Agricultural Engineering on the Prairie: Illinois Style

A HISTORY OF THE UNIVERSITY OF ILLINOIS DEPARTMENT OF AGRICULTURAL ENGINEERING, 1921–1997

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sional careers. His students went on to success in private industry, public agencies, academia, and as entrepreneurs.

He was a Fellow, a Deere Medalist, and a president of American Society of Agricultural Engineers (ASAE).

Frank B. Lanham was the second head of the Department of Agricultural Engineering serving from 1955 to 1978. During his tenure, he made many important contributions to the Colleges of Agriculture and Engineering and to the University of Illinois. Dr. Lanham was instrumental in establishing the doctoral program in agricultural engineering in 1964, served as chair of the University Senate Conference, a member of the Faculty Advisory Committee, and was a member of the University Athletic Association Board of Directors.

Students were important to Dr. Lanham as evidenced by his dedication to both the undergraduate and graduate teaching programs. His greatest joys as a department head were the achievements of students. High standards of academic and professional performance were his quest, and he was an exceptional model for students and faculty alike.

At the time of his death in 1978, he was serving as immediate past president of the American Society of Agricultural Engineers and was a Fellow of that organization. During his career he also held administrative positions in the American Society for Engineering Education, the Engineers' Council for Professional Development, and the Engineers' Joint Council. He also held memberships in the Association for Cooperation in Engineering and the Soil Conservation Society of America. Among his many recognitions was the Massey-Ferguson Education Award presented by ASAE in 1974.

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ACKNOWLEDGMENTS

A task as big as a 75-year history requires the dedicated effort of many persons. In the case of this department, E. W. Lehmann started the ball rolling in 1937 when he asked W. A. Foster to bring material together and write an early history. Foster devoted considerable time to this assignment and we drew extensively on his writings for the early history.

A second major effort was made when F. B. Lanham asked H. P. Bateman in the early 1960s to bring the history up to date. Bateman's efforts culminated with a draft in 1963. Some of the tables used in this history with analyses to 1963 are a result of Bateman's efforts. There was nothing magic about the year 1963, that was just when the effort was made. Again, extensive use was made of his writings.

The period 1963 to 1997 was a challenge because of the growth of the department and its programs during that time. We express our sincere appreciation to our colleagues who searched their files, wrote portions of the text, read drafts or just commented on the material. Without their help, this history would never have resulted. We wish to recognize especially F. W. Andrew, P. W. Benson, P. D. Bloome, P. Buriak, J. O. Curtis, D. L. Day, C. J. W. Drablos, C. E. Goering, E. L. Hansen, M. C. Hirschi, D. R. Hunt, D. G. Jedele, J. W. Matthews, J. K. Mitchell, A. J. Muehling, E. F. Olver, M. R. Paulsen, W. H. Peterson, H. B. Puckett, E. D. Rodda, J. C. Siemens, G. C.

Shove, and R. R. Yoerger. Georgianna Noel, Charlotte Longfellow and B. G. Fry provided invaluable assistance with the files. Ruth Sattazahn helped get the process rolling with her organizational efforts and Diane Voss managed and produced the results from the data bases of faculty, staff and graduates.

Finally, Loren Bode saw the 75th anniversary of the formation of the Department of Farm Mechanics on the horizon and seized the moment to "mobilize the troops." Without his decision to invest department time and resources to this effort and his encouragement all along the way, this history would never have evolved.

We acknowledge and thank Chris Scherer of Scherer Communications for his considerable help, drive, and professional services in getting the book edited and printed.

We express our sincere appreciation to all. We were just the instruments to integrate your ideas and finalize the manuscript. This truly was a departmental effort.

INTRODUCTION

The Northwest Ordinance, passed by Congress in 1787, committed the United States to higher education; however, it was neaı the middle of the nineteenth century before people in Illinoi demonstrated support for that commitment. Certainly, the idea o applying higher education and engineering principles to some agricultural production problems occurred very early, but before 185(most pioneers were too busy wrestling a livelihood from the soil tc worry about higher education.

By 1850 the situation was changing, however. Restless New Englanders were moving westward along the lakes and through the "fir lands" of Ohio—the Western Reserve—in search of land suited foı cultivation. The spring freshets of the Ohio River carried houseboat to southern Illinois, and Virginians and Carolinians filtered througl the Cumberland Mountains to find new homes. The Illinois territory offered a home on the prairie with no forest to conquer. Yet th interior flat land presented challenges to the settlers. For example crops could not be produced on much of the land without breakin the sod and providing better drainage.

Each family or settlement had to be self-sustaining because trail were impassable much of the year. Then the steamboat came into us providing a means of marketing surplus grain. This provided an incentive to produce more which in turn called for more land and improved methods of production. The Louisiana Territory was opened for settlement and the Midwest, with its untapped resources of climate, fertility, rainfall, and river transportation, soon was destined to become the grain belt of America. The invention of the McCormick binder and the use of the steel plow stimulated agriculture. More land was broken, more crops were seeded, and harvest drudgery was reduced.

The farm press came into existence. Articles in the eastern agricultural magazines and papers, by authors such as Solon Robinson, brought new people from all parts of the East to Illinois and other parts of the Northwest Territory. Robinson traveled extensively through the Midwest and his accounts were widely read. His progressive spirit and vision were evident in his strong advocacy of scientific practices that were considered daring and novel to the majority of farmers of his time. For example, he discussed and recommended using fertilizers such as lime, guano, marl, swamp muck, and animal manure; deep plowing; farm accounting; improving breeds of livestock; developing superior varieties of seed through plant selection; adopting new agricultural implements and machines; cultivating trees, shrubs, and flowers; improving diets for human health; ventilating farm buildings; and bettering rural housing. Robinson also promoted feeding animals properly and protecting them from weather, diversifying crops, improving weather record keeping, and using railroads to aid agriculture.

Other agricultural leaders who were born and educated in the East came to Illinois during this time. One was Jonathan Baldwin Turner, a teacher at Illinois College in Jacksonville with a degree in the classics. In spite of his classical background, he was not an "ivory tower" professor. He was a proponent of applying science to agriculture. His philosophy probably developed from being brought up on a poor Massachusetts farm.

Turner was a gifted orator. On November 18, 1851, he addressed a farmers' convention at Granville, Illinois, and criticized universities for satisfying only the needs of a "professional class" who, as he put it, had already created "a volume of literature that would well-nigh sink a whole navy of ships." He called for "new universities that would teach every science and art known to humanity and elevate the farmer and mechanic to that exalted position in human society that God meant for them to occupy." It was at the Granville convention that the following resolutions were passed:

> Resolved, That we greatly rejoice in the degree of perfection to which our various institutions, for the education of our brethren engaged in professional, scientific, and literary pursuits have already attained, and in the mental and moral elevation which these institutions have given them, and their consequent preparation and capacity for the great duties in the spheres of life in which they are engaged; and that we will aid in all ways consistent, for the still greater perfection of such institutions.
>
> Resolved, That as the representatives of the industrial classes, including all cultivators of the soil, artisans, mechanics and merchants, we desire the same privileges and advantages for ourselves, our fellows and our posterity, in each of our several pursuits and callings, as our professional brethren enjoy in theirs; and we admit that it is our own fault that we do not also enjoy them.
>
> Resolved, That, in our opinion, the institutions originally and primarily designed to meet the wants of the professional classes as such, cannot, in the nature of things, meet ours, no more than the institutions we desire to establish for ourselves could meet theirs. Therefore,
>
> Resolved, That we take immediate measures for the establishment of a University, in the State of Illinois, expressly to meet those felt wants of each and all the industrial classes of our State; that we recommend the foundation of high schools, lyceums, institutes, etc., in each of our counties, on similar principles, so soon as they may find it practicable so to do.
>
> Resolved, That in our opinion such institutions can never impede, but must greatly promote, the best interests of all those existing institutions.

Turner's resolutions and an accompanying plan for a proposed college attracted attention throughout the state, the Midwest, and in all sections of the country where agriculture was common.

Early Engineering

Before the University of Illinois opened in March 1868, engineering problems for agricultural production were solved by the efforts of individuals or small groups who had the inventive genius to design and build new machines or structures. The formation of the university, however, provided teaching programs that would educate students to solve agricultural engineering problems in a more systematic manner.

A professor of agricultural engineering, S. W. Shattuck, was appointed in 1870 to teach courses in agricultural and civil engineering. The title of his course is not known but it likely was similar to "Agricultural Engineering and Architecture" that was listed for the first time in the 1876-77 catalog of courses. Later the appointment of F. R. Crane in 1899 gave new emphasis to agricultural engineering courses since he taught several courses while a member of the Department of Agronomy. Then in 1906 improved teaching facilities were made available with the completion of a building specifically designed for teaching agricultural engineering courses.

After World War I, students requested more agricultural engineering courses. The first step toward addressing this need was taken with the approval of a Department of Farm Mechanics in 1921 and the appointment of E. W. Lehmann as its head. This action set in motion the fulfillment of part of Turner's dream of providing practical education in agriculture and the mechanical arts for the betterment of agriculture. What better way to achieve his dream than through a hybrid program embodying agriculture and engineering. This hybrid program was first called agricultural mechanization and later agricultural engineering. It provided service to the people of Illinois and the nation through teaching, research, and public service. The evolution of this program is discussed in the chapters that follow.

A chronology is presented here to help put the university and department history in perspective.

1867	Illinois Industrial University Founded
1868	Instruction Began
1870	College of Agriculture Established
1870	Shattuck Appointed Professor of Agricultural Engineering
1876	Morrow Plots Established
1880	College of Engineering Established
1885	Name Changed to University of Illinois
1888	Agricultural Experiment Station Established

1895 Davenport Named Dean of College of Agriculture
1900 Division of Farm Mechanics Formed in Department of Agronomy
1901 First Agriculture Building (Davenport Hall) Built
1903 Engineering Experiment Station Established
1904 First Agricultural Mechanization Graduate
1906 Farm Mechanics Building Completed
1907 ASAE Founded
1916 R. I. Shawl Joins Faculty
1921 Department of Farm Mechanics Formed, Emil W. Lehmann Named Head
1922 Agricultural Mechanics Extension Program Developed
1923 Farm Building Plan Service Established
1924 Tractor Laboratory Added to Building
1932 Department Name Changed to Agricultural Engineering
1932 Agricultural Engineering Curriculum Approved
1934 First B.S. Agricultural Engineering Degrees Awarded
1948 M.S. Degree Approved
1949 First M.S. Degrees Awarded
1950 Agricultural Engineering Curriculum Approved by ECPD
1952 Agricultural Engineering Research Laboratory Completed
1955 Frank B. Lanham Named Second Department Head
1956 First B.S. Degrees Awarded in Agricultural Mechanization Option
1957 Agricultural Engineering Curriculum with Four Options Approved
1964 Ph.D. Degree Approved
1966 First Ph.D. Awarded
1978 Roger R. Yoerger Named Third Department Head
1983 Agricultural Engineering Sciences Building Completed
1985 Roscoe L. Pershing Named Fourth Department Head
1986 Fifth Option for Agricultural Engineering Curriculum Approved
1994 Loren E. Bode Named Fifth Department Head
1996 Agricultural Mechanization Name Changed to Technical Systems Management

1 | TEACHING CONTRIBUTIONS TO AGRICULTURAL ENGINEERING

In 1921 a major goal of the newly formed Department of Farm Mechanics was to increase the number of courses available for students in agriculture, especially those students interested in the many newly engineered products that were becoming available to farmers and small rural processors. Because the new department had as a foundation the courses on agricultural engineering subjects that had been offered since the university opened, this chapter will start with a recap of the teaching activities that provided the foundation from which the teaching program was launched.

The Formative Period (1868–1906)

Plans were made early by the University to teach agricultural engineering subject matter as indicated by the inclusion of a position of professor of civil and rural engineering in the 1868 course catalog. S. W. Shattuck evidently filled that position because he was listed in 1870 as professor of agricultural engineering in the College of Agriculture faculty. He continued to be listed on the College of Agriculture faculty until about 1878. Also included with the 1870 agriculture faculty was S. W. Robinson, who was listed as professor of agricultural mechanics. Shattuck was also listed as a professor of mathematics and Robinson as a professor of mechanical engineering.

About 1876 rural architecture was taught by Nathan C. Ricker who had graduated in 1872. His instruction included the inspection of a farmhouse and two large barns that had been constructed on campus about 1870. A description and plans of them were given in the 1871-72 Report of the Board of Trustees. Construction cost of the farmhouse was reported to be $2,500. Later the house became the home of Dean of the College of Agriculture H. W. Mumford and subsequently became known as Mumford House. The house is still at its original location and has served a number of colleges and units as an office facility.

The first course with a title of agricultural engineering was listed in the 1876-77 course catalog and had the following description: "Agricultural Engineering and Architecture—Arrangement of the farm; its improvement by mechanical means as drainage and irrigation; its division by fences, hedges; its water supply; the construction of roads; arrangement, planning, and construction of farm buildings; the construction, selection, care and use of farm implements and machinery." No teacher was identified but it was probably taught by Shattuck. From 1890 through 1893, the course was taught by G. E. Morrow, who was dean of the College of Agriculture. The course was not taught from 1894 to 1896, but in 1899 P. G. Holden taught the course as part of his duties as a professor in the agronomy department. After a short tenure Holden resigned to go to Iowa State College and eventually to the International Harvester Company, where he served for twenty years before his retirement in 1932.

In 1899 Ford Randall Crane, a graduate of Michigan Agricultural College, was employed as instructor of farm mechanics in the Department of Agronomy. The following five courses were organized in the year shown and taught by Crane through 1908: Agron. 1: "Drainage and Irrigation" (1899); Agron. 2: "Field Machinery" (1899); Agron. 3: "Farm Power Machinery" (1900); Agron. 4: "Farm Buildings, Fences and Roads" (1900); and Agron. 17: "Special Work in Farm Mechanics" (1899). In addition, House Sci. 2: "Home Sanitation" (E. A. White and Isabel Bevier, 1900) was taught as a part of the household science curriculum.

In 1904-05, the Department of Agronomy offered the following graduate courses and instructors related to agricultural engineering: Agron. 104: "Drainage Waters, Surface and Subsurface Drainage, with

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In 1904-05, the Department of Agronomy offered the following graduate courses and instructors related to agricultural engineering: Agron. 104: "Drainage Waters, Surface and Subsurface Drainage, with

Special Reference to Soil Fertility" (J. H. Pettit, 1904); Agron. 107: "Erosion of Soils by Surface Washing and Methods of Prevention" (J. G. Mosier, 1904); Agron. 113: "Machine Designing; Advanced Study of Farm Implements with Special Reference to Possible Improvements" (F. R. Crane, 1904).

By the turn of the century, the student demand for agricultural engineering related courses had grown so and the size of the implements had changed so that Agricultural Hall (now Davenport Hall) could no longer provide adequate laboratory space for the courses. A new building, to be located on the farms south of the Morrow Plots, was planned and built. It had doors and ceiling heights to accommodate small threshing machines and other anticipated farm machinery.

Expansion Period After the New Building Opens (1906–1920)

Soon after the new Farm Mechanics Building opened in 1906, new faculty and staff were employed and additional courses were organized. In 1908 and 1909 there were from one to six faculty members to teach the fourteen courses offered. The following six courses were initiated: Agron. 19: "Research Work in Farm Mechanics" (1910); Agron. 20: "Concrete Construction for Agricultural Purposes" (K. J. T. Ekblaw, 1910); Agron. 21: "Minor Course in Farm Mechanics" (1910); Agron. 26: "Farm Buildings and Equipment; Heating, Water Supply, Sewage Disposal, etc." (K. J. T. Ekblaw, 1912); Agron. 27: "Drainage Design" (M. E. Jahr, 1912); Agron. 28: "Advanced Gas Engines and Tractors" (R. I. Shawl, 1920). Graduate courses were discontinued about 1910.

During World War I instruction was interrupted and faculty changes resulted. E. A. White, who earned a B.S. in agriculture at the University of Illinois in 1908, was appointed to the faculty in 1908. He was given leave from 1914 to 1916 to study for his doctor of philosophy degree at Cornell University. The degree was conferred in 1917 in rural engineering and it is believed to be the first Ph.D. earned by an agricultural engineer in the United States. The results of his thesis, a mathematical analysis of the moldboard plow bottom, are still useful and have influenced succeeding agricultural engineers to undertake similar studies.

The Department of Farm Mechanics (1921–1931)

From 1921 to 1931 the faculty was increased to eight members who taught the following sixteen courses (the names and dates in parenthesis indicate the instructor and the date approved, dates in brackets indicate when the course was first introduced as an agronomy course):

FM 1: "Elementary Farm Mechanics" (C. A. Scholl, J. H. Hedgcock, 1921)
FM 2: "Power Driven Machinery" (R. I. Shawl, [1899], 1921)
FM 3: "Gas Engines and Tractors" (R. I. Shawl, [1900], 1921)
FM 4: "Farm Buildings" (E. W. Lehmann, [1900], 1921)
FM 5: "Drainage" (E. W. Lehmann, [1899], 1921)
FM 7: "Horticultural Machinery" (R. I. Shawl, I. P. Blauser, 1926)
FM 11: "Dairy Machinery and Equipment" (C. A. Scholl, 1921)
FM 12: "Farm Home Equipment" (E. W. Lehmann, [1912], 1921)
FM 17: "Harvesting Machinery" (J. H. Hedgcock, 1921)
FM 18: "Thesis: Farm Mechanics" (Faculty, 1921)
FM 19: "Research in Farm Mechanics" (Faculty, [1910], 1921)
FM 20: "Farm Concrete Construction" (C. A. Scholl, [1910], 1921)
FM 21: "Farm Shop" (A. L. Young, [1910], 1925)
FM 27: "Drainage Design" (E. W. Lehmann, [1912], 1921)
FM 28: "Advanced Gas Engines and Tractors" (R I. Shawl, [1920], 1921)
FM 51: "Special Power and Field Machinery" (R. I. Shawl, E. W. Lehmann, [1899], 1923).

Although some of the courses had the same name as in previous years, many new subjects were introduced. Some of the newer subjects were: the general purpose tractor, combines, electric power for farms, soil erosion control practices, and modern equipment and construction methods for homes and farm structures. Research projects were initiated and plans were developed to establish a curriculum for a professional degree in agricultural engineering in the College of Engineering.

The Department of Agricultural Engineering (1932 to 1997)

Teaching activities changed in a number of ways after 1932 when the department name was changed to agricultural engineering. The major changes were the approval in 1932 to administer the curriculum for the Bachelor of Science degree in Agricultural Engineering; the approval in 1948 of the Master of Science degree; the approval in 1956 of the agricultural mechanization major in the general agriculture curriculum of the College of Agriculture; and the approval in 1964 of the Doctor of Philosophy Degree.

The Agricultural Mechanization Program

Originally, the department was named Farm Mechanics and graduates received a degree from the College of Agriculture with that name. But the designation was dropped in 1932 after the agricultural engineering degree in the College of Engineering was approved. Many students in the College of Agriculture, however, continued to take courses in the department to obtain a degree in general agriculture with an emphasis on farm mechanics. In 1949 a number of revisions were made in the college's curriculum and those students pursuing farm mechanics, which had been changed by now to agricultural mechanization, were urged to include courses in commerce, physics, and mathematics. In the mid 1950s there was interest in reactivating an identified nonengineering degree for students returning to farms or going into sales and service positions in industry. An agricultural mechanization major was approved and the first degrees with this designation were awarded in 1956. Since then, the department has had a formal means of identifying the graduates that had been identified "informally" as farm mechanics or agricultural mechanization majors since 1904.

By 1958 the agricultural mechanization major was administered within the department as a section responsibility. John Matthews had popular and well-established skills courses for vocational agriculture majors and for agriculture students in general. The courses included welding, carpentry, and electric wiring. In 1960 Matthews spent a year in India during which his position was filled by Roland Espenschied. "Espy" finished his Ed.D. degree and subsequently filled Matthews' position when he left the department in 1961 to head the Vocational Agriculture Service.

Espenschied developed special relationships with faculties at the many community colleges established throughout the state during the early 1960s. These relationships were to assist the department in many ways in the years to come. The mechanization major received a further boost in 1960 when Donnell Hunt joined the faculty and assumed responsibility to strengthen the course offerings on farm machinery management. This led to the further development of his textbook on the subject. The text, and many subsequent editions, spanned computational methods from the slide rule to programmable calculators and eventually to personal computers. As a further ingredient to the program a student agricultural mechanization club was formed in 1961 to foster interaction between the students, develop an esprit de corps, and provide opportunities for leadership development.

The types of positions held by agricultural mechanization graduates in 1963 are shown in Table 1. Analyses have not been made in recent years, but the perception is that the distribution would not have changed greatly other than that those classified as military service would be distributed under the commercial service category with a slightly higher number going to administration and management than the other subdivisions.

The enrollment in curricula wax and wane for unexplained reasons irrespective of the subject. Such was the case for agricultural mechanization during the 1970s and early 1980s. So when Espenschied retired in 1987 the department reevaluated the program before making a decision on filling the vacant position. The decision was made to reenergize the program and Philip Buriak joined the faculty in 1988 to assume a major responsibility for teaching agricultural mechanization courses. Within a few years, enrollment began to climb and soon more than seventy students were enrolled even though entrance requirements were raised. One important element of the comeback was renewed support from industry, especially Deere and Company. Buriak worked with Deere to establish a mentor program in which students spend two summers working for a Deere dealer. In addition, Deere provided equipment to upgrade the educational program and scholarship money for outstanding students in the mentor program. As a result of these efforts a new cadre of graduates emerged from the College of Agriculture.

In 1994, the department again made changes to give greater visibility to the agricultural mechanization curriculum. A new curriculum name, Technical Systems Management (TSM), was proposed as being more descriptive and more in tune with the industry's needs for

Table 1. General Types of Positions, Agricultural Mechanization Graduates to 1963.

Position	*Number*
Public Service	
Teaching	7
Research and design	4
Military service	16
Foreign service-machinery adviser	1
Sub Total	28
Commercial Service	
Administration and managers	8
Design and development	4
Sales, advertising, journalism	17
Service	4
Insurance	1
Sub Total	34
Other	
Farming	8
Unknown	4
Deceased	5
Sub Total	17
Total, all categories	79

graduates. The new TSM name was approved by the Board of Trustees in August 1996.

Appendix A provides a list of the courses taken by the students in agricultural mechanization along with the names of the instructors who taught them over the years.

THE PROFESSIONAL AGRICULTURAL ENGINEERING PROGRAM

In 1932 the department received approval to offer a professional curriculum in agricultural engineering in the College of Engineering.

The curriculum included basic engineering courses followed by number of design courses to qualify students for design or other posi tions in industry, graduate study, teaching, or research. The Univer sity of Illinois curriculum was unique because it required students t pick an option in either power and machinery, which used the strengt of the College of Engineering's Department of Mechanical Engineer ing, or in farm structures and drainage, which used the strength of th College's Department of Civil Engineering, both of which were na tionally acclaimed. The genius of this approach was to have student take their basic analysis courses in those departments thereby permit ting the smaller staffed Department of Agricultural Engineering t concentrate its resources on the application of engineering to the so lution of agricultural problems.

The curriculum description in the course catalog stated:

> The University has an assortment of tractors, gas engines, and farm machinery in the department for students to use. Lighting units and water systems are provided in the equipment laboratory. There is a drafting room for work in farm buildings, and facilities are provided for concrete construction.
>
> Two options are provided: one is a power and machinery option, and the other is a drainage and farm structures option. The student who is interested in power and machinery will be given an opportunity to have a thorough training in machinery design, while the student who is interested in farm drainage and structures will have an opportunity to study design problems in these fields.

Courses offered in 1934 and the instructors included:

AE 1.	"Introduction to Agricultural Engineering"	A. L. Young
AE 2.	"Field and Power Machinery"	R. I. Shawl
AE 3.	"Gas Engines and Tractors"	R. I. Shawl
AE 4.	"Farm Buildings"	W. A. Foster
AE 5.	"Drainage and Surveying"	E. W. Lehmann
AE 11.	"Dairy Machinery and Equipment"	A. L. Young
AE 12.	"Farm Home Equipment"	E. W. Lehmann
AE 17.	"Harvesting Machinery"	R. I. Shawl
AE 18.	"Investigation with Thesis"	Faculty

AE 20.	"Farm Concrete Construction"	A. L. Young
AE 21.	"Farm Shop Work"	A. L. Young
AE 28.	"Advanced Gas Engines and Tractors"	R. I. Shawl
AE 51.	"Special Power and Field Machinery"	R. I. Shawl

Beginning with the 1937-38 course catalog, a "five-year program" was initiated by the College of Agriculture whereby students with one additional year of study could earn two B.S. degrees, one from the College of Engineering and the other from the College of Agriculture. The first student to complete such a program was Thomas W. Brock in 1949. Six students followed during the next two years, and since then several have graduated with both degrees.

Beginning in 1957 the number of options was increased from two to four to identify the broader scope of the agricultural industry and of the department. The options became: electric power and processing, farm structures (now structures and environment), power and machinery, and soil and water engineering. Food engineering was added as an option in 1984 through the efforts of Errol Rodda of the department and Marvin Steinberg of the Department of Food Science. This new option required some changes in the required course sequence as well as changes in the technical electives because of the emphasis on food properties and food processing.

Today, undergraduates can select from fourteen course offerings to obtain a major in one of the five subject matter options in the department. Following is a list of the general professional courses offered since 1958 with the name of the instructor who first taught the course, the names of other instructors who have taught the course in parenthesis, the date the course was first taught, and the dates when the course number or title was changed. (The department fully recognizes the contributions graduate student teachers have made in various courses, but their names are not listed because of the limited time they were involved. They know who they were and the department says thank you.) Similar information on the courses that make up the options is in Appendix B.

AE 100: "Introduction to Agricultural Engineering" F. B. Lanham, (L. E. Bode, R. L. Pershing, R. R. Yoerger) 1958.

AE 126: "Engineering in Agriculture" G. E. Hall, E. D. Rodda, G. F. McIsaac, (J. F. Reid), 1959, discontinued 1992.

AE 127: "Engineering in Agriculture II" D. R. Hunt, 1959; "Production Systems in Agriculture" D. R. Hunt, 1979 (L. L. Christenson, L. K. Ewing, S. R. Eckhoff), discontinued 1992.

AE 199: "Undergraduate Open Seminar" Faculty, 1958

AE 221: "Engineering for Agricultural and Biological Systems" G. F. McIsaac, J. F. Reid, 1993.

AE 222: "Engineering for Bioprocessing and Bioenvironmental Systems" L. L. Christenson, S. R. Eckhoff, 1993.

AE 296: "Honors Project" 1958.

AE 298: "Inspection Trip" 1958, "Undergraduate Seminar," Faculty, 1967

AE 299: "Undergraduate Thesis" Faculty, 1958.

AE 311: "Instrumentation and Measurements" R. R. Yoerger, (N. L. Buck, D. L. Hoag, T. S. Stombaugh), 1968.

AE 315: "Applied Machine Vision" J. F. Reid, 1992

AE 320: "Kinematics and Dynamics of Mechanical Systems " (same as ME 320)

AE 340: "Introduction to Applied Statistics" R. D. Seif, (S. Aref), 1969.

AE 345: "Statistical Methods," S. G. Carmer (W. M. Walker), 1969.

AE 396: "Special Problems" Faculty, 1934, AE 51, 1934; AE 393,1948; AE 396, 1958

The option system has provided students an education that has enabled them to compete with graduates of many other disciplines and assume responsibility for many engineering positions in industry and academia. Graduates may be found in everything from farming to banking, to the missile and space industry, to teaching and research, to owning their own businesses.

In 1948 the department received approval of its graduate program for the master of science degree to be awarded by the Graduate College. In 1964 approval was received to administer a program leading to a doctor of philosophy degree with Lanham, Jones, and Yoerger authorized to direct theses, again to be awarded by the Graduate College.

Before the department was authorized to award graduate degrees through cooperative relations with other departments in the College of Engineering, particularly civil and mechanical engineering, graduates of the department who wanted to pursue a master's or doctor's degree could enroll in those departments and receive a degree from them but could conduct their theses research on an agricultural engineering problem, often using agricultural engineering laboratories and facilities. With this arrangement nine students received M.S. degrees and six received their Ph.D.s.

The following graduate courses are offered for students who are working for advanced degrees. In addition, the 300-level courses in the department may be used for graduate credit.

AE 400: "Research Orientation" Graduate faculty, 1960.

AE 434: "Computer Aided Kinematics" R. C. Coddington, 1989, revised 1995.

AE 436: "Dynamics of Farm Machine Elements" G. E. Pickard, (R.C. Coddington, C.E. Goering, D. L. Hoag, R. R. Yoerger), 1958.

AE 446: "Farm Tractors" J. A. Weber, 1959, discontinued 1985.

AE 490: "Seminar" Graduate faculty, 1960.

AE 496: "Special Problems in Agricultural Engineering" Graduate faculty, 1960.

AE 499: "Thesis Research" Graduate faculty; AE 493: 1947; AE 499: 1957.

In 1963 an analysis was made of the 337 graduates awarded B.S. and M.S. degrees to that time to determine the type of positions they held. (Table 2). The analysis showed that 32 percent of the graduates held positions in universities or government service, 54 percent were employed in industry, 7 percent were farming, and 7 percent were in other positions.

The responsibilities of the graduates were varied. Nearly 52 percent had positions that were directly related to agricultural engineering. Another 24 percent have positions classified as industrial work in machinery, buildings or commercial areas. As related to type of responsibility, the largest group of the graduates, nearly 33 percent were designing products to be manufactured for agriculture or industrial purposes. The second-largest group, nearly 22 percent, were teaching or conducting research and doing development work. Another 17 percent had administrative duties in universities or commercial organizations.

During the fall of 1968, five years after the 1963 study, Curtis and Jones studied the employment of agricultural engineers from 1947 through 1968. During this period, 344 bachelor's degrees and 105 master's degrees were granted. Employment was classified under three categories: Subject-matter interest, type of activity, and type of employer (Tables 3, 4, and 5). Of the 344 persons holding B.S. degrees, 5 were deceased and the employment of 17 was unknown, leaving 322 providing data. Similarly, of the 105 M.S. graduates, 2 were deceased and 11 were unknown, leaving 92 for the study.

Thirty-nine percent of the B.S. graduates and 48 percent of the M.S. graduates were employed in the power and machinery area (Table 3). At the time researchers felt that these percentages were typical of graduates of large agricultural engineering departments located in the central United States near the center of machinery manufacturing. The percentages likely were not typical of western states, which then had greater emphasis on land development.

Teaching Facilities and Equipment

The 1906 Farm Mechanics Building served the department well until the advent of the tractor which generated the need for more teaching laboratories. To meet the needs a one-story tractor laboratory was added to the building in 1924. The building had minor remodeling after World War II but facilities were essentially unchanged until 1952 when the Agricultural Engineering Research Laboratory was completed. Some of the special equipment available for undergraduate and graduate teaching after the Agricultural Engineering Research Laboratory was opened were:

1. Tractor dynamometers and a fuel-knock testing engine.
2. Hydrostatic transmission equipment to study principles of operation.
3. A soil bin to study forces on tillage tools and transport characteristics of wheels.
4. A soil and water engineering laboratory equipped with constant head water supply, glass flumes, weirs, and special recording equipment.
5. Two- and eight-channel oscillograph recorders for use with strain gages and other transducers.
6. A general purpose analog computer.
7. Swine environmental buildings and measuring equipment on the Moorman Swine Farm.
8. An automatic feed-handling laboratory and special installations on the University farms.

Table 2. 1963 Employment of Illinois B.S. and M.S. Engineering Graduates.

Educational institutions	
1. Teaching, research, or extension	35
2. Graduate studies for additional degree	13
3. Foreign volunteer service	1
4. High school teaching	1
Sub Total	50
Government	
1. Soil Conservation Service and USDA	16
2. Bureau of Reclamation and Corps of Engineers	17
3. Military service	15
4. State highway	8
Sub Total	56
Missile and space industry	12
Machinery companies	
1. Agricultural machinery	60
2. Industrial machinery	45
Sub Total	105
Building design and construction industry	
1. Agricultural buildings	19
2. Industrial buildings	17
Sub Total	36
Electric power and processing companies	
1. Rural power companies	11
2. Commercial manufacturing and controls companies	13
Sub Total	24
Farming	22
Other employers	
1. Engineering (other than listed above)	15
2. Banking, journalism, pilot-engineer	7
Sub Total	22
Positions and address unknown	6
Deceased	4
Total, all categories	337

Table 3. Classification of Engineering Graduates 1947–1968 by Subject-Matter Interest

Subject Matter	*B.S. Graduates*		*M.S. Graduates*	
Power and machinery	125	38.8%	44	47.8%
Soil and water	40	12.5	14	15.2
Electrification and processing	20	6.2	7	7.6
Food engineering	3	.9	1	1.1
General agricultural engineering	3	.9	2	2.2
Other engineering	62	19.3	4	4.3
Non-engineering	49	15.2	4	4.3

Table 4. Classification of Engineering Graduates 1947–1968 by Type of Activity

Activity	*B.S. Graduates*		*M.S. Graduates*	
Design, testing, production*	141	43.8%	18	19.5%
Research and development	51	15.8	31	33.7
Education	28	8.7	25	27.2
Sales and service	27	8.4	4	4.3
Military service	22	6.8	2	2.2
Farming	18	5.6	0	0.0
Management	16	5.0	3	3.3
Graduate school	14	4.3	8	8.7
Other	5	1.6	1	1.1

* Almost three times as many B.S. graduates were in design, testing, or production as in any other single activity. The next largest group was in research and development. Education ran in third place. The largest single activity for M.S. graduates was research and development. These three categories accounted for 80 percent of M.S. graduates' activities.

Table 5. Classification of Engineering Graduates1947–1968 by Type of Employer

Employer	*B.S. Graduates*		*M.S. Graduates*	
Industry*	185	57.4%	43	46.7%
Government	47	14.6	10	11.0
Non-engineering	44	13.7	4	4.3
College and universities	40	12.4	35	38.0
Self-employed	6	1.8	0	0.0

* Private industry employed 57 percent of the B.S. graduates and 47 percent of the M.S. graduates. College and universities plus government agencies accounted for most of the other employment opportunities. Agricultural engineering seemed to provide few opportunities for self-employment such as consulting.

The 1983 opening of the Agricultural Engineering Sciences Building provided state-of-the-art classrooms, laboratories, and equipment. Since that time an emphasis of the department has been to upgrade equipment regularly to maintain an environment to foster enthusiastic learning.

Faculty Teaching Contributions

In addition to the normal contributions of teaching courses, there were some activities of the faculty that merit special mention. E. W. Lehmann made special effort to encourage and provide work opportunities for students and graduates. During the 1930 to 1935 depression years, Lehmann helped many graduates obtain positions in the newly formed Civilian Conservation Corps (CCC). He also helped state and national leaders formulate policies for Corps camps. Also through his efforts many rural electrification programs were initiated with the goal of removing drudgery on the farmstead and improving the farm home.

R. I. Shawl had a long and distinguished career teaching farm machinery and farm tractor courses in the department. He started as an assistant for two courses in 1916 and was in charge of power and machinery courses from 1919 to 1958, a period of forty-two years. Frequently, former students inquired about Professor Shawl and reported that he was an excellent instructor and had an enthusiastic attitude that helped them. Enrollment in his courses was normally high because of continual new developments in tractors and machines. Soon after World War II, the combined enrollment for Agricultural Engineering 112 and 142 (later 241), two of his beginning courses, reached 229 students during one semester.

A. L. Young taught many courses during the thirty-five-year period (1923-1958) he was a faculty member. He taught the beginning agricultural engineering course in a patient, careful and conscientious manner for twenty-six years. The enrollment reached nearly two hundred students during the first semester in 1947, 1948, and 1949, the largest number of students in one course dating back to 1921.

When Wendell Bowers and Ben Jones were assigned the responsibility to develop a new introductory course for agricultural mechanization students following the retirement of Young, no suitable text was available. Therefore they wrote *Engineering Applications in Agricul-*

ture in 1959. Elwood Olver joined them as a co-author for the second edition in 1966. The book is now in its sixth edition and is widely used in Illinois community colleges as well as in other state universities with agricultural programs.

D. G. Carter and K. H. Hinchcliff were national leaders in teaching programs on farm housing. Books, bulletins, circulars, and models were prepared to present the information to agricultural and home economics students and to other extension and industry leaders. Hinchcliff often used the chalk-talk medium to present new ideas in an interesting and effective manner.

The faculty was continually changing its teaching methods to use new technology. Worthy of note was the first closed circuit television demonstration for the faculty of the college conducted in the Great West Hall of the stadium by Jones in April 1954 at the request of the assistant dean Marshall Scott.

After D. F. Kampe resigned in 1963, Hunt added the senior machine design course for the engineering students to his responsibilities and taught it for the next 20 years. The senior design problems were selected to stimulate creativity and ranged from a strawberry picker to a sweet sorghum juice harvester. In addition, Hunt served as advisor to many cooperative program students in the department. Quite likely this was a factor that contributed to his becoming the College of Engineering Director of Cooperative Education in 1985. He served in that role until he retired in 1996.

"Nothing is as certain as change," might be stated in the converse as "nothing is more constant than students." They come from near and far, from tiny to large high schools, some with fear and uncertainty and some with extreme confidence. They dress differently, wear their hair differently, even talk differently, but they come year after year with the same enthusiasm and eagerness to learn, and with an expectation that they can make the world a better place in which to live if "it will only accept their ideas." They continually challenge the faculty from their patience to their ability to find the teachable moment, and to find the spark that will develop the creativity of young minds that do not know that "it can't be done."

Unfortunately from a historical standpoint, when a department is generating its history by its actions day by day, both the students and the faculty are often too busy to make or keep many records. In many ways that is what happened in the Department of Farm Mechanics and subsequently the Department of Agricultural Engineering. Most of what was kept in the early years was lost either with changes in administration or in the move between buildings.

From the student standpoint, fortunately the Farm and Industrial Equipment Institute (FIEI), a group of equipment manufacturers, saw the benefits of fostering student activities through the American Society of Agricultural Engineers (ASAE). The institute provided support to initiate national competitions between student branches to determine the best in the country. The Illinois Student Branch competed year after year and prepared a report annually to submit. Those reports and some of the supporting files provide some gems of student life and activities. A selected few are incorporated here in hopes of "striking a chord" in the memory banks of some alumni.

The Student Branch of the American Society of Agricultural Engineers

Department records do not show the nature of student activities before the formation of the Student Branch of ASAE. Surely there were some, but perhaps the agricultural mechanization majors participated in other clubs of interest such as Field and Furrow of agronomy or the agricultural economics club. However, it is known that after the formation of the Student Branch, agricultural mechanization majors as well as other majors, were welcome and did participate; and some may have served as student officers of ASAE.

The Illinois Student Branch of the American Society of Agricultural Engineers held its first meeting on October 9, 1934 according to a letter from Hubert Myers, the club secretary and treasurer, published on page 233 of the 1935 volume of "Agricultural Engineering." The other officers of the club that first year were president, W. D. Rusk; vice president, W. Ramsey and secretary-treasurer W. S. McKown. Ramsey graduated in Agricultural Engineering in 1935. Rusk graduated in Agriculture with a major in Agricultural Engineering and McKown graduated in Agricultural Economics. There were 12 members at the time of that first meeting with three additional members added during the school year. Professor E. W. Lehmann, the department head, was always interested in student activities and was instrumental in the organization of the branch.

Two U of I agricultural engineering students attended the annual meeting of ASAE in Detroit in June 1934. They were W. C. Gilham and R. U. Winters. Gilham, along with H. Paul Bateman, received his B.S. degree in agricultural engineering that year and Winters had graduated in general agriculture with an interest in agricultural engineering in 1933.

One of the branch activities their first year was a lunch stand set up in the machine laboratory of the Agricultural Engineering Building during Farm and Home Week held January 14 to 18, 1935. Hot sandwiches, coffee, milk, pie and ice cream were served. The net profit, $31.12, was used by the Branch to pay its various expenses. The lunch stand at Farm and Home Week became a tradition for the Student Branch until 1962 when Farm and Home Week was discontinued.

Another activity was cooperation with other student groups in the College of Engineering to provide displays for Engineering Open House. With the help of the faculty in 1935, exhibits and demonstrations were prepared as follows:

1. Demonstration of soil erosion control and water conservation.
2. Blueprints, charts, photographs and bulletins on farm building and housing improvements.
3. Developments in rural electrification illustrated by charts and exhibits.
4. A power and machinery display showing a diesel tractor and terracer and other special machines.

It is interesting to note that the agricultural engineering students have continued their interest to cooperate in Engineering Open House for over 60 years, frequently winning first place with their displays, exhibits, and demonstrations.

As mentioned earlier the Farm and Industrial Equipment Institute (FIEI) initiated a student branch competition in 1935. (FIEI has since changed its name to the Equipment Manufacturers Institute, EMI.) It was 25 years (1960) before the U. of I. Student Branch won the FIEI competition, but it has been a frequent winner since. Most recently Illinois won the competition four years in a row from 1993 through 1996.

Student engineers have participated in various other national competitions. In 1949, during its second year in existence, Benjamin A. Jones, Jr. was awarded second place in the undergraduate division of the student paper competition. Maurice L. Burgener (B.S.'48) was awarded second place in the graduate division. The competition has changed over the years, and a graduate division no longer exists, but during the time of two divisions, 1949 was the only time students from one university won in both divisions in a given year. Additional winners have been Irvin A. Eickmeyer in 1957 and James Smith in 1962.

Student engineers have also participated in a competition to identify the ASAE Student of the Year. Since the competition's inception in 1969 two Illinois students have won the award: Ronald L. Elliott in 1972 and Thomas Glenn in 1977.

Since 1950 the Engineering Student Council has selected students who exhibit outstanding qualities of leadership in the College of Engineering to be Knights of St. Patrick. Whereas agricultural engineering students make up only about three percent of the total enrollment of the College of Engineering, they have made up about eleven percent of those honored as Knights of St. Patrick. Those selected by year have been:

1950	Errol D. Rodda
1951	David E. Cash
	James A. Garman
1952	David M. Harris
	John R. Huber
1954	Cletus E. Schertz
1955	James E. Smith
1956	John A. Replogle
1959	John Brennan
	Herschel H. Klueter
	Finis W. Schultz
1960	Lyle S. Martin
	Gary L. Wells
1961	Wayne L. Peterson
	Rolland D. Scholl
	Rollin D. Strohman
1962	Douglas B. Bauling
	Patrick A. Duffy
	John R. Rosenthal
1963	Charles N. Anderson
	Jerry R. Weibel
1964	Peter D. Bloome
	George A. Puzey
1965	Lyle E. Stephens
1966	Wayne A. Peterson
	Robert W. Schottman
1967	Robert D. Carlson
	Leland P. Wolken
1968	Keith H. Haselhorst
1969	Wayne A. Knepp
1970	Daniel G. Roley
1871	Robert J. Gustafson
	Norman L. Klocke
	John L. Roll
1972	Ronald W. Schneider
	Joseph A. Teijido
	Earl H. Williams
1973	Melvin H. Buescher
	Albert L. Humke
	Paul J. Klazura
1974	Dale E. Gramm
	James R. Steffen

1975	Michael B. Brennemann	1984	Brett S. Miller
1977	Lawrence J. Brizgis	1985	Bryan Groth
	Thomas E. Glenn		Joe Lehman
	Warren R. Groth	1986	Dave Griffith
	Nickey D. Hoyle		Marcia McCutchan
1978	Jeffry W. Healy	1987	James W. Brown
	Robert A. Montgomery	1988	Dale Brockamp
	Christopher A. Myers	1989	Doug Awe
1979	John Brach	1991	William C. Hughes
1980	Christine A. Berglund		Kenneth Ramsay
	James D. Walker	1992	Jeannie Bloome
1981	John E. Andrews	1993	Rene Denhart
1982	Randy K. Pound	1994	Julie Madison

In addition, Frank Lanham, Roscoe L. Pershing, and Howard Wakeland have been selected as honorary knights.

The Student Agricultural Engineer, 1937

The department hosted the ASAE annual meeting during June of 1937. In preparation for the meeting the Student Branch published its first student publication known as "The Student Agricultural Engineer." The publication was distributed to all attendees. Some examples from it seem relevent to this history.

EDITOR'S PAGE

Welcome to Illinois. For the first time in thirty-one years Illinois has the pleasure of being host to the annual summer convention of the American Society of Agricultural Engineers. It is the sincere wish of the local members that your visit be a pleasant and enjoyable one. We hope that the information contained in this publication will further increase your pleasure while visiting our campus. With this thought in mind, the Illinois Student Branch dedicates this booklet to you.

The exhibit of old plows now in the Agricultural Engineering building brings to mind the annual Wheatland and Big Rock Plowing Matches in Illinois. The thousands of spectators that annually witness these two events definitely establish them as being one of the most popular of agricultural sports. The Wheatland Match was established in 1877 by James Patterson for the purpose of promoting closer fellowship and more profitable farming. The Big Rock Match was founded on essentially the same principles about 1900 by William T. Thomas. During the past thirty years, interest in these events has increased rapidly; they are well worth attending.

Recently I was introduced to a young business man who had graduated in Commerce a short time ago. During the conversation he asked me which field of engineering I was in. When I mentioned agricultural engineering he seemed surprised. He told me that it must be something new because he had never before heard of it. It is surprising how many other people have this same misconception. As early as 1845 comprehensive books were being written on the subject of Agricultural Engineering. A short time ago I looked through "Rudimentary Treatise on Agricultural Engineering," by G. H. Andrews, which was published in England in 1853; this book discussed the questions confronting agricultural engineering at that time. This, however, was not the beginning; such men as George Washington, Thomas Jefferson, Colonel Fairfax, Daniel Webster, and Eli Whitney realized the need of trained men to cope with agriculture's technical problems.

To the members of the faculty and to the students who assisted in the preparation of this issue of the *STUDENT AGRICULTURAL ENGINEER* I wish to express my sincere gratitude.

R. F. Skelton

Some Activities of the Agricultural Engineering Staff

R. F. Skelton, '38 A.E.

The activities of the department are divided into three types of work: research, college teaching, and extension. The head of the department, Professor E. W. Lehmann, is responsible to the Director of the Experiment Station and Extension Service, and to the Dean of the College for the activities in these fields. Fortunately these activities are headed by one man at Illinois. Professor Lehmann has had an active part in the rural electrification work of the state and is a member of the governor's committee. He has also assisted in the Soil Conservation and Drainage programs that have been inaugurated. He teaches Home Equipment and Rural Electrification, and Drainage, as well as special problem courses for advanced students.

One of the important services of the department of agricultural engineering is the preparation of farm building plans, that are made available to farmers through the plan service. Professor W. A. Foster has designed many farm homes and other farm structures, and in cooperation with representatives of other departments has prepared a wide variety of circulars. Another research problem to which he is giving attention is grain storage. He teaches the farm building courses, the course in concrete construction. and a course in home architecture.

The power and machinery courses, which are leading in popularity in the department, are taught by Professor R. I. Shawl. During the past semester he had 137 students enrolled in these courses. That part of his time devoted to research is devoted to lubricating oil study, to tractor operation costs and to harvesting problems.

There is one introductory course in Agricultural Engineering that is required of all students enrolled in the general agricultural curriculum, in the College of Agriculture. Most students take this course during the freshman year. It is taught by Professor A. L. Young with the assistance of E. L. Hansen. Professor Young also teaches the shop course for teachers and the dairy machinery course. In research most of his attention has been given to problems in harvesting, including work on combines, threshing machines, and corn pickers.

While the men engaged in teaching devote a limited time to research the major part of the research work of the department is done by those men who are devoting their entire time to this work. The work on dehydration, with emphasis on the drying of seed corn, is being done largely by R. H. Reed. Mr. Reed has worked for several years with the assistance of F. R. Wiley in developing a special temperature and humidity control experimental drying unit which is of special value in studying some of the fundamentals of the problems of dehydration. During recent months Mr. Reed has given some attention to apple washing and stationary spraying.

A new field of research which is being explored by the department is a study of the power, machinery, and labor relationship in efficient and economical farm production. It is recognized, according to Professor Lehmann, that "the economical use of labor is dependent on proper and adequate equipment and machines of production and adequate power and the efficient and economical use of power is dependent on proper loading of the power unit, which is a problem in engineering." Paul Bateman began working on this problem last September and is devoting his attention particularly to soybean production.

