TO DEMONSTRATE THE TRUTHS OF "CHYMISTRY"

An Historical and Pictorial Celebration of the Art of the Lecture Demonstration in Honor of Dr. Hubert Alyea

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The name of Hubert Newcombe Alyea is virtually synonymous with the term chemical demonstration and is known to every chemical educator of this generation. He has delighted countless audiences with his lectures and has enriched the chemical demonstration literature with his series of TOPS demonstrations and the Alyea projector. The following paper is based on a lecture entitled "Chemical Demonstrations BA (Before Alyea)", given at a symposium in Dr. Alyea's honor sponsored by the Division of Chemical Education at the 197th National ACS Meeting in Dallas, Texas, on 11 April 1989 (1).

The origins and use of lecture demonstrations in the teaching of chemistry are essentially coextensive with the origins of academic chemistry itself, and the origins of the latter, as historians have begun to realize, are in many ways the accidental side-effect of the activities of the 16th century Swiss-German iatrochemist, Philippus Aureolus Theophrastus Bombastus von Hohenheim (1493-1541), better known as Paracelsus (figure 1). Usually presented as a transitional figure, wedged between the age of alchemy and the phlogiston period in histories of chemistry, Paracelsus is generally credited with having deflected the activities of chemists from the pursuit of the transmutation of metals and the elixir of life into the development of chemical models of the human body and disease and the chemical preparation of drugs and medicines. Though a modern chemist would probably consider iatrochemical theories of physiology and materia medica, which were heavily tinged with mysticism and astrology, as little improvement over their alchemical predecessors, the importance of the iatrochemical movement for modern chemistry lies in the fact that, by fixing the medical community on chemical models of the human body and drug action, it inserted the wedge whereby chemistry gradually entered the traditional university curriculum under the guise of introductory service courses taught to students of medicine and pharmacy (2).

Table 1. Some early appointments in medical and pharmaceutical chemistry (3)

A. Libavius	Rothenburg	1592
D. Sennert	Wittenberg	1602
J. Hartmann	Marburg	1609
G. Rolfinck	Jena	1641
G. Davisson	Paris	1648
C. L. van Maets	Leyden	1669

Figure 1. Philippus Aureolus Theophrastus Bombastus von Hohenheim, better known as Paracelsus (1493-1541).

By the beginning of the 17th century, a small, but increasing, number of medical schools were employing professors of medicine with explicit chemical interests (Table 1), such as Andreas Libavius (1540-1616) at Rothenburg (1592) or Daniel Sennert (1572-1637) at Wittenberg (1602), and in 1609 Johann Hartmann (1568-1631) was actually appointed to an explicit chair of "iatrochemistry" at the medical school in Marburg. In the case of pharmaceutical chemistry, the appointment of "Demonstrators" in chemistry in connection with famous botanical or drug gardens became increasingly common, including that of William Davisson (1593-1669) at the Jardin du Roi in 1648 and Charles Louis van Maets at Leyden in 1669. Indeed, by the last half of the 17th century, private lectures on chemistry (figures 2 and 3), complete with demonstrations, were being offered successfully by such chemists as Nicolas Lemery (1645-1715) in Paris, which not only attracted students of medicine and pharmacy, but a substantial number of foreigners and private citizens, including many women (3, 4).

The impact of the teaching of medicine on the teaching of chemistry is perhaps best seen in the case of the Jardin du Roi or Royal Gardens in Paris (5). Beginning with the appointment of the Scottish chemist, William Davisson, in 1648, the positions in chemistry at the Jardin would be held by some of the most illustrious names in 17th and 18th century French chemistry, as shown by the far-from-complete list given in Table 2, and would also engender a famous series of elementary textbooks (6). Just as the teaching of anatomy made use of both a professor, who offered lectures on the subject, and a demonstrator or surgeon, who demonstrated the truths of the lecture by dissecting a body in front of the students (figure 4), so the positions in chemistry at the Jardin involved both that of a professor or lecturer and a demonstrator. For just as the truths of internal anatomy were hidden from the eye and had to be revealed to the student by the surgeon's knife, so the truths of chemistry were hidden until extracted and demonstrated by the artifice of the laboratory.

Generally the professor would first deliver his lecture on the facts and theories of chemistry, after which the demonstrator would present experiments to support the professor's assertions. That this arrangement did not always lead to the desired result is illustrated by the case of Louis-Claude Bour-

Figure 2. An early 17th century woodcut of a chemical lecture. Note the lecture assistant tending the furnace in the background.

delain (1696-1777), who was professor at the Jardin in the 1750s, and Guillaume-François Rouelle (1703-1770), who was the demonstrator and is shown in the romanticized 19th century etching in figure 5 beguiling his audience with one of his famous demonstrations. It is reported that Bourdelain would end each lecture with the statement, "Such, gentlemen, are the principles and theory of this operation, as the Demonstrator is about to prove to you by his experiments," whereupon Rouelle would enter and generally proceed to prove the exact

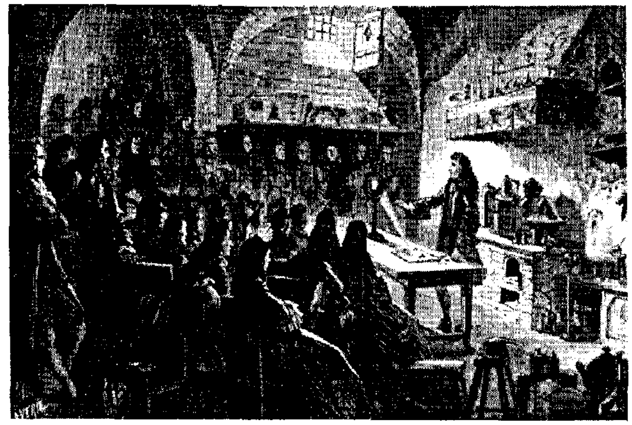


Figure 3. A 19th century reconstruction of one of Lemery's chemical lectures in the late 1600s. Note the large number of women in the audience (39).

opposite. Indeed, Rouelle is rumored to have been highly eccentric. As one observer reported (7):

He [Rouelle] would come to the lecture room elegantly attired with a velvet coat, powdered wig and a little hat under his arm. Collected enough at the beginning of his demonstrations, he gradually became more animated. If his train of thought became obscure, he would lose patience and would gradually divest himself of his clothing, first putting his hat on a retort, then taking off his wig, then untying his cravat. Then, talking all the while, he would unbutton his coat and waistcoat and take them off one after the other. He was helped in his experiments by one of his nephews, but as help was not always to be found close at hand, he would shout at the top of his lungs, "Nephew! O' the eternal nephew" and the eternal nephew not appearing, he would himself depart into the back regions of his laboratory to find the object he needed. Meanwhile he would continue his lecture as though he were still in the presence of his audience. When he returned, he had generally finished the demonstration he had begun and would come in saying, "There, gentlemen, this is what I had to tell you." Then he was begged to begin again, which he always did with the best grace

Table 2. Some early occupants of the positions in chemistry at the Jardin du Roi (5)

G. Davisson	1648
N. LeFévre	1651
C. Glaser	1660
E. F. Geoffroy	1707
L. Lemery	1730
G. F. Rouelle	1743
L. C. Bourdelain	1743
H. M. Rouelle	1768
P. J. Macquer	1771

