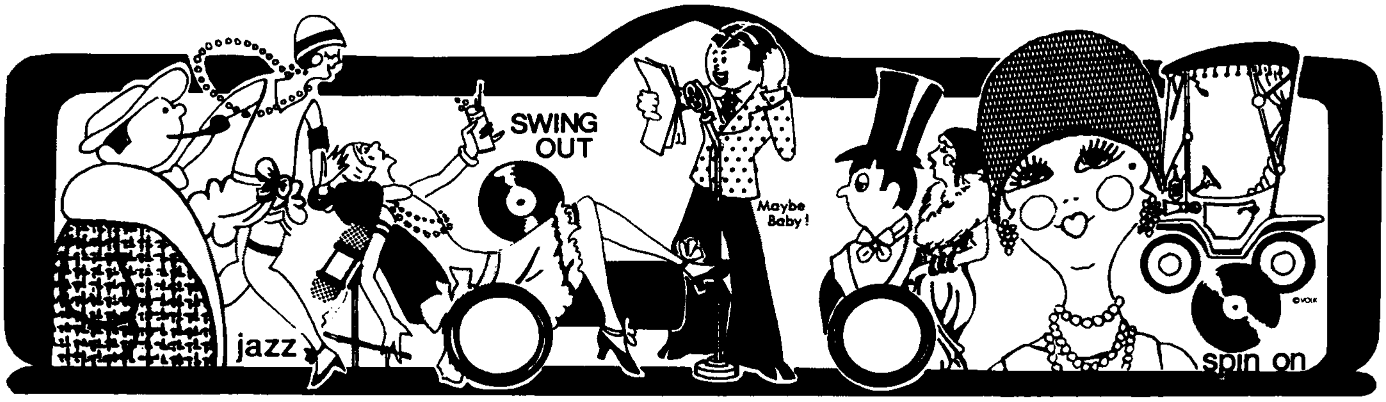


Continuous solvent extraction

Editor's Note: On Nov. 13, 1855, a patent to extract fat from bones and wool using carbon bisulphide was issue in France to E. Deiss. On Dec. 3, 1856, additional patents were granted the same inventor covering extraction of oil from oil bearing seeds. Development of solvent extraction grew relatively slowly until the middle third of this century when American farmers began to produce soybeans in previously undreamed of quantity. Continuous solvent extraction merged with American farm production to launch a giant new industry. Before the 1930s, American oilseeds were crushed in mechanical presses or expellers to product oil, with some batch solvent extraction efforts. American soybean acreage has risen more than a hundredfold since the 1920s and accounts for three-fourths of the domestic vegetable oil consumed in the United States. The development of continuous solvent extraction of soybeans is reviewed in these articles.

America in the 1920s roared with Model Ts, flappers, and music that wouldn't quit. Jazz was blooming in the land of cotton, and cotton, if no longer king, was tops in the nation as a source of textile fiber and vegetable oil.

Few in insular America had been watching what was happening across the Atlantic Ocean on the docks of a war-torn Germany, but at those harbors German scientists were building a new technology to extract oil from imported Manchurian soya beans. And deep within the United States, in places where jazz was heard but not understood, researchers and farmers pondered those same soya beans-how to grow them and how to use them.

Eventually the technology of continuous countercurrent solvent extraction would combine with ever-increasing soybean crops from America's heartland to surpass cotton as a vegetable oil source. If jazz developed from inspriation and perspriation, so did America's extraction industry—complete with tales of corporate intrigue, international blockades, and legal squabbles.

The pioneering efforts at solvent extraction in the United States may likened to Leif Erikson's discovery of America–the initial efforts did not produce lasting developments. Americans had little economic incentive to use solvent extraction before the 1930s, Warren Goss, a frequent writer on the industry's development, has said.

German industry, however, had developed with Warren Goss termed the multiple-contact, countercurrent batch system. A plant using such a system would have a series of kettles for batch extraction, usually ten, with solvent pumped through in series with freshly filled extractors at the end of the line where the full miscella would be taken off for oil recovery and recirculation of the solvent, Goss says. Each kettle held one to two tons of beans. The system required intensive hand control and manual labor, but it worked. The Germans would improve on the technology later to produce continuous countercurrent extractors.

