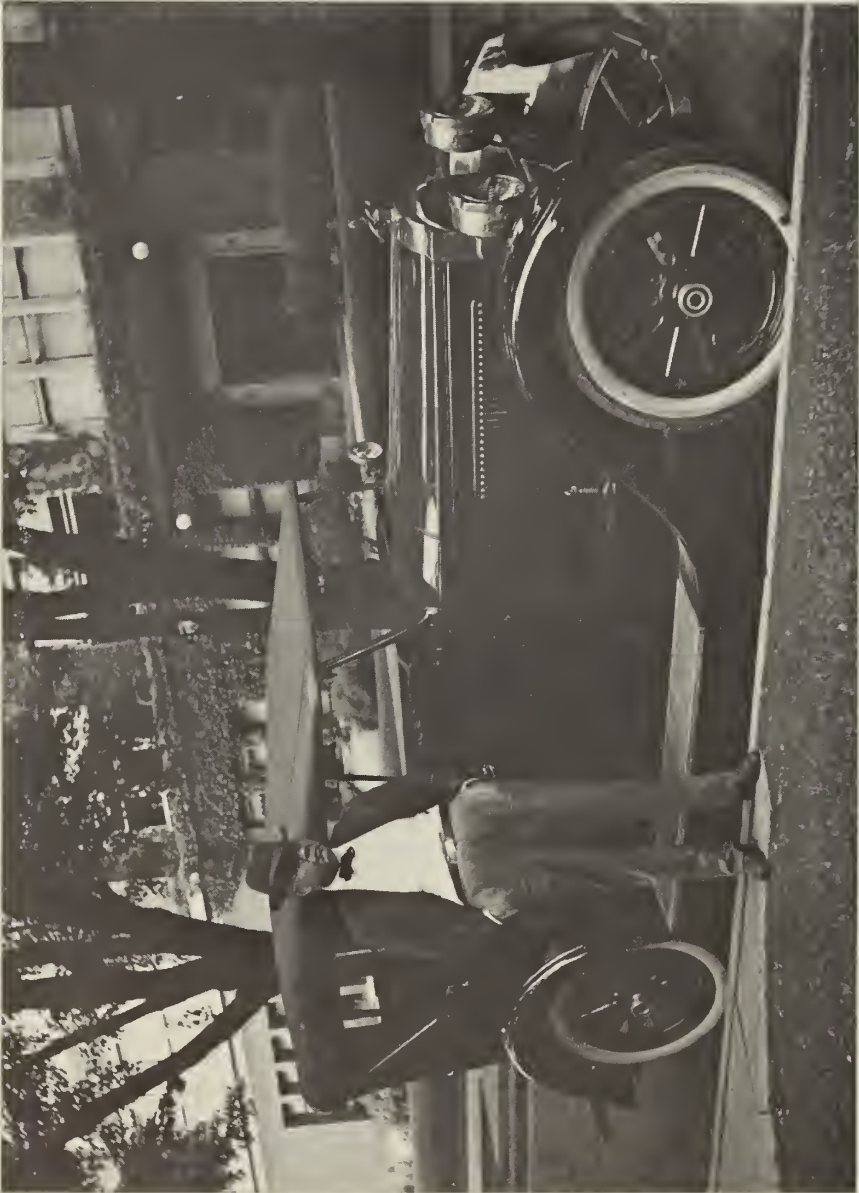
"It is now apparent how the two phenomena, supersaturation and the lagging of the water drops, are interlocked. Neither phenomena alone will account for all the experimental facts. When the steam is initially dry or superheated only supersaturation need be considered: when the steam carries a large amount of water, say 20 per cent, supersaturation is practically negligible and only the slow speed of the water need be taken into account. Within these limits, both phenomena require attention."

Part I, Sept. 27, 1927 and Part II, October 4, 1927, *Power*, pp. 466-469 and 511-514, 1927.

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“Mr. Packard arrived here Tuesday, and a washing made him look fine—better, in fact than when we got him from Paris”

(From a letter to Professor A. C. Willard, dated August 11, 1922. It is assumed that Paris refers to the town in Illinois, south of Urbana.)



The death of Professor Goodenough occurred in 1929. Some 43 years later this assessment of the professional accomplishments and contributions to engineering literature is being made; in the meantime there has been no consistent effort to keep alive the memory of his life. However, many people have stored in their memories impressions and attitudes concerning Professor Goodenough and only now, when invited to do so, have decided to place in writing their deep feelings.

*LETTERS
FROM
EDUCATORS*

If we had set about this task twenty years ago we would have had a considerably longer list and a more vivid recollection of events and incidents. Unfortunately we were not able to obtain the impressions of those close friends and colleagues that were on the staff at the same time—such men as President Arthur Cutts Willard, Professor Alonzo P. Kratz, Professor Oscar A. Leutwiler, Professor Clarence W. Ham, and many many others. However, I am grateful for the opportunity of reproducing the material submitted by those faculty members who responded to our invitation.

It is fitting that we introduce this series of letters with an unusual dedicatory article written by Dean C. R. Richards entitled: "George Alfred Goodenough", from the May 1919 issue of the *Technograph*. In scanning through the old issues of the magazine only one other example was found where a living and active faculty member was so honored. The following excerpt is from the article:

"The student who appeals to Professor Goodenough for advice or assistance may feel sure that his problems will be considered fairly, and that the advice or assistance rendered will be the best that he can give. In the same way in his relations with the faculty, I have found his judgment is always highly regarded, for he has the ability to present his ideas in a clear, logical, dispassionate and convincing manner which carries with it his sincerity and honesty of purpose."