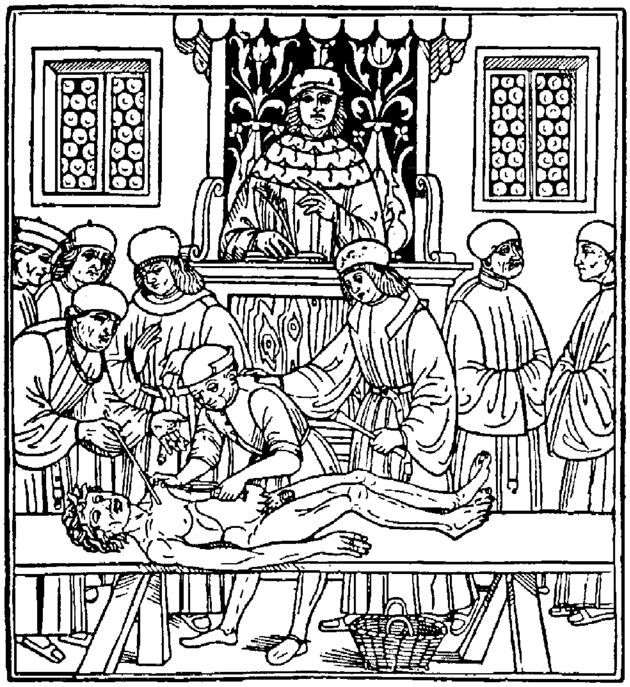


Figure 4. A 16th century medical lecture. The surgeon performs the actual dissection as the professor reads his lecture.

in the world, in the conviction he had merely been badly understood.

By the end of the 18th century the roles of demonstrator and professor had begun to fuse or, at least, to redistribute into professor and lecture assistant. This is certainly implied by the drawing in figure 6 of Antoine-François Fourcroy (1755-1809), who, though professor at the Jardin beginning in 1784, is shown posing with both lecture notes and demonstration apparatus (8). Indeed, in the case of the 18th century Scottish medical schools, the differentiation into professor and demonstrator seems never to have occurred, and, as far as we know, Joseph Black (1728-1799) did his own demonstrations (figure 7) with the help of an assistant (9). Certainly this was true in France as well by the first decades of the 19th century, as shown in the drawing of Louis-Jacques Thenard (1777-1857) in figure 8 lecturing on chemistry to a class of medical students in the early 1800s (10).

Figure 5. A 19th century reconstruction of one of Rouelle's famous lecture demonstrations at the Jardin du Roi in the 1750s (39).

Chemistry was taught solely by demonstration for the first 225 years of its academic existence, that is, from the beginning of the 17th century until the second or third decade of the 19th,

Figure 6. Antoine-François Fourcroy (1755-1809) posing with his lecture equipment and notes (8).

during which time it largely retained its status as an introductory service course for students in medicine and pharmacy. Consequently, it is really not possible to separate out an explicit demonstration literature for this period, since the use of demonstrations was the implicit basis of all aspects of chemical pedagogy, from the organization of textbooks to the design of teaching facilities.

Its impact on the latter can be seen in John Webster's (1793-1850) design for the chemical laboratory at Harvard University, which he inserted as a plate (figure 9) in the 1826 edition of his textbook, *A Manual of Chemistry* (11). As can be seen, it is really a plan of what we would call a lecture hall and prep room. Indeed, the use of the word laboratory during this period almost invariably refers to a work room off the front of a lecture hall in which the professor, and perhaps one or two lecture

Figure 7. John Kay's caricature of Joseph Black at his lecture bench. The white squares cluttering the bench top are Black's lecture notes.

assistants, could prepare lecture demonstrations and occasionally conduct original research. Private research laboratories and large teaching laboratories for students were generally nonexistent. Other examples of similar design include the famous laboratory at the Royal Institution used by both Humphry Davy (1778-1829) and Michael Faraday (1791-1867) (12) and Robert Hare's (1781-1858) laboratory at the University of Pennsylvania (figure 10), in which virtually all of the laboratory operations, including the apparatus and chemical storage areas, were open to the view of the audience (13).

Figure 8. Louis-Jacques Thenard lecturing on chemistry to a class of medical students in the early 1800s (10).

Webster, by the way, is known in Harvard chemical lore for his famous volcano demonstration - a large plaster mountain filled with potassium perchlorate and sugar which Webster would ignite without warning using a drop of sulfuric acid and then dash for the nearest door, leaving the students to fend for themselves (14). Webster was also eventually hung for murder - not for igniting one of his students on fire with his volcano, but for murdering a fellow faculty member in the medical school (15).

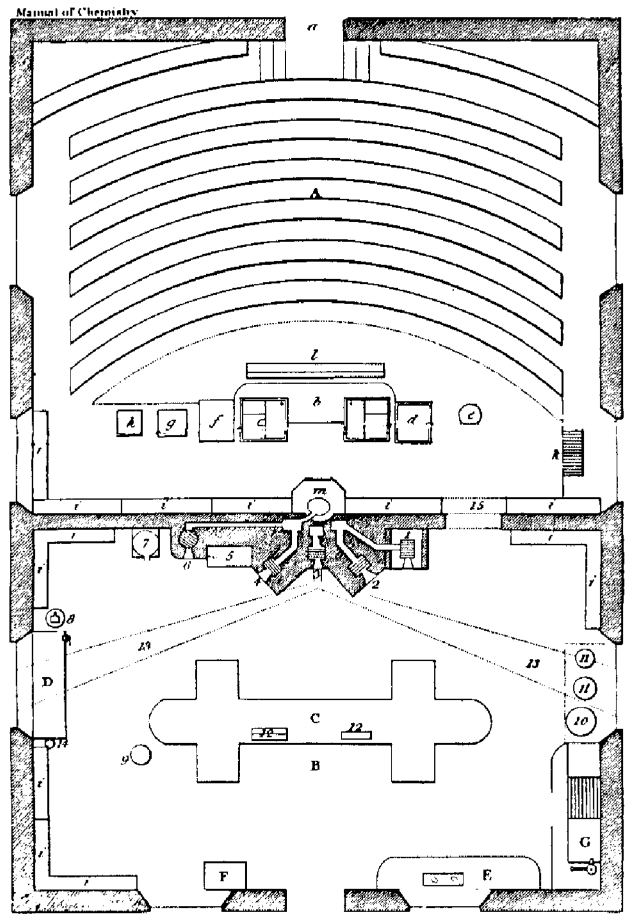


Figure 9. John Webster's floor plan for his lecture hall and laboratory at Harvard, circa 1826 (11).