In the United States, a solvent extraction plant at Southport Mills, New Orleans ran in 1917-19 on aviation-type gasoline and later benzene to remove oil from cottonseed cake, copra, palm kernel, and other oleaginous material, A.E. MacGee noted in 1947 article for *Oil Mill Gazetteer.* The experiment ended when business condition became normal in the United States after World War I.

The end of World War I left Germany with a shortage of fats and oils as well as animal feedstuffs. The Germans began to seek better ways to get the most out of their imported Manchurian soybeans. Two continuous solvent extractors using countercurrent principles were developed. The Bollman, or basket, extractor, was patented in Germany in 1919 and 1920; the Hildebrant, or U-tube, extractor, was patented in 1934.

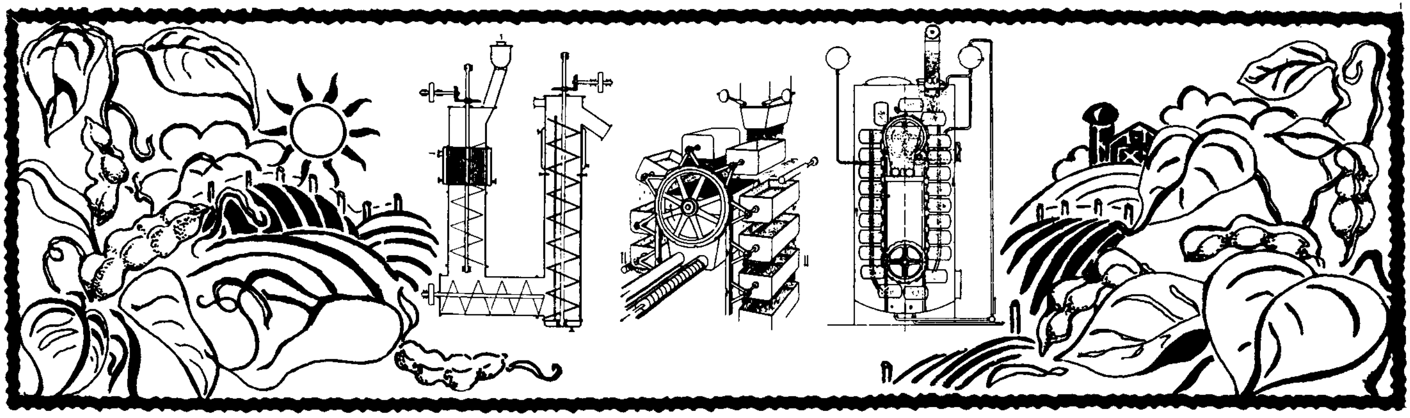
Solvent extraction also was being tried in the United States. In Monticello, Illinois, the Piatt County Soybean Cooperative Company operated a batch plant in 1923-24; Eastern Cotton Oil Company operated a Bollman extractor from Germany, at Norfolk, Virginia, in 1924-25. Both ventures proved unprofitable.

Prosco Oil in Norfolk ran a solvent extraction operation for several years. Prosco's Chief Chemist Clarence Eddy reported to a 1930 AOCS meeting, "During nearly eight years, oil has been extracted from five kinds of seeds and one type of presscake, using two different kinds of batch extractor and one kind of continuous extractor." For several years the firm depended on profits from oil extracted from presscake previously run through hydraulic extractors, Eddy said. MacGee says the plant was profitable until the Depression. Prosco did relatively little soybean extraction. Most early efforts at solvent extraction failed at least partially because of a lack of sufficient volume of soybeans.

The best publicized extraction effort in the United States was part of Henry Ford's soybean research plant at the Edison Institute (see accompanying article). Ford perceived farmers as prime customers for his Model T automobile and decided if he wanted farmers for customers, he would have to find a way for industry to become a customer of farmers.

