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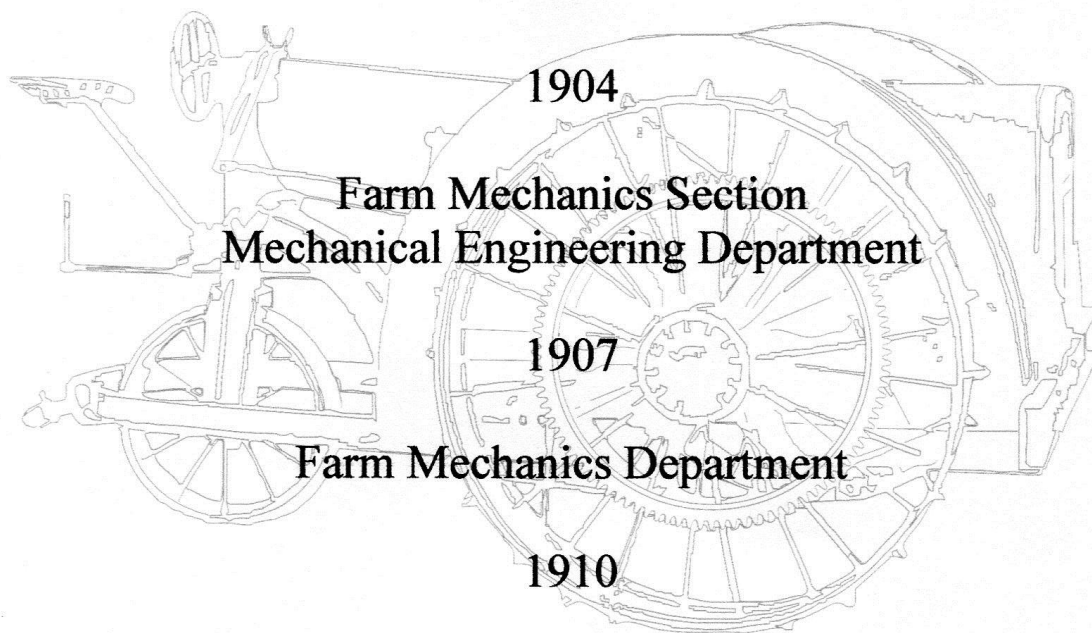
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HISTORY OF THE
BIOLOGICAL SYSTEMS
ENGINEERING PROGRAM
IN
NEBRASKA



Agricultural Engineering Department

1990

Biological Systems Engineering Department

UNIVERSITY OF NEBRASKA-LINCOLN

BIOLOGICAL SYSTEMS ENGINEERING

THE NEBRASKA HISTORY

1895-2011

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PREFACE: HOW MECHANIZATION HAS IMPACTED FOOD PRODUCTION

The mechanization of food production was recognized as the seventh most important engineering development (out of twenty) by the National Academy of Engineering. The efficient production of low cost, nutritious food has been the economic driver for the success of the United States as a world economy. Many disciplines such as Agronomy or Animal Science have contributed to superior yielding crops or livestock, increasing production per acre. However the mechanization of agricultural operations, the American Food Machine, has allowed a major shift in population from the farm to urban living and allowed manpower for the development of television, automobiles, dishwashers and the like and has provided the free time for activities such as sports, the arts, travel and hobbies. It is interesting to see what the impact of mechanization has been on energy cost and labor cost in the raising of a food crop.

The mechanization of the production of food began some 8000 years ago with the beginning of the Neolithic period where crude tools such as animal shoulder blades and horns were used for tilling the wild plants that were being domesticated to afford a more reliable source of food. As civilization advanced into the Bronze Age and the Iron Age better wearing implements evolved but the practice of hand tillage still exists in some parts of the world and some populations still exist at the hunter-gatherer level.

However man has very limited work capacity. When one engages in physical exertion, heart rate and oxygen consumption increase linearly with work output in a normal work situation up to a point of oxygen debt (Suggs and Splinter, 1957). At a heart rate of 110 beats/min, a workload of around 2500 ft. lbs/min can be maintained by a person accustomed to working. This would power a 60 watt light bulb. Using a mattock (a heavy steel hoe) and working at the above work rate, one man can till about 1/10 acre in a 10 hour work day. Some lazy, but clever person figured that life would be easier if he could get some animal to do the tedious work. Over the centuries everything from dogs to elephants have been domesticated and put to work. The horse seems to have found itself the standard for rate of doing work. A "standard" 1200 lb. horse can work at 33,000 ft.lbs/min, equivalent to 13 men. Therefore, in the U.S. we have transitioned from using our backs to raise our food to the bullock, then the horse. Today, the bullock, camel, water buffalo, elephant, yak, donkey and horse are still used for food production in parts of Africa and Asia. The llama is used to carry burdens in South America. Sled dogs and reindeer are used in the arctic. Gradually even these animals are being replaced by small tractors, ATV's and snow mobiles.

For mechanical power the steam engine was introduced in the late 1800's, primarily pulling plows and providing power for threshing machines using flat belts. Production of steam powered traction engines continued until about 1930. Tractors incorporating the internal combustion engine began to replace steam traction engines starting around 1900, using kerosene, distillate, gasoline and now diesel for fuel. How has this affected the time and energy efficiency of food production?

For our purpose of illustration we will consider only the time and energy requirements for tillage prior to planting, not including the energy required for chemicals and manufacture of machines.

Interestingly, the conversion of “fuel” into mechanical work is about the same for man, horse and internal combustion gasoline engine, roughly 25%. If we feed the man an adequate diet, the horse hay and oats and the tractor gasoline or diesel fuel we can gain an appreciation of the relative cost of energy to perform work.

To provide the man the 2600 calories he will need to work for a day we will need a diet costing \$11/day (estimated from Official USDA Food Plans using 2009 food costs). Using a mattock a man can till about 1/10 acre per day. The energy cost per acre then comes to \$110. Feeding the horse requires 12 lbs. of timothy hay and 16 lbs. of oats per day, costing \$90/ton for the hay and \$8 per 50 lb. bag for oats. One horse can do the work of 13 men, and one horse can plow 1.3 acres per day for a cost of \$3/acre for “fuel”. We must add to that the energy cost for one acre for the man, \$8.50, now giving us an energy cost of \$11.50/acre.



Figure 1 This painting by Millet illustrates the use of a mattock to till soil, a practice still followed in parts of Africa and Southeast Asia. If it were not for agricultural mechanization 9 out of 10 of us would still be using this tool.

How does this compare with a tractor? If we consider a 19.1 horsepower Farmall H, that was common in the 1940's, burning 2 gal/hr of \$3.50/gal gasoline, and plowing 8 acres in a 10 hour day with a two bottom, 14" Plow, the energy cost is \$8.25/acre, adding the energy cost for the driver, \$1.38/acre, the total is \$9.63/acre. Farm operations are seasonal and there are periods of time when no work is required. However a man burns meats and vegetables and the horse hay and oats 24 hours /day and they do not work 365 days per year. The tractor, on the other hand burns no fuel when not working. Also the driving a tractor requires less energy, and therefore less food intake. When resting or

sleeping a man burns about 1200 cal/hr and the horse would have a similar reduction in energy use so this continued energy use is as if the tractor sat idling when not in the field. The diesel engine efficiency is about 30%, explaining the transition to diesel powered tractors today.

Today the plow is obsolete, as are the disking and harrowing operations that preceded planting. Either once-over till-plant system or disking followed by surface planting (mulch till) is now the dominate method of tillage for planting. Let us consider surface planting using only a tandem disk being pulled through last year's stubble. A 406HP Big Bud tractor pulling a 65' tandem disk at 5 mph burns 27.34 gallons of diesel fuel per hour. At \$4.50/gallon this costs \$820 per 10 hour day. During that time the tractor will cover 350 acres per day for a cost of \$2.34/acre. Adding the energy cost of the driver riding comfortably in the cab (\$0.04/A) we get \$2.38/acre. With today's large capacity equipment and high operating speeds energy cost per acre is surprisingly low despite extremely high fuel costs (Table 1). Recognize that these figures only show comparative costs in March, 2011 and energy costs fluctuate.

TABLE 1—ENERGY COST TO TILL ONE ACRE

Power Source	Implement	Fuel	Cost
Man	Mattock	Adequate diet	\$110
Horse	Plow	Hay & Oats	12,85
Farmall "H" tractor	Plow	Gasoline	9.00
Big Bud tractor	Disc	Diesel	2.34

Time is also a cost. If we pay a hired man to do the work we have a time cost.

TABLE 2—TIME COST TO TILL ONE ACRE

Job	Time/Acre	\$/hr salary	Cost/A
Using mattock	100 hrs	8	\$800
Driving horse	7.7	8	62
Driving Farmall	1.16	10	14
Driving Big Bud	0.03	15	0.45

The total cost per acre for time and energy will be \$910 for the man with a mattock, \$74.85 for a man plowing with a horse, \$23 for a man plowing with a Farmall "H" and \$2.79 for a man driving a Big Bud tractor pulling a disk.

So can we justify the cost of purchasing such a large tractor as a power source? Working at a level of 1/10 of an acre per day per worker, a work force of 3500 would be needed to till 350 acres in one day. At today's minimum wage of \$7.25/hr or \$72.50/day per worker the labor cost for 3500 workers would be \$253,750 per day. Since one of these large tractors and associated equipment replaces thousands of workers performing

manual labor it would seem to justify today's high equipment costs as being economically sound.

The result of this transition from human to animal to mechanical power can be easily demonstrated. Farming at the time of the Revolution, with the exception of using the bullock for tillage, was conducted by hand, requiring 90% of our population to be engaged in food production. The 1800s were a time of invention where most farming operations were mechanized using bullocks, then horses, then steam traction engines as a source of power. By 1900, 40% of our population was engaged in food production, releasing manpower that could now be used for the production of consumer items, greatly improving our standard of living. The 1900's were the time of supplanting the horse and steam traction engine by the internal combustion engine, and productivity was greatly increased. By 2000 less than 2% of our population was engaged in food production, allowing the fantastic development of the electronics, aviation, automotive and chemical industries, utilized today in every facet of our everyday life. A significant portion of our food is sold on foreign markets broadening the impact of mechanization.

Mechanization goes beyond tillage in its impact on food production efficiency. The mechanization of irrigation exemplified by the center pivot, environmental management for livestock housing and feed handling and the utilization of electronic technology such as the GPS in field equipment operations have all afforded parallel impacts in establishing the extremely efficient production of food that we have today. When you couple this with the agronomic advances in crop genetics, soil nutrient management and insect and disease control that are responsible for the significant increases in production per unit of land area you can appreciate the magnitude of the change in food production efficiency we have experienced over this past century.

How has the Farm Mechanics/Agricultural Engineering/Biological Systems Engineering program at the University of Nebraska contributed to this evolution from human to animal to machine powered food production? I will first recognize the contributions of those who were pioneers in the establishment of our profession and our department. Next will be the contributions of former faculty members, as many as possible in their own words. This will be followed by the history of the facilities that have housed the department as it grew. Finally, the department's major contributions to this evolution will be described. *(Dr. W. E. Splinter, Editor)*

THE PIONEERS WHO ESTABLISHED THIS DEPARTMENT

OSCAR VAN PELT STOUT

Following the establishment of the University of Nebraska as a Land Grant University in 1869, and following the stipulation that these Universities include programs in “agriculture and the mechanical arts”, the College of Industrial Arts was formed in 1877. The Industrial College started with teaching programs leading to a B. Sc. in Agriculture and a B. Sc. in Civil Engineering as one administrative unit. In 1895 the Industrial College was divided into a two-year School of Agriculture, the Agricultural Experiment Station and the College of Engineering.



Figure2 Dean O.V.P. Stout, credited as the “Father of Agricultural Engineering” and first recipient of the McCormick Gold Medal awarded by the American Society of Agricultural Engineers

Stout, born on a farm in Jerseyville, IL in 1865 moved with his parents to a farm near Beatrice, NE in 1877. He graduated with a degree in Civil Engineering from the Industrial College in the University of Nebraska in 1888. While a student and following graduation he worked with the Union Pacific, the Chicago, Burlington & Quincy and the Missouri Pacific railway engineering departments until 1890, then he was hired as city engineer for Beatrice, NE. He joined the faculty at the University of Nebraska in 1892, as Instructor, and was appointed Department Head of Civil Engineering in 1893. When the two year School of Agriculture and the Agricultural Experiment Station were formed in 1895 Stout was listed as Associate Professor of Civil Engineering in the Industrial College, Agricultural Engineer in the School of Agriculture and Irrigation Engineer in the Agricultural Experiment Station. He was appointed Dean of Engineering in 1912. He served as Dean until 1920, entered private practice for one year, then he joined the U.S. Dep’t of Ag., working in hydrology and irrigation research in Berkley, California. He had served as a Major in the Army during WWI. He died in 1935.

Stout is credited with being an early supporter of the establishment of a separate professional area of engineering specifically focused on agriculture. He published Nebr. Ag. Experiment Station Bulletin #41 titled "Water Supply in Nebraska". Quoting from Hurlbut, (1960), "Professor Stout wrote about "The Engineering of Agriculture" in a 1902 issue of AGRICULTURE. He started with the sentence, "Here on the prairie where we see but little work recognized as engineering"--- then went on to mention the future importance of such agricultural engineering subjects as irrigation, farm highways, drainage, water supply and sewage systems, application of various forms of power to farming operations, power use efficiency, need for knowledge of the capacity and limitations of machines, computing stresses in farm structures, heating ventilation, refrigeration and mechanical drawing. Professor Stout pointed to Agricultural Engineering as a promising field".

In recognition of his forward thinking and leadership he was elected an Honorary Member of the American Society of Agricultural Engineers and was awarded the first McCormick Gold Medal by that Society in 1932. He was also awarded an Honorary Doctorate of Engineering by the University of Nebraska in 1932. The Mechanical Arts Hall, housing the Civil Engineering Department, was named Stout Hall in his honor. It has since been demolished and replaced by Manter Hall.

In his citation for the McCormick Gold Medal he was credited with being the "Father of Agricultural Engineering". We believe Stout was the first engineering professor to hold the title Agricultural Engineer. (*Dr. W. E. Splinter*)

CHARLES RUSS RICHARDS

Although not recognized in previous histories of the Biological Systems Engineering program at the University of Nebraska, Richards must have played a key role in establishing the Farm Mechanics program in 1904 and the Agricultural Engineering program in 1910. Richards was born in Clarkehill, IN Mar. 23, 1871 and received his B.Sc. in Mechanical Engineering from Purdue in 1890, a Professional Degree in M.E. in 1891 and, later, a Master's degree in M. E. from Cornell Univ. in 1895.



Figure3 Charles Russ Richards served as Head of the Mechanical Engineering Department at the time the Farm Mechanics program was introduced as an adjunct to that department.

After serving for one year in the Mechanical Engineering Department at Colorado State College he joined the University of Nebraska in 1892 as Adjunct Professor of Manual Training in the Industrial College. Richards became Associate Professor of Practical Mechanics from 1895 to 1897 and then Professor of Mechanical Engineering and Director of the School of Mechanic Arts until 1909, when he became the founding Dean of the College of Engineering in 1909. Two of his students in Mechanical Engineering became pivotal in the establishment of the Agricultural Engineering profession, L. W. Chase and J. B. Davidson. Davidson and Chase graduated in Mechanical Engineering in 1904. Chase taught blacksmithing in the M.E. department as an undergraduate Senior student and Davidson was appointed as an Instructor to teach courses in the newly formed program in Farm Mechanics, which was under the Mechanical Engineering Department. He taught Farm Machinery and Forge. Therefore Richards, as head of the M.E. department, would have had to be immediately involved. Later, as Dean of the College of Engineering, he would have played a leadership role in establishing Agricultural Engineering as a separate department in 1909, reporting to the Dean of Engineering for the academic degree program, and to the Dean of Agriculture for Research and Extension programs. This unique administrative arrangement continues to this day.

Richards resigned as Dean in 1911 and joined the University of Illinois as Dean of Engineering. He was appointed President of Lehigh University in 1922 and served until 1935. He was awarded an Honorary Doctor of Science degree by the University of Nebraska in 1920 and gave the Dedication Address for Memorial Stadium in 1923. He was responsible for the design and construction of Richards Hall that housed the Mechanical Engineering Department for many years. The American Society of Mechanical Engineers, together with Tau Beta Pi, M.E. Honorary of which Richards was a founding member, sponsors the Charles Russ Richards Memorial Award each year recognizing outstanding achievement in Mechanical Engineering. Richards died in Minneapolis in April, 1941. (*Dr. W. E. Splinter*)

J. BROWNLEE DAVIDSON

J. B. Davidson is recognized as the most far sighted and influential leader in the establishment of the profession of Agricultural Engineering. Prior to his defining an academic program leading to a branch of engineering dedicated to bringing engineering analysis and design into the field of production agriculture in 1909, there had been various permutations of programs offering practical instruction in forge work, farm machinery operation, tractor operation, drainage, farm building construction and rural road construction taught at nearly all of the Land Grant institutions. In most cases this program was under the Agronomy department, while some were under an engineering department and they were oriented toward training farmers to better manage their farming operations. There were a number of titles given to these programs, including Farm Engineering, Farm Mechanics and Rural Engineering. The term Agricultural Engineering had been used as early as 1859 at the Michigan Agricultural College but there is no evidence of an engineering degree program.



Figure 4 J. B. Davidson, lead the Farm Mechanics program in 1904, then moved to Iowa State College where he developed the first academic program in Agricultural Engineering.

Davidson was born near Douglas, NE on Feb. 5, 1880. His Senior Design project was with L. W. Chase and they designed, built and tested a two cycle gasoline engine. Davidson was also a founding member of Sigma Tau, national engineering honorary society, later to join Tau Beta Pi. Following graduation in Mechanical Engineering (M.E.) in 1904, Davidson was hired as Instructor to direct a new program in Farm Mechanics within the M.E. department. This program consisted of three years of study in Mechanical Engineering, one year of Agricultural courses and a fifth year in M.E., graduating with a degree in M.E. Eighteen hours per week in the department were required. Davidson taught courses in Farm Machinery and Farm Motors and Forge. He would have worked directly under Charles Russ Richards using M.E.shops. After one year, he moved to Iowa Agricultural College where he introduced the first four year program in Agricultural Engineering with design as the core of the program, defining a new field of employment for engineers in commercial manufacturing and government

service as professionals. The first B.Sc. degree in Agricultural Engineering was awarded to Jacob Waggoner at Iowa State College in 1910.

In 1904 the Board of Regents of the University of Nebraska had allocated \$15,000 for the construction of a building on the University Farm (now East Campus) called Machinery Hall. However, it is easy to see why Davidson chose to go to Iowa State, since they had allocated \$60,000 for a four story building having 24,000 ft².

In addition to establishing the first four year Agricultural Engineering program at Iowa State, Davidson played a key role in establishing Agricultural Engineering as a recognized field of Engineering. He was instrumental in setting up the meeting at the University of Wisconsin in 1907, founding the American Society of Agricultural Engineers, and served as its first President. Over the years students graduating from Davidson's program at Iowa State went on to leadership roles as Heads of Agricultural Engineering Departments, as Presidents of ASAE and as industry leaders.

Davidson and L. W. Chase published the first text in Agricultural Engineering in 1908, titled "Farm Machinery and Farm Motors". Davidson later published "Agricultural Engineering" in 1913 and "Agricultural Machinery" in 1931.

Davidson received the first Professional Degree in Agricultural Engineering from the University of Nebraska in 1914 and the first Honorary Doctorate in Engineering and Architecture by the University of Nebraska in 1931. Davidson Hall, housing the Agricultural and Biological Engineering program at Iowa State University is also named in his honor. He is known as the Dean of Agricultural Engineering. (*Dr. W. E. Splinter*)

LEON WILSON CHASE

L. W. Chase was born in Jacksonville, Vermont, August 27, 1877, moved with his parents to a farm in Nebraska and graduated from the Pawnee City High School. He was appointed as an Instructor in the Mechanical Engineering department as a senior student in 1903, teaching Forge and Foundry. His Senior Thesis, which was with J.B. Davidson, was started in 1902, in which they did the calculations, drew the blueprints, did the pattern making of the parts, poured the castings, assembled, then tested the performance of a two-cycle gasoline engine.

After graduation with a B.Sc. in Mechanical Engineering in 1904, the University catalog listed Chase as Instructor in ME but at some point Chase took a position with Fairbanks Morse Mfg. Co. When Davidson left the newly established Farm Mechanics program in the Mechanical Engineering department, Chase returned to Nebraska and was appointed Assistant Professor of Farm Mechanics. He then designed Machinery Hall, using \$13,000 of the \$15,000 allocated by the Board of Regents. His salary was \$1000/yr and he had \$200 for expenses. Machinery Hall was constructed immediately behind the Plant Sciences building, where the East Campus Student Union now stands. It consisted of a Farm Machinery and Motors Laboratory and office on the first floor and a classroom and three offices on the second floor. A forge shop extended north from the main building. The total area was 9051 ft², for a cost of \$1.44/ft². In 1905 a course in woodworking was added with 82 students, 69 students taking Forge and 52 taking Farm Machinery and Motors. These courses would have been primarily for students in the School of Agriculture.



Figure 5 Leon W. Chase, Assistant Professor of Farm Mechanics, 1905-1909, and then Head of the Department of Agricultural Engineering, 1909-1920. He founded the Chase Plow Company in Lincoln in 1920..

The Farm Mechanics teaching program expanded rapidly to a total of 284 in 1907, when the department was placed under the Dean of the School of Agriculture. In 1908 a course in Farm Machinery and Motors was added for students in engineering, with 6 students. In 1910 the name of the department was changed to Agricultural Engineering, with the

engineering teaching program being under the Dean of Engineering and the service courses, research and extension programs being under the Dean of Agriculture.

Three students were recognized as being specifically within the Farm Mechanics program during these early years. C. K. Shedd graduated from the program with a degree in Agriculture in the winter of 1909 and was hired by the department as Instructor in Farm Machinery. Two other students, J. P. Burke and L. F. Seaton graduated in 1911 with degrees in Mechanical Engineering.

In 1912 three students received the first degrees in Agricultural Engineering, C. D. Kinsman, E. B. Lewis and I. D. Wood.

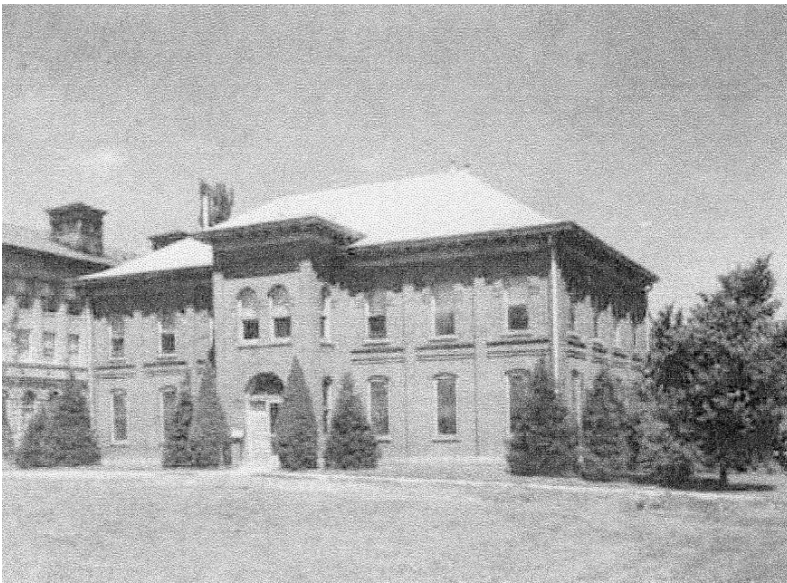


Figure 6 Machinery Hall, home of the Farm Mechanics program, 1905-10 and the Agricultural Engineering Department until 1919. Designed by L. W. Chase.

Under Chase the Agricultural Engineering department grew to national prominence. The first M.Sc. degree in Agricultural Engineering was awarded to Ivan Wood in 1914. The first Professional Degree in Agricultural Engineering was awarded to J. Brownlee Davidson in April 1914. Chase received a reciprocal degree from Iowa State in May of that year. Chase also received a Professional Degree in Mechanical Engineering from Nebraska that year. Chase co-authored the first text in Agricultural Engineering, titled *Farm Machinery and Farm Motors* with Davidson in 1908. Chase was a Charter Member of Sigma Tau, Engineering Honorary established at the University of Nebraska (it has since joined Tau Beta Pi). Chase was also a Charter Member of the American Society of Agricultural Engineers and served as the sixth President in 1913.

In addition to designing Machinery Hall, Chase also designed Agricultural Engineering Hall (now Chase Hall), providing new quarters for the department with construction starting in 1916 and completed in 1918. This building was far advanced for its time. It

housed probably the first soil tillage research facility, having a soil bin 156' in length and 12' wide, with an electric driven test carriage and recording dynamometer. The machinery laboratory had an overhead trolley system to move machines in and out and a series of powered drums recessed into the floor surface allowing students to actually drive planters and other farm machines in the laboratory. A hydraulics laboratory was provided to study irrigation pumps and domestic water systems. A motors lab had a dynamometer to measure engine performance. Farm buildings, an important area at that time, had a complete woodworking lab. The forge room continued teaching blacksmithing, the first academic course that had been offered by the department starting in 1904. Chase also had a sense of historical significance. He had visited his grandfather's farm in Vermont and brought back a collection of Colonial era artifacts that serve today as the core of the Lester F. Larsen Tractor Test and Power Museum collection. He also acquired plows from around the world and early American farm machines.

Chase's most notable contribution was the development of the Nebraska Tractor Test program. Chase and Davidson had been judges for the Agricultural Motor Competition, sponsored by the *Canadian Thresherman and Farmer* magazine, conducted from 1908 to 1913, held in Winnipeg, Canada. Chase was in charge of the tests for 1913. At that time there was no clear understanding of how tractor performances could be compared between the multitudes of new designs being brought to the market. Initially tractors were categorized by the number of plow bottoms they could pull. Soil conditions are quite variable so this allowed a great deal of latitude in defining tractor capability. The first Winnipeg tests consisted of pulling loaded wagons, plowing and measuring belt power with the Prony brake—simply a drum with a lever applying a frictional load. Measurements included such things as the number of breakdowns, the amount of cooling water used and whether or not the company could get their tractor to the appointed test position on time

Tests became more sophisticated and more complex each year, to the extent that, by 1913, thirty-three parameters were measured for the brake tests and twenty one for the plowing comparisons. Taking these data and analyzing them would have been a very time consuming job. WW I precluded testing for 1914 but there was also resistance on the part of manufacturers who thought the tests were too complicated.

Pressure for some means for farmers to be able to compare tractor performance continued and in 1917 another plowing demonstration was held near Fremont, NE. In conjunction with these demonstrations, Chase conducted a test of 67 tractors and published the results in *Agricultural Engineering*. He provided the results for a particular tractor to its manufacturer but did not name specific tractors in his paper. His objective evidently was to provide manufacturers data that would allow them to improve the performance of their tractors without potential embarrassment.

Tractor performance continued to aggravate farmers and one such farmer, Wilmot F. Crozier of Osceola, NE became a member of the Nebraska House of Representatives with the specific objective of developing a legal means to provide unbiased performance

information to the farmer. Accordingly in 1919 he sponsored a bill, together with Senator Charles Warner requiring that any manufacturer intending to sell a tractor in Nebraska must first bring an unmodified model of his tractor to the University of Nebraska Agricultural Engineering Department for tests to verify their claims. L. W. Chase, because of his experience, provided the technical support for this bill while also serving as a Lieutenant Colonel in Ordinance during WW I. It was passed unanimously and testing started in 1920. Interestingly, Chase was never involved in any official test. He left the University that year to establish the Chase Plow Company in Lincoln, NE. .

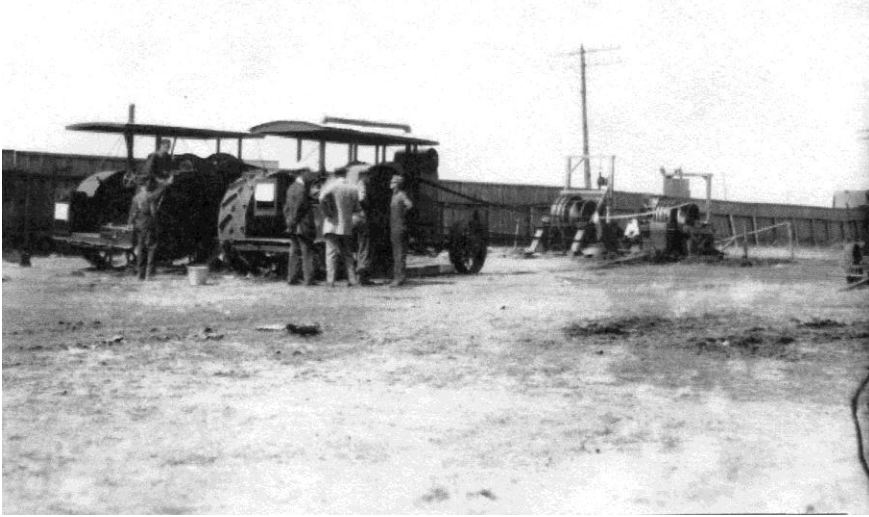


Figure 7 Measuring belt horsepower at the Winnipeg tests using a Prony brake. L W Chase was one of the judges and was in charge in 1913.

Tractor performance continued to aggravate farmers and one such farmer, Wilmot F. Crozier of Osceola, NE became a member of the Nebraska House of Representatives with the specific objective of developing a legal means to provide unbiased performance information to the farmer. Accordingly in 1919 he sponsored a bill, together with Senator Charles Warner requiring that any manufacturer intending to sell a tractor in Nebraska must first bring an unmodified model of his tractor to the University of Nebraska Agricultural Engineering Department for tests to verify their claims. L. W. Chase, because of his experience, provided the technical support for this bill while also serving as a Lieutenant Colonel in Ordinance during WW I. It was passed unanimously and testing started in 1920. Interestingly, Chase was never involved in any official test. He left the University that year to establish the Chase Plow Company in Lincoln, NE.

Among the planting and cultivating machines he manufactured was the first sweep plow for conservation tillage of wheat and other small grains. This was in response to the drought and dust storms of the 1930's. Two Professors of Agronomy, J. C. Russell and Dr. F. L. Duley were concerned with the erosion of soil during the drought of the 1930's and contacted Chase to see if a machine could be developed to control weeds but leave a

cover on the field to reduce erosion. Chase's son Fred then modified a bindweed cultivator the company was marketing, and it was successful. The machine undercut stubble, killing weeds, but left the stubble on the surface to protect the soil from wind or water erosion. This is the first machine placed on the market to allow conservation tillage of small grains, and in doing so reduced the time and fuel required, rendering the plow obsolete for small grains.

I met Mr. Chase in 1948 and have his signature on my Sigma Tau paddle. He was pleased that I was taking Agricultural Engineering. Chase died May 28, 1951. (*Dr. W. E. Splinter*)

FORMER FACULTY AND THEIR CONTRIBUTIONS

LAURENCE FROYD SEATON

L. F. Seaton graduated from the University of Nebraska with a B.Sc. in Mechanical Engineering in 1911. As a student he was associated with the Farm Mechanics program, teaching a course in steam engines as an undergraduate. I have been unable to locate documentation on this but Prof. George Petersen related to me that the Farm Mechanics program, as part of the Mechanical Engineering Department, had a course program based on three years of study in Mechanical Engineering, one year of agricultural courses and a final year of Mechanical Engineering, graduating with a degree in M. E. Records show that Seaton was registered in the School of Engineering in 1907. George Petersen lists Seaton and J. F. Burke as graduating from the Farm Mechanics program in 1909, receiving their M.E. degrees in 1911. Chase, (1920), and Hurlbut, (1959) list Shedd, Burke and Seaton as the first graduates of the Farm Mechanics program. The degree program in Agricultural Engineering was approved in 1910. In 1909 the University was transitioning from the Industrial College to the Colleges of Agriculture and Engineering so it is difficult to clearly define what Seaton's undergraduate program was.