Since the textbooks of the period were often only thinly disguised transcriptions of the actual lectures, they usually incorporated direct verbal descriptions of the demonstrations as they were performed in the course of the lecture itself. In a survey of 68 American texts published between 1788 and

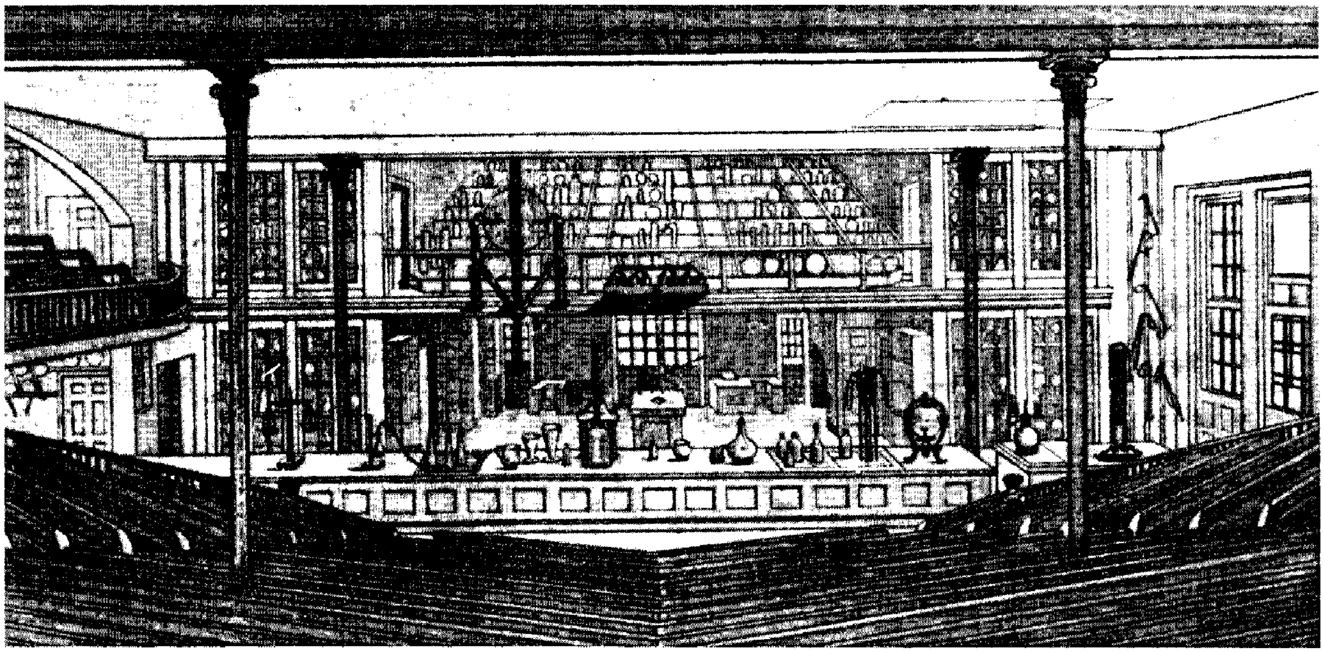


Figure 10. Robert Hare's laboratory and lecture hall at the University of Pennsylvania Medical School, circa 1830 (13).

1890, Mangery (16) found that an average of 30 demonstrations and 68 experiments were described, the record being held by James Cutbush's (1788-1823) 1813 text, which contained 820 (17). Often these were simply part of the ongoing flow of the text. In other cases the authors used various devices to draw attention to them. Thus Thomas Duché Mitchell's (1791-1863) text, *Elements of Chemical Philosophy*, published in 1832, used the marginal notation of "Experiment" to indicate at what points in the lecture Mitchell performed actual classroom demonstrations (18), whereas Robert Hare, in his *Compendium of Chemistry*, which went through numerous editions between 1822 and 1840, divided his text into sections in which each descriptive segment was followed by a section entitled "Experimental Demonstrations", much as Rouelle had followed Bourdelain a century earlier (19).

Hare's compendium was in many ways a pictorial guidebook to the lecture demonstrations used in his introductory service course for the medical students at the University of Pennsylvania, and his career seems to have been largely devoted to their improvement and elaboration. The result of this obsession was an odd mixture of success and failure. Success, in that the improvements led to many novel discoveries and several new forms of apparatus - including the oxyhydrogen blowpipe - and resulted in one of the most productive research records of any American chemist prior to the Civil War. Failure, in that the resulting demonstrations became so elaborate that they virtually ceased to have pedagogical value. This is illustrated by Hare's apparatus for demonstrating the reaction of oxygen and hydrogen to form water (figure 11) - an elaborate complex of tubes and valves which can hardly be considered an improvement over the simple expedient of lighting the end of a zinc-acid hydrogen generator inside a large dry bell jar, as in the standard demonstration. Indeed, Hare seems to have been aware of this failing, as he confessed in his introduction that one reason for writing the compendium was the fact that his apparatus had become so complex that students were unable to follow the demonstrations without having a printed illustration and description to study before class. In fairness, I should point out that not all of Hare's demonstrations were this elaborate, and occasionally one stumbles across an old favorite, like the oxygen-hydrogen cannon shown in figure 12.

An even more extreme version of Hare's approach is found in Amos Eaton's (1776-1842) 1833 text, *The Chemical Instructor*, in which each topic was divided into a "Proposition" or statement of fact, followed by "Illustrations" or supporting lecture demonstrations, followed by the theoretical "Rationale" and by practical "Applications" (20). Eaton's text also calls to mind the existence of another nonacademic tradition of lecture demonstrations - that of the itinerant lecturer. These private lecturers, who were quite popular in the late 18th and early 19th centuries in Great Britain and America, earned their livelihood or supplemented it, in the case of some university professors, by traveling from town to town to give short courses on chemistry, amply illustrated with demonstrations, to groups of private citizens, usually under the sponsorship of local ministers, educators or natural history societies. Indeed, Miles has assembled a list of some 50 such chemical lecturers who were active in the United States in the 19th century (21).

Eaton's text is actually a handbook for the itinerant chemical lecturer, outlining the minimum content for a proper course of lectures, what demonstrations to use, what apparatus to buy, etc. It also offered more general advice, warning the would-be lecturer to avoid "those blazing, puppet show-like experiments common with quacks and impostures" and local authorities to avoid (20):

> ... those peddling swindlers who offer to sell tickets for insulated [i.e., single] lectures, [instead of a full course of 15-30] who ought to be despised. They are always contemptible quacks of no integrity and they ought not be allowed to sleep near traveler's baggage at public inns.

Finally, Eaton argued that (20):

> ... every city, large village, or populous district ought to be too liberal to depend on itinerating lecturers. They should support permanent teachers of the right kind; particularly avoiding those self-styled chemists who swarm about our large towns, possessing no qualifications but impudence. These are chiefly illiterate Scotch, Irish or English. But justice demands that we make many honorable exceptions.

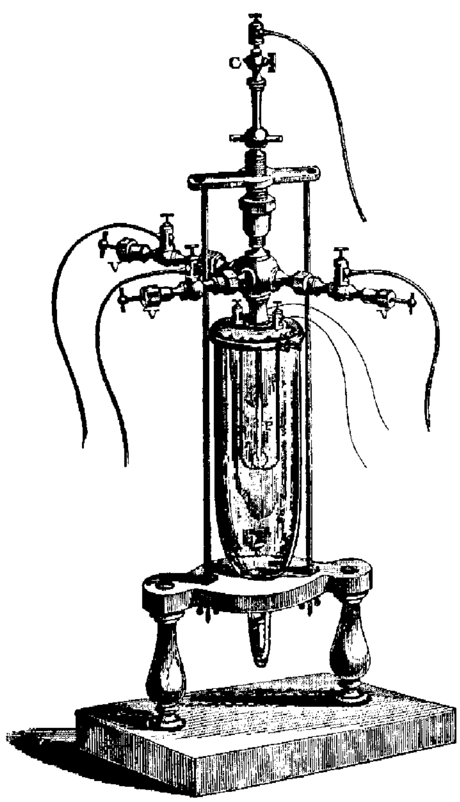


Figure 11. Hare's elaborate apparatus for demonstrating the synthesis of water (19).