Considerable emphasis is being given to weed control by the Agricultural Experiment Station in an organized project in which C. W. Veach of the department is actively cooperating. Mr. Veach is working primarily on the problems of seed cleaning. Representative types of seed cleaning machines have been secured for test purposes and an air conditioned laboratory provided for studying the physical characteristics of weed seeds.

Through cooperation of the Bureau of Agricultural Engineering T. Cleaver has been stationed at the University of Illinois and is devoting attention to the problem of grain storage. A considerable part of the facilities used in this research were developed by the department for an earlier study on the storage of soft corn.

Another problem which is receiving attention is drainage improvement, the need of which is in evidence in many sections of Illinois. Work on this project is being done by H. D. Fritz, who is also on the Bureau of Agricultural Engineering staff. Mr. Fritz is studying the effect of drainage maintenance on the coefficient of roughness "n" as used in Kutter's formula.

The extension work of the department has been given greater emphasis during the past year in the programs of the County Program Planning committees than ever before. There was a greater demand for extension help in rural electrification than in any other phase of extension work offered in the state. This work is being done by R. R. Parks.

The interest in soil conservation is also on an increase. R. C. Hay has had his time fully taken in conducting terracing demonstrations and schools. A new phase of extension work devoted to an old problem is the work that T. A. Pitzen is doing on drainage.

A departmental activity of special interest to prospective students is the curriculum in Agricultural Engineering in the College of Engineering. The freshman year of this curriculum is the same as other Engineering curricula. The chief feature of the curriculum which makes it different from most agricultural engineering curricula is the option provided at the beginning of the junior year. At this time a student may major in either the field of power and machinery or structures and drainage. These options make possible a more thorough training in design in either of these fields.

A Brief History of the University of Illinois

D. L. Searls, '37 Ag., '39 A.E.

On March 2, 1868, the doors of the University were opened for the first time, with a total enrollment of fifty men students. It could be said that Illinois was far behind her neighboring states in starting state universities. Ohio had begun in 1802, Indiana in 1820, Michigan in 1821, Missouri in 1839, Iowa in 1850, and Minnesota in 1851.

Although Illinois was slow in getting a state university under way, it was a citizen of Illinois, Jonathan Baldwin Turner, who probably had more to do than any one else with the passing of the Morrill-Land Grant Act, which has made the state universities possible.

Before its signing by President Lincoln in 1862, no state university, however early in its founding, had made much progress. The Land Grant Act gave to the states 30,000 acres of land for each congressman or delegate, to be devoted to the cause of education. For Illinois, the grant amounted to 480,000 acres. All except 25,000 acres were sold for an average price of seventy-five cents per acre within five years after the university was established.

The subjects actually taught at its opening were algebra, geometry, natural philosophy, history, rhetoric, and Latin, and the work was carried on in a brick building which was the donation of Champaign County.

The faculty for the first term consisted of the Regent and three instructors—a head farmer, and two non-resident lecturers. A decided contrast in numbers with our faculty today! The two towns likewise presented a very different appearance. Street pavements were laid some twenty years later than this; the buildings, for the most part, were of the cheaper grade of wood frame construction; and the streets themselves were more often adorned by wood piles than by sidewalks. Stock of all kinds ran at large in both towns and in the country, so all houses were securely fenced to keep out the predatory town cows and hogs.

Women were not at first admitted to the university. In 1869, the question arose and was finally decided in the affirmative in March 1870.

In spite of the prominence of agriculture in the state and the important part which the farmer took in the industrial movement, the agricultural department lagged. Meanwhile the engineering course developed rapidly. Stillman W. Robinson may be regarded as one of the most important men in developing the College of Engineering. He appreciated the educational possibilities of shop work and made it a part of the engineering instruction.

At the end of the first five years the organization of the university consisted of four colleges—the College of Agriculture, of Engineering, of Natural Sciences and of Literature and Science. These were subdivided as follows:

The College of Agriculture included the Schools of Agriculture and Horticulture.

The College of Engineering embraced the four schools of Mechanical, Civil, and Mining Engineering, and Architecture.

The College of Natural Sciences included the School of Chemistry and the School of Natural History.

The College of Literature and Sciences embraced the School of Modern Language and Literature and the School of Ancient Language and Literature.

Thus we see the beginning of a great university. Attendance increased, state appropriations were made, buildings were constructed, new colleges were added, new departments added, and the University of Illinois lifted its head out of the mud and soon became one of the leading universities of the country.

Student Activities of 1936-37

K. E. Fuller, '38 A.E.

The student branch of the A.S.A.E. enjoyed an unusual year in the environment of agricultural engineering. The reasons for such a season of wide and varied events of interest were largely attributed to the many speakers in the fields of agriculture and engineering who presented many topics pertinent to agricultural engineering.

Professor Polson, of the Mechanical Engineering Department of the University of Illinois and a nationally known authority on internal combustion engines, presented many interesting phases of diesel power.

Another speaker, in the field of agricultural engineering, was Mr. Mason Vaugh, recently returned from India. His description of Indian agriculture and its present problems presented quite a contrast to the problems which we are confronted with in this country. Mr. Vaugh graduated in agricultural engineering at the University of Missouri.

Topics presented by the members of the Agricultural Engineering Department, University of Illinois, were "Recent Developments in Rural Electrification," presented by Professor Lehmann, "Methods and Applications of Electric Fencing," presented by Mr. Veach and Mr. Hansen.

As to student presentations, Willard Bixby, '37, recounted his experience with the horse-pulling dynamometer truck which he operated at many contests held throughout the state during the summer of '36. Robert Skelton, '38, told of his experiences with the cellulose digestor operated on the University farm south of the campus. He explained the process of obtaining methane gas from the action of bacteria on soybeans and pointed out many of the limitations of the plant. Kenneth Fuller, '38, on a quite different subject, related his experiences in the field of amateur radio. Several pieces of equipment as are used on the high frequency communication channels were displayed and operated in a demonstrative fashion. Ken's call is (W9PSL).

The year's student exhibits were displayed during the Little International and the Illinois Student Engineering Exhibit (Open House). At the open house, the Agricultural Engineering exhibit consisted of a replica of Cyrus McCormick's first reaper as contrasted with the latest in the one-man combine type. Frank Andrew, Robert Skelton, Kenneth Fuller, and Richard Boardman demonstrated the accuracy and the function of the University's constant pull horse pulling dynamometer.

Other pieces of equipment were terracers, a radio-equipped tractor, corn picker, and many of the crawler and rubber-tired tractors used by the students in laboratory.

The student branch of A.S.A.E. greatly appreciates the interest and cooperation given by their instructors and local business firms in making their school year and engineering exhibit successful.

Graduate Training Course with a Machinery Company

Richard Duncan, '36 A.E.

On June 8, 1936, I received my diploma which stated that I had fulfilled the requirements for and had received a B.S. degree in agricultural engineering at the University of Illinois.

On June 30, 1936, late in the afternoon, I climbed off the train at Racine, Wisconsin. I was reporting to J. I. Case Co. for a two-month training course, on pay, with the prospect of further connections with the company.

On the morning of July 1, I reported for duty. I found myself one of eighteen fellows. A check-up disclosed that we were all college men. There were ten widely scattered colleges and universities represented from Dartmouth to Nebraska and from Wisconsin to South Carolina. We checked in and got started on what was to be two months spent in learning as much as possible about a large organization and its products. At that time J. I. Case Co. had three plants for production: The Main Works and the Tractor Works at Racine, Wisconsin, and the Rockford Works at Rockford, Illinois.

We stayed in Racine several days, becoming acquainted with the policies of the company. The Case Co. operates on only sound, time-proven business policies, and builds only quality products. We should endeavor to sell the customer the kind, size, and amount of machinery which would prove the most profitable to him. This meant that we, who were to go into sales work, were to make selling not only a job of salesmanship but also a problem of the power and machinery requirements of the farmer and operator.

After several days we were sent to Rockford. All of the smaller and lighter machinery units are made at the Rockford Works. There our time was divided three ways. Approximately one-third of our time each day was devoted to taking up the sales features of the Rockford products. We were also given points and suggestions on salesmanship. During another third of our time we worked individually with inspectors. We worked with the inspector on his particular round of inspection. There are thirty-two men working in the inspection department. While working with the inspectors, we saw at first hand how closely quality and accuracy are checked. Each inspector is thoroughly familiar with his phase of inspection and could give us detailed information on the production methods. During another third of our time we set up new machinery. We took the bundles from the warehouse and set up the new machines the same way that the dealer does. One short field trip was made to observe a binder in operation. We were out on the testing grounds one full day operating tractors and different tillage tools. The sales manager and the special representative of the Rockford Works were in direct charge of our group while at Rockford.

After two weeks we returned to Racine, where we spent three weeks at the Main Works where threshers, combines, balers, silo fillers, hammer mills, corn pickers, and paints are made, and advertising literature is printed. The major part of our time was divided two ways. One part was out in the plant seeing as much as we could and learning from the workmen, shop foreman, and superintendents. The remainder of the time we were in the assembly hall or on the display floor taking up each machine in as much detail as time would permit.

Time was spent in the paint shop where the paint is made for all Case machinery, in the printing department where all advertising literature is printed, in the repair department where all branch house repair orders are filled. We visited the departments where the routine business is handled, such as bookkeeping, branch house accounts, and inventory. We also visited the Racine Branch and saw how the business is handled at the branch house. We made several field trips and observed tractors, combines, threshers, and pick-up balers in operation. While at the Main Works, the special representative of the Main Works had charge of the group.

From the Main Works we went out to the Tractor Works. We started at the drop hammers and the foundry and ended at the loading docks where tractors were being pushed into box cars for shipment. We learned that the castings in Case Tractors and other machinery are semi-steel castings. The tolerances allowed on all machinery in the Tractor Works correspond to those allowed in making an eighteen hundred dollar automobile; cut gear teeth are closely checked to keep the tooth shape within one-thousandth of an inch of a perfect tooth. The crank-shafts pass through ninety-two operations and inspections. All case hardening and heat treating are held rigidly to the best known practices. All assembly work is continuously inspected. Every tractor coming off the assembly line can be turned by hand, using the fan belt. The tractors are tested and run in for not less than three hours. After the complete tractor has been assembled it is thoroughly tested for power, fuel consumption, quietness, and general performance.

We partially dismantled a model "CC" Tractor, reassembled it and then tested it. A tractor was operated on number one furnace oil to convince us that Case tractors would operate successfully on low-grade fuels. At several different times during the two weeks, we had discussion meetings. To top the two weeks off, we were given a detailed examination on tractors. The special representative of the Tractor Works was in direct charge of our group.

During the last week we were in the assembly hall most of the time. We heard a number of interesting and instructive talks by men in charge of different lines of work. Topics were covered such as transportation, exporting, foreign business, accounting and bookkeeping, engineering department, purchasing, advertising, sales, industrial units, repairs and repair service. The Banker-Dealer Program and the approach to contacting new dealers was fully covered. While at Racine and Rockford, we rubbed elbows with and became acquainted with, to a certain degree, a number of the Case Co. officials.

Some of the benefits of this training course were the knowledge we gained of the products, the contacts we made, and the conviction that when it comes to quality and performance, we were representing products which were second to none.

After a short interview I was sent to the Branch House at Dallas, Texas. I was to see if I could put some of the things I had learned to work. Since the time of this training course, J. I. Case Co. has purchased the Rock Island Plow Works at Rock Island, Illinois, and the Shower Brothers Factory at Burlington, Iowa, and the Dixon Plow Works at Dixon, Illinois, has been reopened. Future training courses may not coincide with this particular one.

What Does a Student of Agricultural Engineering Do During Vacation?

K. E. Fuller, '38 A.E.

I am going to attempt, in a personal way, to bring to the reader of our publication just what the activities of any one particular student might be. So without trying to let my conscience bother me, I'm going to pick on myself as a subject careening along with agricultural and engineering problems.

As it has been my fortune to be closely in contact with my father, who manages many farms for private landowners in central Illinois, I can assure you that one comes in close contact with many and varied problems. Just to begin with, about the first week or so at home is spent in dragging the steel tape in mapping and blueprinting farms. Such maps are kept by the tenant, landowner, and manager. Another week is spent soil mapping, a little more tedious but more interesting.

As it happens, again this year there is a great need for hybrid corn drying equipment and considerable time will be spent in its construction. Such problems in the process of corn drying as efficient methods of handling of corn and controlling the air behavior must be worked out in a little more detail. By the middle of July all hands will be turned to detasseling and inbreeding work in the hybrid fields. After the period of detasseling about two week in duration, work is resumed on the construction of the drier until the middle of August or thereabouts. New especially in farm management there has always been a need for considerable drainage and soil control. Such control has been in running levels for small terraces. Many times we have laid out these terraces first by maintaining our grade line with stakes across a field and then by driving along the outside of these stakes with a car to indicate to the terracer the proper curvature. Along these car tracks, the terracer can operate with ease. By such a method farmers can efficiently do much to save their soil and educate their neighbors.

Thus, these are some of the problems anyone may come in contact with if he is at the right place at the right time.

The Value of the Tractor Short Course

Erwin Dueringer, '40

The tractor short course held each year by the Agricultural Engineering Department of the University of Illinois is proving to be quite valuable to the farmers attending. This is revealed by the fact that, during the last few years, there has been an increasing number of applicants desiring to attend. No doubt the large number of tractors in use today on Illinois farms is responsible for this interest in the care and adjustment of tractors.

The course includes several interesting lectures by Professor R. I. Shawl on ignition, timing, valve grinding, and the tightening of bearings, and also includes laboratory work supplementing these lectures. Mr. C. G. Kreiger of the Ethyl Gas Corporation gave a demonstration last year on fuels and their anti-knock qualities. Various machinery companies sponsored motion pictures to show the operation of diesel motors.

After spending an entire week here at the course in 1935, I felt that I had really learned something about tractors. When I returned home, I said, "Dad, from now on we're going to do our own tractor repair work." "It's all right with me," he agreed.

So that fall he decided that I would do it. We had an eleven year old tractor; it needed quite a lot of repair work. The main trouble, however, was that it burned too much fuel. I realized I had quite a job before me, but I started right in and took off the head. As I took the different parts off, I laid them on the bench. Dad said "How many parts do you think you'll have left over when you finish, Erwin?"

"Why do you suppose I went to that tractor course, anyway?" I answered. Before I had finished my job, I had spent three days of hard work, putting in new sleeves and pistons, grinding the valves, adjusting the "Mag" and carburetor, and I didn't have any parts left over. However, I couldn't find any reason for such fuel consumption. But without looking further, I decided to start the tractor, hoping that the work I had done would lower the amount of fuel used. I set the spark, tripped the "mag," filled the priming cups, and lifted the crank one-quarter turn—the first time it started. The next morning I checked the amount of fuel used, only to find that I hadn't reduced it.

That evening after supper I was wondering what I could do. Dad would be home tomorrow, and I did want to have that fuel consumption lowered. I got out my notebook that I used in the short course and looked for causes of high fuel consumption. I knew that the spark plugs were in good shape. I was very careful about adjusting the timing, so it wasn't firing too soon. I had put in new rings and pistons and had ground the valves; therefore I was convinced that the carburetor was causing the trouble. I went out to the garage, took the carburetor off and brought it in the house. With utmost care I dismantled it, being very careful to examine each part. Since I found all other parts in perfect condition, I noticed that the cork float seemed to be slightly porous. I dried it out thoroughly and painted it with two coats of clear shellac. I was anxious to see the results. Sure enough, when Dad brought out the usual five gallons of gasoline in the middle of the morning, the tractor would hold only four gallons.

"What in the world did you do to it, Erwin?" Dad asked, as the gas began to run over the edge of the tank. "Oh, just another one of those things I learned at the tractor school," I replied.

But in all seriousness I did accomplish quite a lot during that week of tractor schooling. In fact, I liked it so well that I came back in 1936 for a similar course, and now I'm a student here in agricultural engineering.

The course has real value: for all that we learned pertained directly to the practical tractor problems on the farm. Now that horses are rapidly being replaced by tractors as a source of farm power, the value of a tractor course of this kind became more apparent.

A Rookie in a C. C. C. Camp

C. J. Bush, '39 A.E.

During the summer of 1936 the Federal Government offered students of agricultural engineering an opportunity to go to the C. C. C. camps as enrollees for the summer months to gain experience in drainage and soil erosion work. I signed up to get the experience and to get out in the open for the summer. I was assigned to Camp Eldred, which was a drainage camp about one mile south of Eldred, Illinois, in Greene County. This was only about two miles from the Illinois River and about ten miles from the Mississippi River.

The camp was located on what was a former river bed and one of the banks which was a high bluff rose up on the east side of the camp; it gave the camp a pretty setting. The buildings on this camp had been well arranged; the administration building was near the entrance with parking space for cars on either side of it. All of the land in the region of this camp was drained by a network of drainage ditches and it was the work of this camp to keep these ditches in condition as well as to build roads and to build dams or spillways where needed.

I entered camp on the first of July. After receiving a health examination, I was vaccinated for typhoid and smallpox. On the second day that I was in camp, a group of new enrollees were brought into camp. That night the regular enrollees decided that the new rookies ought to be initiated, so before long we were all headed for the showers and had a swell time removing green paint with cold water and G-soap. (G-soap is a yellow laundry soap issued by the army.)

The camp itself was supervised by the army, while work in the field was supervised by the technical men employed by the Bureau of Agricultural Engineering. A number of enrollees were needed in the camp itself. The first sergeant had charge of all the work that was done in camp. The various jobs in camp were clerk and typist to keep records of the enrollees, a clerk who worked in the superintendent's office, and men to work in the mess hall, supply room, pumping station, garage, canteen, and the library.

The camp had a good library which contained some good books and where one could also read the daily papers. There was an educational adviser in camp, and he held classes in different subjects; it was his duty to help students in their work, and if there were any enrollees who were too delinquent, they were required to take instruction from him.

Everyone was awakened at five o'clock in the morning by a bugle call and from then until seven, he had to clean up and fix up his bunk and clean around it, eat breakfast and stand for inspection. At seven o'clock everyone started for work, and if a crew was working too far from camp to return at noon, they took their lunch along in the truck. They worked until four o'clock and then returned to camp and cleaned up for supper. We worked in the field five days a week and on Saturday morning we worked around camp and occasionally one would have K.P. on Saturday or Sunday.

The camp at Eldred, Illinois, had seven draglines operating and enrollees were assigned to various machines as oilers. While I was in camp I substituted as oiler when one of the regular fellows couldn't go out. The machines that were equipped with lights were operated day and night. There was one bulldozer which was operated by enrollees and was used to level out the dirt that the draglines dug out of the ditches. A few of the enrollees went with the engineer, and they helped him with his work by doing the chaining, holding the rod, clearing the path of any brush which obstructed the vision between the level and the rod and driving stakes, where necessary. The engineer had to survey the ditches in order to find out the amount of earth that had to be removed. The engineers also had to do all of the other engineering work, such as surveying for new roads, and making maps of the work he did.

While I was in camp the crews that went out in the trucks had to remove young saplings and trees from the banks of the ditches so that the draglines would have an unobstructed path in which they could travel and work. About half of the crews worked in Illinois while the other half crossed the Illinois and Mississippi Rivers every day and worked in Missouri. We crossed the Mississippi on a ferry boat and at the latter part of the summer, the water got so low that the ferry could hardly cross because of the great drought that summer. In some of the ditches we worked along in Missouri, thousands of fish were dead or dying because these ditches had gone dry. This was quite a contrast to the great floods we had a few months later.

Students Exhibit Their Creativity

One of the exciting and rewarding things about teaching is the opportunity to work with young people in their formative years. At a university you see their creativity develop in many ways, but the ultimate creativity often shows itself when the students have the opportunity to poke good-natured fun at their professors. Then you have the opportunity to learn the faculty's peculiarities and the way students see them. One example of student creativity has been preserved from the second annual banquet of the Student Branch of ASAE, May 24, 1941. The identification of the author or authors has been lost, if it was ever known.

The Senior Class

And in those days it came to pass that a blessed event occurred in the fair city of Urbana which was in the land of the Illini. In that town there was an institution known as a quiz factory. And in that quiz factory many great men did work with grim determination in a manner not unlike that of a butcher in his slaughter house. The unhappy victims corralled within the confines of quiz city were known as students. Theirs was an unhappy lot. Day unto day they arose from fitful slumber. Night unto night they dragged their aching bodies into Bidwells.

And the years passed and many things happened. Everything happened. Students came and went. Great men came and stayed. And that is how it happened that all the great men of the world were drawn by a force not unlike the current of the mighty Mississippi right to the Agricultural Engineering Department.

And in the year 1941 the great men gathered together under the mighty roof of the colossal Agricultural Engineering Building were known by various and sundry names:

There was Emil Wilhelm of the House of Lehmann, lord of all he surveyed, Chief of Agricultural Engineers, mighty potentate of the campus, and owner of a 12 cylinder white elephant. Gathered about him were the others. There was George of the House of Petersen. Tall and mighty was he. His strength not unlike that of the angered bull. In those days he was called the Great Dane from Nebraska. Sir Veach was also gathered together with the flock of learned men. Strong was his mind though weak and trembling his desecrated body. By various and sundry names was he known. Some called him windy, stinky, dopey, honey, etc., etc., ad infinitum.

And Ralph the Duke of Hay was drawn by that mighty force to the Agricultural Engineering Department. Out of the west rode he. He did not ride to escape the Rose Bowl, the Cotton Bowl, the Orange, or the Sugar Bowl. Ralph, the Duke of Hay, the tall, the strong, the mighty man of Kansas rode to escape the dust bowl.

And there was Paul of the House of Bateman, better known as "skippy," short of stature was he with a draft number subject to immediate call to arms. Afraid of no man was Paul. On his mighty charger he rode to do battle with the wicked oil filter, the villaninous air cleaner, the treacherous breaker points and the unfaithful radiator. No enemy should harm his beloved tractor.

Who was the mighty Skelton, who was he that every Mother's boy should long to be? Skelton, a man of many abilities, wielder of the red pencil, weak of mind but strong of purpose, Casanova of the campus, report grader extraordinary. Colorful was the name of Skelton. Skelton who made no bones about the matter.

And there was Hansen, the tall man from Iowa. With his mighty stride he roamed the world. Keen was his mind and strong his throwing arm. But baseball was not destined to keep the talents of Hansen. Other things had he to do. Mud bricks were to receive his attention. And within a few years he was the world's greatest mud slinger. Here are his latest stories. Story No.1—censored. No. 2 censored. No.3—censored!

In those days Big Harted Guy was the over lord of the learned group of men. His was a hard lot. Never a moment's rest did he get. From 7 to 5 he roamed the building, his mind profoundly working on devious schemes to keep the boys of NYA busy. He was a great success.

Fred of the House of Wiley was there. A cunning villain was he. How he loved to tease. Day unto day he shorted magnetos, stoppered gas lines, unseated exhaust valves and ruined the engine timing. But everyone loved the precious rascal.

And Ray, the Prince of Shawl, was there. Rollicking Ray was a playful boy. He loved his binders, his tractors, his picker sheller, and his talkington hitch. But his bassoon was his real love. And how he could blow the horn that sounded not unlike the roar of the mighty Niagara.

Even in those days humanity was blessed with twins. Two men with but a single mind were Rucker and Henderson. Never before, since the beginning of time, had man been produced in four dimensions. To the combination Rucker gave height and depth. Henderson gave width and breadth. Burning fuses was their specialty.

And there was Sir Arthur Leighton, of the House of Young. Young in name but old in experience. A business man was he, master of mass production, instructor in funnel making, belt lacer extraordinary, and authority on domestic problems. A lover too was he, but alas and alack, he loved them and left them.

To the distinguished group of mighty men there came another known as Herman the Hermit. Others called him Rip Van Finkel—not because of a 20-year sleep but because of 20 sleepless years. No rest was there for Herman the Hermit. Night unto night he endeavored to escape the hand of fate which pursued him in a manner not unlike that of the hungry hound after the injured deer. A sad story it is. Herman the Hermit is now the dear that was sought.

And so it came to pass that a great banquet was prepared in a great banquet hall. And to the banquet all those greats eagerly and hungrily made their way. The first to arrive was that distinguished scholar Emil Wilhelm, of the House of Lehmann. And the sumptuous feast was carried in on mighty trays. And Emil Wilhelm was carried out on a mighty stretcher, and straightway taken to his home. In his peaceful slumber he saw visions and dreamed dreams. And it happened that in his dreams there came to him a beautiful blue-eyed blond. A strange thing occurred. For the first time in all his life he could not speak. Not a word could he utter so transfixed was he at the beauty of the vision. And the vision said to him "Hush, I am Psyche. If you love me you will listen. When the next year comes all the cattle will be slaughtered—gone to feed a starving Britain. Come next year and all the world will be without the most precious food that nature gives us. There will be no cows, there will be no calves, there will be no milk. What does it mean to you?"

And Emil Wilhelm thought of a starving land. No milk for the babies, no milk shakes, and no ice cream cones. Dark was the picture and sad were his thoughts. But the psychic smite him with her wand and caused a great plan to enter into his mind. And so thinking he fell asleep. Straightway in the morning he made his way to the colossal Agr. Engineering Building. Impatiently he awaited for the appointed hour of eleven for the gathering together of the learned men in a staff meeting.

And so it happened that Emil Wilhelm stood up in the midst of the great men and spake as follows, saying: "Fellow great men and Ag Engineers all, give ear to what I say. In but a few months all the sown on the face of the earth will be dead. The spirit has spoken. It is our duty to save for humanity the products of the cow. Gentleman, we must design and construct a mechanical cow that converts the luxurious grass and the waving corn of our great prairie state to delicious milk. I have spoken." So saying he sat down.

Then did Ralph, the Duke of Hay, arise to his feet and in a clear voice he spake and said, "Oh learned one, it is right that we should build a mechanical cow. And I offer the suggestion that the cow must also be made to eat hay. I myself will design the hay eater. I have spoken."

Rollicking Ray then arose to his feet and with one accord the great men around fell asleep. And Ray spake to unhearing ears saying, "My services I offer. A modern cow must have a duel horn system. One bassoon and a slide trombone shall it have. I have spoken, class dismissed."

Sir Arthur Leighton of the House of Young awoke with a start and with a loud voice spake and said, "The cow must hold together. Therefore rest assured gentlemen, that I will supervise the fitting of the skin and personally direct the lacing operation. I am finished."

Then did Sir Veach jump to his feet. "Partners in cattle making," he cried, "A cow must smell like a cow; my great ability now stands us in good stead. As chief maker of insecticide machines, I volunteer to provide the odor of the narcissus to the glorious cow." And as he spoke, wiley Fred Wiley toppled over in a faint. He knew that Sir Veach would nauseate then all with his foul odors.

Then to his feet sprang Paul of the House of Bateman, and George of the House of Petersen came to stand beside him. "Gentlemen," they said in a voice as though but one were speaking, "We have gone too far. We must start with a calf for is it not written that the calf shall grow to a cow? Our cost of production shows that a calf eats less than a cow." And they sat down, George sitting on Paul's knee. Wiley Fred then regained his consciousness and promptly fainted away again.

Handsome Eddie Hansen rose to his feet. "That reminds me," he said, "have you heard the one about the cow and the—(the rest is censored). He finished and amid great guffaw of laughter took his seat. Wiley Fred who had again revived to hear the story fainted away again.

And Herman the Hermit sat in the corner. In his hand was a book, and in the book was a review of drainage methods. And in an inspired voice he said with a sweet quaver, "Oh mighty men, what about the drainage problem." Then did Emil Wilhelm exclaim, "An excellent question. You may solve it for us. Assume all the conditions and work out the answer." And as he spoke he winked at the handwriting on the wall which said, "Opinions are tolerated only when facts are lacking."

Then the great man Skelton spoke. With words of wisdom he said, "Who is to work on the milk production," and in one voice all the men answered, "The udder guy." But even as they spoke, far off in the distance they heard the mighty clock. Then the bell rang and rang and all the great men followed wiley Fred Wiley down the stairs and so to lunch.

Another example of the creativity of students was an ode written to immortalize the passing of one of "Pappy Shawl's children." The students wrote the following.

A Memorial to "FRIEND"

We felt deeply impressed and want to pause at this time to pay tribute to a friend who has passed on. It is fitting that we pause at this time of year to pay tribute as Memorial Day draws near and it is with increased feeling that this day means to us this year.

I know you all feel deeply moved in the passing of our much needed friend in the great project which our country needs to accomplish to win the war. However we will have to struggle along without her in the future. The future looks rather dark without the help of our dear friend. True indeed were we to learn of the untimely death of your good comrade and mine the Farmall.

The IHC Farmall was brought into this world in 1924, the daughter of Mr. and Mrs. McCormick-Deering. Due to their many children she was soon adopted by Professor Shawl who was a loving and faithful father during all her life, in caring for her many needs. Her early life was spent on the South Farm of the University of Illinois and most of her life was spent on the farm of Mr. Riegel of Tolono.

She received her education in the Agricultural Engineering Department each winter and put the theory into practice each summer in difficult and long hours of work. She received an education through the efforts of her tutor Professor Shawl and his assistant Fred Wiley. Her efforts and experience were the basis for many articles, talks and opinions of her tutor.

She passed on May 4, 1942 at the tender age of 17½ years as a result of a sudden attack of a broken connecting rod.

Her example set the pace for many other people of her race. Her example of a long life will be long remembered and striven for by other engineers.

After her passing we all reflect and wonder how we will get along without her. However we realize she felt her work in the present form was complete.

In her memory the following poem was written.

The Shawl's Masterpiece, or,
The Wonderful IHC Farmall of 1924

Have you heard of the wonderful IHC—Farmall,
That was built in such a logical way
It ran seventeen and one-half years to a day,
And then, of a sudden, it—ah, but stay,
I'll tell you what happened without delay,
Scaring the hired man into fits,
Frightening people out of their wits,
Have you heard of that, I say?

Nineteen hundred and twenty-four.
Claude Chapman was then foreman
Of the expanding South Farm.
That was the year when Chapman
Saw the corn come up on the South Farm
Along with the terrible weeds so green.
Chapman in this hour of trouble,
To Shawl came he for assistance.
Shawl with a spirit to help,
Called upon the great company, IHC.
And it was on that troublesome day,
That IHC had finished the wonderful Farmall.

Now in building of chassis, I tell you what,
There is always somewhere a weakest spot,
In hub, tire, ring, in valve or radiator cap,
In piston, bolt, magneto, condenser or spark plug gap,
In screw, bolt, thorough brace, lurking still,
Find it somewhere you must and will,
Above or below, or within or without,

And that's the reason, beyond a doubt,
That a chassis breaks down, but doesn't wear out.

But Shawl swore (as professors don't, with an "I dew 'um
or an "I tell you") He would build one tractor to beat tl
town
'N' the county 'n' all the country raoun';
It should be so built that it couldn't break down
"Fur," said Shawl, "T's mighty plain
Thut the weakest place mus' stan' the strain;
'N' the way t' fix it, uz I maintain,
Is only jest
T, make that place as strong as the rest."

So Shawl inquired of the village folk
Where he could find the strongest steel,
That wouldn't be wore nor bent nor broke,
That was for spokes and frame and rings,
He sent for pistons to increase the compression ratio,
The block was cast from the best of iron
In which many cylinder sleeves were installed.
The shocks on the aging steel
With rubber tires were softened.
The best of oil was used
On which tests galore were run.
On and on it ran in dirt and grime
Without an oil filter during all this time.

To improve its compression
New types of valves were tried.
Repairs ad infinitum by Shawl were ordered
Each year for replacements wore out,
And skillfully assembled by Wiley.
Each winter did this happen
With great care and
Part by part was it replaced
until only did the frame, wheel steering, remain,
along with the seat many of the human kind
Which it did wear upon.
Tests of its power did reveal
A few horses had faltered
But the Faith of Shawl
And the great mechanical skill of Wiley

These horses did they revive.
That was the way he 'put her through.'
"There!" I said Shawl, "naow she'll dew."

Do! I tell you, I rather guess
She was a wonder, and nothing less:
Colts grew to horses, and passed out of the picture,
Other tractors came and to the junk pile did go,
While Old Betsy did purr on and on.
Farmers the question would ask,
How long will a good tractor last?
To answer is quite a task,
Shawl would answer to this question so indefinite,
"It all depends!
Old Betsy, down on Mr. Riegel's 1,400 acres
Has run 15 years now," he would reply,
"For 100 to 1000 hours per year to boot
And we expect her to do some more,
Twenty years or more I hope.
Her cost of operation real low was kept,
As low in fact as other tractors in use.
But these many parts did cost
Enough to invest in and enjoy
the advantages of a tractor right new.
But there stood the stout old Farmall
As fresh as on the day she was made."

Nineteen Forty—it came and found
the Shawl's masterpieces strong and sound.
Nineteen forty-one game;
Running as usual; much the same
And then came forty-two.
And finally the morn of May 4th.
Little of all we value here
Wakes on the morn of its seventeenth and one-half year
Without both feeling and looking queer.
In fact there's nothing that keeps its youth,
So far as I know, but a tree and truth.
(This is a moral that runs at large;
Take it. You're welcome. No extra charge.)

May 4th—the fatal day,
There are traces of age in the old Farmall

a general flavor of mild decay,
But nothing local, as one may say.
There couldn't be, for Shawl's art
Had made it so like in every part
That there wasn't a chance for one to start.
And yet, as a whole it is past a doubt
in another hour it will be worn out.
This afternoon the hired man takes a drive.
Now, horses, chickens, and cows, get out of the way!
Here comes the wonderful Farmall.

A turn of the crank. Off she went.
All at once the engine its purring did cease,
First a tick and then a clatter,
Then something decidedly like a rattle't bang-
And the hired man was off with a "Gol Dang."
What do you think the hired man found,
When he got up and started around?
The poor old cylinder number one and block
Had taken terrific sock,
From the flying connecting rod which broke
You see, of course, if you're not a dunce,
How it ended, all at once,
All at once, and nothing first,
Just as the bombs do when they burst.

End of the wonderful IHC Farmall
A long life of many hours in all
To prove for deprecator's of cost of tractors,
That the maximum tractor life for
the IHC Farmall No. xxx to be an age
Before the obsolescent age of twenty years
An elapsed time of many hard hours
At the tender age of seventeen and one-half.
Logic is logic. That's all I say.

The Agricultural Mechanization Club

With increased enrollment in agricultural mechanization in the late 1950s and with a desire to have programs more closely attuned to their specific interests, the department encouraged the formation of a new club for those majors. At the time the national society of ASAE was beginning to encourage the separation of student groups to help the total profession grow by providing leadership opportunities in different segments of the profession. With this as a backdrop Richard G. Wilson, an Illinois student, with the assistance of Donnell Hunt, became the catalyst for the formation of the Illini Agricultural Mechanization Club in 1960. Unfortunately Wilson was killed in an auto accident in 1961 and never had the opportunity to see the club mature. Jim Rowley, '60, became the club's first president. After graduation he became the owner of an insurance agency in Plainfield, IL. Bob Fry, another charter member, still has intimate ties with the club as a resource and policy analyst for the department.

The Ag Mech Club has always been very active and public spirited. During its first year it began a farm machinery restoration project. A corn planter and a mowing machine were stored in the attic of the old Agricultural Engineering Building. These old machines were disassembled by the students, cleaned, reassembled to working order, and painted. The funds necessary were donated by the students themselves. The machines were frequently used in classrooms to illustrate the progress of farm machinery over the years. They are now displayed in the Champaign County Historical Museum at Mahomet.

Since the early 1980s the club has been active in the ASAE promoting programs of interest to ag mech students and graduates. They enthusiastically supported the development of the national Agricultural Mechanization Club organization and several members have served as national officers. Beginning in 1976 an FIEI/EMI trophy competition was initiated for agricultural mechanization clubs. The U. of I. Ag Mech Club won this trophy the first time in 1986. From 1986 through 1996 they were winners nine out of eleven years.

The Ag Mech Club has matured and grown substantially since its start thirty seven years ago. Some of its most successful current activities were started when the club was new. For example, lawnmower winterization, still the club's largest money making project, was started in 1961 by the first club adviser, D. R. Daum. Tours have always been popular events so students and faculty can visit equipment companies, engineering projects in progress, machinery shows and other activities that extend the student's education beyond the classroom. The first club tour took the students to International Harvester and Allis Chalmers in 1961. A current activity is the club's annual fall

Sweater Drive. Warm clothing is collected and distributed to those in need through local charity organizations.

Contributions of Graduates

Even before the Department of Farm Mechanics was approved five men interested in farm mechanics graduated. They subsequently made many significant contributions to teaching and research in agricultural engineering.

C. A. Ocock (B.S. 1904) became the chair of the Department of Agricultural Engineering at the University of Wisconsin. Later he was an engineer for the Avery Manufacturing Company and the J. I. Case Company. He became one of eighteen charter members of ASAE, which was founded in December 1907 at the University of Wisconsin.

E. A. White (B.S. 1908) was an instructor at the University of Illinois from 1908 to 1919. During that period, he earned an M.S. degree at the University of Wisconsin and a Ph.D. at Cornell University. Later, he helped promote the expansion of rural electrification in the United States as chair of the Committee on the Relation of Electricity to Agriculture. He was active as a student in the formation of the American Society of Agricultural Engineers and was a charter member of the society.

C. O. Reed (B.S. 1911) was an instructor of farm machinery at the University of Illinois from 1911 to 1917. In 1922, he became a professor of agricultural engineering at The Ohio State University and remained in that position until his death in 1940. Recognized by college presidents and university students as an outstanding teacher, he refused administrative positions to pursue the teaching of undergraduates. In 1937 he was awarded the Cyrus Hall McCormick Medal of the American Society of Agricultural Engineers.

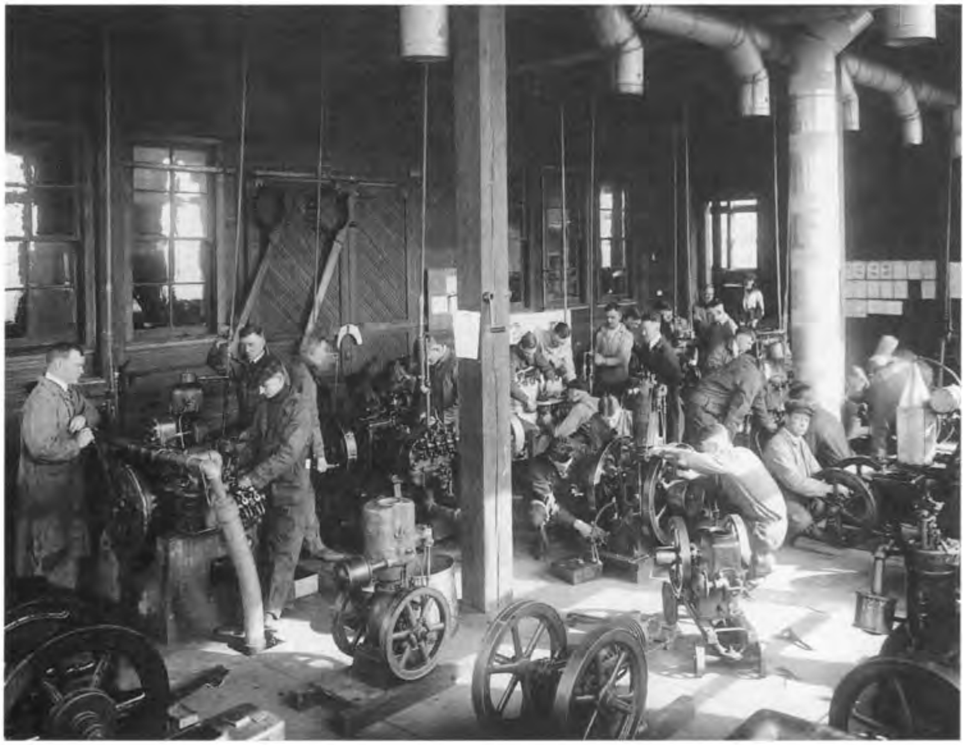
G. W. McCuen (B.S. 1915) became chair of the Department of Agricultural Engineering at The Ohio State University in 1924. He directed the teaching, research, and extension programs of that department until he retired in 1956.

R. I. Shawl (B.S. 1916) taught power and machinery courses from 1916 to 1958, when he retired. During that forty-two year period Shawl conducted research and taught courses on the many new tractor and machinery developments that took place during this period.

S. W. Shattuck was the first professor appointed to teach courses in agricultural and civil engineering for the University of Illinois.

A mid-1920s class studying home lighting in the Farm Mechanics Building.

The Tractor Laboratory in the late 1920s.



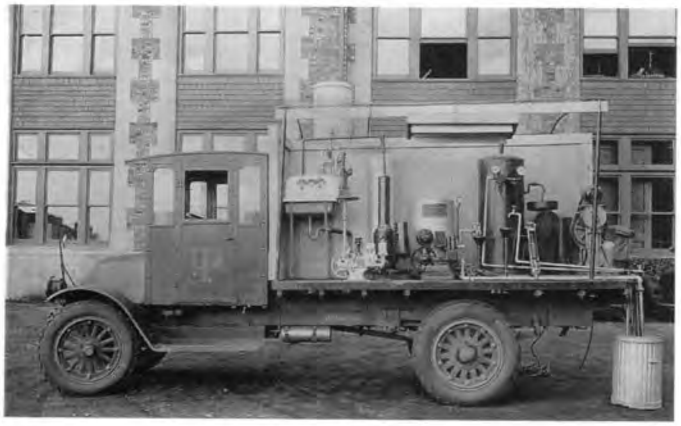
Engine short course in 1920.

Farm Mechanics 3, in the late 1930s, provided a laboratory session to study magnetos in the Tractor Laboratory.

East side of Farm Mechanics Building after the Tractor Laboratory was completed in 1924. Note Dairy Manufacturer's Building in background.

Agricultural Engineering Building (left) surrounded by Tractor Lab and Agronomy Seed House (right) with the "new" Agriculture Building (Mumford Hall) in the background. Circa 1942.

1926 Farm Gas Engine Contest. One hundred and sixteen club boys listening to a talk on gas engines before taking an examination on the subject. Six of the individuals tied in the contest



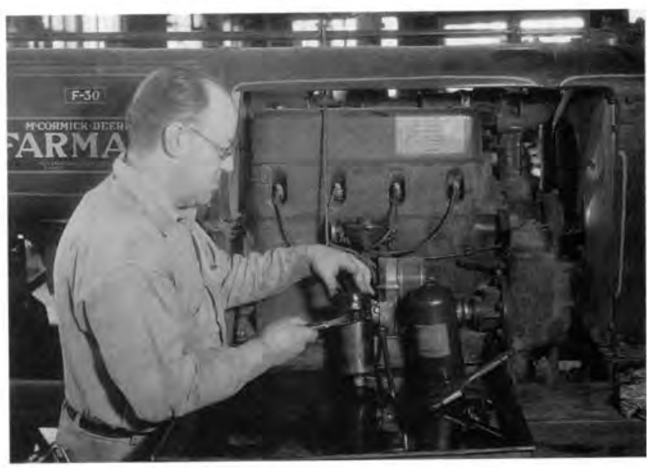
The water system truck set up to demonstrate simple and complete water systems.

Professor Shawl's "Harvesting Machinery— Ag. Eng. 17" class. O'Cock at left front.

T.E. Laydon, Leland S. Stallings, Arthur M. Brunson and W.C. Vauble demonstrate their surveying skills in 1913.

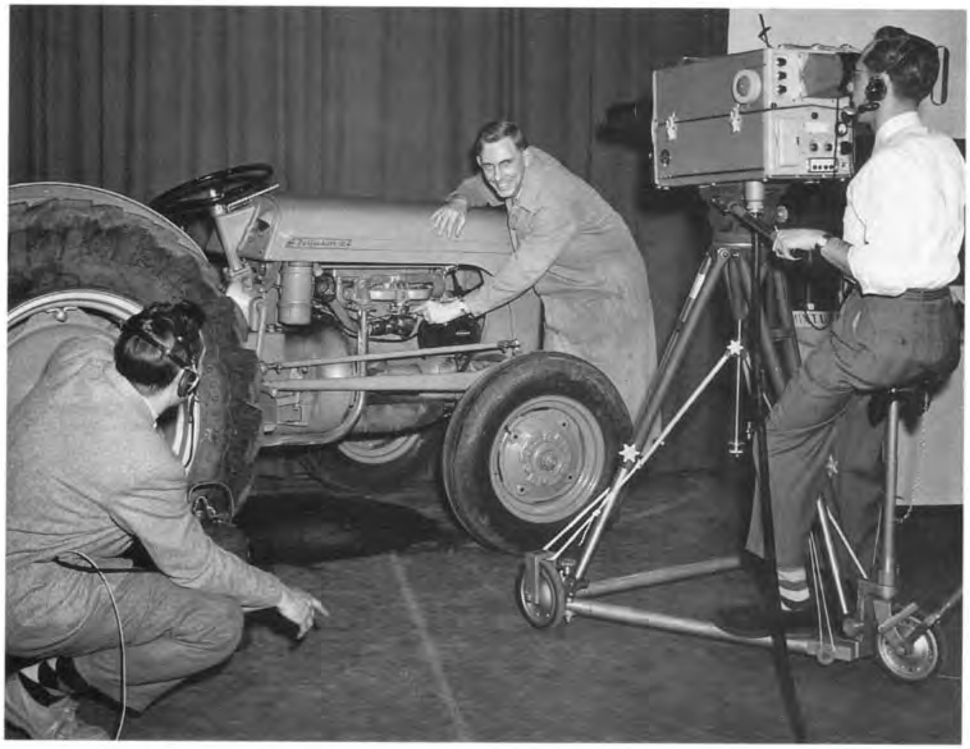
J. A. Weber served as project leader when a 350 horsepower dynamometer to test tractors was added to the tractor maintenance research program in 1961.

Fred Wiley, long remembered for his "fouling up of tractors," and his wife attend his retirement dinner in 1958.



Ray Shawl conducts studies on tractor maintenance using an early McCormick-Deering Farmall tractor. Circa 1935.

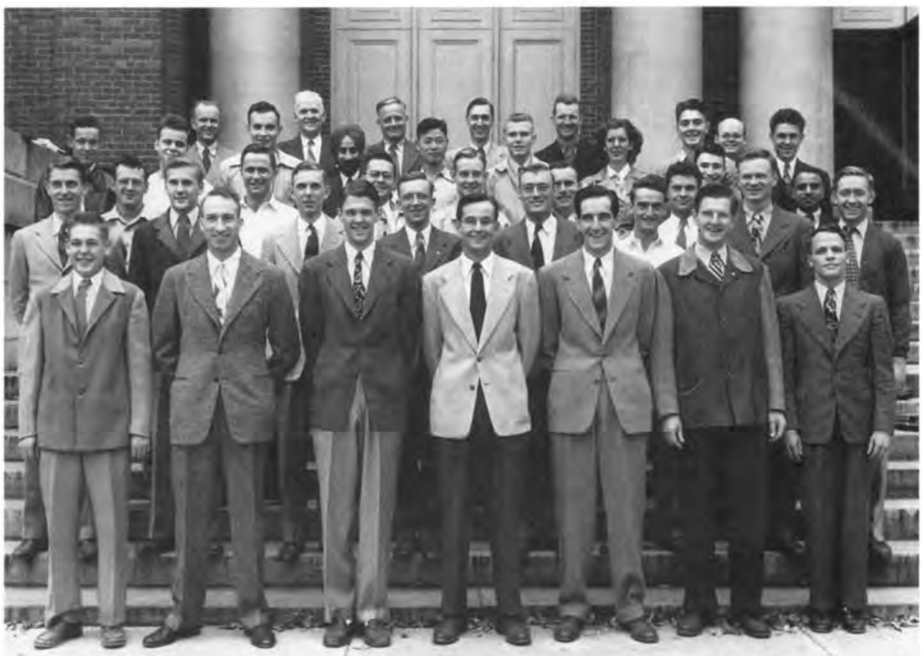
Ralph Hay conducts a Tractor School in LaSalle County, 1939.



Ben Jones demonstrated for the College of Agriculture faculty the potential for closed circuit TV on April 27, 1954. Studio was the Great Hall of Memorial Stadium.

A clear-span, plastic-covered building houses Agricultural Engineering's exhibits at Engineering Open House on Burrill Avenue in the early 1960s.

Roger Curry serves as toastmaster at 1965 Spring Banquet. To his right are Frank and Mrs. Lanham.



1947 ASAE members. Top row: Faculty: Ralph Hay, Emil Lehmann, John Ramser, Robert Whitaker, Frank Andrew, Paul Bateman.

Fourth row: Jack Butler, William Talbott, Randall Beasley, Gurnam Singh, Dah Cahng Wu, John Storks, Barbara Jordan, Russell Mighell, Jack Leathers.