"ADM and Glidden initiated large-scale solvent extraction of soybeans (in the United States) in 1934,"' John Cowan wrote recently in an introduction for a forthcoming volume on soybean oil. "By importing equipment from Germany for the manufacture of oil, meal, and phosphatides. The plants processed about 100 tons a day."

The ADM and Glidden plants were both in Chicago and both utilized Hildebrandt, or U-tube, extractors with a petroleum of the hexane type as a solvent. The ADM plant went on stream in March 1934, MacGee says, with the Glidden plant following about November 1934.



...the early beginnings of a giant industry

On Oct. 7, 1935, the Glidden plant at 1845 N. Laramie Ave. reopened after being shut down for five weeks. At 11:40 that morning the plant was destroyed in an explosion that shattered windows as far as a mile away and rained bricks on nearby structures. Eleven persons died and 43 were injured. The five-story palnt collapsed into rubble so tangled that the 11th body was not found until three days after the blast. The explosion apparently was triggered by a solvent leak, Goss notes, but several teams of investigators failed to pinpoint the precise cause. Newspapers quoted survivors as saying the extraction room was restricted to only a few employees and was called the "secret room." Cowan says the plant was immediately rebuilt at double its original capacity.

In those early 1930s while Ford was looking for industrial uses for soybeans and the first large-scale plants were rising in Chicago, Procter & Gamble in Cincinnati had set Norman F. Kruse to work on soybean oil research. P&G was examining soybean oil for use in Crisco and salad oils. In January 1933, P&G shifted a recent Purdue graduate, R.P. Hutchins, to the project as Kruse's assistant. Kruse and Hutchins became friends, a friendship that would endure corporate animosity more than a decade later when each was with a different firm.

"Kruse was a wonderful man," Hutchins recalls. "He set about to teach me everything he knew. He was completely unselfish." Kruse directed lab work with Hutchins, letting Hutchins write the reports so Kruse could spend more time working with the pilot plant crew.

In September 1936, Kruse left P&G for Central Soya and Hutchins became head of P&G's soybean research efforts. Hutchins says Kruse left because he wanted to work on soybean oil extraction on a larger scale. If so, Kruse went to the right place. In 1936, the two-year-old Central Soya firm sent Kruse and Harry C. Offutt to Germany to study continuous extractors.

Kruse and Offutt recommended that Central Soya buy a Bollman (basket) extractor.

That recommendation, however, carried some problems for Central Soya. The capacities were greater than Central Soya had anticipated or was prepared to handle. Dale W. McMillen, founder of Central Soya, told Kruse and Offutt in January 1937 during a trans-Atlantic phone call to go ahead and buy—and to buy the largest size available, not the smallest.

"This decisions came when the economy was still on the rocks, the solvent extraction process was new, and the future of the soybean was still regarded with skepticism by many," McMillen's son, Harold W. McMillen told an Indiana dinner audience in 1966.

The 275-ton-a-day plant, the largest of its time in the United States, went on stream in November 1937 in a five-story structure beside a cluster of 110-foot silos that increased Central Soya's storage capacity by a million bushels.

The initial soybean meal produced was off-color, too dry and had a solvent odor, Harold McMillen said. Animals did not like the meal. Toasting solved part of the problem and a patent was sought and granted. Another idea at the time—using steam to add moisture—was not pursued immediately. It would be later to greatly improve the feed quality of soybean meal. It also would figure in a patent dispute with French Oil.

Meanwhile, other companies began building plants based on the German process. The Clinton Company of Clinton, Iowa, put a 50-ton-a-day corngerm plant in operation during August 1936; Hiram Walker & Sons in Peoria, Illinois, activated a 100-ton-a-day distillers grain plant in the summer of 1938; later that fall, Honeymead Products Company opened a 100-ton-a-day plant at Cedar Rapids, Iowa.

Americans patents began to be issued for continuous extractor systems. Michel Bonotto received patents in 1937, 1938, and 1939 for a system later modified by Allis-Chalmers and V.D. Anderson. A.B. Kennedy had patented a paddle-wheel type continuous extractor in 1927.