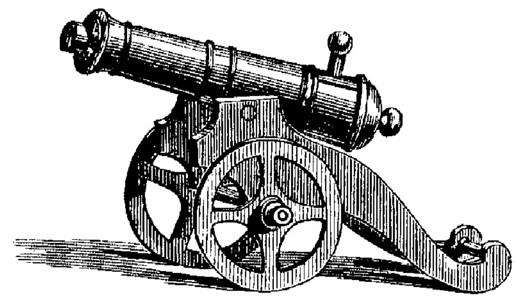


Figure 12. Hare's brass oxygen-hydrogen cannon, which was ignited with a spark from a Leyden jar (19).

I presume that Eaton would have included Dr. Alyea - whose later career must resemble in many ways the hectic life style of the itinerant lecturer - in his list of honorable exceptions!

Just as laboratory design and textbook organization were both inexorably intertwined with chemical demonstrations during this period, so too was the literature dealing with chemical manipulation and the chemistry set. The former was intended to introduce novices to the more common kinds of apparatus and to train them in the simple operations of the laboratory, whereas the latter was intended to provide educational amusement. In the case of the manipulation literature, the experiments used often doubled as standard lecture demonstrations for the simple reason that proficiency in the art of lecture demonstration was considered as part of the education of a well-trained chemist. As for the chemistry set literature, obviously whatever could entertain and instruct at home could do the same in the classroom. Michael Faraday's classic *Chemical Manipulation* (1827) and George W. Francis' encyclopedic *Chemical Experiments Illustrating the Theory, Practice and Application of the Science of Chemistry* (1854)

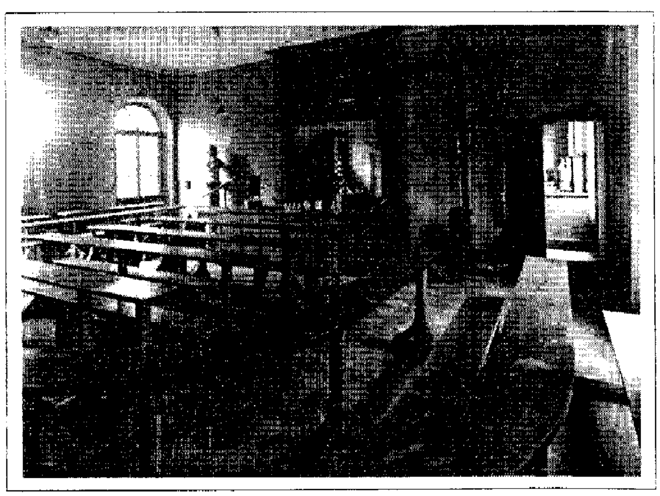


Figure 13. Liebig's lecture hall at Giessen. Note the door leading to the laboratory and the opening behind the lecture bench (38).

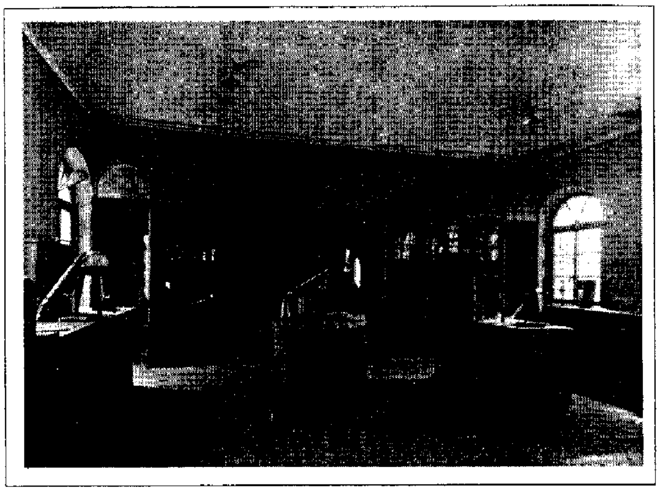


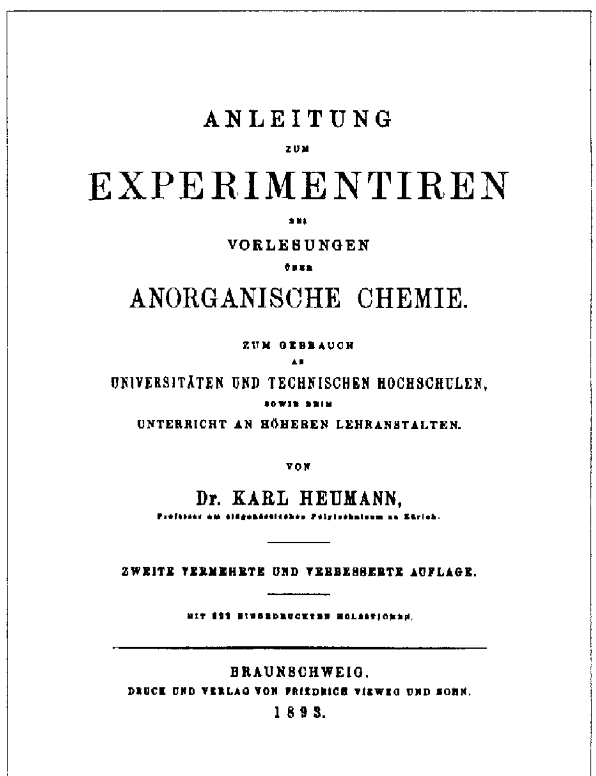
Figure 14. The student laboratory-prep room behind Liebig's lecture hall at Giessen. Note the opening for passing demonstrations through to the lecture table (38).

come immediately to mind as typical early 19th century examples of the first of these traditions, and Fredrick Accum's *Chemical Amusement* (1817) is perhaps the most famous example of the second. In fact, the literature in both of these areas is surprisingly rich, and I have discussed both traditions in greater detail elsewhere (22, 23).

As already noted, the transition from the demonstration method to the laboratory method of teaching chemistry began in the 1820s and 1830s and was coextensive with the rise of complete chemical curricula in the university designed to train professional chemists, in contrast to the earlier introductory service course for other professions. As everyone knows, the small teaching laboratory started by Justus Liebig (1803-1873) at Giessen in 1824 played a key role in this process and, indeed, the teaching facilities at Giessen reflect this transition in an interesting way (24, 25). The central feature, as in Webster's plan, still appears to be a lecture hall (figure 12) directly connected at the front to a laboratory (figure 13) for the preparation of demonstrations. However, this preparation room is now large enough to allow 20 or more students to also work directly on their own experiments. In other words, it can double as a traditional prep room and as a teaching laboratory.