Third row: Harlan Baker, Henry Grein, Murray Forth, Norman Slack, Edward Hunley, David Cash, Maurice Shaff, Alimohamed Memon

Second row: Albert Rust, Lawrence Bittermann, Benjamin Jones, Maurice Burgener, Robert Eagleton, Ralph Williams, John Mattingly, William Fletcher

Bottom row: William Zumwalt, Leo Stoeber, William King, Sanford Brock, Thomas Brock, Henry Thomas, Earl Moss

Not pictured: Eugene Barnes and William Bowers

"Introduction to Analog Computation" class taught in1963 following the department's purchase of an analog computer. Back row, Gene Shove, Harold Beaty, Donald Conant, Ben Jones, Guy Moser, John Wasserlein, Jack Butler, Peter Blake, Pete Holsberg, James Curtis, and Roger Yoerger. Second row, Donald Daum, Roy McConnell, Charles Barnett, Betty Caugherty, R.J. Maddock, Donnell Hunt, Jay Weber, M.E. Clark, and Burton Rolland. Front row, F.T. Dun, Elwood Olver, Donald Day, and Walter Edwards.

Elwood Olver, on right, explains his automatic-feeding system at a farm electrical controls workshop about 1962.

Frank Andrew piloted himself to many Extension meetings throughout Illinois. Andrew prepares to "take off" for a meeting in 1967.

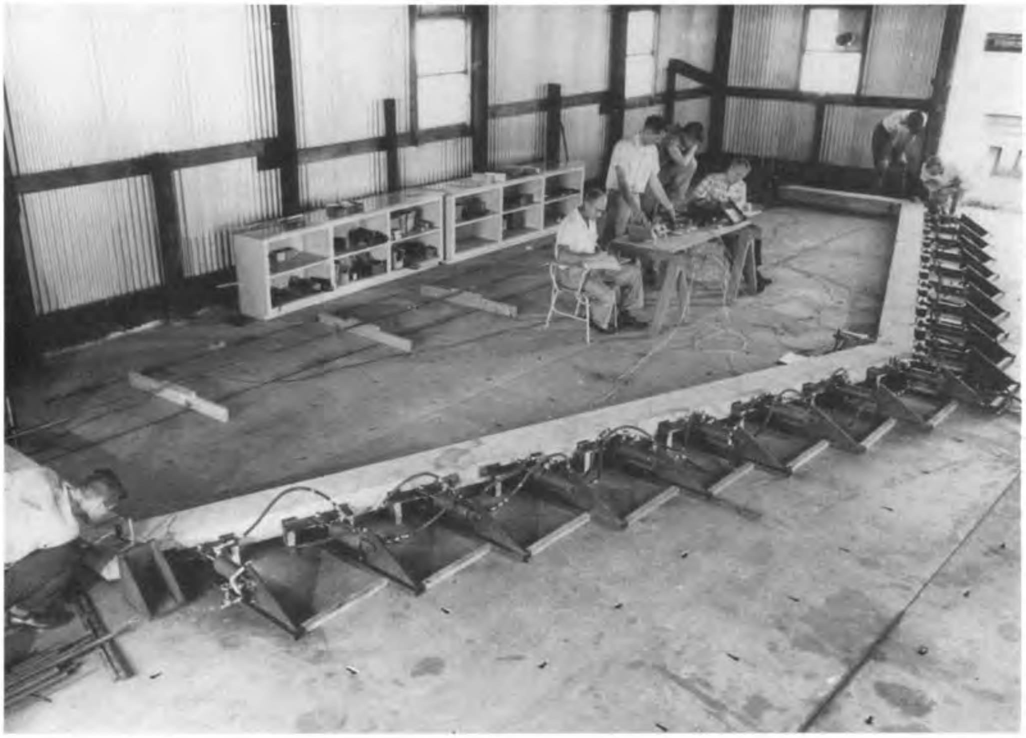
A little old time fun at a faculty social event: on getar Don Jedele, seated, Donna Jedele, Dottie and Wendell Bowers; standing, Dottie and Don Day.

1964-65 agricultural engineering students. Top row: Patrick Sinkler, John Jeschke, Bob Schottman, Philip Leman, John Goodenough, Keith Haselhorst, Robert Carlson, Peter Bloome, Robert Emery, Larry Kaufman, Alan Bell, John Knobloch, David Wiedeman, and Greg Heinz

Third row: Curtis Freeberg, Dick Moyer, Reynold Durre, Alan Chidley, Neil Whitely, Don Jones, John Heath, David Heath, David Hopkins, David Daniel, John Miller, Gerald Mundy, Merrill Pinter, and Larry Thompson

Second row: Richard Fenzl, John Litherland, Roger Curry, Wayne Peterson, John Tunnel, Ray Hauk, Lyle Stephens, Lester Thompson, and James Curtis

Front row: Richard Beyers, Robert Adams, Charles Heavner, Leland Wolken, and Ronald Gehrig.

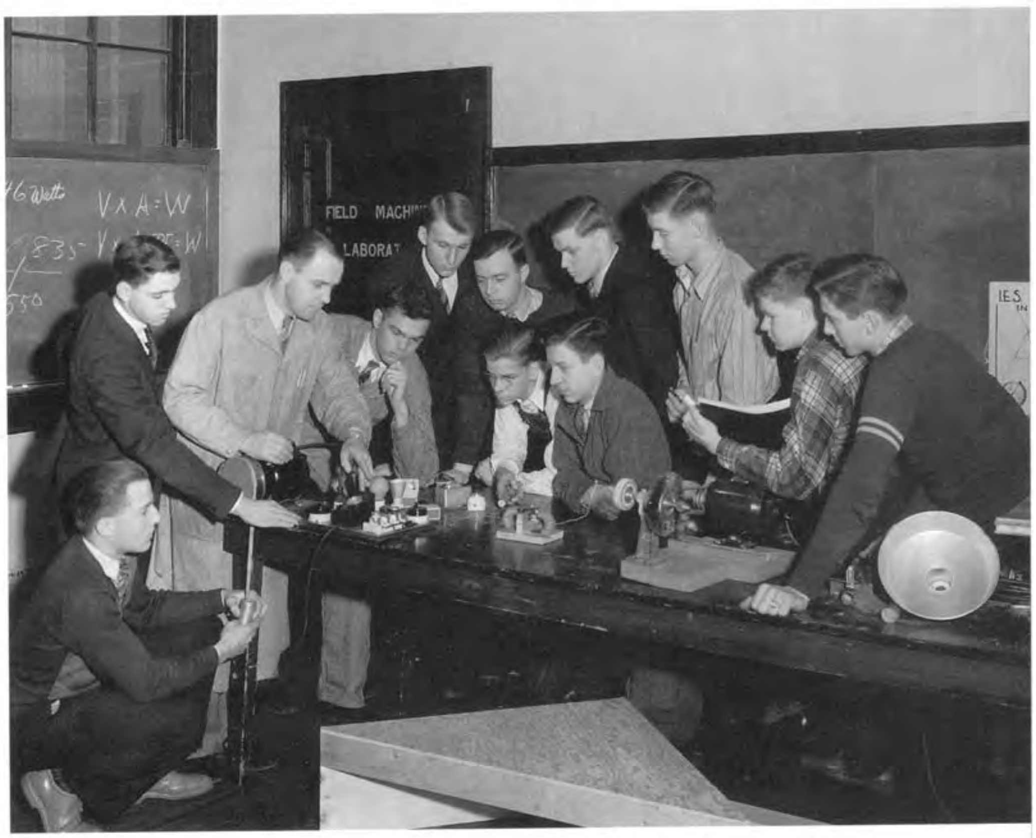


Ed Hansen, Maurice Paul, Charles Spillman, and Jim Curtis, at table, test rigid concrete frames for farm buildings.

Frank Andrew, center, demonstrates the use of augers for automatic conveying of grain and feed.

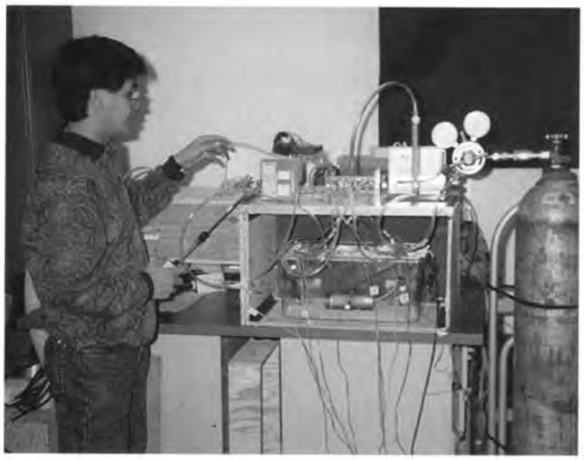
Roar Irgens, a microbiologist, led the way in the departmental aerobic research program.

Don Day conducts some of the first oxidation ditch research in the country.



Ralph Parks, third from left, demonstrates electrical principles to students in a lab in the Agricultural Engineering Building.

Alexander Zhivov, an academic professional from Russia, conducting clean air research in Les Christianson's laboratory.

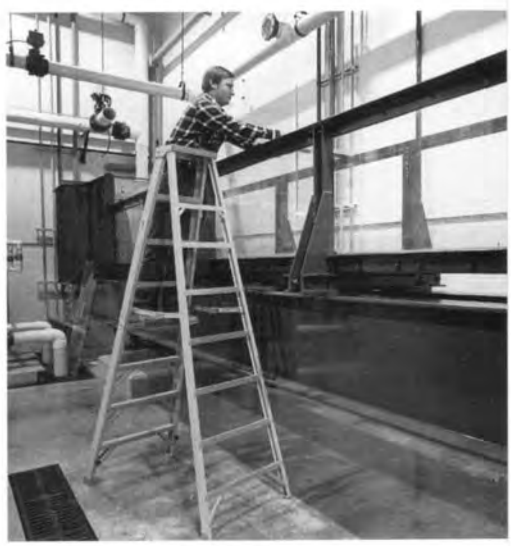


Ronald Maghirang, a post-doctoral student with Gary Riskowski, conducts a NASA funded research project involving animal cages to be used in future space missions.

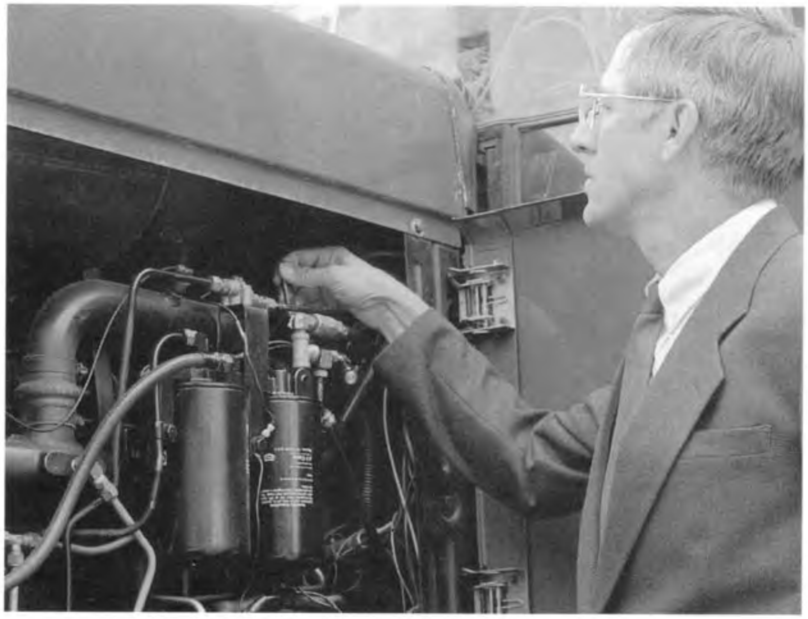
Don Day with undergraduates and graduate students who helped him with his research and teaching in 1979.

Emeriti professors welcome John Matthews into their ranks at the time of his retirement in 1976. Front row: Ed Hansen, Paul Bateman, and Ray Shawl. Back row: Harold Beaty, John Matthews, Ralph Hay, and Frank Andrew.

Kent Mitchell, right, and Steve Maddock, left, build equipment to make soil erosion measurements.



Steve Maddock prepares a large glass-lined flume in the hydraulics laboratory for an erosion control study.



Carroll Goering adjusts a dual fuel tractor engine that burns either ethnol or diesel fuel.

Loren Bode tests spray distribution in the spray laboratory of the new Agricultural Engineering Sciences Building.

It is difficult to measure the specific contributions of the graduates. However, a few additional examples of early graduates will illustrate the types of responsibilities and the contributions made by them.

J. W. Randolph, B.S. '20, contributed to a number of machinery developments for tillage machines, for harvesting sugar cane in Florida, and for processing forage crops. For several years he was on the staff at Auburn University and the USDA National Tillage Laboratory at Auburn. Before his death in April 1960, he developed new processes to dewater forages to improve the utilization of these crops under tropical and subtropical regions.

Lee H. Ford, B.S. '23, made important contributions to farm machinery in his many positions in the International Harvester Company. Before his retirement he supervised engineering product publications, parts catalogs, and manuals.

D. A. Milligan, B.S. '24, M.A. '25, was a member of the Department of Farm Mechanics faculty from 1928 to 1930. Later he was employed by a number of tractor companies to supervise industrial machinery development and sales. He later became vice-president of J. I. Case Company in charge of the industrial division.

T. J. Shambaugh, B.S. '30, managed a farm near Cerro Gordo, Illinois, until 1950. He then took foreign assignments to advise on farm machinery problems in Israel, Yugoslavia, and northern Nigeria.

Lynn K. Huffman, B.S. '40, became a manager of the farm machinery service department for Montgomery Ward Company a few years after graduating. For many years he helped Finlay, Morley and Hodgsons, Inc., Chicago, plan advertising programs for several large farm machinery companies.

Some graduates have made major contributions to improve machines for special crops that are not grown in Illinois. For example, R. A. Duncan, B.S. '36, spent most of his life in Hawaii. As chief engineer of the Hawaiian Sugar Planters Association, he made many improvements on machines for harvesting sugar cane.

R. M. Ramp was the leader of an ARS, USDA project to develop a sugar cane harvester for use in Louisiana. Ramp graduated in general agriculture in 1936 then obtained degrees in mechanical engineering and electrical engineering at the University of Delaware.

H. J. Finkel, B.S. '40, founded and became the first head of the Department of Agricultural Engineering at the Israel Institute of Technology at Technion, Haifa. In addition, he traveled to Peru and the

West Indies to plan drainage, irrigation, and soil conservation projec for the government of these countries.

Administrative responsibilities for design work on agricultural m: chines is illustrated by the positions of four graduates.

O. E. Johnson, B.S. '43, was chief engineer for the advance impl ment engineering department of International Harvester Compan Johnson was in charge of the design of tillage and planting machine

W. E. Hartman, B.S. '51, M.S. '52, used his education to advan to the position of department engineer for the J. I. Case Compan where he was in charge of engine design.

R. W. Whitaker, B.S. '46, M.S. (Civil) '47, was engaged in plar ning research projects to develop new storage uses for the Harvesto manufactured by A. 0. Smith Corporation.

M. W. Forth, B.S. '48, M.S. '53, made many improvements t machines manufactured by Deere and Company in his position senior development engineer in the product development departmen A specific contribution was the unique design and patent obtaine for a bale thrower.

Contributions also were made in research and development of ne building materials. M. L. Burgner, B.S. '48, M.S. '49, was an assistar to the vice-president for the Portland Cement Association.

Barbara E. (Emily) Jordan, B.S. '48, the only woman to graduat in the agricultural engineering curriculum before 1950, taught hig school mathematics in Kansas for many years.

A. A. Memon, B.S. '50, M.S. '50, directed the teaching prograr for all the college courses in his position as principal of the Govern ment Agricultural College of Maharashtra, Kolhapur, India.

E. J. Monke, B.S. '50, M.S. '53, Ph.D. (Civil) '59, directed so and water engineering teaching and research programs for the De partment of Agricultural Engineering at Purdue University from 195 until his retirement in 1990.

Similar administrative duties were assumed by two Indian student who manufactured simple tools for Indian farmers. D. C. Borpujar B.S. '54, M.S. '55, was manager of the manufacturing plant a Allahabad, India, and A. A. Swamy Rao, M.S. '58, was chief enginee of the same plant.

L. K. Pickett, M.S. '62, was senior project engineer with J. I. Cas in East Moline.

D. L. Bosworth, M.S. '64, was manager of engineering testing and reliability at Deere Harvester Works in East Moline. He was president of ASAE in 1992.

Allen R. Rider, Ph.D. '73, is vice president of operations, New Holland North America, Inc., New Holland, Pennsylvania and is currently (1996-97) president of ASAE.

Other graduates have made contributions by establishing their own small companies to render an engineering service.

R. F. Skelton, B.S. '38, M.S. (TAM) '41, made a significant contribution in the processing and handling of feed by designing and manufacturing a small hammermill that automatically metered several feed components into the mill. These mills were used in feeding systems in all parts of the United States. He was vice-president of the Belle City Engineering Company at Blufton, Indiana.

K. E. Fuller, B.S. '38, provided an engineering service to farmers as manager of the Fuller Seed Company at Lincoln, Illinois.

E. C. Dueringer, B.S. '40, formed a plastics company to develop plastic structures to store farm products.

Lyle G. Reeser, B.S. '46, was president of Global Energy Systems, Peoria, Illinois, and Blanco, Texas. The company researches the production and utilization of liquid fuels from biomass.

William Ayers, B.S. '74, is president of CIMCO, a company in Bement, Illinois that manufactures fuel filters and industry accessories. The company was originally started by his father A. R. Ayers who was an extension agricultural engineer in the department from 1945 to 1951. The company is expanding into the production of a fuel preparatory system to remove air from diesel fuel to improve performance. Another product is an absorbent that takes oil out of water.

Bill Hughes, B.S. '91, is owner of a business in Woodstock, Illinois, that manufactures electronic digital rain gauges.

Many of the department's graduates have become leading engineers in public service. Here are just a few examples: David C. Ralston, B.S. '52, design engineer, SCS, Washington D.C.; Neil F. Bogner, B.S. '49, design engineer, SCS, Washington D.C.; Joseph W. Haas, B.S. '53, assistant to the Chief, SCS, Washington D.C.; Jeffery W. Healy, B.S. '78, state conservation engineer, SCS, Indianapolis; and John C. Brach, B.S. '79, state conservation engineer, St. Paul.

Agricultural engineering graduates have made contributions in many other engineering activities. Probably the most advanced type of engineering responsibilities has occurred in space and missile programs. Dean F. Hopkins, B.S. '51, M.S. '58, Ph.D. (M. E.) '62, was a research engineer for the Douglas Aircraft Company at Santa Monica, California. M. Lenard, B.S. '50, had similar work as research engineer for the General Electric Missiles and Space Vehicles Department at Philadelphia.

W. J. Fletcher, B.S. '50, made a contribution in agricultural journalism by making agricultural information available to a large number of farmers. He was associate agricultural engineering editor for *Successful Farming* magazine. Later in his career he was with the National Safety Council.

A number of graduates contributed to rural electric and utilities programs in Illinois and throughout the United States. These included Dean L. Searls, B.S. '37, manager of Adams Electric Coop; F. W. Andrew, B.S. '47, extension agricultural engineer; J. B. Johnson, B.S. '47, Public Service Company; H. H. Baker, B.S. '48, Commonwealth Edison Co.; R. L. Beasley, B.S. '48, Coles-Moultrie Electric Co-op; Wayne D. Jones, B.S. '50, Illinois Power Co.; H. D. Kraft, B.S. '51, Northern Illinois Gas Co.; A. D. Moodie, B.S. '52, Peoples Gas, Light and Coke Co.; J. K. Mainey, B.S. '53, Consumers Power Co.; J. J. Slepicka, B.S. '54, Illinois Bell Telephone; D. G. Suhre, B.S. '54, Detroit Metro Water Dept.; J. E. Smith, B.S. '56, Central Hudson Gas and Electric Corp., D. W. Smith, B.S. '58, Menard Electric Coop.; and J. B. Heath, B.S. '69, Natural Gas Pipe Line Co.

In departmental newsletters from 1988 to 1996 the following alumni were listed as having college wide program responsibilities as deans or department heads at various academic institutions.

Deans or Directors

Wendell Bowers, B.S. '48, M.S. '56, assistant director of extension agriculture programs, Oklahoma State University, Stillwater.

Benjamin A. Jones, Jr., B.S. '49, M.S. '50, Ph.D. (Civil) '58, associate director of agricultural experiment station, University of Illinois at Urbana-Champaign.

Howard L. Wakeland, B.S. '50, M.S. '54, associate dean of the College of Engineering, University of Illinois at Urbana-Champaign.

Surenda V. Ayra, M.S. '56, dean of J. Nehru Agricultural University of Jabalpur, India.

Larry F. Huggins, B.S. '62, M.S. '64, head of the Department of Agricultural Engineering, then associate dean of College of Engineering, Purdue University, Lafayette.

Pershing, M.S. '64, Ph.D. '66, head of the Department of Agricultural Engineering then associate dean of the College of Engineering, University of Illinois at Urbana-Champaign.

Peter D. Bloome, B.S. '65, M.S. '69, and Ph.D. '70, assistant director, Cooperative Extension Service, University of Illinois at Urbana-Champaign.

Elbert C. Dickey, B.S. '70, M.S. '74, Ph.D. '78, assistant dean, Cooperative Extension Service, University of Nebraska, Lincoln.

Gerald. F. Arkin, Ph.D. '72, associate director, Georgia Agricultural Experiment Station, Griffin.

Soedoda Hardjoamidjojo, M.S. '78, dean of College of Agriculture, Engineering, and Technology, Institute Pertanian, Bogar, Indonesia. He was head of the Department of Agricultural Engineering from 1981-83 before becoming dean.

Thomas E. Glenn, B.S. '78, assistant to the dean of the College of Engineering, University of Illinois Chicago.

DEPARTMENT HEADS OR CHAIRS

Joe T. Clayton, M.S. '51, Agricultural Engineering, University of Massachusetts, Amherst.

C. Gene Haugh, M.S. '59, Agricultural Engineering, Virginia Polytechnic Institute and State University, Blacksburg.

Melvin Ray Smith, M.S. '59, Agricultural Engineering, University of Hawaii, Honolulu.

Charles K. Spillman, B.S. '60, M.S. '63, Agricultural Engineering, Kansas State University, Manhattan.

James L. Smith, B.S. '61, Agricultural Engineering, University of Wyoming, Laramie.

William E. Larsen, Ph.D. '68, Agricultural Engineering, Montana State University, Bozeman.

Jaipal S. Panwar, M.S. '68 and Ph.D. '71, Division of Agricultural Engineering, Indian Agricultural Research Institute, New Delhi.

Michael F. Walter, B.S. '68, M.S. '70, Agricultural and Bioengineering Department, Cornell University, Ithaca.

James C. Converse, Ph.D. '70, Agricultural Engineering, University of Wisconsin, Madison.

Gary D. Bubenzer, Ph.D. '70, Agricultural Engineering, University of Wisconsin, Madison.

W. Cecil Hammond, Ph.D. '70, Extension Engineering, University of Georgia, Watkinsville.

Robert J. Gustafson, B.S. '71, M.S. '73, Agricultural Engineering, The Ohio State University, Columbus.

Lalik Kumar, Ph.D. '72, University of Zambia, Lusaka.

3 | EXTENSION PROGRAMS AND DEVELOPMENTS

From the beginning of time tillers of the soil—farmers—have striven to improve production. Initially knowledge of improvements was spread from one farmer to another. Then, particularly in the United States, as implements and other products became available, companies carried out their "extension" activities through their marketing efforts often using demonstrations. Farmers also banded together and formed societies that provided an opportunity to come together to discuss their results and common problems. Some societies even established publications to get wider distribution of their information. Once land-grant universities were formed they assumed a role by providing unbiased sources of information and of evaluation of products.

The Mid-1800s

The mid-1800s brought many implements that started an unprecedented evolution in U.S. agriculture. Cyrus Hall McCormick had invented the reaper in 1831 and John Deere had developed the steel plow in 1837, and by 1857 Deere's walking plow had evolved to a riding sulky plow.

Public exhibition of new machines were made on many occasions, and a statewide emphasis was given to these showings in the form of the first state fair held October 11–14, 1853. The officials of the Illinois State Agricultural Society offered prizes to encourage the development of mechanical devices and machines to help in agricultural enterprises. A plowing match was first held at the fair in 1856 and demonstrations were conducted for reapers, mowers, headers, and grain binders. The fair association also sponsored machinery trials at other locations in the state.

The potential for mechanical power for farm operations was recognized by the fair officials in 1858 when they offered a $3,000 first prize and a $2,000 second prize for the best steam engine to pull a plow. The Fawkes steam engine (with a six-bottom plow) was the only machine demonstrated at the 1858 fair held in Centralia. Later that fall a steam engine plow-demonstration was held near Decatur. Although the equipment did not perform satisfactorily, the officials presented J. W. Fawkes $500 for his demonstration. In 1859 the steam plow was again demonstrated at the state fair held at Freeport, and after much discussion the officials presented him $1,500 for demonstrating the machine.

The Illinois Central Railroad also encouraged the development of a steam engine by providing a prize of $1,500 in 1859. Three trials had to be completed along the railroad line to qualify for the prize. Records do not indicate whether these trials were held. After the demonstration in 1860, the officials agreed that the steam engine would not be a substitute for animal power in plowing and other farm work. The trial of the steam plow, however, caught the attention of J. B. Turner, who predicted in an article on "Plowing and Drainage" that the perfection of such a machine, which cost about $2,500 to build and used coal for fuel, would benefit agriculture in Illinois.

About 1890 a number of gasoline engines were adapted to the steam engine chassis to produce a machine called a "gasoline traction engine." This name was used until 1906 when the word *tractor* was used in an advertisement by the Hart-Parr Company. Later it was learned that the word had been used in a patent in 1890.

The University to 1914

Soon after the university opened, the faculty presented talks and held discussions on subjects that would help to improve farming methods. Because a considerable amount of the state was level and in need of drainage, this subject was given considerable attention in extension meetings. S. W. Shattuck presented a talk on drainage on several occasions in 1870 and 1871. A nine-page record of his talk is given in the Third Annual Report of the Board of Trustees. Interest in drainage increased and the first meeting of the Tile Makers Association was held in Springfield on January 12, 1879. At subsequent meetings of the association the faculty presented talks on drainage. These talks included "Engineering for Drainage" by Ira O. Baker in January 1881, and "Benefits of Farm Drainage" by G. E. Morrow in January 1883. During this period there was rapid progress in draining the soil with tile and by 1881 it was estimated that there were about nineteen thousand miles of tile lines in Illinois.

The improvement of homes was discussed in a talk on "Rural Architecture" by J. M. Van Osdel in 1870. Two years later, discussions were held and a talk presented on "Our Home and Their Ornamentation" by W. C. Flagg, the superintendent of the farms. During the same period Shattuck gave a talk on "Sewerage." These three rather lengthy talks were also printed in the Board of Trustees Reports.

An early example of a machinery extension activity was the trial of implements held June 15, 1871. The Board of Trustees Reports give the following account of the event. "At the request of Professor T. J. Burrill, a number of farmers met for the purpose of examining and testing several corn cultivators and other implements for stirring the soil." The machines were judged on five points: capacity for working crooked rows, quality of work, adjustability, durability, and ease of management. The implements tested included walking cultivators, riding cultivators, the Thomas smoothing harrow, Bakewell's improved harrow with cultivator attachment, and Harper's harrow attachment.

Extension activities related to agricultural engineering were often initiated by faculty in other subject matter areas. For example, demonstrations on spraying to control San Jose scale on fruit trees were conducted by S. A. Forbes, an entomologist using a sprayer he, J. C. Blair and others designed and built. The sprayer was operated by a gasoline engine designed and built in the university shops. This sprayer and engine was described in Bulletin 56 of the Agricultural Experiment Station, published in 1899. Plans for beef cattle housing were released in 1906 by H. W. Mumford in Bulletin 110 and Circular 104. Descriptions and plans of silos and barns for dairy cattle were given in Bulletins 102 and 143 prepared by W. J. Fraser. Improved lighting of the home was described in Circular 121 "Lighting Country Homes by Private Electric Plant," which was published in 1908 and prepared by T. H. Amrine of the Department of Electrical Engineering.

In 1901 the first Farm and Home Week program was held on campus. The nature of the programs varied, but they were well attended by farmers, who obtained many new ideas from the talks, classes, and exhibits presented. These programs continued for sixty-two years, until 1962.

From 1914 to 1921

After the Smith-Lever Act was approved on May 8, 1914, extension work on agricultural engineering subjects was conducted as a part of the activities of extension personnel in the Department of Agronomy and by the faculty teaching agricultural engineering subjects at that time. Special emphasis was given to programs related to the war effort and the solution of labor shortage problems. More than fourteen articles were published in popular magazines by the faculty during this period. Examples included, "Machinery Preparedness for the Big Drive," "Shall I Buy a Tractor?," "Relation of Tractor to Horse for Farm Work," "Multiple Horse Hitches," and "Extension of Power Farming Education." Circulars and bulletins published during this period included: "Washing of Soils and Methods of Prevention," "Soil Moisture and Tillage of Corn," "Selection and Storage of Seed Corn," "Construction of the Dairy House," and "Arrangement of the Rectangular Dairy Barn."

In 1918 R. I. Shawl offered, between the first and second semester, the first on-campus winter tractor short courses . Subsequently, two one-week courses were offered each winter until about 1941.

From 1921 to 1997

After the Department of Farm Mechanics was approved in 1921, Frank P. Hanson was appointed in September 1922 as the first extension specialist for agricultural engineering programs. He planned and conducted all the extension programs for the department. A major effort was placed on terracing demonstrations that were held in many parts of the state. These demonstration projects provided some of the early research data on the construction and maintenance of terraces for different soil and climatic conditions. Other early projects included developing new building plans and demonstrations using power-driven machinery. The combine was introduced in 1924 and programs were held to advise on its use, especially for harvesting soybeans in Illinois.

Extension programs were conducted by either Hanson or Earl G. Johnson until 1934, when Ralph C. Hay was employed to take charge of soil and water conservation and machinery projects, and Ralph R. Parks, who was on the teaching faculty, was given responsibility for farm electrification and farm structures programs. Frank W. Andrew, employed during summers from 1939 to 1941 to conduct horse-pulling and farm electric demonstrations, replaced Parks in 1946 and developed extension programs in farm electrification, automatic feed handling, corn drying, and many other subjects. His tenure spanned from 1946 to 1972, when he retired. Keith H. Hinchcliff joined the faculty in 1943 to work on farm housing and farm buildings.

After World War II the extension faculty was increased with the addition of A. Richard Ayers as the power and machinery specialist. By 1963 there were five full-time extension specialists and one part-time faculty member for programs in the department. By the late 1970s, three full-time extension specialists and four part-time faculty members were assigned to department extension programs. A detailed listing of the extension staff is given toward the end of this chapter.

A Learn-by-Showing Teaching Method

Extension programs during the early 1920s were characterized by demonstrations, building plans, talks at county meetings, news articles, and personal correspondence. Many individual farmers were given special help with new programs so they would succeed with them and influence their neighbors to adopt them. In the early 1930s, the radio became a new communication tool and was used often to broadcast programs. A thirty-minute noon farm program began on WILL in April 1937 and agricultural engineering subjects were presented on Wednesdays. Television programs were first broadcast on Chicago stations around 1952. Television programming was begun in East Central Illinois about 1953 on WCIA and in 1954 on the university television station WILL-TV.

By 1963 teaching methods had been altered to reach more farmers and even urban people. Programs were planned to teach leaders who would, in turn, teach people in their area. Teaching aids for leaders were mass-produced in the form of slide sets, models, posters, and printed material. Extension programs were often integrated into those of other departments to present related information at a meeting or in a publication. The programs or displays were presented where large groups of people gathered for events such as the state fair, *Prairie Farmer's* Farm Progress Show, and at plowing and corn picking contests.

New transportation methods shortened the time necessary to reach many parts of the state. Early extension trips were taken on trains, in slow-traveling cars on unimproved roads, and some even traveled by horse and buggy. Frank Andrew was the first extension specialist in Illinois to pilot his own plane to make visits to various counties in the state. He began using this method of travel about 1947 making former two-day trips into short one-day trips. Harvey Hirning also was a pilot and often flew himself to do extension work, and Donald Day, of the teaching and research staff, frequently helped extension specialists by piloting them to special events.

Power and Machinery Programs

Before 1934 extension programs were conducted by either Frank P. Hanson or Earl G. Johnson. In 1934 Ralph C. Hay was employed and given the responsibility for soil and water conservation and machinery extension programs. Ralph R. Parks, who was already on the faculty, was given responsibility for farm electrification and farm structures. Shawl continued to offer the annual tractor short course, conducted several farm machinery schools, and added a series of meetings on lubrication. It was believed that farmers were not getting reasonable service from their machinery, largely because of a lack of knowledge of recommended maintenance and repair. To meet this need Shawl published Circular 425: "Tractor Repair and Maintenance" in 1934. The circular became very popular.

In 1936 Arthur L. Young and Edwin L. Hansen conducted a plowing contest while Hay conducted thirteen county meetings on farm machinery. At the time, Illinois was the leading state in the number of tractors, with an estimated 140,000 machines.

By 1938 applications for enrollment in the gas engine and tractor short courses taught by Shawl had more than doubled, exceeding the number of students that could be handled. Dean H. W. Mumford noted the situation and wrote to E. W. Lehmann, "I am wondering if serious consideration should not be given to extending somewhat these short courses to meet the demand for them. What are the limitations and difficulties involved? It may not be possible to work this out during the present year, but it does seem to me that serious consideration should be given to meet so definite a demand."

By 1939 the extension program was conducted by Hay and Parks with the assistance of resident faculty members H. P. Bateman, E. L. Hansen, E. W. Lehmann, R. I. Shawl, and A. L. Young.

During World War II, Parks was given military leave and Frank Andrew began working part time with Hay on extension programs in farm machinery. Farm power and machinery programs were most important because of farm labor shortages.

The emphasis on maintenance and operation of farm power and machinery continued to dominate extension activities until 1946. The wartime slogan was "care, share, and repair." A tractor maintenance guide, Circular 574, "Relief from Tractor Troubles" by R. I. Shawl, became quite popular, as were clean moldboard plowing demonstrations for corn-borer control.

After the war the extension faculty was increased to four, and in 1948 a fifth member was added to the team. A. Richard Ayers, appointed as the first full-time machinery extension specialist in 1948, devoted much of his time to county meetings and covered topics such as fuel and lubricant selection and tractor maintenance. The importance of tractor care and maintenance was also indicated by interest in the 4-H Tractor Program. Statewide 4-H leader clinics were started in 1944 on the campus by Hay and Shawl. Later, these clinics were carried as area meetings at locations throughout the state first by Ayers and then by Wendell Bowers. Financial support for the yearly leader clinics, originally supplied by the Standard Oil Company, was discontinued in 1964. At that time, new literature on 4-H Tractor Programs, prepared by Bowers, was released for use on a national basis.

One outgrowth of the 4-H Tractor Program was a tractor operator's contest that emphasized skill and safety. The first state-wide contest with twelve contestants was held at Springfield in 1950 as part of the Illinois State Fair. The number of contestants grew to an average of nearly seventy in the early 1960s. The first multi-state event, which included six Midwestern states, was held at the *Prairie Farmer's* Farm

Progress Show in Armstrong, Illinois, in 1953. The contest was discontinued briefly, then started again in 1957 on a larger scale. Illinois contestants won regional events involving all states west of the Mississippi in 1957 and 1963.

Another program of great importance, "the care and adjustment of sprayers," began in the late 1940s. Chemical weed and insect control became a reality, and programs were developed to provide information to farmers through news releases and county meetings. Further emphasis on chemical weed and insect control was given by the inauguration of a training school for custom spray operators. The program was started in 1949 as a combined college event with Ayers; H. B. "Pete" Petty, agricultural entomologist; and Walter O. Scott, of the agronomy department. This event continues as a college function and attracts six hundred to eight hundred persons a year.

The European corn-borer became a menace about 1948 and created a need for emphasis on clean-plowing to accompany chemical control. Again Ayers cooperated with Petty to present many clean-plowing demonstrations.

In the early 1950s researchers tried minimum tillage, a revolutionary new approach to growing corn. One of the first researchers of this idea was Paul Bateman who tested some basic tillage systems on the Agricultural Engineering Research Field starting in 1951. Using eight field trial sites throughout the state, Samuel R. Aldrich, an extension agronomist on sabbatical leave from Cornell University in 1956, worked with Bowers and Bateman to demonstrate the potential of minimum tillage to Illinois farmers. A full-scale extension program on minimum tillage was then carried out from 1959 through 1963. Educational materials developed for this cooperative project involving the Department of Agronomy were films, slide sets, and circulars that were mass-produced and used by farm advisers, vocational agriculture teachers, and others.

Ayers was called to military service in 1951, so Wendell Bowers conducted the extension programs in power and machinery. Major activities were the annual 4-H Tractor Maintenance Leaders' Training Program, an annual corn picking contest, spray schools, farm machinery and tractor maintenance, and safety. Regular activities included plow adjustment, plowing contests, and combine adjustment. Circular 697, "Corn Picker Operation to Save Corn and Hands," written by H. P. Bateman, G. E. Pickard, and Wendell Bowers, was published in 1952. Bowers wrote Circular 755, "Six Steps in Adjusting Moldboard Plows," in 1956. In 1957 it was clear that minimum tillage was to become a major program for extension and teaching material was developed. Also J. A. Weber wrote a fact sheet on "Use of the PTO Shop Dynamometer" for use by machinery dealers.

By 1957 John C. Siemens began helping with the power and machinery extension programs on a part-time basis while still a graduate student. He worked in extension until 1963, when he joined the agricultural engineering faculty at Cornell University.

Charles A. Snavely replaced Harold Kreig as executive secretary of the Illinois Retail Farm Equipment Association in 1953 and immediately cemented a long-lasting relationship with the department. The two most significant developments that grew out of that relationship were the inauguration of an advisory committee by the association to work with the extension farm machinery specialist and an annual field day for implement dealers. The first field day was held in 1954, and the annual event continued until 1969. It regularly attracted more than 150 of the leading farm equipment dealers in Illinois.

In 1959 major extension programs in power and machinery were minimum tillage and band spraying of pesticides. Research had established that corn could be grown in a rough seedbed without reducing yields, and corn planting could be done directly in freshly plowed ground. By 1960 Vernon Veatch, a cooperator from Roberts, had developed a five-bottom plow with a two-row planter attached. Power was provided by two three-bottom tractors in tandem which were used to make more power available to a single operator.

Illinois farmers received their first exposure to farm machinery management and record keeping in the fall of 1961 with a limited number of exploratory meetings conducted by Wendell Bowers. On the basis of these trial meetings, all-day training sessions were developed and conducted in cooperation with the agricultural economics department and their farm and family business clinics in 1962, 1963, and 1964.

The increased demands by farmers for technical information on machines and tractors became more obvious in the early 1960s. Several short courses were developed by interdepartmental extension teams. In crop production and protection clinics, beef schools, and swine schools farmers received as much as ten hours of instruction. The department also cooperated with the officials of many large state and national contests and field day events. Wendell Bowers and C. L. Hill, extension specialist in farm power and machinery at Purdue University, worked as a team in 1952 to develop rules for state and national corn picking contests. The national corn picking contest was held near Bloomington in 1953 and at Rockford in 1960. The national plowing contest was originally sponsored by the National Association of Soil Conservation Districts and later by the Plowman Association. The national plowing contest was held in Illinois in 1954 and again in 1963, with the department playing an important role in organizing and assisting with the judging and scoring of both contests.

Wendell Bowers resigned in 1967, and Peter D. Bloome, serving as an area agricultural engineer in Dixon, conducted the 4-H Tractor Program. John Siemens returned from Cornell University in 1968 and began working on programs dealing with pesticide application equipment and tillage systems for corn and soybean production. Ten one-day clinics were held for many years for pesticide dealers and applicators.

In 1970-71 Siemens took a year's leave of absence to work with Deere and Company and began the development of a computerized farm machinery selection program. A paper by B. Jack Butler and Siemens was presented at the twenty-fourth annual custom spray school on "Incorporation of Surface-Applied Pesticides."

Major power and machinery extension activities in the 1970s included programs on machinery management; maintenance and calibration of sprayers at county crop protection days; and clinics for pesticide dealers and applicators. These clinics had attendance of over two thousand individuals. Siemens and William R. Oschwald of the agronomy department took on a major tillage research project sponsored by Deere and Company. Results from that project were used at many agronomy field days, county crop production meetings, and other extension events.

The energy crisis and its potential effects on Illinois agriculture was given top priority in 1973. Siemens prepared five articles on energy crisis concerns that were published in *Prairie Farmer* magazine.

The 1972 Federal Environmental Pesticide Control Act required all users of restricted-use pesticides to be certified as competent by a regulatory agency, and the Cooperative Extension Service was assigned the responsibility of training those desiring to become certified. At the time there were 123,000 private applicators in Illinois, with 20,000 to 40,000 requiring training to become certified to apply restricted-use pesticides. Loren E. Bode was hired in 1973 to provide leadership for the agricultural engineering portion of the training. Bode worked with an interdisciplinary team to develop the training program. The educational program included the annual custom spray clinics for pesticide dealers and applicators, clinics for urban pesticide dealers and applicators, county and multi-county agronomy days and crop protection meetings, and the *Insect, Weed, and Plant Disease Bulletin*. By 1977 more than six thousand commercial pesticide applicators and operators and more than thirty-eight thousand private applicators were being trained annually at twenty-four clinics.

During the 1980s, extension programs in power and machinery were conducted by Siemens, Bode, and Stephen Pearson. Siemens led programs related to conservation tillage for corn and soybean production and machinery management while Bode and Pearson were responsible for the programs on pesticide application equipment. Pearson covered equipment operation at the one-day training sessions held before the Illinois Department of Agriculture administered a test for licensing applicators. About 1988, Robert Wolf was hired as the pesticide applicator training specialist to coordinate this training. Included on the training team were specialists in agronomy, plant pathology, horticulture, entomology, and agricultural engineering. The sessions changed format to a two-day event that ended with the Illinois Department of Agriculture test for certification. In 1992 the presentation changed from the use of slides and overheads to on-screen computer presentations that added animation, color and other associated new technologies to improve the teaching process.

Although the concept of conservation tillage was not new to Illinois farmers, adoption was slow. By the early 1980s it was estimated that at least 90 percent of the 9.5 million acres of soybean stubble and 50 percent of the 11 million acres of corn were no longer moldboard-plowed. Chisel plowing and disk harrowing had become more common. However, in the spring, three secondary tillage operations were still commonly used. The first was to level the soil, followed by two tillage operations to incorporate herbicide. It was not until the 1990s that the practice of no-tillage was fully adopted by many Illinois farmers. The no-tillage practice increased to about 30 percent of the acreage planted to soybeans and about 15 percent of the acreage planted to corn. These changes in farming practices provided an impetus for Siemens, with help from several graduate students, to rewrite the "Farm Machinery Selection and Management Program" that he had developed earlier.

Soil and Water Conservation Programs

Climatically, the state of Illinois is located where rain often falls in excess of the ability of the soil to absorb it. Originally, large areas of the state were flooded river-bottom lands, swamp, or marsh. Drainage systems had to be installed to convert these areas to productive agricultural land. Once plowing of the soil began erosion started on the slopes. This erosion subsequently silted the drains, thereby recreating flooding conditions. That cycle pointed to the need for joint erosion control and drainage developments.

From 1920 to 1930, demonstrations on farms were used to show the effect of drainage and erosion control. Extension's emphasis was on developing drain and terrace spacing and layout criteria. Guidelines were developed and applied to both demonstration-fields and land in general.

During the 1930s classes on applying soil erosion control practices using surveying levels were started by county farm leaders and extension advisers. Demonstration terraces were constructed with farmer- or township-owned equipment, including plows, scrapers, drags, and special terracing machines. Waterway construction was necessary to make the terrace systems successful and gully shaping and contour cropping were recommended where terraces could not be constructed.

During the depression years, federal agency and state extension staffs cooperated in the construction of soil conservation structures on farms where farmers could not afford to do so. Civilian Conservation Corps (CCC) camps were started in 1934 and cooperation between state staffs and the new federal agency expanded. This entailed a great deal of coordination. The Vocational Agriculture Service of the College of Agriculture was initiated and leader training in erosion control work was carried out with vocational agriculture teachers. Soil conservation districts were formed and leader training was carried out to develop district leaders and supervisors. All of these educational programs enhanced the camps' programs by providing more local interest in demonstration and construction activities.

A committee of extension specialists from the Departments of Agronomy, Animal Husbandry, Agricultural Economics, and Agricultural Engineering within the college was appointed to provide an integrated approach to soil erosion management. This committee worked with the U.S. Soil Conservation Service, the Vo-Ag Service, local soil conservation districts, and county extension councils to foster erosion control programs. World War II curtailed most construction activities due to shortage of equipment, personnel, and fuel. The aggressive programs of the previous decade were reduced to maintenance programs but local soil conservation districts continued to form and ultimately they covered the state.

Soil erosion control activities of the 1940s required an involvement of agricultural drainage and the interpretation of the Illinois drainage law, which to that time had consisted of a statement of philosophy and a series of court opinions. A state-wide interdisciplinary committee was formed to provide a drainage code acceptable to the state legislature, the state courts, landowners, drainage district commissioners, engineers, attorneys and the public.

At the close of the war Benjamin F. Muirheid was added to the staff. Immediately he conducted tests of drain tile quality the results of which were emphasized to both manufacturers and installers. Design aids were developed to increase technical knowledge and competence of field personnel in conservation. District and area meetings were adopted to reach wider audiences. Air tours were used to stimulate 4-Hers' interest in conservation and a program was developed for teaching practical surveying to 4-Hers in conservation camps. Muirheid also designed and supervised construction of the dams for the lakes in the State 4-H Camp located at Allerton Park near Monticello. The camp added new educational opportunities to develop future leaders.

The formation of conservation districts throughout the state was completed during the 1950s and resulted in the development of a grassroots level of education offered by conservation district personnel. This permitted extension specialists to devote more time to interagency cooperation. Subsequently, enhanced cooperative programs were developed with user-contractor groups such as the Illinois Well Drillers Association, the Illinois Septic Tank Contractors Association, and the Illinois Land Improvement Contractors Association.

During the mid-1950s Ben Muirheid, with the cooperation of Illinois Soil and Water Conservation District, SCS staff and land-leveling and small earthmoving equipment manufacturers, developed educational materials and held on-farm demonstrations on the construction of surface drainage systems. The demonstrations started in the slowly permeable soils area of northeastern Illinois but soon spread to the clay-pan soils of southern Illinois. Interest in surface drainage and questions on the best depth and spacing for subsurface drains led to the development of the *Illinois Drainage Guide*. The guide was a cooperative effort of many specialists who brought together, in a comprehensive way, soils, crops, and engineering data to provide specific recommendations for draining individual soils mapped in Illinois.

Below-average rainfall in Illinois in the early and mid-1950s and the availability of light-weight aluminum pipe sparked farmer interest in sprinkler irrigation, especially in sandy-soil areas such as Mason, Whiteside, and Kankakee counties. Mason County, with its ample water supply at a shallow depth, was soon known as the county with more kinds of irrigation systems than any other county in the Midwest. Questions concerning irrigation system design led to another cooperative effort that brought together soils, crops, economic, and engineering data for the development of the *Illinois Irrigation Guide* in a format similar to the drainage guide. These two guides soon became the models for the development of such documents throughout the Midwest and still serve as basic extension resource material for educational programs.

Ralph Hay, who had been involved in almost all of the soil and water extension activities from 1934 to 1962, except for a two-year assignment in India, helped form the Illinois Land Improvement Contractors Association (ILICA). Early on he recognized that land improvement contractors had a vested interest in properly installing conservation practices and that they were receptive to educational efforts of the soil and water extension staff. One of the benefits of the cooperative relationship was that the contractors frequently came forward with ideas for new construction techniques and new design criteria. Although some of their ideas resulted in practices that were not successful, others resulted in innovative changes that improved conservation practices and made them more appealing to farmers.

One example was the idea of constructing several small dams, each with a pipe outlet, in fields instead of installing traditional terraces. Even when carefully constructed, terraces had frequently been a headache for farmers because they often resulted in many point rows that were difficult to farm especially with multi-row equipment that began to become standard in the 1960s. To many farmers, anything that would conserve soil and not involve point rows was attractive. New approaches generated much productive discussion among farmers, conservationists, contractors, and extension and soil conservation service personnel. These groups from Illinois and other states were among the first to assess what would provide more acceptable conservation practices. In the end, the idea of parallel tile outlet (PTO) terraces, an old concept, was revived and improved upon to combine the effectiveness of terraces with farmability by multi-row equipment and drainage of low areas in a field. Today PTO terraces are a standard erosion control practice, an example of contractors' ideas that contributed to better, more effective, soil conservation practices.