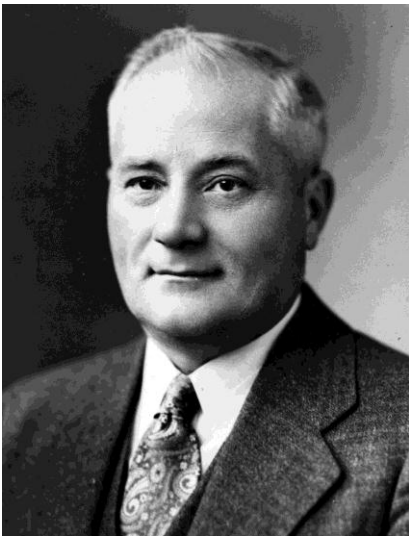


Figure 8. L. F. Seaton graduated from the Farm Mechanics program with a degree in Mechanical Engineering in 1909, served as Assistant Professor and Professor of Agricultural Engineering, Head of Mechanical Engineering and then as Purchasing Agent and Operating Superintendent of the University.

In 1912 Seaton joined the Agricultural Engineering Department as an Assistant Professor and was appointed Professor in 1916. In 1918 he left the department to be Head of the Mechanical Engineering Department. He received the degree Professional Mechanical Engineer in 1919. In 1920 he was made Purchasing Agent and Operating Superintendent of the University, now being in charge of all of the business operations in the University such as all building construction, supplies and equipment purchases, the dormitories,

print shop and book stores. Seaton served the University for 35 years and died in 1948. Seaton Hall is named in his honor and now houses the Graduate College. (*Dr. W. E. Splinter*)

IVAN D. WOOD

Ivan D. Wood was in the first class to receive a Bachelor of Science Degree in Agricultural Engineering from the University of Nebraska, completing the new four-year curriculum in 1912. He received a Master of Science degree in Agricultural Engineering in 1914, the first such degree conferred by any institution.

From 1912-1914, Wood was an Instructor in Rural Architecture in the Agricultural Engineering Department. In 1914 he was appointed to the position of state Extension Agent in Agricultural Engineering, a new position in the department. Extension activities in the Department began as early as 1910 with the Farmer Institutes. Wood was involved in a broad range of extension activities, developing extension programs in tractor operation, in farm structures and in soil and water utilization and conservation. In the farm structures field he developed the farm building plan service, which was later incorporated into the Mid-West Plan Service.



Figure9. Ivan Wood, first to receive a MSc. Degree in Agricultural Engineering and first Extension Agricultural Engineer, Nationally He pioneered engineering design for farm buildings and soil conservation practices.

A unique, and possibly original innovation was the development of 5'X5' detailed muslin sheets to support his lectures where electricity was not available or where the large bulky glass slide projectors were impractical. There are 32 sheets comprising seven lectures covering grain storage, poultry housing, farmstead layout, farm house design and heating with an under floor furnace. These are placed in the Archives located in Love Library. The information presented was quite technical even to the use of psychometric charts for grain drying and comfort control in the home. The sheets were signed by persons named Whitfield and Barr. Whitfield signed and dated the sheets as being drawn from 1930 to 1933. According to student records Whitfield was an Engineering College student, Wilbur Allen Whitfield, enrolled from 1927-28 and 1930-32 respectively. There have been no graduates in Agricultural Engineering with either the Whitfield or Barr name. It has been a common practice to hire students going back to L. W. Chase who was hired by the Mechanical Engineering Department to teach blacksmithing in 1903.

Wood was also responsible for planning and arranging many of the buildings on the Agricultural Experiment Stations at North Platte and Scottsbluff. He designed and assisted in building a demonstration model farmstead just north of the Machinery Building as well as a number of farm building models for his extension program.

Wood also became widely known for his work in soil and water conservation and utilization. He was a leader in developing education and demonstration programs in drainage, the use of terraces and dams for erosion control, planning and utilizing shelterbelts and tree plantings for control of wind erosion, and in planning and developing irrigation systems and practices. One idea that I believe is attributed to Wood was the use of tubes in irrigation to supply a uniform flow of water to each row. They were made of four laths nailed together to be placed in the supply ditch to distribute water evenly to each row. The hired man and I spent most of one winter building these tubes and dunking them in used crankcase oil to slow decay. These were then inserted into the irrigation ditch bank and the water was turned in from the supply canal. Their flow rate was insufficient for our sandy soil and for the supply rate from the canal so we went back to shoveling each row open to water and each row closed to go to the next "set". This idea was later incorporated in plastic tubes utilizing gravity to siphon water from the ditch to the row.

In 1940, Professor Wood resigned from his position at the University of Nebraska and went to Denver, CO. to work as National Extension Program Leader for the USDA in irrigation.

Wood served as President of the American Society of Agricultural Engineers from 1952-53 and in 1952 was awarded the John Deere Gold Medal by ASAE. In 1954, Wood received an Honorary Degree "Doctor of Agriculture" from the University of Nebraska. I met Mr. Wood at several ASAE annual meetings and he was always cordial. He died November 17, 1978. (*Dr. W. E. Splinter*)

OSCAR W. SJOGREN

Oscar Warner Sjogren was raised on a farm near Funk, NE. He graduated from the University of Nebraska with a degree in Agricultural Engineering in 1915. He must have been an excellent scholar and involved in campus organizations as he was selected as a member of the Innocents Society during the Spring of 1915. Following graduation he joined the faculty of the Agricultural Engineering Department as Assistant Professor, and followed L. W. Chase as Chairman of the Department, serving from 1921 to 1929.



Figure 10. O. W. Sjogren followed Chase as Head of the Department and served as President of ASAE before moving to the Killefer Plow Company in California.

Since Chase had left the Department to establish the Chase Plow Co. Sjogren was immediately involved in the administrative problems associated with setting up the Nebraska Tractor Testing Laboratory. His signature is on the first test report as Chairman of the Tractor Test Board for the Waterloo Boy, the first tractor meeting its advertised claims. He served as Chairman of the Board until 1929. Sjogren was elected as President of the American Society of Agricultural Engineers, serving in 1926-27.

In 1920 research was initiated studying unit farm electric plants. At that time commercial electric power was virtually unknown on Nebraska's farms and ranches. Wind generators and 32 volt DC generating plants were becoming available during the 1930's.

Sjogren moved to the Killefer Manufacturing Co. in Maywood, CA in 1929, a manufacturer of plows and tillage tools. There he received a patent on a disk harrow design in 1939.

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the specific objective of developing a legal means to provide unbiased performance information to the farmer. Accordingly in 1919 he sponsored a bill, together with Senator Charles Warner requiring that any manufacturer intending to sell a tractor in Nebraska must first bring an unmodified model of his tractor to the University of Nebraska Agricultural Engineering Department for tests to verify their claims. L. W. Chase, because of his experience, provided the technical support for this bill while also serving as a Lieutenant Colonel in Ordinance during WW I. It was passed unanimously and testing started in 1920. Interestingly, Chase was never involved in any official test. He left the University that year to establish the Chase Plow Company in Lincoln, NE. Tractor performance continued to aggravate farmers and one such farmer, Wilmot F. Crozier of Osceola, NE became a member of the Nebraska House of Representatives with the specific objective of developing a legal means to provide unbiased performance information to the farmer. Accordingly in 1919 he sponsored a bill, together with Senator Charles Warner requiring that any manufacturer intending to sell a tractor in Nebraska must first bring an unmodified model of his tractor to the University of Nebraska Agricultural Engineering Department for tests to verify their claims. L. W. Chase, because of his experience, provided the technical support for this bill while also serving as a Lieutenant Colonel in Ordinance during WW I. It was passed unanimously and testing started in 1920. Interestingly, Chase was never involved in any official test. He left the University that year to establish the Chase Plow Company in Lincoln, NE.

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CHAUNCEY W. SMITH

Professor Chauncey W. Smith was born in Colfax County September 21, 1886. He attended Peru Teacher's College and then was a country school teacher in Stanton County, 1905-6, Principal in Harrison, NE 1906-7 and Superintendent in Grafton, NE 1909-12. Professor Smith joined the Agricultural Engineering Department in 1912 to teach the course in Physics offered for Agriculture College students. At that time the Agricultural College, being located two miles east of the main campus, also offered courses in English, Chemistry, Mathematics, German and History. It had a separate Military Science program, cultural programs such as Literary Societies, stage programs. German and Swedish clubs, and athletic programs including a separate football team called the Aggies



Figure 11. Chauncey W. Smith, recipient of the ASAE McCormick Gold Medal in 1962, was known as a superior teacher. He served for many years on the Tractor Test Board and led the research leading to the adoption of pneumatic tires for tractors.

Smith received a B.Sc in Agriculture in 1914. He served as County Agent for Seward County during 1917-18, then rejoined the Agricultural Engineering Department as instructor, teaching U.S.Army recruits courses in engines, trucks, cars and tractors. He continued teaching the course on internal combustion engines for both the engineering students and the Ag. College students. Your first impression as a student was his perfect penmanship as he lectured from the blackboard. Second was his rigorous presentation of the course and you immediately understood that he expected you to do everything exactly right. His conduct as a Professor was strictly academic, to the point of being austere. So you were very surprised when, at a student-faculty dinner he and his wife sang a duet. He also played tennis well into his 60's. Upon completion of your degree you realized that he was the best instructor you had.

Smith served as a member of the Tractor Test Board from the beginning in 1920 and as Chairman from 1947 to his retirement in 1955. He studied under physicist –Millikan, the person who first measured the magnitude of the charge of an electron, at the University of Chicago, and received a M.Sc.in Physics in 1932. He also received a Master of Engineering from the University of California. In 1925 Smith conducted some of the early research on the operating characteristics of the combined harvester-thresher and also the one-way plow used for conservation tillage of wheat stubble. His most notable research was conducting the first studies on the use of pneumatic tires on agricultural tractors from 1932 to 1937. He, together with his graduate student, L. W. Hurlbut found that rubber tires required 25% less fuel to accomplish the same work when compared to steel lugged wheels. This work led to the world wide adoption of pneumatic tires for tractors. He also conducted some of the early research on oil filters for tractors. In 1934 Smith conducted studies of the sweep plow developed by the Chase Plow Company in maintaining protection of the soil from wind and water erosion while maintaining weed control. In the 1940's Smith studied the picker-sheller for harvesting corn, removing only the grain from the field.

Professor Smith received the Award of Merit from the Nebraska Chapter of Gamma Sigma Delta in 1963 and was presented the ASAE Cyrus Hall McCormick Gold Medal in 1962. Following retirement in 1955, Professor Smith taught at the National University, Palmira, Colombia, S.A. and was a visiting professor at Michigan State University and later at Ohio State University. Professor Smith's service to the University of Nebraska, and to the profession of Agricultural Engineering for 45 years was outstanding and those of us who profited from associating with him are most appreciative. (*Dr. W. E. Splinter*)

ELMER E. BRACKETT

Elmer Brackett was born in Jamesburg, NJ in December, 1876. His family moved to a farm near Pawnee City, NE and he attended the University of Nebraska, receiving a B.Sc.E.E. in 1901. He joined the Agricultural Engineering Department in 1913 as an Assistant Professor. He received a B.Sc.in Ag. Engineering in 1916 and was appointed as an Associate Professor. He was appointed Professor of Agricultural Engineering in 1919. He served in France and Italy in WWI. In 1929 he followed Oscar Sjogren as Head of the department, holding that position until retirement in 1947. I met with him as a student when I transferred from Mechanical Engineering to Agricultural Engineering in 1947.

Brackett was involved in a broad range of activities related to Agricultural Engineering. He was active in design and construction of the Agricultural Engineering building, which was completed in 1918. He was also heavily involved in the design and operation of the Nebraska Tractor Test Laboratory, working with Carleton Zink and Charles Adams in the design of the test car. He served on the Tractor Test Board from 1919 until his retirement.

In addition he was the leader in research and extension programs in farm structures, rural electrification and soil and water conservation and utilization. He authored two bulletins

on the use of electric motors for filling silos and pumping water for irrigation in 1917. Starting in 1920, Brackett led an expanded program in rural electrification, first studying unit farm electric plants, such as the 32 volt Delco plants for farms lacking access to commercial electric power. Wind powered generators were also studied. Three years later the Department assisted the Farmers Rural Electric District of Saunders County with its organization and system design problems. This was the first rural electric program organized in Nebraska. It comprised an area slightly more than 22 square miles near Wahoo. The service was first delivered to 32 customers from a main line that carried 2300 volts. No connection was more than five miles from the generating station.

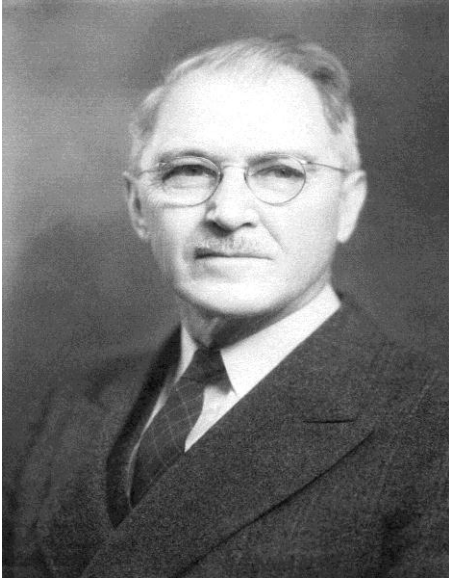


Figure 12. Professor E. E. Brackett served as Department Head from 1929 to 1947. He served as President of ASAE and was a leader in the electrification of rural Nebraska.

These studies were expanded in 1924 to include usage and cost of electricity on farms connected to central power-station lines. These studies provided the basis for widespread growth of rural electrification in Nebraska finally culminating in the REA . At this time only 10,584 farms had lighting other than with kerosene lamps. Brackett authored, with E. B. Lewis, seven farmer bulletins covering these areas.

In 1937 the Agricultural Engineering B.Sc. curriculum at Nebraska was one of the first three undergraduate programs accredited by the Engineer's Council for Professional Development. The other two accredited programs were at Iowa State and Kansas State Colleges. Accreditation is awarded only after submission of a detailed report and an on-site visit by highly qualified engineers.

Brackett was elected to the Sigma Tau engineering honorary, served as President of ASAE during 1940-41 and was elected to the grade of ASAE Fellow. He died in September, 1963 at the age of 86. *(Dr. W. E. Splinter)*

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the specific objective of developing a legal means to provide unbiased performance information to the farmer. Accordingly in 1919 he sponsored a bill, together with Senator Charles Warner requiring that any manufacturer intending to sell a tractor in Nebraska must first bring an unmodified model of his tractor to the University of Nebraska Agricultural Engineering Department for tests to verify their claims. L. W. Chase, because of his experience, provided the technical support for this bill while also serving as a Lieutenant Colonel in Ordinance during WW I. It was passed unanimously and testing started in 1920. Interestingly, Chase was never involved in any official test. He left the University that year to establish the Chase Plow Company in Lincoln, NE. Tractor performance continued to aggravate farmers and one such farmer, Wilmot F. Crozier of Osceola, NE became a member of the Nebraska House of Representatives with the specific objective of developing a legal means to provide unbiased performance information to the farmer. Accordingly in 1919 he sponsored a bill, together with Senator Charles Warner requiring that any manufacturer intending to sell a tractor in Nebraska must first bring an unmodified model of his tractor to the University of Nebraska Agricultural Engineering Department for tests to verify their claims. L. W. Chase, because of his experience, provided the technical support for this bill while also serving as a Lieutenant Colonel in Ordinance during WW I. It was passed unanimously and testing started in 1920. Interestingly, Chase was never involved in any official test. He left the University that year to establish the Chase Plow Company in Lincoln, NE.

CLAUDE KEDZIE SHEDD

As the first Director of the Nebraska Tractor Test Laboratory, covering the first 44 tests in 1920, Claude Shedd had a very interesting and probably stressful experience. With the passage of the Nebraska Tractor Test Law in 1919, requiring testing to verify manufacturer's claims prior to sale of tractors in Nebraska, there was intense pressure from the manufacturers to get their machines tested. A laboratory building had to be erected, dynamometers and other instrumentation procured, a test track constructed and procedures developed to comply with the law. Complicating the situation, L.W.Chase, who had been actively involved with the Winnipeg Plowing contests and with testing tractors near Fremont, NE, as well as providing the technical basis for the Tractor test Law, chose at that time to leave the University and establish the Chase Plow Company in Lincoln. Shedd had been an Associate Professor and Acting Department Head in the Department of Agricultural Engineering at Iowa State College and he had participated in the Winnipeg Plowing demonstrations as a scorer, meaning that he was doing the calculations. He was probably instrumental in setting up testing procedures that were much simpler than the Winnipeg procedures.

So who was Shedd? Details are difficult to come by but a sketchy background indicates that he had an interesting career. Born near Pickrell, NE in 1883, he had attended Crete Academy (now Doane College) in 1905 possibly for one semester since he also indicates that he was involved in ROTC at the University of Nebraska in 1905. He graduated from the Industrial College in 1909 with a B.Sc. in Agriculture. He joined ASAE that year. At that time both engineering and agriculture were within the Industrial College. His actual

coursework is not known but he must have had a sufficient affiliation with the Farm Mechanics program, an adjunct to the Mechanical Engineering Department, to be hired by Davidson at Iowa State where he was appointed Assistant Professor of Agricultural Engineering in 1912. Shedd reduced his employment to 2/3 time for three semesters and received a B.Sc. degree in Agricultural Engineering from Iowa State in 1914, receiving credit for courses taken in Nebraska.

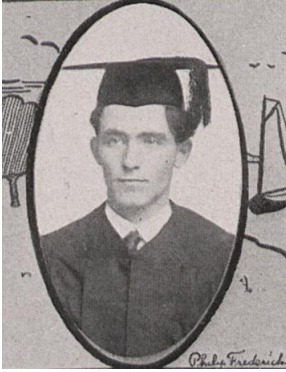


Figure 13. C. K. Shedd, 1909, received his degree in Agriculture but with a sufficient engineering background to be hired by the Farm Mechanics Department, then as Assistant Professor of Agricultural Engineering by Iowa State, returning as the first Director of the Tractor Test Program.

Shedd, however, resigned from the tractor test program following test No. 44 on August 9, 1920. That would not be surprising since there would have been pressure on all sides, and especially since Chase, who had hired him, had departed. The first test was completed on March 31, and they had tested 44 tractors in a little over 4 months, or about 10 tractors per month. Fred Nohavec was then placed in charge and they went on to test 69 tractors that year, ending on October 27—a number of tests never again achieved. Nevertheless, the procedures they worked out for these tests still stand, although modifications have been added with new technologies.

It is not certain where Shedd first went following his departure from Nebraska, but he was employed in Cooperative Extension at Kansas State College from 1925 to 1928., when he moved to the University of Missouri. There he authored a paper “Eroded and Terraced Farms Require Special Methods and Machinery” in the 1932 Yearbook of Agriculture, as an employee of the Bureau of Agricultural Engineering, USDA. He then moved back to Iowa State and conducted research with E.V.Collins and J.B. Davidson on farm machinery with his first publication with them in 1937. Later he began work on grain storage, his first publication in that area being in 1955. He was elected to the grade of Fellow in ASAE in 1954 and retired in 1959 although he co-authored three publications in 1965. His basic work on airflow through grain still stands as the major part of ASAE Standard D272.3, “Resistance to air flow of grains, seeds, other agricultural products and perforated sheets”. He passed away in 1966. (*Dr. W. E. Splinter*)

RUBY M. LOPER

Ruby M. Loper was born near Douglas, NE. Her parents were Albert and Martha Loper. She was their only daughter. They also had a son, Neil. Sometime between 1910 and 1920 Albert and Martha Loper, along with Ruby, moved to Lincoln, NE where Ruby graduated from Lincoln High School. She was a member of Delta Zeta Sorority and studied Architectural Engineering at the University of Nebraska from 1920 through 1922. Ruby began working as a draftsman in the Department of Agricultural Engineering at Nebraska in 1923, and from 1924 to 1933 was the Department's Chief Draftsman. She became an Assistant Extension Engineer in the Department in 1934, a position she held until 1946. Ruby continued her Architectural Engineering studies while she worked in Agricultural Engineering and, in August of 1946, received her B.S. in Architectural Engineering at Nebraska. Contrary to some reports, she was not the first woman to graduate with an engineering degree at Nebraska. That honor belongs to Meredith Thomas who graduated from Civil Engineering in 1929. The distinction would have been Ruby's had she finished her degree in 1923. She was the third woman to earn an engineering degree at Nebraska.



Figure 14 Ruby Loper is the first female serving as a professional in Agricultural Engineering. She received her degree in Architecture and designed farm buildings.

Ruby Loper left Nebraska in 1946 to join the Agricultural Engineering faculty at Cornell University in Ithaca, NY. She was the first female faculty member in Agricultural Engineering at Cornell and Nebraska. She authored numerous extension articles and was a charter member and a director of the American Association of Housing Educators. She served as national chair of commercial and farm housing standards, and as the national design chair of the committee on electric light in the farm home. She was also a member of the national committee on farm fire prevention and protection. While at Nebraska, her publications included *Farm Buildings for Nebraska*; *Space Requirements and Storage Capacities for Nebraska Farm Structures*; *Summer Shelter for Poulets* and; *Adequate*

Wiring for the Farm Home. In 1937 Ruby authored *Farm Houses That Farm Families Want* in *Agricultural Engineering*, @ forerunner of the *Transactions of the ASABE*.

Before moving to New York, Ruby lived at 3801 Apple, near the East Campus in Lincoln where her hobby was gardening. She owned a farm near Douglas, NE much of her adult life and identified with the problems of farm ownership and management. For example, a part of her early Nebraska extension career was to survey farms for contours and terraces, a new practice at that time, to prevent soil erosion. Also, due to the absence of male farm labor during World War II, Ruby participated in extension programs that taught women how to operate farm tractors.

Ruby M. Loper truly pioneered the involvement of women in the profession of Engineering and, on April 15, 2011, was inducted into the Department of Biological Systems Engineering Hall of Fame at the University of Nebraska.

LESTER F . LARSEN

As the Engineer-in-Charge of the Nebraska Tractor Test Program from 1946 to 1975, Lester Larsen was known internationally as a man of integrity whose data on the performance of agricultural tractors was accurate and unbiased. The Nebraska Tractor Test Law, passed in 1919 stipulated that any tractor sold in the state of Nebraska must have its advertised claims verified by a Test Board of three engineers through tests conducted by the Nebraska Tractor Test Laboratory. Although the law has jurisdiction only within the state of Nebraska the results were regarded as the standard of performance internationally so tractors were submitted for testing from around the world in order show that their advertising was credible.

Larsen was born in 1908, was raised on a farm near Copenhagen, NE and attended school in Brunswick, NE.. He entered the University of Nebraska in 1928 studying dairy farming but switched to Agricultural Engineering where he could study tractors. As a student he hung around the Tractor Test Lab. When he graduated in 1932 he was employed by International Harvester at a salary of \$100/mo. This was in the Great Depression and he was responsible to work with farmers in western Kansas who owed money on their farm equipment. He returned to the University in 1937 and worked for a M.Sc. degree in Agricultural Engineering. He then taught and conducted research for the Agricultural Engineering Department at South Dakota State University from 1939 to 1943, then he rejoined the Ag. Engineering Department at the Univ. of NE as an extension engineer. One of his activities was working with farmers who were converting horse drawn equipment for use with a tractor.

During WWII no new tractors were designed so the laboratory was closed. Larsen was named Engineer in Charge of the lab when it re-opened in 1946. Starting from one tractor that year, the program built up to a peak of 56 tractors tested in 1965. This approached in number the 69 tractors tested in 1920. As tractor manufacturing developed in Europe and Japan tractor test laboratories were developed there, primarily as government agencies, so

the number of tractors submitted for tests declined. During his time as Engineer-in-Charge Les completed 790 official tractor tests, not counting those that were withdrawn. The Test Lab was credited with being “The Supreme Court of Tractors”.



Figure 15. Lester Larsen and the Square Turn tractor, the only tractor manufactured and sold in the State of Nebraska.

Also during this time Les published many technical papers and public reports on the various findings of the tractor testing program. His major contribution was “Farm Tractors, 1950-1975”, a 184 page documentary providing the test specifications of each of the tractors tested during that time. The book followed R. B. Grey’s documentary “Farm Tractors, 1920-1950. Well over 30,000 copies of Les’s book have been sold world wide.

Upon his retirement Les began the development of what was to become the Lester F. Larsen Tractor Test and Power Museum. Tractors had outgrown the dynamometers and space in the original Tractor Testing Laboratory, built in 1919, and a new facility was constructed in 1979. The University wanted to demolish the old building but Les moved the tractors he had collected into the former lab building. He had acquired seven historic tractors that were first housed in a rammed earth building just north of the lab. When the new facility was built this building was demolished and the tractors were moved to the Mead Field Lab or the old Horse Barn. After the completion of the new lab and use of the old lab for teaching, these tractors were brought to the former tractor test lab building where they still serve as the core of the historic tractor exhibit. Les accepted donations of additional tractors collecting a total of around 40 tractors.

The University refused to provide any support for Les’s collection and the roof deteriorated to the extent that holes in the roof 20 feet in diameter formed. A funding drive was initiated and sufficient donations were received to repair the roof. The collection began to attract visitors and a Friends of the Museum organization was formed for support. In 1980 the building was declared a Historic Site by the American Society of Agricultural Engineers and Larsen took the unpaid position as Curator until 1987. In

1998 the University Board of Regents recognized the building as the Lester F. Larsen Tractor Test and Power Museum and although it was a cold and blustery day Les was able to attend the dedication with his family.

Still another activity that Les was instrumental in starting was the exhibit and parade of antique tractors at the Nebraska State Fair in 1983. As many as 14 of the Museum tractors have participated in the Fair exhibit. The exhibit and parade were a highlight of the Fair. In 2010 the Fair was moved to Grand Island and the Museum exhibited only one tractor. Les passed away in 1998—but he leaves an indelible imprint for the State of Nebraska. (*Dr. W. E. Splinter*)

LLOYD W. HURLBUT

Lloyd Hurlbut was born in Sylvan Grove, KS Feb. 29, 1909. He graduated from Kansas State College with a B.Sc. in Ag. Eng. in 1932. Hurlbut then studied under Prof. Chauncey Smith and received a M.Sc. degree in Ag. Eng. in 1934. He served on the Ag. Eng. faculty as Instructor from 1934 to 1938, and then as Assistant Professor until 1942. He, with Prof. Smith initiated studies of the use of pneumatic tires on tractors in 1932, in cooperation with Allis Chalmers Tractor Co. and Firestone Tire Co., completing them in 1937. They established that pneumatic tires were 25% more efficient in drawbar tests than drive wheels with steel lugs. This revolutionized the capabilities of the agricultural tractor making it not only more efficient but also usable for transport of materials on finished roads. Their use became virtually universal within a few years.

Hurlbut and John Sulek developed the first academic program in Mechanized Agriculture that was offered in 1958 to students desiring to enter farming operations, sales or service work. This complemented the engineering program in providing a means to utilize engineering background material as a basis for business applications or farming. Hurlbut worked with Jimmy Butt, Executive Vice President of ASAE in developing the framework of the program.

. Hurlbut was continuously involved the Nebraska Tractor Test program, and served on several international conferences, traveling to Russia, Egypt and France. He also made a number of other significant contributions to the field of Ag. Engineering. One of the most visible was the introduction of “Tractor Day” by the department in 1950, in cooperation with the Nebraska Farm Equipment Dealer’s Association. The attendance was around 250 people. This program exhibited the tractors that had been tested during the past year and evolved to include a wide range of research and extension programs, to the extent that it became known as “Tractor Power and Safety Day” (TPS day) and soon outgrew its first location on the Mall in front of the Ag. Eng. Building (now Chase Hall), expanding to the area around the tractor test track and then moving to the UNL Field Lab near Mead, NE in 1963. Approximately 20,000 visitors attended the exhibits and presentations in 1964. A number of other state Universities followed this idea, sponsoring major equipment shows. With the advent of Husker Harvest Days, now offering a week of demonstrations near Grand Island, manufacturers lost interest in participating in TPS

day, the program became diffused with other departmental programs at Mead and the public lost interest.



Figure 16. Professor Lloyd W. Hurlbut, Department Head from 1947-1965, established many innovative programs including Tractor Power and Safety Day. After service in the Navy as Lieutenant Commander in the South Pacific during WWII, Hurlbut joined the faculty at Purdue University but returned to the University of Nebraska as Head of Ag. Eng., following the retirement of Prof. Brackett in 1947.

Hurlbut was continuously involved the Nebraska Tractor Test program, and served on several international conferences, traveling to Russia, Egypt and France. He also made a number of other significant contributions to the field of Ag. Engineering. One of the most visible was the introduction of “Tractor Day” by the department in 1950, in cooperation with the Nebraska Farm Equipment Dealer’s Association. The attendance was around 250 people. This program exhibited the tractors that had been tested during the past year and evolved to include a wide range of research and extension programs, to the extent that it became known as “Tractor Power and Safety Day” (TPS day) and soon outgrew its first location on the Mall in front of the Ag. Eng. Building (now Chase Hall), expanding to the area around the tractor test track and then moving to the UNL Field Lab near Mead, NE in 1963. Approximately 20,000 visitors attended the exhibits and presentations in 1964. A number of other state Universities followed this idea, sponsoring major equipment shows. With the advent of Husker Harvest Days, now offering a week of demonstrations near Grand Island, manufactures lost interest in participating in TPS day, the program became diffused with other departmental programs at Mead and the public lost interest.

An important component of the TPS program was the farm safety demonstrations. It had been recognized that farming was second to mining as the most hazardous industry. Hurlbut first demonstrated the instability of a tractor in 1952 using his own tractor, an International Cub Cadet and broke the tractor in half when it overturned. A roll bar was

built for a John Deere “B” and it was taken around the state by Delbert Lane and Bill Lutes, extension Ag. Engineers, to demonstrate to farmers the hazard of injury or death if a tractor overturned. This demonstration was an important component of TPS day. In 1959 Lutes left and Rollie Schnieder headed the project. A manikin called “Jughead” was placed in the seat of the tractor to make the demonstration more realistic. These demonstrations lead to intense engineering studies of the kinematics of overturn by George Steinbruegge and engineers in industry, resulting in ASABE-SAE codes setting the design standards for a roll bar or cab to protect the operator during an overturn event. This code is used internationally today and the result saved thousands of lives.

Hurlbut, with Prof. Ole Olson, George Petersen and Francis Yung lead the research that established that unheated forced air could be utilized for drying grain, a significant energy saver. He pioneered several other areas that are broadly used today, the use of air to meter corn seed during planting, the replacement of the corn picker with combines and the development of a mechanical harvester for castor bean seeds, (with Mike Arms and Prof. Chauncey Smith).

Hurlbut pioneered the conservation tillage or till-plant method for planting corn (with Rollie Schnieder and Dr. Howard Wittmus). A blade was mounted on a John Deere tractor to undercut corn stubble, followed by a two-row planter. This was successful and then a four row planter was modified with sweeps to allow a one-pass planting and fertilizing operation directly into the stubble left from the previous year. This afforded protection of the soil from wind and water erosion and captured snow during the winter. This reduced the number of tillage operations from cutting stalks, disking, plowing, disking, harrowing and planting to a single operation. This obsoleted the plow and allowed very significant reductions in energy, time and equipment for planting corn. The adoption of this practice is now nearly nation wide, and serves as a major contribution to agriculture.

Hurlbut received a patent covering the mounting of a picker head on a combine to allow the combine to be used to harvest corn, (patent #2,770,087), bypassing the use of corn pickers and shellers. This is now the dominant method for harvesting corn. Although assigned to Research Corporation, a company that licenses patents for Universities, there is no information that any royalties were received.