ADM and Glidden had broken the trial. Central Soya's 275-ton plant was a milestone—and was to be a factor in the entry of French Oil Mill Machinery Co. and Blaw-Knox into the continuous extraction industry.

Kruse's former employer, Procter & Gamble, had a subsidiary firm in Louisville that produced cottonseed oil for P&G products, Hutchins says. Cotton acreage around Louisville was declining, soybean acreage was increasing. P&G decided to buy a Bollman extractor from Germany for a new plant in Louisville.

In September 1939 with ground broken and foundations started in Louisville, and the extractor sitting on the Hamburg docks for immiment shipment to the United States, England declared war on Germany and a blockade of her ports. Hutchins recalls the German manufacturer said the extractor could be delivered via overland routes to Italy, still neutral at that time, for shipment to the United States. P&T, perhaps mindful that its English operations depended on government allocation of scarce raw materials, decided not to try to circumvent the English blockade. Instead, P&G turned to Piqua, Ohio, where French Oil Mill's C.B. Upton recently had hired Harry Robinson as solvent plant superintendent. Robinson had been with Central Soya when the Decatur, IN, plant was built, but apparently he and Kruse had clashed. Robinson left and brought his know-how to French Oil.

French Oil told P&G it could produce a virtual copy of the Hansa-Muhle V. Bollman unit stranded on the Hamburg docks. Allis-Chalmers preparation equipment was to be used, but the extractor was the first one built in the United States by French Oil. The extractor based on Central Soya's unit, when into operation during February 1941.

Blaw-Knox had decided during the 1930s to enter the extractor production field also, but it was not until 1943 that concerted effort began. Dr. H.B. Leslie had been hired as Blaw-Knox technical director in 1936. He had acquired an interest in soybeans while working in Decatur, Illinois, according to George Karnofsky, whom Leslie recruited for Blaw-Knox in 1943. During 1943, Leslie, H.B. Coats, and others visited Decatur, Indiana, to examine Central Soya's plant. They came back able to put together a plant based on the German concepts, Karnofsky says, but it would have been essentially identical to the one offered by French, who had lower costs. Blaw-Know decided it had to develop new equipment and concepts that would be less costly.

Karnofsky says Leslie had promised Central Soya free engineering services for a plant in exchange for the 1943 studies. There is no indication Central Soya ever accepted Leslie's offer, possibly because of the firm's different approaches to toasting soybean meal.

Blaw-Knox decided to invent. The first commercial plant it built for Allied Mills employed vapor desolventizing and pressure toasting. Karnofsky was assigned to develop an improved extractor.

At the time he was working, Karnofsky recalls, there was still a carryover impact from Henry Ford who was very much interested in doing something for the farmer, or at least promoting soybean production in the 1930s.

"Ford said at that time that soybeans would never be raised in competition with corn unless someone could devise a small plant to put in a farmer's barn. He said the farmer would never give up his independent position to sell to a large company," Kanfsky says.

"Our salesman would come back from the field asking if we could develop a small plant concept, something less costly than the vertical basket but that would retain the best features. . . .something that would take up a small space and cost less."

Under the direction of Dr. Leslie (who died in September 1976), Blaw-Knox undertook fundamental laboratory and engineering studies of extraction. Karnofsky disclosed their findings in 1948 during a six-day short course at the University of Illinois.

The result of the Karnofsky and Blaw-Know work on a new extractor was the Rotocel. One of the first unveilings was at a 1949 AOCS short course where Karnofsky spoke on the theory and practice of solvent extraction. Dr. Cowan recalls the audience gave Karnofsky a standing ovation. The Rotocel patent was applied for in 1949 but not granted until 1958 because of litigation with an English firm with a similar design.

During World War II, materials for new construction were difficult to acquire. After the war, however, materials became available and businesses of all types began to expand. French Oil Mill, for example, had built six extractors between 1940 and 1945; from 1946 to 1950, they built 15; and from 1951 to 1955, they built 27.