(Dean C. R. Richards was later President of Lehigh University. The *Technograph* contained many articles by faculty members in the early years of its publication. A number of names familiar to Illinois engineers emerge from the yellowed pages, both faculty and students: Avery Brundage of Olympic Games fame, Herman Krannert, the philanthropist, L. P. Breckenridge in combustion, Ellery B. Paine, the early Electrical Engineer, and Ira O. Baker, the early Civil Engineer, and many others. Men make a University.)

UNIVERSITY OF KENTUCKY

LEXINGTON, KENTUCKY 40506

COLLEGE OF ENGINEERING
DEPARTMENT OF MECHANICAL ENGINEERING

E. B. PENROD
PROFESSOR
EMERITUS

I was pleased to learn that a brochure is being prepared in memory of the late Professor George Alfred Goodenough. I never had the pleasure of meeting him; however, I was the first one to use Goodenough's textbook on the Principles of Thermodynamics at Western Reserve University at Cleveland, Ohio during the academic year of 1920-1921. In my opinion, Goodenough's book was the first good engineering textbook (in English) that was published in the United States of America. It was used by my successor at Western Reserve University for many years, and I used it along with Goodenough's Steam and Ammonia Tables on alternate years while I was Head of the Physics Department of Hillsdale College, Hillsdale, Michigan.

I had correspondence with Professor Goodenough concerning his researchers and methods of teaching thermodynamics. On one occasion he had John Goff, an instructor, solve one of the problems in his book on thermodynamics and mail it to me. I still think that Goff's solution to the problem is the best solved example that I have ever read. This indicates, I believe, that Professor Goodenough was an excellent teacher as well as an outstanding and productive research professor.

One of my associates, Walter Merriman, at Western Reserve University obtained his Masters degree in Physics at the University of Illinois in the same year that I received an M. S. degree in the same subject at Purdue University. Walter had on his desk a copy of Essentials of Calculus by E. J. Townsend and G. A. Goodenough. I had access to this excellent book and often referred to it while teaching thermodynamics. Mr. Merriman knew Professor Goodenough and gave me some interesting information concerning him, and his researches and publications.

While I was a member of the Hillsdale Kiwanis Club, Professor Townsend often came to our club to make up Kiwanis attendance after his retirement to his farm in Michigan. He often spoke enthusiastically about Goodenough as did my neighbor and friend Dr. Frank Smith a retired Professor of Zoology from the University of Illinois.

Yale University *New Haven, Connecticut 06520*

DEPARTMENT OF ENGINEERING
AND APPLIED SCIENCE

*Dunham Laboratory
10 Hillhouse Avenue*

Prof. G. A. Goodenough was the one teacher who influenced my life's principal activity (teaching) more than any other person.

*LESTER C.
LICHTY*

As a graduate student in the Mechanical Engineering Dept. at the University of Illinois (1914-1916) I recall his interesting and inspiring Thermodynamics lectures, and particularly those dealing with actual mediums and combustion in internal-combustion engines. His lectures and later work* in this field accounted for most of the discrepancy between the Ideal Air-Standard Analysis and Actual Combustion Engine Performance. Only, the availability of Energy and Equilibrium Constant Values, based on spectroscopic analysis, about 15 years later, have improved the ideal performance analysis.

*ROBERT
HIGGINS
PROFESSOR
EMERITUS*

Prof. Goodenough discussed the high ideal thermodynamic efficiency possible (90 percent) for the chemical-electrical process, our present-day fuel-cell process. As a consultant with General Electric Co. at Schenectady, N. Y. he was in touch with Steinmetz who was interested in a coal battery process. This and other outside contacts stimulated Prof. Goodenough's interest in thermodynamic applications which made his teaching most interesting and stimulating for those in his course.

Prof. Goodenough's attitude toward his class and department is indicated by a final thermodynamic's examination. After the last lecture period he announced that the School of Engineering required him to give final examination. He said that he knew what we had done in his course and that he didn't think it was necessary, but that he would comply by giving a short oral examination.

This amounted to sending a student to the blackboard and asking him a question. If the student started to answer the question in a manner that indicated he knew the answer, Goodenough would interrupt and say, "Good! Sit down."

The last student called in alphabetical order, was not too good in this subject and had told some of us that he knew he would flunk the course. When his turn came, he stood at the board,

chalk in hand and chalk white, touching the board, and after what seemed a long silence said, "Professor, I can't answer that question."

Prof. Goodenough asked another question which was easier. Again, the same long silence and reply, and the same procedure until the student started to answer the 4th question, and Goodenough said, "Good, sit down. I can now report that I have given a final examination and that all have passed the course.

*Thermodynamics, G. A. Goodenough, 1911, 1920, Henry Holt and Co. University of Illinois, Engineering Experiment Station Bulletin, No. 139, Goodenough and Felbeck 1924.
University of Illinois, Engineering Experiment Station Bulletin, No. 160, Goodenough and Baker, 1927.

State University of New York at Buffalo

FACULTY OF ENGINEERING AND APPLIED SCIENCES

*PAUL MOHN
PROFESSOR
EMERITUS
FORMER HEAD
OF
DEPARTMENT
OF
MECHANICAL
ENGINEERING*

"—In regard to the Goodenough matter; the first name that occurs to me is John Goff. Next is that of one of the earlier Bowditch brothers who did graduate work under him. I believed he was the one who did the calculation on the super-saturated steam work which was published in "Power" in about 1927. In addition, if you can find an author of thermodynamics books that has done adequate historical research, he will find that Goodenough's 1917 Thermodynamics text was at least 15 years in advance of its time and of other thermodynamics texts. Even though it was based on Preston and Bryan, both published before 1905, it was a big step beyond either of them. For years, he was a consultant for General Electric Company and used to bring his current problems to his graduate students to give them a work-out. I doubt that any one remains in General Electric Company who knows it. There was a man name Green (now retired) who went from the Mathematics Department of Illinois to General Electric research; if he is still extant he might know. Sorry this is the best I can do."