Before the 1960s, clay and concrete were the primary materials used for subsurface agricultural drains. In 1962 extruded corrugated plastic drain tubing (CPT) was introduced in California from Europe. Soon after, CPT began to be used in Illinois. Seeing the potential for this new material, Carroll Drablos, with the help of Paul Walker, developed methods for evaluating the performance of plastic drain tubing in place. In the mid-1960s Drablos succeeded Hay as educational adviser of the ILICA and in cooperation with engineers from the Soil Conservation Service began conducting workshops for drainage contractors on proper installation practices for CPT. Those workshops continued through 1996 under the leadership of Michael Hirschi, who became the extension soil and water engineer following the retirement of Drablos in 1990.

The practice of using subsurface drainage systems to control the water table and effectively sub-irrigate the soil was introduced many years ago, but the use of plastic tubing and plastic structures for water table control made the concept of sub-irrigation more appealing in the 1970s and 1980s. Drablos organized short courses on sub-irrigation and brought together those with practical experience and research knowledge on the subject. During all of these activities the ILICA served as an effective sounding board.

Wholesale changes in animal waste management systems in the 1970s resulted in the need to control the runoff from such systems and manage the application of manure to land in such a way as to minimize air and water pollution. Dale H. Vanderholm joined the soil and water extension staff in 1973 to lead the educational effort in this area and continued until 1983. Vanderholm, with assistance from Elbert Dickey, constructed demonstrations of grass filter strips used to treat runoff from feedlot areas to acceptable standards of quality for Illinois streams. Vanderholm and Muehling, along with engineers from the Illinois Environmental Protection Agency and the Soil Conservation Service, developed extensive educational materials and conducted many large-scale meetings with farmers in Illinois who were involved with all aspects of land application of animal wastes. These efforts were supported by a number of different governmental agencies and industry groups, all interested in meeting new regulations for higher-quality water in Illinois streams.

Vanderholm, with the support of the Illinois Environmental Protection Agency and the Department of Public Health, also addressed the problem of inadequate domestic waste treatment in rural areas of Illinois. Plentiful water supplies became available in many rural areas, and community water systems replaced old, inadequate farm wells. The availability of a plentiful supply of water accentuated the problem of polluted water coming to the surface of the ground near septic tank drainage fields. Vanderholm, along with David Ralph, developed a sand filter system that could be used in rural areas to treat domestic sewage economically so the effluent would be of a quality acceptable to streams. They constructed several demonstrations with such filter systems and conducted workshops to familiarize homeowners and developers with the technology.

Interest and expertise in water quality grew in the department and major projects were begun with multiple sources of funding, of which the Little Vermilion River Project was one. Hirschi became water quality project coordinator in 1992 and coordinated the department's activities, which included both outreach and monitoring. The Vermilion River Project, led by researcher J. Kent Mitchell, grew to a $1.25 million project.

As Hirschi took on more teaching duties, Mitchell began to assume extension activities, especially those involved with the Illinois Land Improvement Contractors. In 1997 the ILICA will assist with the construction of ponds for the University's arboretum with Mitchell serving a major role coordinating, planning, and constructing them. In addition, Ellyn Bromberg, extension administrative staff, began working with Hirschi on coordinating educational programs on water quality and health risks.

Farm Structures Programs

There were no full-time extension farm buildings specialists in the 1920s and 1930s. A farm buildings plan service was available in the 1920s, however, and with the start of the Midwest Plan Service in the early 1930s the plan service grew to be—and continues — as an important phase of farm buildings extension work. Plans for many of the structures were developed from designs originating at the University of Illinois.

Depression and drought affected programs in the 1930s. Trench silos and other temporary forms of silage storage were promoted to salvage drought- and grasshopper-damaged crops. Few new farm buildings were erected because of the financial depression.

By the early 1940s, just as it appeared that a program in rural housing and farm buildings would be in demand, World War II delayed long-needed improvements on farms. Portable buildings for poultry and swine were being recommended.

After World War II, extension programs placed emphasis on family housing, partly due to the interests and talent of those on the staff and partly due to the demand of farm people to improve their living conditions after a long period of financial and wartime restrictions. The Federal Housing Act of 1949 also contributed to the emphasis on improved family housing.

The first full-time farm buildings extension specialist Jimmie C. Andros was employed in 1948, and from then until 1956 the position was filled by four different individuals. Even with the discontinuity of personnel, the extension program showed continuity in recommendations for clear-span roofs, loose housing for dairy herds, and farmstead reorganization to permit labor-saving building arrangements and mechanized choreing. Arthur J. Muehling of the teaching faculty and Leo Fryman of the dairy science department authored the firs circular on "free-stall dairy housing." Considerable demand for information on dairy and beef housing continued through 1956. In the late 1950s and early 1960s demands for information on beef housing and grain storage continued, requests for information on dairy housing declined, and requests on confinement swine housing increased.

Sound construction and good farmstead planning underlaid the continuing extension program in farm buildings regardless of the emphasis on a particular livestock enterprise. A great deal of work was done on the remodeling of existing farm buildings with poultry buildings being converted to swine buildings, and ear-corn cribs being converted to hold shelled corn. Clear-span construction was emphasized and just adding a shed to the side of an old building was discouraged. The slogan among the staff became: "Build from a plan; build clear-span; sheds be damned."

The structures division underwent much change in 1956. On January 1, Donald G. Jedele joined the structures faculty as extension agricultural engineer. Less than a month later, Arthur J. Muehling began his career on the staff as a researcher and teacher. Deane G. Carter left the department to lead the University's international programs, and Edwin L. Hansen replaced him as division leader in the department. Curtis and Hinchcliff remained on the staff, but Hinchcliff devoted full time to family housing while the rest of the staff specialized in farm structures. This five-person team was together for four years until Hinchcliff died in 1960. After his death family housing continued as a major part of the extension program under the leadership of Jedele.

Conferences • After the nationwide depression of the thirties and the shortages during World War II, there was a great need for farmers to upgrade their farm buildings. Farm buildings were either built by the farmers themselves or by carpenters who bought their materials from a local lumber yard. Recognizing this Deane G. Carter forged a relationship between the department and the Illinois Lumber and Material Dealers Association (ILMDA) to sponsor conferences to inform lumber dealers and builders about research results and other developments in farm buildings and rural housing.

The first conference was a three-day event in December 1944 and subsequent conferences were held annually except in 1953. They were

called Lumber Dealers Farm Structures Short Course and the entire structures staff helped with the programs. In 1954 the event was changed to a one-day program called Farm Structures Day with Joe Clayton in charge, assisted by Frank Andrew.

In the fall of 1956 Jedele took over the leadership of the program and in 1973 the first Livestock Waste Management Conference was held in lieu of the Farm Structures Day. Since that time the two conferences have alternated years.

As farm building practices changed, there were fewer farmer and carpenter-built structures and more package or pole-buildings. The lumber dealers were less involved. The ILMDA was the only cooperator with the department until 1978. The National Frame Builders Association (NFBA) joined the effort in 1980.

As the ILMDA dropped out in 1988, the Illinois Department of Energy and Natural Resources became a co-sponsor with NFBA. The name of the conference was changed in 1988 to Light-Frame Buildings Conference to reflect a broader scope than farm buildings.

After Jedele retired in 1988, Muehling organized both building and waste management conferences until he retired in 1992. Ted Funk, area engineer, was employed as a state specialist in 1995 and took over the management of the conferences. These two conferences represent the longest running extension education activity in the department. The 1996 Light-Frame Builders Conference was the 39th dating back to 1944.

Clear-Span Construction • One of Jedele's first extension initiatives was to teach farmers the advantages of having post-free interiors in their buildings. He also taught and demonstrated how to build trusses and how to lift them into place. Even before Jedele arrived, Joe Clayton had a truss-raising demonstration at a Farm Progress Show near Belvidere in 1955.

The common method for attaining adequate strength in the connections in trusses in the 1950s and early 1960s was to use plywood gusset plates, glue and nails, or TECO split-ring timber connectors that required a special drill bit that was expensive for individual farmers who were still their own builders to purchase for building just a few trusses.

The Midwest Plan Service published books of truss designs for glued, split-ring, and nailed trusses in 1965. Jedele and J. O. Curtis were on the regional committee to develop those designs. Clear-span construction did not become popular until a commercial company developed the first steel-plate connectors that were pressed into the wood. That type of connector is now the standard. It is believed that the early educational programs and design standards developed by extension structures and environment agricultural engineers created farmers' acceptance of clear-span principles.

Confinement Swine Housing • Before 1955, most pigs were raised on pasture. It was assumed that pigs got a part of their nutrients by rooting in the soil. Animal scientists in the 1950s developed complete rations for swine that included all vitamins and minerals which made confining swine to buildings possible. This meant that many more pigs could be raised on smaller acreages.

In late 1955 Jedele designed a farrowing house and a finishing building that were published in *Successful Farming Magazine* with an article by Damon Catron, an Iowa State College animal scientist, that described what Catron called "the life-cycle nutrition program for pigs." The article is considered by some as the beginning of confinement housing. Although there were central farrowing houses before that and some outside concrete lots for finishing, the 1955 article put a system together in a program of nutrition and housing.

Even though that first article was written by Iowa State College faculty members, Jedele moved to Illinois in January 1956, and soon Illinois swine producers led the way in developing confinement swine housing systems. Jedele, and later Muehling, helped farmers with the engineering of early slotted floors, ventilation systems, insulation of buildings, and selection of building materials.

Livestock Waste Management • In 1958 Jedele gave what is thought to be the first ASAE paper on liquid manure handling for swine. It was based on what Illinois producers were already doing, not research. The paper called for a research program and such a program did develop. Waste management research at Illinois led by Donald L. Day was an outgrowth of the need of swine producers. The Department of Agricultural Engineering became a leader in all of the developments in confinement housing, although many other states had parallel research programs.

Muehling changed from research and teaching to extension in 1961. While in his research position he visited the first "swine lagoon" in

Sangamon County in 1958 and began helping operators with design and management practices. With the development of slotted floors, he simultaneously began working with swine producers to use liquid manure safely. Realizing the importance of providing the latest information to Illinois producers, Muehling's extension programs dealing with livestock housing added the latest developments in waste management. He developed a series of ten highly regarded and well-attended Illinois Livestock Waste Conferences, first held in 1972.

Recognized as an authority in Illinois, Muehling was asked by the State of Illinois to be an adviser to the Illinois Environmental Protection Agency and the Illinois Institute for Environmental Quality in drafting proposed Illinois livestock waste regulations to be considered by the Illinois Pollution Control Board in 1978. Between 1978 and his retirement in 1992 he testified at numerous hearings as regulations were modified.

Muehling is perhaps the best known swine systems agricultural engineer in the world through his many international activities. In 1966 he made his first study tour to Europe with a group of Midwestern pork producers visiting farms and research institutes in England, Germany, Norway, Denmark, and Sweden. During a sabbatical leave in 1969-70 he studied different types of slotted flooring for farrowing in Germany, Czechoslovakia, and Hungary. Since then, he has organized and lead three different swine-producer study tours to the Netherlands, Germany, Russia, Austria, Sweden, Finland, Norway, Poland, Denmark, China, and Hong Kong.

In 1982 he was the only agricultural engineer to serve on a team that developed a swine repopulation plan for Haiti after the swine there were killed to eradicate an infection of African swine fever. In 1991 he lead a MUCIA project in the Dominican Republic to study conditions and make recommendations to solve livestock waste management problems.

Farm Housing • Illinois took the lead in a study to evaluate the potential for farm housing research in the North Central Region. The circular that resulted was entitled "Development of Cooperative Farm Housing Research in the North Central Region." Extensive regional research began about 1950, and the result was the 1952 Flexi-Plan Series prepared by Robert C. Cohlmeyer and Merlin R. Hodgell under the direction of Keith Hinchcliff. The flexi-plan procedure offered six to thirteen variations for each of three basic farmhouse designs. To illustrate the new designs, an extension circular was published and released as a North Central Region publication.

After Hinchcliff's death in 1960 the Department of Home Economics appointed Glenda Pifer as housing specialist and Jedele cooperated with her on engineering aspects of housing. Pifer left in 1971 and the School of Human Resources and Family Studies reduced their emphasis on housing. Jedele contracted with the Illinois Department of Energy and Natural Resources to conduct residential energy conservation education programs from 1978 to 1985.

By 1985 extension budgets were in decline, so when Jedele retired in 1988 he was not replaced. The family housing component of extension essentially ended and Muehling handled all of the farm structures extension work. When Muehling retired in 1992 he was not replaced. Structures extension was handled by four area extension engineers with Ted Funk of the Effingham office spending part time in Urbana to coordinate statewide activities. The research staff supported the extension program ably by answering mail and telephone questions from farmers. Not until Peterson retired in 1995 as extension agricultural engineer from the food and bioprocess engineering division did the college administration allow the department to fill an extension position. Funk then became a state extension specialist full-time in Urbana. His current work is primarily in the structures and environment division.

Farm Electrification Programs

In the early 1930s the program in rural electrification was practically nonexistent. There were only a few farm customers in the Public Service Company area of northern Illinois. Considerable interest, however, was shown by many people in generating some electricity by means of a small, engine-driven generator. But an engine that would burn kerosene and drive a generator to make electricity for light was about the extent of rural electrification during the depression years of the early 1930s although some manufacturers and many ingenious individuals tried to build wind-driven units that would charge batteries at no cost for power. However, distribution lines from central station service had been built experimentally in 1924 and kilowatt-hour consumption for several farm jobs, such as pumping water, incubating eggs, and grinding feed, had been determined.

The establishment of the federal Rural Electrification Administration (REA) made low-cost loans available for utilities and for cooperatives to build electric lines in rural communities. Much of the effort of the first full-time extension specialist from 1936 to 1941 was spent with local groups working out the problems of how to organize themselves to make use of this new federal program. In addition questions of cost, how to use electricity, and the hazards of fire and shock were answered at every turn by lectures, tours, and demonstrations.

In the late 1930s the extension specialist often cooperated with the "electric fair" or "electric circus," an event sponsored nationally as a tour that stopped at several places in Illinois. The extension specialist furnished demonstration materials and lectures that applied particularly to Illinois conditions. He also arranged for participation by local farmers who had developed good equipment and procedures for using their new electric power. During the early 1940s and the beginning of World War II, labor-saving shows were conducted in many counties. Great interest and ingenuity was shown by farmers who made their own equipment to solve equipment shortage problems.

Ralph Parks held the extension specialist position during World War II but during a portion of that period was in the military. Upon his return the extension program emphasized safety, hay-drying, and water systems. Water system and septic tank demonstrations were held in practically every county in the state in cooperation with Claude Kincaid, the field engineer with the Portland Cement Association. The meetings demonstrated that electricity could raise the standard of living in homes by making running water and other conveniences possible. At the same time, water under pressure could boost livestock production and output more than enough to pay for the investment in equipment.

During the 1950s extension programs for mechanical feeding and grain drying applications were developed and the Illinois Farm Electrification Council (IFEC) was organized. The financial and manpower support provided by the utilities and cooperatives was the backbone of the extension service's program in the then-new 4-H Electric Project. In 1960 Harold H. Beaty became the executive secretary of the IFEC as part of his duties as a faculty member. He held that position until he retired. Subsequently the position has been held by Elwood F. Olver and Paul W. Benson.

In cooperation with the IFEC the first of five workshops on electric controls for materials handling systems was held in 1959. The conference became the Materials Handling and Grain Drying Workshop in 1965 with emphasis on grain drying systems and their integration into materials handling systems for farmsteads. In 1967 the workshop became the Grain Conditioning Conference and was held nearly ever year thereafter through 1996. Program emphasis was placed on grain drying procedures, storage practices, quality characteristics, and processing methods.

The 1959 workshop was planned to acquaint power-use advisers with the basic function of control elements and how they are used to produce an automatic electric power controller. That workshop proved that it can be disastrous to try to teach simple principles with too many different types of equipment at hand. Too much time was spent looking at equipment and too little learning principles. However, out of that conference, cooperation developed between the Vocational Agriculture Service and IFEC to supply vocational agriculture teachers with control kits for use in their classrooms. Another outcome of that conference was the development of "Controls for Farmstead Automation," a laboratory manual written by Beaty, Herum, Olver, Peart, and Puckett.

Farm and Home Safety Programs

The department's extension programs have always emphasized safety as a component of the subject matter. Lehmann was an ardent supporter of farm and home safety and devoted many years of service to the National Farm Safety Council. Lehmann advocated the appointment of a full-time safety specialist in the department but his desires were never fulfilled. From about 1956 until 1984 the safety specialist for the Extension Service was at the college level. However, when the safety specialist for the college Ordie Hogsett retired the position was transferred to the department. Robert E. Aherin was employed even while he was still working on his Ph.D. at the University of Minnesota. He completed his degree and became an assistant professor with a full-time appointment in extension education. Aherin brought new approaches to farm safety. He designed his program based on his research in behavior modification to bring about change in unsafe behaviors. For example, his research had shown that a farmer's children and spouse were the most influential in modifying his behavior; thus, unsafe farmer behavior was best approached by convincing the children and spouse of the need for change.

Aherin launched a farm accident reporting system to obtain a clearer picture of farm accidents. A survey instrument was sent to farmers selected through a stratification process that included geographic location and farm size and type. The results identified demographic characteristics of those involved in farm accidents, including an in-depth analysis of tractor accidents.

Aherin received a grant from the Kellogg Foundation in 1991 to develop a model program for community empowerment to deal with agricultural health and safety issues. Robert E. (Chip) Petrea joined him as an academic professional to assist in the safety program. In the model community empowerment plan, a major medical center was identified as the regional project sponsor, and state and private agencies with interests in agricultural safety and health were enlisted to join the coalition. Two regional coalitions were functioning by 1995.

Aherin and Petrea also initiated a disabled farmers program. The objective was to develop a model program for providing comprehensive assistance to meet the needs of those who are disabled and want to farm.

Energy Programs

In the late 1970s and early 1980s, as a result of the Arab oil boycott, gasoline shortages, and long lines at gasoline service stations, there was a considerable increase in interest in energy conservation. Extension engineers began conducting programs that were funded through contracts with the state energy office, a part of the Illinois Department of Energy and Natural Resources. These contracts provided funds for salaries, travel expenses, local meetings, and the publication of literature. Thirty to fifty educational meetings were conducted each year throughout the state. The two main thrusts of these meetings were home energy conservation, under the direction of Don Jedele, and farm energy conservation, under the direction of Bill Peterson.

Suella Hill, a home economist, was employed for five years to work in the home energy conservation area, and David Morrison and Jon Carson, both agricultural engineers, were hired to assist with agricultural conservation programs.

One project consisted of selecting several Illinois homeowners witl whom to work intensively to demonstrate the results of adding energy conservation features to their operations and keeping records o energy use. In addition, twenty-one counties were designated as pilo counties and selected advisers were designated as energy advisers tc receive special training and conduct energy programs in those pilo counties. Among the topics covered in the programs were window construction and treatments and labeling of energy efficiency of home appliances.

The USDA also became interested in funding on-farm demonstration projects. One project involved ten farms that were modifiec to use solar energy for heating livestock shelters. This program was conducted by Chris Rahn and coordinated by Art Muehling.

Another USDA demonstration project was devoted to the use of solar energy for drying crops. Bill Peterson coordinated that project. With the help of David Morrison seven farms were used as models. Illinois was also one of nine states successful in securing funding in a competitive proposal process. As a result farmers were assisted financially for about half the cost of adding solar features to their systems. Funding for those projects began in 1987 and continued for nearly five years. Then interest in energy as a topic for an entire meeting program began to wane, funds for home energy education were reduced, and changes were made to integrate farm energy information into more ongoing educational programs such as crop-drying and tillage. The name of the state energy office was changed to the Office of Energy and Recycling in the Department of Commerce and Community Affairs. Funding for energy information programs as part of the ongoing extension education program continues.

State Extension Staff

Faculty Responsible for All Subject Matter Programs (1922-35)

Frank P. Hanson, 1922-26; Israel P. Blauser, 1926-27; Glenn F. Hoover, 1927-28; Earl G. Johnson, 1929-34; and Ralph C. Hay, 1934-35.

Soil and Water and Power and Machinery (1936-45)

Ralph. C. Hay, 1934-45; and A. Stephen Paydon, 1941-42 (machinery)

Rural Electrification and Farm Structures (1936-45)

Ralph R. Parks, 1936-46 (military 1941-45); and Keith H. Hinchcliff, 1944-45.

Electric Power and Processing (1946-96)

Frank W. Andrew, 1946-72; Russell E. Heston,* 1957-59; Floyd L. Herum,* 1958-63; Harold H. Beaty,* 1959-70; Harvey J. Hirning, 1972-75; Jerry L. Baker, 1976-77; Sherwood S. DeForest, 1977-78; William H. Peterson, 1978-95; Paul W. Benson,* 1980-present; and Peter D. Bloome, 1995-present.

Farm Structures (1946-96)

Keith H. Hinchcliff, 1944-60 (on leave 1954-55); Jimmie C. Andros, 1948-50; Joe T. Clayton, 1951-53, 1955; John C. Campbell, 1954-55; Donald G. Jedele, 1956-88; Ove W. Uggerby, 1959- 60; Edwin L. Hansen,* 1960-61; Arthur J. Muehling, 1961-93; and Ted L. Funk, 1995-present.

Power and Machinery (1948-96)

A. Richard Ayers, 1948-51; Wendell Bowers, 1951-67; Loren E. Bode, 1973-present; and John C. Siemens, 1957-63*, 1967-present.

Soil and Water Conservation (1934-96)

Ralph C. Hay, 1934-47, 1947-54,* 1964-72; Benjamin F. Muirheid, 1946-56; Benjamin A. Jones,* 1958-60; Peter A. Boving, 1961-65; Carroll J. W. Drablos, 1966-90; Dale H. Vanderholm, 1973-83; and Michael C. Hirschi, 1985-present

Farm and Home Safety

Robert A. Aherin, 1984-present.

Special Programs

Merlin R. Hodgell 1950-54, (Farmhouse Flexi-plan); James F. Gastel,* 1977 (Illinois Land Improvement Contractors); Christopher L. Rahn, 1979-83; David W. Morrison, 1979-85; and Jon M. Carson, 1981-85 (Energy Programs); Suella J. Hill, 1980-85 (Residential Energy Conservation); Stephen L. Pearson, 1979-88; and Robert E. Wolf, 1988-present (Pesticide Applicator Training).

*Part-time extension faculty.

Area Extension Specialists

The Cooperative Extension Service instituted area specialists in 1962. These individuals were not staff members of the Department of Agricultural Engineering, but the department was influential in getting acceptance of the criteria of requiring graduate agricultural engineers for the "engineering" positions. Marvin Hall, the first area engineer, was located in Macomb. Peter Bloome accepted a similar position in 1964 and was located in Dixon. When Bloome returned to campus in 1967 to pursue advanced degrees, Marvin Hall remained the only area engineer for many years. In 1980 three area engineers were hired, Ted Funk for the Effingham office, Warren Goetsch for Springfield, and Donald "Tad" Kerr for Dixon. Hall retired and Goetsch resigned in 1989 and Kerr left in 1991. In 1993 extension replaced the three area engineers with William P. Campbell in Springfield, Wayne P. Block in Moline, and Lester O. Pordesimo in DeKalb. Funk moved to Urbana as state extension specialist in 1995; Pordesimo and Block left the University in 1996.

Area Engineers • Marvin D. Hall, 1962-89; Peter D. Bloome, 1964-67; Warren Goetsch, 1980-89; Ted L. Funk, 1980-95; Donald "Tad" Kerr, 1980-91; Wayne P. Block, 1993-96; Lester O. Pordesimo, 1993-96; and William P. Campbell, 1993-present.

Looking Back

The following incidents, as recalled by Frank Andrew, represent efforts to improve the lives of farm families by taking information to them.

> As a summer employee, I ran horse-pulling demonstrations at fairs. E. V. Collins, professor of agricultural engineering at Iowa State College, designed and built a horse-pulling dynamometer which was on loan to us. A. L. Young checked me out on the use of it at Ashley, Illinois (Washington County Fair). E. T. Robbins of the animal science department set up the schedule for the fair circuit. Robbins drilled into me that contestants should drive with a tight line and should not abuse the horses. The sure winner at one contest let his line slip on the back of the team and I threw him out, much to his displeasure. There was also a woman spectator who came running out shaking her fist at me and yelling, "You SOB, you just lost me a lot of money." I was an

innocent country boy and didn't realize people were betting on the teams.

I helped Ralph Hay with tractor clinics during World War II. These included clean-plowing demonstrations which were quite a contrast to present trash farming and minimum tillage.

Hundreds of pig heat lamps were made by 4-H members as a 4-H electricity project using a one-gallon bucket as the shield.

Most of the agricultural engineering specialists had the experience of flying to extension events with me in my Ercoupe two-seat private plane. I used to shave with an electric shaver en route and often did dictation on an Ediphone and Voicewriter, which I powered through a converter from the plane's electrical system.

A reciprocating "electric engine" model made from a solenoid, a micro-switch and spool timer created lots of attention at exhibits.

I conducted sewing machine maintenance clinics with home economics advisers for groups of fifteen to twenty-five women. The principle taught was that the eye must be on the point of the needle.

Agricultural engineering extension specialists cooperated with other departments of the college on a legume-grass caravan in the late 1940s or early 1950s. Dick Ayers and I designed a fold-up display case from a 4' x 8' sheet of plywood. Ten of these were built for table-top displays.

Hoyle Puckett, USDA engineer, helped with many ideas on exhibits and models for pneumatic conveying, feed handling, and automatic feeding of livestock.

Agricultural Engineering Days were held in many counties, and the department usually took two station-wagons full of exhibits and five or six specialists. Two exhibits were called "Homer" and "Jethro." Keith Hinchcliff had designed and built "Homer" to feature some of his home designs, especially the Flexi-Plans, and "Jethro" was Frank Andrews' exhibit of cascading augers for moving grain and feed around the farmstead, an exhibit developed from a Puckett idea.

The first "Walkie-Talkie" communication was used by Wendell Bowers and me for transmitting scoring results at ear corn harvesting contests. Bowers and I also put on safety demonstrations. Bowers demonstrated hydrogen explosions with storage batteries and I put guppies in a petri dish and electrocuted them with a hot wire dipped into the water. The guppies were resuscitated by blowing oxygen into the water. The whole procedure was shown to an audience by setting the clear petri dish on an overhead projector.

In the late 1950s I was tired of talking about shelled corn drying at a time when only 5 percent of corn was harvested in the shelled form. I was advocating drying when all the department had was a design for a home-built batch dryer.

"Old Rube" was an animated exhibit to get attention for automatic feed preparation. It was a series of wooden gears that activated a mallet that came down on an ear of corn. There was a cutout of a cow's head with a moving tongue that reached for the ear of corn. Bill Schwiesow timed the descending mallet to just miss the cow's tongue. Kids and adults both loved this exhibit.

Another exhibit was a standpipe with several faucets to demonstrate the need for pipes and pumps of the correct size. This was used when farmers were just starting to install private water systems on farms. Along with water systems came the need for sewage disposal. Claude Kincaid of the Portland Cement Association and I demonstrated installation of septic tanks and tile effluent disposal fields on farms.

I took many aerial photos of farmsteads over the years and started using them for farmstead planning with Joe Clayton and continued with Don Jedele and Art Muehling. My slides were used at many meetings and several prints showed up in extension publications and farm magazines. I also gave air tours of conservation farms.

A dangerous practice was to use a tractor to pack grass silage in stacks and bunkers. Wendell Bowers and Ordie Hogsett put on several demonstrations of overturning tractors.

I often demonstrated the principle of split-phase electric motors with a tin can on an axle with copper wire wound around it to create a field. The can would rotate when the field winding was energized. I used this technique to play a joke on one of my colleagues who was teaching an agricultural engineering class on electric motors. I wrapped a cardboard oatmeal box with aluminum and hid the foil by replacing the paper label. I then put a couple of pencil marks across the box and told him that the pencil marks conducted enough electricity to make magnetism and cause the box to rotate like a tin can. He was impressed and showed it to his class, not realizing that it was the aluminum foil wrap that made it turn. I apologized to him for letting him get up before his class before I could explain that the pencil mark theory was a hoax.

Wendell Bowers and Don Hunt were into machinery management programs long before personal computers came along. It may even have been before computers or calculators of any kind. But many in the department remember punch cards and card-sorting machines under the stairwell in the old building.

From a different perspective some of the emeriti in the soil and water area made these observations primarily about extension.

> It is always risky to attempt to assess the impact of the contributions of a program over time because new knowledge and its application is built incrementally one small element after another. What appears to be insignificant at one time may be of greater significance at another. Further, the real reason for developing new knowledge is to help citizens solve real problems. Thus there must be a continuum from research to application if the work of the faculty is to benefit the state and federal taxpayers that support it. It is this continuum that we attempt to address remembering all the time that the intervening work makes a contribution to the next finding that has direct application.
>
> The first major impact in soil and water management was the application of broad-based terrace systems on sloping land throughout the state to assist in the control of erosion. The early studies, begun in 1922 by Lehmann, provided the design criteria and the practical knowledge for building the systems. Extension agricultural engineers, particularly Ralph Hay, over a period of years went into almost all counties in the state to organize demonstrations to show farmers how they could build terraces on their own land. In those days the highway system was in its infancy so many, many demonstrations had to be held near enough to farmers to get them to participate. These demonstrations took Hay into all parts of the state where he got to know almost all of the little towns. After joining the teaching faculty, he surprised the students each fall with his knowledge of the state by his ability to pinpoint their home towns on a map after they had introduced themselves at the first student meeting of the year. Students will remember Hay for his knowledge of the state while farmers and landowners will remember him for his hands-on demonstration of terrace systems many of which were still working to control erosion when land improvement contractors appeared on the scene after World War II and began rebuilding them to fit new and larger field machines.
>
> The next major impact occurred in the early and mid 1950s. After the subsurface drainage studies of Kidder and Lytle showed that it was not economical to subsurface drain the slowly permeable soils of the state, Ben Muirheid, in cooperation with local soil conservation districts, the U.S. Soil Conservation Service, and land leveling equipment manufacturers, developed and led surface drainage demonstrations. These demonstrations continued for a number of years in northeastern and southern Illinois and led to wide-scale adoption of

surface drainage. The demonstrations did for surface drainage what the terrace demonstrations did for erosion control. Today surface drainage is a common practice but it developed from an educational program led by the department.

The third major contribution took place in the 1950s also. This was the development of an irrigation guide and a drainage guide for system design in Illinois. These guides were extension initiatives that involved the expertise of research faculty from agricultural engineering, crops and soils, and specialists from the Soil Conservation Service and equipment manufacturers. The guides brought all of the pertinent information together into one source and led to common recommendations by all on what was needed in system design, a major consideration for farmers and landowners. Although Illinois was not the first state to release such documents, its guides, with major refinements on earlier ones, soon became the models for other states. These guides, in updated form, are still used today by the industries.

A pioneering step was taken by the department in the late 1940 when the decision was made to initiate rainfall-runoff studies on the Allerton Trust farms near Monticello. Watershed studies of that size in central Illinois had not been conducted prior to that time and the watersheds provided an opportunity that the department seized. In spite of all the challenges of managing data over a twenty-five year period, the data were useful to test many of the models developed in recent years.

A fifth major impact was the activities associated with the study of highway and agricultural drainage and engineering practices. These studies and the ensuing policy statement and highway manual opened a dialogue between highway authorities and the agricultural community that resulted in the development of cooperative relationships that enhanced the entire process of highway locations, design, and construction. In today's language, it became a win-win approach with many winners.

A sixth impact is one that started in the 1970s and continues today—the application of new knowledge to improve the quality of water in rural areas and to improve the design of production systems that reduce sediment movement. The development of design criteria for vegetative filters was a major step forward. Then all of the field, laboratory, and modeling studies that provided data and insight into the erosion process made a significant contribution to knowledge that led to the revision of the Universal Soil Loss Equation. The revised equation will have a major effect on the design of future production systems. Finally, the studies enhanced the scientific understanding of the nature of agricultural chemicals in surface waters.

One of the responsibilities of a Land-Grant university is to take education to the people so they get a direct return from the investment of their tax dollars. The knowledge generated by applying engineering to agriculture has been taken to the people by the extension staff and the teaching and research faculty and that knowledge has had a major impact on the development of agriculture in Illinois, the Midwest, and the nation.

4 | RESEARCH PROJECTS AND ACCOMPLISHMENTS

Research in agricultural engineering has contributed to many basic improvements in Illinois agriculture. The time and labor required to perform most farm operations have been reduced and improvements in the environment have enhanced family living. Engineering principles have been applied to a large number of farm processes to improve quality and increase efficiency of producing, harvesting, and handling farm products. Agricultural engineers have also found better ways to use and conserve our natural resources.

Research Before 1921

Three years after the University opened, the faculty recognized the need for research as shown by excerpts from the "Report of Committee on Experiments to Convention of Friends of Agricultural Education," presented on August 25, 1871, by W. C. Flagg, superintendent of experiments and secretary of the University's Board of Trustees. Flagg's report included the following references to agricultural engineering experiments needed:

Mechanical experiments.

1. In strength of materials.
2. In native powers.
3. In trials of agricultural and other industrial implements.

> Experiments in physics, especially in the effects of different degrees of light, heat, and electricity and moisture on vegetative life.
>
> Experiments with soils in their drainage, pulverization by different implements and their compaction; the variation of soils in adjoining plots, then continuous cropping without manure and others — irrigation.

Of the three specific experiments proposed for 1872, one was designed to compare the planting of corn in hills versus rows. Results of these comparisons were presented in detail in Board of Trustees reports the next two years. Reports of results of agricultural engineering research were not published elsewhere until agricultural experiment station bulletins were published beginning in 1888.

Results of an early research study conducted by C. O. Reed, an agricultural engineer, on corn planter metering accuracy were published in the 1911 volume of Transactions of the American Society of Agricultural Engineers (ASAE). Other studies relating to agricultural engineering conducted soon after that, as reported by the ASAE committee on research for 1913 and 1915, were listed as follows:

Machine Projects:

- C. O. Reed, "Accuracy of Drop in Corn Planters" (1913)
- O. Allyn, Agronomist, "Calibration of Seed Drills" (1915)
- A. N. Brunson, Agronomist, "Devices for Accurate Planting" (1915)
- R. W. Stark, Agronomist, "Influence of Different Types of Cultivators on Corn Yields" (1915)
- J. G. Mosier, Agronomist, "Cultivation as a Factor in Corn Production" (1915)

Tractor Projects:

- I. W. Dickerson, "Fuel Economy of Gasoline Engines" (1913)
- I. W. Dickerson, "Distribution of Farm Motors" (1915)
- G. E. McCuen, "Relative Economy of Gasoline and Kerosene as a Fuel for Internal Combustion Engines" (1915)

Research After 1921

Three research projects were initiated soon after the Department of Farm Mechanics was established in 1921. The purpose of the first project was to evaluate the performance of new machines that were being adapted to tractors. The goal of the second project was to evaluate methods for improving the efficiency of threshing machines. The third project was to find ways to improve the health of farm people through improved sewage disposal.

The general availability of tractors and electrical power on most farms made it possible to use machines that speeded operations and reduced labor. These new types of power became the major sources of power used on farms. By 1950 horse power had practically disappeared and tractor power had begun to increase rapidly. Since 1924 many investigations relating to farm tractors have contributed to the formulation of principles for tractor design, selection, maintenance, operation, and safety.

Electrical power has made possible the use of many machines to reduce labor in caring for farm livestock. From 1948 to 1965, studies were made to design and test suitable electrical controls, metering and blending devices, and conveyors for use in automatic feed-handling systems for livestock and poultry. These units blended rations uniformly and delivered them automatically at given periods. This new equipment, along with new building materials and construction methods, made it possible to design hog confinement systems that replaced pasture production systems. Environmental studies produced building design requirements for improving livestock gains, saving labor, and disposing of hog wastes more conveniently. Building size was increased to accommodate increased crop and livestock production from larger farm units, storages were redesigned to fit new harvesting methods, and livestock buildings were improved to permit more efficient production.

Optimal soil physical conditions for plant growth were studied in relation to drainage, erosion, water conservation, and tillage. Basic field and laboratory investigations to determine the principles of water movement in open channels, through the soil, and into tile made it possible to establish drainage specifications for soil types that provided proper aeration for crop growth. Other studies showed that irrigation can be profitable for some crops and locations in Illinois by maintaining optimum soil moisture during the growing season. Soil and water conservation practices were improved through study of various designs and methods of construction and maintenance of terraces and other erosion control structures and practices.

A soil bin was built to study tillage tools and soil interactions using basic soil mechanics theory. Laboratory equipment was also developed to determine energy-pulverization curves for various soil conditions. The tillage investigations showed the types of machines and methods of operation that created favorable soil conditions for plant growth. The new methods reduced production costs and also helped to conserve both soil and water. The improved tillage practices, larger machines, and improved seeds made it possible in 1964 to produce a bushel of corn with less than two minutes of labor compared with about thirty minutes in 1920.

The use of combines and corn pickers speeded harvesting operations and at the same time made them more efficient. Machinery company representatives used the combine to harvest soybeans in Illinois for the first time in 1924. The result was a significant yield increase because a larger percentage of the soybeans were harvested. By 1964 practically all grain crops and soybeans were harvested with either a corn picker or a combine. On the basis of 1964 harvesting machine numbers in Illinois, each corn picker harvested an average of only forty-five acres during the season, and each combine averaged about ninety-seven acres of small grain and soybeans. Research started in 1950 indicated ways to adapt the combine for harvesting corn. In 1964, 55 percent of the corn was harvested as ears by corn pickers. The other 45 percent was shelled: 38 percent by combines and 7 percent by field picker-shellers.

Crop-drying experiments begun in 1924 and continued through 1964 showed ways to improve the quality of crops and often shorten the harvesting period. The effects of many drying variables were evaluated in terms of seed germination, crop quality, insect control, and drying efficiency.

Tests on rapid drying of corn at temperatures up to 800 degrees were conducted from 1962 through 1964. The results indicated that such high temperatures do not damage the food value of the corn if the kernel itself does not reach that temperature. Corn was also dried under a vacuum to remove moisture at a slow rate. The results helped engineers design more efficient farm crop dryers and systems for handling and storing grain and forage.

Crop storage investigations suggested environments within structures needed to maintain quality of naturally and artificially dried crops during storage. Grain drying soon became a regular practice, as indicated by the fact that in 1964, 20 percent of the corn was dried on Illinois farms and an additional 3.5 percent was dried at off-farm sites.

Many of these research studies were conducted in cooperation with other departments in the College and with a number of USDA agencies. For example, the federal government furnished workers and funds to conduct studies on corn-borer control, grain storage, farmstead labor efficiency, and automatic feed handling. Manufacturing companies contributed funds and advice on many projects.

Following are some of the specific research projects that contributed to the mechanization of agriculture. They are grouped into the traditional divisions of agricultural engineering.

Field Power and Machinery

The purpose of the research projects in power and machinery conducted since 1921 has been to improve tractor power, tillage, harvesting, machinery management, and application of chemicals.

Quantifying Mechanisms

Some early work of the department involved a study of the metering characteristics of the mechanisms on a corn planter in relation to grading of the seed, seed-to-cell size, and accuracy in dropping a specified number of kernels per hill. The first results were published in 1911 by C. O. Reed. Another study completed by Shawl and Benjamin Koehler of the Department of Agronomy in 1928 reported the effect of seed treatment on the wear and accuracy of the metering mechanism. Bateman later made tests to determine ways to ensure more accurate planting rates with higher planter travel speeds (five to seven miles per hour) and higher numbers of kernels per acre. Some factors that were found to improve accuracy of cell fill were slower plate speeds, correct size of cells, coating of seed with graphite, and use of plastic instead of cast-iron plates. Data from these studies were used to develop a calibrating procedure for adjusting planter travel speed and plates.

Studies were also made to determine the metering characteristics of granular applicators. Accurate metering requires a constant travel speed, calibration of the distributor for different types of chemical granules used, and consideration of field conditions. From the results of these studies, a method was developed for calibrating applicators on the farm.

Equalizers for Animal Power Transmission

In 1918 E. A. White made force analyses of various combinations and arrangements of equalizers that transmit power from a team of horses to a machine. For narrow machines such as plow tandem hitches, Lehmann and E. T. Robbins of the animal husbandry department designed ways to reduce side draft and thus lower power requirements. Young tested and redesigned commercial hitches and studied them under farm conditions from 1923 to 1929; he also devised hitches so horses could be used to pull tractor plows.

Tillage and Planting Machines

A mathematical analysis of the shape of its surface had made it possible to improve the design of the moldboard on plows before formal research studies were started at Illinois. This analysis resulted from work for a Ph.D. dissertation completed at Cornell University in 1917 by E. A. White, who was on leave of absence from the Illinois faculty to complete his graduate work. The analysis is still useful, even though computers can now be used to solve complicated equations to determine specifications required for minimum draft and efficient pulverization of soil.

Shawl studied new types of plows introduced in the 1920s to evaluate their draft requirements for various soil types and methods of soil management. This information helped to evaluate new designs of plows and indicated the size of tractors required for various sizes of plows and various soil conditions.

The information on use and adjustment of the moldboard plow helped to control the spread of the European corn borer in the mid-1920s. Completely covering cornstalks during spring plowing was demonstrated as an effective method to kill the larvae. The tillage investigations also included evaluations of preplowing treatments of stalks, new designs for coulters, trash shields, and wider plow bottoms. The effectiveness of plowing on private farms was also surveyed. From 1927 to 1935, this work was conducted by Thayer Cleaver, a USDA engineer stationed at Urbana, and A. L. Young in cooperation with William P. Flint in entomology and George H. Dungan in agronomy. The results provided ideas for a circular on better plowing and information on clean plowing to control borers. The introduction of chemical insecticides after 1945 provided a more effective method of control for this pest.

Binder–Thresher Harvesting of Grain

A grain threshing machine investigation was one of the first three research projects Lehmann organized soon after the Department of Farm Mechanics was established in 1921. The performance efficiency tests by I. P. Blauser of farmer-owned threshing machines indicated that normally more than 95 percent of the oats and wheat yields could be saved by harvesting directly in the field with a combine. The tests also indicated that grain could be saved by making various adjustments. Methods of saving labor were studied in conjunction with the economic management studies being made by the Department of Farm Management.

Tractors

Because of the location of the University of Illinois relative to the farm machinery industry and the interest of Ray I. Shawl in carrying on early studies of farm tractor performance, the Department of Farm Mechanics and subsequently the Department of Agricultural Engineering has been one of the pioneer leaders in farm tractor research.

Studies of uses for farm tractors appeared for the first time in a formal project in 1921. In 1924 Shawl, in cooperation with the International Harvester Company, initiated field tests of a new general-purpose tractor, the Farmall. The objective of these tests was to study the improvements needed in tractors and machines designed to be used with them to meet Illinois farm conditions. The tests involved more-than-average yearly use over a thirteen and a half year period of a tractor on the farm of W. E. Riegel near Tolono, Illinois.

A major change evaluated in 1933 was the use of rubber tires on tractors. This work produced one of the first reports ever published on the use of rubber tires under farm operating conditions. Results of the tests indicated that rubber tires substantially increased the effectiveness and versatility of tractors for both field and farmstead operations.

The Farmall test tractor originally used kerosene for fuel. In a cooperative project with the Ethyl Corporation in 1935, the test tractor was converted to high compression by use of eight thousand-foot altitude pistons, a cold manifold, and cold-type spark plugs. It was a revolutionary step for tractor engines to burn gasoline. With this change, dynamometer tests showed a dramatic gain of 32 percent in horsepower and a 12 percent fuel saving over results from the Nebraska Tractor Station where the tractor was originally tested. This pioneer study of a high compression tractor engine produced results, in 1936 and succeeding years, that influenced tractor engine design of high-compression engines for years. In addition, hundreds of older tractors were converted to high compression by means of conversion kits furnished by the manufacturers.

Yearly progress reports on high-compression and the use of rubber tires given at annual Farm and Home Week programs attracted great interest among Illinois farmers who, in 1936, owned a hundred thousand tractors. Records kept on the 1924 Farmall covered 13.5 seasons, or about ten thousand five hundred hours of operation. When the tractor was new, its life was estimated to be three thousand hours; however, its durability through ten thousand five hundred hours of operation led to revision of the estimate to fourteen thousand hours, or seventeen years. As a result of these studies, Shawl published a circular on tractor maintenance in 1934. This circular, which was revised twice, was reprinted in magazines and became one of the most widely-read publications of the College of Agriculture.

From 1937 to 1948, H. Paul Bateman made detailed records of all field power operations on nine Champaign County farms. The records provided useful information on the labor and fuel required per acre to do various jobs and provided the first proof that the average tractor load required for all operations was about half of the rated horsepower.

Bateman, J. Arthur Weber, and James W. Martin brought eighteen tractors from these nine farms to the agricultural engineering laboratory in Urbana for dynamometer tests to compare the performance "as found" with that after simple repairs and adjustments had been made. After the tests the tractors were returned to the farms with an average increase of 14 percent in power and 19 percent in efficiency. Although these results were widely publicized and similar studies elsewhere confirmed the poor performance of most farm tractors, it was not until about 1957, when a company developed a shop dynamometer, that dealer mechanics were able to show similar improvements in performance to their customers after completing repairs and adjustments.

As the horsepower of new tractor engines increased, troubles developed in new areas. One difficulty was burning and sticking of exhaust valves. In 1949 Weber started a series of field tests that showed that rotating valves could prevent valve-burning problems. From 1951 to 1955, a cooperative project with the Northern Regional Laboratory, USDA, Peoria, showed that alcohol-water injectors could be used on farm tractors to permit operation on low-octane fuels. This project, which also included a study of valve rotation, was the first Illinois tractor research in which statistical procedures were used to determine significant differences of such things as wear rates and valve face roughness.

Field studies in the early 1950s showed that farm tractors required better care to ensure good performance and maximum life. In 1955 a project was initiated to improve farm tractor maintenance. The Illinois Farm Supply Company (now FS Services, Inc.) provided funds for this research and tractor and parts manufacturers provided technical assistance and equipment.

This study involved sixty farm tractors and the maintenance practices of the operators showed that the poor condition of many parts was due to the complexity and nonuniformity of maintenance recommendations. As a result of this work, Weber was able to make suggestions that led to the adoption of new uniform standards for farm equipment manuals.

From 1958 to 1964, work on this project concentrated on items found to be in poor condition on the sixty tractors of the cooperating farmers. A laboratory and field study conducted by Weber and John C. Siemens showed that the standard test for determining efficiency of air cleaners was not adequate for the new dry-type cleaners. Pulsating air flow and slow dust feed rates, first tested in the department's laboratories, were adopted by the industry to obtain better correlation between laboratory and field results. Also studied was the effect of maintenance variables on the life of valves, spark plugs, and ignition contacts.

In a related investigation, Charles J. Ricketts monitored the operation of twenty-five tractors to determine the number of hours of operation per year at various percentages of maximum horsepower. This information was used to redesign a tractor carburetor and add a vacuum spark advance to get better part-load fuel efficiency and a predicted 15 percent annual fuel saving. Studies made during 1964 indicated that fuel could also be saved in the field in many kinds of operations.

Design engineers were interested in these results and used this new carburetor principle in designing future engines.

Working with John C. McMunn and Earl A. Hudson, Roger R. Yoerger determined the characteristics of the wave patterns in the tractor intake manifold. The purpose was to find how wave patterns affected the performance characteristics of dry-type air cleaners. Richard G. Carlson designed equipment to produce the typical wave patterns and wrote a master's thesis on the results.

The department used two approaches in an attempt to automate farm tractor operations. Frank W. Andrew worked out one idea as a student in 1938. He instrumented a tractor so that a control wire would unwind from a stationary wheel and cause the tractor to move in a circle. Later during several seasons he used this method of guiding the tractor to prepare the seedbed, plant, cultivate, and combine crops on his farm in Macoupin County, Illinois. He obtained a patent on the method in 1941. In 1964 Yoerger made a second study of the automatic operation of a "slave" tractor and used an analog computer to evaluate the transfer functions involved in the control system.