Hurlbut was elected to membership in Sigma Tau, Sigma Xi, Gamma Sigma Delta and the Steel Ring honoraries. He served as President of the American Society of Agricultural Engineers 1960-61 and was also a member of the American Society of Engineering Education, the Nebraska Engineers Society and the Lincoln Engineers Club. Hurlbut died Jan. 7, 1965. (*Dr. W. E. Splinter*)

ROLLIN SCHNIEDER

Rollie was born on a farm near Kramer, NE on Dec. 18, 1930. Following service in the U.S. Navy from 1948-52 he enrolled in the Univ. of Nebr. and received a B.Sc. degree in Ag. Education in 1956, and a M.Sc. degree in Ag. Education in 1960. He taught one year at Red Cloud, NE before joining the Department. As a student in 1954 he had begun working for Hurlbut who was working with John Deere to see if a corn header could be attached to a Model 45 JD combine. It was successful and, according to Rollie “L. W. jumped up and down and had a grin from ear to ear”. Today nearly all corn is harvested by combine with the exception of seed corn.

Rollie did the mechanical work with the early development of conservation tillage for a row crop such as corn. Russ Poyner from IHC donated two 36” sweeps to Hurlbut with the idea of undercutting the corn stubble like the machine developed by L. W. Chase for wheat stubble. They were mounted on a JD two-row cultivator and Rollie modified them by narrowing them to 16” and removing a subsurface shoe. The idea was to eliminate plowing, discing and harrowing by a single pass through the stubble in the Spring. In 1955 eighty acres of the Agricultural Engineering Farm were planted into soil that had



Figure 17. Professor Rollin Schnieder established a nationally recognized program in farm safety and was a leader in the Tractor Power and Safety program.

been undercut with these blades and the result was an excellent yield of corn. Poyner then donated a four-row IHC planter in 1958 which was modified with undercutting blades. This now allowed planting corn in a single operation. This machine was successfully used by a farmer, Dick Schurr near Platte Center, NE. This method of

planting created some problems with cultivation because of the bulky corn stalks. A workable cultivator was developed by Bruce Villars, an Ag. Eng. graduate who farmed near Minden, NE. In 1954 the Fleischer Mfg. Co. of Columbus, NE. began manufacturing and selling the planter and cultivator. Thus was born the “Till Plant” system for planting and tilling corn. Modifications of this system now dominates corn planting nationwide.

In 1959 Rollie also worked with Hurlbut’s idea of planting small grain with an air planter. It used a PTO driven air pump blowing the seeds through plastic tubes to knives similar to those used for ammonia applicators. Today, many grain crops, including corn are planted using this method.

As if these activities were not enough to keep Rollie busy, he also became involved with Tractor Day as a student in 1954. At that time it was primarily a tractor parade of the new tractors that had been tested that year. First located in the Mall south of the Ag. Engineering Building (now Chase Hall), it attracted large crowds and was moved to the tractor test track. The scope of the program was broadened to include the latest in research by the department and demonstrations related to safety on the farm. In 1952 the Department had started a safety program concerned with tractor overturn so it was then named Tractor Power and Safety Day. In 1959 Rollie was named Safety Specialist to continue the programs developed by Bill Lutes and Dan Kitchen. Crowds continued to increase and the program was moved to the Field Lab. near Mead, NE., where as many as 20,000 visitors participated. Rollie served as Chairman from 1976 to 1985.



Figure 18 Schnieder demonstrating how quickly a person (the dummy called Jughead) can be trapped and killed with an unshielded power take off.

As Safety Specialist Rollie was involved with George Steinbruegge and Delbert “Red” Lane in the development of overturn protective structures and an educational program for farmers on safe tractor operation. The roll bar built by Dan Kitchen for the John Deere “B” was mounted on an Allis Chalmers “WC” donated by the Bender John Deere Dealership in Sutton, NE (Fritz Bender was an Ag. Eng. graduate). Accelerometers were mounted on the frame and high speed motion pictures were used by George Steinbruegge

to determine the forces on the frame and tractor during an overturn event. Schnieder, Steinbruegge and Lane worked with manufacturers of tractor cabs and with farmers to reduce the number of fatal accidents each year resulting from improper operation of the tractor and the lack of protection in case of overturn. In 1965 John Deere announced that they had developed a roll bar, which they made available to other manufacturers. Working with ASAE and SAE industry standards were developed to assure the integrity of rollover structures and codes were written which have now been adopted world wide. The Tractor Test Laboratory now includes overturn compliance with the codes as a component of the official test. The work Hurlbut started in 1952 with his own tractor has resulted worldwide adoption of safety structures for tractors.

Coupled with the work on tractor overturn protection Rollie developed extrication protocols to train emergency medical technicians, nurses and volunteer fire departments on the procedures for extricating victims from overturned equipment, PTO injuries and hazards from gases in confined spaces. Training programs, coordinated with UNMC doctors, were offered state wide and have been adopted by at least 15 other states.

Rollie has also worked effectively with youth programs such as 4H, FFA and Hunter Safety related to his work in safety. He also served as an emergency specialist for the Nebraska football games.

In recognition of his work Rollie has received national attention including the title “Mr. Safety”. In 1989 he received the top safety award from the National safety Council, the “Distinguished Service to Safety Award”. He was given a USDA Distinguished Service Award in 1984. In 1986 he received the ASAE Packer Engineering Safety Award and he was elected to the grade of Fellow in ASAE in 1989. He has received numerous awards in Nebraska for his extension programming and many Safety Councils and Emergency Medical Associations in Nebraska. He received the Gamma Sigma Delta Award of Merit in 1984 and was elected to the Biological Systems Engineering Department Hall of Fame in 1998. (*Prof. Rollin Schnieder*)

Rollie served in the Navy during the Korean War. Rollie passed away in May 1, 2011.

HOWARD D. WITTMUSS

Howard was born on a farm near Papillion, NE in 1922. He served in the Navy from 1943 to 1946, and again from 1950 to 1952 as an engineering officer. He earned three degrees, a B.Sc in Ag. Engineering in 1947, a M.Sc. in Ag. Engineering in 1950 and a Ph.D. in Soil Physics and Ag. Engineering in 1956.

Wittmuss was the principal researcher in the development of the till-plant system for corn and other row crops. Wittmuss started formal research in the efficacy of till planting in 1958 at the following six locations across the state: Lincoln, North Platte, Hastings, Franklin, Concord and Mitchell. Both irrigated and dry land plots were planted. Increased yields at much lower labor and equipment costs were achieved. The Fleischer

Mfg. Co., Columbus began manufacturing the design that Schnieder and Wittmuss had developed.

Using sprinklers as a rainfall simulator, Wittmuss and Norris Swanson (USDA), conducted studies of soil losses due to erosion from till planted and conventionally planted fields. They found that there was a 3:1 reduction in erosion with till-plant on disked but non plowed land, compared to conventional practice of disking, plowing, disking and harrowing, and a 10:1 reduction using the till planter directly into untilled corn stubble. Together with Delbert Lane and Larry Olson, Wittmuss reported that the total U.S. energy cost for corn production could be reduced by 60% by disking and planting (commonly used today), by 67% by using the till plant system and by 70% using slot planting (still not commercially utilized).

Farmers greatly resisted the idea of “trash farming” but through efforts of the extension engineers such as Lane, Schnieder, Bert Somerhalder and Elbert Dickey, Nebraska farmers have totally abandoned plowing and this has now spread nationally.

Wittmuss and Swanson were also pioneers in developing parallel steep back-slope terraces designed to reduce acreage loss to terracing, and fitting the planting row widths to eliminate point rows. Many thousands of acres have these installed in Nebraska and Iowa. corn stubble. Together with Delbert Lane and Larry Olson, Wittmuss reported that the total U.S. energy cost for corn production could be reduced by 60% by disking and planting (commonly used today), by 67% by using the till plant system and by 70% using slot planting (still not commercially utilized).

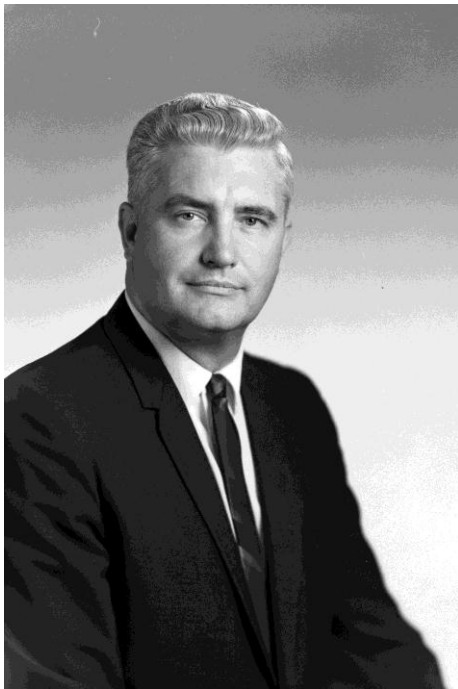


Figure 19. Dr Howard Wittmuss was a leader in establishing conservation tillage and steep back-sloped terraces into farming practices, greatly reducing soil erosion.

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Howard played a key role in the elimination of the plow as a primary tillage instrument literally revolutionizing farming practices. He received many awards including the Commendation Award from the Soil Conservation Society of America and the Ridge Till Hall of Fame.

Howard served in the Navy in both WWII and the Korean War and rose to the rank of Lt. Commander.

Dr. Wittmuss died in 1991. (*Dr. W. E. Splinter*)

DEON AXTHELM

The Department of Biological Systems Engineering has had a program directed at access to and efficient use of water for irrigation beginning in 1895 with O.V.P. Stout. E.E. Brackett and others worked with farmers on irrigation pumping plants. Ivan Wood, the first extension engineer included irrigation management along with his work in soil and water conservation. The fact that Nebraska is first in the nation in number of irrigated acreage is due in no small program to the research and extension program in this department over the years. Deon Axthelm has written a synopsis of this activity that I will include as he has written it.

“The drought of the 1950’s in Nebraska resulted in a rush by farmers to drill wells to obtain water for irrigating cash crops. The Agricultural Engineering Dept. (Dept) quickly geared up to respond to the new problems and opportunities.

Pre 1956, John C. Steele, Dept staff engineer, had helped develop a concept of using a local farm to demonstrate new irrigation practices. ‘Jack’ was in charge of that program. This was in conjunction with the Bureau of Reclamation program of establishing an irrigation practices demonstration on a farm within the boundaries of the lands to be irrigated by water from the recently built Harlan County Reservoir on the Republican river. Later, Paul Fischbach worked with that project. He then was requested to move to Lincoln to head the Cooperative Extension Service component of the Dept’s state irrigation program.



Figure 20. Professor Deon Axthelm, working with State Senator Maurice Kramer, established the State program that led to the protection and management of Nebraska's water resources.

Paul, using his knowledge of agronomy and soil combined with his engineering skills developed, tested and demonstrated many new irrigation practices. One of those was the determination of soil moisture levels at various crop depths. The purpose was to curb the deep percolation resulting in the loss of water and fertilizers. He investigated methods of controlling water flow in furrow irrigation by using gated pipe and siphon tubes where canals and ditches supplied water. He determined and taught irrigators depth of water penetration, first by soil probe, then by introducing soil moisture blocks. He consulted with center pivot manufacturing companies to help them develop and refine the water control and water saving devices the pivot systems offered. He also helped design water reuse systems which returned irrigation runoff to fields. A major contribution of his was the research in the field application of fertilizer delivered through center pivots.

John Decker, hired about the same time as Paul, was also a Coop.Extension Irrigationist within the Dept. He was stationed at Loup City, NE to work with irrigators receiving water from the Sherman Co. Dam for the Farwell project and including ground water users. This was a cooperative project with the Dept. of Interior. John introduced the same irrigation practices as mentioned above for Paul Fischbach.

Robert "Bob" Mulliner became the 4th Coop Extension Irrigationist to join the Dept. in 1956. He was stationed at Hastings, NE. The surrounding counties he served contained the largest and best aquifers for deep well irrigation in Nebraska. Irrigation wells were being drilled at a phenomenal rate. Bob introduced and demonstrated the same methods to new and also older users of groundwater for crop irrigation as mentioned above.

Thus the Dept's irrigation development program for NE was adequately staffed and functioned very well to meet the expanding needs for accurate, research based education

for new and also experienced irrigators. However, one segment of the Dept water program still remained to be addressed. Irrigation wells were being drilled at an accelerated rate. Pumps and power units were sometimes inadequately matched or improperly adjusted to meet the hydraulic conditions surrounding those wells. There was a need for a Dept. staff member to develop a state wide education program focused on wells and pumps.

Following my Co. Agent years, I and my brother-in-law rented and further developed a 400 acre irrigated farm. We installed a second irrigation well, added newer gated pipe and used the latest irrigation methods. In 1956, after five years of irrigation farming and then a short stint as an irrigation educator and sales person with an irrigation sales company, I resigned the sales position. I was unemployed when an unexpected telephone call came. This need resulted in the Cooperative Extension Director, Ed Janike and Prof. Lloyd Hurlbut, Dept. Chairman calling me to see if I would be interested in working with the Dept. staff to learn about existing pumping plant research and to develop a demonstration program. I had experience as Clay Co. Ag. Ext. agent in advising on and helping site irrigation wells. This was possible through contacts with and cooperation of the UNL Conservation Survey Division. I had learned from them and had used their maps of aquifer thickness and depth, ground water levels and other details.

It was an offer to join the Dept. as Extension Irrigationist and to work with John Sulek. John had devised a field test for irrigation well pumping plants. He had combined UNL tractor engine tests for fuel consumption with optimum deep well pump turbine water production. If irrigation engines and pump turbines were improperly designed or matched for specific field conditions the pumping plant standard would show where the problem was occurring. Often simple pump impeller adjustment would result in larger water production at less const. If impellers were producing water properly then a problem with the engine could be determined. The test was titled The Nebraska Pumping Plant Test Standards.

By request of County Extension Agents we conducted several hundred irrigation pumping plant test demonstrations through out Nebraska from 1956 to 1958. Test results often saved irrigation well owners many dollars in annual pumping costs. The demonstrations always were attended by many irrigators of farmers who were planning to install irrigation wells. In addition those attending were taught about the occurrence, movement and replenishment of ground water supplies. A few separate demonstrations involved removing the pump from the well. Then a water proof camera was slowly lowered into the well to visually determine if the casing was incrustated and if the incrusting material needed to be removed.

Many Nebraska people of this era thought ground water was an inexhaustible resource. At well sites, following the test demonstration, attendees were educated about how and why ground water occurred, and how it was induced to move toward a well.

During my term as County Agent in Clay Co., Corwin Mead, the Co. Agent in adjoining Hamilton Co., had organized a Pump Irrigator's Association. Among the programs

Corwin and I discussed were crop fertilization, a new development: crop varieties and planting rates; machinery for irrigation farming; in addition to other items, the effect pumping water for crops would have on the ground water resource and the possibility of a dropping water table level. We agreed the latter was of the utmost, long term importance. Thus work toward gathering in county data about the annual groundwater rise or fall was begun.

The design and techniques for the groundwater measurement programs were coordinated with the UNL Conservation and Survey Division. The Division had established many data covering wells through out much of the state. However, there was a need to determine the groundwater rise or fall locally.

The Hamilton Co. association had already begun to measure the ground water level, spring and fall, in specifically identified irrigation wells. The Clay Co. Association agreed they wanted to start a similar program. I assisted them in hiring a technician and then trained him how to take the measurements. The Association continued the program which after several years of data gathering showed areas of groundwater level decline.

York, Seward and Fillmore counties then followed suit and organized irrigation associations to gather information and do similar work. These five associations became legal entities by a law enacted in 1967 by the Nebraska Unicameral. Their name was changed from associations to Groundwater Conservation Districts.

Those county districts continued to ask me for advice and counsel about various technical and other local programs. In 1975 the Clay Co. Groundwater Conservation District asked me to assist them to devise a regulation to help control excessive irrigation water runoff. Normally dry creeks were running water during dry weather. The association published a regulation to the effect that an irrigator using groundwater had to keep irrigation water on his own fields. This was the first attempt to conserve groundwater by legal means. One farmer-irrigator challenged that regulation. His case was taken to court. The regulation was upheld. That case legitimized the control of groundwater runoff by the Groundwater Conservation Districts. Their rules and regulations were never again legally challenged.

That regulation also had the affect of emphasizing irrigation water reuse systems and resulted in a large number of such installations. Their design, in large part, was the work of Dept. staff. The regulation also fostered extensive use of irrigation water saving methods that had been researched, proven and field demonstrated by our staff.

One area of emphasis of Dept. research was on improved irrigation water application methods and improved mechanical delivery systems, including the center pivot. That research coupled with state wide field application demonstrations by the extension irrigation staff had gained the Dept. a reputation as having the best irrigation program in the nation. Moreover, the economic results were self evident in greater crop yields for irrigators and expanding ancillary commercial enterprises.

In 1964, John Davis, the Dept. Chairman changed my responsibilities and title. I became Water Resource Specialist, the first such position in any university Ag. Engineering department in the U.S. Rapid acceptance of groundwater use for irrigation resulted in thousands of irrigation well installations on former dry land farms throughout the state. In addition the center pivot system made possible the irrigation of rolling and rough terrain. Irrigation information, although still needed, began to decline as farmers became proficient.

My new role now called for state wide education regarding conserving ground water. Surface water irrigators were already subject to regulations by specific state laws and by districts which store and distribute water. No regulations, other than those of the five existing Groundwater Conservation Districts, existed for the pumping and use of ground water. Historically, county supervisors were in charge of county wide operational programs and were considered as potential groundwater regulators.

In 1975 Senator Maurice Kremer of Hamilton Co. and the Public Works Committee of the Unicameral were concerned about the burgeoning use of groundwater for irrigation purposes. They held numerous hearings on what should be done. The voluminous testimony and detail proved to be too much for them to digest. Senator Kremer then called upon me, ex-senator Don Thompson of McCook, NE and James Cook, legal counsel for the Nebraska Natural Resource Commission to use the testimony as a basis for drafting a potential statewide law. After many sessions our ad hoc committee presented the Public Works Committee a draft of a potential law for groundwater development and use in Nebraska. Subsequently Senator Kremer introduced LB 577, the Groundwater Management Act. With much debate, the bill became law. This law, although changed in minor ways through the years, has remained the basis as a guide and rule for state wide groundwater management in Nebraska.

Considering all of the irrigation and the attended legal aspects of managing Nebraska's groundwater, Clayton Yeutter, a doctoral candidate in Ag Economics Dept., and I studied the possibility of counties to develop and supervise groundwater regulatory measures. Since Nebraska has 93 counties there also seemed to be possibly some economic saving by mergers of 2 or more counties. We then developed a seminar titled, "How Local Should Local Government Be?". It was attended by state and county officials, state senators and specifically the State Soil and Water Conservation commission members. The latter were in charge of state wide water programs.

The Natural Resource District [NRD] law was a direct out-growth of that seminar. Their boundaries became larger than county lines and followed large surface water drainages. Today, within their respective boundaries, they administer many and varied groundwater and soil conservation and related programs. Local control of many issues was maintained while operating under state rules. A few years after the NRD's began program operations the 5 county Groundwater Conservation Districts were disbanded by law. Their programs were then absorbed by the respective NRD.

In a few years groundwater depletions began to cause local and regional concerns. Colorado, Kansas, Oklahoma, Texas and Nebraska each had various state or district laws and water related organizations. After consultations with the respective state Ag. Eng. Extension personnel and with their help, I organized an informational program for the region regarding groundwater levels, existing state programs, and other pertinent information. Delynn Hay, Kansas State University Ag. Eng. hosted that regional water seminar at Garden City, KS. We anticipated about 50 persons would attend from all of the respective states. Over 120 persons came. The question arose about continuing regional meetings. Each state polled, unanimously agreed to continue meeting annually. They named temporary officers to draft organization plans. Thus the Groundwater Districts Association was born. It continues today with added member states such as Mississippi, Florida and others. It has become a great force for information exchange and solutions for groundwater use and control. In addition, I am fortunate to be considered the grandfather of the Groundwater District Association.

As groundwater levels continued to decline, often causing interference with neighboring wells in local areas, NRD directors were faced with developing regulatory measures. To assist them in making informed decisions, I led educational tours to irrigated areas in Texas, New Mexico and California. The directors and NE state waster officials observed how each state managed irrigation water supplies. They observed required metering of surface and ground water, the results of no limits on groundwater withdrawal, methods of groundwater recharge, local versus state management and other water programs. They then used their observations to develop regulatory measures compatible with their local problems. The tours profoundly affected the way water, especially groundwater is managed and regulations enforced in Nebraska today. (*Prof. Deon Axthelm*).

Deon flew a P-40 Tomahawk fighter in the China-Burma-India Theater during WWII.

PAUL E. FISCHBACH

Professor Fischbach was born July 4, 1919 and lived on a farm near Orleans, NE. He served in a special Army unit assigned directly with General Patton throughout WWII. Following the war he received the B.Sc. degree in Agronomy in 1949 and the M.Sc. in Soil Science in 1950. He then worked with the Central Nebraska Public Power and Irrigation District in Holdrege, joining the University of Nebraska as a District Irrigation Specialist in 1952. He then joined the Agricultural Engineering Department and served as an irrigation specialist until he retired in September, 1984. Many of his research and extension activities are included in Deon Axthelm's material (above).

Fischbach was involved in many innovations in irrigation. His work greatly increased irrigation water application efficiency through improved scheduling to apply water only when needed, utilizing a surge method to obtain more even application down the row, using re-use pits to capture excess water at the end of the row and reuse it, and the development of a unique automated gated pipe system using a controller to program surface water application. He used inflatable rubber pads to serve as valves. His work

showed that a water savings of 35% could be achieved. He was also a leader in the application of fertilizers and insecticides through center pivot irrigation systems.



Figure 21. Professor Paul Fischbach led the irrigation Extension program for the department into one of the strongest in the nation.

Another of his major projects was the utilization of a 35KW photovoltaic panel to power the irrigation pump for an automated gated-pipe irrigation system on the Department's Energy Farm.

Utilizing this extensive research program, Fischbach developed a statewide irrigation extension program to bring the results of this research to the farm. He coordinated the irrigation programs with Bert Somerhalder and Darrell Watts at North Platte, with Dean Yonts at Scottsbluff, with Bob Mulliner and Dean Eisenhauer at Clay Center and with Bill Kranz at Concord.



Figure 22. Fischbach and the automated gated pipe irrigation system he developed.

Fischbach received many University, State and National awards for his work. In 1961 he was named "Man of the Year" by the Irrigation Association; in 1973 he received the

“Distinguished Service Award” from the Nebraska Cooperative Extension Association. In 1976 and again in 1978 he was presented the “Award of Recognition” by the National Fertilizer Solutions Association for his work in the application of chemicals through irrigation systems. In 1979 he received the J. Sterling Morton Distinguished Service Award and the Distinguished Cooperative Extension Service Award. In 1981 he received the Gamma Sigma Delta Award of Merit and the United States Presidential Award on Energy Efficiency. In 1982 Fischbach received the Nebraska Hall of Agricultural Achievement Special Award for Innovative and Effective irrigation Extension Activities and in 1983 he received the American Society of Agricultural Engineers Hancor Soil and Water Conservation Award. Paul passed away Feb. 24, 1997. (*Dr. W. E. Splinter*)

Dr. Stuart O. Nelson

Stuart O. Nelson was born in 1927 on a family farm in Stanton County in northeastern Nebraska, which his grandfather bought from the Homesteader and broke the prairie, leaving the natural waterways in native prairie grasses, and farmed hilly land on the contour to reduce erosion. His parents, Irvin A. and Agnes E. Nelson, lived on the farm and operated it, with formal recognition of sound conservation and custodial practices, until their retirement in 1970. Stuart and his younger brother, Don J. Nelson, who retired as Professor of Electrical Engineering at the University of Nebraska, still own the farm on which they grew up. They were educated through the 8th grade in a one-room country school, District No. 50, built on a corner of the family farm. They went to Pilger High School, and Stuart graduated in 1944. He enrolled immediately in engineering on a Regents scholarship at the University of Nebraska to obtain as much education as possible before his anticipated call into the armed services. After enlisting in the U. S. Navy in 1946, he served 2 years, completing the Navy Electronics School before serving as the senior Electronics Technician on board the U.S.S. Bausell DD-845, the flagship of Destroyer Division 12 in the Pacific, where he was awarded a Captain’s Commendation.

After returning to college, he earned the B. S. and M. S. degrees in agricultural engineering and the M. A. in physics from the University of Nebraska and the Ph. D. in engineering from Iowa State University. He worked for the U. S. Department of Agriculture (USDA), Agricultural Research Service (ARS), as a Research Engineer for 22 years at the University of Nebraska and at the Russell Research Center in Athens, Georgia, for 31 years before retiring with 55 years of Federal service in 2007. He held academic appointments as Professor of Engineering at the University of Nebraska and The University of Georgia, serving as a member of the Graduate Faculty and supervising the research of several graduate students at both Universities. He served as the Major Professor for the first Engineering Ph. D. granted at The University of Georgia.



Figure. 23 Dr. Nelson was a pioneer in measuring the dielectric properties of grain and is now recognized as a World authority in the dielectric properties of grains plus other biological materials.

Dr. Nelson is internationally known and recognized for his research on electromagnetic energy applications in agriculture, on dielectric properties of materials, techniques for radio-frequency (RF) and microwave measurements of these properties, and their applications. He was the first to measure and publish dielectric properties of grain. Whenever grain and seed crops are traded, their moisture contents are measured with instruments that have been developed based on Dr. Nelson's studies. Findings from his dielectric properties research have also been implemented for grain moisture sensing on combines manufactured over the past decade or longer. He also pioneered research on RF selective dielectric heating for control of insects in grain, on RF and microwave dielectric heating treatments of seed to improve germination and seedling development, and on dielectric heating to improve the nutritional value and quality of agricultural products. He explored dielectric spectroscopy for rapid determination of the dielectric properties of fruits, vegetables and other agricultural products and investigated correlations between the dielectric properties and quality attributes of such products. He led the development of a general and versatile computer program for the precise calculation of complex dielectric constants of materials from microwave short-circuited waveguide measurements, which was furnished to more than 40 interested laboratories around the world. He published comprehensive and critical review papers on electrical properties of agricultural products, assessment of RF and microwave energy for stored-grain insect control, assessment of microwave energy for soil treatment to control pests, and RF and microwave energy applications in agriculture. He compiled and prepared Engineering Practice, Radiation Quantities and Units, and Engineering Data, Dielectric Properties of Grain and Seed, for the ASAE (now ASABE) Standards, used worldwide as an engineering reference. Although he spent his career in research for the Department of Agriculture, he also measured broad-frequency-range dielectric properties of coal

and coal fractions for the Department of Energy and similar properties of minerals and coal for the Bureau of Mines and the Mine Safety Division of OSHA, the Occupational Safety and Health Administration, U. S. Department of the Interior. In connection with that research, he developed important relationships between the dielectric properties and densities of powdered and granular materials, which were applied in studies on dielectric properties of grain, grain kernels, and other materials as well.

Dr. Nelson published more than 700 scientific and technical articles, book chapters, and encyclopedia contributions during his career in more than 50 different engineering and scientific journals. He presented keynote and plenary session papers at international conferences in Germany, Brazil, China, Korea, Japan and India. He hosted visiting scientists from Canada, Korea, China, Poland, Tunisia, Egypt, and Portugal, who came to work in his laboratory. Dr. Nelson presented more than 300 papers, seminars and lectures at national meetings and international conferences and symposia and during visits in England, France, Germany, Italy, The Netherlands, Belgium, Israel, Poland, Russia, Japan, Korea, China, India, Australia, New Zealand, Canada, Mexico, Brazil, and Argentina.

His work has been recognized nationally and internationally by his election as a Fellow of four engineering and scientific societies, the American Society of Agricultural Engineers (ASAE), the Institute of Electrical and Electronics Engineers (IEEE), The International Microwave Power Institute (IMPI), and the American Association for the Advancement of Science (AAAS). He was named Federal Engineer of the Year in 1985 by the National Society of Professional Engineers and awarded the Founders Gold Medal upon being selected from engineers nominated for the award by all Federal Government Agencies, including NASA's Chief Engineer credited with the design of the earth-orbiting space vehicles, and the director of President Reagan's Star Wars program. He was presented with the IMPI Decade Award in 1981 "for the most significant scientific and technical contributions in the field of microwave energy," 1970-1980. ASAE awarded him the McCormick-Case Gold Medal for "meritorious engineering achievement in agriculture," and he was awarded the Medal of Honor by the Georgia Engineering Foundation. Other honors included an Honorary Dr. of Science degree from the University of Nebraska, the Professional Achievement Citation in Engineering Award from Iowa State University; Professional of the Year Award from the Organization of Professional Employees of the Department of Agriculture, induction into the USDA, ARS Science Hall of Fame, and the University of Nebraska Biological Systems Engineering Hall of Fame. He was the first faculty member of The University of Georgia elected to the National Academy of Engineering. A special session honoring Dr. Nelson's research career was held at the 8th International Conference on Electromagnetic Wave Interaction with Water and Moist Substances in Espoo, Finland, in 2009.

Since retiring, he has continued working as a Collaborator (Research Agricultural Engineer) in the laboratory that he developed at the USDA-ARS Russell Research Center in Athens, Georgia, and presenting papers at national and international meetings.

DR. KENNETH VON BARGEN

In the fall of 1948, after graduating from Hemingford High School, I enrolled in Agricultural Engineering. As an undergraduate, I was elected to membership in Sigma Tau and as a graduate student at Purdue University I was elected to membership in Alpha Epsilon. After graduation in June of 1952, I spent two years in the Army most of it in Tokyo, Japan. In the fall of 1954, I helped at Tractor Testing for three months and later worked at Lockwood Graders in Gering, Nebraska, before joining the faculty as an Instructor of Agricultural Engineering in August of 1956. A National Science Faculty Fellowship allowed me a three-year leave of absence for graduate studies at Purdue University. I returned to the faculty the fall of 1969. As a UNL faculty member I was elected to membership in Alpha Zeta and Gamma Sigma Delta and subsequently served as faculty advisor to both organizations. I was honored with the second Gamma Sigma Teaching Award in the Department. John Sulek of the Department received the first award given in this category. After retirement I served as President of the Nebraska Chapter of Gamma Sigma Delta. For most of my teaching years I was a faculty advisor to the Student Branch of ASAE or the Mechanized Ag. Club. I also was faculty advisor for the student Engineering Executive Board. Professionally I am a member of ASABE, served as their representative to the American Forage and Grassland Council and later was elected to the Board of Directors of AFGC I was a member of the Society of Automotive Engineers for over 25 years. I retired in 1996.

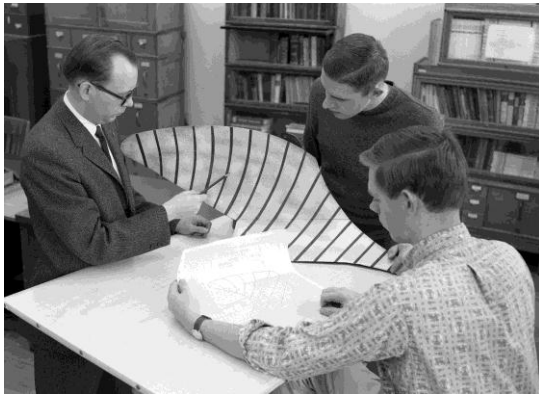


Figure 24. Dr Kenneth Von Barga instructing students Dave Sandford and Carl Bern in the design of a plow. He served as a member of the Tractor Test Board for many years.

Engineer's Week each spring was a competition between the students in the several engineering departments. Before 1950, the Ag.Es carted equipment and displays to the City Campus and setup on parking areas adjacent to the temporary buildings on the mall, now the green area north of Love Library. A Caterpillar portable generator set was towed

to City Campus for night lighting. However, the AgEs were never competitive with outdoor displays and usually finished in last place in the competition between departments. About 1950 or '51, the AgEs moved the displays into space in old Bancroft Hall. The AgEs placed second in E-Week competition about 1958. This accomplishment was celebrated with a big banner inside the back door of the building. Later the AgEs went on to win first place for many years.