Incidentally, Liebig himself doesn't appear to have been much of a success as a lecture demonstrator, at least if we are to believe Carl Vogt's description of his experiences in Liebig's lectures in 1834 (26):

He [Liebig] was then at the height of his power and enthusiasm and his every word proclaimed his determination to give us the most thoroughgoing instruction. The lectures were, certainly, not models whether one considered the descriptions, the performance of the experiments, or the derivations of the conclusions and inferences. Liebig was at that time still overly hasty in everything that he undertook. He was very prone to leave out the intermediate steps of a course of reasoning. Starting out from a major premise, he instantly came down with both feet plump upon the final conclusion. In the lecture experiments he constantly seized the wrong materials or succeeded only because the assistants on the right hand and the left placed the proper instruments and reagents into his hands. The excellence of his manipulation in the laboratory was equaled only by his lack of success in the lecture-demonstration; and in spite of these defects, we were carried along and inspired by his ardor for his subject. "Now, gentlemen!" he would say, "I have a liquid in this test tube. It is a solution of acetate of lead. You might believe it to be water - it appears just like water - but I would be able to show you that it is a solution - for the present you will have to take my word for it. Well then, this water is a solution of lead acetate! And here in this glass you see a yellow liquid! (Takes the glass and looks at it.) That's right! A yellow liquid! This yellow liquid is a solution of potassium chromate in water. (He puts down both glasses, goes to the board, takes the chalk and writes some formulas.) ... Now gentlemen, I pour the two liquids together. (He pours them together, goes to the board and completes his equations.) You see, a chemical decomposition takes place. The acetic acid combines with the potassium and forms acetate of potassium which is soluble in water and colorless; the chromic acid combines with the oxide of lead and forms lead chromate which is insoluble in water and produces a beautiful yellow precipitate which is used as a dye, as chrome yellow!" He shakes the glass and goes,



ANLEITUNG

ZUM

EXPERIMENTIREN

BEI

VORLESUNGEN

ÜBER

ANORGANISCHE CHEMIE.

ZUM GEBRAUCH

AN

UNIVERSITÄTEN UND TECHNISCHEN HOCHSCHULEN,

SOWIE BEIM

UNTERRICHT AN HÖHEREN LEHRANSTALTEN.

VON

Dr. KARL HEUMANN,

ZWEITE VERMEHRTE UND VERBESSERTE AUFLAGE.

BRAUNSCHWEIG,

DRUCK UND VERLAG VON FRIEDRICH VIEWEG UND SOHN.

1893.

Figure 15. The title page of the second edition (1893) of Heumann's book on lecture demonstrations.

constantly shaking it, up and down, along the front row of the students, all the time repeating, "Chrome yellow! A beautiful yellow precipitate! You see gentlemen, you see!" At last he raises the glass and holds it in front of his own eyes. "That is you see nothing - the experiment has failed." (In a rage he throws the glass in a corner.) Ettling, the assistant, shrugs his shoulders without speaking and points to a glass still on the table as a way of telling the students that the professor in his zeal has again used the wrong solution.

A reproduction of Liebig's original lecture notes, complete with detailed descriptions of his lecture demonstrations, has recently been published by Krätz and Priesner (27).

By the 1870s the laboratory and research aspects of chemical instruction had become sufficiently developed and differentiated from the older demonstration aspects that we can begin to talk of an explicit and separate demonstration literature. The first book to appear within this tradition was the 1876 text, *Anleitung zum Experimentiren bei Vorlesungen über anorganische Chemie*, by Karl Heumann (1850-1893) of the Technische Hochschule in Darmstadt (28). In this book he outlined the design of a proper lecture hall and demo prep room and explicitly described hundreds of demonstrations based on those used by Bunsen, Liebig, Hofmann, and others. By 1893, when Heumann had moved to the ETH in Zürich, the book, then in its second edition, was more then 700 pages thick and contained over 322 illustrations. The copy in the Oesper Collection at the University of Cincinnati (figure 15), which dates from the early days of its chemistry department, has been rebound as two separate volumes - one for demonstrations relating to the nonmetals and one for demonstrations relating to the metals - and has interleaved blank pages containing the comments of past faculty, in both German and English, on improvements and alterations in the demonstrations.

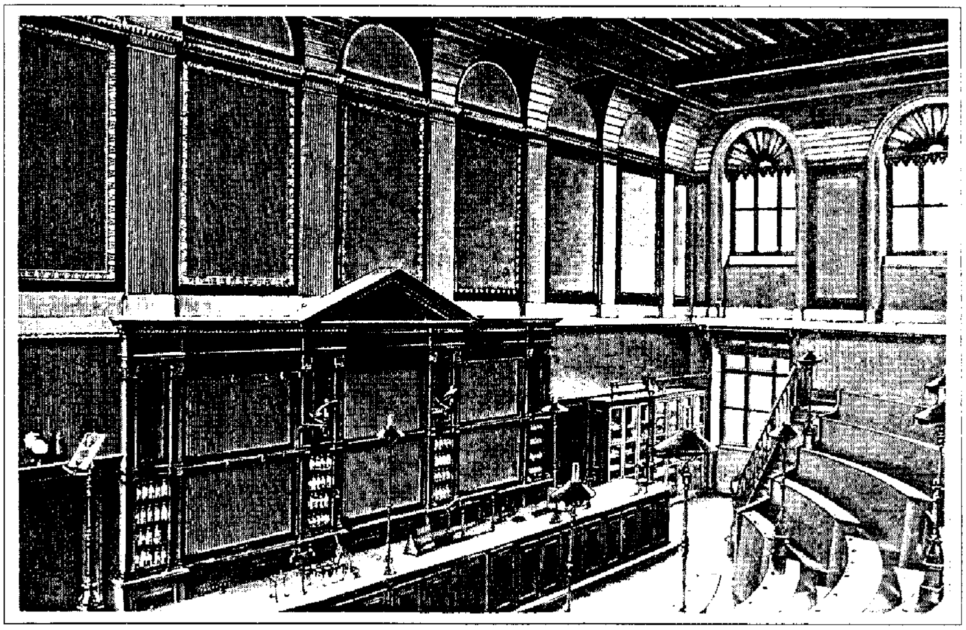


Figure 16. Heumann's lecture hall at the ETH in Zürich, circa 1893 (28).

Among the famous chemists that Heumann mentioned, the name of August Wilhelm Hofmann (1818-1892) should be singled out for special attention. In 1865 he published a series of 12 introductory lectures on chemical theory which stressed the central importance of Avogadro's hypothesis and the newly developed valence concept. Though not intended as a handbook of lecture demonstrations, the book gave detailed accounts, complete with illustrations, of the demonstrations used by Hofmann in his lectures, many of which employed apparatus specially designed by him. These demonstrations were quickly adopted by others and laboratory supply catalogs for the last quarter of the 19th century carried an extensive line of "Hofmann Lecture Apparatus", including the well-known Hofmann electrolysis cell. It is doubtful whether any other single chemist has ever originated so many pieces of commercially manufactured lecture apparatus (29).

Even more impressive than Heumann's epic tome was Rudolf Arendt's (1828-1902) 1881 text, *Technik der anorganischen Experimentalchemie*, which by 1910 had reached a fourth edition with over 1,011 pages and 1,075 illustrations (30). Arendt, by the way, should be of great interest to chemical educators since he was, as far as I know, the first specialist in this field, teaching courses in the pedagogy of chemistry to would-be science teachers at Leipzig and writing textbooks on how to scientifically teach chemistry (31).