PURDUE UNIVERSITY

OFFICE OF THE DEAN OF ENGINEERING
LAFAYETTE, INDIANA 47907

"My contacts with Professor George Alfred Goodenough date back over 50 years. I used his textbook in Thermodynamics which I taught at Kansas State Agricultural College 1905 to 1920. I saw very little of him after I came to Purdue University in 1920.

His textbook on Thermodynamics was considered for many years the best in the English language. Alumni of the University of Illinois spoke very highly of him as a teacher.

Having been retired for nearly 20 years, I regret not to be able to send you more information about Professor Goodenough."

(Dean Potter was born in Europe August 5, 1882 and came to the United States at the age of 15, and was naturalized in 1906. He was graduated from Massachusetts Institute of Technology in 1903; employed by General Electric Co. from 1903-1905; on the staff of Kansas State University from 1905 to 1920; and associated with Purdue University since 1920. The Dean among Deans is still serving in his capacity as a consulting power engineer.)

*A. A. POTTER
DEAN
EMERITUS
OF
ENGINEERING*

EHRHART & ASSOCIATES

411 SOUTH BOYLSTON STREET • LOS ANGELES, CALIFORNIA 90017

I am pleased to forward the 46 year old copy of Professor Goodenough's Properties of Steam and Ammonia including his large Mollier Diagram for Steam, plus his Lefax Mollier Chart for Steam. I also have a 1920 edition of Principles of Thermodynamics should it be of value to you.

*LYMAN F.
SCHEEL
SENIOR
MECHANICAL
ENGINEER*

This text and tables were used at the University of Nebraska during the 1920's by Professor William L. DeBaufre. The latter apparently knew Professor Goodenough quite well and would often relate some of his experiences and anecdotes. Both men had a great sense of humor and were excellent teachers. DeBaufre described Goodenough as a "Foxy Grandpa", bald with a white impish smile, much like the character in the comics 50 years ago that bore the same title.

UNIVERSITY of PENNSYLVANIA

PHILADELPHIA 19104

*The Towne School of Civil
and Mechanical Engineering*

JOHN A. GOFF
PROFESSOR
OF
MECHANICAL
ENGINEERING

You will forgive me, I know, if I start my response to your recent letter on a personal note with reminiscences. On a Sunday afternoon in September 1919 in Fort Collins, Colorado, I was challenged by a friend to transfer to Illinois where he had done his graduate work in Chemistry. I picked up the challenge and was soon on my way, by car to Kansas City, by the Santa Fe to St. Louis, by the Illinois Central to Champaign. In looking for a job then a room, I picked up advice from somewhere that I would do well to register early. Acting upon it, I went early to a large classroom in Engineering Hall where I sat in the front row for hours before Professor Leutwiler entered at eight o'clock from his office at the back of the room. My turn didn't come until almost six o'clock, and then I was sent upstairs to see Professor Goodenough who was handling all transfer students.

In a tired voice the Professor asked "What do you want?" I, too, was tired and, still not knowing exactly why, answered "Differential Equations!" This seemed to please the Professor for he immediately perked up and without further ado signed me in, overlooking the fact that Foundry, a requirement for graduation in Mechanical Engineering, was left off my roster. It took a bit of doing on his part later on to have the requirement set aside in my case.

Jobs were scarce in 1921 when I was graduated BS in ME but, just before the start of the fall semester classes, I received a telegram from Professor Goodenough offering me appointment as Assistant Instructor in Mechanical Engineering. I was more than ready to accept and, from then on until his death, was closely associated with both Professor and Mrs. Goodenough, and ever after that have I felt the Professor's influence upon my life and career. He was a kindly man of great wisdom, of broad perspective, a great teacher genuinely interested in his students and the shaping of their careers, a man of keen mind and sound judgment held in high esteem by all associated with him.

Looking back over thirty years of active connection with college teaching, Professor Goodenough could hardly view with equanimity the changing ideals and ambitions of engineering

students. Well and good, he contended, that the greater number of these should enter the industries to become great executives, but a just balance requires that a few—a very few—of the most promising should turn resolutely from the flesh pots and take up the ascetic life of the intellectual; if the intellectual career is not well rewarded with money, the reward in real satisfaction is immeasurably greater; and if the pendulum can be swung back just a little, the situation may be saved. Perhaps this assessment explains the Professor's eagerness to sign me up for Differential Equations.

Professor Goodenough was an avid reader. Among his favorite authors were Charles Dickens, Francis Parkman, Joseph Conrad. He studied the scientific works and writings of Maxwell, Gibbs, Kelvin, Helmholtz, Darwin and other great thinkers. He was fascinated by the beauty of Fourier analysis, by the grandeur of the theory of interpolation, by the cleverness of dimensional analysis. He was enough of a mathematician to put mathematics to work for him in the analysis of engineering problems from the elastic behavior of barred chain links, to the formulation and tabulation of the thermal properties of steam and ammonia, to the effects of supersaturation on the performance of steam turbine nozzles, to chemical equilibrium in gas mixtures and the limitations imposed thereby on combustion temperature and pressure.

I choose to end my response to your recent letter in a lighter vein. In thermodynamics, which was Professor Goodenough's special field of interest, there are two important properties now called enthalpy, h , and internal energy, u ; the Professor called them thermal potential, i , and intrinsic energy, u , respectively. At the blackboard where the Professor liked to teach by teasing, one student made the mistake of adding instead of subtracting the pressure-volume product, pv , according to the definition, $u = i - pv$, whereupon the Professor pounced upon the wayward student with "Which is bigger, u or i ?" to which the student replied, "You are." The Professor, looking down at his waistline, chuckled.

UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN
DEPARTMENT OF MECHANICAL AND INDUSTRIAL ENGINEERING
URBANA, ILLINOIS 61801

S. L. SOO
PROFESSOR
OF
MECHANICAL
ENGINEERING

It is a pleasure to learn of the belated recognition of the contributions of Professor G. A. Goodenough. Such a late and sober identification of the significance of his work, of course, also means the permanence of his place in the growth and prestige of the University of Illinois, and particularly, Mechanical Engineering.

Professor J. H. Keenan (*Thermodynamics*, 1940, John Wiley) once remarked that the historical differences in the instruction of thermodynamics between chemists and engineers arose because chemists were introduced to thermodynamics via Gibbs while engineers were largely influenced by Rankine. The influence of Professor Goodenough is that he brought the methods of approach of Gibbs' to the attention of engineers more than 50 years ago (*Thermodynamics*, 1911, Holt, and 1920). His was the first engineering book of thermodynamics to include general equations. The epoch making book of Keenan of 1940 was strongly influenced by the book of Professor Goodenough.

It might be said that Professor Goodenough was the first member of the Mechanical Engineering Department of University of Illinois who has a national influence and career, and an international reputation. As a matter of fact, the first time (1940) that I had ever seen the name of the University of Illinois was in the title page of Professor Goodenough's book. I have been grateful for being introduced to thermodynamics via Professor Goodenough's book.

A further anecdote is that the first course I ever took on thermodynamics was taught by a former student of Professor Goodenough—Professor Dah-sih Chen of the National Chiaotung University. In the early forties, Professor Chen claimed that there were only 2½ real "thermodynamics men" in wartime China (1937-1945); that is, he and another student of Professor Goodenough and still another man who took thermodynamics from a former student of Professor Goodenough.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

DEPARTMENT OF MECHANICAL ENGINEERING

CAMBRIDGE, MASSACHUSETTS 02139

Please forgive me for my tardiness in replying to your letter on September 23. Your request called for some thought, and I have just now found some time, however inadequate, to devote to it.

Let me make a few observations concerning the contributions to engineering literature by G. A. Goodenough.

He was the first author of steam tables in America to use rigorous thermodynamics to relate the various properties of steam. Callendar in England and Canada was working on this subject about the same time, but he was so enamoured of certain mathematical simplicities which he thought he had discovered that he neglected some of the good experimental data available. Goodenough's steam tables did justice to the existing data with a simple mathematical formulation which he developed with good thermodynamic techniques.

His interest in the heat capacity of gases led him to make what was probably the first sound thermodynamic analysis of internal-combustion-engine processes (U. Ill. Eng. Exp. Sta. Bulletin 160, 1927). This was the forerunner of working charts such as those prepared by Hershey, Eberhardt, and Hottel (S.A.E. Journal, Oct. 1936, pp. 409-424)

About the year 1927 Goodenough published a paper in the McGraw-Hill journal "Power" on the subject of moisture and supersaturation losses in steam turbines. This was a fairly comprehensive study of a subject which was not well understood at the time. It made quantitative estimates of the losses resulting from irreversible condensation of supersaturated vapor and from the frictional acceleration of water droplets by the stream of vapor in which they are carried. This paper brought some order into the subject of losses inherent to the two-phase region of flow through a steam turbine.

While I was employed by the Steam Turbine Engineering Department of the General Electric Company in Schenectady, Professor Goodenough would visit us as a summer-time consultant. My recollection is that he was a good listener who could marshal various pieces of information into an orderly whole

*JOSEPH H.
KEENAN
PROFESSOR
OF
MECHANICAL
ENGINEERING*

which was amenable to relatively simple mathematical treatment. He was a born teacher who could communicate effectively with people at all levels of engineering skill. College campuses used to love the colorful professional figure with all its individuality and inherent dignity. George Alfred Goodenough was a notable example of such a one. He offered an example of self-assurance, dignity, and kindness which, though often present today, is valued less—much to the loss of all of us.

In the novel, "The Source", by James A. Michener, layer after archaeological layer was removed to reveal a different facet of a long period of civilization. The request for assistance from former students of Professor Goodenough reminded me of the "The Source" because each respondent covered a different period of a long career and each peeled off a new layer of history. In the letters that follow are some which go back to the very earliest years of this century, when the University of Illinois was less than fifty years old.

*LETTERS
FROM
FORMER
STUDENTS*

Some time between 1900 and the first World War, there existed on our campus an era that will never again be duplicated, boys and girls from Chicago and downstate living in a world apart. Here in this densely wooded area in southeastern Illinois flourished a small universe composed of students, faculty, service personnel and townspeople. The students of the time were not involved in national or international policies; life was an internal bustle of classes, drill, campus activities, and social whirl. Football was still small-time and 5000 spectators on the wooden bleachers of Illinois Field constituted an enormous attendance.

The layer of history that is peeled away brings back memories to the old timers that seem to glow with time. This may be only a trick of memory wherein one tends to forget the unpleasant side and remembers only the pleasureable scenes.

The period between 1900 and 1918 must have been an unusual one on the Urbana campus, because no other campus in the country can claim a similar record of organizational activity. The following appeared in the Alumni News of 1969 under "Reflections".

"Over the years I have been impressed with the organizational initiative of the engineering students back in the era between '05 and '20. Perhaps some of our alumni can tell me something of the "climate" that existed on the engineering campus that led to such fervent activity of the following sort:

The origin of Pi Tau Sigma, national Mechanical Engineering honorary
the origin of Chi Epsilon, national Civil Engineering honorary
the origin of Eta Kappa Nu, national Electrical Engineering honorary
the origin of Triangle, national social fraternity for engineering and architecture students and

the origin of Homecoming, for the return of alumni to the campus.