On Friday nights before home football games, the ASAE Student Branch when I was an undergraduate setup bunks for the team. The old wood lab, the SE area, first floor of Chase Hall, was turned into an athletic dormitory for one night. After the game the bunks came down, were stored for the next home game and the lab benches were returned to their proper places for classes. It was a different use for the wood lab, but a good money maker for the Student Branch.

Student-faculty picnics were held at Peter Pan Park south of East Campus. Professor Chauncy Smith at one picnic did several chin-ups in the shelter house. He was about retirement age--no one else attempted to better him or even try! He was a great teacher and wrote notes on the blackboard in the style of Palmer Penmanship--no doubt developed from his earlier days of teaching before becoming a faculty member at the University of Nebraska.

A senior field trip was required of all seniors in the College of Engineering. My senior class visited the John Deere Tractor Works at Waterloo, Iowa, a conservation farm at Shenandoah, Iowa, and the first heated air grain dryer in Nebraska just west of Nebraska City during the fall of 1951. A year or two later, Bill Stout (later Department Head at Michigan State and Texas A& M Universities and President of CIGR), was badly injured in an automobile accident during his senior field trip ending those trips.

Faculty and Teaching

When joining the faculty, I replaced Mr. Bruning. An office was shared with Francis Yung and Stuart Nelson. Norvin Pearce, an AgE senior student, worked for Stuart also had a desk in the same office--now a classroom.

Because I had no research project upon joining the Department, I helped John Sulek perform an irrigation well test on the Dr. Kiesselbach farm near Gresham, NE. This was after the Nebraska Pump Performance Standard was developed by the staff. John also converted a car to operate on propane fuel. John was the lead person in developing the Mechanized Agriculture curriculum later renamed Mechanized System Management. The first name proposed was Agricultural Systems, but faculty in the College of Agriculture objected. John was the first recipient of the Gamma Sigma Delta Teaching Award.

Francis Yung conducted a survey on several area farms to determine farm water use. At times I helped with the data collection visits in Lancaster and Seward counties. Mike

Mumgaard had a materials handling extension meeting in southeast Nebraska, and I accompanied him to gain experience. He didn't outline his program until he visited with several farmers. Then he organized his materials and presented the program--no need to go over material the audience already knew.

I taught a multitude of courses and became a generalist in Ag Engineering. I began with an Introduction to AE for Ag students (forerunner of Mech Agr 109) and Farm Machinery for Ag students. Professor Lloyd Hurlbut was selected for an Ag Engineering visit to Russia, and he designated me to teach the engineering farm machinery course. That was a challenge. One time my preparation was sufficient for only a half class period. The students were very understanding. The basic course set up lasted many years through several instructors. Ag Engr Electricity, Farmstead Electricity for Ag students, Materials Handling for Mech Ags, Crop Processing and Handling for Engrs (co-taught with George Petersen--I didn't qualify to teach a senior/grad level course at that time) were other courses. After returning from Purdue University in the fall of 1969, I taught several Systems Engineering courses, later discontinued because systems concepts merged into other department courses, Equipment Systems Management and Equipment Testing for Mech Ags.

Red Lane and George Steinbruegge and perhaps others worked as judges for the mechanical harvesters at the Nebraska Corn Picking Contest. George made a giant slide rule (probably 3 x 9 ft) used to compute scores.

During the energy crunch of the '70s, Dr. Splinter had some energy saving schemes. In the NW upstairs corner laboratory where electricity classes and others were taught, plastic was put over the inside of the windows to keep the cold air out. The windows leaked like sieves, and when the wind blew strong from the NW, these plastic sheets billowed out a foot or so into the room. No wonder the building needed renovation.

Al Rider joined the faculty as an Extension Engineer for hay and grain harvesting systems. His goal was to know the answers to 95 percent of the questions that could be asked before he presented a program. Years earlier I tried to recruit him as a graduate student during the ASAE meeting at Fort Collins, Colorado.

Tractor Power and Safety Day

Tractor Power and Safety Day, TPSD, was held on campus until 1964. My first assignment was directing the parking of cars on campus. All went well by using the campus rodeo grounds for parking space except when it rained. One year an inch of rain fell about 6:00 am, and we didn't know how many people would arrive. When farmers can't get in the field, they attend shows. There was a huge crowd. When the program ended on the Tractor Test test track it moved to the mall in front of Chase Hall. Space was then available to park cars on the concrete test track with just the rear wheels on the concrete (to keep oil drips on the concrete to a minimum).

One year Mike Mumgaard and I setup a full-size automated feeding system display for TPSD just east of Chase Hall--now a parking lot. There were two bins with unloaders, a hopper bottom bin for supplement and auger conveyors to mix and deliver the ration to a feed bunk. The electrical control system was setup by Norris Public Power District. That control panel was still used in the Farmstead Electricity Course for teaching control systems when I retired. Other haying displays were an alfalfa pellet mill mounted on a semi trailer bed and experimental wafering machines by International Harvester and Lundell. The Lundell machine had the wafering chamber welded shut so no one could see the pelleting mechanism. An Allis-Chalmers fuel cell tractor and a Ford turbine tractor were on parade one year during the on campus program.

After the University of Nebraska Field Laboratory (UNFL), now the Agricultural Research and Development Center, south of Mead, NE, was acquired from the Federal Government, TPSD moved to the Field Lab in 1964. George Petersen did most of the work preparing for the UN acquisition of part of the surplus ordinance depot. My role was directing vehicle parking and participating in the parade of equipment. Vehicles were parked in the triangular field east of the load line road, When the field was filled, parking moved to the west side of the load line. All the concrete areas extending to the south end of the load line were filled. It was estimated 20,000 attended.

A new haying system was displayed and demonstrated in 1994. Self-propelled windrowers, self-propelled balers (rectangular) and two Harobed/New Holland bale wagons (one SP and one pull-type) were described during the equipment parade. After the parade the bale wagons went to work demonstrating loading in fields near the load line. There was much interest and farmers drove into the field to watch the operation. These were the first bale wagons made in California and used in Nebraska. New Holland purchased the company that made the bale wagons.

Another year a round-baler demonstration was held. Eight balers of different types and manufacturer were demonstrated. One company representative commented it was the best round baler demonstration in the US that year.

Several years the parade included round bale handling equipment, retrievers and transporters. One manufacturer was Wheatley from Iowa. At first he was invited for the parade of equipment. Several years afterwards he just showed up and wanted to parade. That was irritating to say the least, but we bent and allowed him to participate.

During one machine parade, I really goofed. SP windrowers were being paraded and I was commenting about the features of each. As a Case windrower passed the speakers stand, I called the windrower a Hesston. That was a goof! The windrower with Case colors and decals was made by Hesston for Case. From then on, I always tried to speak in generic terms.

Research

When I joined the faculty, a system for corn harvesting by a conventional grain combine along with grain drying was being investigated by a faculty team. Till planting, another

new concept at that time, was being researched by Howard Wittmuss and Red Lane. Red even used the system to plant in sod without prior tillage. Lloyd Hurlbut worked on pneumatic seed metering for wheat.

My initial research was to investigate the drying of alfalfa components, leaves and stems, for my Masters program. At that time, I could take one course a semester for a Master's Degree while being a full-time instructor. Samples were harvested from the dairy alfalfa field, now the parking lot for the Dental College. Drying chambers with relative humidity controlled by saturated salt solutions were setup in the walk-in refrigerator chamber in the basement. One year some wallabies died because of freezing temperatures at the Omaha Zoo. The carcasses were put in the refrigerated chamber until the museum could have them mounted.

Leon Nelson conducted hay bale storage research (insulated boxes with thermocouple measurements). He compared conventional rectangular bales and experimental 10x15x30 inch high density bales. These were never marketed because John Deere feared eastern farmers would store them in hay mows, and the mow floor would collapse. His setup was in the welding lab during the summer, now the room is the lower floor lecture hall. Jim Pichon remotely controlled a tractor using model airplane radio controls. His demonstration at TPSD-almost got away one year. I think it was due to radio interference from a helicopter. He later did research on a buried wire system to guide an operator-less tractor that was the forerunner of the center pivot corner buried-wire system.

Haying system research at the new UNFL was the focus of my work in 1964, '65 and '66. It was important to begin to utilize the facilities at the new UNFL, and there were 4000 acres of alfalfa being harvested by the Field Lab crew. A machine-operator productivity study was superimposed on the windrower-baler-bale wagon harvest system. My team put 10,000 miles of highway and field travel each year. One time our car rolled over a pig on the highway. Another time a rear wheel stopped turning caused by alfalfa wrap. We were lucky to escape an accident in both situations.

In 1964 rain caused a very large number of bales to lie in the field for 20 days. The bale wagons could not retrieve those bales, and they had to be picked up and stacked manually making a very unhappy crew. The next year, productivity was down—the operator of the pull-type bale wagon was literally waiting for bales to drop from the baler.

Leon Nelson and I observed a baled hay fire just north of Mead. Afterwards, we requested permission to conduct an experiment to generate combustion in stacked alfalfa bales; however, the Field Lab needed money to keep operating and permission was denied. We tried anyway, but never succeeded because the balewagon stacks did not have enough mass and a wet-dry interface to trigger combustion.

When mechanical hay stackers entered the market, there were questions about the keeping quality of the hay. Lalit Verma did his PhD research to define moisture entry into stacks made either by compression of the hay while loading or blowing the hay into

the stack chamber. Lalit later became Department Head at Louisiana State University and most recently as the University of Arkansas.

Saleh Suhaibani from Saudi Arabia did his PhD research to develop a machinery management model. He later became Dean of Agriculture at King Saud University in Saudi Arabia.

Abdel Bahri investigated variable rate planting with a grain drill using technology that could be applied to farms in Morocco for his PhD studies. He later became the leader of a research station in Morocco.

Forage systems, particle size reduction of alfalfa and equipment systems management were the focus for my research after returning from Purdue. This included 12 international graduate students. One day a student was grinding alfalfa in the basement before renovation of Chase Hall, and there was a tremendous clank. A knife came loose and hit the shear bar. The noise did make an impression in the department—no one was hurt, and there was little damage to the machine.

Later I lead a team to develop a milkweed pod harvester and machine to open the pods to provide milkweed floss as an alternative source of down for comforters and other products. Our first trial was a failure. The milkweed field near Paxton had been hailed and there were few pods. We found a huge roadside patch and tried the harvester. It collected only a few pods over half of the patch. We stopped and later made some machine changes while Dick Zeller, also a Hemingford High School graduate, of Natural Fibers Corporation sprayed the milkweed. Three weeks later, the harvester collected 95 percent of the pods when the plants were dry.

I joined forces with George Meyer to investigate the use of near infrared reflectance to sense the presence of a weed. The purpose was to spot spray weeds. We were threatened with a law suit to stop our research, but the threat proved to be a bluff.

Leonard Bashford lead a team that conducted a fuel use survey in the 1970s. This defined the energy used for most agricultural field operations in Nebraska. Dave Shelton was a team member.

Tractor Testing

As a student I worked at the Tractor Testing Laboratory. Lester Larsen was developing a prototype hydraulic load cylinder for drawbar testing, and I did some stress analysis. When engineers from Intenational Harvester saw it, they asked to take the design to their Hinsdale Research Center. The next year they returned with the 10-square inch cylinder still in use. Subsequently, cylinders with larger diameters were made using the same concept.

Prof. Smith called a few days after I was released from the Army. The lab needed some help for a heavy test schedule and I was available. Three Oliver tractors were tested in one week by putting in 16 hour days--not possible anymore. Afterward testing ended, I

did the initial cut and fill survey for the concrete test course. Prior to the concrete, the earthen track was watered and rolled and rolled to make a somewhat repeatable compact surface. That probably took as much time as the formal test.

After George Steinbrugge retired in 1981, I became Chairman of the University of Nebraska Tractor Testing Board. We had many "what if" meetings about testing procedures for new concepts. A good number never resulted in tests. Prior to 1986 there was industry pressure to utilize a drawbar testing machine rather than running tests on the concrete track. A project to investigate drawbar testing on a machine was started. Without warning it was proposed that tractor testing be eliminated because repeated testing of the same tractor model was required worldwide. The Nebraska law was nearly eliminated and lobbying of the Legislature was intense. The outcome was a modified Nebraska Law allowing Nebraska sales based upon Organization for Economic Development and Cooperation (OECD) test procedures. Nebraska then began using the OECD procedure. Once a tractor model was tested, all OECD stations accepted the test results. At that point, Nebraska began interacting with OECD and participating in the annual conference in Paris, France. *(Dr. Kenneth Von Barga)*

DR. JOHN R. (JACK) DAVIS

Dr. Davis joined the Agricultural Engineering faculty in 1964 replacing Dr. Paul Schleusener, who had accepted a position in Washington D.C. with the Cooperative State Research Service, USDA. Davis was in charge of the Soil and Water Engineering program and was involved mainly in sprinkler irrigation systems. Following the untimely death of Professor Lloyd Hurlbut, Davis was named Head of the Agricultural Engineering Department in 1965. At that time the construction equipment industry challenged the Nebraska Tractor Test law requiring testing of tractors, which had the potential of repealing the law. Davis worked with the industry and by exempting certain track laying tractors, those used primarily in construction rather than agriculture, from the law, the program survived.



Figure 25. Dr. Jack Davis, former faculty member, Department Head and Dean of the College of Engineering and Technology.

After only six months as Head of the department he was appointed Dean of the College of Engineering and Architecture in 1965, where he served until 1971. During his tenure as Dean the College added several new programs; Construction Management, Industrial Engineering and Computer Science and Engineering. With the help of a State Legislator Rob Raun and Chancellor Hardin a line item was added to the University's appropriation setting up, for the first time, the Engineering Research Center. Prior to this time the College had only served as a teaching program. Starting from a base establishing a research position in each department, this program has developed into a comprehensive, nationally competitive program with \$25 million in research funding.

Dr. Davis was also elected to the Board of Directors, American Society of Agricultural Engineers, and served on the Board of Directors, Engineers Council for Professional Development, the accrediting body for engineering in the United States.

Dr. Davis came to Nebraska from Stanford Research Institute, Pasadena, CA where he had served as Hydraulic Engineer in the new Agricultural Research Center. One of his more interesting projects involved the evaluation of off-road mobility for military vehicles in the Mekong Delta in South Vietnam. During the period 1957-62, he served as Lecturer and Specialist with the Department of Irrigation at the University of California, Davis. He had previously served on the Agricultural Engineering faculties at Purdue University and at Michigan State University. Davis had graduated from the University of Minnesota with a B.Sc. (1949) and M.Sc. (1951) in Agricultural Engineering. He then completed a Ph.D. in Agricultural Engineering from Michigan State University in 1959.

After leaving the Dean's position in 1971 Dr. Davis served as Head of the Ag. Engineering Department at Oregon State University until 1975. He then assumed several titles, becoming Director of the Agricultural Experiment Station and Associate Dean of the College of Agriculture, member of the Governing Board of the Water Resources Research Institute, member of the Board of Directors of the Western Rural Development Center and Director of the Agricultural Research Foundation.

One of the unique areas of activity "outside" of the area of engineering was Dr. Davis' involvement with College Athletics. In 1969 he was appointed Faculty Athletic Representative for the University of Nebraska. When he moved to Oregon State University he continued there as Faculty Athletic Representative, and was later elected to the Board of Directors of the National Collegiate Athletic Association (NCAA). He served as Secretary-treasurer of the NCAA from 1983 to 1985, and was elected as President of the NCAA for the period 1985 to 1987. He finished his career as the Associate Director of Athletics, Oregon State University until 1991. During that time he also served as Special Assistant to the President, coordinating efforts to convert the school calendar from the quarter to the Semester system.

Jack is now Emeritus Professor of the Bioresource Engineering Department, OSU. (*Dr. J. R. Davis*)

DR. ROBERT W. KLEIS

My relatively brief period (2 1/2 yrs,) as Head of the University of Nebraska Department of Agricultural Engineering was a very important phase of a rewarding career; a career that at all stages involved very fortunate circumstances and the mentoring support of very special people. And it involved work.

At age ten a work pattern started with dairy farm assignments by my father involving early morning, after school, and non-school periods. Until age sixteen and WWII draft of hired men, working at home, and for neighboring farmers, combined with many a 4-H and FFA projects, and girls, left no time or inclination for mischief. But it was most valuable.

Starting junior year in high school and following a ten day crash course at Michigan State University, I replaced the Dairy Herd Improvement Association Tester. This involved an over night at each of a dozen farms so that milk weights and samples from each cow could be taken both night and morning before returning to school. Testing and calculating during ag class provided pay and credit without attending class. Continuing FFA projects and serving as senior class president during this time added to a busy schedule.



Figure 26. Dr. Robert Kleis served as Department Head from 1966-1968 and was quickly moved up to Associate Director of the Ag. Experiment Station

Then came 1944 graduation and the U.S. Army for two, rather casual, years in the Pacific Theatre. I took several USAFI correspondence classes through the University of Maryland for college credit and was admitted to Michigan State University which had already started classes before my discharge and my arrival in early September 1946.

An assigned advisor, Professor F.W. Peikert, managed my conversion from Agriculture Education to Agricultural Engineering. Nineteen to twenty-two credits per quarter led to an engineering degree three years later.

In 1949 Dr. A.W. Farrall appointed me a full time instructor for covering teaching and research of Dr. De. E. Wiant while he took two years leave to write a book. This led to co-authoring several publications and completing a M.S. degree during this period. Their recommendation to Professor E. W. Lehman, University of Illinois, Department Head lead to my 1951 appointment as Assistant Professor and electrification section leader. These three men set the stage for my 1956 appointment as Department Head at the University of Massachusetts after sideline completion of a PhD degree.

Dean Dale Sieling of the University of Massachusetts took a chance with my appointment and he gave me great support as that department evolved from near extinction to regional distinction by adding four experienced PhD level staff which combined with other turnovers made a faculty of thirteen only two of which preceded me. In eight years the M.S. and PhD degrees programs were established as the only such in New England and professional agricultural engineer licensing. This staff had extensive regional and national involvement in the ASAE.

Then in 1965 came the call from Dean of Engineering Jack Davis of the University of Nebraska who had recently moved to and from the Agricultural Engineering Head position, following the death of long time Chairman Lloyd Hurlbut. He urged me apply for that opening. My reaction was that I could not do that. We had a new building under construction. We were hosting the annual ASAE International Meeting the next summer (1966). A new home, a recreation camp on a nearby lake, civic involvement, rental real estate, daughters in school, and Bea's teaching were complications.

But the historic stature of the UNL Department and the much greater relative importance of agriculture and agribusiness in Nebraska was compelling. And the department was in need of the invigoration which Dr. Davis had begun. In January 1966 we were living in Lincoln, Nebraska and I started as Head of the Department of Agricultural Engineering.

The faculty included a great deal of capability, not all of which was utilized fully. It was almost totally alumni of the department. Only one staff member had a PhD. in A.E. There was very little clerical and technical support staffing and only three graduate assistantships. Three of the more dynamic and effective staff members were graduates of agronomy and agricultural education. Dr. Davis had activated remedial efforts and as Dean of Engineering both he and Dean Frolik of Agriculture were very supportive of continuing the rebuilding process. This process involved broadening the faculty base via out of state recruiting as a priority. This, of course, required increased support from within and interacting with relevant industry.

Dr. Donald Edwards was the first to arrive with his Purdue doctorate and South Dakota background. He was eager, competent, and effective in soil and water program activation. Continued emphasis on recruiting key staff brought DeShazer from North Carolina for the livestock systems program and Dr. Tom Thompson from Purdue University of instrumentation, and computers. These three men made a major difference in the atmosphere of the department during my brief period. Secondly, the non-engineering faculty members were recognized administratively as the high performers that they were.

A second area of initiative which Dr. Davis had begun was pursued to coordinate teaching, research, and extension functions for maximum staffing efficiency through special abilities usage in two or all of all three of these areas. Extension specialists had been allowed and earlier encouraged to consider themselves apart from the department. But a newer Director of Extension was very supportive of integration which made a broader base of special expertise available for public service needs.

Some very modest renovation of building space created needed new faculty offices and updated teaching facilities . Some new furnishings were added. Student recruitment was emphasizes and the Nebraska Chapter Of Alpha Epsilon was chartered.

Two particular personnel actions are recalled with much satisfaction. As a young Assistant Professor Von Barga was identified as having great

potential. We soon convinced him that a PhD. would enhance his future and supported his leave to study at Purdue. He subsequently returned and executed an outstanding career at Nebraska.

Another more senior Associate Professor, George Peterson, had conspicuously lost his motivation for accomplishment through unfortunate interactions with the department head years before. Having no research or teaching assignment left him basically without duty, but with tenure. His strong engineering abilities were conspicuous.

About a month after my arrival, the university signed a large technical assistance contract for the Ministry of Agriculture of Colombia S. A. I was asked to go there with two other administrators to determine staffing and organizational needs for that project. I struck upon designating Professor Peterson to serve in my absence. This confidence in him proved to be just inoculation he needed to return to professional viability for his remaining years.

The Colombia Project called for five agricultural engineers to be recruited in a tight market. The administration authorized offering positions in the department upon completion of their two or more years abroad . Dr. Watts and Professor Teter returned to pursue distinguished careers at Nebraska.

The mechanized agriculture curriculum and its students had not had appropriate status in the department or in the ASAE. Professor John Sulek had been an able advisor and advocate for this program. I was privileged to join him in his efforts to activate a Mechanized Agriculture Club and caused ASAE to provide for such graduates.

The decade of the 1960's had me very heavily involved in the ASAE; serving on many committees, offices in two national divisions, chairing special task forces on geographic organization, and on national organizational structure as well as curricula accreditation. I was honored to be elected as a Fellow in 1966.

Dean E. F. Frolik would have the next special impact on my career path by asking me to become Associate Dean for Agricultural Research starting in April 1967. I continued also as Head of Agricultural Engineering until July of 1968 as I chaired a search for my replacement. This decade of eleven years of heading two agricultural engineering departments was enjoyable and rewarding. But there was need for continued growth and progress in the UNL

department. This need was very ably provided by the able leadership of Dr. W. E. Splinter for more than two decades starting in 1968.

Twelve years as Associate Dean included four periods of Acting Dean totaling three years. In 1976 Vice Chancellor Massingale would interrupt my comfort by asking me to create a new Division of International Agricultural Programs and serve as its Dean. The timing was ideal and numerous programs and initiatives involved with grants and contracts. I continued also as Associate Dean of Research until 1982.

In 1984, then Chancellor Massengale appointed me Executive Dean for International Affairs for the UNL while continuing as Dean of International Agricultural Programs. This exciting and rewarding duty continued to 1990 retirement with a 1985-87 interlude to serve as Executive Director of International Agricultural Development in the U.S. State Department in Washington, D.C. And thus I rather totally strayed from the Agricultural Engineering Profession as such. But that early training and experience served me well. Hopefully, I served it well during my years in it. *(Dr. R. W. Kleis)*

Dr. Kleis passed away following a fall on December 17, 2009.

DONALD M. EDWARDS

Donald (Don) M. Edwards is a native of Amiret, Minnesota. Upon graduating from Tracy High School, he enrolled at South Dakota State University. In 1960, he received his Bachelor of Science (B.S.) in Agricultural Engineering and in 1961 he received his Master of Science (M.S.) in Agricultural Engineering. From 1957-62, he worked as an engineer with the USDA Soil Conservation Service in Minnesota. In 1966, he received his Doctor of Philosophy (Ph.D.) In Agricultural and Civil Engineering from Purdue University. As a graduate student, he held teaching and research assistantships.

From January 1966 to August 1970, he served on the Agricultural Engineering teaching and research faculty at the University of Nebraska. With his area of specialization in water and soil management, he taught and advised undergraduate and graduate students and conducted research projects. . In August 1970, he was appointed Assistant Dean in the College of Engineering and Architecture at the University of Nebraska. He was appointed Director of the Engineering Research Center in November 1973. In July 1976, he was also named as Director of the University of Nebraska Energy Research and Development Center. During this time he continued to teach classes to freshmen and seniors in the College of Engineering and Technology.



Figure 27. Dr. Donald Edwards taught and conducted research in irrigation engineering before being selected as Chair of the Ag. Eng. Dep't at Michigan State U. He subsequently moved back to Nebraska as Dean of Agriculture.

From September 1980 to June 1989, he was Professor and Chair of the Department of Agricultural Engineering at Michigan State University. In addition to administrative work, he taught undergraduate and graduate courses, advised graduate students and conducted research in water resources. In July 1989, he served as Dean of the College of Agricultural Sciences and Natural Resources at the University of Nebraska. He continued in this position until June 2000. From June 2000 to June 2001, he served as Director of Special Projects in the Institute of Agriculture and Natural Resources. In June 2001 he was named Emeritus Dean and Professor of Biological Systems Engineering. From 1989 to the present he continued to teach. One course that he co-taught for most of that time was a freshman engineering design course in the Department of Biological Systems Engineering.

He has been a consultant and/or collaborator to numerous local, state, federal and international agencies, industries, businesses, foundations, and educational institutions. He is a registered professional engineer and a member of many organizations, including, among others, Nebraska Society of Professional Engineers, National Society of Professional Engineers (Fellow Member), National Association of Teachers in Agriculture (Life Member), American Society for Engineering Education (Fellow Member), Accreditation Board for Engineering and Technology, National Safety Council (Life Member), American Society of Biological and Agricultural Engineers (Fellow Member), Alpha Epsilon, Gamma Sigma Delta, Alpha Zeta, Tau Beta Pi, Sigma Tau, and Who's Who in Engineering, America and World. He has been awarded with about every local, national and international teaching awards available to him. He has been recognized as a Distinguished Engineering graduate from both South Dakota State University and Purdue University. He has served in numerous national offices of the organizations that he has belonged to. He has extensively published articles and

textbooks in irrigation, water resources and pollution, remote sensing, energy, porous media development, and education. His activities and scholarly work have received national and international recognition.

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He is married to Judy (Wilson), originally from Young America, Indiana. They met and were married while doing graduate studies at Purdue University. They have four children and 11 grandchildren. While in retirement he continues to be involved in family, community, church, professional, educational and social activities. (*Dr. D. M. Edwards*)

DR. JAMES R. GILLEY

WHAT a welcome to Nebraska!!!! Karen and I, plus our two daughters (Alison, 4 years old and Alicia, 1½ years old) arrived in Lincoln, Nebraska at the end of December, 1974 to start our career in the Agricultural Engineering Department at the University of Nebraska-Lincoln. We had just moved from the University of Minnesota in St. Paul. Following a nice Christmas holidays with our families in southeastern Colorado, we returned to our rental home in Lincoln piled high with moving boxes and several feet of snow drifts outside the garage door. We thought that we had left all the snow and cold weather behind in Minnesota. That was just the beginning of our learning about the weather; and the people of Nebraska and what a wonderful experience that relationship became!



Figure 28. Dr. Gilley conducted research and taught in the field of irrigation. He later served as Department Head at Iowa State University and later at Texas A & M University.

We were welcomed with open arms by everyone we met; our departmental faculty colleagues and their families, the IANR administration team, and the fantastic folks that we met throughout Nebraska. Dr. Splinter and his family made us feel right at home and provided our family with a wonderful place to stay during our pre-visits and move to Lincoln. Needless to say, the people in the Agricultural Engineering Department made our stay at the University of Nebraska-Lincoln a fantastic experience from the time we arrived until the time we left.

Karen and I were both raised in southeastern Colorado. Her paternal grandparents were part of group of families who started the town of Pritchett, Colorado and her mother moved from Arkansas to accept a grade-school teaching position in Pritchett, where she met her husband. Her parents moved from Pritchett to Fowler, Colorado when she was in the 6th grade and her sister Jane was in the 9th grade. Both Jane and Karen completed there secondary education there. Karen's mother, Juanita, lived to be over 99 when she passed away in January, 2011. My mother's parents homesteaded, along with several of her brothers in the ranch land north of Boone, Colorado. I recall my mother telling me that she moved to Colorado in a covered wagon from a small town in Missouri in 1913. My father was originally from the town on Ennis, Texas, and he moved to Colorado about the same time as my mother. Neither of my parents graduated from high school as none existed in that part of the state during that era. I completed grade school and junior high in Boone and transferred to Fowler High School in the 9th grade, in 1958. As I recall, I started driving a tractor around 8-10 years of age and was farming in partnership

with a brother during my high school years. I developed an interest in agricultural equipment during that time and, I suspect these experiences ultimately led to my career in agricultural engineering, but with a passion regarding water, as we did not have enough groundwater to provide for irrigation on our farm.

I met Karen when we were both students at Fowler, Colorado High School. We began dating when she was a sophomore (class of 1964) and I was a senior (class of 1962). Following high school I chose to attend Pueblo Junior College (now Colorado State University-Pueblo). I transferred to Colorado State University at the start of my sophomore year and graduated with a BS in Agricultural Engineering on June 3, 1966. While at CSU, I became active in the student organization and developed life long friends with many of them. Karen and I were married on June 5, 1966 and I started my MS program under Dr. Norman Evans, who was then head of the Agricultural Engineering Department at CSU. Dale Heermann was the leader of the research project and his “guiding hand” led me through the entire thesis process, much as he did the remainder of his life. Following completion of my MS on the hydraulics of surface irrigation in June 1968 we moved to St. Paul, Minnesota where I started my Ph D. program in the Agricultural Engineering Department at the University of Minnesota under Mr. Evan Allred. I received my Ph D. in December 1971 on the hydraulics of sub-surface irrigation and joined the faculty in that department in January 1972. Our two daughters, Alison and Alicia were born in Minnesota. We remained at the University of Minnesota until we moved to Lincoln in December 1974.

Recollections of our time in Nebraska in random order: my first visit to the Sandhills Ag Lab with Darrell Watts (one of many that followed over the years). My goodness what a trip and what an experimental site in typical Darrell fashion with randomized, replicated, single-line sprinkler experiments located everywhere. I particularly recall many fall trips to hand-harvest all the plots. Seems as though we harvested over a 100 acres every year! My first presentation at Paul Fischbach’s January Irrigation Conference with a packed house every year, certainly not there for my talk! The daily car-pool with Ken Von Barga and the many conversations both morning and evening. The annual Tractor, Power and Safety Day at Mead, NE. which always attracted a large crowd with all faculty present. The deer-hunting trips to western Nebraska with Leonard Bashford, many of them not successful, at least from a deer harvesting perspective. The annual departmental review of all teaching, extension and research programs – we certainly were aware of each others programs! The many departmental social events, holiday parties, and other activities were an important part of the departmental fabric, and certainly different of the departmental functions of today.

I was initially hired on a 100% research appointment which was modified to a partial teaching appointment which included an undergraduate irrigation course (taught annually) and a graduate irrigation course (taught every other year). Critical to the success of our research program were the excellent graduate students the department attracted. I was indeed fortunate to serve as a major professor to several outstanding graduate students and research associates over the years. Dr. Derrel Martin and Dr. Robert von Bernuth were especially important to our departmental irrigation research

programs and they are extremely successful and recognized as outstanding international leaders in irrigation water management. The success of our irrigation program provided many international travel opportunities for both Karen and me over the years. We spent a sabbatical with Dr. Jan Feyen at the Catholic University of Leuven Belgium from February-August, 1984 and again in February-August, 2002. The contact with Dr. Feyen provided many additional international opportunities for several of us involved in irrigation research and teaching over the years. He and his family spent a sabbatical with us in the Agricultural Engineering Department at UN-L in 1986 and again with us at Texas A&M in 1990-91.