Toward the end of World War II, Warren Goss, then with the Northern Regional Research Laboratory in Peoria, Illinois, made a trip to Germany to inspect oil mills and plants. He came back with a list of ideas for investigations, but also with the observation, "In general, the German technology appears to have lagged behind ours in the past decade." The United States, which began by borrowing German technology, had surpassed its teacher.

Meanwhile, Central Soya and French Oil had drawn closer when Hutchins became head of the Ohio firm's solvent extraction division. Kruse and Hutchins retained their friendship from their days at P&G. French Oil was picked to build a 300-ton-a-day plant for Central Soya at Gibson City, Illinois. The plant was later virtually duplicated for Minnesota Linseed Oil Co., Minneapolis, Minnesota, in 1948; for Swift at Champaign, Illinois, in 1949; for Plains Co-Op, Lubbock, Texas, in 1950; and for Lauhoff Grain at Danville, Illinois, in 1952.

While driving from Piqua to Gibson City one day in 1948, Hutchins says, he mentally calcualted as he drove that the steam required to desolventize the flakes while condensing on the meal would be almost exactly equal to the amount of water then being used to humidify the meal in order to produce a toasted product. He discussed the idea with Kruse and others at lunch that day in Gibson City and recalls Kruse saying it sounded good and paralleled some thinking Kruse had been doing. A co-worker of Kruse says in later years Kruse talked of working out calculations on the back of paper napkins.

Central Soya agreed to have French Oil build a pilot unit for the process at the Decatur, IN, plant. The pilot tests were very promising from an operational point of view; in addition, Central Soya, with its background in animal feedings, recognized superior nutritional value in the desolventizer-toaster meal over that of previous processes. In 1949, Hutchins and French Oil filed for a patent.

In 1952, Hutchins and French Oil were dumbfounded when Central Soya received a process patent for desolventizing with steam that showed as one of the illustrations a schematic version for the desolventizer-toaster unit. The Central Soya patent application had been filed in 1950.

The resulting patent interference dispute was settled with French Oil agreeing to pay a royalty for using the steam injection system, for which Central Soya had received the patent. French's patent on the desolventizer-toaster unit was approved in 1954.

By the end of 1952, French had already sold more than 30 units and the desolventizer-toaster was on its way to becoming the industry standard.

Further litigation was avoided, Hutchins says, in the interest of maintaining harmony in the industry. In addition to the 1952 process patent, Central Soya later obtained a product patent and two machinery patents covering improved designed. Hutchins says his friendship with Kruse continued through the patent dispute.

The Rotocel patent dispute was resolved with Blaw-Knox prevailing in the United States and eventually licensing overseas manufacturing rights. Simon-Rosedowns and Krupp are among current licensees. There were to be more patent squabbles as the industry evolved.

Since the early 50s, extractors have continued to increase in size. The Rotocel was designed partially in response for requests for a small extractor. Some Rotocel unit now handle up to 3,000 tons a day.

French Oil improved its early extractors and developed a horizontal extractors, rectangular basket extractor and a stationary basket extractor. A 3,000-ton-a-day unit was under construction in 1976 for Swift in Des Moines, Iowa.

Crown Iron's Glen Brueske, in an article last year, commented, "In summary, the solvent extraction process has been around a long time. Today it is basically the same process that has been used for 25 years. The process differs mostly only in subtle refinements which have been made in flowsheets and machinery. Also extraction plants are getting larger, some of the soybean plants are operating in the 3,000-ton-a-day range."

No radical changes have been made in 25 years—which may mean some are due soon. Soy protein is increasingly used for human food. New soybean hybrid seeds may increased yields 20 to 30 percent. New uses and more soybeans may spark changes to produce a meal better suited for conversion to human foods—perhaps in new solvents, perhaps in new machinery. ●

● R.P. Hutchins, recently retired from French Oil Mill Machinery, says he recalls the hazards of early solvent extraction quite well. "I used to point out during my talks in those days that most of the early patents in the field were take out by heirs of the inventors." ●

Solvent extraction still growing

While the accompanying article traces the early history of solvent extraction in the United States, a dramatic surge in use of continuous solvent extraction worldwide has occurred since 1963, according to figures from eight major extractor manufacturing firms.