“Were the students clustered in beer joints, asking each other: ‘What can we organize that has never existed before?’ Were they encouraged by their faculty advisors? Was this the substitute for the later water fights, panty raids, goldfish swallowing competitions, push-ball contests and student protest marches? Alumni reply: ‘Well it was a small campus’. But I see no counterpart activity in other colleges. There must exist a good reason, and only our oldtimers are in a position to tell me something of the climate that existed in those days. So Help! Help! My curiosity is killing me.”

This point is brought up because the letter from “Red” Matthews, Class of 1902, shows that some of these originations were prompted by the faculty, and Professor Goodenough in particular. The influence of an outstanding faculty member has a leverage effect that few realize. A push given to Matthews by Professor Goodenough established a life-long and dedicated Secretary of Tau Beta Pi. A similar push exerted by Professor Goodenough on William Nelson Espy, resulted in a long-time treasurer for the same organization.

One can only conclude that the “climate” was right. Even now the University benefits by this legacy because alumni support from members of these two decades is as strong as at any school in the country. Men of the caliber of Professor Goodenough produced this leverage effect.

"If anyone can give you data on "Goody", I should be the one; I was, I think his first assistant. At this late date I know only that he wrote a Thermo text, and that all the M.E.'s loved him.

As I remember—sixty-six years ago we young faculty were active in Tau Beta Pi, which we regarded as a real fraternity—even the regular Greeks like "Prep" Henry and Eddie Mehren did. What do you know of the Tau Beta Pi "House"? On third street I think. Avery Brundage liked to come there to play bridge. Mrs. Johnson, mother of late Illinois Central President, was house mother.

R. C. (RED)
MATTHEWS
CLASS OF 1902

Things got lax in that time: letters weren't answered, nor badges ordered promptly. We got involved in general society affairs because we elected Ethel Ricker to membership and the 1903 Convention turned her down. We sent Bob Kuss '03 to the '04 convention "to get Ethel approved and "Breck" (Breckenridge) or "Goody" on the Council." We didn't get by on Ethel, but got "both" on the Council, and the '05 Convention to be in Urbana.

It must have been at the Fall '04 initiation that Goody said to me, "Matthews, you're one of these fellows who does things, how about looking over the Tau Beta Pi Council records and seeing what they're all about?". I was teaching Drawing and Descrip' but was tickled to do anything either for Tau Beta Pi or for Goody.

Well, all early '05 I did practically all the Council work. I arranged the installation of Colorado Alpha and Beta, wrote all letters—often signing Goody's (even Breck's) name. I did well enough that they recommended me for permanent national secretary. Also one day Breck said to me, "Matthews, we feel that at last you've got some sense, and we want you to come teach M. E." WOW!

That's enough: sorry I didn't get to see more of the M. E. men when there in '67 for Illinois Alpha's 70th. I used to get by Urbana a lot in the early days—before World War II— but after getting oriented down this way, (and getting around 90 years old) I can't move so freely."

(Professor "Red" Matthews was known as "Mr. Tau Beta Pi" and became a legend at the University of Tennessee.)

1201 S. W. 29th Street
Fort Lauderdale, Florida 33315

DAVID ROY
BETTS
CLASS OF 1905

“My memories of Professor G. A. Goodenough take me back quite a long time as I graduated in the class of 1905 and I have thought of him and his smiling countenance and pleasant and fatherly manner and how patient he was with a well-meaning student who was just plain too slow mentally. He sort of made a hobby of telling us early and often to think!!! I used to sit in my seat and think how I sure would certainly like to think correctly. I was with him all the way but I just did not have the brilliant and masterful mind like he had. To me he was a wonderful professor and teacher.”

(Mr. David Roy Betts worked five years with the Wabash Railroad in Springfield, then four years with the American Car and Foundry Co. in Detroit. He then moved to New York City and joined Fairchild Publications, Inc. and worked as a free lance trader on the New York Produce Exchange and the Chicago Board of Trade. After 46 years of this dual life he retired in 1970 and sold his seats on the N. Y. Produce Exchange and the International Commercial Exchange.)

Post Office Box 322
Mattapoisett, Massachusetts 02739

CHAUNCY B.
OLIVER
CLASS OF 1912

“During 1908 through 1912 graduation, I knew him and Mrs. Goodenough as a student friend. I was in his classes and found them stimulating and rewarding. His quiet understanding, yet forceful leadership was a rare combination and his classes were more than just a learning time.

I took my thesis work under him, theoretically proving one of his pet ideas that the addition of water to the fuel in gasoline engines materially improved the power therefrom. That was a very satisfactory personal friendship.

He was very interested in athletics and was on the board over a period of years. I played on the football team. He particularly loved football and did much to ease G. Huff's problems with the scholarly side of the University. Those were the days that football was under fire as “brutal”.

He was an honored member of the Phi Gamma Delta fraternity chapter at Illinois. Mrs. Goodenough was very interested in the new chapter house and was enthusiastically active in getting money, advice and work done to completely furnish the

interior. It was my chapter responsibility to get the job done. I was often at their house for tea, discussions and dinners, and these lasted over many years after graduation. I have always considered this frequent association with him was one of the most valuable character contacts one could have. He was everything a man should be: A quite forceful gentleman; always interested in the individual student to make good men and citizens. He was vitally interested in all phases of the University. His whole life was wrapped up in it."

(Mr. Oliver is connected with the Everpure Water Purifiers, Oak Brook, Illinois. He founded Everpure, Inc., now a wholly owned subsidiary of Culligan, International Company. He is also part owner of United Filter Company now a part of Dorr-Oliver. His retirement residence is at Oliver Rancho, Blue Diamond, Nevada.)