Also under the supervision of Yoerger, tractor stability while in operation on steep slopes, such as roadsides, was studied during the summer of 1963. Roscoe L. Pershing collected field data on tire creep and incorporated them into a mathematical model describing steady-state vehicle behavior. He then used a digital computer to develop curves and equations for a wide range of operating conditions. The results showed the effects of design and operating variables on the stability of the vehicle on slopes of varying degrees. The mathematical model simulated the operation of two- or four-wheel drive and rear- or front-wheel or four-wheel steering designs on various types of roadside cover and degrees of side slope.

Farm Machinery Management

Soon after the tractor became an important source of power on Illinois farms in the 1920s, it became evident that information would be needed to help farmers select the most efficient and economical power and machine units for given sizes and types of farms. (It had been relatively easy to determine the number of horses needed to pull various kinds of machines.) The early study of the Farmall tractor provided detailed labor, power, and machine costs for individual tractor operations. Shawl first obtained cost records on four-row machines commonly in use at that time. Then the cost of tractor machine operations was determined at intervals during the thirteen and a-half-year study of operation of the same tractor.

Bateman and E. W. Lehmann started a second machinery management study in 1937 at about the time the farmers were increasing the use of tractor power. These studies were continued for eleven years on Champaign County farms, with twelve to fifteen tractors being studied each year. The tractors were equipped with time and mileage recorders and a means for determining fuel consumption for each operation completed in each field. The results indicated the time and fuel rates required per acre for various sizes and combinations of tractors and machines at different speeds of operation. A knowledge of the time and fuel requirements along with the field efficiency of the machine made it possible to recommend the lowest cost combination of machines and operations to produce various crops. Repair costs obtained in this study over a ten-year period are still being used with some revision in calculations. The performance efficiency values calculated for many operations were included in textbooks and the ASAE Handbook.

Donnell R. Hunt began investigations in 1961 to optimize the capacity-selection of farm field implements. A measure of timeliness in the equations he developed was the first analytical measure of this important item. As farm machines and tractors became more costly and the capital investment per farm increased, there was a greater need and demand for procedures to work out optimum practices for the operation of tractors and other machines. Computer methods were used to solve problems that previously could not be solved.

Combine Harvesting of Soybeans, Wheat, and Oats

Soybeans were first tested on the Agronomy South Farm soon after 1900. It was reported that 1,000 acres were harvested by farmers for seed in 1916. But in the early 1920s the large amount of loss during harvesting was recognized as a major limitation on the increase in acreage of soybeans. Blauser conducted some tests that indicated losses of 15 to 45 percent. These results stimulated the search for an improved harvesting method.

Lehmann and other staff members contacted engineers of machinery companies with a view to testing their combines for harvesting soybeans. Most of these men felt that farmers would not be able to justify the purchase of combines even though the machines were successful in harvesting the new crop. Combines had been developed to meet the harvesting needs of the large farms in the West and had been used on the Pacific Coast since 1845. They were not introduced into the Great Plains, however, until about 1917. Despite the negative attitudes of engineers, Lehmann began to test a combine to harvest soybeans.

Through the interest of C. C. Dennison, then branch manager for the Massey-Harris Company, a combine was sold to Garwood Brothers of Stonington in Christian County. The performance of this combine was encouraging, and a public demonstration on October 22, 1924, is believed to be the first time a combine was used to harvest soybeans. Nineteen farmers were convinced that a machine of this type would be a profitable investment for them, and by October 1925, they all had bought combines. The number increased to 65 in 1926 and to 322 in 1927. There were 38,000 combines in Illinois by 1945 and 89,000 by 1964. The Illinois soybean acreage also increased rapidly, from 106,000 acres grown in 1925, to 2,000,000 acres in 1940, 5,700,000 acres in 1964, and to 9,620,000 acres in 1979. Acreage has remained essentially constant since then.

After the combine was introduced in 1924, field tests by Blauser and Arthur L. Young indicated an average soybean harvesting loss of 8 to 10 percent, considerably below that of former methods. This improved efficiency helped to increase farmers' yields. The state average yield increased from 12.6 bushels per acre in 1925 to 17.3 bushels in 1930, to 29.5 bushels in 1963, and to an all-time high of 46 bushels per acre in 1994. Comparative tests with the binder-thresher method showed the combine to be more efficient for harvesting soybeans but to have little advantage for harvesting wheat and oats. Nevertheless, 98 percent of the wheat was being harvested by combine by 1948. It can be concluded that the combine was first justified in Illinois for harvesting soybeans, but other benefits, such as more timely harvest and lower labor requirements, also made its use feasible.

In 1935 and 1936, Young, Cleaver, and Bateman made field tests to compare new small combines (with five- and six-feet wide headers) with larger models. These new machines were as efficient as the larger machines in cutting harvesting losses in oats, wheat, and soybeans and their lower cost made it possible for farmers with small acreages to own a combine.

Improved Methods of Harvesting and Storing for Artichokes

In the early 1930s, the agronomy department conducted studies that indicated that artichokes might be a viable crop in Illinois, however, the irregular-shaped tubers presented harvesting problems. In an attempt to solve this problem, a sorting table with a conveyor and riding facilities for workers was built to pull behind a potato digger. R. H. Reed designed a washing machine to clean the tubers for more satisfactory storage. Rate-of-drying tests were made for various temperatures and humidities.

The Corn Picker

The corn picker was invented about 1874, and horse-drawn models were marketed at the turn of the century. The use of pickers increased during World War I because of the labor shortage, but farmers did not really become interested in buying the machines until about 1926, when the new tractor power take-off was introduced. Two-row models were marketed about 1928. Low farm income and low labor costs, however, delayed the general use of corn pickers until the mid-1930s.

Young made the first tests of performance efficiency of corn pickers in Illinois in 1929 and 1930. His results showed that the grain loss was about twice the 5 percent normally lost by hand shucking. This extra loss was, however, offset by the saving in labor and more timely harvesting of corn. Mechanical corn pickers therefore became widely accepted in Illinois as economic conditions improved in the late 1930s. By 1938 pickers were used to harvest about 43 percent of the corn in the state, a proportion that increased to 75 percent in 1946 and to 96 percent in 1956. The number of pickers in Illinois grew from thirty-seven thousand in 1945, to seventy-six thousand in 1950, and to one-hundred nine thousand in 1964.

In 1940 the J. I. Case Company introduced a corn picker-sheller consisting of a corn picker with a drum-type sheller mounted on its frame. Robert F. Skelton and Bateman made field tests on the machine that showed that it would save a large percent of grain and shell the corn without too much damage to the kernels. This type of machine was not widely used, however, until about 1947, when portable farm dryers became available.

After corn-heads were introduced for combines in the mid-1950s, shellers were designed and built for more makes of corn pickers. Thus, it was possible to use the same machine to harvest both ear corn and shelled corn. Because tests and farmers' experiences indicated that self-propelled combines had more capacity than picker-shellers, the losses were lower, and the combines could be used for more crops, picker-shellers were not widely accepted. Compared with 60,400 corn-heads produced for combines from 1956 through 1963, only 14,400 picker-sheller machines were produced during the same period.

Field-shelling machines have been widely accepted for harvesting corn in Illinois despite the problems of investing in special dryers and storage facilities. In 1964, 38 percent of the corn was shelled in the field by combines and 7 percent by shellers on pickers. Farmers reported that corn losses were low when combines were used to shell corn, being below the 10 percent considered average for ear corn pickers. Field-shelling also made it possible to harvest earlier in the season and make way for other operations such as fall plowing.

Yoerger investigated the rapid drying of corn to determine if corn could possibly be dried as it is shelled. Results of this study are reported under the section on storing and drying grain (page 141).

SEED CLEANING

The need for a method to clean weed seed from various kinds of seed used to establish pastures and clover fields was recognized soon after the Department of Farm Mechanics was established. Blauser made preliminary studies to determine what screen combinations and amounts of wind blast were needed to clean clover, alfalfa, and timothy seed.

In the early 1930s, Lehmann conducted investigations to determine how commercial companies cleaned seed and what machines farmers could profitably use for this job. His work led to the establishment of a project on seed cleaning and weed control. From 1936 to 1941, C. W. Veach developed special equipment and machines to clean noxious weed seed from forage seeds, including a special machine to clean dodder seed from lespedeza. R. O. Schlegerlilch conducted tests to determine air velocities that would support various seeds and other physical characteristics of the seed that could be used as a basis for seed separation.

Use of Combine to Shell Corn

Even before 1930, records indicate that field trials were made on the university farms to harvest corn with a Holt combine. Tests were made with special corn attachments on a Gleaner-Baldwin combine on farms near Tuscola about 1930. In the late 1930s and early 1940s, the Allis-Chalmers Company produced test machines with special row attachments to gather the ears of corn and deliver them to the cylinder of their combine. Because farm crop-dryers were not readily available at that time, however, these combine row-gathering attachments were not placed on the market.

In 1950 Pickard and Hopkins initiated studies to determine the corn shelling performance of various types of combine cylinders and concaves. Field trials indicated that shelling, separating, and cleaning mechanisms would operate efficiently in harvesting and shelling corn. In 1955 several machinery companies introduced a limited number of corn-heads for use on self-propelled combines. Research results stimulated the companies to provide suitable machines for this new harvesting method. In 1956, 4,000 corn-heads were manufactured, largely by Deere; by 1960 the number manufactured by all companies had increased to 11,000. From 1956 through 1963, 60,400 corn-head units were manufactured for use in all states. The new use for the self-propelled combine stimulated a greater demand by farmers, and self-propelled combines made up 85 percent of the total combine production in 1963 compared with only 9 percent in 1950. New types of drying units made available during this period helped make field corn shelling more acceptable to farmers.

Pickard and Bateman made further combine harvesting studies from 1957 to 1960 to determine the possibility of harvesting dwarf corn with combines equipped with special pick-up reels and extension cutter bars. Losses were greater at the header with this arrangement than with the corn-header used on the combine. Also, the separating losses were larger because the stalks were run through the combine. These studies were discontinued because the available dwarf corn varieties did not appear to be able to compete with normal varieties. The low ears on dwarf corn increased the snapping roll loss, and the yield of dwarf corn did not equal that of normal varieties.

HAY HARVESTING

The process of crushing hay and compacting it into small wafers was studied intensively for thirty years. Early investigations by R. H. Reed and Lehmann in 1930 demonstrated that drying time could be reduced from one-third to one-half by crushing alfalfa and soybean plants. Crushing the stems caused them to dry faster than leaves and thereby reduced the problem of overdrying and loss of leaves. Less exposure to the weather and a higher percentage of leaves improved the feeding quality of the hay.

Early commercial hay crushers were first tested in 1932. During the next six years Reed and G. M. Petersen worked out design changes to improve the performance and lower the cost of these machines. The high cost of the early machines limited their use on the farm until about 1957, when manufacturers began to make new, less costly designs of hay crushers available. John Ramser evaluated the newer designs to determine which were most effective in drying and maintaining hay quality.

Pickard initiated hay-wafering research in 1958. The first studies concentrated primarily on the mechanism for forming the wafers. Specifically they involved the factors of pressure-volume relationships, size stability, durability, drying characteristics, and the effects of hay moisture, maturity, density, and wafer configuration on these factors. Pickard designed and built a laboratory toggle press and closed compression chamber that produced cylindrical wafers 3.5 inches in diameter. Walter M. Roll and Pickard determined and reported quantitative values for pressure and energy, moisture limitations, time of pressure hold, wafer relaxation rates, and wafer durability. Although this method required a relatively small amount of power, no suitable hay feeding and metering device was available to adapt it to a field machine.

In 1959 a fundamental study of water cohesion by Yoerger and Barney K. Huang revealed the importance of hay leafiness, moisture content, interlacing of stems and leaves in the wafer, and plastic flow of the hay under pressure to obtain good adhesion in wafers. These data led to a study of the effect of maceration prior to wafering hay. This pretreatment was found to be significant in reducing the energy required to form durable wafers by the closed chamber method.

In 1961 Hunt and Dwight Witte reported results of tests to determine the energy required for extruding hay. The purpose of this work was to ascertain the parameters of die configuration that would minimize the energy to form a wafer. Variable moisture contents and hay conditions (long or chopped) were studied. The wafers were extruded through an adjustable, converging die rectangular in cross section. Final wafer dimensions were approximately 2" x 2.5" x 1". A die convergence angle of 3.5 inches per foot was found to produce the greatest energy efficiency. A high proportion of the required energy was due to friction between the compacted hay and the die.

Commercial field machines for crushing and wafering hay were first marketed in significant numbers during the 1961 season. Several major machine companies made the machines for farm use. The practice of wafering hay, however, was not very popular on Illinois farms in 1965.

Chemical Application Equipment

Equipment for the application of pesticides has been of continuing interest. In 1929 Lehmann and R. H. Reed initiated a research project on the stationary spraying of plants to control orchard pests. A ten-year study by Reed in cooperation with H. W. Anderson and R. L. McMunn of the horticulture faculty produced information on the design, operation, and economics of stationary systems, which at that time were competing with portable sprayers. Velocity criteria were developed for preventing deposition of spray materials in the lines and for producing the most efficient spray patterns and best pipe layouts.

In the late 1940s new herbicides and insecticides spurred research on low-pressure, low-gallonage spraying. In 1949 research by B. Jack Butler resulted in a recommendation that rates of 2,4-D solutions as low as five gallons per acre be avoided because of reduced effectiveness, increased drift hazard, and increased nozzle stoppage. The use of flooding, flat-fan nozzles was also recommended because the larger droplets they produce are more effective and less likely to drift. These recommendations are still in effect for the above-stated and other reasons.

In the 1940s, with increasing use of bulk spreader trucks to apply lime and rock phosphate, Shawl made extensive studies of spreading patterns and actual field distribution. These studies showed the value of proper overlapping of swaths, the use of proper truck and spreading fan speeds, and frequent calibration. In 1958 and 1959 Melvin R. Smith and Butler investigated the application of anhydrous ammonia during plowing and other tillage operations and recommended it as an efficient practice. Losses of ammonia on silt loams and silty loams were shown to be very low, and the distribution in the soil was excellent.

In 1957 G. E. Pickard and S. V. Arya completed the first laboratory studies of penetration of liquid jets in soil. From 1957 to 1962, Dean F. Hopkins and Butler conducted extensive laboratory and field studies of the use of high pressures to inject anhydrous ammonia into the soil. They determined the relation of orifice size, shape, and entrance condition to penetrating ability with changing pressures. Gary L. Wells then made field studies of continuous injection using criteria obtained in laboratory tests. Power savings were as much as 50 percent over those in the normal knife application, but some plowing had to be done to aid penetration and minimize losses of ammonia.

In 1958 and 1959 C. Gene Haugh and Bowers studied the flow of liquid fertilizers through plastic tubing and fittings, especially low-pressure, gravity-flow systems. They determined friction losses as well as orifice coefficients and used them in recommending gravity-flow system design and proper orifice selection.

Field and plot work conducted on band applications of herbicides from 1956 to 1959 by Bowers and Butler indicated the need for a variety of methods for incorporating different chemicals in the soil, especially under differing rainfall and temperature conditions. The research indicated the shortcomings in equipment and the need for an educational program to ensure safe, economical, and effective use of chemicals. One series of field tests showed the need to keep nozzle pressures under 40 psi to avoid drift. This recommendation was widely adopted. Some counties enacted laws to limit the maximum pressure used for spray operations.

After the retirement of Butler in 1983, Loren E. Bode continued the research, extension and teaching program in pesticide application technology. Through this program, Illinois became the national leader in application technology, and Bode became known across the United States as "Mr. Sprayer." The program was designed to increase the precision of applications so pesticide effectiveness could be achieved with minimal environmental impact. The program was well integrated; the research supported the extension program and helped to keep the AgM 333 course, "Agricultural Chemical Application Systems," up to date.

One of the focuses of Bode's research program was droplet size and drift. A state-of-the-art laser scanner was obtained to measure the droplet size spectra produced by a nozzle. Conventional, electrostatic, and CDA (controlled droplet application) nozzles were all evaluated, both as to droplet sizes produced and spray drift potential. Bode's Ph.D. student Jong Rhee helped put a stronger theoretical foundation under the research by developing a computer simulation of spray transport into the crop canopy.

Another focus was the incorporation of granular herbicides. Distribution of granular herbicides is crucial to their effectiveness. Bode's Ph.D. student Floyd Dowell developed a system for tagging the granules with a fluorescent dye, illuminating a soil cross-section with appropriate light, and using machine vision to evaluate the distribution.

A third focus was application automation. To maintain a constant application rate, the nozzle flow rate must be varied with travel speed as a sprayer moves across a field. Because changing the flow rate through a conventional nozzle shifts the droplet size spectrum, Bode and his graduate students evaluated the effectiveness of bypass nozzles. A bypass nozzle allows part of the flow to be bypassed back to the tank, thus changing the controlled flow to the target with minimal change in the droplet size spectrum. In another automation project, it was known that soil organic matter captured herbicides, thus herbicide application rates must be increased on soils with higher organic matter. Research was initiated to develop a soil organic matter sensor. It was difficult research and took nearly a decade to complete.

With the departure of Butler, additional help was needed to maintain strong programs in pesticide application technology. Stephen L. Pearson joined the program as an academic professional to provide needed assistance. When Pearson left to join Spraying Systems Company in 1989, Robert Wolf replaced him. Wolf continued participation in the multidisciplinary sessions held at various locations in the state to train pesticide applicators about proper application techniques. Wolf and Bode also developed "fly-in" clinics as part of the extension program. Aerial applicators could bring their spray air planes to a clinic, load their tanks with water tagged with fluorescent dye, and take off and fly across a paper strip laid across the runway. By the time the planes landed the strip's had been scrolled though a fluorometer connected to a microcomputer, and a diagram of the spray distribution pattern was available for pilots to inspect. The fly-in clinics thus provided a powerful means for helping pilots improve their application accuracy.

Tillage and Machinery Management

Results of the field studies with farmers from 1937 to 1948 indicated a need to study tillage operations under more controlled conditions. In designing tillage and planting machines, there was need to understand the effect of tillage on the physical condition of the soil and plant response. In 1950 Bateman began research on the new agricultural engineering research farm to relate the effects of various tillage mechanisms and operations to the results obtained in agronomic studies of soil edaphology.

Agronomists cooperated in this study by suggesting fertilizer and planting rates, weed control measures, and desirable statistical plot designs that would make it possible to interpret crop responses. Tillage mechanisms evaluated included the moldboard plow, disk blade, rotary tiller, mulch tillage machines, and special mechanisms used on plows or planters. The evaluations were made for various soil types, fertility applications, row spacings of corn, and seasonal conditions.

Results obtained from 1950 to 1965 indicated that the seedbed for corn could be produced with fewer operations than were normally used in the conventional methods farmers practiced. In general, corn yields depended more on seasonal rainfall than on differences created by tillage.

Attaching planters to plows made it possible to prepare seedbeds and plant in one operation. A once-over till planter that used a large sweep to force residue from the row was studied from 1950 to 1956. The results indicated that more nitrogen was required to produce the same corn yield with this new method than when clover sod was plowed before planting. Equal yields were obtained from the two methods tested on cornstalk ground.

Reducing the number of operations in turn reduced the energy required to prepare the seedbed. In succeeding seasons less energy was required for plowing, and the soil pulverized more completely because there had been less compaction the previous year. A rotary tiller required more energy than most other machines, and the finely pulverized rotary-tilled soil did not produce as much corn per acre as the less pulverized seedbeds. Soil compaction studies indicated that there was less yield reduction than was expected from the heavy compaction from machine and tractor traffic. Rear tractor tires caused most of the soil compaction. The major yield reduction due to compaction occurred on a Drummer silty clay loam soil. Little effect was noted on a Thorp silt loam soil.

Wendell Bowers initiated field research demonstration plots in many parts of the state to demonstrate the merits of these new tillage practices. As a result of the studies and demonstrations, many farmers reduced the number of operations to save labor and power, and on some soil types there were actually some yield benefits. Manufacturers developed and marketed special machines or attachments for existing machines on the basis of the results.

John C. Siemens followed Bowers as extension specialist in 1967 and quickly developed a research program to support his extension program. His primary interests were machinery management and tillage. Farmers have to make crucial decisions regarding machinery purchases. If they purchase equipment that is too large, investment costs are high and profits fall or if too small, field operations cannot be accomplished in a timely fashion, and profits suffer. In cooperation with Deere and Company, Siemens and his students developed a computer program to enable farmers to choose the optimum-sized equipment for their farming operations. The program found an enthusiastic audience because farmers found it to be highly realistic in assessing their operations and selecting optimum-sized machinery.

Tillage is a critical issue in Illinois especially after the General Assembly enacted the T-2000 law which requires farmers to limit soil erosion to a tolerable level by the year 2000 or suffer certain penalties. Tillage practices have a strong effect on erosion and thus Siemens and his cooperators conducted a tillage experiment that spanned more than a decade. He and his cooperators studied the effects of tillage practices ranging from moldboard plowing to no-till on crop establishment and growth, soil condition and fertility, soil erosion, weed control, crop yield, and economics. Subplots within the main tillage plots were used to study effectiveness of various weed control measures. One of the cooperators was Kent Mitchell, who developed a rainfall simulator to provide artificial rainfall on the tillage plots while runoff and sediment transport were measured. One result of the tillage research was that the moldboard plow was largely retired in Illinois. Instead, chisel plowing after corn production was adopted as a means to reduce soil erosion. Spring disking or field cultivating became the preferred tillage method following soybean production.

With the growth in size of farm machinery, soil compaction became a concern, and Siemens initiated field trials to study its effect on crop yield. Effects of compaction were different in wet years than in dry years. Compaction reduced crop yields in some wet years and led to some herbicide injury.

Combine Harvesting of Sunflowers

Different sizes and types of combines were tested to find ways to improve their efficiency in harvesting various kinds of forage seeds. From 1948 to 1952, Bateman, Weber, and Ayers conducted tests to establish the specifications for an attachment to harvest sunflowers with combines. R. O. Weibel of the Department of Agronomy, who was testing new sunflower varieties, cooperated in these tests. This new crop had the potential of producing a very high-quality oil. Machinery companies furnished combines with special attachments for test purposes. The sunflowers were first made available for tests by a group of interested farmers in Piatt County and later some were grown on the agricultural engineering experimental field. Even though efficient harvesting methods were established the crop did not become popular because of low yields and insect and disease problems and the lack of an established market.

Highway Maintenance

G. E. Pickard initiated a project in 1958, in cooperation with the Illinois Division of Highways and United States Bureau of Public Roads to study and improve equipment for establishing and maintaining roadside cover.

As a result of this work, Butler developed and patented a remote-control spray nozzle cluster to vary the swath width as the roadside width changed. This nozzle assembly and control, as well as several other features developed in this study, were incorporated into the design of a commercial highway sprayer. The results of this work were presented to ASAE in June 1964.

Dwight F. Kampe and Yoerger took high-speed motion pictures of the process of flail mowing to find ways to reduce the windrowing effects and Butler studied the amount of wear on various kinds of swinging blades used on rotary mowers.

Kampe investigated the uniformity with which fertilizer was spread by a nozzle projectile. Robert E. Reints calculated the projectile paths of various-sized spheres with the aid of an analog computer as part of his master's thesis problem under the direction of Yoerger. He then constructed special laboratory equipment to determine the projectile paths of various sizes of plastic balls. The results were found to be close to the theoretical curves.

In cooperation with the Department of Agronomy, Butler tested various once-over machines and methods for tillage and seeding to improve the seeding of roadside slopes. Butler also designed and built an improved conveyor to move bales of straw into a straw shredder and blower to mulch a new seeding. This conveyor moved the bales more uniformly into the hammermill chamber than other methods then in use.

Corncobs are useful for mulching new seedings, controlling weeds, and retarding evaporation of water. Yoerger designed and constructed a cob crusher to make more effective use of the cobs for these purposes.

Soil Mechanics

The many uses for tractors and other machines brought a need to study the engineering properties of soils that affected traction and tillage tool performance. In turn, some of these measurements needed to be related to crop response. Basic soil dynamics studies were made on the operation of simple tillage tools in artificial soils after 1962.

A soil bin designed and built by Weber and Siemens opened the way for many laboratory studies. Siemens developed a system for making a high-speed movie to simultaneously record the forces acting on the tool and the failure pattern of the soil. This work led to the completion in 1963 of his Ph.D. dissertation that tested the validity of using retaining-wall and free-body theories to predict the forces acting on simple tools as they were pulled through artificial soil. A master's thesis study included the effect of travel speed on the soil failure pattern in front of tillage tools. Another study by Alvin C. Bailey compared and analyzed the results obtained from measuring the shear strength of the same soils with several different devices. David J. Olson studied and completed a master's thesis on the effect of speed on draft of tillage tools. These results were used in developing theory for the design of tillage tools and in interpreting the performance of tools in natural soils.

Bateman studied the application of energy to produce an optimum degree of pulverization of natural soil. Under laboratory conditions from 1961 to 1965 he applied force with a laboratory machine similar to the Charpy apparatus used to test the impact strength of metal and other elastic materials. Comparison of the energy required for this method with that for a slow loading rate showed that the latter required less energy to pulverize the soil. These results provided energy-pulverization curves for various soil conditions that indicated the minimum energy required for given degrees of soil pulverization and helped determine the specifications for new designs of tillage tools.

Vegetable Planting and Fruit Harvesting

Tests showed that application of polyethylene sheet film on the soil to control weeds and moisture along the row of specialty crops was a disadvantage the next season because the film did not deteriorate adequately. Considerable expense was involved to remove the film to permit subsequent tillage.

In 1959 the Mosinee Paper Mill Company provided funds for Yoerger to adapt commercially available mulch-laying machines to lay fragile kraft paper which was less costly than film and deteriorated during the growing season so normal tillage could follow.

Loren P. Boppart designed and constructed a planter wheel with spokes to puncture paper or plastic film so that seeds could be planted through the mulch which permitted the mulch to be laid and seeds planted in one operation.

Students in the senior machinery design course taught by D. R. Hunt designed and built the first model of a strawberry picker in the spring of 1963. Dean L. Hoag did further work on the design, construction, and testing of this machine under both laboratory and field conditions for his master's thesis problem in 1964. Hoag did some of this work in cooperation with Chester C. Zych of the Department of Horticulture. He concluded that stripping is an effective way to remove the berries; a .4-inch space between round bars made it possible to remove ripe berries with little damage; a vertical velocity of three inches per second was found to be too high during picking; and strawberries need to be bred to form higher on the plant and ripen more uniformly.

SITE-SPECIFIC CROP MANAGEMENT

W. Ralph Nave and John Hummel, USDA employees with courtesy appointments as professors of agricultural engineering, played a key role in the research program on soybean harvesting in the 1970s. Their work focused on loss reduction and combine capacity. Nave added an engine driven fan to the combine and used it to blow air across the front of the sickle bar to force shattered beans onto the platform rather than letting them fall to the ground. This system reduced soybean harvesting losses from about 8 percent to about 4 percent. This 50 percent reduction in losses encouraged combine manufacturers to improve their combine headers. Because the cutterbar and reel limited travel speed and field capacity in harvesting soybeans, Hummel and his students developed a way to eliminate these components. They adapted rotary cutters and a system of air jets to convey cut soybeans into the header. Hummel's students dubbed this machine the "Rambo Reaper" because the limiting factor on travel speed was an operator's ability to stay in the seat and steer the combine.

Hummel's research also included corn and soybean production systems where he was an active participant in the tillage studies mentioned earlier. He also became interested in crop root development. To conduct these studies he and his students developed a means for inserting a special video camera into transparent tubes which were driven into the soil after a crop was established. By periodically inserting a video camera into the tubes, it was possible to study root development in situ.

Concerns for environmental quality led Hummel to participate in the development of a newly emerging field—site-specific crop management (SSCM). The basic goal of SSCM was to accommodate within-field soil variability by adjusting application rates to match the inherent productivity of each part of the field. Although a version of SSCM was described in an Illinois Agricultural Experiment Station Bulletin in 1929 (involving site-specific application of lime), the concept awaited technological developments needed to support it. Among these, were the development of the Global Positioning System (GPS) by the U.S. government for use in military navigation. GPS could also be used to continuously locate farm machinery in fields. SSCM involves collection and analysis of huge quantities of data requiring the development of the use of a computer and the necessary software to handle the data. Finally, new sensors were needed to measure the many variables involved in SSCM, and Hummel and his graduate students set out to develop some of them.

First they developed a soil organic matter sensor. The initial studies had been performed years earlier in connection with Bode's pesticide application research, but no satisfactory sensor resulted from that work. At least six graduate students devoted their research to the project over more than a decade before a successful sensor was developed. It used fiber optics that directed NIR illumination onto moist soil in a furrow and analyzed the wavelengths of the returning radiation to determine the soil's organic matter content. The same sensor could also measure soil moisture. A U.S. patent was obtained on the soil organic matter sensor.

Illinois farmers make heavy use of nitrogen fertilizer to increase corn yields. Nitrates not captured by the corn crop can dissolve into the ground water and leave fields through tile drains. They can then enter the public water supply. Excessive nitrates in water are a health hazard to infants and pregnant women. Thus, there is strong incentive to apply enough but not too much nitrogen fertilizer. Therefore, Hummel and his graduate students began research to develop a soil nitrate sensor. An ion-selective, field-effect transistor (ISFET) was chosen as the sensing element. The most difficult part of the research was in finding a way to create a soil-water slurry, extract the filtrant, analyze the filtrant and discard the soil as the sensor moved through a field. This research still continues.

Yield-mapping, an important part of SSCM, permits assessment of the extent of productivity variation within a field and thus an assessment of the need for SSCM. Hummel recruited a postdoctoral agronomist, Michael Cahn, to work on SSCM. One of their activities was to equip a combine for yield-mapping. To map yields, it is necessary to know the gathering width and speed of the combine as well as the flow rate and moisture content of grain entering the combine grain tank. Hummel and one of his graduate students developed a sensor to measure the depth of grain on the clean grain elevator and convert that depth into a grain flow rate. Cahn brought to the project his expertise in geostatistics, the science of analyzing spatial distribution of grain yield and soil properties.

Yield-map interpretation is complicated because so many factors affect yield. For example, a low yield might occur in a highly productive part of the field but be associated with missing plants caused by a planter malfunction. To aid in interpretation of yield maps, Hummel and M.S. student Chad Plattner developed a light-beam breaker system to detect and count corn plant populations.

Carroll Goering became involved in SSCM in 1989 when his Ph.D. student Shufeng Han chose to work in that area. Han's project was to develop a field information system (FIS) for SSCM. This was PC-based software to handle the large quantities of data needed in SSCM. The FIS used geo-referenced data to build a series of stacked maps for a field. For example, there was a map for soil type, for pH, for phosphorous, and for potassium. The FIS used agronomic models and the other maps to create a map of geographically referenced target yield. From such yield maps, other agronomic models could be used to calculate spatially referenced amounts of the various nutrients needed to produce those yields. The concept of FIS thus reversed the concept that earlier proponents of SSCM had used—to create uniform fields by making heavier applications of nutrients to less fertile areas in a field and vice versa. The concept of the FIS was to map the inherent productivity of each part of the field and apply nutrients in accordance with that natural productivity, a concept subsequently adopted as the correct philosophy for SSCM.

In SSCM, fields are subdivided into rectangular subareas called cells. In theory, the soil in each cell is uniform and thus applications can be uniform within a cell. Han developed a basis for choosing the optimum cell size based on geostatistical theory. At the time, the most common cell size was 1 hectare (2.5 acres) because more intensive soil sampling is too expensive. Han's theory suggested use of a far smaller cell size that could become economic if sensor development reduced or eliminated the cost of soil sampling.

The influence of research is often difficult to trace. It was widely accepted that SSCM was primarily a scientific curiosity, and adoption was very slow until Deere and Company entered the field in 1994 with the introduction of their yield-mapping system. The Deere name for SSCM was "Precision Agriculture." After that introduction, farmers began taking SSCM seriously. Many farm organizations began to sponsor workshops on SSCM and farmers attended them in large numbers and began to purchase yield-mapping equipment. Numerous companies began to offer services and/or equipment needed for SSCM. At least a year before announcing their precision agriculture system, Deere engineers contacted the University of Illinois and other universities involved in SSCM research to request information. Hummel and Goering supplied the numerous research reports they had produced over the preceding decade so Deere had the benefit of accumulated university research before deciding to enter the SSCM field.

ALTERNATE FUELS AND FLUID POWER

Goering and his students had two other research interests in addition to work on SSCM: alternative fuels research and fluid power.

OPEC oil embargoes and the petroleum price shocks of the late 1970s emphasized the great dependence of agriculture on petroleum fuels, causing Goering and his students to begin research to find renewable alternatives. The primary candidates were ethanol and vegetable oils. The focus of the research was on fuels for diesel engines which are used in farm tractors, large highway trucks, and city buses.

Ethanol is a high-octane fuel for spark ignition engines but is difficult to self-ignite in compression-ignition engines. In early experiments, Goering and his students formed "diesohol" by blending ethanol with diesel fuels. The diesel fuel caused the blend to ignite by compression, but the two fuels tended to separate. Later, research with microemulsions overcame the separation problem. Still later, a large farm tractor was modified to enable it to run on either ethanol or diesel fuel. An additive in the ethanol caused it to ignite by compression, but because the ethanol contained less energy than diesel fuel, the tractor could not produce full power. The problem was solved by fumigation, a technique by which additional ethanol was injected through the air stream of the engine. The compression-ignition, flexible fuel engine (CIFFE) could be quickly converted between ethanol and diesel fuel and could produce full power on either. The research on the CIFFE was supported in part by the Illinois Department of

Energy and Natural Resources (ENR) who borrowed the tractor to demonstrate it at several Illinois State Fairs. At one fair Illinois Director of Agriculture Becky Doyle drove it to a press conference on ethanol fuels. With her as passengers in the tractor cab were Governor Jim Edgar and the U.S. Secretary of Agriculture Ed Madigan.

Diesel engine manufacturers were extremely wary of the use of ethanol in their engines when Goering's research program began in the late 1970s. By 1990 their views had changed completely, and some manufacturers were building engines capable of running on ethanol or methanol. One of these was Detroit Diesel Corporation (DDC), which adapted their two-cycle diesel engine to run on ethanol. The two-cycle DDC engine was a popular engine for city buses, and ENR arranged for a portion of the Peoria city bus fleet to be equipped with ethanol engines. To reduce the cost of the fuel, ENR was interested in the possibility of running the DDC engine on hydrated ethanol and provided a grant to investigate the feasibility of doing so. The research was underway at the end of 1995.

Vegetable oils are a natural compression ignition fuel but have other properties that limit their use in diesel engines. In cooperation with faculty members in Mechanical Engineering and the USDA regional laboratory in Peoria, Goering and a series of graduate students worked on ways to overcome the problems associated with vegetable oil fuels. In 1983 Andy Fitzgerald experimented with production of the methyl ester of soybean oil (methyl soyate) as his AE 299 undergraduate thesis project. The next year, M.S. student John Einfalt carried out a study in which 2,000 gallons of methyl soyate were consumed in a 578-hour test on an AC 190 diesel tractor. In the late 1980s, Goering participated in a Washington, D.C. conference on the use of ester fuels as diesel fuels. Out of that conference grew the national program for the promotion of biodiesel (the methyl ester of soybean oil). In cooperative tests with the mechanical engineering department, using an instrumented engine, Goering and his co-workers found that the high levels of NO_x emissions in methyl soyate could be reduced by retarding the injection timing.

In 1991 Deere and Company provided an important boost to the department by providing funds to establish a fluid power laboratory and a laboratory was remodeled and six fluid power trainers purchased to equip it. The laboratory provided opportunities for both teaching and research and was used in several agricultural engineering courses. Both undergraduate and graduate students decided to conduct research projects in fluid power. One of these, Ruth Book, had spent more than ten years working in the fluid power industry before deciding to return to the department for graduate study. Her Ph.D. research, with Goering as her advisor, was in the newly emerging field of mechatronics. This discipline combines ideas from mechanical and electronic systems to achieve results beyond the capabilities of either field. The aim of Book's research is to develop a generic, computer-controlled directional control valve that can assume different behaviors by changing the computer program.

Instrumentation Automation

Nelson Buck was on the power and machinery staff from 1983 to 1993, when he accepted a position with the USDA in Beltsville, Maryland. His undergraduate degree was in electrical engineering, and his contributions to the department were in electronics where he conducted research on electronic applications to agricultural problems. In a cooperative effort with the animal sciences department, Buck helped to automate the University's dairy farm by developing a milk conductivity probe to detect mastitis. He also developed a vaginal probe for the detection of estrus and a scale to automatically weigh cows in transit to the dairy barn.

Buck cooperated with Goering in research to improve part-load tractor efficiency. With Ph.D. student Xinqun Gui, they developed a computer control system for continuously-variable transmissions (CVTs). The CVT output speed was compared to a desired speed and the resulting error signal was used to control the engine fueling rate. The system adjusted the CVT ratio to keep an optimum torque load on the engine automatically. The system demonstrated fuel savings up to 25 percent, depending upon the power demand on the engine.

Virtual Reality and Farm Safety

Richard Coddington, who joined the department in 1985 after working for Deere and Co. used computers to simulate many conditions. He and Aherin developed programs for simulating machinery accidents. The primary purpose of the simulations was to quantify the range of conditions that contributed to accidents.

During a sabbatical leave with Caterpillar, Coddington became involved in developing virtual reality systems for the design of equipment. In virtual reality, a high-speed computer simulation is able to create a visual and auditory environment that simulates reality. The Caterpillar virtual reality system was intended to aid in the design of operator's stations on Caterpillar equipment. A person in the simulator could operate the controls, and the simulated equipment and environment would behave as if the operator was operating the actual system. The design of the operator's station could thus be evaluated before the first prototype was built. Coddington continued the virtual reality research until he left the department in 1994 to become assistant dean of engineering and director of the Engineering Placement Office.

Aherin cooperated with other faculty colleagues in developing strategies to combat farm accident situations. He cooperated with Nelson Buck in the development of a sensor to detect human presence near a dangerous location on a machine. Buck also developed a device for detecting the electrical field around high-voltage power lines. The intention was to mount the devise on pieces of farm equipment that were tall enough to encounter power lines and thus warn operators before contact occurred.

Aherin also cooperated with Pearson in a survey to evaluate the use or nonuse of personal protective equipment for those handling or mixing pesticides. Later, Aherin conducted a study to evaluate the extent to which migrant workers used safe procedures for handling pesticides. He cooperated with Chris Todd in the human development and family studies department in a survey to evaluate safety practices involving farm children riding on or being near farm equipment. In 1995 Aherin initiated a four-year project to reduce the fatality risk for persons working around livestock manure pits.

Machine Vision

When Reid joined the department in 1986, he brought expertise in machine vision which he had developed during his Ph.D. studies at Texas A&M University. He quickly developed cooperative arrangements with several other scientists. In cooperation with Ben Zur, a visiting scholar from Israel, and with faculty in agronomy, Reid and his graduate students developed a machine vision system to record the growth and development of maize throughout a growing season.

The resulting data were of great help in the development and calibration of mathematical models to predict corn growth and development.

Reid and his graduate students cooperated with Paulsen in machine vision techniques to assess grain quality. As one example, algorithms were developed to analyze images of corn kernels to detect cracks in the seed coat. High-speed inspection of kernel quality would enable grain elevators to consider quality in setting grain prices, thus rewarding farmers whose harvesting and drying procedures protected grain quality.

Reid and his Ph.D. student Dan Humburg developed a machine vision sensor to assist in asparagus harvesting. Conventional, hand harvesting of asparagus is back-breaking work, but machine harvesting can be feasible only if an automatic means is available for detecting harvestable asparagus spears. The system Reid and Humburg developed used machine vision to detect plants in the row, select the images of harvestable spears, and locate the coordinates of the bases of those spears.

Reid applied machine vision techniques to two other power and machinery applications. In one, machine vision was used to inspect diesel injector nozzles to measure the amount of carbon deposits on them. That work was later extended to inspection of engine valves during Reid's sabbatical leave at the University of Natal in South Africa. In another application similar to his Ph.D. research, Reid used machine vision to find a guidance directrix based on the foam blobs released at the end of the boom of large sprayers.

In cooperation with his departmental colleague Bruce Litchfield and with Mary Ann Smith, a horticulturist, Reid undertook research on use of machine vision to control bioreactors. Conventional optimization of bioreactors is time-consuming. Variables that control cell growth can be controlled, but the results of changes cannot be determined until the cells are harvested many hours later. Reid and his coworkers used machine vision microscopy to speed the optimization process. Samples from the bioreactor were placed under a microscope to enable the machine vision system to capture images of the living cells. Through image analysis, changes in cell growth resulting from bioreactor adjustments could be detected in near real time. Thus, the production efficiency of bioreactors could be increased greatly. One of the bioreactor products was plant pigments, which find many uses in the food and cosmetics industries.

Soil and Water Conservation

Soil and water, two of the basic natural resources that are important to agriculture, have been the focal point of investigations since agricultural research began. Research in the area of agricultural engineering has dealt with the conservation of these resources as well as with drainage and irrigation to improve the environment for plants, the movement of water across or through the soil, and the structures used to protect the soil or impound water.

EROSION CONTROL

In 1922, thirteen years before the formation of the federal Soil Conservation Service, E. W. Lehmann and F. P. Hanson initiated studies to determine economical and practical ways to control erosion. Their studies centered around terrace systems built on farms throughout the state. More systems were added each year until by 1930 the study included systems in fifty counties. Data were taken over a fifteen-year period by G. F. Hoover, D. A. Albrecht, E. G. Johnson, and R. C. Hay to compare terrace spacings, grades, construction equipment, construction methods, and costs. In addition, observations were made by E. L. Hansen and Hay to determine causes of failures and evaluate various maintenance methods and practices.

The results of these studies led to standardization of methods for constructing broad-base terraces that could be tilled with modern farm machines. They also provided information for developing design criteria used throughout the Midwest for twenty-five years.

By 1950 larger field machines and changes in farming operations had created new challenges in the design of terrace systems. To help solve these challenges, B. A. Jones, Jr., and Hay, in cooperation with H. B. Atkinson, R. E. Burwell, and C. A. Van Doren of the Agricultural Research Service, USDA, constructed a system of terraces on the Elwood Experiment Field to determine the effects of new farming operations on terrace cross-sections and grades and develop more acceptable design criteria. After a few years, parallel terraces were incorporated as part of the study. This study, conducted from 1950 to 1957, showed that farming across terrace ridges reduced the cross-section area by an average of 12 to 15 percent annually but capacity of the terrace channels could be reestablished easily by plowing. The study also emphasized that maintaining a terrace near an outlet is difficult, but doing so is the key to satisfactory performance, especially during large rainstorms.

In a study conducted from 1948 to 1954 by the Department of Agricultural Economics, on the economics of soil conservation, Hay served on a consulting basis and made field observations and recommendations. In 1958 he and W. S. Harris completed a study drawn from field observations of gully rehabilitation and waterway design.

In 1958 Jones and J. A. Replogle began a study of rainfall energy and soil erosion, along with L. C. Johnson of the Agricultural Research Service, USDA, and D. M. A. Jones of the Illinois State Water Survey. G. D. Bubenzer of the department and J. S. Rogers of the ARS, USDA, also worked on the project near the end of the study, which was discontinued at the end of the 1964 cropping season. This study, located on the Forestry Farm at Urbana, used an extensive electrical system to photograph raindrops, measure surface flow, sample sediment loss from the corn plots, and record soil moisture tension. From these data, rainfall energy was determined and related to soil and water loss and changes in surface condition of the soil. Thus a better understanding of the mechanics of soil erosion was developed.

From 1966 to 1969, Bubenzer and Jones used artificial rainfall to investigate the effect of size and impact velocity of raindrops on the detachment of soils. Multiple correlation techniques were used to relate soil splash for each soil to rainfall characteristics.

During much of the 1970s erosion control research was often conducted as a part of water quality research because the environmental community was emphasizing quality of water. The department faculty was working on a continuum, and the following account is arbitrary about whether it concerns erosion control, hydrology, or water quality.

After completing his doctoral program and joining the professorial faculty, Mitchell and many graduate assistants conducted studies to understand the basics of the erosion process and the impact of changes in component values on erosion and sediment transport. A plot rainfall simulator was built and widely used to obtain comparable data for different soils, tillage practices, and chemical applications. Some of these data were used to improve the Universal Soil Loss Equation; other data were used to analyze and understand chemical transport in surface and soil water.

Some of the data were used to develop the Modified Answers (MODANSW) model. Some of the specific studies were those of S. W. Park on modeling soil erosion and sedimentation on small agricultural watersheds; L. K. Ewing on numerically simulated soil surface degradation; R. H. Chen on the effect of rainfall duration and slope steepness on aggregate and particle size distribution on eroded soil; D. D. Gustavson on erodibility of reclaimed soils; and M. C. Pond on particle and aggregate size distributions of eroded soils. Lembke and R. A. Lah also contributed a study of hydraulic conductivity of reclaimed surface-mined soils.

Lembke and E. Mings conducted a study of terrace design by computer to explore ways of using this new tool for design of an important erosion control practice. Later, M. C. Hirschi developed software to use the computational and graphics power of microcomputers and the knowledge of expert designers to plan terrace systems. The software permits the user to accept or discard expert suggestions at any point in the design process.

In the mid-to-late 1980s, studies with the rainfall simulator continued at an accelerated pace. Of special interest were the effects of different tillage systems, row direction, residue, and canopy cover. Pesticide loss was also a major consideration. Such studies were important because of the emphasis on water quality and possible pesticides in water. G. F. McIssac joined the team working in this area. Ewing and Y. M. Mohamoud also studied the effect of tillage on rainfall infiltration and surface depression storage. Mitchell and Sodeghian studied overland flow on disturbed soil, while Mitchell and J. D. Wells evaluated pesticide runoff models for agriculture.

A computer model, Overland Flow, Erosion, Sediment Delivery, and Soil Surface Degradation (OFESSD), was developed that simulated runoff, erosion, sediment routing, and soil surface degradation in a manner comparable to observed data. Various soil surfaces, including rill and interrill, were simulated. The model is applicable for dynamic overland flow, sediment routing, and soil surface degradation on small fallow areas where erosion is by raindrop splash and runoff sheer stresses. A procedure for obtaining parameter values of the modified Holtan infiltration equation was also developed as an improvement of the model.

Mitchell and C. L. Armstrong studied the influence of vegetative canopy on drop size and spatial distribution of rainfall. Distribution curves of concentrated volume and area were developed to describe the spatial redistribution of rainfall by canopies.

With each passing year, additional field or laboratory data became available and hence the ability to test and evaluate the many computer models proposed to analyze erosion and hydraulic theories. The faculty tested the Chemical, Runoff and Erosion from Agricultural Management Systems (CREAMS) model and OFESSD. Ewing and D. L. Liu conducted a sensitivity analysis of the soil surface degradation model and learned that there were no highly sensitive parameters for soil surface degradation.

M. C. Hirschi and D. R. Feezor evaluated Sediment, Erosion, Discharge by Computer Aided Design (SEDCAD+) for use on agricultural watersheds and wetland sediment modeling. DrainMod Soil Data Input Preparation Program (DMSOIL) was tested, and a method of extrapolating hydrologic data from soil textual information developed. DMSOIL was evaluated by establishing the optimum drain spacings for four soils using measured soil data and soil data predicted by DMSOIL.

In the early 1990s emphasis continued on the effect of tillage practices on sediment, chemical, and nutrient losses from cropland, the vertical movement and degradation of a herbicide at high concentrations under rainfall, and the development and evaluation of computer models. Using the 1984–89 field data, nonlinear regression models were developed using plot slope, residue cover, and canopy cover as independent variables. A laboratory study was conducted by Hirschi and B. J. Lesikar to examine the effect of concentration and rainfall pattern on degradation and vertical movement of alachlor. Mitchell and A. L. Kenimer developed the Pesticide Availability and Transfer Simulation (PATS) model to define the movement and degradation of pesticides in surface runoff and sediment transport.

An alachlor movement and degradation study was also conducted using Leaching Estimation and Chemistry Model-Pesticides (LEACHMP). Ewing and F. H. Naqvi studied CREAMS representation of tillage effects on pesticide runoff, and Mitchell and B. T.

Linvill used CREAMS for representation of land-formed, alachlor-contaminated soils. Finally the Agricultural Nonpoint Source (AGNPS) model was evaluated for predicting runoff and sediment delivery from small watersheds in east central Illinois.