Many wonderful people have served as my personal mentors during my career. I first met Dale Heermann when I was a sophomore at Colorado State University and he was working on his PhD, following his stint in the U.S. Air Force. He was truly my personal mentor from that time until his untimely death in 2009. He initiated me to the HUSKERS and was instrumental in my obtaining a faculty position at Nebraska. Dr. Norman Evans supervised my MS program at CSU and guided me through many drafts of my thesis. Mr. Evan Allred, a faculty member at the University of Minnesota, served at my PhD graduate adviser. He along with his wife Donna welcomed us into their home when we moved from Colorado to Minnesota, our first experience living outside Colorado. Dr. Landis Boyd, the head of the Agricultural Engineering Department at the University of Minnesota hired me as an instructor when I joined the department as a PhD student in the fall of 1968. He then hired me as an Assistant Professor when I completed my degree in December, 1971. Dr. William Splinter provided me the opportunity to join the University of Nebraska and begin my irrigation career. Dr. Irv Omtvedt Vice-Chancellor of UN-L, IANR gave me the initial opportunity to become a department head, when he asked me to become the interim head in February 1988. Dr. David Topel, Dean of the College of Agriculture at Iowa State University who hired me as the Department Head at Iowa State University in November 1988.

During the summer of 1988 I was offered the Agricultural Engineering Department Head position at Iowa State University. I was teaching the graduate irrigation course that fall semester and remained at UN-L until November 1 to complete that assignment. That fall, our oldest daughter, Alison, enrolled at the University of Kansas, and Karen and Alicia moved to Ames, IA where Alicia started her sophomore year in high school in August, 1988. That year was clearly a time of personal change for our family. As many of you many recall, those years were also a time of change for our profession and ASAE. Following a great deal of discussion and debate and with the strong support of the department faculty, we were successful in changing the departmental name to Agricultural and Biosystems Engineering at ISU. We were indeed fortunate to recruit several outstanding faculty members to the department and many of them have been named Fellow of ASABE.

We remained at Iowa State University until January 1, 1994 when Karen and I moved to College Station, Texas when I became the Head of the Agricultural Engineering Department at Texas A&M University. We were able to successfully change the name of the department to Biological & Agricultural Engineering in 2001. Several new faculty

members were added to the department during that time. I stepped down as department head on December 31, 2001 and returned to the department faculty as Professor and resumed a teaching and research position. Karen and I were on a sabbatical leave from January 1, 2002 through August 1, 2002 at the Catholic University of Leuven with Dr. Feyen.

Over the years I have had the opportunity to work with many absolutely fantastic faculty members who truly inspire our students and make a difference in their careers and lives. Further, I have been fortunate to observe and experience the leadership of some wonderful departmental leaders and university administrators. Over the past few years, Karen and I have been looking for a way to recognize those who make a difference in department leadership. Dr. Norman Evans (Colorado State University), Dr. Landis Boyd (University of Minnesota), Dr. William Splinter (University of Nebraska-Lincoln) and Dr. Irv Omtvedt (University of Nebraska-Lincoln) were all excellent roll models for me. We recently established the James R. and Karen A. Gilley Academic Leadership Award within ASABE to recognize annually an ASABE member who is currently providing outstanding academic leadership while serving as the department head/chair of a Biological and Agricultural Engineering Department that presently has an ABET accredited Agricultural/Biological Engineering program located in the United States. The first recipient (Dr. K.C Ting of the University of Illinois) was recognized at the 2011 ASABE meeting in Louisville, KY.

Our oldest daughter, Alison, is married to a Naval Officer (Commander Sean Kentch, who recently completed a one year assignment as head of the Intel Unit in Kandahar, Afghanistan) and they have two children; Madison (12 years old) and Logan (9 years old). Alison graduated from Washburn University in Topeka, Kansas with a degree in nursing. Our youngest daughter, Alicia is married to Bob Dunn and they have one daughter Chelsey (15 years old). Alicia graduated from Iowa State University with a BS degree in Agricultural and Biosystems Engineering and received her MS in Biosystems Engineering from Oklahoma State University. I had the wonderful opportunity to place her MS hood around her neck during graduation ceremonies at OSU. She now is the Director of the Bio-solids Division at the Metro Wastewater Reclamation District in Denver, Co, following stops with Black & Veatch Consulting Engineers and the City of Olathe, Kansas.

While Karen and I did not attend the University of Nebraska-Lincoln, we are both life-members of the UN-L Alumni Association. We look forward to the HUSKERS again hosting the National Football Championship trophy as members of the BIG 10! GO HUSKERS!

DR. GLENN JERRALD HOFFMAN

I was born in Delaware, Ohio in 1939. I graduated first in my class from Dublin High School in 1957 and then entered Ohio State University, majoring in Agricultural Engineering. I chose this major because my father once told me I was too lazy to be a

farmer and my high school vocational agriculture teacher told me I could combine my interest in agriculture with my abilities in mathematics and science. In 1963, I graduated from Ohio State with combined degrees of B.S. in Agricultural Engineering and a Master of Science. I then attended North Carolina State University to study under Dr. Jan van Schilfgaarde, a world-renown drainage engineer. Half way through my Ph.D. program, Jan was appointed to a leadership role in the USDA, Agricultural Research Service in Washington D.C. At the time I thought I had been left stranded but Dr. William Splinter agreed to be my advisor. As it turned out having two outstanding engineers to guide my program was a tremendous benefit. I graduated in 1967 with a Ph.D. and my dissertation was on measuring the water potential in an intact plant-soil system, the first and only time that has been done



Figure 29. Dr. Glenn Hoffman, Department Head, 1989-2003. He led the change in Department name from Agricultural Engineering to Biological Systems Engineering.

In October, 1966, I accepted the position as research agricultural engineer at the U.S. Salinity Laboratory of the USDA, Agricultural Research Service (ARS), in Riverside, California. I remained in Riverside for 17 years. That period was a particularly productive time for the laboratory. Dr. Gene Maas, a world-renown plant physiologist, and I published a paper in 1977 on the salt tolerance of agricultural crops. The model proposed is still widely accepted and used throughout the world. Dr. Rien van Genuchten, a soil physicist, and I proposed a steady-state model in 1983 to predict the leaching (drainage) requirement to protect crops from excess salinity. This model is comparable in accuracy to computer, transient models developed later. In the 1980's, I lead the staff of the Salinity Laboratory to conduct field studies on the leaching requirement of citrus and alfalfa in the Wellton-Mohawk District in Arizona. The results of these studies were instrumental in the reduction of the size of the desalination plant near Yuma by half, saving the U.S. millions of dollars. I also led a team of scientists from the University of California and the Salinity Laboratory in field and greenhouse studies to establish the water quality standard necessary to protect agriculture in the Sacramento-San Joaquin Delta of California. The California State Water Resources

Board, co-sponsor of the project, revised the water quality standards in accordance with our findings. The impact is many millions of dollars annually through decisions on the quality and quantity of water delivered to the Delta and to Southern California. Just before I left the laboratory, I served as Chair of the committee to plan new facilities for the Salinity Laboratory which was built on the campus of the University of California, Riverside. While in Riverside, I hosted visiting scientists on sabbatical from Israel, Australia, and Morocco. These contacts led to a 6-month sabbatical leave in Israel in 1977 and several consulting assignments.

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From 1984 to 1989, I was the Location Leader (Director) of all the ARS research units in Fresno, California. These units consisted of 66 scientists and staff. In addition, I was the Research Leader for the Water Management Research Laboratory. I was a participant in the studies on remediation of the selenium problem in the Kesterson Reservoir in the San Joaquin Valley of California and led a field study on the salt tolerance of mature plum trees that remains as the only long-term experiment on tree crops. I led the team that planned permanent facilities for the research unit at the University of California Parlier Experiment Station. These research facilities are now open and functioning well.

In 1989, I was selected to be Professor and Head of the Agricultural Engineering Department at the University of Nebraska. I led the faculty to change the name of the Department to Biological Systems Engineering (in 1990), developed and implemented a new engineering program in Biological Systems Engineering, revised the Agricultural Engineering major, developed and implemented an interdepartmental major in Water Science, and renamed and revised the Mechanized Agriculture technology major to Mechanized Systems Management. Research efforts in the department were focused into four areas (engineering soil and water environments, bioprocess engineering for adding value, engineering for spatial and temporal variability, and biomedical engineering). Research grant funding more than tripled. In extension, grant funding increased five-fold and activities were focused on priority initiatives to increase agricultural profitably, conserve and manage natural resources, and enhance water quality. During my tenure from 1989 until 2003, twelve faculty positions were filled and all eligible faculty members were tenured and promoted. Through two National Science Foundation grants and financial support from the University, more than 6,000 square feet of space was renovated into five state-of-the-art research laboratories in 1995. Funds from the University in 1999 provided new laboratories on gas emissions and tissue culture and a 900 square foot laboratory for biological engineering. All five classrooms in Chase Hall were completely renovated in 2001-2002. While Head the faculty successfully achieved ABET accreditation twice (1993 and 1999) for both Agricultural Engineering and Biological Systems Engineering. The Department also successfully completed two comprehensive reviews (1994 and 2000) that were conducted by the U.S. Department of Agriculture and the University.

I have authored more than 170 scientific publications and was senior author of 101; these publications include 17 book chapters. I was the senior editor for the ASAE monographs on the "Management of Farm Irrigation Systems" and the 2nd Edition of the "Design and Operation of Farm Irrigation Systems". I also served as Editor of the Soil and Water Division for the "Transactions of the ASAE" and the international journal "Irrigation Science".

I have been honored in receiving a number of awards. The most important to me are: USDA/ARS Certificate of Merit for Research, 1984; Fellow, American Society of Agricultural Engineers, 1989; Distinguished Alumnus, Ohio State University, 1995; Hancor Soil & Water Engineering National Award, ASAE, 1999; and the Massey Ferguson Medal for Education, ASAE, 2003. The honor I cherish most, however, is the Department receiving the university-wide Departmental Teaching Award in 2002. As an authority on the design, operation, and management of irrigation and drainage systems for salinity control. I continue to be asked to review the literature and apply experimental results and field experience to evaluate the influence of various irrigation, drainage, and agronomic options on the management and reclamation of salt-affected soils. I have consulted in the Central and Imperial Valleys of California, the Colorado River Basin, central Kansas, and northeast Colorado and many foreign countries including Australia, India, Egypt, Turkey, Israel, and Pakistan. As one example, on a team of three engineers, we established that a \$2 billion siphon under the Indus River in Pakistan was not needed if irrigation water management was improved. As a second example, I was the U.S.

consultant on the Handbook sponsored by Denmark on the “Salinity Management of Dry Regions” written by scientists from Egypt, Israel, Jordan, and Palestine.

I retired in 2003 and moved to Fountain Hills, Arizona with my wife, Maria. Two of our daughters, Kimberly and Sheryl, also live in the Phoenix area; our third, Karen, lives in the Los Angeles area. To date we have three grandsons. I remain busy consulting, field-collecting mineral specimens for my collection, playing golf and bridge, volunteering at the Arizona Mineral and Mining Museum, and traveling. (*Dr. G. J. Hoffman*)

DR. DARRELL WATTS

Agricultural Engineering At the West Central Research and Extension Center

The research and extension program in Ag Engineering began at WCREC in 1949 when Bert Somerhalder was assigned to what was then known as the North Platte Station. Bert worked with Paul Fischbach and Delbert Lane from the Lincoln campus on research projects in irrigation and minimum tillage. Field work with the Buffalo till-planter showed the promise of this technology for conserving soil water.

By the early 1970’s the advent of center-pivot irrigation sparked an explosion in irrigation development across Nebraska. This had the potential for significant economic gain for the state. At the same time, people were concerned about the impact that such rapid development might have on both the quantity and quality of the ground water resource. Most of the new pivot installations were being made by farmers who had little or no irrigation experience. To meet some of these concerns the Nebraska legislature provided special funding to UNL for several new positions in “irrigation development”, including one in research and extension in west-central Nebraska. I was offered that position and moved to North Platte from UNL’s Colombian project in July of 1972.

One area of irrigation expansion was in the Sandhills where some of the cow-calf ranching operations were installing pivots to produce their own corn, enabling them to expand into feedlot operations for “back-grounding” their calf crop. They were very much in need of management guidelines to help them minimize wind erosion and nitrate leaching. A greater hazard on a much larger scale was the activity of developers who were buying large tracts of land for conversion from rangeland to irrigated corn. Relatively cheap land underlain by abundant ground water was a magnet for this kind of operation. Unfortunately, some of the large scale installations became environmental disasters as a result of wholesale bulldozing of the thin topsoil layer to get the land level enough for large machinery to pass. There was little sound information available about how to develop and manage pivot irrigation for row crop production on these fragile soils.



Figure 30. Dr. Darrell Watts worked with the program in Colombia, S.A., then as Research/Extension Engineer at the North Platte Station, completing his career as Professor of Irrigation Engineering in Lincoln. During his time in Lincoln he served as Program Leader in Columbia S.A. and in Morocco.

To meet this need the Agricultural Engineering Department spearheaded an effort to develop a research site in the Sandhills. In early 1972 a ten-year lease was signed on a block of land north of Tryon in McPherson County, about an hour's drive from North Platte. When I arrived in July Burt Somerhalder was deeply involved in designing and installing a 40 acre solid set sprinkler system and three small center pivots for the new Sandhills Ag Lab (SAL). This was done with grant funds and donated equipment obtained through the efforts of Bill Splinter, Paul Fischbach and Somerhalder. The focus of the work was to determine the optimum amount and frequency of irrigation for corn in the sandy soils and to evaluate planting and tillage methods designed to minimize wind erosion and soil-water evaporation.

In 1973 I obtained additional grant funding from the Water Resources Research Institute to evaluate different approaches to reduce nitrate leaching and contamination of the ground water. This work included direct measurements of nitrate leaching under irrigated corn and both native and cool season grasses under irrigation. Extensive use was made of ten ft long vacuum extraction devices installed horizontally at the bottom of the root zone as well as ceramic suction samplers installed at various depths. Under excess irrigation we found nitrate from spring applied fertilizer moving past the six-foot depth level by mid-August. Deep sampling showed nitrate movement of 15 feet or more during a complete calendar year.

To complement the field work and provide a better understanding of the interaction of irrigation, cropping and fertility practices, a comprehensive model of the soil-plant-water system was developed and calibrated with data from SAL. It was successfully used to

predict the leaching potential of different nitrogen management practices in the sandy soil environment.

Another pressing issue was that of a declining water table in southwest Nebraska as the result of irrigation pumping, and the possibility of having to irrigate with a reduced water supply in that region. We were asked how much yield reduction could be expected if irrigation amounts were reduced. To provide some answers while also making the best use of limited human and financial resources, we decided to expand the irrigated area at SAL rather than try to set up another research site in the southwestern counties. At SAL we were able to study crop response to limited water on a soil that would almost assure stress when water was withheld.

Additional grant funds enabled us to install another 16 acres of solid set sprinklers at SAL. This system was designed as a “line source” to provide a gradient of water application across the plots, creating six different levels of irrigation across the sixty foot wide plots. Charles Sullivan, an ARS plant physiologist based in Lincoln, worked with us to evaluate yield response under variable stress levels in both corn and grain sorghum. Faculty and graduate students from Agricultural Meteorology and Entomology were also involved in the project. Five PhD dissertations and four MS theses resulted from this work. Data collected during this project have proved invaluable in calibrating or checking models used to evaluate different limited irrigation strategies for Nebraska.

To provide additional information to the farmers of southwestern Nebraska I worked first with the board of the Southwest Ground Water management district and subsequently with the Upper Republican Natural Resources District to examine questions of water use by irrigators. Beginning in 1974, 33 irrigation wells on both center pivot and furrow irrigated fields were metered in Dundy, Chase and Perkins counties. Results from the first year’s study showed irrigation amounts ranging from nearly forty inches down to eight inches. The highest two or three application amounts were by furrow irrigators, but some center pivots applied almost 30 inches, indicating that they were turned on in June and ran all summer. Cheap energy and an attitude of “if some is good more is better” led to a lot of over-pumping.

To give irrigators a better idea of crop water needs, a weather station was set up near Imperial and in cooperation with the local Extension office, a crop water use “hotline” was established. Producers could call in and get an estimate of water use for any three-day period. To my knowledge this was the first such system in Nebraska.

Probably the greatest good that came from these efforts was the increased awareness by farmers, community leaders and the general population that steps had to be taken to slow the decline of the water table if irrigation agriculture was to continue as an engine of economic growth in the region. To help producers and decision makers get a better sense of the extent to which the decline could be managed, the NRD board was helped to connect with a ground water modeling team in UNL’s Conservation and Survey Division. This resulted in the development of a ground water model of the entire NRD. The model

has been refined over time and has assisted the board in developing their current policies for limiting irrigation pumping.

In the mid 1970s Norm Klocke filled a new agricultural engineering position at North Platte and began work on adapting and improving no-till drills for use in the evolving practice of eco-fallow in dryland production. When I moved to Lincoln in the fall of 1977, Norm shifted into the irrigation specialist position that I had vacated. Subsequently, he did some excellent research at SAL on measuring the soil-water evaporation and transpiration components of ET under sprinkler irrigation and on quantifying the effect of different levels of residue cover on the reduction of evaporation under irrigated production. He documented how adequate levels of residue can reduce soil evaporative loss by two inches or more during a growing season.

Subsequently, Norm worked with Gary Hergert, the Extension Soil Scientist at WCREC, to install a large solid set system at the North Platte research station. It was used for studying possible strategies for use of limited water supplies in continuous corn and in rotations with other crops. Norm also installed a series of 8-ft deep drainage lysimeters to examine long term nitrate losses under monoculture corn and a corn-soybean rotation. The results of that work clearly showed that in contrast to findings in more humid regions, the corn-soybean rotation had no advantage in reducing nitrate leaching loss in the semi-arid climate of west-central Nebraska. In some years the rotation actually had a greater loss than continuous corn.

Colombian Agricultural Engineering Program

From the mid 1960's through the early 1970s UNL was involved in a substantial institution building program in Colombia. The goals were to improve undergraduate education in agriculture and to help establish a graduate program in agriculture and veterinary science. Funding was from USAID. Support was given to several existing departments on university campuses at Palmira (near Cali) and Medellin, and for establishment of new departments of Agricultural Engineering in those institutions.

The original plan was to establish the graduate program on the campus of the National University in Bogota. However, sporadic student strikes made it impossible to maintain a suitable environment for learning. The program was shifted to Tibaitata, the headquarters of the national agricultural research institute (ICA), a 40 minute drive from the city. The Ag Engineering faculty members supplied by UNL were contracted from various institutions. Three, including Dean Manbeck, Norm Teeter and myself subsequently became faculty members in Nebraska. There were also Colombian faculty with MS degrees from the US, some of whom were sent for PhD programs.

Sometimes a chance encounter can have a dramatic and long-lasting effect on a person's life. In 1969 while working a PhD at Utah State, I spent a summer on the north coast of Colombia doing a study of salinity problems in an area being reclaimed and developed for irrigation. An acquaintance from years back happened to be working on the

development of the Agricultural Engineering graduate program at Tabaitata. On a brief trip to Bogota I dropped by to see him and was introduced to Clayton Yeutter, the Nebraska project's chief of party. I was subsequently recruited to fill a project position in irrigation, drainage and water management in Nebraska's program there, thus beginning what ultimately became a 30+ year association with UNL.

Tabaitata proved to be a tranquil environment for teaching and learning. When I arrived with my family in Bogota in January of 1971 the first Ag Engineering graduates were just emerging from the new programs in Cali and Medellin. A few continued in graduate school. However, most of our graduate students, particularly in the soil and water area, were Ingeniero Agronomos (agronomists), with perhaps a little better background in math and problem solving skills than the typical agronomy graduate of that day at UNL.

Mark Twain once said that nothing focuses the mind like the prospect of being hanged. A close second might be the prospect of teaching university classes in a language with which one has, to state it kindly, very limited facility. Fear of failure is indeed a great motivator. At least it helped me to absorb the necessary Spanish vocabulary to begin teaching a graduate course in irrigation management a few weeks after arriving in Colombia. Fortunately, the students had patience. I don't know if they learned very much, but I sure did. Subsequently I was asked to teach a graduate soil physics course and to build a soil physics-irrigation lab. All proved to be interesting challenges.

Other important areas of emphasis in the Ag Engineering program included mechanization and the processing and storage of many different crops. The mechanization work included adaptation of equipment for tropical, semi-tropical and cool climate environments (all found in Colombia) and development of appropriate machinery for small farmers. Post harvest drying, processing and storage was and remains a particular challenge in tropical and semi-tropical climates. Engineers in Colombia must deal with the typical grain and seed crops, but also are faced with various root crops as well as many different fruits and vegetables, all in a multiplicity of climatic zones.

The Agricultural Engineering program also worked with experiment stations around the country and had technical personnel in a half-dozen major research stations. Most of these were recent BS graduates from the newly established programs who needed a lot of support and encouragement. I spent at least a third of my time traveling to various parts of Colombia to work with the engineers on the research stations. I was always impressed with the willingness of these people to work hard with limited resources under sometimes trying circumstances.

The greatest single accomplishment of the Nebraska project was the development of a group of well trained young Colombians who have continued to contribute in one way or another to the development of their country. Unfortunately, the financial and emotional drain of the long-running internal conflicts in Colombia together with the warping of the economy by the on-going drug trade has financially devastated most of the institutional programs with which we worked. On the positive side, I note on Colombian university

web sites the emergence of new programs in biological engineering and similar 21st century careers that we could not have envisioned in the early 1970s.

In 1972 funding from USAID was significantly decreased and the Nebraska project began to close. I accepted a position at UNL's research center in North Platte and moved there in July of that year. (*Dr. D. G. Watts*)

LAVERNE STETSON

The Department has had a long history of cooperative Research with the Research arm of the U S Department of Agriculture (USDA). USDA employees have been stationed in the department and conducted research in joint ventures with the department.

In 1950 a project to look at the use of microwave energy to treat grain to kill insects was started by The USDA Bureau of Plant Industry, Soils and Agricultural Engineering. Leo Soderholm was the project Leader. Leo set up a lab in the basement of the Department. In about 1952 Stuart Nelson was hired as a graduate assistant to help Leo. Stuart's master thesis was on measuring the dielectric properties of grain and seed in the 1-50 MHZ range. They needed to know the dielectric properties to calculate the microwave energy injected in to grain and seeds.

In 1954 the USDA Bureau of Plant Industry was renamed to Agricultural Research Service (ARS) and the project was placed under the Agricultural Engineering Research Division, Farm Electrification Research Branch. Leo Soderholm left in 1954 to work for his relatives at Leuck Radio, an electronics supply house, in Lincoln. Stuart Nelson was appointed the Project Leader. Stuart led the project until 1976 when he was transferred to the USDA Laboratory at Athens Georgia. During that 22-year period he had many undergraduate and graduate students who worked on the project.

Stuart obtained funds to construct a lab to control the temperature and humidity of the grains and seeds he was working with so an enclosed lab was built in the northwest corner of the basement. This allowed working with seeds and grain over several days without significant changes in temperature or moisture content. Many experiments were conducted to determine the level and duration of microwave energy that it would take to kill stored grain insects in grain.

In addition it was found that the rapid heating by the microwave energy was good for reducing the percentage of hard seed in alfalfa. This was significant in that the hard seed reduction lasted for several years. The standard method of scarifying the hard seed to make it germinate was damaging to all the seeds and the leftover seeds would die in storage.

LaVerne Stetson was hired by Stuart in 1962 in a cooperative arrangement with the Department. Francis Yung had retired from the department and the Department used those funds to supply 40 % of LaVerne's salary from 1962 to 1968. In 1968 LaVerne was paid entirely by ARS.



Figure 31. LaVerne Stetson was a USDA Agricultural Engineer attached to the department. He conducted research with Dr. Stuart Nelson in the dielectric properties of grain and later electrical safety problems in irrigation and livestock housing.

Master thesis projects by Jim Jorgenson (electrical engineer) and LaVerne Stetson expanded the frequency range of dielectric measurements from 50 MHz to 500 MHz. Paul Corcoran developed an audio frequency method for determining dielectric properties of grain as part of a student project. Stuart went to Iowa State in 1967 to work on a Ph.D. As his thesis, he developed a broad-band technique for measuring properties of insects and grain over a very wide frequency range. The reason for measuring both insects and grain was to be able to calculate differential heating to see if some frequency would be better for killing insects in grain without damaging the grain. A student, Paul Corcoran, refined an audio frequency method for calculating dielectric properties. Paul went to work for Caterpillar and was part of the team that developed the “Challenger”® tractor. Paul spent a lot of time at Tractor Test in evaluating the “Challenger”

The dielectric properties of materials are described by a complex formula. Most formulas used are sinusoidal approximation because of the complexity of calculating hyperbolic functions. Stuart, LaVerne and a student, Carl Schlaphoff spent nearly a year developing a computer program to calculate the dielectric properties using the hyperbolic functions to more accurately calculate the dielectric properties. That program was released in 1967 and was requested by scientists from many parts of the world.

The research identified the methods and benefits for killing stored grain insects without damaging the grain and for reducing hard seed in legume seed. However the cost of energy and equipment for this process has prevented the application of this information to commercial use.

Stuart is a very organized and meticulous researcher and a prolific writer. He has authored numerous papers including seven book chapters, over 200 articles in 25 different refereed journals and more than 200 papers in Conference proceedings. He has

been honored by many organizations. He is a Fellow of ASAE and of the IEEE (Institute of Electrical and Electronics Engineers) and is an elected member of the National Academy of Engineering. He has been active in many professional organizations and was named the Federal Engineer of the Year in 1985. In 1989 he was awarded an honorary Doctor of Science Degree by the University of Nebraska. He continues to do research in dielectric related areas as of this writing in 2005.

In 1971, Laverne was asked to look in to the electrical safety of center pivot systems. The electric drive concept had been introduced in 1979. There were electrical inspectors in some states who would not give permits to install or operate these new systems. With the help of Mike Muumgard and many electric utility personnel in Nebraska he examined many center pivots of the different manufacturers. Mike Muumgard had been an Extension Engineer in farm electrification and had recently been transferred to the Tractor Testing Laboratory to develop methods for testing sound levels on tractors.

LaVerne determined that an electrical safety standard for the industry was needed. He assembled electrical test equipment and tested several systems. These tests and many working meetings with the center pivot industry and the electrical inspection authorities resulted in an ASAE Standard S362 and Article 675 in the 1975 National Electrical Code. These documents were endorsed and used by the industry and were accepted by the inspection authorities.

In 1976, two electrocutions on center pivot systems occurred. Investigations by LaVerne of the fatalities revealed that the wiring on the center pivots was all right but the wiring to the center pivots was faulty. This resulted in development of ASAE S397 "Wiring and equipment of irrigation systems". With assistance from the rural electric systems, the center pivot industry and the electrical inspectors, Laverne conducted numerous workshops to teach the proper methods and equipment for wiring irrigations systems. Workshops were held across Nebraska and in many other states where center pivots were being installed. With the help of the center pivot industry and the rural electric systems, hundreds of existing center pivots in many states had retrofit wiring to improve the grounding of the systems serving the pivots..

In 1972, Darrell Watts, an extension irrigation engineer, at the University of Nebraska North Platte Station teamed up with LaVerne to develop an electrical load management system for center pivots to reduce the peak electrical demand of Custer Public Power District of Broken Bow, NE. This system had some pivots off each day for a few hours during peak demands. Radio control signals were sent to the selected pivots to shut them off and later send a signal to restore power. Paul Fischbach and John Addink worked with LaVerne to further evaluate the limits of load control on center pivot crops. This system saved money for both the irrigator and the power supplier. The concept was improved and expanded and to date has saved hundreds of millions of dollars for irrigators and power suppliers in many states.

In 1976, the issues of stray voltage in animal confinement structures and proper wiring of those structures became a concern. LaVerne teamed up with Jerry Bodman and Jack

Schinstock in the Department to develop equipment lists and wiring procedures for use in animal confinement facilities. Jerry and LaVerne conducted electrical wiring workshops in Nebraska and in many other states throughout the 1980's. They also developed techniques for detection and correction of stray voltages. The cooperative work between Jerry and LaVerne ended in 1994 over disagreements on measurement techniques and level of exposure that animals could perceive. Jerry did not believe the research that was being reported.

LaVerne was involved with agricultural wiring standards in ASAE in IEEE and served on Panels 13 and 19 of the National Electrical Code. He was elected a Fellow of ASAE and of IEEE and received numerous awards for his load management, agricultural wiring, and standardization efforts. He developed a tongue-in-cheek video entitled "Electric FUNdamentals". Those videos have been used nationwide as a comic relief at conferences and meetings. He retired in March of 2000.

Some of the students who worked for LaVerne are; Kathryn "Kitt" Farrell, the first female graduate from the department, Greg Stark, Douglas Shepherd, Shawn Meyer, Ron Clinch, Art Beccard, Steve, Greg, and Jodi Wolford (Their dad, Wayne, worked as a student for Norris Swanson).

USDA Soil and Water Research

Norris Swanson was with SCS irrigation research in the high plains of Texas. He was assigned to ARS when it was formed in 1954. He was transferred to Lincoln in 1955 to perform runoff and erosion research in cooperation with the Department of Agricultural Engineering and the Nebraska Experiment Station. He developed a stationary rainulator and rotating boom rainfall simulator to assist in evaluating runoff and erosion from both irrigated and non-irrigated crops. Some of the agricultural engineers and others who worked for Norris were: Del Fangemeier, Gordon Kruse, Dale Heermann, Allen Dedrick, DeLynn Hay, Lloyd Mielke, Jeff Lorimor, Chuck Linderman, Steve Oltmans, Cliff Hunter, Glenn Johnson (now NRD manager), Dave Fischer, Marvin, Darrell and Warren Bishop and Wayne Wolford.

1967-68 Norris began investigating runoff from beef feedlot operations. That research was a major influence on cattle feedlot operations in the United States. He was elected a fellow of ASAE and of the Soil Conservation Society of America. Norris retired on February 29, 1980 with 43 years of service.

In 1968 Conrad Gilbertson was transferred by ARS to the Agricultural Engineering Department to also work on problems of confinement beef. He was assigned to research on manure and insect problems. He had been at the USDA Meat Animal Research Center at Clay Center, Nebraska since 1966. Before that he was an extension agricultural engineer at North Dakota State University from 1963-66.

He conducted research with cooperating feedlot owners and had substantial grants through the University of Nebraska. Otis Cross and Jimmy Gartung were his

Departmental cooperators. He later hired Jack Nienaber as an associate. Jack got his M.S. under Conrad and then went to Columbia MO for his PHD. After completing that degree, Jack returned to the Meat Animal Research Center.

Conrad was transferred to the Entomology Department to work with an ARS unit there involved with fly problems in feedlots. That ARS group was led by Ivan Berry, an agricultural engineer. Conrad maintained his office in the Agricultural Engineering Department. He also had cooperative work with Animal scientists and tried some experiments with rabbits. He was very active in NSPE. Conrad died of cancer in August 1989. (*Prof. L. E. Stetson*)

LEONARD L. BASHFORD

After graduating from high school, I volunteered for the draft and spent two years in the US Army. I was sent to a signal repair school and learned repair of cryptographic machines. This was my real first taste of traveling, as I was stationed in Germany for 14 months and worked at 7th Army Headquarters. I had the opportunity to travel all over Europe during this time. Most all my fellow soldiers I served with were drafted from college, as the draft was still in force. I did get lots of encouragement that one should give college a try. They mostly talked about the good times in college. I don't remember anybody talking about studying. Needless to say, I soon learned that it was study or look for a job.

After leaving the Army in 1959, I enrolled in electrical engineering at the University of Wyoming. After my first semester, a new engineering program was initiated at UW, the Department of Agricultural Engineering. I promptly switched my major and joined two other students in this new engineering major. Clarence Becker was the department head. In a very short while, there were faculty in the power and machinery, irrigation (Bob Burman), and structures areas. There was an extension engineer, Mike MacNamee, who worked with Dr. Becker in sugar beet technology.

Up on finishing my BS degree in 1963, I did stay an extra semester and finished six hours of graduate credit. After this, I worked in a lumber and hardware business for about six months. Dr. Becker stopped one day and indicated that he would help me obtain some financial assistance if I wanted to finish my M.S. degree.