2100 Clearwater Drive
Oak Brook, Illinois 60521

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"It was my privilege to study thermo under the late Prof. Goodenough. He was, surely, the outstanding scholar on the M. E. staff of that era. He stood out among such intellectual giants as Leutwiler, Willard, Richards, Dent, Kratz and others who staffed the M. E. Department.

*GILBERT S.
SCHALLER
CLASS OF 1915*

Professor Goodenough authored the text on Thermo that we used. His memory was so phenomenal that he would frequently ask for the assignment and then recite a complete page verbatim.

He was interested in the work of Professors Harding and Willard in their new field of Heating and Ventilating. However, it was in the power plant field that Professor Goodenough was pre-eminent."

(Mr. Schaller is a younger brother of Alwin Schaller and a long-time member of the faculty at the University of Washington, Seattle. He was retired in 1964 and now lives on beautiful Bainbridge Island, just a ferry boat ride away from Seattle).

Route 8, Box 8274
Bainbridge Island, Washington 98110

OTTO H.
HEDRICH
CLASS OF 1922

"I received my B. S. in Mechanical Engineering in 1922 and was one of those privileged to take thermodynamics under Professor Goodenough. He was a most excellent teacher, a mathematician of the first water, and was without question the most outstanding instructor that I had through all of my college days.

I think that his fantastic memory with regard to the values in his steam tables and the logarithmic tables impressed all of his students. He could quote values of pressure, temperature, enthalpy, and entropy from memory with uncanny accuracy. The incident which stands out in my memory occurred one spring day when he was working out a problem in thermo before the class at the blackboard. Involved was the multiplication of a three digit number by a four digit number.

"Now" said Prof. Goodenough "all that is necessary is to add the logarithm of this (3 digit) number to the log of this (4 digit) number and take the antilog to get our answer."

And, while it may sound unbelievable, he did this logarithmic operation from memory without reference to the log tables.

I don't know that this little story of Prof. Goodenough will have any place in the memorabilia you are compiling but it may be of interest to some of the former students of a most remarkable man.

(Mr. Hedrich retired in 1964 after a long career with steam-electric plant design, construction, operation, and maintenance. He built plants up to 75 Mw capacity for the municipalities of Pasadena, Glendale, and Burbank in California. During the war he was with Fluor Corporation of Los Angeles to design and build boiler and steam electric plants for oil refineries throughout the United States and Arabia. In 1949 he headed the Power Department of the Corporation.)

352-C Avenida Sevilla
Laguna Hills, California 92653

“Some of my most pleasant recollections of my four years at Illinois, are those of my studies of “Thermo” under the always intelligible and genial “Prof. Goodie”. He was one of the best loved and most respected of a fine Engineering Staff.

*HAROLD D.
ROSENDALE
CLASS OF 1922*

We, of the Class of '22, had heard that he had received a fine offer from Packard Motor Co. and we wondered why he passed up the more lucrative remuneration in favor of continued teaching of dumb M. E.'s. So the question was finally put to him. The gist of his reply was as follows:

“To me the real and deep satisfaction in life is represented by an equation in which the material emolument plus the pleasure I get in my every day endeavor is equal to a constant. Here at Illinois, the pay may not be very great but going into industry, I could never approach the deep comfort and satisfaction that I get from my work here.”

There stands Prof. Goodenough in my memory as the finest teacher I ever had.

(Mr. Rosendale, Class of 1922, was associated with Standard Oil Company of Indiana as Lubrication Engineer and Sales Promoter and was located in Milwaukee, Wisconsin in the Industrial Plants Division. He retired in 1958 and moved to Florida.)

515 84th Street, N. W.
Bradenton, Florida 33505

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“I was a student in his course in thermodynamics back in 1922. It seems that many of the new students entered his class with chattering teeth and racing hearts. Prof. Goodenough reassured us that thermo was not so difficult. He told us that the chemistry students got the “tough stuff”. We heaved a sigh of relief and all felt reassured. In thermodynamic processes he emphasized the physical significance of what was occurring rather than mathematical dexterity. On occasion when we had “time on our hands” he urged us to direct our thoughts to matters thermodynamic rather than waste time in idle pursuits. After we had covered the first few chapters in his textbook—he would announce: “We have now finished thermody-

*LOUIS CULKIN
CLASS OF 1923*

namics—from here on we will study its applications. Personally, I could see little difference between the former and the latter.

There were a few interesting stories about him circulating the campus. One is concerned with the selection of a pump for supplying water. The salesman tried to convince G. A. that a centrifugal pump would require less power to force the water through the piping than other designs. When G. A. fully understood his claim—he asked pointedly: “Once that water gets into the pipe what does it care whether a centrifugal or some other type was used to put it there.” As all engineers know (well most anyway) the cross compound engine is a type of engine—not a proprietary name. We had on campus, in those days, a chronic namedropper. One day engaged in his accustomed pursuits, Goodenough asked him if he had met Mr. Cross of the cross compound engine company. The event that comes to mind most often involves another alleged scientist. This man challenged the concept of entropy and proceeded to “prove” it invalid. Goodenough accepted the challenge and submitted his refutation. G. A.’s final parting shot went like this: “He has demolished a man of straw which he, himself, has constructed.”

The period preceding World War I was an era of development in mechanical engineering education and Prof. Goodenough played an important role in its promotion.

“G. A.” was a versatile man. His interests went far beyond heat-power. He seemed ready and willing to extend a “helping hand”. Here are a few examples:

Harding and Willard in their textbook *Mechanical Equipment of Buildings* wrote: “the authors are especially indebted to Prof. Goodenough for many valuable suggestions.”

“Prof. Leutwiler, in his *Machine Design* wrote: “. . . to his friend and colleague Prof. Goodenough, the author is deeply indebted for much valuable advice and the many suggestions received in preparing the manuscript, also for the critical reading of the proof.”