According to figures supplied by the eight cooperating firms, by 1945, their combined total of continuous extractors built was a half-dozen. Between 1945 and 1950, 30 were built; by 1955, 97 had been built; between 1955 and 1960, 91; between 1960 and 1965, 156; between 1965 and 1970, 159; and, since 1970, 218 continuous solvent extraction plants have been built. And as the numbers have increased so has the capacity. Some units now can process up to 3,000 tons of soybeans a day. The number of extractors listed above does not include more than 160 Rotocels that Dravo has sold for which no year-by-year totals are available.

The eight firms whose figures were used are Construzioni Meccaniche Bernardini, Crown Iron, EMI, Extraction De Smet, French Oil Mill Machinery, Krugg Industrie-und Stahlbau, Lurgi Apparate-Technik GmbH, and Simon-Rosedowns.

Several of those firms have entered the field since World War II. The most notable exception to that statement is Simon-Rosedowns, which has been at the same site since 1777. The firm may well be the oldest oil mill machinery manufacturing firm in the world. Its site in Hull, England, was an early center for linseed crushing. In 1868 the firm shipped a hydraulic oil mill to China where, the company says, workmen hastily fled when they saw the hydraulic press rams rise noiseless out of their cylinders, "attributing the operation to the work of devils who were pushing up the rams." Local residents became frightened as well and the plant had to be moved from Chefoo to Newchwang before it could be operated.

The Hull site of Simon-Rosedowns began producing batch solvent extraction equipment in 1898; its first continuous solvent extractor was built in 1949-50. Simon-Rosedowns solvent extraction plants can process all types of oilseeds. The firm has supplied about 50 continuous solvent extraction plants since 1957.

Krupp Industrie-und Stahlbau, in Harburg, traces its entry into oil extraction to the firm G. Koeber's Eisenhutte, founded in 1855 in Harburg, which began producing installations and machinery for palm oil production in 1870. The firm's equipment is for all phases of oilseed processing. Since 1961, Krupp has built 33 continuous solvent extraction plants around the world with "Rotocel"-type extractors.

Extraction De Smet S.A. was founded in 1946 by J.A. De Smet, at that time an engineer and manager for a large Belgian oil mill. De Smet offered a process that was simply mechanically more flexible and more economical in solvent consumption than others available at that time, the firm says. Plants were sold mainly in Europe until 1952 when worldwide sales began rising toward the current total of 263 plants since 1945. The firm now emphasizes the overall performance of its extraction system from seed preparation through meal desolventing and conditioning units.

Lurgi has been in the oilseed extraction business since 1946. Through 1955 it supplied 35 solvent extraction plants with Bollmann extractors as a licensee of Hansa Muehle. Now the firm markets the Lurgi frame belt extractor and since 1955 approximately 125 plants have been supplied by Lurgi. Lurgi Apparate-Technik GmbH is the Lurgi division handling oilseed extraction equipment.

EMI, a U.S. firm with headquarters in Des Plaines, IL, was founded in 1957 and began building solvent extraction plants in 1959. The plants may be built with extractors of various designs and types. The firm has built, sold or helped design and install ten extractors and has completed more than 500 projects in various oil extraction and refining plants, many of these associated with operations improvements in operating extractors.

Crown Iron of Minneapolis, MN, entered the extractor field after World War II and has now sold or built 59 of its unique extractors.

French Oil, whose entry into the field is described in the accompanying article,has built 143 continuous solvent extractors through this year. ●

One effort to produce a small, safe extractor during the 1930s and 1940s led to an unexpected result—the death of cattle that ate meal processed through a trichloroethylene extractor developed at Iowa State University.

Trichloroethylene was selected for possible use because it is nonflamable at normal temperatures. The Iowa State researchers wanted a small plant that could foster decentralized industry and provide minimum transportation costs for moving beans to a plant and processed meal back to the farms.