I did pursue this path and ended up at the University of Arizona in the fall of 1964, working toward a M.S. degree under the direction of Dr. Ken Barnes. I was fortunate to obtain some financial assistance as I looked after the ongoing research of Frank Wiersma while he spent a year finishing his advanced degree. He had a study going on at a dairy in Tempe, Arizona monitoring the use of fans to keep dairy cows cool during the summer. I made round trips from Tucson to Tempe to collect the data many times during the year. For my thesis, I worked with the US Forest Service in designing a scale to weigh range cattle in the desert area. I designed a scale that cattle would walk across and their weight would be recorded. A watering hole was fenced off, and the scale placed in

an alley that the cattle had to use while entering and leaving the watering hole. The instrumentation was powered by a pickup battery. One would show up early in the morning set up the transducers and then hope the cows would come in for a drink. However, they did not seem to need water every day. The biggest test for the accuracy of the scale was when a number of Forest Service employees showed up one day, each having been accurately weighed and carrying weights. They positioned themselves at different locations on the scale to be sure that no matter where they stood on the scale, their weight would register the same. After the “test”, Dr. Barnes called me to his office and said I was really lucky, as I passed the test.



Figure 32. Dr. Leonard Bashford taught and conducted research in power and machinery, served as a consultant in Morocco and then served as Director of the Tractor Test Laboratory.

After finishing my MS degree in 1966, I took a job with Ford Tractor located in Birmingham, Michigan, a short distance north of Detroit. I was a test engineer and worked in an area that reviewed frequent similar field failures that were occurring, testing the components, and suggesting to the design department ways to modify the design of the failed parts. The challenge was always not to chase the failure to the next weakest link. This was mostly a stress analysis job. This proved to be a very educating experience that served me well during my teaching and research career. I lasted less than one year on this job. I really enjoyed the job, but disliked living in the Detroit area. Being reared in Wyoming did not prepare me to deal with all the traffic and people everywhere.

I then took a job at the University of Arkansas in late 1966. I worked on a research project investigating a heating problem in stored seed cotton. This was a good opportunity to better understand heat transfer, as thermal conductivity of seed cotton was investigated. It was quickly obvious that one would not advance very far in academia without a PhD degree. I then started taking graduate courses at the University of

Arkansas with the intention of transferring the courses in preparation to seek the PhD degree. During my time at Arkansas, I had the opportunity to become acquainted with the faculty and Agricultural Engineering program at Oklahoma State University. I took the plunge and started working on my PhD at Oklahoma State University in the fall of 1969. My dissertation focused on thermal desiccation of cotton plants. Instead of using chemicals to desiccate cotton plants prior to picking, I studied the intensity, temperature, and heat exposure time necessary to cause a cotton plant to defoliate. If the heat was too much, the plant died and would not drop its leaves. If the heat was not sufficient, nothing happened. There was a happy median. I did build a machine that would straddle two cotton rows for the defoliation process. A lot of time was spent in the laboratory defining the time and temperature process by inserting thermocouples in cotton leaf veins to measure the time-temperature necessary for the desired effect. I had a student use a planimeter to define the area of cotton leaves linked to leaf dimensions. It was a successful endeavor. I finished all the requirements for the degree in fall 1971.

After an interview with Dr. Bill Splinter and a visit to UNL, I was offered a job at the University of Nebraska starting January 1, 1972. The position was in the Physical Properties of Biological Materials area. My dissertation area and graduate studies served me well for this job. I taught an undergraduate and a graduate course in this area. The research focused on physical properties of biomaterials. I probably was, in a sense, a biological systems engineer.

This position was a new position, and I was quickly baptized in teaching classes. We squeezed a lot of cheese, meat, and bread, trying to define some mechanical property that would relate to freshness, tenderness, or some measure of consumer acceptance. No universal Bashford Squeeze was identified that distinguishes any palatable property, but my former students still talk about squeezing cheese, etc. I worked in this area for approximately three years and then was reassigned to a power and machinery position, teaching the engineering machinery course and the mechanized systems machinery course. Thus, I returned to being an agricultural engineer.

In 1977, another faculty member, Ron Gaddis, and I formed an agricultural engineering consulting company. We both left the university that year for this consulting agricultural engineering company. We developed a computer program for nozzle selection on center pivots, and had many pivot and nozzle company clients. At one time we had nozzled 55 different manufacturers of pivots. Today, there are about five major pivot manufacturers. We also did testing and adjusting of irrigation pumps to maximize pumping plant efficiency.

During this same period, I also taught a machine design course as a visiting professor in the mechanical engineering department at UNL. One of the design teams was very successful in providing a design to modify a tractor for a paraplegic farmer. This did result in a refereed publication in ASAE.

The introduction of the personal computer quickly diminished the importance of the computer portion of our business.

Again, Dr. Splinter offered me an opportunity to return to the university as an extension engineer in May 1980. This position was in the power and machinery area, and I held that position for approximately one year before switching to a teaching-research position in the power and machinery area.

I had the good fortune of visiting The Soviet Union in 1980 along with Dr. Splinter. I believe some other faculty member was initially going to make the trip but backed out, and I was invited. We spent approximately two weeks visiting tractor test facilities, several communal farms, and an experiment station. This was an eye opener and the catalyst that sparked my interest in international work throughout my career. Working with Ken VonBargen, an in-field sweet sorghum juice expresser for ethanol was developed. This was in concert with an all encompassing energy sources project including solar, and a methane digester, to name a few. I was also involved in testing engines fueled with various vegetable oils and fumigating ethanol into a diesel engine. I initiated a machine design course for agricultural engineers that was very similar to the design course I taught in mechanical engineering. In fact, there were also mechanical engineers taking the course.

During this time period, I became involved with the Tractor Test Board. I also spent time working with minimum till planters. Lloyd Mielke and Alice Jones, both soil scientists, and I investigated compaction reduction. Lloyd and I were awarded a patent for a ripper tool that fractured soil. At this time, I also initiated research studies on tractive efficiency with tractors under actual field conditions.

I was invited to visit Morocco as a machinery consultant during a period of time when Darrel Watts served as the team leader for a project involving five Midwest states. The focus of the project was improving dryland agriculture in all respects including plant breeding, soils and agronomic studies. Dr. Watts lived in Morocco along with other faculty who rotated in and out on short periods as needed or for periods ranging from two to six years. In 1988, I accepted a two and one-half year assignment in Morocco, working on the development of stationary threshers and the mechanization of lentils. The threshers were imported from Egypt and modified for Moroccan conditions. After their modification, Ken VonBargen joined me in testing the machines before they were distributed to some farmers for their evaluation. In Morocco, small grains are planted in the fall and harvested in late spring. Horses were used to thresh the grain in the areas designated for introduction of the stationary threshers. One farmer indicated that he would not be using the thresher, as his animals had nothing to do all summer and they would do the threshing.

A young Moroccan engineer who worked with me on this project could speak French, Arabic, and Berber, and just a little English. I knew survival French, and he knew survival English, so we got along well. Not all Moroccans can speak Berber, and some of these threshers went into the south areas close to the Sahara Desert where Berber was the language.

Lentils are a high protein crop, but because of the tremendous amount of hand labor required to grow the crop, the production of lentils had fallen way off. Another task I worked on was the mechanization of lentils. We introduced planting the lentils in rows where cultivation could be used to control weeds and, hopefully, a combine used for the harvesting operation. Planters were available at the experiment station and, I had a row crop cultivator shipped from the states and had it modified at the experiment station. While I was in Morocco, we successfully advanced to the planting and cultivating stage of lentils at the experiment station.

Some of the work in Morocco was somewhat like an extension job, in that I had the privilege of visiting a lot of small farms in very remote areas. We were always welcomed and fed a nice meal at noon, always with plenty of hot mint tea. The “hot” was very important, as it provided a way to sterilize the water. One learned very quickly the reason for “pure” water. During one of these dinners, served to us sitting on rugs, I caught one of the biggest cases of chiggers, or flees, or something. It took six months or more before I quit having flare ups of severe itching around any piece of clothing with an elastic band. At one location, a sheep was killed in the late afternoon, and we were not allowed to leave until we sat and enjoyed some of the liver. It would have been a major insult to the farmer to have left before dining.

At this time I also served as an advisor to a graduate student, Chakib Jenane, at The IAV Hassan II University in Rabat, Morocco. I had the opportunity to give a number of lectures to their agricultural engineering students on testing tractors and on tractive performance of agricultural tractors. This was accomplished in French with some real misunderstanding and wide-eyed looks from the students. Either they were impressed with my French, or they couldn't understand a word I was saying.

I returned to the University of Nebraska continuing to work with the Tractor Test Board and eventually becoming Chair of the Board of Tractor Test Engineers. I continued my research work on tractive efficiency of tractors equipped with various tires, tracks, and drive axles. I also assumed my teaching responsibilities.

In 1993, the Nebraska Tractor Test Laboratory entered into a contract to bring approximately ten Egyptian engineers to UNL to instruct them on how to test tractors. Lou Leviticus and I made a trip to Cairo and Alexandria to interview potential candidates and to visit their tractor testing facilities and test track. There is always room for improvement. The group of engineers did arrive at Nebraska for a period of approximately six months, as I remember. A new John Deere tractor was purchased, instrumented for test, and used as the training tractor. Lou Leviticus was the principal lead in this training process. Needless to say, there was a small clash of cultures as to work schedule. All worked out in due time, but a very educational experience resulted for all of us involved in the training process.

Chakib did receive his PhD degree from IAV Hassan II. Louis Leviticus and I returned to Rabat, Morocco to serve on his jury for his PhD orals. Chakib did obtain a Fulbright

Fellowship and taught my engineering machinery course at UNL for a semester while I was on sabbatical in 1994.

Precision farming, global positioning systems and yield monitors were quickly becoming the buzz words in the early 90's. I did take a one-year sabbatical in 1994, spending five months at Lueven, Belgium and six months at Montana State University, working with some faculty at these respective universities working in this area.

After returning to the university with the help of graduate students, yield monitors were developed for combines and a big roll baler. This research was very helpful in the teaching area of understanding the how, what and where of yield monitors. I had one PhD student who developed a guidance system for a tractor using the GPS system. His objective was very simple: use GPS as the guidance system to steer a tractor once around the tractor test laboratory concrete track without a human touching the steering wheel. His oral exam was a demonstration.

In 1995, I had the opportunity to go to Aleppo, Syria. I was invited, along with another individual, to review the mechanization program at ICARDA, an international research station. This assignment lasted approximately 10 days.

In my capacity as Chair of the Tractor Test Board, I served as a delegate to the OECD Designated Authority, an international consortium of countries involved in testing tractors. The group met annually in the spring in Paris. This was a dirty job, but someone had to do it. I served as the Chairman of this group for two years and as an advisor for six years.

The agricultural engineering students became very involved in the ASAE 1/4 scale tractor design competition. This provided many good design projects for the senior design class. The students did design and build a load sled for the testing of the tractor designs. A dirt test track was constructed adjacent to the concrete test track.

I assumed the position of Director of the Nebraska Tractor Test Laboratory in 1998 and held that position until my retirement in August 2006. I continued to teach the power and machinery courses in the department. During my tenure as Director of the Tractor Test Laboratory, a new computer controlled drawbar dynamometer was designed and put into service, and I oversaw the design of a new tractor test concrete track prior to my retirement.

As I give some thought to my career, I owe Dr. Splinter a big thank you for the many opportunities he provided me during the formative portion of my career and his mentoring. The students have also been a big part of my career. I have had the opportunity to follow some of my former students throughout their careers. All have done well and I have always enjoyed visiting with them when the opportunity arises. If my students learned as much from me as I did from them – mission accomplished! (*Dr. L. L. Bashford*)

NORMAN C. TETER

My remembrance of professional service at the University of Nebraska consists of an ambulance ride brought about by a fall on the ice covered steps between the agricultural engineering building and the student union building on the East Campus. Thanks for the practical traditions of the pioneering experience in Nebraska, the hospital doctors got me up and going on my new assignment to work with a Midwest consortium to foster the development of agriculture in Colombia, South America, by implementing Institutions of Teaching, Research and Extension based on the Land Grant College system used in the United States. Several professionals served together to build various disciplines of study in the new system.

While taking classes in Spanish (Castilian) at the Universidad de los Andes in Bogota, I gave some talks about the value of Engineering in Agriculture. It was a little discouraging to learn that the students at National University were not moved to tears by my talks but by the tear gas fired by the police who were working to break up the political type of protests being made by students. That led to early knowledge of the problems that we faced in defining the Institution of Education. More than learning Spanish was needed.

It was a great tour of duty helped by several Agricultural Engineering Professors who visited the progress of the work. Wes Hobb's expertise in shop work made engineering a successful component of our team progress. The portable outdoor field model of a herringbone milking parlor was my pride. But Fischbach's interest in the bonfire under the farm tractor to warm it up to get it started stole the show away from the unique milking parlor. Perhaps my purchase of a dead dog that had been released, while alive, in front of our car impressed Splinter as much as the cotton drier, the portable cattle scale, the garden tractor and other marvels built for the engineering field day.

If our students who were given local shop and technical training reinforced by the U.S. - University school courses had enjoyed the gift of higher remuneration we may have been able to retain enough professionals to work greater improvement in the agriculture of Colombia. Our students took a course called biological engineering. We wrote a text book for this course. It was written in Spanish and addressed the climate, crops and livestock of Colombia. This made it valuable training for tropical and subtropical ~culture. Tho technical ideas were valuable in a large area in South America. Many people simply left Colombia for better jobs in Brazil and other places.

I also got the privilege of going back to Nebraska to a good paying job. Nebraska was a state where Agriculture was an important industry. My slot was extension and research in rural electrification with teaching when needed. Bill Splinter handed me a ball peen hammer and said that I might have to get some other tools to get a decent shop wired and stocked in the Quonset hut on the Agricultural Engineering research farm located east of Lincoln. That worked out well because it fit into research on continuous flow com drying. The excellent computer system for University of Nebraska made it possible for me to work with Thompson on mathematically defining the growth of meat animals (swine, beef cattle, broilers and turkeys). DeShazer gave us input related to the animals physical

characteristics. Papers that we wrote could be put on the computer for the University main campus. We could revise the paper until it suited us and then call on it to be typed by an electronically controlled typewriter. One day a man came in and saw the typewriter busy with no one typing on it. He asked, "Don't you fellows even write your own papers?" Typing, like key punching, has been replaced by keyboarding and other types of data entry.

A farmer near Kearney Nebraska very generously let the University photographers film his practice of grinding-wet com and packing it down in his trench silo. That film was a great help in extension teaching. The farmer also practiced good Agricultural Economics techniques for paying for the com in a way to make it profitable for both the buyer and the seller. That film also attracted a television specialist who tried me out for filming in broadcasts but I didn't pass.

What was really pleasing for me was work with farmers with farmstead layouts for actual changes that they planned. Since this was a time when many farms were being enlarged, the demands for new plans were plenty. One memorable plan entailed a day of surveying and discussing facilities and locations of a new cattle feeding layout. The farmer invited me to eat lunch with him at his home place. The odor from the cattle feeding lot next to his house made the lunch a bit inedible. I said, "Maybe we should go back over to your renter's and look at the location that we planned for the feed lot. It seems to be too close to the house."

"Oh, no", he responded, "it is further away than the lot here, and we have never noticed the smell here." This gave me understanding of the statement, "The smell of money is pleasant."

A specialist is never regarded as being very special. One misunderstanding entailed a request from a county agent to discuss a plan that a lady had for heating her home with electricity. I'm convinced to this day that the agent wanted me to get the lady to stop bothering him. We visited her house. It was big, uninsulated, ninety years old and somewhat out of line. In short, it was close to a drafty barn. I was shocked. I said, "Electricity is expensive heat. This house could not practically be remodeled to reduce heat loss to the point where you could pay for electricity to heat it."

"Oh you don't understand," she said "I want to install a wind charger to generate the electricity to heat it. I won't have to buy the electricity." I have not solved that lady's problem.

When Anne and Janice, two of our daughters, returned to Lincoln in March, 2005, to place my wife's, Gwen's, ashes in a crypt in the 14th street cemetery memorial to veterans of World War Two, Dr. Bill Splinter agreed with me that I had not solved that ladies problem. Furthermore that my work had not been finished and I needed to write more explanation. The big unfinished work on the need for energy is indeed unfinished. The problem is that we are residents on land in the midst of oceans made up of hydrogen and oxygen to burn it. That is a mind boggling source of concentrated energy.

Annie Dillard in her book, *Pilgrim at Tinker Creek*, wrote, "And one day it occurs to you that you must not need life. Obviously. And then you're gone. You have finally understood that you are dealing with a maniac."

In describing herself Annie Dillard says, "I am no scientist. I am a wanderer with a background in theology and a penchant for quirky facts."

If we ignite the oceans no one will be left to use the heat. If we collect hydrogen, from water or whatever source, we must develop precautions to avoid its dangers. That can be done. People eat all sorts of things that are slowly metabolized, another word for oxidized, burned. Hydrogen is the simplest element in the world. Like Nebraska one might say it is number one. A 1950's encyclopedia says hydrogen is the ninth most abundant element in the earth's crust. That is in spite of it being the lightest element on the earth, being only 1/14th the weight of air. It boils at -253 degrees C and freezes at -259 degrees C. In other words, not many have seen it as anything but gas or in a compound. That makes it difficult. It does not easily pump like gasoline.

Since the late 1980's, hydrogen filled lighter than air ships and at a later date, bombs, have been used in warfare. The name Graf Zeppelin is familiar to those my age for the feat of flying it around the world in 1929. The Hindenburg, its model, made 54 flights before it burned killing 36 passengers when it landed in Lakehurst New Jersey in 1937. A century of research has collected data on hydrogen, some of it being classified.

I'm a gambler by nature, so I lean toward research on concentrated energy, not diverse such as sun and/or wind. This requires a major, can I use the word cataclysmic, change in government projects like that of the land grant act that created the state universities. The research, teaching and extension now needs to concentrate on energy use. No doubt exists that abundant energy sources are available to us, but we are too ignorant to look for them. Chances are that people, as a majority, will support change that is essential.

Last night talk radio attracted enough people who are ready to kill if their food supplies for their family are not trucked to them, and killing will be necessary to take some else's food from them. Forward looking, modern people are fiercely supportively against the modern change required to develop unconventional sources of energy that are here. Conservatives and liberals are all anxious to maintain the "old" ways. I have enjoyed a life of working with people that according to news columnist writer are "bass" players that continually play one note. These people strongly belittle new ideas, rightly so. New ideas are fostered by private money making.

Let me illustrate this with peanut harvest, one thing that I have experienced. Many see failure in anyway to cure peanuts than on the stack pole. Hence the stack pole is the right way. Others with radical, new ways, foster "once over" curing where peanuts are dug from the ground and immediately hauled to driers where the water content can be quickly taken out so molds and rots will not consume them. Large sums of money are spent to by each conviction. The winning conviction comes when people personally makes money

when they practice it. In the peanut case, the research workers complained that their ideas were not being used.

So we said, "Let's make farmer Samson (a pseudonym) rich." We did. It worked. A farmer built a drying building. In a fall with unfavorable weather, peanuts did not cure properly. Samson dried them for \$1 per bag. It cost him \$0.1 per bag. Those who hired him said, "That's unfair robbery." He replied, "Well." No one has stack poles.

That example is too simple. The energy problem requires major 50 state wide cooperation focused on the lady's problem with heating her house with electricity from her wind charger. As crazy as it sounds, money to hire people is needed over a long time. I have not finished my work because the work requires "political" support. (*Prof. N. C. Teter*)

DR. LOUIS LEVITICUS

The Tractor Test Lab Between 1975 and 1998

The first time I saw Lincoln was in December 1974, after I had been to an ASAE meeting in Chicago. Bill Splinter, then department head, had "smuggled" me in on a consulting assignment to see if he could interest me in accepting the position as head of the tractor testing program and professor at the department. Even though Lincoln was about at its ugliest with black goo where there had been white snow, I still accepted proof of Bill's powers of persuasion. The Tractor test crew was on vacation and I was to start in April or May.

The story of my "official" arrival merits mentioning since it is a perfect example of stereotyping people. Lester Larsen had been told that "some guy from Israel" was going to be the new head. Lester and John Carlile were waiting at the airport fully expecting their idea of an Israeli to arrive; their idea was that I would be a fellow in long black coat with a long beard, a black hat and side dreadlocks. As their luck would have it, there happened to be a Hassidic Jew on the plane, so when he came walking out of the gate they both pounced on him and asked: "Are you Dr. Leviticus" - whereupon two elderly people came forward and said that this was their son and not Dr. Leviticus. I've never ascertained if Les and John were glad or disappointed that I hadn't lived up to their expectations.

Lester Larsen had retired by the time I came to the lab in April of 1975. He provided me with a short training period - a few days at most and then told me that from there on I should "row my own boat". Luckily there was his right hand technician, John Carlile, who kept me on the straight and narrow during the first few months of the learning process.

It was clear from the start that there was a great need to make things run more efficient and with less personnel. Apart from myself there were two senior people John Carlile and

Mike Mumgaard, plus two junior staff members and about twelve part-time students. A secretary was shared with the department, but her salary was paid by the lab.



Figure 33. Dr. Louis Leviticus directed of the Tractor Test Laboratory during the time it transitioned to electronic instrumentation and supervised its move to the new laboratory complex.

One of the first problems which were addressed was the data processing which was done by hand and with old mechanical electric calculating machines such as the Marchant and Monroe units, which we still have on display. Apart from the annoying clattering and the time consuming operation, those machines were prone to hang up in the middle of calculations, forcing us to start over. Input errors were also difficult to correct.

Another source of inefficiency was the method of determining the drawbar pull and drawbar power. The paper strips with the tracings, which represented the instantaneous pull had to be measured with a planimeter. This is in itself a laborious project, but we did the reading of each strip twice and the resulting readings on the dials had to be within a very narrow range. In case this did not happen, extra readings were required.

In addition, more than one person had to "read" the charts. Since for each drawbar run there was one chart for each side of the track for each gear, the number of charts was large. Test such as the two-hour run and the ten-hour runs, which required even more charts to be taken. Their number increased even more when the number of gears in the range, which was to be tested, increased in the more modern tractors.

In addition, at that time Radial Tires were introduced and several manufacturers started making claims of increased drawbar horsepower. This meant that those tires had to be tested in addition to the bias ply tires in order to verify the claims. This required twice as many drawbar tests per tractor.

So the lab went to computers for load integrations and calculations. However, in those early days of the late seventies and early eighties there was little assistance for selecting the right systems at the University and as a result there were a number of missteps which, at the time, cost a great deal of money. Our electronic genius, Mike Mumgaard, did his best but was defeated a couple of times by slick sales people.

The laboratory had always used hydraulic cylinders for measuring the draft forces and used a steam engine pressure indicator system with springs to measure the pressure and inscribe the trace on pressure sensitive paper. We would change springs on the pressure indicator to accommodate the pressure changes caused by the different force ranges between low gears (high pull=high force=high pressure) and the high gears (low pull=low force=low pressure). The cylinders were of a very special construction which was practically without friction under dynamic conditions. We had different cylinder sizes for different tractor sizes. They were also very rugged and practically never gave us serious problems.

It took quite a number of years to construct a system, which would provide the required accuracy. Every time a new piece of electronics was introduced it was necessary to determine that the results were of an accuracy not less than the system which was originally developed and which had gained the confidence of both the testers and the industry. That took at least one test season every time.

We ended up using the same hydraulic cylinders we had used before, but the pressure was measured with two pressure transducers. If we had used an electronic load cell for measurement, we would have needed multiple changes of load cells to obtain the required accuracies in each range. This would have meant stopping the drawbar test, replacing the load cell and warming up to the right temperature again. With the hydraulic cells we did not have to do that. For the higher pressures the high pressure transducer was used and if we had a lower pressure test, a flip of a switch put the low pressure transducer in the circuit. We ended up with having a local electronics company construct our system to our needs. There was really nothing available on the market at a reasonable price for our specific purpose. As time went by, this company built more sophisticated systems for us.

The power-take-off test had its own problems. For one, the size of the tractors was increasing rapidly and the old tractor test facility became hopelessly inadequate. First of all, new doors had to be installed. Also the air flow for temperature control became a serious problem. We had big fans blowing all over the place, but that did not help much on a 70 degree day with a 250 hp tractor. Luckily by 1980 a new facility was built where we had designed and built an air handling system more or less to our specs.

Going over to the new building also meant that we installed new dynamometers which would be capable of absorbing the ever increasing power levels of the modern tractors. The newer tractors also came with newer fuel injection systems where the total fuel flow was much higher than in the past and so we had to upgrade the measuring systems.

Similarly, the PTO-dynamometer test instrumentation had to be modified to increase the efficiency and accuracy of the data collection. Obviously this became an ongoing project because of the continuously changing availability of electronic test equipment and the changing requirements of the test procedures. Tractor engines were continuously proving to be more of a challenge to test, due to so-called "constant power ranges" or "high torque engines" (the language depending on the advertising geniuses at the companies) being developed

In time both John Carlile and Mike Mumgaard retired and Dave Morgan and Brent Sampson, had very capably replaced them. They were there when I retired on December 31, 1997, and have been main stays of the program.

Apart from the aforementioned changeover from bias ply to radial, there were a number of changes in the test procedures which were mandated by technical developments in the tractor industry as well as by changes in the test code itself.

The latter changes came about in 1986 when the old Nebraska Tractor Test Code was replaced by the OECD test code. The latter code had been developed in Europe but had evolved from the original Nebraska Test Code. In principle there was not much difference in the basic tests but the OECD code required more tests to be performed and thus increased the scope of each test. The OECD code requires the testing of tractors in the country of manufacture. All other member countries are supposed to accept the results of that test. Had we not accepted the OECD test, and this required a change in the Tractor Test Law, other countries would not have accepted our tests of US-made tractors.

This would have forced many companies to take their tests overseas and would have closed the Nebraska Tractor Test program, which had been a success since 1920.

Other procedures were changed as well. In the late seventies we abandoned the after-test engine inspection. This had been mandatory for all tractors. The inspection was made to ensure that the engine had not been tampered with for the test. There had been cases where the intake manifolds had been polished or changes were made in the bore or the valves. The check was performed fairly easily since the majority of tractors had spark ignition engines, but by the end of the seventies many tractors had diesel engines, where such "improvements" would have had little effect. Especially when those engines started to become much larger and complicated it became a major operation to inspect the inside of an engine. It would also have required us to build a special inspection stand for larger tractors in order to comply with OSHA safety laws. The extra time and personnel the inspection would have required was judged not justifiable.

Of course, our joining the OECD test scheme significantly reduced the number of foreign tractors which were brought in for testing. Before that time we had many foreign tractors and had about just as many problems with them. In general this happened because the manufacturer was used to over-advertise the capabilities of their product. I will mention only three cases, without mentioning the manufacturer's names.

Case 1: A foreign manufacturer was marketing their tractors under a US manufacturer's name. The factory representatives tried their best to wring the advertised power from the tractors. The result was that the engines overheated and either seized up or lost compression because of burnt valves. The company withdrew the 5 tractors and returned later with redesigned models. There were several instances of such over-advertising and we caught them all.

Case 2: It was at the time that we required overturn protection (Roll-Bars) to be mounted on all tractors tested and sold in Nebraska. This foreign company came without a roll-bar. The company had a roll bar made, brought it here and mounted it on the tractor. It looked a bit weak to me, so I stood on the seat, grabbed the two sides of the bar and tried to shake it. To my great surprise the frame bent in my hands. Clearly this was not a properly designed frame and the company had to go back to the drawing board.

Case 3: This manufacturer had advertised power and fuel economy data. It barely made the power, but the fuel consumption at the power level they forced out of the engines was far over their advertised fuel consumption limits. They withdrew the tractors and never came back.

During the later 70s, more and more diesel engines appeared. One of the problems we encountered in the tests was the fuel temperature. A diesel engine has some marked differences with a gasoline engine. First of all there are different systems of fuel injection. Apart from different pump types and injectors, the amount of "return fuel" (fuel which is returned to the tractor's fuel tank) varies. On later types, the injectors actually were "cooled" by an overflow of fuel. This obviously would make a difference in injected fuel temperature as the test proceeded.

In addition, the injector gives a "measured" amount of fuel to the cylinder. As with any liquid, increase in temperature will decrease the fuel density, resulting in less energy available per fuel injection. We therefore needed to run preliminary tests to determine the "equilibrium fuel temperature" and perform all the tests at that temperature. John Carlile and I developed the system, using some basic temperature controllers and "low-density" fuel heaters used in the arctic by truckers, engines and the military. John built the actual system, which is why the cylinders are still in use at the time of writing. He always used ample safety factors.

In 1980 the lab was moved from the old building to the new Annex (currently the W.E. Splinter Laboratories). That was a great improvement - we had big doors, better air flow, separate tool room, fuels storage room and electronics room. In addition, the offices were roomier and we had better lights.

After I left at the end of 1997, many other improvements were made, notably a new test car and modernizing equipment and the offices. At the time of writing of this article, the lab is still a viable and successful entity under the capable leadership of Dr. Leonard Bashford.

More or less since 1986, when we became part of the OECD scheme, we had to fight a battle in the legislature against efforts by the Iowa-Nebraska Farm Equipment Association. This group has consistently claimed that the tests were not needed and that the test law should be abolished. Their reasons and methods have varied over the years, but most of their endeavor has been driven by a few unhappy dealers, who could not market tractor models which had not been tested. Which tractor models to test was the choice of the manufacturer. Which tractor models, which were OECD-certified in the country of manufacture, to ask sales permits for, was also the choice of the manufacturer. We will see where the Legislature takes us in the future. (*Dr. L. I. Leviticus*)

[Dr. Leviticus has published a book “Tales from the Milestone” describing his experiences escaping from Nazi capture and surviving during and after WWII.]

DR. JAMES DESHAZER

Dr. DeShazer brought a new dimension to the livestock engineering program. Nebraska has a long history of involvement in animal housing going back at least to Ivan Wood whose work is shown in the muslin sheets showing the design of farm housing, grain storage and farmstead layout. A plan service exemplified by the work of Ruby Loper under the direction of E. A. (Ole) Olson provided farmers with plans for nearly all of the buildings normally found on farmsteads. Together with other states the Midwest Plan Service made these plans available across the region.

Jim started his education at the University of Maryland where he received a B.Sc. in Agriculture in 1960, followed by a B.Sc. in Mechanical Engineering in 1961. He then received a M.Sc. in Agricultural Engineering and Animal Physiology from Rutgers University in 1963. He then went to North Carolina State University where he studied under Ken Jordan in the area of animal calorimetry. There he designed and built a gradient layer calorimeter capable of precision measurement of the heat and moisture given off by an animal such as a chicken to a new level. The calorimeter was capable of measuring the animal's heat loss to 0.1 watt.

Upon graduating from N.C.State he was hired as an Associate Professor at the University of Nebraska in the department of Agricultural Engineering. Since there were no other researchers at N.C.State involved in animal calorimetry I had his calorimeter shipped to Nebraska. This allowed him to get an immediate resumption of his calorimetry studies. He developed and taught graduate and undergraduate courses in bio-environmental engineering, livestock production systems, environmental factors affecting biological systems and creative problem solving.



Figure 34. Dr. James DeShazer taught and conducted research in animal calorimetry, leading to improving the environment for animals raised in confinement.

He expanded his calorimetry research program measuring the effect of infrared heating, floor heating and daily cyclic temperature changes on the energetics of pigs and poultry. He also led research in livestock housing and welfare, greenhouse control systems mathematical modeling of biophysical systems and electronic stockmanship (imaging analysis, vocalization patterns and biophysical models for care of livestock). The design data from these calorimeters are presented in the ASHRAE Handbook of Fundamentals, Midwest Plan Service publications and ASABE monographs on Ventilation of Agricultural

His work was integrated with the work of others in the 2009 ASABE monograph "Livestock Energetics and Thermal Environmental Management" that Jim edited. He established the First International Livestock Environment Symposium through the sponsorship of ASABE that was first held in the Nebraska Center for continuing Education of East Campus in April 1974. The symposium was attended by 230 researchers and practitioners from 11 countries. The symposium is held every five years, the last being in Brazil in 2009.

