REFLECTIONS ON PHYSICS AT WASHINGTON UNIVERSITY

Robert N. Varney, WU faculty 1938-1964

As of about 1919, the Department of Physics at Washington University was deemed to be inadequate.* As a first remedy, a new department chair was brought in, who was Arthur H. Compton. He was 28 years old as he took over the position in 1920. He only stayed four years, being lured to the University of Chicago in 1923. While in Eads Hall, he performed the work for which he won a Nobel pize several years later.

It might parenthetically be mentioned what the findings were that earned him the prize. The nature of X-rays had been debated since their discovery in 1898, whether they were beams of particles like electrons or electromagnetic waves like ordinary light. As of about 1913, the Bragg father and son, had "proved" that X-rays were waves by observing the phenomenon of diffraction, certain evidence of wave motion. Compton measured the slight change in wave length of X-rays on scattering in matter, and from his observations deduced that the X-rays must be particle-like in character, a remarkable feat in that he used a wave length measurement to establish that they were in effect NOT waves! The "Compton Effect" is today a matter of everyday observation in X-ray technology.

Compton was succeeded as chair in 1923 by Arthur Llwellyn Hughes at age 40, and much of the growth of the department occurred during his administration, which lasted until 1952. One carrot that was used to lure him to W.U. was the promise of a new building for Physics, to replace Eads Hall which was already inadequate. Hughes began at once on his arrival to consult with architects and design a new physics building. After five years without progress, he put the plans on the shelf as he faced the forthcoming years of depression. In 1933, an anonymous donor approached the university with the thought that building prices were the lowest they would ever be, and asked when the university could start work on a new physics building. He provided three quarters of a million dollars for the task. In a scant month Hughes had unveiled his long-ready plans and construction of the Wayman Crow Hall of Physics was begun. When completed in 1935 the construction had consumed $390,000 of the donation, and the balance became an endowment for the department.

Again as a side comment the writer was employed in 1938 at New York University, University Heights branch, in a physics building that had been a mansion until 1897 at which time it became the university physics building. At that time, the writer met the secretary of the American Physical Society who told the writer that he would be moving from the worst physics building in the country to what was probably the best.

The department that Hughes had to work with consisted in addition to himself, four further faculty members, a professor, an associate professor, an assistant professor, and an instructor. Hughes determined to reserve the instructorship for a theoretical physicist. He always advised the instructor and the assistant professor that there was no apparent prospect for promotion, and that while they would not be terminated unwillingly they would need to feel free to search for promotion elsewhere. He also made a practice of visiting many of the smaller colleges in the state and nearby, with the result that these faculties might recommend a prospective graduate student to him perhaps only once in three years, but this procedure did indeed provide him with the highest quality of graduate students. To be sure, they might have known a little less physics than graduates of more prestigious schools, but Hughes accepted the responsibility of teaching them the physics that they needed.

In addition, Hughes instituted a policy at once whereby each graduate student began research from his first day at W.U. Considering that the department in those years consisted of five faculty and eight graduate students, it is interesting to note that a glance at the Physical Reviews of 1936 to 1940 showed a disproportionately large number of papers from the Wayman Crow Hall of Physics! Hughes was known to advance the view that 10 years after earning a Ph.D. degree in physics, no prospective employer would ask what grade he had earned in quantum mechanics a dozen years earlier but might indeed ask what – and how many – research papers he had published.

Another of Hughes's procedures was to spring surprise oral examinations on all the graduate students once every semester. The aim was two fold: One was to prepare them for their ultimate final oral exam; the other was to test what immediate knowledge of physics they were carrying, unprepared, around in their heads. The students were not "passed or failed" in these tests but were advised afterwards wherein their shortcomings lay.

Still another Hughes practice was to hold a picnic lunch every Friday from 12 to 1 o'clock for the entire staff including graduate students. During the first half hour, talk about physics was banned. In the second half hour one graduate student would deliver a prepared talk on a current journal publication.

Ph.D. study took exactly 4 years. The Ph.D. qualifying examinations (prelims) were in writing. The final oral always consisted of 9 examiners with at least one from a student's minor department and one examiner from an entirely different, non-scientific department. According to faculty lore, the ninth member had been instituted at W.U. when the dean of the graduate school determined that he couldn't attend all Ph.D. final orals in person, and the ninth examiner was the representative of the dean with the duty of seeing that procedures were properly observed and followed.

In 1939 the W.U. School of Medicine determined that it should obtain a Cyclotron, for strictly medical purposes, and Hughes was charged with the task of determining how and where it was to be built. He obtained a grant of $100,000 from the Rockefeller Foundation and ultimately selected the present site. Some considerations today seem obvious, others are startling revelations of the economics of the times. Thus the site was to be completely underground to avoid the cost of massive radiation (and neutron) shielding. The precise spot, literally adjoining the university power house was to minimize the cost of longer electrical power cables!

Hughes succeeded in hiring Robert Thornton with the rank of associate professor, who had "grown up" under E.O. Lawrence in Berkeley and who indeed produced an excellently designed and operating instrument. In fact a scant year later, with World War II in progress, the W.U. Cyclotron (which was capable of running at high yield for 24 hours a day) produced the first micro sample of plutonium that Seaborg used to identify the chemical properties of the new element.