“Mechanics of machinery was a course originally taught from notes compiled by Goodenough. Later on these notes were expanded and additional material added, culminating in a textbook by Dent and Harper. In the preface we read: “the authors wish to extend their thanks to Prof. Goodenough for valuable suggestions and criticisms in the preparation of this work.”

Prof. Seely in "Analytical Mechanics" is "indebted to Prof. Goodenough for valuable material in the treatment of governors." And so it goes—Gebhardt of Armour, Robert Streeter of R. P. I., Taylor of M. I. T. plus others I've overlooked or didn't even know about.

This era of development produced a noteworthy team: Willard, MacIntyre, Leutwiler, Polson and their own dean—George A. Goodenough to provide inspiration and leadership."

(Mr. Culkin, Class of 1923, a native of New York, left Union College at the end of the freshman year, and on the basis of glowing reports from Mechanical Engineering graduates of Illinois, came to the midwest. After graduation he worked for New York City until the depression hit, taught at Oswego Teachers College, and finished out his career in the engineering department of Syracuse, New York. He is now retired and actively engaged in his hobby, the steam automobile.)

132 East Avenue
Syracuse, New York 13224

"I graduated in Mechanical Engineering with the Class of 1927 and while many, many years have passed, I still feel that perhaps the most memorable and most valuable of my experiences at Illinois was my fairly close acquaintance with Professor Goodenough. As one of his students, I had upon several occasions the privilege of being a guest in his home which was indeed an honor not to be taken lightly.

*C. C.
BAUMGARDNER
CLASS OF 1927*

"While the passing years dims one's memory of many things, a few items relating to him as a teacher and a man still remain with me. The first was his most delightful sense of humor. I remember one occasion where the star student of our Thermo class was solving a problem on the blackboard. After overheating his slide rule on the many equations involved, he finally reduced his answer to the simple 6×8 . By sheer habit this also went into his slide rule and unfortunately came out as 47.9 I can still hear the good professor's laughter which, because of his kindly manner was equally shared by the student.

“Another example of his sense of humor was his absolutely fiendish delight in helping prepare the questions for the examination required of all candidates for admission to Tau Beta Pi. This was surpassed only by his joy at reading the responses of undergraduate someday-to-be engineers. We undergraduates knew very little about music, history, the arts, literature, or geography but Professor Goodenough was indeed a learned man in all these fields as well as in still others.

“One of his outstanding personal characteristics was the extremely high value he placed upon integrity and personal honor. To him, cheating in any form was incomprehensible and the handling of such cases, rare as they were, was simply beneath his dignity. No person guilty of such an offense ever regained admission to one of his classes.

“Another principle of Professor Goodenough’s, often expounded in his teaching, was that he had no desire to teach his students a lot of statistics but instead wanted to show us where to find what we needed and then what to do with it once found. In this he was eminently successful. This principle was verified by his pre-examination instructions to the effect that we could bring anything whatever to our final exam sessions. Then his puckish humor would come forth in a statement that nothing we could bring would help us pass the exam. His professed aversion to memorizing statistics was however contradicted by his ability to state the logarithm of any number with complete accuracy to four decimal places!

(Mr. Baumgardner, class of 1927, was an employee of Mobil Oil Co. for 35 years, and held positions in Lubrication Engineering, Sales, and Operations, the longest in tenure being as Manager of Distribution in Chicago. He obtained an M. B. A. degree through the University of Chicago Executive Program. His ROTC commission took him into the service in 1941 for almost five years and he retired as Colonel in the USAFR. He retired from business in 1966 and moved to Florida).

440 South East 5th Terrace
Pompano Beach, Florida 33060

"In the classroom, my memory of Professor Goodenough is outstanding. He was always very jovial, always had time for your explanations and to listen to your problems. We would marvel at his abilities when he would ask us to add 4 or 5 columns of figures and before we could get an answer on a calculator, he would have added up the figures in his head. He could multiply and divide quicker than we could do it on a slide rule. He loved mathematics and enjoyed his superiority here and wanted us all to practice to achieve the same. Naturally, his knowledge of thermodynamics made the course extremely interesting, because he knew his own textbook by heart, which not only made the course more realistic but also more difficult. His introduction of the course to his students indicated how much he expected you to absorb by the very fact that on the first examination he said the average of the class would be about 60. Naturally, this set us all back because normally this would be a flunking grade. This caused us no problem even though this was the average grade of the class because he graded on a curve."

*LESTER G.
LEUTWILER
CLASS OF 1929*

(Mr. Leutwiler, the son of the late Professor Oscar A. Leutwiler, is now Vice President Production, Grocery Products Division of Pet Incorporated, a St. Louis based concern with both domestic and international divisions.)

Pet Incorporated, 400 South Fourth Street
St. Louis, Missouri 63166

"Of all my professors, I always seem to remember Prof. Goodenough most vividly. I guess I was one of his good students, since I would have left a deep sense of shame to turn in anything less than a B for him. I will offer a series of anecdotes about him:

*THOMAS V.
SHEEHAN
CLASS OF 1929*

"1. The first day that I ever appeared in Professor Goodenough's class, he told us that we could buy his book if we wanted to; he would receive a little royalty, but he warned the class that they would only understand this subject by putting their feet upon a radiator, thinking about it, and trying to use some horse sense.

"2. He always carried a table of logs in his hip pocket. In fact, he knew all the logs of prime numbers by heart. A favor-

ite maneuver was to put a series of numbers on the board and ask the “men in the first row” to solve it for him. Slide rules began to work furiously; meantime, he would add and subtract a few logs from his head (sometimes he used the little book) and write down the answer. Meantime, the “men in the front row” would continue to slide feverishly, eventually getting the number he had written down.