Jim was also a major contributor to the design and research conducted on the Energy Farm. His unique design for farrowing had the sows situated on a cool floor while the little pigs enjoyed a warmer floor, heated by solar collectors.

Jim served as a Visiting Professor at Cornell University, the University of Alberta and the national Institute of Agricultural Engineering in England. He served as Assistant Dean, IANR Research Center in 1988-9. He then served as Head of the Agricultural Engineering Department at the University of Idaho from 1991-2001, when he retired.
(Dr. J. A. DeShazer)

WILLIAM E. SPLINTER

I was born on my grandparent's ranch 5 miles northwest of North Platte on November 24, 1925. I was raised on an irrigated farm. My life has been a series of fortunate events and this was the first. The responsibility and skills I learned on the farm have been the foundation for my professional career.

My second fortunate event followed a lengthy argument with my advisor in Mechanical Engineering over having to take a required course in Economics. In desperation, I think, he asked me just what I wanted to do. With my farm background I thought designing tractors would be something I could do. He suggested I check with the Agricultural Engineering department, which was a branch of engineering I had never heard of, but I talked to Professor E.E. Brackett. I had now found people who spoke my language. I also became involved in the Engineering College student magazine, the Nebraska Blue Print and served as feature writer and editor. I graduated in January, 1950

My third fortunate event was being offered a scholarship by Professor A.W. Farrall (an alumnus) to attend Michigan State College to work on a M.Sc. degree. I have the strange idea that students, who are paying the bill, should be able to select the courses, rather than following a rigid curriculum. The graduate program there allowed me to work on a degree program without taking a formal course in Agricultural Engineering and to take courses without taking prerequisites. I could then take advanced courses in Math, Physics, Metallurgy and Physical Chemistry without having to spend time in the entry courses. My graduate work involved dielectric properties of wheat and electrostatic deposition of dusts. The key thing that I learned from Dr. Farrall was not to be hesitant in trying out new ideas.

Fortunate event number four was being hired by Professor Wallace Giles (also an alumnus), in 1954, directly as a Research Associate Professor, Department of Agricultural Engineering, N.C. State College, with a research budget of \$3000 per year. My responsibility was to mechanize the production of flue cured tobacco to eliminate the need for over 460 man hours per acre of back breaking work under high temperature and humidity conditions. Tobacco was transplanted by hand. We were among the first to conduct human factors engineering studies of the effort required and the accuracy of workers using a mechanical transplanter. We determined that man's reactions limited the speed of transplanting to around 2 mph (still much better than by hand). We then designed an automatic transplanter dropping plants grown in small soil cubes directly into the row (two patents).

We then studied the growth dynamics of the plant in order to be able to plant uniformly sized plants. In our studies of how plants react to environmental changes we established that the plant stem diameter of a plant gave an accurate measurement of total plant leaf area for plants exhibiting apical dominance (having one stalk). We utilized a simple shop micrometer to measure stem diameter in field studies. We then developed an electronic micrometer that allowed us to measure growth rate changes within a three minute period. We developed growth chambers supporting a plant above an air tight chamber where we

determined that oxygen, not nitrogen, caused plants to “drown” if flooded for a period of time. We developed growth chambers utilizing an air curtain to reduce the entrance of carbon dioxide into the chamber when someone was working with the plants. From these studies we developed a computer model using a modified first order chemical reaction equation that would accurately calculate the growth in total leaf area of a plant as affected by temperature, soil moisture, light intensity and humidity. This held for corn, cotton, tobacco and cocklebur.



Figure 35. William Splinter, Department Head, 1964-1988, President, ASAE 1978-79, Elected to National Academy of Engineering, 1984.

We developed a topper to mechanically remove the blossoms of the plant to increase yield (two patents). Flue cured tobacco ripens from the bottom to the top so the lower leaves must be harvested without damaging the upper leaves. We developed a mechanical harvester that would selectively remove ripe 16” x 24” leaves without damaging the remaining leaves (two patents). By 1976 there were over 2500 mechanical harvesters in use. All of these machines are in the field. I think we accomplished the task for which I had been hired.

Then the medical profession determined that smoking tobacco was a serious health hazard. So much for being a second Eli Whitney.

While at N.C.State, however, my students and I also conducted research in the mechanical harvesting of cabbage and sweet potatoes. Henry Bowen and I also continued research on increasing deposition of agricultural sprays and dusts through electrostatic charging. I developed an air curtain nozzle that was highly efficient for both sprays and dusts (one patent). Charging the spray or dust particles drives them, through electrical field forces, to any grounded surface, such as a plant leaf, and the finer the particle the less material needed to accomplish pesticide control. These machines are being used for cotton and grapes. Because several of our faculty were utilizing basic

biology in our research we were the first department to adopt the name Biological and Agricultural Engineering in 1965.

My fifth fortunate event was being hired to Head the Agricultural Engineering program at the University of Nebraska-Lincoln in 1968. The department, and the University as well, were primarily involved in teaching, (classroom and extension). The Agricultural Experiment Station was the primary research unit for the University, supported by Federal funds. Research grants were practically unknown. The department had one \$3000 grant for conservation tillage. There was no central University research office. My two predecessors as Chair had both been hired away after only 2 years, Dr. Jack Davis to be Dean of Engineering and Dr. Robert Kleis to be Associate Director of the Ag. Experiment Station. Dr. Kleis had made strategic hires of new faculty, Dr. Don Edwards, Dr. Jim DeShazer and Dr. Tom Thompson, so there was some momentum gathering to strengthen the program.

We were successful in bringing in new faculty such as Dr. Milford Hanna, Dr. George Meyer, Dr. Leonard Bashford, Dr. Louis Leviticus, Dr. Dennis Schulte, Dr. Jack Schinstock, Dr. Jim Gilley, Dr. Al Rider and Dr. Elbert Dickey. While attending the ASAE meeting in Pullman, WA I received a phone call from UNL President Durwood Varner and was told to hire five irrigation engineers. This resulted in being able to add Dr. Darrell Watts at the North Platte Experiment Station, Dr. Dave Fonken at Scottsbluff and Dr. Judson Morin at the Northeast Station, Dr. Dean Eisenhauer at the South Central Station near Hastings and Dr. John Addink at Lincoln. This was in addition the teaching and extension programs in Lincoln and it resulted in an extensive irrigation engineering program throughout the state. Nebraska now has more irrigated acreage than any other state.

The Department became very involved in sponsored research. Having had to write competitive grants at N.C. State U., I successfully wrote research proposals that I then turned over to able faculty to conduct. These included around \$200,000 for irrigation research for Jim Gilley, around \$200,000 for feedlot waste research for Conrad Gilbertson and around \$800,000 for the Energy Farm Project for Dennis Schulte. Other faculty were also successful so that the research program grew, expanding our graduate program and a Ph. D. program was added. This has an interesting side bar in that at that time the College of Engineering had only four Ph. D. programs (EE, ME, CE and EM), but there was pressure from the Board of Regents to eliminate graduate programs because they were “too expensive”. Under Dean Hanna we wrote a proposal to have only one Ph. D. degree in Engineering, with the proviso that departmental programs could operate under this umbrella program. The result was essentially eight Ph. D. programs, and the Board of Regents was happy that they had eliminated three programs.

Fortunate event number six was my election as President of ASAE. I had served on numerous committees but this was a new challenge that I enjoyed very much. First I moved all Executive Board and many committee meetings to ASAE Headquarters at St. Joseph because I believed ASAE staff should have immediate access to Board members and vice versa. Then I became involved with external national and international

engineering organizations such as the Engineers Joint Council, American Council on Engineering and Pan-American Engineering Society, involving North American and South American engineering organizations. I was an advocate in combining EJC and ACE into one umbrella engineering council, the American Association of Engineering Societies (I interviewed for being Executive Director of AAES but New York City is not a place for family). Bob Tweedy and I set up the ASAE Foundation and I served as its first President. Jimmy Butt told me in recent years that Bob Tweedy and I were the best ASAE Presidents he served under as Executive Vice President of the ASAE, Bob for developing the Foundation and me for bringing ASAE into the mainstream of the national and international engineering societies.

Fortunate event number seven was the surprise letter in 1984 indicating that I had been elected to the National Academy of Engineering. There were only two Ag. Engineers serving as members at that time. This was a mule entered in the Kentucky Derby situation but I helped organize and served as the first chairman of Section 12, Special Fields. I served on several committees, the most interesting was the committee to select the top 20 engineering developments in the past 100 years. Other committee members included the Nobel Prize winner who developed the Maser and Neil Armstrong, the first Astronaut to step on the moon. I was able to get Agricultural Engineering recognized as the 7th most important area in engineering. Another side effect was being seated at the head table at a luncheon with Jacques Cousteau.

In 1988 my eighth fortunate event was my selection as Associate Vice Chancellor for Research. For years the University had regarded itself as a teaching institution. What research coordination existed was conducted by the Dean of Graduate Studies. Under Chancellor Martin Massengale, Dr. John Yost was named the first Vice Chancellor for Research. When I heard that the position as Associate Vice Chancellor was open I made contact and was hired. After 20 years as Head of Ag. Eng. it was time to turn the department over to new leadership.

At that time the University had one patent providing royalties and scattered areas of sponsored research, the only major project being drilling in the Polar Ice Cap. I hired Dr. Sharon Davis and we set about conducting grant writing workshops and set up a program to support grant writers. We also had workshops on patenting. We assisted in setting up spin-off companies based on University research. After two years Dr. Yost left and I was named Interim Vice Chancellor for one year, then Vice Chancellor. I hired Dr. Henry Baumgartner to replace me. I was now responsible as Dean of the Graduate College and the University Press and the Nebraska State Museum reported to me. I was also involved with the Foundation and the business community in setting up a Research Park in Northeast Lincoln. It was a great position. We were successful in increasing research grant funding up to \$75M, moving the University from a Carnegie Category II research institution to a Category I. I was also the key University official involved in setting up the Research Initiative. Hopefully it can be claimed that my team set the stage for the major sponsored research program that exists today.

I retired in 1993 and that set the stage for the next opportunities. I worked briefly for the Foundation, then the Dean of Engineering was removed and I was asked to serve as interim Dean until a new one could be selected. This opportunity was interesting but more of a challenge. The program was torn by squabbles within departments and between the UNL and UNO programs. The UNO program had been intentionally ignored by the three previous Deans with the intent that it disappear. The Omaha business community however was very interested in strengthening the program in Omaha. At my own expense I rented an apartment in Omaha so that I could spend more time with the faculty and with the UNO Deans and Chancellor. I think they appreciated that. A new Dean was hired after one year still inheriting a few problems.

Along with these “downtown” functions I had also been involved with a small committee interested in preserving the history of the tractor testing program and the artifacts gathered by previous Ag. Eng. faculty over the years. Against the interests of the University management we wanted to utilize the original Tractor Test building to house these historic items. We were conditionally allowed to raise funds to repair the roof and to occupy the building but without any University support. Having no academic home left us in limbo but I was successful in getting Dr. Jim Estes, Director of the Nebraska State Museum to incorporate the tractor museum as an auxiliary unit similar to the Ashfall and Trailside museums. I was named Director at \$100/mo. (allowing me to drive University vehicles) and we were given a half time secretary/bookkeeper/manager position (Judy Ray) to staff the museum. We were able to participate in the Museum Studies M.Sc. program, allowing us to have students training to be professional Museum directors doing their one year practicum work with us. Luis Vasquez was our first student and we were now gaining some semblance as a museum with hours of operation. The building was recognized with a bronze plaque as an ASAE Historic site in 1980 and the museum was dedicated as the Lester F. Larsen Tractor Test and Power Museum in 1998.

Again, in 2003, the Dean of Engineering was removed and I was given the second opportunity to serve as Interim Dean (I described my position as Intermittent Dean). By now Walter Scott, Peter Kiewit CEO, had built a very modern engineering building and modern dormitories on former AKSARBEN property in Omaha and my wife and I were allowed to occupy one of the new dorm apartments. At Lincoln, a major donation for new engineering facilities by Henry Othmer was funding construction of new facilities adjacent to the Walter Scott building and I was the first to occupy the Dean’s office there. The Omaha and Lincoln programs were accelerating and this was a pleasant year to be involved.

I then returned to the Larsen Tractor Museum. Funding allowed us to upgrade the support position and this allowed me to step out as Director in 2011, leaving Jeremy Steele in that position with an active support program of Docents, a strong Friends of the Museum organization and professionally designed exhibits.

The most significant professional recognition of my career was the dedication of the Ag. Engineering Annex as the Splinter Laboratories in 2004. This facility has special meaning to me as I had laid out the design to specifically house the major noise

generating functions of the department. It included the tractor testing lab, the engines lab, the machinery lab and the shop along with flexible research laboratories. To achieve the maximum space within the budget I had taken what I saw as excessive costs to the Board of Regents. We actually got more space. The building has proven highly functional—good engineering design if I say so myself.

My professional career has allowed me to travel world wide, primarily related to business. I have visited 39 countries and flown around the world four times. The highlight was spending six months with the University of Melbourne in Australia.

I cannot conclude without covering the love of my life—flying. I soloed just out of High School and bought my first plane while at N.C. State. I used a plane primarily as a means of transportation for business, a major asset in the profession of Agricultural Engineering, as most Land Grant Universities are located in rural settings inaccessible by commercial airlines. At N.C. State I could attend meetings at Auburn, U. of Kentucky and the U. of Georgia and be home that night. At Nebraska I could have a meeting in North Platte, fly to Scottsbluff for lunch, have a meeting and return to Lincoln for supper. I could reach either coast in a day. I concluded my flying when a pacemaker was installed, having flown nearly 5000 hours with an instrument rating. I consider this capability was a major asset for my professional career.

And finally, I served as a radarman on a destroyer during the Korean War. (*Dr. W. E. Splinter*)

DEPARTMENTAL PHYSICAL FACILITIES

FARM MACHINERY HALL

The building that first housed the program that evolved from the Farm Machinery Department to Agricultural Engineering then to the Biological Systems Engineering program had a long and useful presence with the University of Nebraska. It was the fourth building erected on the University Farm (now East Campus) in 1904, and was situated just east of the Plant Industry building, housing the Agronomy Department at that time. It stood there until it was razed in 1964.



Figure 36. Farm Machinery Hall, first home of Department. Note the experimental windmill on the roof.

O. V. P. Stout is credited with conceiving the idea of offering engineering courses to address the emerging technology dealing with agricultural tractors, machines, structures, irrigation and country roads, beginning with his appointment, as a Civil Engineer in 1895, to address the rapid expansion of irrigation in Nebraska. In 1903 he was instrumental in offering hands-on courses related to farm operations such as care and operation of farm machinery. In 1904 the Board of Regents, in response to the great interest in these courses, allocated \$14,000 to build a facility specifically designed to teach these courses and J. Brownlee Davidson was hired to set up courses in Farm Mechanics as an adjunct program under the Mechanical Engineering (ME) Department. Davidson left after one year and L. W. Chase was hired to continue this program and he is the person credited with the design of Farm Machinery Hall. Chase had taught the forge course in the ME Department in 1903 as a senior student and as and instructor in 1904.

The building provided space for a machinery laboratory and forge shop, together with an office and washroom on the first floor and a woodworking laboratory and office on the second floor. The total enclosed space was 7406 ft². The program rapidly outgrew this facility and additional space on the campus was needed. At one point a model farmstead was constructed north of the building and a windmill of an unusual double bladed design

was mounted on the roof of the building. In 1909 the Farm Mechanics teaching program became the Agricultural Engineering program.

In addition to housing teaching courses in engineering Machinery Hall also housed courses for students in the School of Agriculture (a two year program) and short courses for farmers. A very popular short course was the Farm Motors Short Course. It was a hands-on program taught from June 4 to June 29. One subject was forge work, wood working and construction and repair of farm machinery. A second course dealt with gasoline and oil engines (oil meaning kerosene), covering their repair and maintenance. The third course concerned steam tractors, covering their operation and adjustment. The fourth course's topic was automobiles, their design and maintenance. These courses were offered in the morning and the afternoons were devoted to laboratory application of the course material including hands-on operation of tractors powering threshing machines and other chores and driving automobiles. Tours were conducted visiting equipment dealerships and time was allocated for recreation at 5 each evening. There was a stag picnic and a banquet following the final exam, followed by graduation.



Figure 37. Forge shop in the north wing of Machinery Hall. Blacksmithing was an essential skill as machines were being introduced for farming, both for manufacturing and for repairing them .

When the Agricultural Engineering faculty moved to the new Agricultural Engineering building in 1918 the building housed a number of programs including the Animal Husbandry Meats Lab, Home Economics, Ag. Chemistry, and the Chemurgy program that has evolved into the ethanol programs today.

The building was razed in 1964 and the site was utilized for the East Campus Student Union

L. W. CHASE HALL

By 1915 the Agricultural Engineering enrollments and other activities had outgrown the capacity of Machinery Hall so the Board of Regents elected to construct a new building for the program utilizing a Special Building Fund established in 1914. The new building was designed by the Coolidge and Hodgdon architectural firm as part of their grand vision for the University. On each campus one building site was selected on which to place a large and monumental structure to serve as an anchor and focal point for each campus' design scheme. On the Agriculture Campus that building was the Agricultural Engineering building located across the north of the central mall, arguably the best location on either campus.



Figure 38. L. W. Chase Hall today. It still fills its designed role as the anchor for East Campus.

Construction began in 1916 and the building was completed in 1918. Before the building was totally completed it was used to quarter WW I troops, with instruction including a truck operator school and the construction of caissons. Like other buildings on the mall it was constructed of buff brick, with limestone trim. The entrance was slightly elevated

with four large ionic columns. The main form of the building was rectangular with two stories for classrooms and offices and the basement for machinery testing and shops, including the motor pool for the Ag. Campus. L. W. Chase and the other faculty members contributed greatly to the design and the resulting building had many features that placed it as the most advanced Agricultural Engineering teaching facility in the nation. Among its unique features was a soil bin in the basement for measuring the draft of soil engaging tools such as disks or cultivator shovels. The machinery laboratory on the first floor had a rail system for conveying farm machines into and out of the laboratory. There were openings in the floor with a line of driven drums so that a farm machine such as a planter could be powered so the students could learn to calibrate seed flow for example. There was also a modern engines teaching laboratory and a second laboratory housing pumps and flumes to study water hydraulics. A large woodworking laboratory was used for basic woodworking and wooden structures. Also on the first floor was a large forge room and courses in blacksmithing, and later welding, were taught until 1995. On the second floor there were classrooms and laboratories for teaching chemistry and physics and the departmental offices. The first classes were taught in the Spring of 1920.

In 1979 the Nebraska Legislature provided funds for the complete modernization of Agricultural Engineering Hall and the addition of a separate research laboratory facility north of the tractor test track. The exterior of the Agricultural Engineering building was modified through the replacement of windows with an energy efficient design, and the entrance was modified to accommodate handicapped students. Insulation and an energy efficient heating/cooling system were added. The interior was completely re-organized. Fortunately we were working with an architect who basically allowed Prof. George Petersen and I to lay out the interior of the building. All faculty and staff offices were placed in the second floor utilizing a modular design with faculty offices set around a secretarial area allowing more convenient communication. All classrooms and teaching laboratories were placed on the first floor allowing students easy access to classrooms, a study area and a computer resource center. All graduate student offices were placed along the south wall.

The lower floor was an open area encompassing a metals working area (with lathes, shapers, etc.), a welding area (with acetylene and the latest arc welding systems) and an agricultural construction area (with complete woodworking tools).

The remodeled Agricultural Engineering building was dedicated March 18, 1982 as L. W. Chase Hall, named after the professor who had headed the Farm Mechanics program, designed Machinery Hall, initiated and headed the Agricultural Engineering program and designed Agricultural Engineering Hall.

Since this dedication the classrooms and laboratories have been further modified to meet the changing academic program. Recognizing the professional move to more basic approaches in the teaching and research, now encompassing the biological sciences as well as the engineering sciences, the program was renamed the Biological Systems Engineering Department in 1990. The traditional courses in welding, machine tools and

wood fabrication were phased out. Modifications of the laboratories have included the addition of an expanded computer lab, and telecommunications classrooms and the complete conversion of the lower area to five research laboratories covering climate dynamics, environmental instrumentation, sensors and controls, bioremediation and pollution prevention. The building configuration continues to respond to changes in the fields of Biological Systems Engineering, Agricultural Engineering, Agricultural Mechanization Systems and Water Science utilizing the latest developments in the presentation of lectures and laboratories. The building still enjoys the premier location on the campus and will adequately serve the University for many years ahead.

The remodeled Agricultural Engineering building was dedicated March 18, 1982 as L. W. Chase Hall, named after the professor who had headed the Farm Mechanics program, designed Machinery Hall, initiated and headed the Agricultural Engineering program and designed Agricultural Engineering Hall.

SPLINTER LABORATORIES

Concurrent with the renovation of Agricultural Engineering Hall a new facility was added in recognition of the need for expansion in departmental programs and the need for greater space to accommodate the increased size and horsepower of agricultural tractors. The new Agricultural Engineering Laboratories facility was designed to house the departmental shop, engines and machinery teaching laboratories, a bioenergetics research lab and the Nebraska Tractor Test laboratory. A second floor housed an open research laboratory allowing flexibility as research programs shifted from one area of emphasis to another. During renovation of Chase Hall this space housed most of the faculty of the department.

The shop was expanded in space and greatly improved in accessibility. The former shop was accessed down a ramp, making it inaccessible if there was snow or ice. The new shop included a range of machine and welding tools and could accommodate large equipment. Adjacent to the shop was the Machinery Laboratory, again accessible to the largest equipment. This space is used for research projects as well as teaching and provides space for the student's ¼ scale tractor project, which is a national student competition. The bioenergetics laboratory housed climate controlled chambers for research in animal response to environment, under the direction of Dr. James DeShazer. . He left to be Head of the Agricultural Engineering program at the University of Idaho and that space was converted to project space adjacent to the shop. The teaching laboratory for internal combustion engines was placed next to the Machinery Laboratory.

An open, flexible research laboratory was placed above the bioenergetics space and the engines laboratory. It was designed with accessible utilities but without internal walls so that spaces for projects could be changed when some projects are closed and new research programs added.

The west 1/3 of the facility houses the Nebraska Tractor Test Laboratory. As the size of tractors continues to increase both in size and complexity, a dynamometer with a capacity of 1000 horsepower was installed and the newest instrumentation is added as it becomes available. The laboratory continues to be the world standard in the measurement of tractor performance. Increased size of tractors also required an increase in the width and strength of the concrete test course in 2008.

The facility was re-named as Splinter Laboratories by the Board of Regents in 2004.

THE LESTER F. LARSEN TRACTOR TEST AND POWER MUSEUM

The first collections were Colonial (1700's) hand tools and other items such as lanterns brought to the Agricultural Engineering Department by L. W. Chase in the early 1900's according to his son Fred Chase, who was a small boy at that time. L. W. Chase had visited his grandfather's farm in Vermont and returned with the early hand tools that were displayed in glass cases for many years in the Agricultural Engineering Machinery Laboratory. L. W. Chase also designed and supervised the construction of the Nebraska Tractor Test Laboratory building in which the L. F. Larsen Museum is housed in 1919.

At a later date, probably in the 1920's, Professor Chauncey W. Smith, a Professor in the Agricultural Engineering Department collected a number of ancient plows, oxen yokes and early horse drawn machines such as corn planters and cultivators that were exhibited on the walls of the Machinery Laboratory.

There are no records or correspondence that we know of related to these collections.

In 1980 the Agricultural Engineering building, (now Chase Hall), was renovated and the artifacts were placed in storage. Also at that time a new laboratory building (Biological Systems Engineering Laboratories) was constructed (now Splinter Laboratories) that included space for the tractor test laboratory since the size of many tractors now required more door width and dynamometer capacity than could be accommodated by the tractor test laboratory.

Professor Lester F. Larsen had retired after serving 39 years as the Director of the Tractor Test Laboratory in 1975. When the old Tractor Test Laboratory building became vacant following the move to the BSEL building, Bill Splinter discussed with him the possibility of setting up a collection of historic agricultural tractors in the vacant building. Professor Larsen had many contacts through the State and region and, as a result he had established a collection of around 40 tractors representing the various stages in the evolution of agricultural tractor design that he had stashed in various locations on East Campus and at the Mead Field Laboratory. Also at that time the building was dedicated as an ASAE landmark on July 25, 1980. Many of Larsen's historic tractors were moved into the old tractor test building and Larsen re-occupied his old office. The University Administration however wished to raze the old unsightly building. Having Larsen's

tractors sitting there caused them to delay demolition but they cut off all services to the building. The roof had seriously deteriorated to the point that there were holes 20' across at two locations, allowing rain and snow to enter, Larsen persevered and, with student help restored a 1925 Ford Model T pickup and a 1917 Minneapolis Ford tractor and met with visitors.

A small number of individuals, including farmers and State Senator Richard Maresh formed a support group that later evolved into the Friends of the L. F. Larsen Tractor Test and Power Museum. Alumni and others were solicited for funds to restore the roof and a new covering was installed, however, still with the proviso the University could raze the building if it wished. The artifacts that had been stored were brought to the museum and displays were set up. The museum still had no official presence within the University structure but Dr. James Estes, Director of the State Museum, incorporated the museum as an adjunct of his program along with the Ashfall and Trailside museums. A ½ time position was set up and hours were established. The University restored electricity and water service (the power plant next door had maintained steam service without authorization).

A formal dedication of the museum as the Lester F. Larsen Tractor Test and Power Museum was held on May 2, 1998. With the critical support of volunteers, walls were painted, windows replaced, exhibits set up, janitorial services provided and tours guided. Museum Studies Masters student provided professional support in organizing and displaying the museum holdings. Tractor restorations had continued, detracting from the exhibits, and these functions were moved to a historic Behlen steel building that the University moved as part of the installation of an electrical substation. The Behlen building had survived the explosion of a nuclear device in New Mexico and is an excellent shop facility for tractor restoration. Since opening, selective additions have been added to the collection, the most significant being the 1909 Ford tractor that was the model whose performance led to the creation of the Nebraska Tractor Test Law. With a full time Director and the support of volunteers the museum now functions as an active contributor to the educational structure of the University, attracting visitors world wide.

DEPARTMENTAL PROGRAMS

TEACHING

Prior to a specific program directed toward the mechanization of agriculture, by 1903 students in the School of Agriculture were receiving instruction in operation of farm machinery by O.V.P. Stout and blacksmithing by L. W. Chase within the Mechanical Engineering Department on the main campus. With the formation of the Farm Mechanics program under the Mechanical Engineering Department in 1904, J.B. Davidson taught courses in farm machinery, farm motors and forge on the main campus. With the completion of Machinery Hall in 1905 woodworking was added to the courses taught, instruction was moved to the University Farm and the program was placed under the Dean of Agriculture in 1907. Students in Agriculture were required to take 18 hours per week of course work in Farm Mechanics in 1905, increasing to 30 hours in 1906, 40 hours in 1907, 52 hours in 1908, 59 hours in 1909 and 67 hours in 1910. The number of students in Agriculture increased from 135 in 1904 to 402 in 1909, now including 38 students in rural architecture and 37 young women taking woodworking. The Agricultural Engineering program was initiated in 1908 with 6 students, increasing to 32 students in 1909 when the department was recognized as a separate department under the direction of both the Dean of Engineering and the Dean of Agriculture. The engineering students took courses in Farm Machinery, Farm Motors, Rural Architecture, Farm Drainage, Rural Highways and Spraying Machinery.

In 1912 the first three students graduated with a B.Sc. in Agricultural Engineering. The Department then graduated the first M.Sc. in Agricultural Engineering in the U.S. in 1913. This program in Agricultural Engineering was, along with Iowa State and Kansas State, the first degree programs in Agricultural Engineering accredited by the Engineers Council for Professional Development in 1937.

The department had taught service courses for students in the College of Agriculture from the beginning but in 1958 a formal course program in Mechanized Agriculture was added for students wishing to enter the business rather than the design area of work, one of the first, if not the first such program in the U.S..

Although the Department was authorized to offer the doctorate degree when it started there was no interest in the profession for education at that level, although the University of Nebraska awarded the first Honorary Degree in Agricultural Engineering in the U.S. in 1931. In the 1950's, following WWII, several Universities instituted Ph. D. degree programs in Agricultural Engineering but it was not until the 1970's that the Department wished to institute such a program. Unfortunately this was a time that the Board of Regents felt that doctoral programs were too expensive and were taking resources from other programs, not realizing that doctoral programs were magnets for grant support. At that time the College of Engineering had only four programs at the doctoral level, Electrical Engineering, Engineering Mechanics, Civil Engineering and Mechanical Engineering. Several other departments, including Agricultural Engineering wished to also have doctoral programs so, in order to circumvent the bureaucracy the College of Engineering gave up the four active programs and instituted only one doctoral program, the Ph. D. in Engineering. In doing so, all engineering programs now came under this umbrella so the result was eight engineering doctoral degree programs, including

Agricultural Engineering. Our first student, Dr. Lalit Verma, graduated from that program in 1976 and he has gone on to a distinguished career at Louisiana State University and at the University of Arkansas.

With the increased involvement of the Agricultural Sciences in the research and teaching program at the University of Nebraska-Lincoln, the department name was changed to Biological Systems Engineering in 1990. A program in Water Science was added and the name of the Mechanized Agriculture program was changed to Mechanized Systems Management.

RESEARCH AND EXTENSION

As a Land Grant University, the University of Nebraska established a School of Agriculture, an Agricultural Experiment Station and a College of Engineering in 1877. Research sponsored by the Agricultural Experiment related to the future department of Biological Systems Engineering started immediately with the provision of \$60 for Professor ---, a geologist, to investigate the potential of irrigation in Nebraska. This resulted in Agricultural Experiment Station Bulletin #1. This was followed by O. V. P. Stout's Agricultural Experiment Station Bulletin #47, "Water Supply in Nebraska". It was early recognized that the utilization of water would provide the economic engine for Nebraska through stabilizing agricultural production. To this day the Department has maintained a statewide program in irrigation research.

From the beginning, before there was a formal recognition of Extension as a recognized activity for faculty, the Department has always recognized that research needed to be oriented to the needs of the farmer and the results taken to them through educational programs. Chase was involved in short courses teaching tractor, truck and automobile operation and maintenance. He developed tests to define tractor performance, the foundation of the Nebraska Tractor Test program. Brackett worked with the introduction of electrical power to farmsteads. Water use efficiency has been addressed through pumping plant tests, re-use pits to recover surplus water and pump it back for re-use, irrigation scheduling, and management of our water resources have all resulted from a combination of research and extension programs across the State. Residue management through conservation tillage has allowed the planting of crops without need for the plow, resulting from research carried to the farmer through demonstrations. The Tractor Power and Safety Day program and the Irrigation Short Course were major programs providing the latest research findings to the farmer.

Examples of major programs resulting from this integration of research and extension are presented here.

IRRIGATION

Beginning with O.V.P. Stout in 1895 the Department has maintained a strong leadership role in water management and irrigation over the years. Irrigation technology has transitioned from centuries old systems distributing water through lateral ditches to

individual rows or by flooding an area of cropland to highly sophisticated systems allowing precise control of water application for greatest efficiency in use of water and energy. Through research and strong extension programs the Department of Agricultural Engineering, now the Biological Systems Engineering Department, has provided Nebraska farmers and manufacturers of irrigation equipment strong technical support to the extent that Nebraska now leads the nation in irrigated acreage.