The first American book on chemical demonstrations was published in 1877 by Samuel P. Sadtler (1847-1923) and carried the somewhat lengthy title of *Chemical Experimentation, Being a Handbook of Lecture Experiments in Inorganic Chemistry* (32). In his introduction, Sadtler, who was at the time an Assistant Professor of Chemistry at the University of Pennsylvania, claimed that, prior to the publication of his book, there had been "in the English language no book designed to give full instructions for the illustration of chemical lectures". Though the vast majority of his illustrations were taken from Heumann, Sadtler further claimed that most of his

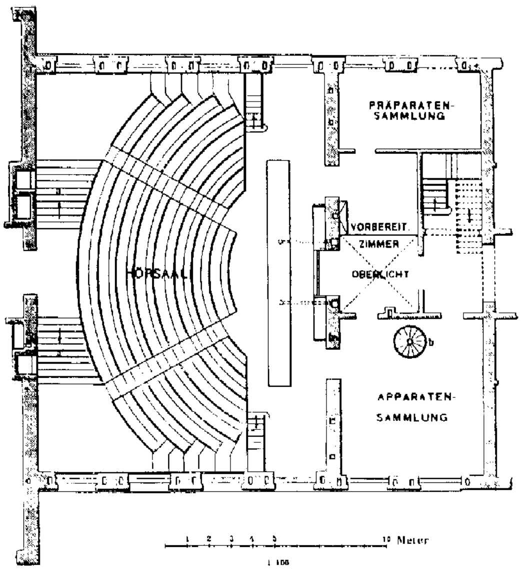


Figure 17. The floor plan of Heumann's lecture hall and prep room at the ETH in Zürich (28).

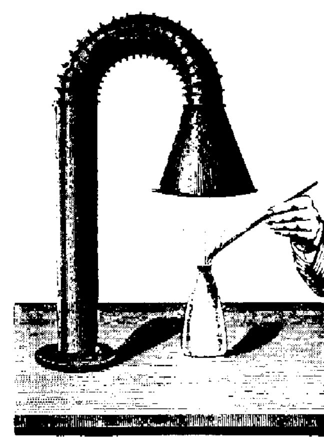
book had been written without knowledge of Heumann's work, which had been brought to his attention only after he had written Heumann's publisher for permission to use illustrations from other volumes published by them. In addition to some last minute copying from Heumann, Sadtler also mentioned having made use of Hofmann's famous text, a volume by Gorup-Besanez and an earlier inorganic text by Arendt, which I haven't seen. Sadtler's book was only 225 pages long and did not cover questions of lecture and demo room design. It also appears not to have been very successful and was rapidly displaced by the more elaborate books by Heumann and Arendt.

Assuming that Sadtler's complaint about the lack of English-language books on chemical demonstrations was true, then the first British book to deal explicitly with this subject would appear to be the 1892 volume, *Chemical Lecture Experiments*, by G. S. Newth, the chemical demonstrator at the Royal College of Science in South Kensington (33). Much less complete than its German predecessors, it had, like Sadtler, nothing to say about lecture and demo room design and dealt only with demonstrations relating to the nonmetals.

A second American volume dealing with chemical demonstrations, and having the same title as Newth's book, was published by Francis Gano Benedict (1870-1957) of Wesleyan University in 1901 (34). As with the other English-language books, it also lacked sections on lecture and demo room design and was largely based, by the author's own admission, on the earlier works by Heumann, Arendt and Newth.

The most intriguing and, by modern standards, the most depressing parts of the texts by Heumann and Arendt are their descriptions of the lecture halls and demo rooms. Heumann included a plate of his lecture hall at Zürich (figure 16) as well as a floor plan (figure 17) and Arendt specified the most minute details of the construction of a proper lecture bench (figure 18), including a table-top hood system for obnoxious odors and smoke (figure 19), a built-in safety screen and pneumatic trough, which could be cranked in and out of the desk top (figure 20), and such supplementary devices as mirrors to enhance the visibility of certain demonstrations (figure 21).

Figure 19. A close-up of the bench-top hood system recommended by Arendt (30). See also figure 18.



The use of optically projected chemical demonstrations (figures 22-24), including an early forerunner of the modern overhead projector, was also discussed by Arendt and in greater detail

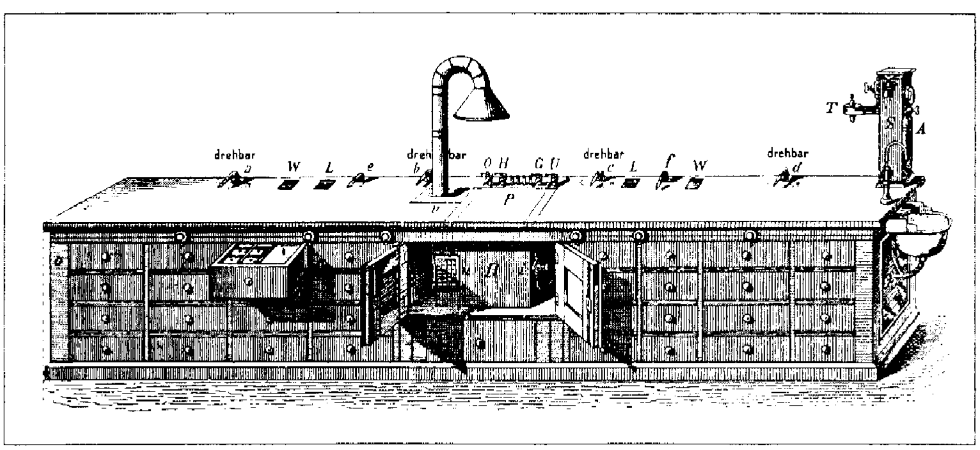


Figure 18. Arendt's design for a lecture bench (30).

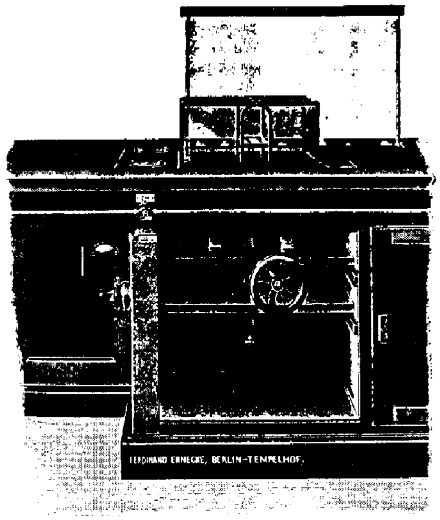


Figure 20. A pneumatic trough and glass safety shield which crank into the top of the lecture bench (30).

in an 1890 volume on optical projection by Lewis Wright (35).

Laboratory designers in Europe, Britain and the United States took these suggestions seriously, at least until the 1930s, as witnessed by lecture halls built in Germany in the 1850s (figure 25); at Yale in 1887 (figure 26); at Lehigh in 1884 (figure 27); at MIT in 1883 (figure 28); at the Imperial College of Science in London in 1906 (figure 29); at Leipzig in 1897 (figure 30), where Wilhelm Ostwald (1853-1932) is shown giving an inaugural lecture in his new lecture hall to an audience containing most of the great names of 19th century physical chemistry; and, finally, at Cincinnati in 1895 (figure 31). This last lecture hall, by the way, had, according to contemporary accounts, the crank-up safety shields recommended by Arendt.