A comment on the "new" building may be in order. It seems clear that no detail had been overlooked. The two large lecture halls were the most modern of their day. Hughes had not even overlooked obtaining slide projectors of the proper focal length for each hall; the requirements were not identical. The building had an elevator, something the chancellor (a professor of Greek) took violent exception to. Hughes won out by telling the chancellor that the elevator was to be so slow that no one would even want to use it for personal transportation. The building had a large sub-basement, a space that was not utilized for several years. Since it was completely underground it was air conditioned,

a relatively unusual facility at this early date. There was also a large attic space. The six-inch astronomical telescope that had existed for years in a small wooden house of its own was now transported to the roof of Wayman Crow Hall. For some years there was plenty of room for expansion; in fact Crow Hall became filled up in 1955, 20 years after its opening, another feature to Hughes's credit. In fact the enormous growth in physics that had occurred with the end of World War II could not have been predicted. The department at W.U. grew from 5 faculty and 8 graduate students to 24 faculty and 50 graduate students.

The expansion was nationwide. The department of physics at the University of California at Berkeley had 14 faculty before the war and soon after had 58.

The war years saw a horde of wartime trainees. In Crow Hall, Professor G. E. M. Jauncey was in charge of an array of 40 "teachers," drafted from other departments as necessary. Among the best of these were Professor Morrissette from the French department and Professor Lemmon from Psychology. All of the laboratory rooms were converted to temporary class rooms. Students marched in under the command of a sergeant to attend their classes.

The end of the war saw many changes. By the fall of 1946, there were 9 faculty members. The beginning course for engineering students started the fall with some 350 students as against the earlier total of 85. A total of 50 graduate students was set, the need for teaching assistants alone dictating this number. Pay levels for faculty had taken a drastic turn upwards, something that Hughes discovered in his first attempt to fill out the staff. But by 1948, Hughes was on the road again to fill four more vacancies. He interviewed a total of 18 candidates, to each of whom he wrote a letter of appointment with the stipulation that he would appoint the first four who accepted, but no more. Ultimately only six of the eighteen ever accepted.

The change in size of the department alone dictated further changes. The semi-annual oral examinations had to be abandoned for logistic reasons. The development of new fields like magnetic resonance demanded that prospective students simply had to have more advanced training in quantum mechanics before they could possibly start research. The traditional period of 4 years to complete the Ph.D. program was beginning to feel a pinch. Of 15 students admitted in 1946, 9 actually finished by 1950. The rules required approval of the entire faculty to extend the allowed time to the end of the summer session, at which time at least three more had finished. Very soon later, the first student to need five years took the necessary time without even any formal action.

As of the fall of 1946, most of the students were war veterans, hence older on the average than former graduate students and markedly more informed on technical matters. In fact by 1948 the seeming naivete of the new influx of students who in fact were not veterans, and younger, required new adjustments by the staff.

The rise of research grants also provided new aspects for the department. The Office of Naval Research was the first to make an annual grant to the department, a sum of $175,000 per year. The grant was nominally for nuclear research, although it was possible to interpret such things as Geiger-Müller counter research as "nuclear." Professor Robert Sard succeeded in obtaining his own, separate Naval Research grant for cosmic ray work. Naval research grants persisted as the primary source of money for some years. There was considerable pressure from Congress that the research should prove its value to the Navy. The Air Force, and the National Science Foundation slowly moved into the granting business. Private grants from, for example, Research Corporation also developed. A

considerable fraction of the grant money went to stipends for graduate students.

Pake succeeded Hughes as department chair in 1952. One of his early moves was to persuade the School of Engineering to include Engineering Physics as a major. Prior to this time undergraduate physics majors were enrolled in the College of Liberal Arts. At that time and earlier, students were only allowed to take a course outside of their own college by special permission. The basic, sophomore level course in physics for engineering students had been officially proclaimed to be and Engineering School course. Physics majors were only allowed to take that course instead of the liberal arts course by special permission, which, however, was usually granted. Prior to 1952 there were only an average of four physics majors per year. By the fall of 1957, the engineering physics course had led to a total of some 70 odd majors in the four years. In 1958, twelve majors graduated and progressed to winning a Rhodes, four Wilson scholarships and three others.

The engineering physics program was intentionally set up to allow flexibility. Thus only three basic engineering courses were required: A semester of engineering drawing, a year of applied mechanics ("strength of materials"), and a year of alternating current theory.

The last two were selected on the basis of recent history among physicists. Thus van de Graaff building the ten million volt accelerator at M.I.T. had mounted the beam tube between the high voltage terminals on a seven-foot thick plastic I-beam under the impression that an I-beam would not bend at all which it of course did breaking the vacuum tube it was suppose to support. At Berkeley, E.O. Lawrence was drawing up to a hundred kilowatts of electric power for his Cyclotrons before an engineer advised him of the advantages of using three-phase power.

Thanks to the flexibility of the engineering physics requirements, the Liberal Arts department of Philosophy offered a beginning course in philosophy for seniors in engineering. The instructor in due course reported that he had never faced a class with such an advanced grasp of logic.

Between 1946 and 1964 the Department of Physics had a total of 37 faculty and post-doctorals come and leave! The turnover grew somewhat in the early 1960s, to some extent because of a growing rebellion at any regulations whatsoever. Undergraduate courses were completely changed at the will of the instructor, by contrast with earlier times when any change in course content had to be approved by the entire faculty of Liberal Arts. The rebellion in turn was in part due to the vast changes in physics that were occurring throughout the country. A catchword of the times was: "If we don't get into high energy physics, we are dead." That particular requirement did not in fact prove either necessary or possible. and the department has thrived notably in the ensuing years.

Between 1923 and 1964, the department granted 125 Ph.D. egrees. There had been none during the early Compton regime although at least one pre-doctoral student (Frank Bubb) went with him to Chicago.

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*This was some ten years after the retirement of Francis Nipher, the first Wayman Crow Professor (1875-1908), who published widely on topics including animal mechanics, short-term memory, the theory of measurements, meteorology, and electromagnetism. He was one of only a handful of Washington University faculty who enjoyed a national reputation for research. His text *Electricity and Magnetism*, published by Van Nostrand in 1886, was the "Jackson" of its day. (JWC)