The federal Hatch Act, which provides funds to agricultural experiment stations, provides mechanisms for coordinating research conducted in two or more states. The program is known as regional research, but states are not limited to any single region and may participate anywhere in the United States. The great advantage of regional research is that it permits a number of states to address a specific objective thereby generating a larger pool of data than any one state can generate. Illinois took a position of leadership on several regional committees dealing with erosion and sediment control, hydrology, and water quality. Notable were "Effects, Mechanisms and Control of Erosion and Sediments from Agricultural and Forest Lands" (S-174, Mitchell); "Hydrologic/Water Quality Modeling of Sediment and Chemical Movement" (S-211, Ewing); "Control Prediction, Economics and Environmental Effects of Soil Erosion" (S-218, Mitchell); and "The Impact of Agricultural Systems on Surface and Groundwater Quality" (S-249, Konyha).

Participation in a succession of these regional activities since the early 1980s was a strong positive factor leading to the development and testing of a number of the models described earlier. It also meant that the Illinois data had a much greater impact than if it had been limited to the state.

Drainage

Many Illinois soils need subsurface drainage to produce maximum crop yields. In 1926, Lehmann, Hanson, and R. C. Kelleher, with C. E. Ramser and R. A. Norton of the USDA as cooperators, initiated field studies using draw-down wells, primarily in soils of questionable permeability, to determine the rate and extent of water movement to tile drains. After 1949, W. F. Lytle, E. J. Monke, Jones, and Hay worked with Van Doren and E. H. Kidder of the SCS and R. T. Odell and R. S. Stauffer of the Department of Agronomy on drainage of the plastic till soils of northeastern Illinois and other slowly permeable soils farther south in the state. These studies provided information on depth and spacing of tile and also helped to determine if it was feasible to tile-drain given soil types.

Until 1955 drainage research was conducted in the field, because few laboratory facilities were available. After new facilities became available in the Agricultural Engineering Research Laboratory in 1955, they were used in the development of more basic drainage research programs by Jones, D. R. Sisson, Monke, R. D. Black, Replogle, and R. N. Fenzl.

One of the first studies was Jones' investigation of the effect of the amount of space between adjoining tile on soil movement into the line. Sisson then studied the effectiveness of filter materials in keeping soil out of tile lines. Jones's study, for his Ph.D. thesis, showed that soil enters tile joints at the bottom, below the air-water interface; and the soil moves as a result of energy supplied by drainage water moving into the joints. A joint itself disturbs flow very little, and the disturbance has little effect on soil movement. The main effect of water flowing past a tile joint is to carry soil particles away as drainage water pushes them in. The study showed that a sixteenth-inch crack is the widest suitable for the silt loam soil used in the test, but an eighth-inch crack could be used for a silty clay-loam soil. Submerging the outlet increased the soil discharge from 30 to 100 percent over that from a free outlet.

The study by Sisson showed that filter materials did not decrease the rate of drainage flow. Sheet plastic, straw, and sawdust around tile joints were greatly superior to no filter material in keeping soil out of tiles. These results were used in Illinois and Indiana to prepare guides for constructing tile drains in soils with high water tables.

Monke's study for his Ph.D. thesis, based on an idealized flow system, showed that probably no theory could encompass all of the gross variabilities within a natural drainage region. Theories based on idealized flow conditions could not resolve such effects upon drainage discharge as structural cracks, roots, and holes in the soil. Nevertheless, he predicted these theories would be used in the future as a basis for rational design.

Before the beginning of the development of the interstate highway system in the 1950s, there had been a general lack of understanding of the application of drainage laws as they related to highways and landowners. For this reason, Hay, Jones, and C. J. W. Drablos initiated a study in 1959 to compile and analyze the laws that were applicable to highway and agricultural drainage and determine the practices and procedures highway authorities used in meeting the requirements of the laws. The first two phases of the project resulted in an Engineering Experiment Station bulletin and an Engineering Experiment Station circular that were widely used and became models for similar studies in other states. Finally, to translate the findings into a useful product, the Illinois Division of Highways had Drablos and Jones prepare a manual for division personnel. This latter publication generated a great demand from all over the United States and soon was out of print.

The release of the manual led to discussions between agricultural organizations and the division on ways in which they could cooperate to achieve good drainage for highways and the adjacent land. The discussions resulted in a memorandum of understanding outlining procedures to be followed by a number of parties to initiate dialogue and cooperation as new highways were built or existing ones were reconstructed. The entire research and resulting actions took nearly ten years of effort but have proven to be one of the more useful research projects of the division.

In 1969 Jones, C. J. W Drablos, and R. L. Bengtson completed a study to identify physical features of land that significantly affect benefits from drainage improvements. Three factors were identified and used, with an increase in corn yield as an indicator, to develop an empirical equation to determine the assessment for any tract of land in a drainage district. The equation has been used by some drainage districts in preparing their assessments. In the same years Jones and G. B. Johri completed a similitude analysis of tile inflow.

In the early 1970s plastic drainage tubing was emerging as a successor to clay and concrete tile, and Drablos initiated extensive field studies to evaluate the suitability of this material for agricultural drainage. He found that installation technique was a major factor in gaining the maximum strength of the tubing. Additional studies were conducted by P. N. Walker and C. L. Armstrong.

Also in the early 1970s Lembke and R. L. Elliott, and Drablos and L. W. Wendte developed models to predict available spring work days and earliest planting dates for fields having a subsurface drainage system with a fluctuating water table. As a result of these studies, Walker and M. L. Voorhees conducted a study to determine the amount of soil moisture at which the soil becomes trafficable for moldboard plowing.

In the late 1970s and throughout the 1980s Lembke and Walker continued to lead a number of field and laboratory studies to understand basic physical phenomena or determine results from their application. Walker and P. N. Singh studied the structural stability of mole drains, while Walker and W. Goetsch studied soil moisture and corn yield on clay-pan soils. With updated field values of permeability, Walker, J. D. Wells, Lembke, and J. G. Arnold revisited the question of spacing of subsurface drains on slowly permeable soils in Illinois and Indiana. They reaffirmed that on most soils tested, subsurface drainage was not economically feasible.

In 1984, twenty-five years after initiating the study of highway and agricultural drainage laws and fifteen years after preparation of the Division of Highways practice manual, Drablos and Jones in cooperation with D. L. Uchtmann in agricultural law were asked to bring the earlier results of their research up to date. This resulted in an Agricultural Experiment Station bulletin and recommendations for changes in the manual.

IRRIGATION

Some Illinois soils are more seriously affected by periods of irregular rainfall than others. To determine the feasibility of irrigating some of these soils, Lytle, R. W. Whitaker, H. L. Wakeland, and Jones, in cooperation with L. E. Gard, G. E. McKibben, and R. J. Webb at the Dixon Springs Agricultural Center, conducted studies in the late 1940s and early 1950s to determine the response of grass-legume pasture and corn to irrigation and the optimum stage of plant growth at which to irrigate corn. The studies provided data on the use of forage produced under irrigation and the most economical time to irrigate under southern Illinois conditions.

In 1969 Lembke and R. J. Godwin developed a multidimensional irrigation water balance model to study the effect of varying system parameters upon crop stress and irrigation. Three methods for scheduling irrigation of corn were compared. A satisfactory practice was to irrigate corn after any seven-day period in which it did not receive an inch of water.

During the late 1970s Walker and Lembke, with some agronomists, initiated a study of irrigation and drainage on clay-pan soils. The study showed benefits for both drainage and irrigation when continuous corn was grown. The comparison of two methods of scheduling irrigation showed no significant difference.

In the late 1970s trickle irrigation was a widely used practice in many parts of the world and in the United States, but it had had little use in the Midwest because of the soils and climate there. Mitchell and S. Mostaghimi undertook a basic study of moisture distribution in the soil profile using this practice to better understand its application to Illinois soils.

In the mid-1980s an irrigation scheduling program was developed for use on a minicomputer with the potential to reduce water use and energy costs. Lembke and B. A. Engel developed corn crop coefficients for the new program. Through cooperative effort the Illinois State Water Survey provided telephone-accessible weather information to farmers on a daily basis.

In 1985 the study of irrigation and drainage on clay-pan soils was discontinued. The project reaffirmed that the selection of crop variety may be as important as the production practice used. Also in 1985, a combined drainage subirrigation project was initiated by Lembke on the agricultural engineering research farm at Urbana. Results indicated limited benefit from subirrigation on this soil. Later studies using Drainage Model (DRAINMOD) confirmed that irrigation is not economically viable for the silty clay-loam soil at the test site. In the late 1980s Lembke and M. A. Gingerich numerically simulated unsaturated flow under a center pivot irrigation system limited to 180-degree rotation.

In the early 1990s K. D. Konyha and S. C. Yu conducted a study of boundary modeling of saturated flow during steady application of municipal effluent in a subsurface irrigation and drainage field. Some of the studies contributed to regional research under "Irrigation Scheduling Methods for Efficient Water and Energy Use," (NC-163). Lembke was the station representative to the committee.

HYDRAULICS

The small hydraulics laboratory in the Agricultural Engineering Research Laboratory made it possible to add hydraulic studies to soil and water research that consisted of more intensive, controlled investigation of an existing project or new studies of hydraulic phenomena related to agricultural problems. One example was the complete redesign of sediment-sampling equipment for the rainfall energy-soil erosion study by Replogle in cooperation with Johnson of the Agricultural Research Service, USDA. The work began with the calibration of existing Coshocton sampling wheels. However, because tests disclosed some inaccuracies the system for sampling soil and measuring water lost from the plots was completely redesigned. Another example was a model study by Replogle and Black of the drop-inlet spillway used on one of the watersheds in the hydrologic studies. Precise calibration of the structure was needed to accurately measure the flow from the watershed.

Hydraulic phenomena studies have included a study of the flow characteristics of grates for surface inlets by Black, Replogle, and L. F. Huggins; turbulent velocity distribution in smooth pipes by Huggins and Jones; variation of tractive force in sewers and drains by Replogle and V. T. Chow of the Department of Civil Engineering; the effect of sidewalls on laminar flow in open rectangular channels by Woerner and Jones; and the mechanics of square elbow losses by Black. These studies have added to the understanding of hydraulic phenomena, and the results have been reported in Ph.D. theses in civil engineering by Black and Replogle and in master's theses by Huggins and Woerner.

In two studies conducted by R. N. Fenzl between 1962 and 1964, the isolated roughness concept and other proposed means for describing hydraulic resistance in open channels were tested for applicability to conditions of natural roughness. Results indicated that additional research would be required before relationships suitable for describing the resistance artificial roughnesses produced could be applied to natural channels.

In 1965 Jones, Fenzl, and A. O. Weiss conducted a laboratory model study of channel scour immediately upstream from straight-drop spillways. The objectives were to determine the causes of such scour and, if possible, to define design modifications that would provide greater channel stability at the spillway. The study showed that the severity of scour was influenced by the ratio of channel width to spillway width and the Froude number at the point of maximum scour.

A study by Fenzl and W. F. Brutsaert in 1966 of the effect of downstream boundary conditions on the solutions of unsteady, spatially varied flow equations showed that solutions obtained with the variable boundary were stable and compared favorably with those values measured in a laboratory flume. Results using the fixed boundary conditions tended to be unstable. In 1967 Fenzl and J. D. Hendrick investigated the factors important in scour from a cantilevered pipe outlet.

With the resignation of R. N. Fenzl in 1967 hydraulic studies gave way to studies of flow on the surface of the soil as it would occur in watersheds.

HYDROLOGY

Hydrologic studies were initiated in 1948 and 1949 by Lytle and Hay at the State 4-H Memorial Camp and the adjacent Allerton Trust Farms near Monticello. The work was conducted cooperatively with the Watershed Hydrology Section of the Agricultural Research Service, USDA. Four agricultural watersheds ranging from 45 to 390 acres were fully instrumented with recording rain gauges and water-level recorders to measure rainfall and runoff.

The Allerton watersheds were monitored until 1983, with supervision of that work passing to Jones and then in 1964 to Mitchell. Several studies have resulted from the data obtained. Hay and D. L. Brakensiek in 1952 used the data to demonstrate watershed and infiltration capacities, and Jones and D. L. Pigg in 1959 completed an early rainfall-runoff analysis of two of the sub-watersheds. Mitchell and S. Hardjoamidjojo in 1978 provided a hydrologic frequency study of the rainfall and runoff data. Mitchell and S. Mostaghimi evaluated peak runoff model applicability to the Allerton watershed data. Mitchell and E. C. Dickey examined the value of some hydrologic models to east central Illinois situations using the Allerton data. Allerton watersheds data continue to be requested by hydrologic researchers to validate models for mild topographic conditions.

Additional watersheds, located in Champaign and Piatt counties, were instrumented with peak-stage gauges and installed at structures located near their outlets to determine peak flows from watersheds ranging widely in size. Results were analyzed in a series of computer programs to supply data for more accurate and economic design of runoff control structures.

The measurement of infiltration rates for Flanagan, Elliott, and Cisne soils by Jones, Bubenzer, and Fenzl was completed in 1964. As a part of NC-40, the Purdue sprinkling infiltrometer was used, and the effects of antecedent moisture conditions and crop cover were determined. The data were added to those obtained on other soils by investigators throughout the North Central Region of the United States. These data were published in a regional research bulletin by the Illinois Agricultural Experiment Station.

In a new project initiated in 1964, Fenzl and A. Klute of the Department of Agronomy developed a mathematical model for simulation of hydrologic processes in small watersheds. The model included provisions for both surface and subsurface flow as influenced by variation in rainfall, topography, and soil.

From 1966 to 1968 R. A. Rastogi and Jones used the geomorphic characteristics of six small ungaged drainage basins in Illinois to develop morphological relationships to formulate drainage basin models for different drainage densities. The morphological relationships were used to develop a drainage basin model with a network of different order streams and channel characteristics. Then a mathematical model using kinematic wave theory was used to study the effect of rainfall excess intensity, duration, and pattern and basin size and roughness on time parameters and shape of hydrographs for a third-order stream system.

Mitchell and Jones, from 1966 to 1970, determined quantitative values of micro-relief surface depression storage and how storage changed with different rainfall characteristics. Artificial rainfall was applied to a three-foot-square soil bin using four intensities and three durations. The results showed that the change in surface depression storage during a rainfall event can be described from pertinent hydrologic parameters. N. A. Barren provided geometric modeling for this effort. Mitchell and R. W. Gunther used the same laboratory facility to define the water quality and erosion effects of soil treated with liquid swine waste.

Water Quality

Starting in 1970 the College of Agriculture brought together teams of faculty from many departments and other units on campus to study nitrogen in the environment. W. D. Lembke provided major leadership directing studies in the laboratory and in the field, Dickey studied pond water quality, L. A. Davenport examined denitrification in sand columns, and F. Kolonda modeled the movement of water and nitrate in the soil profile.

By the time the projects ended in the mid-1970s, studies had shown that livestock or human waste is the primary source of nitrates in shallow wells in southern Illinois and that farm ponds polluted by runoff from livestock areas have low nitrate levels when compared with existing wells in the same area.

The nitrogen study showed that conventional private sewage treatment systems might be a source of contamination of home water supplies. Therefore, in 1976 a project was initiated by D. H. Vanderholm to study alternative treatment systems, especially for slowly permeable soils. A major component was the recirculating sand filter studies by Vanderholm and D. J. Ralph. Studies continued into the 1980s, with other faculty joining the team. Lembke and Ewing, for example, studied numerically simulated unsaturated flow through recirculating filter media. The research showed that systems can produce effluent suitable for surface discharge.

Concurrently, Vanderholm and Dickey studied the use of vegetative filter systems as a method to treat feedlot runoff. Design criteria were determined. Walker and Mak developed a simulation model of recycling agricultural runoff, and Vanderholm and D. R. Kendrick studied nitrate and chloride movement in the soil after the application of manure. Lembke and M. D. Thorne studied the use of sludge and chemical fertilizer for irrigated corn on sandy soil.

In the early 1980s Lembke and faculty in agronomy studied the feasibility of dredging sediment from small lakes and returning it to agricultural land. A major problem was the negative impact on water quality during the dredging and dewatering process. During the late 1980s a sixty hectare subsurface wastewater treatment system was studied to determine its effectiveness as a final water treatment process to decrease phosphorous, nitrogen, and ammonium concentrations. Alternative fertilization strategies were recommended.

By the early 1990s studies were initiated on the construction of wetlands as a possible best management practice (BMP) acting as a buffer between agricultural fields and aquatic ecosystems. Data are being collected for three wetlands on overland and subsurface water and nitrogen (N), phosphate (P), and potash (K) movement. The research will contribute to an understanding of the mechanisms driving wetland nutrient uptake and removal. The goal is to develop specific nutrient-reduction strategies suitable to midwestern agricultural systems.

The Little Vermilion River Watershed Hydrologic Unit Area project was begun in 1991 as a result of concern with the water quality of Georgetown Lake as well as other water supply lakes in Illinois. Mitchell and Hirsch initiated and developed a monitoring project in that watershed. R. A. C. Cooke and V. M. Kurien defined the effective drainage width of single random tile so the drainage area size of several monitoring locations could be determined. Mitchell and S. E. Walker modeled the hydrology and nitrate transport relationships of the upper portion of the watershed. The project has since developed into an extensive monitoring GIS database development and watershed modeling. Participants include Mitchell, Hirschi, Cooke, McIsaac, and Walker, as well as several laboratory and field technicians.

Electric Power, Food and Bioprocess Engineering

Research in electric power and processing, now known as food and bioprocess engineering, has developed practices that have become common on many farms in Illinois. It has emphasized greater use of electric power from central distributing plants, automatic processing and drying of crops, the automatic handling of feed and waste, and improved health of farm people.

EARLY DEVELOPMENTS

About the turn of the century the College of Agriculture recognized the need to improve home lighting. T. H. Amrine, instructor in electrical engineering, was employed to prepare a publication on "Lighting Country Homes by Private Electric Plants." This thirty-five-page circular was published in 1908.

By 1921, when the Department of Farm Mechanics came into being, electric service was available to less than 10 percent of the farms in the state. Electric service was available in Illinois cities and towns, and electric companies were beginning to study the possibility of extending the service to farms. Where electric power was available on farms, most of it was furnished by an individual electric unit located on the farm. These units were small and were not adequate to meet farm needs.

Soon after E. W. Lehmann arrived in 1921, he and his associates became interested in finding ways to expand the use of electric power on farms. In the summer of 1923, Lehmann and Shawl surveyed the use of electricity on ninety-three farms in Bureau County. The results indicated a need for more research, and plans were made to install an experimental electric line to furnish 110 and 220 volts of power to ten farms near Tolono, Illinois. That line was built in 1924. The purpose of the experiment was to determine the extent to which electricity might be used, the requirements for new equipment that could be electrically operated, and the economics and feasibility of farm electric service. Support for the Tolono experiment was obtained from the Illinois State Electric Association. An advisory committee, headed by Dean H. W. Mumford of the College of Agriculture, was appointed to provide counsel on the project.

This early study indicated that electrical equipment could enhance farm life by improving living conditions and decreasing labor requirements both on the farm and in the home. By 1926 farmers on the Tolono line were using 120 kilowatt hours of electricity a month, compared with about 30 kilowatt hours a month by another group of Illinois farmers. By 1937 use of electricity by the ten cooperating farmers had increased more than four fold to 540 kilowatt hours a month, and by 1965 some highly mechanized livestock farms were using more than 1,000 kilowatt hours a month.

A 1933 survey indicated that only 13 percent of the farms in Illinois were getting electrical service from a central station. About 6 percent were still using individual farm lighting plants, only 4 percent less than the number in 1921. Then in 1935 the Rural Electrification Administration, a federal agency, was created to help make electric power available to farms.

Health Improvement

The importance of promoting healthful conditions on farms was recognized almost as soon as the University opened. In several sections of the state, S. W. Shattuck, the first professor of agricultural engineering, gave a talk on sewerage. His talk appears on seven pages of the Board of Trustees Report for 1872.

Because in 1921 electric power was not generally available on farms to provide power for running water, few Illinois farm homes had indoor toilets and bathrooms. Water was supplied by means of hand pumps and windmills. Little was known about the correct size and shape of farm septic tanks suitable for disposal of human waste. A study of experimental farm septic tanks was started in 1924 by Lehmann and Kelleher in cooperation with A. M. Buswell of the Illinois State Water Survey. From 1924 to 1938 they observed tanks located on the university farms. Their final recommendation was that "a tank with a capacity of at least seventy-two cubic feet, holding about five hundred gallons, was suitable to serve one family. A tank of this capacity will not require cleaning oftener than every ten to twelve years. If the tank is too small or is overloaded with sewage, it may need cleaning as often as once every three years." Results from the study were used by the University of Illinois Small Homes Council in a publication on septic tanks.

Production of Gas from Farm Waste

During the depression years of the early 1930s, interest was shown in finding uses for agricultural waste products. A national chemurgy organization was formed to pursue this objective. At Illinois, Lehmann began a project to study the feasibility of producing gas from farm waste. The animal husbandry department agreed to cooperate and a building was constructed near the beef cattle barn in which to house a waste digester that produced the gas.

Tests were made to determine the potential for producing gas for home heating and cooking from crop and livestock waste materials. Results from many tests made from 1933 to 1936, involving various types of materials, indicated that the process would not be profitable because of the heat required to keep the digester operating during cold weather. Equipment and labor costs were high in relation to the amount of gas produced. Determinations made by the Department of Agronomy also showed some loss in fertility value of phosphorus and potassium during digestion, thus further reducing the economic potential of the process.

Industrial Cooperation

Through the years, the department has had the cooperation of industries and organizations interested in electric power and processing. The most notable example was the formation of the Illinois Farm Electrification Council in 1952. The College of Agriculture, farm organizations, electric companies and cooperatives united to help Illinois farmers make more effective, efficient, and safe use of electrical energy and equipment. Funds contributed by the Association of Illinois Rural Electric Cooperatives and by private electric companies assisted materially in developing and improving the research program in farm electrification and processing. In addition, individual equipment manufacturers contributed extensively to the research programs.

In 1995 the IFEC changed its name to the Illinois Electric Council (IEC). Agricultural engineering faculty members have served as the executive secretary or executive director of the IFEC or IEC. Serving in that role have been Harold H. Beaty, Elwood F. Olver, and currently Paul W. Benson. According to the IEC Bylaws, "The purpose of the corporation shall be to provide a forum through which the College of Agriculture, University of Illinois, investor-owned utilities, electric cooperatives and related groups discuss mutual problems, share information and develop cooperative education programs and research activities designed to encourage more effective, efficient and safe use of electric energy and equipment on the farms and in the homes and businesses of Illinois; and to do all, or any, of the acts incidental and necessary to the proper exercise of the powers of this corporation."

AUTOMATIC FEED HANDLING

In 1948 a study was initiated to find ways to reduce the time required for the large number of farmstead chores. A team consisting of M. W. Forth, F. W. Andrew, R. W. Mowery, and L. S. Foote developed feeding systems with many automatic features. It would remove ear corn, supplements, and grains from storage, grind and mix them into a balanced ration, and then convey the ration to livestock.

Through the cooperation of the university and interested industries, ear corn feed processing units were installed on twelve Illinois farms and performed satisfactorily. Soon thereafter the change from ear corn to shelled corn reduced the demand for automatic ear corn feed-processing units.

Further investigations during the period from 1948 to 1964 made it possible to develop many components for feed-handling systems. The components included the first-known mechanical bunk feed distributor suitable for feeding livestock, automatic feed grinding and blending equipment, low- and medium-pressure pneumatic feed conveyors, and metering equipment for blending feed materials into balanced livestock rations. A system was devised to "fluidize" components into a one-inch-diameter pipe with medium air pressure and convey them above or below ground to bulk feeders as far as two hundred feet from the mixing plant. A major improvement in this system was the development by Hoyle B. Puckett, Agricultural Research Service (ARS), USDA, and Herschel H. Kleuter, also of USDA, of a simple method to introduce the feed into the medium-pressure line. The various components of this fluidized system were used in 1958 to develop the Hog-O-Matic system which involved automatic preparation and movement of feed to the feeders as well as equipment for automatic disposal of manure. In addition, automatic systems for dairy and beef animals were installed on the University farms. A predetermined feed ration was delivered at desired time intervals as a result of automatic controls developed by Puckett in cooperation with Mowery, Donald R. Daum, and other Illinois agricultural engineers. These installations permitted studies of the operation of feeding mechanisms and the potential benefits to be gained by feeding given amounts of feed at different intervals of time.

In addition to the university installations, a completely automatic feed-processing unit was installed on a poultry farm near Peoria in 1959. The cooperating farmer, Warren Frye, was well satisfied with this installation and reported that the improvement in rations made possible by the processing of home-grown feeds increased his net income.

The research activities by Illinois and USDA engineers produced many new ideas. Patents were granted for the development of a flat bin unloader for round grain bins and for auger-type pneumatic feed injectors. In 1958 Robert M. Peart developed a low-power vertical auger elevator suitable for silo unloaders. A bucket type of elevator was designed, built, and tested in cooperation with a commercial company. This low-power elevator for granular and fibrous materials was developed by Dwight F. Kampe, Floyd L. Herum, and others from 1958 to 1960.

In 1964 Elwood F. Olver, William Muir, and Kenneth E. Harshbarger (of dairy science) formed a team that developed a metering mechanism that made it possible to feed concentrates to dairy cattle proportionate to the amount of water they drank. In general, a cow would get about one pound of concentrates per gallon of water consumed. The only conclusion that could be drawn from this study was that the production of cows fed from this new proportioning feeder did not differ significantly from that of the control group which was fed conventionally. Olver presented a paper on dairy cattle feeding systems at the Sixth International Congress of Agricultural Engineers in October 1964 in Lausanne, Switzerland as Illinois' work attracted international interest. The automatic feed-handling system also attracted the interest of many organizations, institutions, and visitors, both local and foreign, who came to observe the work.

Crop Processing

In addition to the many studies on grinding of grains, there have been many investigations on the drying of agricultural products. One involved designing and building a machine to wash apples. The machine, designed by R. H. Reed, had a system to heat water to facilitate the removal of spray residue, which was causing some four million bushels of Illinois apples to be rejected each year. The investigation was conducted from 1933 to 1936 in cooperation with the Department of Horticulture.

Grain Storage, Conditioning, and Drying

The first project on grain storage, conditioning, and drying was prompted by the prospects of soft corn in September 1924 and the introduction of the combine to harvest soybeans. The objectives were to study methods of storing soft corn, ventilating corn cribs, artificially drying soft corn, drying seed corn, storing and drying small grains and soybeans, and drying alfalfa, clover, and similar forage crops. The early work was done under the direction of Kelleher, Lehmann, and W. L. Burlison of agronomy. The study included natural, forced-unheated-air, and forced-heated-air drying. The results showed that temperatures above 130 degrees F might injure germination of corn. As early as 1927 a portable dryer was built and used to reduce the moisture content of wheat and ear corn stored in farm-type structures.

Interest in and the need for more basic facts about drying grain became apparent with the introduction of hybrid seed corn about 1935. R. H. Reed and Fred Wiley designed and built a special laboratory drier that would dry a few ears of corn at a time. With this unit, drying rate curves and the effect of heat on corn germination were determined for conditions of constant humidity and temperature. The results indicated that seed corn could be dried at temperatures up to 110 degrees F without destroying the germination. This information was valuable to many hybrid seed companies that were being organized at the time. In addition, tests were made to determine the drying characteristics of other crops and products, such as artichokes. The effect of air temperature and humidity on the control of specific insects was studied in cooperation with the Department of Entomology.

A cooperative project was started with the USDA in 1936 to determine grain storage methods best suited to Illinois. Thayer Cleaver was the USDA collaborator and work was done on wheat until 1941. In 1943 another cooperative project was started with the federal government and commercial companies under the direction of Deane G. Carter and USDA collaborator Leo Holman. Sixty farm-type bins, with a total capacity of seventy-five thousand bushels, were built using different construction methods and types of materials. The results gave information on safe moisture contents, methods of reducing moisture migration, effects of ventilation, and methods of artificially drying soybeans.

Soon after World War II, portable heated forced-air dryers became available commercially and many studies were made to test and evaluate them. These studies included performance tests of various drier designs, methods of drying ear corn in farmers' cribs, and methods of drying baled hay. Holman, Andrew, and John H. Ramser designed and built a column-type batch drier in 1949 and made the plans available to farmers.

In 1953 Ramser initiated research to determine the effect of artificial drying on the milling and baking qualities of wheat and on the wet milling and feeding value of corn. The work was done in cooperation with the Department of Agronomy and the Northern Regional Research Laboratory of USDA in Peoria. The grain drying tests indicated that 140 degrees F was the maximum temperature that should be used to preserve the baking quality of wheat and the wet milling qualities of grain. However, temperatures above 140 degrees F did not seem to affect the nutrient value of grains fed to livestock.

In 1958 a cooperative study was initiated by the Departments of Dairy Science, Animal Science, and Agricultural Engineering and the silo industry on harvesting high-moisture shelled corn, storing it in conventional upright silos, and feeding the shelled corn to different species of livestock. Hansen and Ramser represented the Department of Agricultural Engineering in the project. The research was considered an outstanding contribution to livestock feeding. It established the merits of storing and feeding high-moisture corn, which was widely accepted by farmers and which helped the silo industry in the design of their products.

Many ear corn cribs were converted to dry shelled corn storage with the help of the publication "Remodeling Cribs for Shelled Corn Storage," by Joe T. Clayton and James O. Curtis. Research also was conducted on linings to provide air-tight storage in ear corn cribs.

In 1960 Yoerger initiated a project on the accelerated drying of shelled corn. The objective was to study means of rapidly removing moisture from shelled corn at temperatures up to 700 degrees, with a view to making drying equipment an integral part of the field picking and shelling equipment. By 1964, several preliminary studies had been made of a small rotary drum and a continuous-flow laboratory model drier, and attempts had been made to remove moisture by subjecting a mass of corn kernels or individual kernels to high-temperature air. One feeding trial with small pigs indicated that high-temperature conditions did not lower feeding value.

In 1961 David R. Massie attempted to increase the allowable time for drying grain by using a controlled atmosphere. Allowable drying time was not increased in a carbon dioxide atmosphere but drying time was extended by treating the wet grain with a chemical mold retardant.

Gene C. Shove joined the faculty in 1958 and began his research on grain drying and storage and the control of temperature and moisture in animal shelters and crop storage facilities. His most notable research was his contribution to the development of the concept of the no-heat or low-heat method of drying grain. In the late 1960s he applied refrigeration equipment to the conditioning of grain in storage. The word *dehydrofrigidation* was coined to describe a system of removing moisture from wet grain in storage with refrigeration equipment. Mechanical difficulties with equipment and cost of operation were major reasons for the lack of acceptance of this system by the agricultural community.

Using the experience and information obtained from the dehydrofrigidation investigation and from USDA studies at Iowa State University on the allowable storage times for grains, particularly shelled corn, Shove began working with farmers throughout the state on a method of using small amounts of electric heat to dry shelled corn in storage bins. Data collected from drying bins of cooperative farmers and from laboratory investigations eventually resulted in electric heat energy being used to provide additional fan power to supply larger quantities of unheated air to accomplish more drying during the relatively good early fall weather in midwestern corn belt states. No-heat and low-heat drying became widely accepted methods of drying grain by the middle 1970s.

The low-heat method of drying grain was particularly well suited to the application of solar energy. National interest in the development of alternative energy resources in the mid-1970s helped provide federal and state funding for renewable energy research, including about ten years of work on applying solar energy to grain drying and other on-farm uses.

Beginning in about 1985, Shove directed most of his attention to help define and demonstrate the excellent quality of ambient air-dried corn without additional heat, or with the addition of very little heat to the air. One of the major improvements, compared to heated air drying, was a drastic reduction in kernel stress cracks. Whole, uncracked kernels of corn resist breakage, which greatly reduces the amount of fine particles created by subsequent handling. Whole kernels also improve storage characteristics, reduce dust, and are more valuable to many grain processors.

Marvin R. Paulsen joined the faculty in 1975 and became a member of a research team led by Lowell D. Hill of agricultural economics, studying grain quality. He has helped develop a highly coherent, systematic study to improve the quality of corn and soybeans marketed by the United States. His contributions have focused on engineering factors that identify and measure grain quality.

Cooperation with the Department of Food Science

Errol D. Rodda was appointed associate professor of agricultural engineering in 1968 to accept a two-year assignment in India. Upon returning, he developed a strong interdisciplinary research program with the Department of Food Science and received a joint appointment as professor of food engineering in food science in 1977.

Rodda led an interdisciplinary alternative energy research program including the Departments of Food Science, Animal Science, and Agricultural Economics, that was funded by the Illinois Department of Energy and Natural Resources. The program involved projects on an integrated biomass energy system for Illinois agriculture, biomass utilization in an engine-generator, and butanol production from extruded corn. Later he worked with Alvin I. Nelson of the food science department to develop an extrusion process to produce a corn-based, biodegradable packing material.

In 1986 J. Bruce Litchfield joined the department and began research on food and bioprocessing. The following year, Steven R. Eckhoff began his work on wet milling of corn. Thus, what was once the electrical power and processing unit had become food and bioprocessing engineering.

Farm Structures

Farm structures research has contributed to many of the improvements in buildings used on Illinois farms. Results of early research, in cooperation with other departments, were made available to farmers in the form of blueprint plans for better farm structures. Designs have continually been changed to accommodate machines for saving labor, improve environment, incorporate crop-drying features, and use new materials or construction methods. Size of production and storage buildings have been increased to take care of increased crop production from the larger farm units and to house larger livestock enterprises.

BUILDING DESIGN AND PLANS

W. A. Foster initiated the first formal farm building research project at the University in 1924 to plan farm buildings for greater efficiency, sanitation, economy of construction, and appearance and to develop plans and construction details.

Many early research results were made available to farmers in the form of building plans. A plan service was started in 1924 which by 1932 included about three hundred plans for service buildings and farm homes. In 1932 nearly one hundred of the Illinois plans were incorporated into a plan service fostered by the Bureau of Agricultural Engineering of the U. S. Department of Agriculture. During 1933 and 1934, the first plans from the Midwest Plan Service, a cooperative, were made available. Results of Illinois research have continued to be incorporated throughout the years into the plans of both the College of Agriculture and the Midwest Plan Service.

SWINE HOUSING

It is possible to note the changes in swine management from changes in swine buildings. Swine housing studies were started by W. A. Foster in 1924. At that time, he listed five objectives as most important:

1. To determine the best type of hog house for Illinois conditions;
2. To study the relative merits of individual and community houses;
3. To determine the value of sunlight and placement of windows in lighting efficiency;
4. To study ventilation; and
5. To prepare satisfactory plans for hog houses.

In 1926 and 1927 a two-row farrowing house with gambrel roof and roof windows was developed. In 1929 and 1930 a portable hog house was designed to permit more sunlight to enter through open doors, and by 1931 and 1932 swine-raisers were rapidly accepting this open-front, shed-roof house. The new McLean County sanitation plan of moving hogs to a new location and pasture each year made central farrowing houses obsolete. Many of these buildings were converted to poultry houses.

In the early 1940s some farmers began raising hogs in confinement. The change was slow at first but interest increased. In 1956 a project, "Housing and Environmental Studies of Young Pigs," was started in cooperation with other states in the North Central Region. The work was under the direction of E. L. Hansen and A. J. Muehling. A second project, "Methods of Providing Optimum Environment for Sows and Pigs under Farm Farrowing Conditions," was begun in 1958. Engineering service for a new facility started by the animal science department in 1959 was provided mainly by E. L. Hansen. Known as the Moorman Breeding Research Farm, this facility was the finest of its kind in the world. Many new research projects on swine housing, waste disposal, and ventilation were conducted there.

The project, "Swine Housing Environment," was initiated in 1963 under the direction of D. L. Day. Work was started in the areas of identifying and controlling atmospheric contaminants and analyzing the properties of livestock and poultry wastes. The trend among commercial swine producers was toward use of confinement systems and many poultry houses were converted to central farrowing houses and nurseries, just the reverse of 1931 and 1932.

Poultry Housing

The first project on poultry housing was started by W. A. Foster in 1924, in cooperation with the Poultry Husbandry Division, to develop a poultry house that would best meet the needs of Illinois.

During the next twelve years, thirty-nine poultry house plans were developed and three circulars prepared. During this period the family-sized flock was popular. In 1935, however, requests began to come in for two- and three-story poultry houses. Since that time the demand for plans for small flock housing has nearly ceased and plans for large, modern buildings are now supplied through the Midwest Plan Service.

New Materials for Farm Structures

A major study started in 1947, under the direction of D. G. Carter and R. W. Whitaker, on the use of aluminum in farm structures was continued until 1964 with support from the Aluminum Company of America. Work was done on poultry housing, swine housing, protective roof coatings, dairy barns, and other uses.

Support from other industrial partners helped to carry out a ten-year study on protective coatings for weathered galvanized-steel roof sheets. Several methods were developed to prolong their usefulness.

Through cooperative support from the Granite City Steel Company and the Douglas Fir Plywood Association, a new type of building frame known as a lumber rigid-frame was developed in 1959 by Curtis and Hansen. The use of this frame spread nationwide. The frame could be easily constructed, required a minimum of space in the building, and presented a neat appearance. Following the success of the lumber rigid-frame project, research was initiated, in cooperation with the Portland Cement Association, to develop a precast concrete rigid-frame. The design was finished by E. D. Rodda, M. L. Paul, and Hansen in 1961 and accepted by the concrete industry.

Dairy Housing

In 1945 D. G. Carter, K. H. Hinchcliff, K. O. Roe, and Thayer Cleaver initiated a study of efficient use of labor around farm buildings. As a result, better plans for dairy barns and milk-handling facilities to meet Grade A milk requirements were prepared during 1947 and 1948 . From 1950 to 1956, research was conducted on dairy housing.

Hinchcliff and Cleaver made time and travel studies that showed ways to save labor and physical energy on chores in various kinds of barns.

DESIGN FOR MORE COMFORTABLE LIVING

Illinois has been a leader in the area of farm housing. Between 1927 and 1929, W. A. Foster developed thirteen house plans in cooperation with the Departments of Home Economics and Architecture. A demonstration tour in 1929 and 1930 of a home built from one of these plans was quite successful. One residence built in Coles County from a university plan took first place in the special class for farm homes in the 1930 Better Homes in America contest.

In 1947 Carter and Hinchcliff started a research project on "The Determination and Interpretation of Farmhouse Requirements Based on Patterns of Family Living." Early work was directed toward preparation of a general guide to farmhouse improvement based on existing information. The result was Illinois Circular 620, "When You Build or Remodel Your Farmhouse," which was also approved as North Central Regional Publication 8. Three printings were made totaling one-hundred thirty thousand copies.

A new series of farmhouse plans was prepared in 1947 and 1948 and two were included in the USDA Plan Service. Another activity of this period was the development of the Basic Farmhouse Plan, a design also released as a University of Illinois Small Homes Council circular and given nationwide publicity.

Illinois took the lead in a study to evaluate the potential for farm housing research in the North Central Region. A circular, "Development of Cooperative Farm Housing Research in the North Central Region," reported the results of this study. Extensive regional research began about 1950. The first result of this work was the 1952 Flexi-plan Series prepared by R. C. Cohlmeyer and M. R. Hodgell. The flexi-plan procedure offered six to thirteen variations for each of three basic farmhouse designs. To illustrate the new designs, an extension circular was published and also released as a North Central Region publication.

"Contemporary Farmhouses," an Illinois Station bulletin and North Central Regional publication, was published in 1956. It included a new method of presenting space design, using a split-page presentation, developed by Hodgell and Carter. This process permitted 576 plan arrangement possibilities with only two series of "half-plans" presenting twenty-four layouts in each.

Following this work, attention was given to farmhouse remodeling. Again, after much research, Hitchcliff developed a new technique of presentation. The first house type to receive attention was the "Model T." An experiment station bulletin and North Central Region publication "Remodeling the Model T," involved an overlay system for comparing the proposed renovation with the existing structure, showing both space rearrangement and exterior changes.

O. W. Uggerby and Hinchcliff conducted another regional project on the "Application of Native Materials and Labor to Modern Techniques for Building Farmhouses" in which details of construction were developed. Jedele and Hansen prepared a second publication, similar to "Remodeling the Model T," entitled "Remodeling the Bungalow."

Structures Research Turns to the Environment

By 1956 Muehling was conducting baby pig environmental work in the basement chambers of the old Animal Sciences Laboratory. Hansen was on the NC-23 Committee and attracted some money to build a full-scale farrowing-nursery building on the site of the Moorman Swine Breeding Research Farm. Curtis's lumber rigid-frame was used for the framework of the building. Jedele contributed to the design for the Moorman Farm based on his experiences with swine producers. The lumber rigid-frame was used in many of the breeding research buildings. There was also one concrete rigid-frame and several tilt-up concrete buildings at that farm that were based on the research and design of Hansen, Curtis, and others. In addition to cooperation within the division faculty and staff, there was much exchange of ideas and cooperative research with animal science swine division personnel.

The first oxidation ditch in Illinois for swine waste treatment was installed at the breeding research farm, and a series of various sized lagoons were built. Hansen developed a steel form system for making concrete slats that was tested while the buildings at the breeding farm were under construction. That forming system was later adopted by a concrete slat manufacturer in Illinois that supplied slats for many Illinois swine producers. The structures and environment research of that era was carried out by concept design, physical testing in the laboratories, and practical testing on university farms. There were no computer simulations.

With the arrival of Leslie L. Christianson in 1985 and Gerald Riskowski in 1986, and as sources of research funds changed, research also changed. They designed and built a fan test chamber and convinced fan manufacturers to test their fans at the University of Illinois. Results of these tests have been valuable to manufacturers and designers who specify fans for building ventilation. They also designed and built a room ventilation simulator in 1989. Results are useful in the design of farm, home, office and industrial buildings. As a result, several faculty members are members of the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) committees and regularly contribute to national meeting programs in that arena.

Riskowski became division leader in 1994 with the retirement of Day. His research has been directed toward structural design and materials testing. He has a joint project with the College of Engineering for testing the tolerance of materials to hostile environments found in confinement swine buildings.

Summary

Agricultural engineering research has significantly changed Illinois agriculture. Initially most of the work was conducted to mechanize and improve production systems. Research emphasis changed throughout the years. Since the 1960s use of natural resources and environmental issues have been a major thrust. Energy and alternate fuels then became prominent in the 1970s. Now off-farm handling, storing, processing, and packaging are a part of the department's program. This has led to agricultural engineering being defined as solving engineering problems related to biological systems. This includes such unusual things as developing the systems for transporting rats in space for scientific studies under weightless conditions.

An analysis of the number of projects conducted in the department before 1985 shows that the number ranged from twenty to twenty-five with some small grant projects being reported as a part of the base Hatch and regional research program—the core of the program. Beginning about 1985 the Agricultural Experiment Station began listing grants and agreements as separate projects so that a more accurate count could be obtained and so the broad extent of the program could be recorded. Immediately the number of projects shot up and by 1989 was about fifty and the number continues to range from fifty to fifty-five. The number of projects in the original strengths of the department—power and machinery, soil and water, structures and the environment, and electric power and processing—have held about constant with the growth coming in food engineering and in utilizing new research techniques involving machine vision, magnetic resonance imaging, nuclear resonance imaging, satellite positioning, and super computing.

The scope, emphasis, diversity, and change in the research program can be depicted in part by a review of the titles of the theses written by Ph.D. candidates. The theses projects show the emphasis of the adviser's research program at a specific period of time. Hence they illustrate how research programs change because they provide a mechanism whereby an adviser can explore new concepts without a major investment in instrumentation or equipment. They also establish the continued emphasis of a line of research if it continues to be the major thrust of the adviser and therefore the department. The list of titles of the Ph.D. theses along with the name or names of the advisers is given by year in Appendix G.

5 | INTERNATIONAL PROGRAMS PARTICIPATION

The faculty made significant contributions to the International Programs of the University and its affiliated organizations during the past 75 years. The first formal involvement came in 1952 with Deane G. Carter's appointment to the College of Agriculture Committee on Foreign Programs. In this capacity he visited Indian Institutes at Allahabad and Kharagpur to make recommendations on agricultural engineering education in India.

In 1954, quite likely as a result of Carter's recommendations, Ralph Hay accepted a two-year assignment to serve as group leader of the Illinois Engineering Team and head of the Department of Agricultural Engineering at the Indian Institute of Technology (IIT) at Kharagpur. Hay was the first head of the department at IIT and it was his responsibility to develop the Department. Today IIT Kharagpur is recognized as having one of the strongest Agricultural Engineering programs in India. It has added M.S. and Ph.D. programs over the years to now provide a full range of educational programs for student engineers.

In 1956, Carter was appointed coordinator of International Cooperation Administration (ICA) Programs in the Office of the Provost of the University. He served in this role until his retirement in 1958. In 1958, Hay was selected to succeed Carter as Coordinator of ICA Programs. He was a logical choice because the major responsibility of

ICA was to administer three USAID/U of I contracts for programs in agriculture and engineering in India. Hay continued as coordinator until he resigned that post in 1962 to accept a two-year assignment as advisor to the dean of the College of Engineering at U.P. Agricultural University, Pant Nagar, Uttar Pradesh, India.

The early involvement of the department was not limited to India. In January 1954, Keith H. Hinchcliff began a two-year assignment in Indonesia while on loan to the USDA Housing and Home Finance Agency. His responsibility was to help develop a self-help shelter program for the Indonesian counterpart agency to the USDA.

India Project

In February 1960, John W. Matthews began an eighteen-month assignment as agricultural engineering advisor to Balwant Rajput College, Agra and Bichpuri, India. Balwant Rajput College was one of eleven colleges of agriculture and veterinary science cooperating with the University of Illinois in its Technical Cooperation Mission program involving the states of Uttar Pradesh and Madhya Pradesh in North Central India. His major responsibility was with Balwant Rajput College and Rural Higher Institute although he had some contact with several of the other ten institutions. The main college campus was in Agra, but most of the agriculture was taught at Bichpuri, some seven miles away near the 433-acre college farm.

Agricultural engineering was taught at B. R. College program in the Department of Agronomy. The Rural Institute offered a four-year course in rural services and a three-year diploma course in civil and rural engineering.

Matthews described some of his experiences as follows:

> In addition to some teaching and advising, I worked on improving the curricula and facilities, particularly in the workshop area. I also spent considerable time in improving the drainage and irrigation on the college farm, including the building of a bund former and a land plane. These were tractor operated. Each improvement seemed to bring forth additional problems. The tractor maintenance program was inadequate, particularly in the handling of diesel fuel, so I constructed a system where fuel could be stored and pumped into the tractors with minimum exposure to dust and dirt.

A major effort was directed to developing improved bullock drawn implements including a potato planter and harvester. Finally, I developed what we called the "Balwantpuri Versatool." It was a bullock drawn frame on wheels with a three-point hitch and a set of interchangeable attachments to plow, plant, and cultivate crops.

At the end of a tour such as mine, one must ask some sobering questions. Was anything accomplished that may have made some lasting impressions on the problems of rural India? What changes, if any, were wrought in the people with whom I was associated? One thing sure is that I learned more than I could possibly have taught.

The Department did not always have the appropriate faculty or staff needed to fulfill the objectives of university contracts. In such instances it employed persons outside the department to accept overseas assignments. Notable among this group was Donald J. Minehart who was employed for four years (1965-69) as advisor on land and water development and who helped develop the research farms at UPAU at Pant Nagar and at JNAU at Jabalpur.

From November 1965 to March 1966, Frank B. Lanham served as advisor to the director of research at the J. Nehru Agricultural University at Jabalpur. This was part of the university's contract to help Madhya Pradesh develop educational programs similar to its sister state, Uttar Pradesh.

In July 1967, Elwood F. Olver began a two-year assignment as chief of party at J. Nehru Agricultural University at Jabalpur. By this time in the UI/USAID contract, the team had grown to seven scientists in addition to Olver. Olver's responsibilities, in addition to coordination, were to serve as advisor to the dean of the College of Agricultural Engineering and to two vice-chancellors responsible for JNAU programs. Major needs of the university at that time were the development of laboratory materials and the research farms. JNAU was in the process of developing six satellite campuses which also required attention.

In 1968, Errol D. Rodda joined the faculty to accept a two-year assignment as agricultural engineering advisor and advisor to the dean of what was then called G. B. Gant University of Agriculture and Technology at Pant Nagar. Rodda's major responsibilities were to develop graduate programs, assist in new building design and construction, and to develop the outreach function (extension).

Other Programs

In 1975, Walter D. Lembke went to Indonesia as part of a team from the Midwest Consortium for International Agriculture (MUCIA) to teach an upgrading course in the fundamentals of soil and water engineering to college teachers in Indonesia. One of the teachers, Seododo Hardjoamidjojo, subsequently came to the university and received a M.S. degree from the department. Now he is dean of the College of Agriculture at Bogar Agricultural University.