Though this concern for quality lecture demonstration facilities - the idea that these must be as specifically designed as the teaching and research laboratories - continued into the next generation of buildings constructed in the 1920s and

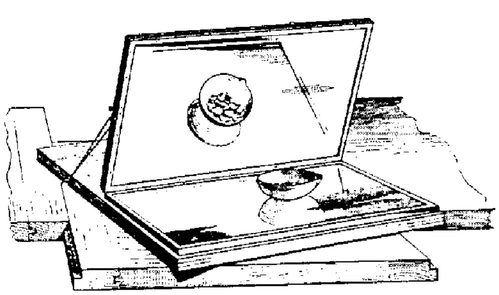
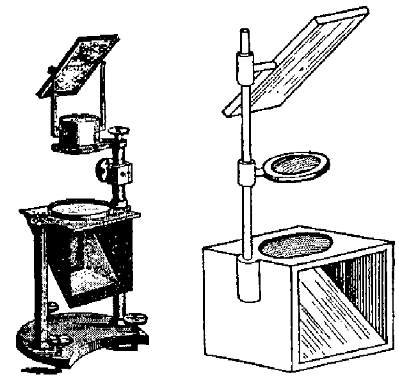
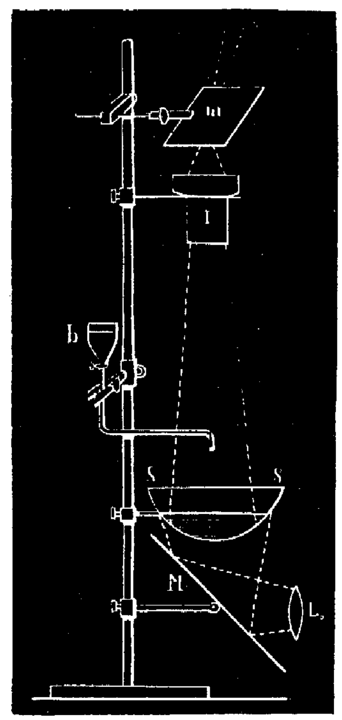


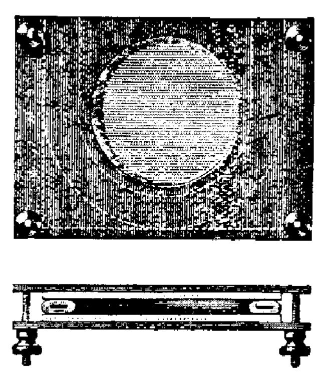
Figure 21. Bench-top mirrors to enhance the visibility of certain demonstrations (30).



Above: Figure 22. Early examples (circa 1890) of overhead projectors. Both of these made use of the light from a conventional horizontal projector which was directed at the mirror mounted in the base (35).



Right: Figure 23. Another setup for the overhead projection of a chemical reaction as described by Wright in 1890 (35).



Below: Figure 24. A cell for the horizontal projection of chemical reactions made by compressing a curved section of rubber tubing between two glass plates. The plates, in turn, are pressed together by a set of outer metal plates held together by thumb screws. After the demonstration is over, the plates are unscrewed and the cell is disassembled for easy cleaning (35).

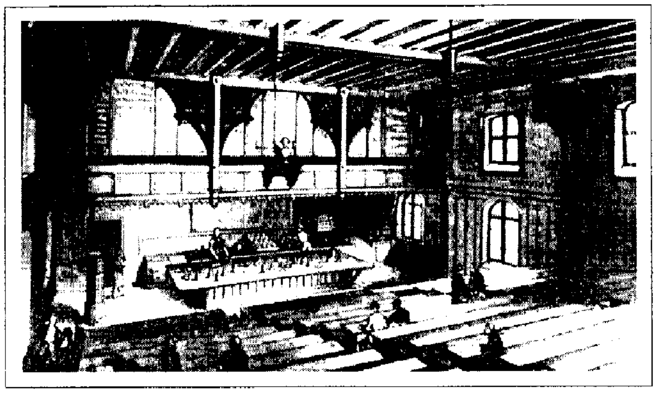


Figure 25. German chemical lecture hall, circa 1850 (38).

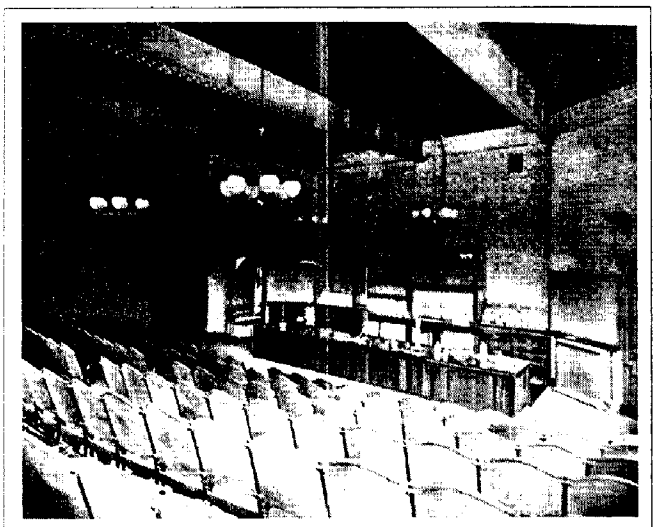


Figure 26. The chemical lecture hall at Yale University, 1887 (36).

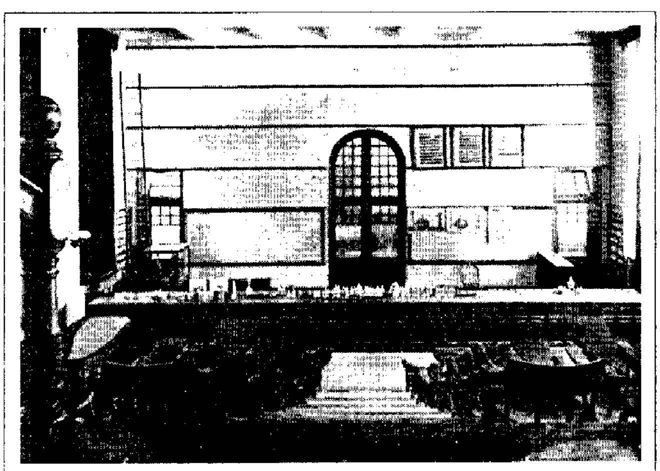


Figure 27. The chemical lecture hall at Lehigh University, 1884 (36).

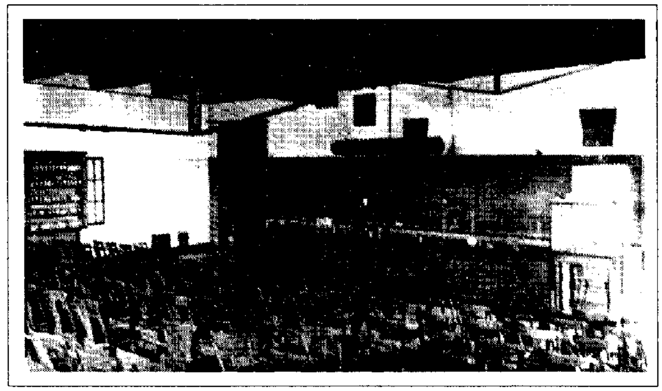


Figure 28. The chemical lecture hall at MIT in 1883 (36).