O.R. Sweeney and L.K. Arnold, in the December 1949 *JAOCS*, noted that trichloroethylene was nonflamable and that it was an excellent solvent for removing oil from soybeans.

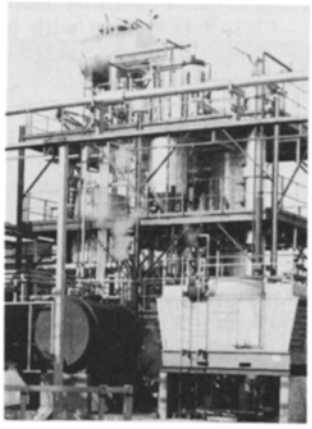
There were obscure warnings of potential danger. "In England, before World War I, cattle were killed with the bloody nose disease that was traced to soybean meal extracted with trichlorethylene," John Cowan says. "In the low countries in 1922-24, in Holland, Belgium, Luxemburg, Northern France, cattle were again killed and trichloroethylene extracted soybean meal (TESOM) was implicated. In the late 1930s through about 1947, soybeans were extracted with trichloroethylene in quite a few small plants with no apparent bloody nose disease."

Arnold, now retired in Texas, says Iowa State shipped quite a lot of the meal to Cornell University where tests were run on two sets of cattle. "Since Cornell reported it as nontoxic, we assumed it wasn't," he said.

He now thinks the reason toxicity didn't show up in the feeding tests "was that the amount they used in the feed mixture was too small. If mixed with other feed as a protein supplement—not used to the amount most farmers would be using it later—it wouldn't be likely to show up as causing any trouble."

Whatever the reason, the danger went unperceived.

Iowa State licensed Crown Iron Works in Minneapolis to sell the extractor. Crown Iron had not been in the extraction industry before, but with the end of World War II had begun to look for ways to diversify, according to Joe



Givens, now manager of Dawson Mills at Dawson, MN. He was to be manager for Crown Iron's pilot extractor plant.

Iowa State has built a pilot plant in Plainfield, IA. Crown Iron's first plant began to go up in Glencoe, MN, in 1949 and was completed in 1950. Plants were to follow rapidly at Blooming Prairie, MN; Granite Forks, SD; Townsend, IN; Vermont, IL; and Fremont, NB.

But in December of 1951, Givens recalls, the roof fell in. Cattle had begun to keel over and die within 35 days. The meal reacted in the ruminants' digestive tract in a unique and fatal manner. Swine and poultry fed the feed did well.

"By January of 1952, I would say all of the plants had closed down with the exception of Dawson Mills," Givens says. "What we did here was to remove the pressure toasting. We scrubbed the meal in process with live steam that either removed the trichlorethylene or the toxic material." The Dawson plant also labeled its product "not for ruminants."

Crown Iron plants were converted to hexane solvent and the firm stayed in the extraction industry, building its first 200-ton extractor in 1959; it recently completed a 2,000 ton plant with two extractors and is finishing a 1,500-ton, one-extractor plant for MFA this year. It also markets a desolventizer toaster-dryer-cooler.

Dr. John Cowan notes the fatal reaction seemed to be more a problem with early crop soybeans. "Trichloroethylene probably reacted with SH groups in the meal to produce agents that caused the bloody nose disease and aplastic anmeia," Cowan says. "S (*trans*-dichlorovinyl)-L-cysteine prepared by McKinney et al. (*J. Am. Chem. Soc.* 79, 3932, 1957) at the Northern Regional Research Center produced fatal aplastic anemia when fed to calves at Iowa State University."

The precise reaction between solvent and meal and cattle was never pinpointed. •

Willkommen!

Benvindos! Benvenuti!

Bienvenus!

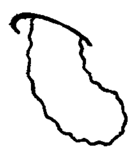
Bienvenidos!

A WORD OF WELCOME TO NEW MEMBERS AND PARTICIPANTS FROM OTHER COUNTRIES

The 1977 Annual Meeting will benefit substantially from the collaboration of new members of the Society, members as yet not widely acquainted, and foreign scientists. We cordially welcome you to this Meeting, and offer our assistance to help you enjoy, to the fullest, both its scientific and social aspects.