In 1985, Rodda again accepted a two-year assignment, this time to the North West Frontier Province Agricultural University at Peshawar, Pakistan. Rodda was team leader and institutional development specialist and worked with the vice chancellor and other senior administrators on restructuring the university and the provincial agricultural network.

During his tenure as associate dean of the College of Engineering, Howard L. Wakeland was largely responsible for the development of a number of programs for students to study abroad. The college established programs in Argentina, Brazil, Chile, China, France, Germany, Japan, Portugal and Russia. If a student wanted more extensive involvement in the international community an international minor was available. Following retirement, Wakeland continued to nurture the programs making a number of overseas trips to foster better working relationships.

Worldwide Research and Education

In recent years, ongoing research projects have called for on-site data collection overseas. Notable in this area has been the grain quality studies conducted within the Agricultural Experiment Station, in which Shove and Paulsen and some of their graduate students have participated. These studies have taken them to Japan, China, Columbia, and to European countries. Earlier, the dairy automation studies took faculty to the UK and other European countries.

Seventeen faculty have taken short term, three months or less, assignments as part of university programs. These assignments have taken them to fourteen countries scattered all over the world. In addition, faculty have accepted consulting assignments for such organizations as World Health Organization, World Bank, U.S. Feed Grains Council, National Pork Producers Council, University of Guadalajava, Mexico, Council for Agricultural Planning and Development, Taiwan, USDA, US Information Agency, Inter-American Institute for Cooperation on Agriculture, American Soybean Association, and Farming Systems, Kenya. These assignments have taken them to forty different countries.

A few faculty have taken sabbatical leaves overseas; Goering, Mitchell, Reid, and Siemens traveled to South Africa; Bloome to Australia and New Zealand; Muehling went to European and Scandinavian countries twice and once to Australia; Puckett and Lembke went to the United Kingdom; Reid to Switzerland; Rodda to China; and Yoerger to Germany. Also the department has hosted a number of faculty on sabbatical leave from overseas universities.

Finally, because research knows no political boundaries, more and more faculty have participated in international symposia and meetings of professional societies such as CIGR.

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6 | FACULTY, STAFF, AND EXTERNAL ADVISORS

The men and women making up the faculty and staff of a department are the life blood and their productivity determines the success of such a unit. Some of the successes of the early faculty are as follows:

J. W. White later became supervising architect for the university, W. C. Flagg was superintendent of agricultural experiments, P. G. Holden became an outstanding extension worker, G. E. Morrow became dean of agriculture, and S. W. Shattuck became the first professor of agricultural engineering in the United States. Other individuals who contributed to the early years of development included: N. C. Ricker, J. H. Pettit, J. G. Mosier, M. E. Jahr, C. R. Newell, J. C. Thorpe, W. B. Jones, C. W. Bullard, and C. A. Scholl.

During the period from 1909 to 1921, when farm mechanics was a part of the Department of Agronomy, several men were added to the faculty/staff who went on to gain national recognition in agricultural engineering: I. W. Dickerson became agricultural engineering editor for a group of farm publications; E. A. White was active in the Committee on the Relation of Electricity to Agriculture; K. J. T. Ekblaw became author, consultant, and head of farm promotion work for the American Zinc Institute; and C. O. Reed became prominent in cornborer control work.

Before the Department of Farm Mechanics was formed in 1921, agricultural engineering subjects were taught by six faculty members in the Department of Agronomy. After the department was formed the staff consisted of four faculty—E. W. Lehmann, R. I. Shawl, J. H. Hedgcock, and C. A. Scholl, and three laboratory technicians—M. D. Rose, J. A. Padgett, and F. R. Wiley. Evidently clerical support was provided by another department, perhaps agronomy, because no one can be identified as serving that role in 1921. By 1925 the staff had grown to a faculty of eight—Lehmann, Shawl, A. L. Young, W. A. Foster, I. P. Blauser, F. P. Hanson, F. C. Kingsley, R. C. Kelleher—and a secretary had joined the group. There was no change in the laboratory support team.

At the time of World War II, the staff was composed of eleven faculty—Lehmann, Shawl, Young, D. G. Carter, R. C. Hay, H. P. Bateman, R. F. Skelton, C. W. Veach, R. H. Reed, R. R. Parks, and E. L. Hansen. Laboratory support was now down to two—Wiley and G. Hart—but clerical support had grown to four with Ruth Klein following Grace Hines as office manager. Of the faculty, Lehmann, Shawl, Young, Bateman, and Hay invested their entire careers in the department while Foster and Carter each invested the last seventeen years of their careers. Fred Wiley provided forty years of dedicated service as a jack-of-all-trades for the faculty and students.

After World War II, with the mass influx of veterans, the small faculty was taxed to meet the teaching demands of the resident instruction and extension programs—tractors, machines, electrification, building materials and improvements, home modernization, and conservation programs. The major changes in staffing were moving Hay from extension to teaching, adding graduate assistants to help teach, and employing a full cadre of extension specialists—at least one per program area in power and machinery, electrification, soil and water management, farm buildings, and rural housing. Additional support staff, such as laboratory technicians, draftsmen, illustrators, and secretaries, was added.

Changing of the Guard

The period from 1955 to the early 1960s brought great changes in the faculty. Lehmann retired in 1955 after thirty-four years of leadership and service and was succeeded by Frank B. Lanham. Carter moved to the campus Office of International Programs in 1956 after serving in the department for fifteen years, and Shawl with forty-two years of service and Young with thirty-five years of service retired in 1958. These changes were followed by the deaths in 1960 of John H. Ramser with nineteen years of service, Keith H. Hinchcliff with sixteen years of service, and George E. F. Pickard with eleven years of service.

By the 1960s a number of the post-World War II engineers had earned the Ph.D. degree, and the college administration decided that, with rare exception, all new faculty had to hold a Ph.D. Also, existing faculty were encouraged and assisted in completing advanced degree programs. This policy led to a complement of faculty that became the core faculty for twenty-five years. This core group included J. O. Curtis, D. L. Day, R. F. Espenschied, D. R. Hunt, B. A. Jones, J. W. Matthews, E. F. Olver, G. C. Shove, and R. R. Yoerger. Other Ph.D.s with several years of service employed during Lanham's tenure included L. E. Bode, C. E. Goering, W. D. Lembke, J. K. Mitchell, M. R. Paulsen, E. D. Rodda, J. C. Siemens, and D. H. Vanderholm.

These two groups were supplemented by other post World War II hires that were equally qualified, dedicated, long-term faculty who carried out important parts of the department's program. Notable on the teaching-research staff were H. H. Beaty, B. J. Butler, E. L. Hansen, and J. A. Weber and on the extension staff F. W. Andrew, Wendell Bowers, C. J. W. Drablos, D. G. Jedele, and A. J. Muehling. All were supported by a large number of faculty of the less than ten years service who went to other universities, private industry, public service, and other callings.

Roger R. Yoerger followed Lanham as head of the department and served from 1978 to 1985. During his tenure new hires in established budget lines included R. A. Aherin, P. W. Benson, M. C. Hirschi, and W. H. Peterson, Peterson being an exception to the doctoral rule.

Roscoe L. Pershing, a M.S. and Ph.D. graduate of the department, followed Yoerger in 1985 and served until 1993, when he became associate dean of student affairs in the College of Engineering. In this role he succeeded Howard L. Wakeland, who served in the dean's office from 1953 to 1993. Pershing's tenure was marked by a period of down-sizing which forced the department to give up budget lines when vacancies occurred. Nevertheless, a number of faculty were employed, including P. Buriak, L. L. Christianson, R. C. Coddington,

S. R. Eckhoff, J. B. Litchfield, J. F. Reid, G. L. Riskowski, and R. E. Wolf.

Loren Bode was appointed department head in 1994. Since that time additions to the faculty have included R. A. C. Cooke, T. L. Funk, L. F. Tian, and Y. Zhang. Peter Bloome moved from extension administration to the department in 1995.

Since 1900 one hundred sixty-seven persons have held faculty appointments including the current ninteen faculty and two college-level administrators (Table 6). Twenty-one of this number are classified as professor emeriti. A complete list of faculty is located in Appendix H.

Academic Professionals

The academic professional designation for staff is relatively new, but the expertise provided by this group of faculty is long-standing. This designation is made up of individuals that have B.S. or higher degrees that are employed to fulfill special needs other than that of the professorial faculty. In the early years of the department, most of this group were employed to conduct research and their titles were assistant or first assistant in the Agricultural Experiment Station. Occasionally Cooperative Extension also used the title. Some of the former staff that fit into the category were Robert C. Cohlmeyer, Murray W. Forth, Merlin R. Hodgell, Robert W. Mowery, William F. Schwiesow, Ove W. Uggerby, Robert W. Whitaker, and Dean W. Winter. After World War II some held this title rather than graduate assistant while working on an advanced degree. Today's academic professionals provide a broad range of support services in all program areas including extension teaching. In 1997 twelve staff have the academic professional designation (Table 6). A complete list of this category is shown in Appendix I.

Support Staff

Any productive academic staff must be supported by a competent dedicated support staff that works behind the scenes. It is they who keep the work moving forward while the faculty teach, advise and counsel students, attend committee meetings, recruit graduate students, answer the phone and e-mail, ad infinitum, and attend to the

Table 6. Faculty/Staff by Ranks 1997.

Full and part-time faculty	*1997*
Professor	10
Associate professor	7
Assistant professor	2
Associate or instructor	0
Administrators	2
Academic professional	12
Visiting scientist	9
Other	6
Sub total	48
Graduate students	
Fellows	0
Assistants	52
Sub total	52
USDA Collaborators	1
Total	101

myriad of details required to keep a university program functioning, especially when the faculty belong to three colleges: Agriculture, Engineering and Graduate.

The department has been blessed from the beginning with support staff that gave their entire careers to the work of the department. Notable among that group are M. D. Rose (1908-36), Fred Wiley (1919-59), Roy Brockett (1950-79), Georgianna Noel (1952-96), Jim Johnstone (1958-94), and Kenneth Umbarger (1956-90).

TECHNICIANS

Fred Wiley served the department for 40 years. He was knowledgeable in many areas and was called upon to do everything from fix the projector, to design instruments, to make finely machined parts for new equipment. Quite likely Wiley will be remembered best by alumni for the ingenious ways he "fouled up" engines in the tractor courses before the trouble shooting laboratory sessions. He could hide wires, insert plugs, and do a multitude of other things always with a twinkle in his eyes. H. W. (Bill) Hempler and later Donald Dodson followed

Wiley with their machinist skills, but by their time, trouble shooting had faded from laboratory schedules.

For many years the department provided its own janitorial service which was combined with a number of miscellaneous tasks such as campus messenger and "go for." Guy Hart, Arthur Carlson, Cecil (Doc) Marsh, and Howard Clennon filled this budget line. By the time Clennon arrived the department had acquired regular janitorial service but he continued as the all around swing man. These men knew more secretaries, storeroom clerks, and other "important" people on campus and it was their ability to "sweet-talk" that alleviated many emergencies.

Some of the laboratory technicians were research project oriented. For example, Roy W. Brockett served twenty-nine years (1950-79) in the tractor maintenance and soil tillage area assisting Jay Weber with farm tractor maintenance inspections, laboratory testing, and air-cleaner development as well as soil mechanics studies. Roy assisted many of Weber's graduate students with instrumentation and often rode the tractor with them to see that everything was working properly.

James R. Johnstone devoted 36 years (1958-94) to keeping farm structures and waste handling studies running smoothly. Regardless of the material—wood, concrete, plastic, metal— Johnstone was capable of handling it. After Don Day arrived on the scene Johnstone's working environment took on a new aroma. He installed many oxidation ditch paddle wheels, aerators, and fans to test new ideas for making liquid manure handling systems work in confinement livestock systems. In between times he assisted Hansen, Christenson, Curtis, Jedele, Muehling, and Riskowski with their studies of building materials and construction and environmental systems.

Frank Carter (USDA 1957-86), augmented on occasion by departmental staff such as Raymond Primmer (1969-72), supported Hoyle Puckett and the electric power and processing faculty. He had more than his hands full trying to keep up with the needs and ideas of Andrew, Olver, Peart, and Puckett who were working to replace hand chore labor with automatic equipment and control systems to make livestock production more efficient and less time-consuming for the operator.

Many staff were involved on the research farm for short periods of time, but the continuity for and the mainstay of operations for thirty-four years (1956-90) was Kenneth R. Umbarger. Umbarger planted thousands of plots during his tenure and was a part of many changes in production systems as a result of working on tillage with Bateman, Bowers, and Siemens, harvesting with Bateman, Nave, and Hummel, and spraying with Butler and Bode. In addition there were classes to prepare for and graduate students to keep satisfied.

Behind the scenes were technicians like Henry Schaper who helped adapt electronic equipment to the instrumentation needs of the department and then kept it going once it was in place. All of the teaching, research, and extension activity at some point called for drawings, plans, charts, graphs, or plain old signs to convey information. The department had many draftsmen but most were short-term when compared to the twenty-two (1968-90) years service of Wayne Pickett. Pickett's handiwork is in all of the student FIEI/EMI reports prepared during his tenure, in graduate student theses of his time, and in the many technical papers written by the faculty and staff.

A complete list of the technical support staff appears in Appendix J. It shows 42 staff have served the department.

CLERICAL

The university, being a public entity, has to have extensive documentation of all of its business to satisfy the auditors and the public. This generates lots of letters, forms, and reports that have to be processed and filed by the clerical support staff. It takes a team effort to get the work done but those in charge of the office were Grace Hines (1925-29), the first full-time secretary, Suzanne Wheeler (1931-36), Ruth Klein (1939-48), Helen Patton (1949-58), William Baker (1959-60), Henry Creech (1960-66), and Georgianna Noel (1966-96). Ruth Klein was efficient and helped many of the returning veterans who came to the department. Helen Patton was aptly known by the students and veterans as "the general," ala General George Patton, because that was the way she ran the office. But perhaps she is remembered most for deciding to learn, as an adult, to drive a car so she could buy a purple Thunderbird that she had fallen in love with and wanted.

Henry Creech was a major contrast to Patton being a mild mannered man, and Noel was of the same temperament. Noel joined the staff in June 1952 as a new graduate of Homer High School and devoted her entire career to the department. She has the distinction of having worked with all five department heads from Lehmann to Bode.

The files are important elements in any organization. In addition to filing and directing phone calls, the department's file clerk also sold building plans and distributed bulletins, circulars, and papers written by the faculty. Graduates will remember "Pat" Forth, Murray's wife (1947-48), Florence Reece, now Florence Kidder (1949-53), and Marge Freebairn (1955-83).

Many of these secretaries went through a period of major change in office procedures from the five carbons, to the "ditto" machine, to the electric self-correcting typewriter, to umpteen models of the computer. Also there was the birth and maturing of the photo copying process. Secretaries like Noel, who started with carbon paper, can really appreciate the ease of making changes in long reports using the computer. Now the "hazard of the occupation" is that the computer will go down without adequate backup or when you have a four o'clock deadline.

A complete list of 122 clerical staff is given in Appendix K.

Graduate Student Employees

A great number of graduate students have been employed in the department. They provided invaluable service in helping teach many courses and in working on many projects. A list of those students appears in Appendix L. It totals 385 persons.

USDA Cooperators

Although they were not university employees, individuals working along side the faculty and participating in all phases of the department programs but employed by the USDA made many contributions, especially in research and extension. All were officed in the department and used its laboratories, farm, and infrastructure to support their programs. The complement included professional engineers, technicians, and clericals. The engineers included Thayer Cleaver (1929-45), Leo E. Holman (1943-51), Tracy A. Pitzen (1937-38), Hoyle B. Puckett (1955-85), John W. Hummel (1977to present), Gary W. Hyde (1969-75), and W. Ralph Nave (1965-82). Support staff included Frank Carter, Dennis King, Teresa Holman, Shirley Collins, Geraldine

Epperson, Chris McGovern, and Pauline Wrona. Their names are included in the various appendices mention above.

The Emeriti

General of the Armies Douglas MacArthur said before the U.S. Congress, "Old soldiers never die, they just fade away." The emeriti of the faculty and staff have not faded away; instead they stay active, maintaining friendships and on occasions helping with department projects.

Retirees meet regularly every Tuesday morning at 9:16 for coffee, tea, or hot chocolate and to keep abreast of both the latest and the "good old days." Their reminiscences have even contributed to this history— so if events aren't as you remember them, perhaps it's faulty memory. On the first Tuesday of each month they are joined by their wives.

Occasionally this group is joined by a former staff member who is passing through or by an alum who wants to say hi to his or her "old prof." If you would like to join them sometime, call to learn the appointed place of meeting and feel welcome to come.

The Distaff

No chapter on the faculty and staff would be complete without a reference to the contributions made to the department by the staff wives group.

In the early years, in fact until the late 1970s or early 1980s, there were few two-earner families in the department. Hence, wives had more time to socialize and as part of this, developed a desire to know one another and the children better since their husbands worked together everyday. After World War II, it also helped that the returning veterans were about the same age, were starting their families at about the same time, and that money was in short supply. It was natural to use the bond of departmental activities for socializing.

The wives group was started in 1948 or 1949 as an evening meeting about once a month during the school year. As the size of the group grew, the wives lent their support to holiday parties and picnics for the students and eventually to a February party for their husbands. These parties and social events ranged from attending Kubici theater to dinners. This group continues to add to the lives of the faculty and staff in the department.

External Advisors

In its charter the university called for the use of citizen advisory groups in the planning of research projects and other programs. The department has used seventy-three farmers and agribusiness representatives from all parts of the state as its sounding board. Over the years these people also represented the department at meetings in their home communities. Annual meetings lasting one or two days are held to discuss the department's activities.

During the early days the major portion of these individuals were actively engaged in farming, with others doing farm management work or holding engineering positions. Today many of the advisors are practicing engineers. More than half of the advisors have been graduates of the University of Illinois. The service of these individuals totals more than 365 years. O. W. Hoit and Royal Oakes hold the record for service; each served twelve years. The external advisors and their years of service are listed in Appendix M.

Faculty In Profile

Individual faculty and staff have contributed significantly over the years. Following are profiles of those who have retired or who have transferred out of the department but stayed within the university. The years under the name indicate the years of service to the department, and an * beside a name indicates that the individual is deceased.

FRANK W. ANDREW
1946–72

Frank Winston Andrew was born July 15, 1914, on a 330-acre grain and livestock farm located southwest of Palmyra, Illinois. He graduated from Palmyra Community High School in June 1932 and that fall enrolled in the two-year self-help Blackburn College at Carlinville. While at Blackburn he quickly advanced to head carpenter in charge of campus maintenance and won the tuition scholarship as student work manager while a sophomore.

Andrew received his two-year certificate and transferred his credits to the College of Agriculture at the U of I. He worked his way through as a member of the National Youth Administration (NYA) which was the WPA for college students. One of Andrew's tasks was to make picture frames for College of Engineering buildings and many of the frames he made are still in use. He earned his room and board by working in Lehmann's nursery at his home.

Frank graduated with a B.S. in agriculture in June 1938 and started farming. Soon he became famous for his circle farming which utilized a set of controls on a tractor so it could do field work without a driver. On September 1, 1946, Frank joined the faculty as extension specialist in farm electrification. During his 26-year tenure Frank had a major impact on the adoption by farmers of grain and hay drying systems, automatic feed handling systems, and farm home improvements such as water and disposal systems. He was recognized by the IFEC with a Certificate of Appreciation in 1969 and its Merit Award in 1971. Frank has been recognized by ASAE as a Fellow and he received the George W. Kable Award in 1975.

As an extension engineer, his work took him all over the state and to adjoining states and he became well known for piloting himself in his single engine plane. He logged more than 200,000 miles in his trips saving thousands of hours for more productive work than driving down the road.

H. PAUL BATEMAN*
1935–68

Harry Paul Bateman served as a member of the power and machinery staff for more than thirty years before his retirement. Research in farm machinery operating costs, tillage, and harvesting were his major interests. He was the first staff member in charge of the Agricultural Engineering Research Farm where he conducted extensive studies in minimum and conservation tillage. Major machinery company engineers had high respect for his knowledge of tillage practices and they visited him frequently to obtain results from his innovative experiments.

Bateman is one of the first two graduates from the agricultural engineering curriculum. He earned a B.S. degree in agriculture in 1932 and a B.S. in agricultural engineering in 1934. Both degrees were awarded with high honors. He continued graduate study to earn a master's degree in mechanical engineering in 1948. After a short term with the Soil Conservation Service, he joined the University of Illinois staff in 1935. During World War II he served as instructor of diesel engines for the U.S. Navy. Following the war he returned to the staff to conduct research and teach. He taught courses in farm machinery and advised several graduate theses and many special problems. As advisor to the ASAE student branch, he gave valuable guidance for several *Agrineers*.

Bateman also helped teach short courses in farm power and machinery and often conducted extension meetings on tillage practices. Using his hobby, photography, he produced many fine photographs that were used in connection with his work. After his retirement at a relatively early age, he and Lorraine Berry, the retired Piatt County home adviser, were married.

DOUGLAS B. BAULING
1964–96

Douglas Bert Bauling was born September 12, 1936, and spent his early life on a farm near Rockton, Illinois. He attended the University of Illinois and graduated with a B.S. in agricultural engineering and a B.S. in agricultural science with highest honors in 1962. He received an M.S. in agricultural engineering in 1964.

He was appointed assistant to the director of the Agricultural Experiment Station in 1964 and served in that capacity until he was appointed planning engineer with the Agricultural Experiment Station in 1968. In 1995 he was appointed associate director for operations for the College of Agricultural, Consumer and Environmental Sciences (formerly the College of Agriculture) and retired from that position in 1996.

Bauling was responsible for programming, planning, and construction leadership for many major building projects of the College of Agriculture during his service, most notably Food for Century III. These projects had a total construction cost of more than $100 million. He also served as the college engineer, solving problems such as blocked drain lines and leaky roofs.

HAROLD H. BEATY
1958-70

Harold Huxford Beaty headed the electric power and processing division of the department for twelve years before his retirement in 1970. During this period he built a strong staff and as a result the program in the processing area has received national recognition in teaching, research, and extension programs. He exhibited a unique ability for organizing and coordinating activities among the department, the USDA, electric power suppliers, and the Cooperative Extension Service. As executive secretary of the Illinois Farm Electrification Council he worked in an organized way with all the rural electric cooperatives and power suppliers to rural areas throughout Illinois. He also taught a number of undergraduate courses and gave guidance to graduate students.

Beaty came to Illinois from eight years of service with the Edison Electric Institute in New York. There, along with many other activities, he developed the Interindustry Farm Electric Utilization Council and arranged the production of a motion picture. Earlier, he served as extension agricultural engineer in rural electrification at Iowa State University, and his strong rural electrification program in Iowa served as a model for other states. He was a native of Iowa, with a B.S. in electrical engineering and an M.S. in agricultural engineering from Iowa State. Beaty was the senior brother-in-law of the Skromme family, his wife, Judith Beaty, being the older sister of four brothers who were all agricultural engineers.

B. JACK BUTLER
1958-84

B. Jack Butler was raised near Astoria and received both his B.S. and M.S. degrees in agricultural engineering from the University of Illinois in 1948 and 1949.

He taught at the University of Missouri from 1949 until 1951 when he joined the USDA staff at Toledo, Ohio. There he served one year as project leader of a study of corrosion and abrasion of sprayers and dusters. Following two years in the Marine Corps, he returned home to farm. In 1958 he returned to the University of Illinois, where he began a research program in agricultural chemical application equipment and techniques, and for many years he led a project for the Illinois Department of Transportation on equipment and chemical needs for roadside maintenance.

Butler retired from the university in 1984 after twenty-six years of service. He distinguished himself in research, teaching, and student-staff relations. In 1970 he won the William Everitt Award from the College of Engineering for outstanding teaching, and in 1983 he received the Stanley Pierce Award, also from the College of Engineering, for the advancement of student-staff relationships.

Alumni remember him for the ability, when using the blackboard, to quickly solve a difficult problem that he had assigned to his class; he would do the math in his head, with no references or computational aids.

DEANE G. CARTER*
1941–58

Deane Carter contributed greatly to the development of the farm structures division in the agricultural engineering department during his seventeen years of service. Upon joining the staff in 1941, he helped develop the undergraduate professional curriculum and the graduate program. He was an effective and popular teacher and advisor for many students. He also skillfully helped to coordinate and develop all phases of the departmental program.

He served on many policy-making committees of the University, including the executive committee of the Small Homes Council. Before coming to Illinois, he served on the staffs at Iowa State University, North Carolina State University, and the University of Arkansas, where he was head of the department for twenty years.

Carter wrote prolifically: two textbooks with Foster and Hinchcliff, fifteen experiment station bulletins, eighteen extension circulars, and thirty-nine papers. His subjects ranged from farm structures and housing to tractors and soil conservation. He also served as a national officer of Alpha Zeta for more than fifteen years. He held a number of sectional, regional, and national offices in ASAE and served on three Engineers' Council for Professional Development (ECPD) accreditation committees.

In 1953, Carter visited India as a member of the College of Agriculture Foreign Program Committee. The assignment led to continuing international programs with the department in India. In 1956 he was named coordinator of international programs under the U of I Provost's Office. After retirement in 1958 he served as a member of the American Society for Engineering Education (ASEE) survey team on engineering education in India and then joined the University of Nebraska contract team to spend two years as a visiting professor at Ataturk University at Erzurum, Turkey.

RICHARD C. CODDINGTON
1985–PRESENT

Richard C. Coddington was born in Champaign and grew up on a farm near Princeton. He attended the University of Illinois and received bachelor degrees in engineering mechanics and mathematics in 1962. He then attended Kansas State University where he received an M.S. degree in engineering mechanics in 1963 and a Ph.D. degree in the same subject in 1966.

Coddington then joined the faculty of the New Mexico State University, Las Cruces, as an associate professor in 1966. In 1976 he took a position with Rose-Hulman Institute of Technology, Terre Haute, Indiana. From 1972 to 1975 he was senior research engineer with Beloit Corporation, Beloit, Wisconsin. From 1975 to 1985 he was an engineering specialist with Deere Dubuque Works, Dubuque, Iowa and while with Deere took an appointment in 1979 as an adjunct associate professor at the University of Iowa, Iowa City. He returned to the University of Illinois and joined the department staff as an associate professor in the power and machinery division in 1985. Presently he is assistant dean of engineering and director of placement.

Coddington is an authority on computer modeling of vehicle performance and taught the senior design course for power and machinery majors for a number of years.

James O. Curtis
1948–85

James Curtis graduated from the University of Illinois with a B.S. degree in agricultural engineering in 1947 and a master's degree in civil engineering in 1948. With the exception of two years when he was recalled to active duty as a meteorologist in the Air Force during the Korean War, he was part of the department's staff from 1948. From 1959 to 1961 he held a National Science Foundation Science Faculty Fellowship to complete his doctorate at Purdue University.

His research activities resulted in recommendations for remodeling ear corn cribs for shelled corn, the development of the lumber rigid-frame system of farm building framing, and the development, in cooperation with E. L. Hansen, of a series of precast concrete components for buildings. His more recent work included post-frame anchorage systems.

Curtis was honored by the ASAE in 1967 with the Metal Building Manufacturers Association (MBMA) Award for his work in advancing the knowledge and science of farm buildings. He was elected a Fellow by ASAE in 1980. His activities on behalf of students and the curriculum and his career-long support of the student branch of the ASAE further distinguish him.

At the time of his retirement in 1986 he was head of the structures and environment division and associate head of the department.

Donald L. Day
1962–94

Donald Day was born August 14, 1931, at Leedey, Oklahoma and grew up on a farm near Trail, Oklahoma, the third of four sons. He received his B.S. in agricultural engineering from Oklahoma A&M College (later Oklahoma State University) in 1954. After working a few months as a research assistant in the Tractor Testing Laboratory of Allis-Chalmers in Milwaukee, he joined the U. S. Air Force. He served for three years and became a B-36 pilot with the Strategic Air Command. From 1957 through 1958 he was an instructor in agricultural engineering at Texas Technological College in Lubbock. Day entered graduate school at the University of Missouri in 1958, receiving his M.S. in 1959 and his Ph.D. in agricultural engineering in 1962. He joined the department 1962 as a member of the structures and environment division, which he headed from 1986 until his retirement in 1994.

Day's research concerned the control of pollution in livestock production and the conversion of wastes and byproducts into feed and fuel. He developed the oxidation ditch method of livestock waste management and techniques for collecting air samples inside livestock buildings. Students remember him as a dedicated and thorough researcher who also taught undergraduate and graduate courses in livestock waste management and air quality.

A Fellow in the ASAE, he continues to be active on committees related to livestock waste management. He is internationally recognized, has advised more than thirty graduate students, and frequently participates in international consulting and lectureship activities.

Day married Dorotha Bamburg in 1954, and they have two sons and one daughter. As a civilian pilot he has maintained his flying proficiency. He frequently flies colleagues on business trips or when aerial photography of ongoing research is needed.

CARROLL J. W. DRABLOS
1959–90

Carroll Drablos was born June 12, 1930, near Raub, North Dakota, and began his education in a one-room country school. He attended Minot High School and Minot Teachers College, taking courses in arithmetic and the sciences. After farming for about a year, he entered North Dakota State University in Fargo, graduating in 1954. After serving as an officer in the USAF with a tour of duty in Germany, he accepted a position with the Soil Conservation Service as an engineer in Valley City, North Dakota. He worked in that position for a year, and then accepted an assistantship at NDSU to work on a master's degree in agricultural engineering.

After he finished his M.S. in 1958, Carroll became a research associate at the University of Illinois and began work on a highway drainage project. This led to his involvement in extension work. Drablos became interested in plastic drain tubing and soon developed an international reputation for his work on plastic drainage materials. A registered professional engineer, Carroll has received numerous honors and awards, including seven ASAE Blue Ribbon Awards for educational aids he prepared. He has been honored with membership in Epsilon Sigma Phi, Gamma Sigma Delta, and Sigma Xi. He is also an honorary member of the Corrugated Plastic Tubing Manufacturers Association and is listed in Who's Who in the Midwest and in Leaders in American Science.

Drablos is best appreciated by students and colleagues for his willingness to listen to their problems, for his caring, and for his subtle wit.

ROLAND F. ESPENSCHIED*
1956–87

Roland Espenschied was born on a dairy farm near Marine, Illinois, on August 27, 1921. He graduated from Marine High School in 1939, enrolled in the University of Illinois, and graduated with a B.S. in agriculture in 1943. His graduation occurred two months after he was called to active duty with the U. S. Marine Corps. He served as a range officer for anti-aircraft and field artillery in the Pacific Theater and was discharged from active duty in 1946, but he remained in the Marine Corps Reserve until 1981, when he retired as a lieutenant colonel.

After several years as a vocational agricultural instructor at Newton and later Fairfield, Illinois, he returned to the University of Illinois to complete an M.S. in education in 1951. After several more years as a vocational instructor at a high school in Franklin, Illinois, he returned to the University of Illinois in 1956 as a teaching assistant in agricultural engineering with additional responsibilities in Vocational Agriculture Service. He was awarded an Ed.D. in 1961, appointed to the faculty of agricultural engineering, and served there until his retirement in 1988. He married Alice Brach in 1951, and had two children, Linda and David.

"Espy" had an enthusiasm for learning and application of knowledge for practical use that permeated his entire career. His infectious enthusiasm and love for students will be remembered by alumni. A special interest was the use of audio-visual aids for effective teaching.

Many of his students will remember his tray of glass eyes. Students in his shop class who were not taking proper safety precautions to protect their eyes would find him behind them with a tray of "eyeballs." Espy would then inquire what color eyeball a student would prefer after the inevitable accident. It was an effective way to promote the use of safety goggles.

During his forty-one years of service as an educator Espy received many honors. In addition to many ASAE Blue Ribbon Awards he received for developing educational materials, he received certificates of appreciation for service from the National and Illinois Vocational Agricultural Teachers Association, the Illinois Farm Electrification Council, Farmland Industries, the National Food and Energy Council, and the Illinois Association of Community College Agriculture Instructors. He was also granted the State and American Farmer Awards from the Future Farmers of America.

WILLIAM A. FOSTER*
1924–41

William Arthur Foster initiated the farm buildings and rural housing program at the University of Illinois. In fact, he *was* the entire division for the seventeen years he served on the faculty until his death in 1941. During that period he taught courses in farm structures and rural housing and developed a farm building plan service. He also served as chair of the farm structures division of the ASAE and vice president of the society. He coauthored two textbooks, *Farm Buildings* (with Deane Carter) and *Home Architecture* (with Rexford Newcomb). He contributed greatly to the development of the farm building plan service and was author of numerous bulletins, circulars, and magazine articles.

Before coming to Illinois in 1924, he served as head of the agricultural engineering department at the University of Georgia and on the staffs of Iowa State, the University of Pennsylvania, and The Ohio State University, his alma mater. He taught manual arts and drafting in high schools in four states before completing his bachelor's degree in education. That was followed by a second bachelor's degree in professional architectural engineering, all from The Ohio State University. As an architect, Foster spent many long hours over the drafting board and was remembered for his green eye-shade. In addition to his busy academic career, Foster had time to provide professional architectural services. He designed several houses in Champaign-Urbana, including his own residence just off Lincoln Avenue at 812 Delaware Avenue in Urbana.

MARVIN D. HALL
1962–89

Marvin Hall was born in 1931 near Linden, Iowa. In 1937 his parents moved to southern Missouri where he graduated from high school in 1949. He entered the U. S. Navy after high school, and after four years of service he entered and graduated from the University of Missouri. After graduation, Hall worked three years for J. I. Case Co. before beginning his career as an extension agricultural engineer at the University of Kentucky. He moved to the University of Illinois in 1962 to become an area engineer and remained there until retirement in 1989.

While working as an extension engineer, Hall became interested in environmental systems of livestock buildings. Although working full time, he continued to study housing systems and received an M.S. degree from Southern Illinois University in 1977. Solar energy development was a major interest, and he worked on many designs to use solar energy in agricultural processing systems and livestock environments. Aquatic engineering was also a major thrust for many years, and Hall's efforts to develop a mechanized fish production system were ongoing. The application of solar energy to many farmstead functions such as grain processing and thermal heat for human work areas, was another focus. Hall is coauthor of *Implementation of Solar Thermal Technology,* published by the U. S. Department of Energy in 1996. Since retirement his hobby has been designing and using golf clubs.

EDWIN L. HANSEN*
1936–41, 1956–75

Edwin LeRoy Hansen was born February 2, 1911. He earned his bachelor's degree from Iowa State University in 1935 and received a master's degree in civil engineering from the University of Illinois in 1941. He was then employed by the Soil Ero-

Donnell Hunt led an artichokes research project.

Ruth Book, a Ph.D. candidate, conducts a test using a hydraulic panel in the fluid power laboratory.

Paul Walker uses the "Illini Mouse" to measure deflection in corrugated plastic drain tubing as part of early studies of proper installation techniques.

Lowell Hill, standing, and Marvin Paulsen, seated right, discuss their corn quality inspection system.

Marvin Paulsen conducts studies on the breakage of corn kernals.

An undergraduate student uses a new electronics distance measuring (EDM) device that replaces the old surveying equipment.

Rolland Espenshied explains the welding equipment in his Ag Mech 201 class.

Donnell Hunt demonstrates to students a device for measuring stress.

Don Holt, Experiment Station Director; Fred Werts, farmer and John Campbell, Dean of the College of Agriculture accept an ethanol powered tractor from Ford Tractor Company representative Mike Follman and dealer Eldon Torbeck.

Douglas Bosworth of Deere and Co. presents William George, Associate Dean of the College of Agriculture, a check for $25,000 in support of the department's Fluid Power Laboratory. Looking on are Carroll Goering, professor; Ron Nelson, Deere and Co.; Wayne Tanner, student; and Mike Senneff, Deere and Co. All Deere employees are UIUC Agricultural Engineering alumni.

Paul Bateman, right, and wife Lorennie, left, visit with new department head Roscoe Pershing. Circa 1989.

Lawnmower Winterization has been a longtime activitiy for the Ag Mech Club.

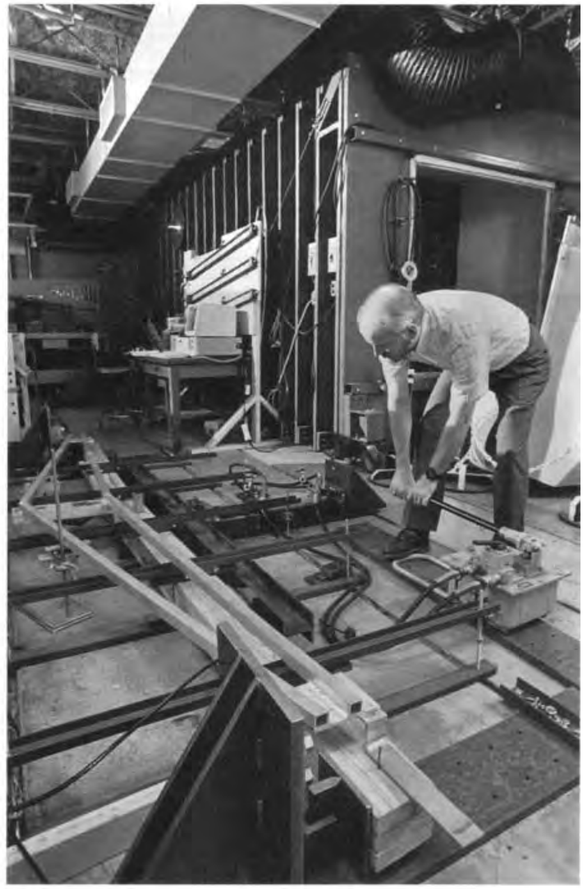
Faculty wives present a Billy Morrow Jackson painting to the department as a memorial to Peggy Lanham Hubbard, wife of the Department Head Frank Lanham. Family members present May 9, 1987 are Edward Cunningham, Fred Hubbard, Susan Kay Lanham Harned, and Caroline Lanham Cunningham. Grandchildren include Christina Cunningham, Bryan Harned, and Curtis Cunningham.

John Siemens atop his "rainmaker" machine for testing soil erosion in the field.

Gary Wells, second from the left, presents the department a Case-IH combine as part of the industry's support. Accepting are Department Head Roscoe Pershing, left, and Dean Reg Gomes, right.

Steve Ford conducts fan studies for the Bioenvironmental and Structural Systems Laboratory.

Gene Shove inspects a solar panel used for drying grain on a cooperators farm.



A graduate student conducts structures stress tests in the Research Laboratory.

Dale Vanderholm examines the distribution pipe for a feedlot runoff filtration system using vegetative filters.

A student measures rill erosion for Kent Mitchell's erosion studies.

JoAnn Bier assists Don Jedele as he measures precast concrete strength.

Al Jensen, Ed Hansen and Art Muehling, left to right, discuss plans during the development of the Moorman Research Farms on South Fourth Street.

A waste lagoon being developed at the Swine Progeny Testing Laboratory at First Street and St. Mary's Road.

A senior design project researching methods of harvesting asparagus.

A graduate student using Magnetic Resonance Imaging (MRI) equipment.

Jon Carson works on development plans as an assistant to Douglas Bauling in the Agricultural

Mumford House, built in 1871, is the oldest building on campus. It was used by Nathan C. Richer in early agricultural mechanization classes as an example of an "improved" farm house. The building is on the National Registry of Historical Places and is currently used by the School of Art and Design.

1970 produced six Ph.D. graduates. Pictured left to right are Kent Mitchell; Ben Jones, adviser; Gary Bubenzer; and Peter Bloome. Not pictured are James Converse, Cecil Hammond, and

Emeriti professors, left to right, Ralph Hay, Paul Bateman, Ed Hansen, John Matthews, and Frank Andrew conduct their own groundbreaking as the Agricultural Engineering Sciences Building project gets underway on May 26, 1981.

The steelwork shows the structured design of the north stair tower of the Agricultural Engineering Sciences Building during construction in 1981.

Workmen securing the art piece "Aurora I" by Bruce White into place near the west entrance of the Agricultural Engineering Sciences Building in 1983.

A two-story bridge joins the Agricultural Engineering portion, left, and Food Sciences portion, right, of the Agricultural Engineering Sciences Building, 1983.

The completed Agricultural Engineering Sciences Building, June 8, 1983.

Governor Jim Thompson (second from left) and University of Illinois President Stanley Ikenberry (left) cut the ribbon for the new Agricultural Engineering Sciences Building as William Forsyth, Board of Trustees Chairman; Roger Yoerger, Department Head; Larry Werries, Illinois Department of Agriculture Director (back row); John Cribbet, Chancellor; John Campbell, Dean; and Orville Bentley, former Dean of the College of Agriculture, watch.

sion Service as an engineer at the Civilian Conservation Corps camp at Mount Carroll, Illinois.

Hansen had two periods of service at the University. He was an assistant in the department from 1936 to 1941. From 1941 to 1946 he was an engineer for the Portland Cement Association in Chicago, and in 1947 he was chosen as a member of a four-person team to go to China to improve agricultural conditions there. When he returned, he went into business with his brother and began the Hansen Brothers Agricultural Engineering Services at Hillsdale, Illinois. He also served as a member of Overseas Consultants, Inc. in Iran in 1948, which proposed a seven-year development program for that country. After five years, the Hansen brothers dissolved their business and Hansen established E. L. Hansen and Company at Cordova, Illinois.

Hansen returned to the University in 1956 and served as head of the farm structures division until his retirement in 1975. His major research contributions concerned the development of concrete as a construction material in agricultural buildings. He also developed the concept of precast concrete components and concrete rigid frames. Hansen was a leader in confinement housing systems for swine, helping develop the "Hog-O-Matic," a facility at the University's farms that featured automatic feeding and floor cleaning.

RALPH C. HAY*
1932-72

Ralph Hay was born on a farm near Parker, Kansas and graduated from Parker High School in 1925. He enrolled at Kansas State University but his university education was interrupted for two years when he returned home to farm with his father. During that time, he taught in a rural school. After his return to Kansas State, he received a B.S. degree in 1932 and then joined the U of I staff. In 1951 he received his M.S. degree from Michigan State University while on leave from the university.

Hay was instrumental in organizing more than thirty Soil and Water Conservation Districts in Illinois and served as executive secretary for the State Soil and Water Conservation Board from 1947 to 1951. He also helped form the Illinois Land Improvement Contractors Association and served as its executive secretary from 1966 to 1972.

In 1954 Hay took a two-year assignment to develop an agricultural engineering department in the Indian Institute of Technology in Kharagpur, India. Two years after returning to the campus he became the coordinator of international cooperative programs in the Provost's Office and was in charge of the India development contracts. He returned to India in 1962, where he served as a visiting professor and advisor to the dean of engineering at Uttar Pradesh Agricultural University in Pant Nager. In 1985 he was invited to return to India to celebrate the twenty-fifth anniversary of the India Society of Agricultural Engineers, which he had helped found. Hay's contributions to international agriculture were so well recognized that he was the first recipient of the Kashida International Award of the ASAE in 1978.

After his retirement in 1972 he worked as a consultant on many soil and water conservation problems throughout Illinois and in many other midwestern states. In recognition of his professional accomplishments he was named a Fellow in both the American Society of Agricultural Engineers and the Soil Conservation Society of America.

KEITH H. HINCHCLIFF*
1944–60

Keith Harry Hinchcliff was the first full-time extension specialist in farm structures and rural housing on the department staff. He came to Illinois in 1944 and served until his death following a family auto-train accident in July 1960. Hinchcliff was well known in the University, in professional circles throughout the country, and to rural people throughout Illinois for his outstanding work as a farm buildings specialist. He was an artist and architect who also understood practical building requirements. His special interest was rural house design, and he gave special attention to remodeling the "model-T farm house." Development of visual aids for use in extension teaching was also a special interest. His chalk talks to illustrate his subject were considered entertaining and technically informative, and he was in great demand by Illinois farm families interested in home improvement.

His degrees, a B.S. and an M.S. in architecture, were earned at Kansas State University. He worked as an architectural draftsman for the National Park Service in the Lake of the Ozark region, on the University of Arkansas architectural staff, and as an extension specialist at Mississippi State University before coming to Illinois. His earlier work with Professor Carter at Arkansas was a major factor in his decision to join the staff. In 1953 Hinchcliff and his family went on a two-year assignment to Indonesia under a U. S. government program. His publication "Leader Training for Self-Help Housing" was based on that experience.

DEAN L. HOAG*
1968-83

Dean Hoag was born May 13, 1939, in Spencerport, New York. He came to the University of Illinois as an assistant professor after receiving his B.S. from Cornell University and his Ph.D. from the University of California in 1968. His M.S. was from the University of Illinois for work on developing a mechanical stripper to harvest strawberries.

Hoag soon became an authority on the use of analog computers to model the physical properties of plant parts as large as tree limbs or as small as soybean seeds. He taught an instrumentation course for advanced undergraduate students in agricultural engineering and other engineering curricula. Alumni remember him as methodical and deliberate in his lectures to ensure that every student understood the material. He was most concerned that his students recognize the unchanging fundamentals of physical science.

One of Dean's consuming outside interests was baseball. He favored the Brooklyn Dodgers, and his love for the game also found expression in his dedication to the University's team. Hoag died in 1983.

DONNELL R. HUNT
1960-96

Donnell Hunt was born on August 11, 1926, in Danville, Indiana. He was one of three children. Following high school, he served in the U. S. Army of Occupation in Japan. After his army service, he attended Canterbury College in Danville, Indiana for a semester and then entered Purdue University where he received a B.S. degree in agricultural engineering, with distinction, in 1951.

After his graduation from Purdue, Don joined the faculty of Iowa State University as an instructor in agricultural engineering. While teaching, working on his M.S. and Ph.D., and assisting with the management of the college farms, he wrote *Farm Power and Machinery Management*, which in 1996 was in its eighth edition. The book is used widely, including in India and South America where it has been translated into Spanish. Don earned his M.S. degree in 1954, his Ph.D. in 1958, and was promoted to assistant professor and then to associate professor.

He came to the University of Illinois in 1960. His research interests continued to center on machinery management and machines for special crops. Don's teaching and advising earned the respect of his students; in a 1982 survey of five- and ten-year alumni, several singled him out as one teacher who had influenced their technical and professional development, or had helped them with personal problems.

Hunt has won international recognition with his work in machinery management. He developed the important "timeliness" factor in machinery management theory, a critical factor in selecting optimum farm machinery sizes. He was also an early user of computers, later using minicomputers for teaching and research in agricultural engineering. Those who attended the university in the 1970s will remember him demonstrating the solution of machinery management problems on the department's only minicomputer in a cramped room under the stairwell.

Hunt authored two additional major textbooks and many professional articles. He has served in many leadership roles in the ASAE and been named a Fellow in that society. He has consulted or lectured in Ireland, Sri Lanka, India, Australia, Canada, Iran, Mexico, the Netherlands, and the Philippines.

DONALD G. JEDELE
1956–88

Donald Jedele was born and reared on a small farm at the edge of Denison, Iowa. His father's business was a small grocery store and meat market. Jedele was planning to study business administration at Morningside College in Sioux City, but World War

II postponed his plans. While waiting for entry into the navy, he worked as an office boy in the engineering department at Union Pacific Railroad headquarters in Omaha. It was that experience that led him to study engineering after the war.

Jedele enrolled in agricultural engineering at Iowa State University in September 1946 and graduated in 1949. He stayed at Iowa State as the manager of the Midwest Plan Service and completed his M.S. in 1954. In January 1956 he joined the U of I staff as an extension specialist and became an advisor to swine producers on confinement swine buildings and waste management. Later he took over the family housing education program, along with farmstead arrangement and beef cattle housing. Farm Structures Day was a program for rural builders that Don organized annually for many years. As a result of this and other programs he was elected into the Rural Builders Hall of Fame sponsored by *Rural Builder Magazine*. Jedele also worked as a housing specialist with the Tennessee Valley Authority Demonstration Program coordinated by the Department of Agricultural Economics. There he provided counsel to many Illinois demonstration families as they made improvements to their farmsteads and homes. He was leader of the department's extension programs from 1960 until 1988.

The American Society of Agricultural Engineers honored Jedele with the Gunlogson Countryside Engineering Award, primarily for planning nearly seventy Illinois county extension offices. In 1984 he was elected a Fellow of the ASAE. He retired in 1988.

BENJAMIN A. JONES JR., 1952-92

Benjamin A. Jones, Jr. was born on a farm located between Bondville and Mahomet in Champaign County on April 16, 1926, the youngest of two sons. He completed high school in Decatur, then served in the navy during World War II as an aviation electronics technician working on radar and communications systems. After the service he entered the University of Illinois, receiving a B.S. in June, 1949 and an M.S. in August 1950, both in agricultural engineering.