Many significant advances have been pioneered in Nebraska. The siphon tube, a bent 2" plastic tube allowed a more uniform flow rate for each row although it traded the back-stressing requirement to stoop and set the tubes for the back-breaking shovel work of opening and closing each row. Siphon tubes were developed by Rex German at Cozad, NE. The side-roll sprinkler system, having a delivery pipe with sprinkler nozzles supported and moved by 5' diameter steel wheels, was successful for crops such as alfalfa. The skid tow system, such as those developed by T&L Irrigation Co., Hastings, NE, where lengths of pipe with sprinklers set on risers were towed back and forth between the rows, now allowing the irrigation of corn for uneven fields. The gated pipe system, pioneered by Hastings Pipe, Hastings, NE, where 10" diameter pipes with gates set along the side has largely replaced the use of siphon tubes as it requires only one operation placing the pipe at the head of the row and the removal of the pipe prior to harvest.

The most significant development in the mechanization of irrigation came with the development of the first center pivot machine by Frank Zybach, Columbus, NE in 1952 on a farm near Strasburg, CO. The basic machine delivered water through a pipe supported on self propelled towers and extending out ¼ of a mile, pivoting about a central source of water and applying water through sprinkler nozzles as the machine slowly advanced. The machine had sufficient flexibility to allow irrigation of irregular topography. Work by Fischbach and others adapted these systems for applying chemicals such as fertilizers and insecticides through the system. To more efficiently use square fields a swing tower was developed allowing the irrigation of the corners of the field not covered by the circular pattern. The machine has mechanized the application of irrigation water, saving a great amount of labor and providing a much more precise and efficient use of water. The center pivot's impact has been world wide and it has become a significant feature of the landscape as viewed during air travel.

The department's extensive involvement in irrigation technology and water resources is discussed in the sections by Axthelm, Fischbach and Watts.

TRACTOR TESTING

Probably the best recognized program at the University of Nebraska, world wide, is the Nebraska Tractor Test Laboratory. Aspects of the program are presented under the sections discussing Chase, Shedd, Smith, Larsen, Leviticus and Bashford. It was a

farmer near Osceola, NE that had the original idea of writing a law to provide the farmer with unbiased information on the performance of the tractors being offered for sale. That farmer was Wilmont Flint Crozier.

Crozier was born January 31, 1883. He graduated from the Osceola high school in 1903 and from Northwestern University in 1909. He attended Stanford University for graduate work and then served for three years in the Philippines as the division superintendant of schools. He became disenchanted with teaching and returned to Osceola to farm.

He saw the potential for the agricultural tractor and purchased a Ford tractor, manufactured in Minneapolis by a company that had hired a hardware store clerk with the last name Ford so they could utilize that name in marketing. The tractor was unsatisfactory so he purchased a Bull tractor that was also unsatisfactory. His third tractor, an Advance Rumely Oil Pull, was satisfactory. He felt that the farmer needed to have accurate performance data to verify the claims of the many companies marketing tractors at that time. He then ran for the Nebraska Legislature and was elected to serve in that body in 1919. (He also served in 1931 and 1933). There he and Sen. Charles Warner of Waverly crafted the language, with the assistance of L. W. Chase that basically survives today as a world standard. We can get a major insight into Crozier's reasoning for formulating this law from an article authored by Crozier and published in the Implement and Tractor Journal dated September 9, 1919 that reads as follows:

FATHER OF NEBRASKA'S TRACTOR LAW EXPLAINS IT
By Rep. W. F. Crozier

(from)
(Implement & Tractor Trade Journal)
(September 09, 1919)

I take great pleasure in complying with your recent request for an account of my reasons for formulating and introducing, in our legislature, what is now known as the "Nebraska Tractor Law". I have watched the development of the tractor industry from its infancy, and have followed many a queer-looking contraption around the demonstration fields, that purported to be able to replace my long-eared mules in front of a gang plow.

The successive years of development proved to me, beyond a doubt, that the tractor, in some form, was the agricultural implement the American farmer had been looking for, for these many years. I began investing a little money in the things, that is, I invested in the cheapest one that had wheels. I soon found out that wheels and cast iron are of no value unless you have power to turn them when they are hitched to something.

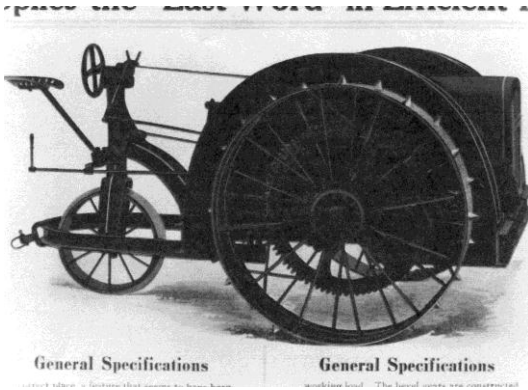


Figure 38. From an add for the Minneapolis “Ford” Crozier purchased.

After operating, or attempting to operate, two excuses for tractors, I finally invested my money in a machine that would really do what the company said it would. Then I began wondering if there wasn't some way to induce all tractor companies to tell the truth.

An Editorial Began It.

The real starting of this tractor law was an editorial written in a Nebraska farm paper under the date of July 20, 1918. It read in part as follows: “Many tractors now on the market are impracticable. They have one or more weak points which make them useless, and it takes only one weak link in the chain to make it of no value. Another reason why costly and valueless tractors are rusting in farmyard corners, or in fields where they refuse to run, irresponsible concerns are manufacturing tractors merely to sell and not to run”.

This was the beginning of a somewhat lengthy correspondence between myself and the editor of the paper, least this is the beginning of a campaign, to eliminate these irresponsible tractor companies you speak of.

Now, lest there should be a disposition to assert that all tractor companies are responsible, etc. I will simply quote from a circular that lies before me, which was sent to me in 1916 to induce me to invest my money in the stock of one of these get-rich quick tractor companies. It says, “The ___ Tractor Cos. estimates that with a force of 1,500 men they can produce 100 tractors a day which would mean 31,200 tractors a year. Producing and marketing 31,300 tractors would, on the previously indicated profits, equal a net profit of \$3,822,000 for the year, which would be 634 percent on the issued shares”.

The Majority are Honest

Possibly we have found one of the “irresponsible” concerns mentioned. And if anyone wishes, I can give you some claims of other companies slightly less glaringly false. However, in my work with the tractor bill, through both branches of the legislature, a great majority of tractor companies honestly endeavor to place on the market a machine

that will come up to standards and will do what they represent it to do. I had one other fact in mind, namely, that the tractor industry is a national institution as far as the American farmer is concerned and no legislation confined necessarily to the boundaries of one state can necessarily fill the bill. However since Congress is so slow to act on anything of the nature, till they get a great deal of pushing, I am in for giving the push where ever we can.

Another relief that the Nebraska law is intended to give the farmers is in connection with the maintenance of service stations. The following clipping from one of the state papers of last October will show the necessity for some relief. This clipping says:

“How Nebraska farmers have suffered serious losses, and production of foodstuffs has been decreasing through inability to replace broken and worn out parts of farm tractors and other farm implement and machinery is told by H. Peters of Hay Springs in a letter written to the governor. He declares the big implement and machinery concerns compel farmers to wait from ten to thirty days, or even longer for necessary parts, and in the meantime grain becomes too ripe and shells open upon the ground. He suggests that the state council of defense issue an order forbidding any new machine company to enter the state for the sale of its goods until it has provided a complete stock of repair parts and proper facilities for getting them to the farmers”.

Now we have taken up two reasons for the introduction of this legislation under discussion. A third is the matter of standardization. I notice in that there was a need for a metaphorical yardstick to be found in the tractor game. In preparing this bill I wish to acknowledge the assistance rendered by other members of the legislature and engineers outside of an official capacity. I also wish to state that, but for my personal effort, certain features would have been injected into this bill, which seemed to me were unfair to responsible concerns.

If this law brings out a better understanding between the producer and consumer in the tractor industry, it will be the chief reason for the framing of this legislation. The farmer has always protested against certain practices in the tractor business, but he has protested singly. Now he speaks with a voice that, at least, is being given attention.

It was reported to me that one Eastern company intended to contest the Nebraska law in the courts. I am glad that it has reconsidered this decision. If there are any defects in the way the present law works out, or if it is shown to be unfair in any way to the manufacturer, I shall be glad to receive suggestions relative to the matter of a remedy or improvement. *Wilmont Crozier*

Tractor Testing Laboratory and Track

As authorized by Crozier's bill, a laboratory building and outdoor test track was constructed just North of the Agricultural Engineering building. The following is a

description of the building and track from an undated history by Professor George W. Steinbruegge who served on the Tractor Test Board :

“The Tractor Testing Laboratory was constructed 1919 to house the belt dynamometer and the fuel, tools and offices of the tractor testing crew. The original building of hollow tile and stucco construction was 41 feet wide and 82 feet long with a 14’ ceiling. A 150 HP Sprague electric dynamometer was installed for conducting the belt tests. Twenty two percent of the wall space was window and door openings to provide adequate ventilation. Two exhaust fans were also installed in the ceiling of the building. Fuel weighing scales and speed counters were also installed.

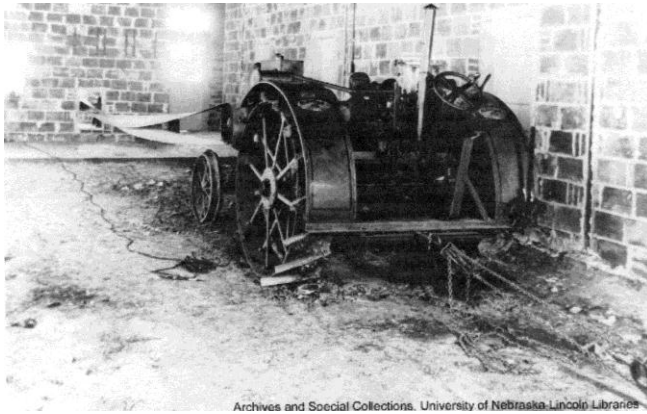


Figure 39. Belt test #1, The Waterloo Boy tractor sits in the newly constructed Tractor Test Laboratory driving the dynamometer through an opening in the wall.

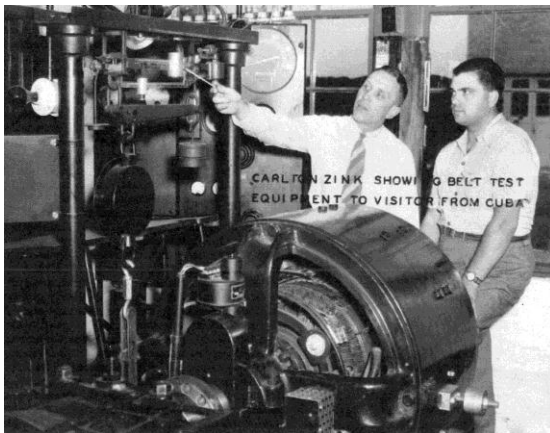


Figure 40 Carleton Zink explaining the use of the Sprague dynamometer which consisted of a large 125 HP generator, scales and resistance bars to measure belt horsepower.

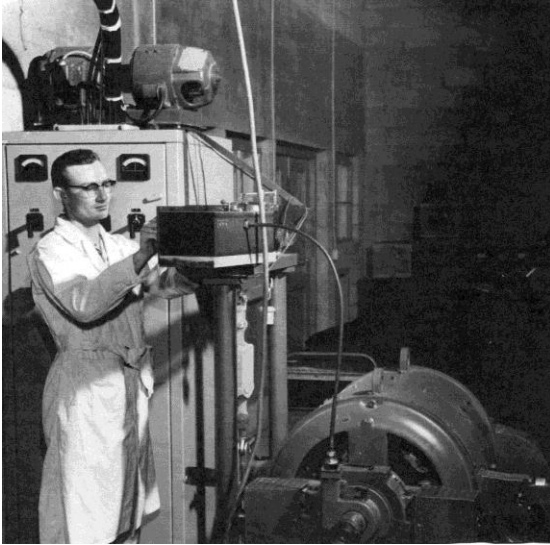


Figure 41. The 40 HP dynamometer. The testing of tractors less than 40 HP was discontinued in 1989 as they were not considered large enough for production agriculture.

The outside drawbar testing work was done on a one-half mile oval track consisting of 3 parts cinders to one part clay. Graders, rollers, drags and sprinklers were used to maintain uniform traction conditions on the track. A dynamometer car was constructed to furnish the drawbar load in these tests. A Gulley Tractor Dynamometer was built into the dynamometer car to give a record of drawbar pull, distance traveled and time. An integrating device was included to give direct readings of work accomplished. After the first year's usage, the cinder track was found to be inadequate for the use it was receiving. The pulverization and grading required to maintain a uniform test track was causing the cinders to disappear into the soil. The track was allowed to revert back to its original clay condition. In 1956, a new and enlarged test track of reinforced concrete was constructed on the site of the old test track. This concrete track was for use in testing pneumatic tired tractors. A new and larger earthen test track was then added outside of the concrete track for use with crawler tractors.

In 1951, another dynamometer room was added to the east side of the original building. In 1953m a 40 HP General Electric dynamometer was installed in this addition for testing small tractors. In 1962, a second addition to the original building was constructed to form the NE portion of the laboratory. In 1964, the 40 HP dynamometer was removed and a 400 HP Westinghouse dynamometer was installed to test the PTO output of large tractors. In 1979, the tractor test operations were moved from the original building to a newly constructed Laboratory building northwest of the old tractor test building. The concrete track and encircling earthen track continue to be used for drawbar testing".



Figure 42. Concrete test track with Tractor Test Lab at left (east) end. Constructed in 1956 as a monolithic pour, without expansion joints, it improved accuracy of testing rubber tired tractors. An earth track extends around the concrete track for testing track-laying tractors.

The tractor test laboratory was moved to what is now the Splinter Laboratories in 1979. This became necessary because the increase in size of the tractors. Door width was increased from 12' to 18'. Water brake dynamometers with up to 1000 HP were installed. Manual processing of data was replaced by electronic instrumentation. In 2040 the dynamometer test car was replaced by a much larger unit and in 2008 the concrete track width was increased from 12' to 16'. In 1975 sound level tests were added and in 2000 hydraulic lift tests were introduced.

Tractor Testing Load Cars

The measurement of tractor drawbar horsepower was accomplished using an instrumented load car that was attached to the tractor drawbar, and it then towed as many draft tractors as required. The load car was attached to the tractor drawbar by a hydraulic piston with an internal spring. As it was compressed by the pull of the tractor the increased hydraulic pressure was measured by a pressure gage of the type used to measure steam pressure. The pressure actuated a pen then moved across a strip chart driven by a ground wheel so that the pressure was recorded as the tractor moved down the test track. The pressure recorded on the strip chart was then measured with a planimeter and draft was determined from the area under the curve. This was a very exact and laborious process. A large dial gage in the test car allowed continuous monitoring of the pressure by technicians riding in the test car. Fuel consumption and wheel slippage were also determined.

Over the years there have been a series of test cars as technology advanced. The first car consisted of an open box housing a Gulley tractor dynamometer, mounted on an Illinois tractor frame being pulled in reverse. The integrator was used to give a direct reading of

horsepower. A technician rode in the box and steered it around corners. This is obviously a very clumsy arrangement and it was soon replaced.



Figure 43. First tractor test car consisting of an Illinois tractor being pulled in reverse driving the engine in reverse to load the tractor. A Gulley Tractor Dynamometer with a mechanical integrator was used to read and record instant horsepower. This is the first trial, testing a Minneapolis 12-25 tractor. The tractor was withdrawn and re-tested as Test # 12. Testing in snow proved impractical.



Figure 44. Test car number 2, using a load tractor which in turn is pulling a steam tractor for additional draft.



Figure 45. Test car number 3 designed by Charlie Adams in 1938, pulling a revised load tractor using the tractor engine as a compressor to provide the load..



Figure 46. Test car number 4, with the Adams car mounted on an Oliver 1855 which serves as an integral load unit. The test car was now self propelled if necessary.



Figure 47. Test car number 5 built on a Caterpillar D300 dump truck frame. Load is provided by a hydraulic pump using four cooling fans as can be seen.



Figure 48. Steiger "Tiger" III tractor with test car #4 and 2 load units. Maximum drawbar horsepower was 356.58. Up to six load units have been used to provide draft.

In addition to the testing program, the Tractor Test Laboratory has also conducted research on the noise level of tractors and its effect on hearing loss of farmers. University Admissions, as a part of their entrance program tested the hearing acuity of entering students. Students from farms were identified with a hearing loss which they called "tractor ear". Working with audiologist Irv DeShayes and in cooperation with Dr. Morris Schneider, Industrial Engineering, Ned Meier measured the noise level of tractors being tested. Many of them exceeded the level recognized as causing hearing loss for his M.Sc. Thesis. The Board, in cooperation with industry engineers, began publishing the noise level of tractors in the test report. The result was a quick response by tractor manufacturers lowering sound level to acceptable values.

In addition to the overturn demonstrations showing the hazard of operating tractors on steep slopes or making rapid turns, originated by Prof. Hurlbut and utilized by Delbert Lane and Rollie Schnieder, in Extension demonstrations, Prof. Steinbruegge and Tractor Test Laboratory personnel conducted tests and demonstrations of the protection offered by proper design of rollover structures. Properly designed they may deflect but not intrude into the operator safety zone on the tractor. Again cooperating with industry engineers, standards were developed and Tractor Test personnel now witness the company tests of cabs or rollover bars to assure that they meet the standards for protection.

A third addition to the test procedures is measurement of the hydraulic lift capacity of the 3-point lift for equipment. The weight of multiple row planters was exceeding the capability of the lift high to clear the soil quickly enough to make a turn at the end of the row so tests were added so that farmers would know if the tractor would handle their equipment.

Engineers-in-Charge of Tractor Testing

1920, Claude Shedd,	44 tractors
1920-1921, Fred Nohavec,	35 tractors
1921-1926, E. E. Brackett,	35 tractors
1926-1930, Lew Wallace,	54 tractors
1930-1941, Carlton Zink,	206 tractors
1946-1975, Lester Larsen	374--to
1974-1998, Louis Leviticus	
1998-2006, Leonard Bashford	
2006-----, Roger Hoy	

By the end of this year (2011) over 2000 tractor models will have been tested since the first test in 1920. (*Dr. W. E. Splinter*)

LIVESTOCK WASTE MANAGEMENT

The Department of Biological Systems Engineering, in collaboration with the USDA Agricultural Research Service (ARS) in Nebraska, has been a national leader in animal waste management since problems arose nearly 50 years ago, when livestock production began its trend toward consolidation, confinement, and increased size of operations. In the 1960s, reports of fish kills caused by manure from livestock and poultry facilities brought a great deal of attention to the industry. In the mid-1960s through the 1970s, research and extension efforts in Nebraska were led by Ole Olson, Norm Teter and Otis Cross along with ARS engineers Norris Swanson and Conrad Gilbertson. They teamed up with UNL and USDA scientists from other disciplines to develop affordable livestock waste management systems for beef feedlots, as well as for dairy, swine and poultry farms. Annual progress reports, at joint meetings of state and federal personnel, state regulators, SCS (now NRCS) engineers and livestock industry representatives, fostered communication and accelerated early application of research results. As a result, designs for runoff control pre-dated U.S. EPA regulations for open lots. In the early 1970s, when EPA raised the requirements from a 10-year, 24-hour design storm to a more restrictive 25-year, 24hour storm, Nebraska livestock producers were already in compliance. In addition, their work showed that beef cattle feedlots did not pollute groundwater due to highly compacted lot surfaces. Agricultural engineers from the Department and USDA-ARS continued to work closely with consultants and SCS engineers on demonstration projects and educational programs throughout the 1970s to bring the latest research findings to the industry. One of the seminal publications of this era was by Conrad Gilbertson "Estimating U.S. Livestock and Poultry Manure and Nutrient Production", which was still being quoted in the 1990s when, as discussed subsequently, attention returned to pollution from livestock waste management.

Working with the early pioneers of animal waste management in the Department during the 1960s and 70s was a group of students and staff who later carried on much of this

work with ARS, universities and agencies around the country. Some of these individuals were Jeff Lorimor, Lloyd Mielke, Jack Nienaber, Gary Riskowski, Dennis Schulte and Ray Tharnish. Others were Dennis Heitman and Gary Buttermore, now with Nebraska Department of Environmental Quality (NDEQ); Jack Sukovoty, formerly with NDEQ now a consultant; Gary Frecks and Marlin Rolfes, now involved in farming; Marlin Peterman and Steve Oltmans, now the Papio NRD in Omaha.

In 1978, Jerry Bodman, Elbert Dickey and Dennis Schulte joined the Department faculty. Elbert provided expertise in feedlot runoff management and land application while Jerry concentrated on facilities, lagoons and manure storage. Soon thereafter, Dale Vanderholm came to UNL to serve as Associate Dean of the Agricultural Research Division and lent additional expertise to the livestock waste management effort in Nebraska. In the 1980s, the focus on animal waste management shifted from prevention of water pollution to using animal manure as a source of energy. Otis Cross did some early work on anaerobic digestion in the mid-1970s, and in the early 80s, Dennis Schulte and his group built a full-scale swine manure digester as part of the Department's Energy Farm near Mead, NE. When the USDA ARS Meat Animal Research Center (MARC) was built in Clay Center, NE, Andy Hashimoto and Yud Ren Chen developed basic research on the kinetics of anaerobic digestion for optimizing biogas production from beef and swine manure. The work at Mead and Clay Center attracted world-wide attention during the - early and mid-1980s.

As the energy crisis of the 1980s subsided, research and extension activities on livestock manure management dwindled until the middle 1990s. Then, when increased size of livestock operations and lagoon spills in North Carolina made headlines, attention was again focused on livestock manure management. Three new issues arose: potential groundwater pollution from lagoons, earthen storage basins and runoff retention ponds; eutrophication due to phosphorus in runoff from land-applied manure; and odors from large livestock facilities. In response, Jack Nienaber, initiated new work on composting at USDA MARC and, with newly-hired ARS engineers Roger Eigenberg and Bryan Woodbury, began work on nutrient management and alternative methods of feedlot runoff management. Jack, Dennis Schulte, Dean Eisenhauer and David Parker (now at West Texas A&M) did work on seepage from feedlot runoff retention ponds. John Gilley, ARS engineer with the Department in Lincoln, initiated research on manure interactions with soil erosion and also did work on lagoon performance. Rick Koelsch joined the Department in 1995 and initiated a strong manure management extension and research program. Chris Henry joined the Department in 1999 to add to the effort as an extension manure management specialist. Rick Stowell came in 2001 as extension animal housing specialist and brought additional expertise in air quality and manure management to the Department's program. In the past decade, these individuals along with Dennis Schulte, USDA MARC engineers, and collaborators from other universities and disciplines have developed internationally known research and extension programs in beef feedlot manure management, seepage from runoff retention ponds, understanding gas and odor emissions from lagoons, modeling of odor dispersion from livestock facilities, and comprehensive nutrient management planning. Today, their graduate students are beginning their careers

at consulting firms and agencies around the country, much like those of past decades.
(*Dr. D. D. Schulte*)

INTEGRATED ENERGY FARM

Among the largest projects in the history of the University of Nebraska at that time was the Department of Agricultural Engineering Energy Farm during the late 1970s and 1980s. The Energy Farm was located on the University's Agricultural Research and Development Center (ARDC) near Mead, NE. The Energy Farm consisted of a series of projects involving a wide variety of energy producing and energy-conserving technologies, all with a goal of zero direct fossil fuel energy input while maintaining high levels of agricultural production using state-of-the-art production techniques.

The first component of the Energy Farm put into operation in 1977 under the direction of Drs. Bill Splinter and Paul Fischbach. Their's was a joint venture with engineers from the Massachusetts Institute of Technology. MIT engineers and those from the Department constructed a 25 kW photovoltaic (PV) array using 100,000 solar cells, which at the time was said to have utilized 75 percent of the world's supply of PV cells. The purpose of this project was to test the longevity and performance of the first generation of PV cells under rugged field conditions and to demonstrate the use of solar energy for pumping irrigation water and powering a natural air grain drying system. An 80 acre site at the ARDC was devoted to the PV project. As an alternative use of this solar-derived electricity, a 3 ton/year fertilizer generation plant, made possible by a grant from the Kettering Foundation, was added to site to produce calcium nitrate fertilizer for use on the corn being irrigated by the solar driven irrigation pump. The Kettering project also included a 12 foot diameter wind turbine to provide additional electrical energy for nitrogen fertilizer production.

In 1980, Drs Splinter and Dennis Schulte were successful in obtaining an \$813,000 grant from the U.S. Department of Energy (DOE) to construct an Energy Integrated Farm System adjacent to PV site. Nebraska's was one of six funded by the DOE. At 157-acres, it was the largest of the DOE projects, and was the only one focused on integrating several energy sources, energy conservation, and both crop and livestock production on one farm. The 157-acre site included the 80-acre PV site. The DOE grant added a 750-head/year farrow-to-finish solar-heated swine facility, an ethanol from sweet sorghum plant, ethanol-powered irrigation pumps, tractors operating on soy diesel and on 100 % ethanol, an anaerobic digester that converted swine manure into biogas for co-generation of hot water and electricity, and a greenhouse growing tomatoes, heated by waste heat and enhanced by CO₂ from the swine facility. The new project also included energy conservation practices such as irrigation scheduling, conservation tillage, natural air grain drying, windbreaks, and computer modeling and operations management. These energy production and conservation features were integrated with one another and were designed, built and operated to be compatible with modern technology and management practices.

Drs. Splinter, Schulte and Fischbach managed the overall Energy Farm project with the help of Department faculty and staff members Bashford, Bodman, DeShazer, Dickey, Gilley, Hanna, Heber, Kottwitz, Meyer, Milanuk, Pierce, Rein, Rolofson, Schnieder, Schroeder, Sullivan, Thompson and Von Bargen. Dr. Otis Cross returned from retirement to do some of the building design. The project was very interdisciplinary with valuable input from faculty in Agricultural Economics, Animal Science, Agronomy, Biochemistry, Electrical Engineering, Food Science, Forestry, Horticulture, and the ARDC. It involved a large number of graduate students who did all or parts of their M.S. and Ph.D. research on projects affiliated with the site. Graduate students included: M. Akhter, A. Heber, M. Kocher, D. Kottwitz, M. Lamb, J. Ma, M. Milanuk, J. Plessing, B. Rein, T. Siebenmorgen, N. Sullivan, B. VanSteelant, and Y. Li.

The Energy Farm was a source of a large amount of energy-related extension and research information from the late 1970s through the 1980s, and it served as a focal point for several of the Department's annual Tractor Power and Safety Days during that time. With numerous open houses, demonstrations, tours and so forth, the Energy Farm served industry and the public well, in era when energy interest was at a peak. It received direct and indirect support from more than 36 companies and trade associations. Many elements of the Energy Farm were decommissioned and removed from the site as energy research was de-emphasized at the federal level in the late 1980s. However, portions of the Energy Farm remain at the ARDC today. For example, although the swine buildings were decommissioned in 1992, they have been re-modeled for use in prawn (shrimp) production research by faculty in Forestry, Fisheries and Wildlife. The ethanol production building is now used for a variety of value-added research projects by UNL's Industrial Agricultural Products Center. The energy-conserving practices introduced at the Energy Farm such conservation tillage, irrigation scheduling, natural air grain drying, windbreaks, and so forth have been adopted nationally (*Dr. D. D. Schulte*)

CONSERVATION TILLAGE

Conservation tillage is the leaving of 30% or more of the crop residue on the surface to protect the soil from wind or water erosion, decrease drifting of snow, reduce field operations, conserve fuel consumption and greatly decrease time for planting originated from research at the University of Nebraska. The impact has been nationwide and is beginning to be adopted worldwide.

The rainfall in the Great Plains is limited and subject to extreme fluctuations. Bare top soil eroded into deep gulleys or blew away in strong winds. In the 1930's an extensive drought wiped out crops and the dust storms eroded the top soil and extended for hundreds of miles. Ivan Wood introduced terracing and soil and water conservation as an Extension Agricultural Engineer in the 1920's.

In 1935, two Agronomists, F. L. Duley and J. C. Russell, at the University of Nebraska began research to see if the soil could be protected and still allow farming (Duley and Russel, 1939, 1941). They contacted L. W. Chase, then President of the Chase Plow Co.,

Lincoln, NE. Chase's son Fred designed a "V" shaped sweep and Chase produced a machine with three 22" sweeps. In 1938 and 1939 Duley and Russell conducted extensive research and showed that the blades left relatively undisturbed stubble and that the next year's crop could be planted with a conventional semi-deep furrow grain drill.

Use of the sweep plow basically doubled the moisture held in the soil and more than doubled the yield of wheat over bare, plowed land. This system was the basis for "stubble mulch" farming.

In 1950, Lloyd W. Hurlbut wondered if corn could be planted directly into listed corn stubble, eliminating disking, plowing, disking and harrowing before planting. In the western Great Plains listers needed to be used to allow the corn to be planted into moist soil as the tillage operations had dried out the top 4 or 5 inches of soil.

In 1954, Russ Poyner, with IHC, donated two 36" sweeps that Rollie Schnieder mounted on a John Deere two row cultivator. They were unsuccessful so Rollie, a student at the time, shortened the sweeps to 16" and they were successful. They were then used in 1955 to undercut 80 acres of corn stubble and trash remaining from corn that had been mechanically picked in the fall. The field was then planted with a lister. The yield was excellent. Russ then donated a 4 row IHC planter in 1958 and the sweeps were mounted directly on the planter. This allowed planting corn in a single operation. However, all of the trash made cultivating difficult. Bruce Villars, an Ag. Eng. alumni who was farming near Minden, NE designed a cultivator that was successful in trashy rows.

Research by Dr. Howard Wittmus led the program that proved the attributes of this system. Wittmus, Bert Somerhalder, Delbert Lane and Norris Swanson found that leaving the trash and stubble on the field following the corn picker or combine captured snow during the winter, greatly decreased water and wind erosion and provided soil moisture for spring planting. The additional soil moisture allowed significant increases in yield. Eliminating the field operations prior to planting greatly decreased the fuel and time required to plant corn and the reduced time allowed more acres to be handled by one farmer. This research was conducted on the Agricultural Engineering Farm, the North Platte Experiment Station and the Roger's Memorial Farm. The till-plant system has been used continuously on one field at the Roger's farm since 1967 and the tilth of the soil has improved to the extent that it was re-classified by the Soil Conservation Service.

In 1960 this basic idea was adopted and first manufactured by the Fleischer Mfg. Co. of Columbus, NE as a planter modification. A rigid till-planter was marketed as the Buffalo Till-planter in 1961. The Buffalo All-Flex cultivator, adapted from Bruce Villars' design was then introduced in 1970.

In depth studies of the effects of planting systems, crop rotations, row direction and row spacing on soil erosion were conducted by Dr. Elbert Dickey and his cooperators. In field studies Dickey used a rotating boom rainfall simulator to research and demonstrate erosion under controlled conditions. His work demonstrated that the till-plant method

gave superior protection from soil erosion and required the least energy to plant crops such as soybeans and corn.

Gradually other manufactures began to develop and sell equipment that would allow the retention of stubble and allow planting and cultivation. The idea has spread to other states and is now even being promoted in California. Today either direct planting or disking and then surface planting are the dominant methods nation wide for planting corn, milo, soybeans and other row crops.

The impact of this research has been to obsolete the plow, regarded as the icon of agriculture. (*Dr. W. E. Splinter*)

CLOSURE

The Farm Machinery/Agricultural Engineering/Biological Systems Engineering program current and former faculty members at the University of Nebraska, as demonstrated here, has made a Statewide, National and World Wide impact on the efficient production of food. The quality of this recognition is evidenced best by peer professionals through recognized ASABE awards received by Nebraska alumni or professors. Since its inception in 1909 and until 2010, there have been 10 national presidents, 19 gold medal recipients and 33 named national award recipients. Currently there are 31 ASABE Fellows and two members of the National Academy of Engineering. This national recognition comes as a result of the professional excellence in research, teaching and extension.

It is the intent that this material be made available electronically rather than as printed material. In that way it is intended to be a living document in which additions can be inserted from time to time. *William E. Splinter--Editor*

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