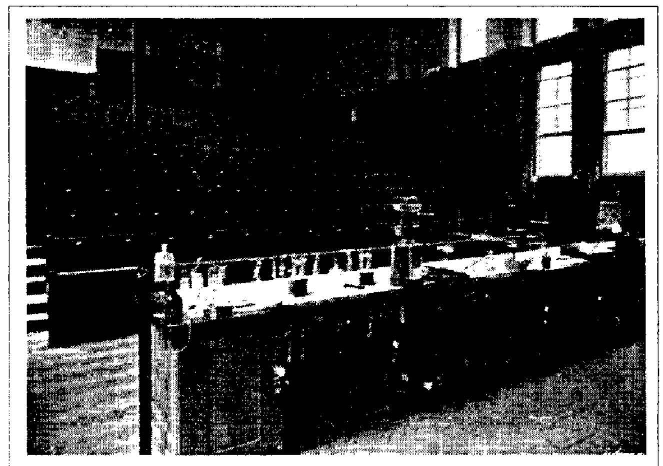


Figure 29. The chemical lecture hall at Imperial College London, circa 1906 (37).

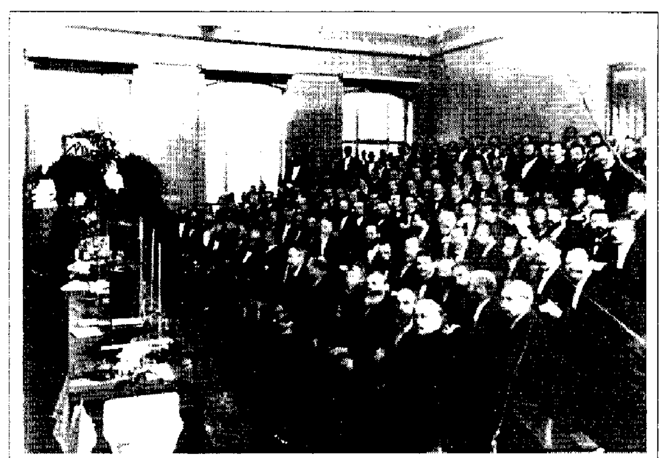


Figure 30. Wihelm Ostwald giving the inaugural lecture for his new institute at Leipzig in 1897. Among the members of the audience are Arrhenius, van't Hoff, Nernst and Boltzmann (38).

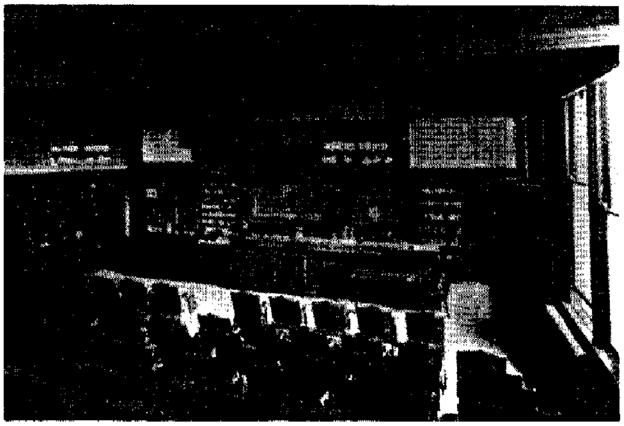


Figure 31. The chemical lecture hall at the University of Cincinnati, 1895 (38).

1930s, the same, alas, cannot be said for many chemistry buildings built in the 1960s and 1970s. I can't count the number of schools I have visited in which I am told that there is no large lecture hall and demo room in the chemistry building and that most introductory lectures are not even taught there, but in lecture halls on other parts of the campus - thus necessitating the dangerous transport of chemicals and apparatus. Often I'm taken over to see "old chemistry", refitted and occupied by sociology or psychology, and wistfully shown the old lecture hall and demo room - now no longer suited for their original purpose.

I'm unsure just what accounts for this sad break in the continuity of a great teaching tradition. Perhaps in their stampede to evolve into research schools and to partake of the government-subsidized upgrades in equipment and research facilities which accompanied the spate of new buildings constructed in the 1960s and 1970s, many departments wished to deemphasize their traditional teaching roles. Perhaps the increasingly common reluctance of administrators to invest in lecture halls and classrooms, which yield no grant overhead, instead of in research laboratories and centers, is responsible - or the increasingly common fantasy of campus scheduling that all classrooms are interchangeable and can be assigned solely on the basis of student numbers and maximized time usage. Whatever the reasons, there is little doubt that a tradition of chemical pedagogy - one indeed that is now almost 400 years old - has undergone a sad decline and that many members of the Division of Chemical Education, including Dr. Alyea, have had to devote a substantial portion of their careers to reminding their fellow chemists of a set of values and techniques which, 50 years ago, were taken as given in virtually every chemistry department.

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HENRY MARSHALL LEICESTER (1906-1991)

A Memorial Tribute

George B. Kauffman, California State University - Fresno

Henry Marshall Leicester, Professor Emeritus of Biochemistry at the Dental School of the University of the Pacific and an internationally renowned authority on the history of chemistry and the biochemistry of teeth, died peacefully in his sleep at his home in Menlo Park, California on 29 April 1991 at the age of 84. He had suffered from Parkinson's disease for almost two decades, but he remained active and alert until the end.

Born in San Francisco, California on 22 December 1906 (the year of the earthquake and fire), Henry was the youngest of the three children of self-taught tax attorney John Ferard Leicester, formerly from England, and Elsie Hamilton Allen Leicester, a secretary and later an heiress, formerly from Virginia. His talent for self-expression probably derived from his father's influence, while his patience and quiet courtesy were due to his mother's influence. His interest in hiking, especially in the Sierras, stemmed from his parents, who were both among the earliest members of John Muir's Sierra Club.

A precocious youth, he graduated early from San Francisco's Lowell High School and at the age of 16 entered Stanford University, from which he received his A.B. (1927), M.A. (1928), and Ph.D. degrees (1930, in organic chemistry), the last at the age of 24. Because of the scarcity of permanent positions during the Depression he spent the next eight years in a variety of activities - travel in Europe (including research in Zürich and London), a year as Instructor at Oberlin College, part of a year at the Carnegie Institution in Washington, and one and three years as Research Associate at Stanford and the Midgley Foundation at Ohio State University, respectively.

During this period he published six articles on selenium compounds (two with F. W. Bergstrom, based on his dissertation research) (1, 2, 5, 7, 9, 10), one on carotene (with Harry N. Holmes) (3), one on betulin derivatives (with 1939 Nobel chemistry laureate Leopold Ruzicka) (4), one on polystyrene (with Thomas Midgley Jr. of tetraethyllead and CFC fame) (6), and two on organic fluorine compounds (with Albert L. Henne) (8, 11).

While at Ohio State University, Henry found a complete set of the *Journal of the Russian Physico-Chemical Society*, which aroused his interest in the lives and works of Russian chemists, an area in which he became the undisputed American authority. He corresponded actively with colleagues in the Soviet Union, and he amassed a unique collection of Russian books on the history of science, which he later donated to the Stanford Library. In 1971, when I attended the XIIIth International Congress of the History of Science in Moscow, all the Russians asked where Henry was, and it was then that I was surprised to