After working as an assistant professor and extension agricultural engineer at the University of Vermont for two years, he returned to the University of Illinois as an instructor in agricultural engineering and began work on a Ph.D. He became an assistant professor in 1954 and in 1958 received a Ph.D. with a major in civil engineering. Jones continued his career at the university as associate professor and head of the soil and water mechanics division of the department. He taught courses in soil and water engineering, directed thesis research, and led teaching, extension, and research efforts in that division. Although his thesis research work was on land drainage, he also conducted research on terraces and wrote extension materials on every aspect of soil and water engineering.

Jones became a full professor in 1964 and was named associate director of the Illinois Agricultural Experiment Station in 1973. He became a member of the USDA Committee of Nine, serving four years, one year as its chair. He was elected to ESCOP and while serving on the committee was appointed to the legislative subcommittee, where he assisted in forming agricultural policy at the national level. Jones continued as associate director of the experiment station until his retirement in 1992.

Alumni will remember Jones as a person sought after in positions of leadership that involved planning and development, whether it was for the First United Methodist Church of Urbana, for a new facility for the ASAE, or for planning a new program for the Agricultural Experiment Station.

FRANK B. LANHAM*
1955–78

Frank Lanham was born in Weston, West Virginia, the son of a Methodist minister. He graduated from Sistersville (West Virginia) High School and received a B.S. in agricultural engineering from Virginia Polytechnic Institute in Blacksburg in 1935 and an M.S. from Iowa State College in 1936. He was then appointed as a research engineer for the University of Georgia. He served as an army officer in the South Pacific during World War II, assigned to the staff of General Joseph Stilwell.

After the war, Lanham returned to Iowa State College, completing his Ph.D. in 1952. He and his family then moved to St. Joseph, Michigan, when he was appointed secretary of the ASAE. Always a proponent of excellence in education, Lanham contributed materially to the strength of the society's relations with the Engineers' Council for

Professional Development, Engineer's Joint Council, and the National Council of State Boards of Engineering Examiners.

In 1955 Lanham was named professor and head of the Department of Agricultural Engineering and continued in that capacity until his death in 1978. During his tenure, he succeeded in building the department by concentrating on academic excellence. As proof of his efforts, the Ph.D. program was approved in 1964. He received several prestigious honors from the ASAE; he was made a Fellow of the society, received the Massey-Ferguson Education Award in 1974 for "Advancement of Engineering Knowledge and Practice in Agriculture," and served as president in 1976.

Lanham loved to camp and fish. His close friends agree that there was nothing better than fresh-caught walleye fried over a campfire by Lanham—especially after a hard day of canoeing and backpacking. He loved gardening and prided himself on a beautiful crop of roses each year.

EMIL W. LEHMANN*
1921-55

Emil Wilhelm Lehmann came to the University of Illinois to head the newly organized Department of Farm Mechanics in 1921. The department's name was changed to "agricultural engineering" in 1932 as the professional agricultural engineering curriculum began under his direction. He continued as head of the department until his retirement in 1955. His career in teaching, research, and extension dealt with all divisions of agricultural engineering. Although Lehmann's primary interest was in rural electrification, he also worked on soil conservation, drainage, water supply, sewage disposal, and harvesting machinery. The first two agricultural engineering graduates completed their degrees in 1934 in the midst of the depression years. During that period Lehmann participated actively in organizing CCC camps for drainage and soil erosion control and in the development of rural electrification and the Rural Electrification Agency (REA).

In the 1920s he encouraged a major farm machinery manufacturer to bring the first combine to Illinois for harvesting a new crop: soybeans. Lehmann's untiring efforts eventually resulted in the graduate program for the master's degree in 1948. He also succeeded in having the professional curriculum accredited by Engineers' Council for Professional Development (ECPD) in 1950. Despite his busy career, he always had time to assist and encourage many students to continue their professional careers.

Lehmann was a native of Mississippi and graduated from Mississippi State University. He then went to Texas A&M, where he earned a degree in electrical engineering, and on to Iowa State and the University of Missouri. He participated in numerous professional activities and served as president of the ASAE in 1923. He also headed the farm division of the National Safety Council. The ASAE awarded him the Deere medal in 1965.

WALTER D. LEMBKE
1968–87

Walter Lembke was born on a farm near Frankfort, Illinois. He graduated from the University of Illinois in agricultural engineering, with a B.S. in 1951 and an M.S. in 1952. He served in the U. S. Navy during the Korean War as an electronics officer on a destroyer and after his release from active duty in 1955, he joined the agricultural engineering faculty of Purdue University as an instructor of soil and water courses. He also began work toward a Ph.D. and received that degree in 1961 with research on the flow of water in steep tile drains.

Lembke joined the faculty of South Dakota State College (now South Dakota State University) as an associate professor to teach and conduct research on drainage of irrigated lands. He joined the faculty at Illinois as an associate professor in 1968, became full professor in 1974, and served in that capacity until his retirement in 1987. He led the teaching, research, and extension efforts of the soil and water division from 1973 to 1983 and carried on research in both drainage and irrigation. His favorite activity as a teacher was to encourage students to experience practical problems.

Lembke and his students studied the impact of drainage systems on water quality and considered the movement of nitrates in soil, finding ways to reduce nitrates that could leach into tile drains. The effect of drainage on the timeliness of agricultural operations was also of interest to him. Lembke and his students worked on irrigation systems, using a computer model to determine the needed pump capacity for supplying water for irrigation, and investigated the hydraulic conductivity of strip-mined spoil-materials and the effectiveness of water table control as an irrigation practice. In cooperation with members of the agronomy department, he studied the use of dredged sediment as a topsoil replacement for crop production.

Lembke was active in the American Society of Agricultural Engineers, serving as chair of the Soil and Water Division and the several offices related to that position from 1982 through 1990. Since his retirement in 1987 he has continued to remain active in the department. He taught a course in 1994 and has assisted in drainage projects involving both university land and that of private owners and drainage districts.

JOHN W. MATTHEWS
1950–76

John Matthews earned three degrees from the University of Illinois: a B.S. in agriculture in 1935, an M.S. in agronomy in 1941, and a Ph.D. in education in 1957.

He began his career as an agricultural instructor at Shabbona, Illinois, in 1935 and taught there for fifteen years, serving as president of the Illinois Association of Vocational Agriculture Teachers. In 1950 he joined the Vocational Agriculture Service (VAS) and the Department of Agricultural Engineering staff. In the VAS he prepared teaching materials, including a loan kit program for secondary schools, and in the department he taught the shop classes developed for students in vocational education. The VAS kit program was recognized nationally as an outstanding example of cooperation between a university and secondary schools throughout the state.

Matthews became head of the Vo-Ag Service unit in 1962 and retained that position until his retirement in 1976. In 1960-61 he served on the university's contract team to India, where he assisted in the teaching program and the design and building of better bullock-drawn implements and land-leveling equipment for irrigation.

Matthews's friends benefit from his interest in playing and tuning pianos and repairing clocks.

ARTHUR J. MUEHLING
1956–92

Arthur Muehling received his B.S. in agricultural engineering from the University of Illinois in 1950. He then received his M.S. degree from the University of Missouri in 1951. From 1952 to 1956 he served in the U. S. Air Force as a weather officer. He began his military training by studying meteorology and then spent three years forecasting weather at bases in Louisiana, French Morocco, and Colorado Springs.

He started in the department in January 1956 as a research associate working on environmental conditions for baby pigs. He also began teaching farm buildings courses and in 1961 became an extension buildings specialist working on livestock housing and waste management, with a major emphasis on swine. In 1968 he received a grant from the National Pork Producers Council to summarize his work on swine housing and waste management, which was printed as *Swine Housing and Waste Management: A Research Review.* He served on a committee that drafted the first proposed livestock waste regulations for Illinois in the early 1970s. In 1975 Muehling was local arrangements chair for the ASAE International Symposium on Livestock Waste, and in 1980 he was overall chair for the international symposium held in Amarillo.

He led Illinois swine producers on people-to-people goodwill tours to Europe and the Soviet Union in 1974, to Scandinavia and Poland with a stop in Leningrad in 1977, and to the People's Republic of China in 1982. During 1980 and 1981 he spent six months studying confinement swine housing and waste management in Australia, a venture coordinated by the Australian Pig Industry Research Committee.

In 1984 he was inducted into the Farm Builders Hall of Fame sponsored by *Farm Building News* and in 1985 was recognized by the Illinois Cooperative Extension Service with a Sustained Excellence in Programs and Service Award. He was named a Fellow in the American Society of Agricultural Engineers in 1993.

ELWOOD F. OLVER
1960-82

Elwood (Woodie) Olver grew up on a Pennsylvania dairy farm. He earned his B.S. and M.S. degrees in agricultural engineering at Pennsylvania State University and continued his education at Iowa State University, earning a Ph.D. in agricultural engineering in 1957.

In September 1960 Olver joined the agricultural engineering staff at Illinois. Combining his engineering skills and his knowledge of the dairy industry, he did much of his research on automatic dairy cattle feeding systems. With Hoyle Puckett, USDA cooperator, and the dairy science department, Olver developed technology for automated feeding of dairy cattle, individually and in groups, that was then used on the university dairy farms.

In addition to his work with dairy farm equipment, Olver also served as executive secretary of the Illinois Farm Electrification Council from 1970 to 1980. He headed the electric power and processing division from 1970 until his retirement in 1982. Woodie also taught an undergraduate course in farm electrification and was advisor to many agricultural engineering students and to the Ag Council.

Olver took an active role in the leadership and development of agricultural engineering at J. Nehru Agricultural University, Jabalpur, India from 1967 to 1969. He spent 1978 with the Cooperative State Research Service, USDA; this was followed by a special assignment from the university from 1980 to 1982, working with the energy program of the USDA in Washington, D.C. He served as a part-time assistant to the dean of the College of Engineering for several years after his retirement.

ROSCOE L. PERSHING
1985-PRESENT

Roscoe Pershing was born in Indiana and obtained his B.S. degree in agricultural engineering from Purdue University and his M.S. and Ph.D. degrees from the University of Illinois. Upon graduation he joined the staff of Deere and Company, where he devoted nineteen years gaining experience in research and development, service, marketing, and corporate management.

He left Deere in 1985 to become head of the department. While head he organized and taught the introductory course in agricultural engineering. The department, which was ranked consistently in the nation's top five by *U.S. News and World Report* based on its graduate program, and which had doubled in size since 1987, hit number one in March 1994. During Pershing's tenure as head, undergraduate enrollment increased 35 percent and job placement continued at virtually 100 percent. He became associate dean for academic programs in the College of Engineering in 1993.

Pershing is a member of a number of professional organizations and honoraries and serves on a number of boards, including the ASAE Foundation Trustees and Worldwide Youth in Science and Engineering. He is a registered engineer in Illinois and holds three patents. His interests include golf, singing, tennis, popular organ, and personal computing. He sings with the Agricultural Engineering Four quartet and the chancel choir of Faith United Methodist Church of Champaign.

WILLIAM H. PETERSON
1978–95

William (Bill) Peterson was born in Hemet, California, but received his early education in Minnesota and Iowa. He served in the U. S. Army during World War II in Italy and France and received the Purple Heart and Oak Leaf Cluster. After the war and a year of farming in Iowa, he enrolled in agricultural engineering at South Dakota State University at Brookings.

His interest in the efficient use of electric energy in farming began after he received his B.S. in 1950 from SDSU. After serving as an electrical advisor at Webster, South Dakota for four years, he became an extension agricultural engineer at SDSU in 1955 and there continued his interest in capturing the sun's energy for direct use in farmstead operations. His M.S. thesis at SDSU, written in 1963, dealt with the use of solar supplemental heat for drying shelled corn. Peterson's solar energy research activity and his contributions to rural electrification in general led to several awards from rural electric organizations in South Dakota and to his contribution to a textbook on rural electrification. He also wrote a chapter for the 1974 *Yearbook of Agriculture*, "Electrical Wiring: Homeowner Tips."

Peterson came to the University of Illinois in 1978 as associate professor and developed extension activities in all areas of rural electrification. He also became manager of a USDA project, "On-Farm Demonstration of Solar Drying of Crops and Grains." In 1991 he was sponsored by the National Renewable Energy Laboratory and the Illinois Department of Energy and Natural Resources to construct a mobile photovoltaic system. He continued to demonstrate the system after his retirement in 1995, and many alumni have seen his trailer-mounted solar power system at exhibitions throughout Illinois.

GEORGE E. F. PICKARD*
1949–60

George Ernest Foster Pickard was born in Ontario and graduated with distinction from the University of Saskatchewan in agricultural engineering. He joined the department as an associate professor in 1949 and remained until his death in October 1960. He became a professor in 1951 and was the first head of the power and machinery division. During this period he taught advanced courses in farm power and machinery design, was advisor to a number of students earning master's degrees, while carrying on an active research program.

He earned a master's degree in agricultural engineering at Iowa State University in 1935 while on leave from Massey-Harris. In 1937 he transferred to a Massey-Harris factory in France, where he became chief engineer. Pickard and his family were interned in France by the German army throughout World War II. During that time, he studied independently and later passed the examination for membership in the Institute of Mechanical Engineers in London.

Pickard came to the University of Illinois staff from the Massey-Harris Company, where he had become assistant chief engineer of the Toronto plant. At Illinois, he served on numerous committees in the department and College of Engineering and was chair designate of the engineering policy and development committee. He supported a more liberal curriculum for engineering students at a time when cultural and humanistic subjects were not readily accepted.

In his major interest, harvesting machinery, he was a pioneer in the development of a corn head for combines. That project developed into the large-scale harvesting of corn with a combine. In 1956–57 he spent six-months on a sabbatical leave in Hawaii, where he worked on the mechanization of sugar cane production. His reviews and applications of ideas that had previously failed due to insufficient technology are well known.

HOYLE B. PUCKETT
1955–85

Hoyle Puckett was born October 15, 1925, in Jessup, Georgia, and received a B.S. degree in agricultural engineering from the University of Georgia in 1948 and an M.S. from Michigan State University in 1949. He began a career with the Agricultural Research Service of the USDA in 1949 as a project leader at Oxford, North Carolina.

Hoyle was assigned leader of the USDA-ARS Automatic Farm Equipment Investigations Project at the University of Illinois in 1955 and joined the faculty of the agricultural engineering department that year. He remained on the faculty throughout his career, retiring in 1985.

Puckett's major research interest was the automation of livestock production systems. That interest led to the development of an automatic feed grinder, a pneumatic conveyor, an electronic silo unloader controller, and several devices for automatic livestock feeding and materials handling systems. His work led to issuance of two patents: a flat-bottom bin unloader and an auger injector for a medium-pressure pneumatic conveyor. His work has also led to authorship of more than a hundred publications on electrical farm equipment and automatic controls. More recently, his research on a system for automatic collection and evaluation of dairy cow production on a day-to-day basis has led to development of the leading laboratory facility for interdisciplinary research on computerized dairy management in the world.

A Fellow of the ASAE, Hoyle received many awards for the excellence of his research. Among these were the Certificate of Merit from the Agricultural Research Service (won twice during his career), the Merit Award from the Illinois Farm Electrification Council, Engineer of the Year from the Illinois-Wisconsin Region of the ASAE, and the Distinguished Service Award of the Food and Energy Council. Alumni remember Hoyle Puckett's analytical approach to solving problems and his ability to separate a complex research task into manageable parts.

JOHN H. RAMSER*
1941-60

John Hubert Ramser was a pioneer in crop-processing research in the department. He began work in 1941 and continued for nineteen years, until his death in February 1960. His research included hay-curing systems, crop-drying equipment, hay crushing, and grain drying in a period when such practices were new to most farmers. He also taught senior courses in internal combustion engines and machine design.

John earned a B.S. in mechanical engineering from the University of Illinois in 1917 and entered the U. S. Navy, becoming an ensign during World War I. Following naval service, he entered industry in factory inspection and testing. He then spent ten years as a sales engineer for the U. S. Gypsum Company, followed by another decade operating the family-owned fruit farm in southern Illinois. He joined the University of Illinois staff during World War II as an associate and became assistant professor in 1957. His elder brother, C. E. Ramser, is widely known in agricultural engineering as a pioneer drainage engineer in the USDA. John is remembered for his technical competence, friendly, helpful attitude, and general good cheer in his work with staff and students.

ERROL D. RODDA
1958-62, 1968-93

After graduating from the University of Illinois in 1951 with a B.S. in agricultural engineering, Errol Rodda joined the staff of Caterpillar, Inc., spending two of his seven years with the company in Johannesburg, South Africa as a field engineer. He returned to the university in 1958 to pursue an M.S. in agricultural engineering and completed that degree in 1960, as well as an M.S. in civil engineering in 1964. He then went to Purdue University where he finished a Ph.D. in 1965. He became an assistant professor in agricultural engineering at the University of California, Davis for a few years, but in 1968 returned to the university's staff with a joint appointment between the Departments of Food Science and Agricultural Engineering. He was responsible for the initiation of the food engineering option and pursued its development through its approval in 1985.

In addition to research of interest to food scientists, Rodda's research included analysis and design of reinforced concrete and wood structures; grain and seed drying, storage, and damage detection; alcohol/ethanol production; automated collection of animal production data; and corn foam loose-fill packing material.

Rodda's international involvement included: University of Illinois/USAID projects in India from 1968 to 1970 and 1986, Sri Lanka for the United Nations Development Plan (UNDP) in 1974, Egypt on a USAID contract in 1978, Hungary for the World Bank in 1982-83, a 1983 sabbatical leave in China, and team leader for the university TIPAN Project in Pakistan from 1985 to 1987. In 1988 he consulted for the World Bank in Pakistan, followed by World Bank assignments in Egypt in 1990 and 1991. Major emphases of these projects involved grain storage and handling, soybean utilization, agricultural mechanization, and organizational rebuilding of agricultural universities.

Rodda met Erica M. Kohl in February 1954 in Mannheim, Germany and married her the following year. Erica was a simultaneous translator for the U. S. Armed Forces and taught English and German at universities in China and Pakistan.

RAY I. SHAWL*
1916-58

Ray Iris Shawl's service at the University of Illinois and in the department spans almost a half century. He taught power and machinery courses for forty-two years before his retirement in 1958 and conducted research that led to the use of rubber tires and high-compression engines on tractors. He also conducted tests on numerous other subjects, including harvesting, moldboard plows, quality of motor oil, and tractor maintenance. His circular on tractor repair and maintenance served as a standard for many years, and his one-week winter tractor short-courses were well attended for a quarter of a century. Material he developed was used in the first 4-H tractor projects.

Ray graduated in farm mechanics from the University of Illinois in 1916 and took a master's degree in the same subject three years later. He served on the staff continuously after his graduation, other than a short period with the navy during World War I. As a student he was editor of the *Illio*, played bassoon in the football marching band, and sang in the glee club and chorus. He continued his career in music throughout his working career. For years he was the oldest member in the marching band. His good humor, hobby of photography, interest in students, and practical approach to subject matter are well remembered.

GENE C. SHOVE
1958-89

Gene Shove was born and raised on a farm near Havensville in northeastern Kansas. Following eighteen months in the U. S. Army, he farmed for two years and then enrolled at Kansas State University in the fall of 1948. He received B.S. and M.S. degrees in 1952 and 1953 and continued on at Iowa State University for his Ph.D. in 1959. While working on his Ph.D. he served in the agricultural engineering department as an assistant manager of farm services and as an extension specialist in crop drying and storage. He joined the University of Illinois staff in 1958.

His M.S. thesis research on using heat pumps to dry grain was followed by research on air distribution from grain aeration ducts for his Ph.D. dissertation. After a brief period of studying automatic feed-handling for livestock, he returned to his work on grain drying and storage.

In the mid-1960s Shove experimented with the use of refrigeration to dry and maintain the quality of shelled corn in storage. Extensive laboratory tests and farmers' experiences with insulated drying/storage installations uncovered many mechanical problems, and the process did not prove practical for midwestern grain producers. The chilled grain drying research did, however, lead to the development of low-temperature grain drying, for which Shove became internationally recognized.

Increases in the cost of fossil-based fuels prompted Shove to obtain funding during the late 1970s and early 1980s to support research on applying solar energy to the drying of crops and other farm uses, such as farm-shop and livestock-shelter heating.

During his career he received the Paul A. Funk Award from the College of Agriculture and Certificates of Appreciation and Merit from the Illinois Farm Electrification Council, as well as the Silver Switch Award from the National Farm Electrification Council.

He married Myrtle E. Ellis in 1949. They have two sons, Gregory and Kent, and a daughter, Myrene. He retired from the university in 1989 after thirty-one years in the department.

HENRY R. SPIES
1982-90

Graduating in agricultural engineering from the University of Illinois in 1953, Henry (Hank) Spies served as an officer in the USAF from 1953 to 1955. He was then appointed assistant editor with the University of Illinois Engineering Experiment Station, where he served from 1955 to 1958. He was also science editor for *Our Wonderful World,* a children's encyclopedia, from 1958 to 1960.

From 1960 to the time of his retirement in 1990 he served as editor and managing editor of the Small Homes Council-Building Research Council at the University of Illinois, responsible for its housing advisory service and providing answers to questions from builders and homeowners. In 1982 he received a joint appointment in agricultural engineering.

After retirement, Spies devoted much of his time to the Spies Home Inspection Service, specializing in pre-purchase and maintenance inspections for homeowners. He also frequently arbitrated homeowner-contractor disputes.

MARVIN P. STEINBERG*
1979–90

Marvin Steinberg, a professor in the Department of Food Science, held a joint appointment in the Department of Agricultural Engineering. He contributed greatly to the department, particularly with the development of the food engineering curriculum, and was a valued member of the faculty.

Steinberg spent much of his early life in Minnesota, receiving his B.S. and M.S. degrees in chemical engineering from the University of Minnesota in 1943 and 1949. He then enrolled in graduate school at the University of Illinois and was one of the first Ph.D. candidates in the newly formed Department of Food Technology. He was awarded that degree in 1953 and then continued his career in that department, becoming a full professor in 1964. Always a believer in interdisciplinary research and the team approach to problem-solving, he was one of the early pioneers in food engineering. He cooperated with Errol Rodda and Donald Day in developing the food engineering curriculum in the department. He also cooperated with Day in conversion of animal waste to feed using electrolysis and with Rodda in the formation of fuel alcohol through the process of solid-state fermentation.

Steinberg was active in the department and is remembered for his ability to interact cordially with his colleagues and students.

HOWARD L. WAKELAND
1951–93

Howard Wakeland received his bachelor degree from the University of Illinois in 1950. After one year as a field engineer for the Illinois State Water Survey, he enrolled in graduate school and received an M.S. degree in 1954. He was also appointed as assistant dean in the College of Engineering and assistant professor of agricultural engineering that same year. Wakeland became associate dean in 1968, when he was also promoted to full professor. During thirty-nine years in the dean's office, he was responsible for certifying graduation of twenty-six thousand students. "Howie," as his associates came to know him, was responsible for the administrative details of the many undergraduate programs in the College of Engineering, many of them the direct result of his efforts.

The Minority Engineering Program was an outstanding example of Wakeland's success in establishing innovations in traditional engineering education. It began in 1968 when he met with a group of black engineering students to discuss the progress being made on campus on their behalf. He responded to their concerns, and by 1973 his efforts in minority engineering were sufficiently well-recognized for him to be invited to Washington, D.C. to be involved in the several national minority engineering education programs. For his pioneering efforts, Wakeland was recognized with the American Society for Engineering Education's Vincent Bendix Minorities in Engineering Award.

An eloquent speaker, Wakeland has become noted for statements remembered as "Wakelandisms:" "Placing a student in a course that is too advanced is like offering him a drink of water from a fire hose;" "The U. S. is not likely to reach its greatest technical potential unless the American engineering community is as capable as that of its global competitors;" and, "Competing successfully internationally requires cultural awareness, international experience, and language skills."

The philosophy in the last two statements led to Wakeland's greatest achievement in international engineering education—his leadership role in the creation and development of the Engineering Alliance for Global Education (EAGLE). This coalition of fifteen engineering schools sponsors students to work in Japanese industry following graduation and completion of intensive language studies. After his retirement, Wakeland served as the executive director of EAGLE, the secretariat of which is located on the Urbana-Champaign campus. Wakeland has also contributed to engineering exchange programs in many countries.

As a fitting tribute to Wakeland and his belief that engineers of the twenty-first century will be bilingual leaders in academe, industry, and government, he was recently awarded the Palmes Academiques by the French government for his efforts in expanding and developing exchange programs with French engineering schools. In retirement, Wakeland is also involved in his family real estate venture, Wakeland Enterprises.

J. ARTHUR WEBER*
1946–76

J. Arthur Weber received a B.S. degree from the university in 1942, and after serving three years in the army in Europe, completed his M.S. degree in 1948.

He joined the agricultural engineering staff in 1946 and distinguished himself as an outstanding teacher and a valuable participant in the team approach to problem-solving. As teacher of the senior power and machinery design course, he won the Stanley Pierce Award for contributing to empathetic faculty-student cooperation.

Before 1960 Weber's research contributions were most notable in improving tractor maintenance. For example, it is estimated that his research on the application of newer, higher-efficiency, dry-type air cleaners, which eventually became standard equipment on tractors, saved farmers three million dollars annually in overhaul costs. After 1960 his work, and that of his graduate students, expanded to involve research in the application of power to the soil including the dynamics of tillage, traction, and earthmoving. The national and international reputation of his research accomplishments led to him being awarded the Paul A. Funk Award in 1974.

Alumni remember Weber as a teacher who had technical capability and a personal commitment to proper execution of assignments. He also had a dedication to answering questions clearly, whether they had to do with technical matters or personal problems. He took the use of the blackboard seriously, and disciplined himself to outline a problem and its solution and discussion in a way that provided the best learning experience for his students.

ROGER R. YOERGER
1958–85

Roger Yoerger grew up on a farm near Merrill, Iowa. As a boy, he participated in those farming activities related to his father's grain and livestock production. He developed an early interest in the business world by assisting with the bookkeeping activities of his uncle's trucking business. After graduation from high school he entered the agricultural engineering curriculum at Iowa State University in the fall of 1945. While an undergraduate student he did fieldwork on the university's farm. Upon completion of his B.S. in 1949, he became a full-time instructor in the department; manager of the College Farm Services, which operated 1,600 acres with a work force of thirty people; and studied for both his M.S. and Ph.D. degrees, received in 1951 and 1957.

He took a position as associate professor of agricultural engineering at Pennsylvania State University in 1956 before coming to the University of Illinois in 1958. He became head of the power and machinery division in 1960 and department head in 1978. As department head he was involved in designing, constructing, equipping, and occupying of the Agricultural Engineering Sciences Building completed in 1983.

He and his graduate students investigated such topics as tractor engine performance, hay and forage handling, instrumentation, engine fuels and pulsations, high-temperature crop drying, computer modeling, and noise reduction and operator comfort. He holds two U. S. patents, is a registered professional engineer in three states, and has served as a consultant to industry, the legal profession, and program-accrediting agencies. He retired from the department in 1985.

Yoerger has always been a strong proponent of scholastic achievement, and this interest continued after his retirement. In 1989 he was awarded the Massey-Ferguson Medal by the ASAE. He and his wife Laura took over the sponsorship of the ASAE Student of the Year Award, which in 1997 became a $1,000 scholarship offered to one student in the United States or Canada.

Yoerger was also very active in the Phi Kappa Phi Honor Society and served on its national board from 1971 to 1992 and as its national president from 1986 to 1989. He was also instrumental in a major increase in the funding of Phi Kappa Phi's fellowship program.

ARTHUR L. YOUNG*
1924-58

Arthur Leighton Young is remembered for teaching the introductory course in agricultural engineering. During his long career, he taught more students than any other person in the department. He came to know many students who have since gained prominence in their professional fields and he always took pride in their accomplishments. In addition to a heavy teaching load in introductory agricultural engineering and power and machinery subjects, Young also carried on field studies in combine harvesting losses and tillage. He enjoyed serving as a judge in numerous plowing matches held throughout the state and was also in charge of the horse pulling dynamometer truck used in contests at county and state fairs until World War II.

Although he spent his entire professional career at Illinois, he came from Iowa. Before earning his M.S. in agricultural engineering at Iowa State University, he earned a B.S. in mechanical engineering there and a bachelor's degree in liberal arts and science from Parsons College. He taught mathematics at Iowa State for a year before coming to Illinois in 1924. He retired in 1958 and was active in the Urbana Exchange Club, Boy Scouts, and the Unitarian Church, serving as church treasurer for many years.

Award Recipients

It is impossible to know all of the awards of various kinds received by the faculty and graduates. One source that is easily cataloged are those awarded by our professional society ASAE. A listing of ASAE award recipients and past-presidents is given in Appendix N.

7 | THE PHYSICAL FACILITIES FOR RESEARCH, TEACHING, AND EXTENSION PROGRAMS

Buildings and Facilities 1906 to 1983

A building designed specifically for the teaching of agricultural mechanization courses was completed for instruction in the fall of 1906. Before then the courses had been taught in the southeast wing of Davenport Hall, which was called Agricultural Hall when it was completed in 1900.

The following statement, taken from the first issue of the *Illinois Alumni Quarterly* in 1906, described the building when it opened for instruction. "The Farm Mechanics Building, which is at the south end of Mathews Avenue, on line with the Beef Cattle Building is a really beautiful addition to the agricultural group. It was begun last spring, pushed to completion rapidly and is already occupied by the Department of Farm Mechanics." At that time there were orchards near the building and a number of the agronomy experimental plots were north of it. The brick, stone and slate exterior of the building tended to overshadow the temporary wooden construction for part of the walls and all of the interior.

There were three floors and a partial basement supplying nearly thirty-five thousand square feet of floor area. The high ceiling for the laboratories and the shop on the first floor provided space for steam engines and threshing machines.

In 1924 another seven thousand square feet were added in the Tractor Laboratory addition on the south side of the original building. Brick construction was used for this laboratory. Then, in 1952, a research laboratory was constructed to add nine thousand square feet of area, to increase the total available area to fifty-one thousand square feet in the two buildings (Table 7). The latter building was built of high-quality brick construction and designed so a future agricultural engineering building could be added to its south, west, and north sides.

Changes were made in the original parts of the building after 1950 to provide more offices, improve the appearance of the laboratories, and provide sound-proofing. A major sound-proofing addition was to close the elevator shaft in 1963. Around 1930 there were thirty-two rooms for the offices, classrooms, laboratories, shops, and other spaces. In 1963 there were sixty-five rooms in the older building and nine rooms in the Research Laboratory (Table 8).

The Agricultural Engineering Research Field

In 1950, sixty acres of the newly acquired McCullough tract was assigned to the department for research and teaching purposes. This tract was located on Race Street Road, one and three-quarter miles south of Florida Avenue. Initially, research projects were devoted primarily to tillage and harvesting studies. Since 1960 from 250 to 300 tillage plots have been prepared each year in addition to the areas for teaching instruction, herbicide, tillage, and harvesting studies. In 1954

Table 7. Farm Mechanics Building and Additions; 1906-52

Building Area	*Date Completed*	*Approximate Cost*
Farm Mechanics Building	1906	$33,000
Freight elevator	1923	5,000
Tractor laboratory	1924	27,000
Research laboratory	1952	204,000

Table 8. Rooms in the Main Building and Tractor and Research Laboratories (1930–63)

Types of Space	*Main Building and Tractor Lab*		*Research Lab*	*Total Space*
	1930	*1963*	*1963*	*1963*
Offices	6	30	1	31
Classrooms	4	5	0	5
Laboratories	8	8	4	12
Shops	1	1	0*	1*
Storerooms	9	15	2	17
Restrooms, lobby	4	6	2	8
Total	32	65	9	74

*There were four shop areas in the four large laboratories of the research laboratory

a 40' x 60' metal machinery building was constructed. In 1958, 2 one-thousand-bushel metal grain storage bins were erected and a dryer was provided to dry the crops in the storage bins. In 1962, a concrete tilt-up machinery building was added to the facilities. Part of this 24 x 60' building was completed as a project of the ASAE Student Branch

Special Research and Teaching Equipment Prior to 1983

A number of pieces of equipment and instruments were added over the years for teaching and research.

FARM STRUCTURES

Grain storage studies on soft corn were begun in the early 1920s. The corn was stored and dried in eight small bins (10' x 10' x 8') that were provided with wheels to run on a railroad track. The bins could be moved over a scales and artificially heated air could be blown through them. These bins, located on the Agronomy South Farm, were remodeled and used for wheat storage studies in the mid-1930s. In 1943 a cooperative soybean storage project was started with the federal government. For this work, sixty farm-type bins were built to store seventy-five thousand bushels of soybeans on the Agronomy South Farm

An aluminum machinery storage building was constructed at the site of the soybean storage study in 1951. This aluminum building was improved in 1958 to provide special fixtures in the concrete floor for testing the strength of structural members. The testing facility provided a site to load full-sized structural frames up to 40 feet in width.

The animal housing buildings on the University's research farm, designed by agricultural engineers, were available for various types of cooperative research related to animal housing. Many new types of construction were used in the buildings built in 1961 and 1962 on the Moorman Swine Breeding Research Farm. These structures provided valuable facilities to study swine environmental impacts, management, and methods of manure disposal.

An instrumentation laboratory was started in 1962-63. A 60-ton universal testing machine was located in the laboratory. It was heavily used by graduate students for making load tests on various structural components. Later a major addition was an analog computer with an x-y recorder and other auxiliary equipment.

Electric Power and Processing

Research information on the use of electricity on farms and in farm homes after 1924 was obtained from private cooperator farms which had been provided with electricity from a specially constructed electric line. Electrical equipment and meters to obtain consumption rates were provided by the department. Early studies on automatic feed grinding and handling were also made on private farms starting in 1948.

An unusual waste-processing system was built to study the production of gas from farm waste from 1933 to 1937. Large and small digestion tanks, a heating system, conveyors, and gas collection tanks were installed in a special building constructed for this equipment and located near the university's beef cattle barn.

When hybrid seed corn was first produced commercially in the mid-1930s, there was a need to know the drying temperature and humidity to maintain high germination. A laboratory dryer was designed and built in 1936 that made it possible to obtain data to plot drying rate curves for given temperatures of drying while maintaining constant humidity. A large amount of basic research information was obtained on the drying characteristics of many agricultural products in addition to corn.

Automatic feed-handling equipment was developed beginning about 1948. A number of types of feed-handling components were available for study in the research laboratory. A pressurized system of moving grain through 1-inch pipes was instrumented to determine the performance characteristics of the various components used in the system. An air-flow test stand provided a regulated source of air for pneumatic conveying research and a means of calibrating other air-flow measuring devices. A mercury manometer on a test stand permitted the reading of static pressures at fifteen remotely located positions.

A power measurement panel was available for measuring the power requirement of electrical equipment. This measurement panel was used with a variety of indicating, integrating, and recording instruments.

The Hog-O-Matic feed-handling and manure disposal system was constructed on the swine farm in 1958. Feed rations were automatically metered to a mill, then ground, mixed, and conveyed to the feeders through small pipes. Automatic manure disposal was a part of the system. The system made it possible to study the feed-handling components under actual animal feeding conditions. The feeding habits of swine and the effects of various rations could also be studied.

Feed-handling installations on the University's beef and dairy cattle farms provided facilities for studying automatic unloading of silos and the processing and distribution of complete feed rations. These systems made it possible to experiment with electrical controls and various materials-handling components to improve the reliability of automatic feeding systems.

In 1962 equipment was assembled for conducting experiments on extending the allowable time to dry grain by controlling the drying atmosphere. Refrigeration equipment was used to condition the drying air which was continuously recirculated in an enclosed system for controlled-atmosphere drying. The equipment was also used to study the movement of temperature and drying gradients in a column of drying grain.

The electrical power and processing teaching laboratory was equipped with six work benches for laboratory work on electrical wiring and equipment. Each work bench was outfitted with instruments, tools, and equipment to perform laboratory exercises. Power at 120 and 240 volts was available at each panel.

Power and Machinery

In 1961 a 350-horsepower dynamometer was installed that was equipped so a tractor could be tested through a PTO shaft or it could be quickly converted to test a stationary engine. The dynamometer could be set to automatically maintain a constant speed or a constant load on the engine and the time to burn various weights of fuel consumed was recorded. Also an installation was completed in 1963 to teach the principles of a hydrostatic transmission.

A major facility was a laboratory soil bin that was designed and constructed to study the mechanics of soil related to agricultural tillage and machine transport. The bin was nearly thirty-four feet long and 30 inches wide. An automatically controlled carriage, cantilevered from two rails, was equipped with a tool-mounting frame and soil-reconditioning equipment. The reconditioning equipment consisted of a tiller for thoroughly loosening the soil, a strike-off blade, and a roller for compacting the artificial soil. A force transducer was used to simultaneously measure two forces which were plotted by an oscillograph recorder. This eight-channel oscillograph recorder and a second two-channel recorder were used for many other projects.

Laboratory-size corn dryers were designed and built to dry corn at temperatures up to 800 degrees F. One dryer was instrumented so a few kernels could be dried and a continuous record made of the temperature and moisture conditions in the kernels during a few minutes of drying time.

Soil and Water

A well-equipped laboratory was developed in 1953 to study various water-flow problems. Located in the research laboratory constructed in 1952, the facility had a large constant-head tank, pumps to supply 1.8 cubic feet per second of water, and a large sump. A weir tank was 9 feet long, 3 feet wide, and 2 feet deep. In addition, a glass-lined tilting channel made it possible to study the flow of water through various plastic models. This channel was 10 inches wide, 15 inches deep, and 12 feet long. Water could be weighed on a ten-thousand pound scale, and the time of discharge controlled with an electric eye timer. Slope studies of various types could be made on an 8' by 12' tilting platform. The laboratory was dismantled in 1984 upon the construction of the Agricultural Engineering Sciences Building which had a new hydraulics laboratory.

A New Agricultural Engineering Sciences Building 1983 to Present

The Agricultural Engineering Sciences Building was completed in the fall of 1983. However, dreaming and planning for the facility began long before its construction. E. W. Lehmann had proposed the construction of a new facility before the Research Laboratory was constructed in 1952. That laboratory was sited and constructed so a new multi-story building could wrap around it on the north, west, and south. But when a new building was finally built, this option was not used. Instead the Research Laboratory anchored the east side of a courtyard along the east side of the new facility.

Keith Hinchcliff was given the assignment in 1954 of preparing a set of drawings depicting the need for a new building. The renderings showed how agricultural technology had advanced; how the value of farm land and buildings in Illinois was greater than in five comparable states; how the production of machinery and tractors was greater in Illinois than in those same states; how farm labor productivity had increased since 1910; and the growth of agricultural engineering at the University of Illinois from the founding of the University in 1867. One drawing compared the size of agricultural engineering physical facilities at the University of Illinois in 1954 with Cornell University and Michigan State University.

Frank Lanham, as department head from 1955 to 1978, also voiced the need for a new agricultural engineering building. On March 27, 1959, he wrote the following to Dean Louis B. Howard:

> It has been some time since we discussed the Department of Agricultural Engineering from the standpoint of the inadequacies of our physical facilities. This comes to my mind so very forcibly at this time as we prepare to host our Farm and Home Festival guests. As one visitor commented last year "it must be a real task to successfully show 1970 agriculture in a 1904 setting."
>
> Aside from suggesting to our guests that in agricultural thought we are well behind in our concept of modern agricultural operations, our serious building inadequacies make it difficult for us to recruit stu-

> dents. We are, of course, in direct competition with other departments especially those in the College of Engineering. As students visit our department they quite naturally compare our facilities with those available to other engineering departments and with considerable logic reason if engineering as applied to agriculture offers so many fine challenges and opportunities then why doesn't the University provide adequate facilities. Yet, I believe you would quickly agree that the agricultural industry needs greater quantity and quality of engineering personnel. To provide for this need we must be successful in our student recruiting efforts and plainly a more nearly adequate physical facility would be of great assistance to us.
>
> The building program in Agricultural Engineering is a matter very near to my heart and I know too that you share my concern and interest. However, periodically, I feel we should discuss this very important problem; one which is seriously restricting our professional prestige not only in Illinois but nationally as well.

Shortly before Lanham's death in 1978, dreams began to come to fruition. In the March–April issue of the *Illinois Land Improvement Contractors' Newsletter*, Don Jedele wrote an article describing the need for better facilities. A new agricultural engineering sciences building was being proposed. Jedele pointed out how the present building was the oldest temporary building on the campus. It had been added to so many times that further remodeling had been deemed impractical by independent study committees. Freshmen who came from modern high schools were now taught in a facility where fumes and noise from shop activities were transmitted throughout the building. Prospective graduate students were asked to come to attic offices and work in outmoded, crowded laboratories. It had become difficult to recruit new faculty when better teaching and research facilities were available at most other land-grant universities.

Jedele pointed out that the department was limited in the research projects that could be done at the same time. For example, when the soil bin for tillage test work was in use, it had to be extended past a main overhead door, so access to the building was restricted. A noise and vibration test stand was located in the same room with the soil bin, and they could not be used at the same time.

Much of research work was being done in scattered, inadequate buildings. For example, structural testing of building frames or trusses had to be done at the Agronomy South Farm in a twenty-five year old pole-frame building covered with aluminum. It was called the "aluminum shed," and there was a certain affection for it, but it was uninsulated, unheated, and not bird proof. Several graduate students and faculty members had produced some excellent research using the test floor in the aluminum shed. They could have used their time more efficiently in a year-round facility near their offices instead of traveling a mile to reach the shed.

Agricultural engineers were also involved in research and teaching that required well-controlled environments (temperature-humidity) for conditioning and storage of research materials. They also needed clean, constant temperature laboratory space for sensitive testing equipment. Work with chemicals, electronics, and computers also required special laboratory facilities.

Jedele also explained that the faculty was not wanting all this for their comfort and convenience. The proposed new facilities would benefit the agricultural industry, because research that could be accomplished would improve that industry in Illinois and worldwide.

Requests for funds failed in 1975 and 1976. Then, in 1977 $200,500 was approved for planning. The turnaround in philosophy was caused by a program developed by some key people in the College of Agriculture: Food for Century III. Those key people included B. A. Jones, Jr., associate director of the Agricultural Experiment Station, and Douglas Bauling, assistant to the director, both agricultural engineers. Food for Century III was a big program that included the purchase of land and the development of research centers away from campus as well as campus buildings. On campus, though, an Agricultural Engineering Sciences Building headed the list.

The proposed building would house the Departments of Agricultural Engineering, the wood technology section of Forestry, and the engineering aspects of Food Science. Those departments already cooperated. For example, the forestry department owned a structural testing machine housed in the Agricultural Engineering Building. Both departments used the machine for research projects and class teaching. Unfortunately, there was little space around the machine, so it was difficult to test large specimens and was hazardous for class demonstrations because the students had to be crowded into such a small space. Although the proposed new building would not give much more total space, the space would be used more efficiently. The program statement developed for the project read:

> Almost 80 percent of the space in the Department of Agricultural Engineering is in a wood frame structure constructed nearly seventy years ago. An obsolescence study of the facility has indicated that further remodeling of the structure is not warranted and that it should be replaced. In addition, the wood science program in the Department of Forestry and the food engineering program in the Department of Food Science are located in poor quality temporary space which cannot meet the needs of these growing programs. Consolidating the engineering-oriented programs of these three departments into a new facility properly designed to provide flexibility and efficiency of use of resources is essential if the research and teaching responsibilities of these departments are to be met. It is desirable to have specialized facilities used cooperatively by several units to eliminate unnecessary duplication. The research work of the departments involved can be greatly enhanced by new facilities in a common structure.

In September 1976 the University of Illinois Board of Trustees approved the proposal for Food for Century III. On January 11, 1977, the Illinois Board of Higher Education approved funding most of the request for the University of Illinois Capital Budget for fiscal year 1978. A $7,859,200 item for the construction of an agricultural engineering sciences building was included. Funds totaling $340,000 were to be made available in the subsequent two years for equipment.

Frank Lanham became ill in 1976 before planning began on the new building, and died in 1978 before construction began. Roger Yoerger became department head in 1978 and provided leadership during the construction and occupation of the new facility.

The building was dedicated on May 2, 1984. It included one of the best food science pilot plant facilities in the country and much-needed modern cold-storage facilities. The department's facilities included a modern shop, a farm mechanics instructional laboratory, and a large open laboratory for resource development research. It also included a specialized wet laboratory for waste management and water-quality research, a soils laboratory, and an agricultural chemicals laboratory. An adhesives and wood chemistry laboratory was included for forestry-related research. The new building was located west of the existing Agricultural Engineering Research Laboratory and on the east side of the South Campus quadrangle.

LABORATORIES

The names of laboratories in the Agricultural Engineering Sciences Building and their respective areas are as follows as of 1996:

	Square Feet
Agricultural mechanization teaching laboratory	2,950
Undergraduate computer laboratory	600
Multimedia instructional laboratory	1,120
Preparation for laboratory work and drafting	500
Drafting room	600
Surveying equipment storage	150
Hydraulics laboratory for erosion, drainage and irrigation	2,000
Soil laboratory for drainage, erosion and irrigation	600
Water quality laboratory	600
John Deere fluid power laboratory	400
Dynamometer laboratory	700
Chemical applications laboratory	600
Assembly of large projects and sprayer calibration	3,000
Small test machine development and nozzle testing	1,200
Soil bin	600
Applied machine vision laboratory	600
Electronics development	660
Electrical power and electronics laboratory	900
Temperature and humidity controlled room	900
Grain drying, grain quality tests, moisture measurements	1,700
Bioprocess engineering	600
Wet milling laboratory	1,100
Wet- and dry-milling pilot plant	3,000
Bioenvironmental laboratory	600
Bioenvironmental and structural systems laboratory	2,150
Wood shop	1,240
Tests of spark ignition engines	1,200
Network administration, GIS, multimedia development center	800
Machine shop	1,500
Total laboratory space	32,570 square feet

Improvements to the New Building and Its Equipment

The $340,000 budgeted for equipment proved to be inadequate because the technology of the computer age changed a great deal during the planning and construction of the Agricultural Engineering Sciences Building. The computer facilities started with an in-house PDP 11/23 that tied into a campus main frame or to other computers by outside telephone lines. A student computation room (undergraduate computer lab) contained six terminals and three printers. That proved to be inadequate to incorporate the use of desktop computers into all phases of classroom instruction.

The Accreditation Board for Engineering and Technology reviewed the College of Engineering during the 1983-84 academic year. One of the its strongest recommendations was that the integration of computing should be greatly enhanced in upper-division courses.

Under the leadership of Roger Yoerger, a proposal was submitted to the University's IBM EXCEL program. A $102,000 grant in 1985 provided twelve IBM AT advanced graphics workstations primarily for teaching functions. The grant also made available technical assistance to develop teaching software. Because of constant changes in equipment, the Computer Laboratory was upgraded again in 1991 and in 1994.

During the past ten years other significant equipment and instrumentation have been added to the teaching program. Some equipment was obtained through grants and gifts, and some was purchased with faculty research project funds. A Geographic Information System (GIS) Center was established as part of the soil and water research program. An Applied Machine Vision Laboratory was developed with a variety of image-processing platforms and other equipment used for instruction in undergraduate courses. A notable teaching equipment gift was $125,000 provided by Deere and Company for the development of a Fluid Power Laboratory. That gift permitted the purchase of six fluid power training units with electrohydraulic control interfaces and engineering software for analyzing fluid power systems.

EPILOGUE

It is impossible to speculate on what the faculty of the Department of Farm Mechanics in 1921 envisioned as the changes engineering would create in agriculture in the years to come. Of course they knew that the unwieldy tractor would take over the big task of plowing and that electricity would do some choring tasks and make the farm home a nicer place to live. But it is doubtful that anyone envisioned that 75 years later you could sit in the air conditioned cab of a fertilizer applicator that could communicate with a satellite linked with sensors that could evaluate the soil and then tell the computer to regulate the amount of fertilizer that should be applied to achieve a specified yield of a crop. Or how about sitting in the air conditioning cab of a corn combine, out of the dust and wind, and receiving continuous read-outs of the yield of the crop essentially foot-by-foot as you cross the field. Or invision the miracle of instantaneous communication any place in the world by telephone, facsimile or computer.

Surely the students, both those in mechanization and those in engineering, have been part of and in part responsible for an engineered revolution in agriculture. Oh to be around at the end of the next twenty-five, fifty, or seventy-five year interval to be amazed at what has transpired in engineering for agriculture.