“3. Classes were in two sections, coming on different days. On the occasion of one major quiz, the first section excitedly warned the second section that it had been an open book quiz, and the problems he gave were already worked out in the book. They discovered this to their chagrin after the quiz was over. So the second section proceeded to look through the book before trying to work any problem. Later someone asked him why he did this. He replied that he thought a man who had enough sense to see if he could save himself some work by copying an already worked out problem, had sense enough to merit a good grade.

“4. Speaking of Bernoulli’s theorem, he put it on the board and turned to the class saying, “Now men, that expression holds for everything—steam, air, gas, sand, gravel, and molasses.”

“5. He would put the men up at the board to work out a simple problem. After they had each successfully made themselves look like the end of a horse opposite the head, he would have previously worked the answer with his little book and would simply say, “you men may sit down. No further discussion.”

“6. By the time we were seniors, the original class of 200 was boiled down to 44. Professor Goodenough registered them personally. He exercised plenty of authority as to what they could do about electives. I elected a course in “Business Letter Writing”. He said, “You can read up on that some Sunday afternoon. Here, let me give a course.” He scratched the Business Letter Writing and put Math 16, Differential Equations and Infinite Series.

“7. Professor Goodenough enjoyed total respect from his students. Witness the procedure on regular quizzes. He would pass out the quiz sheets and say, “Men, I’m going to my office. When you finish, drop off the papers there.” I saw students write their name on the paper and sit there and flunk, rather than ask another student for a hint. They would not cheat on the old man.

"8. A student asked him how long it would take a man to write out the final exam. He said, "A man who gets into high gear can be out here in twenty minutes. But you, Smith, will be here at noon and you won't be finished."

I think that perhaps his major contribution to engineering may reside in the hundreds of students, like me, whom he made feel at home with thermodynamics, particularly if these men went into fields where they could use what they learned, as was my good fortune."

(Mr. Sheehan, class of 1929, was in engineering and operations with Standard Oil Company, Indiana, from 1930 to 1958, during which time he was assigned to do reactor engineering with Brookhaven National Laboratory, and worked on the graphite reactor and the medical reactor. In 1958 he became a full-time employee of Associated Universities, Inc. He is a Fellow ASME and Chairman of Executive Committee of the Nuclear Division of ASME.)

Brookhaven National Laboratory
Associated Universities, Inc.
Upton, Long Island, N. Y. 11973

We close these tributes from former students with a statement issued by the late Professor Leutwiler, on the day in 1929 when he was stunned by the news of the sudden death of Professor Goodenough.

"As a student under Professor Goodenough, I learned more than I ever did from anyone else. He had way of leading students through the solution of problems that helped very much. I valued him as a friend, counsellor, and almost as a father. I shall miss him often in my work and play.

*OSCAR A.
LEUTWILER
CLASS OF 1899*

Late Professor of Mechanical Engineering
University of Illinois, Urbana, Illinois

*ABOUT THE DONOR OF THE MEMORIAL FUND
AND THE SPONSOR OF THIS BROCHURE*

Mr. Alwin Schaller was born August 8, 1886 in Mendota, Illinois, the son of Bertha Gross Schaller and John Schaller.

He was a graduate of the class of 1907 in Mechanical Engineering and earned a Master of Science degree in 1912. During his graduate study he served as Instructor and assisted Professor Goodenough.

In 1911, at a time when jobs were scarce, he learned that a firm in Wellsville, New York (the McEwen Bros.) was seeking a young assistant engineer in the design of centrifugal pumps. Thus began a lifetime association in which he participated in many phases of the small company. The products, over the years, have depended upon the market and have included small steam turbines, horizontal fire-tube boilers, gas engines, and centrifugal pumps for crude oil as well as for water. In less than a year he became factory superintendent. On May 26, 1917 he married Fannie E. McEwen.

He entered military service in World War I for an 18-months period and served as Commanding officer and Captain at the Ordnance Training School at Aberdeen Proving Ground, Aberdeen, Maryland. After this period he returned to the McEwen Bros. company as General Manager. The company weathered the constantly shifting demands of a rapidly growing industry, as well as the intense competition offered by the larger companies, and started development of the first oil-field water-flooding pumps capable of pressure up to 1000 psi. This major development in oil field recovery production was carried on in the diminishing oil fields of New York. At the time of his retirement he actively engaged in the development of oil properties and in the production of crude petroleum. During this period he studied the effect of adding heat to secondary recovery and published the first article on the subject in a technical journal.

His civic contributions have been numerous and of long duration: He has served as Supervisor of the Town of Wellsville for four terms, as Chairman of the County Bridge Committee, as member of the hospital board, as member of the County Reforesting program, as director of the local Blue Cross insurance program, as member of the Allegany War Council during World War II, and as member of the Vocational Training Program at Alfred Agricultural and Technical Institute.

In later life he became interested in agriculture and has pursued a soil improvement program on a run-down farm in

Bureau County, Illinois that has since become a showplace for its physical appearance and the restoration of crop yields.

He has been an ardent hunter with both rifle and camera, and has taken motion pictures of big game in Canada.

The Department of Mechanical Engineering, its faculty and students, salute one of its distinguished graduates, and expresses its appreciation to Mr. Schaller for providing funds for this memorial brochure to one of its most respected faculty members.

S. K.
February, 1972

Seven thousand copies of this memorial book were printed in 1972 on French Crème Blanc text paper and Pewter Strathmore Text, cover weight, at the University of Illinois Office of Campus Publications, using Caledonia and Caslon type faces. This was compiled and authored by Professor Emeritus Seichi Konzo and designed by Joan R. Zagorski.

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UNIVERSITY OF ILLINOIS-URBANA



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