The Welcoming Committee will maintain a post in the registration area, at which it will stand ready to help you, whether in finding a particular scientist, in meeting one another informally, or in taking part in a social event. If, in reserving places for the Wednesday-night banquet, you will mention your wishes to the Entertainment Committee, an effort will be made to place you at a table with congenial companions.

Our constant aim is to catalyze the solvent-controlled melting of the ice, the gradual dissolution of xenophobia, and the full enjoyment of all manifestations d'agrément.



Arthur and Betty Wrigley,
Frank and Sally Luddy
Welcoming Committees

Henry Ford & The Soybean

The pond lay behind the Wayside Inn in Sudbury, MA, and during the cold winter months it would freeze. Robert Boyer, teen-aged son of the inn's manager, liked to sakte on the frozen surface, and so did the inn's owner, Henry C. Ford.

Boyer was 14 when he met the industrialist, then about 60.

The high school student and the automotive manufacturer would skate and talk during Ford's winter visits to the inn. They became friends. Three years later, when Boyer's graduation neared, Ford asked the youth what his plans were.

"I'm going up to Dartmouth," Boyer told Ford.

"What're you going to study?"

"I don't know; I haven't decided yet."

"Tell you what, Bob," Boyer recalls Ford saying, "Why don't you come out to the (Michigan) plant, spend some time in each of our divisions until you decide what you want to do and then go to college."

Boyer leapt at Ford's offer to return to Michigan, where Boyer's father had been office manager at Henry Ford Hospital, Detroit, before moving to Sudbury. Boyer's return to Michigan was the start of a partnership that would produce the most publicized of the early efforts in solvent extraction of soybeans. While oil-and-meal plants elsewhere were also using solvents, it was the effort in Dearborn, Michigan, that would generate public interest in the mysterious Manuchurian soya bean.

In 1929, a few years after Boyer's shift to Micigan, Ford decided to found the Edison Institute. "It was supposed to be a school for inventors," Boyer says. "They (Ford and Edison) were both of the school that believes invention is 99 per cent perspiration and one percent inspiration."

Ford asked the 21-year-old Boyer to be director of the institute. The atumotive giant told him, "We'll bring the best and the brightest of the (River) Rough Trade School students over and give you problems to get you in over your head," Boyer recalls. "If you run into something where you think you need help, we'll call down to Ann Arbor and get some professors up here as consultants."

"We should call this the 'Place for Damned Fool Experiments,'" Ford said. "We don't want to look at anything smaller than an elephant."

When the Depression hit, Ford decided he had to do something to aid agriculture since he perceived farmers as major buyers of his Model T.

"If we expect farmers to be our customers, then we (industrialists) must become the farmer's customers," Ford was quoted as saying at the time.

Surrounding farmland was planted in various crops, Boyer says, and each day when he arrived at the three-story wooden building housing the institute there would be truckloads of a different crop—one time tomatoes, another time potatoes—for the youthful Edison Institute crew to analyze.

"We quickly ruled out the water content plants," Boyer says, and it wasn't long before the soybeans emerged as the best farm crop candidate for industrial use. By 1933, Ford had 8,000 acres planted in soybeans; by 1936 it would rise to almost 60,000 acres, the largest soybean barony in the world at the time (as the New York Times described it).

Edison staffers sought multiple uses for soybean components. They discovered the oil could be used as a base for enamel paints and the meal could be utilized for plastic car parts—if a way could be found to get the oil contact of the meal to below two percent.

"We decided to develop an extractor because the previous methods of extraction did not remove the oil to this extent with sufficient speed and economy," Harold Joyce of the institute staff told the 8th fall meeting of the AOCS in 1934 in Chicago. "The batch system of extracting oil is not continuous, and the time required for extraction is execessive. The pressing method is not continuous and the pressed meal contains too high an oil content to warrant its use. The expeller method is continuous but the meal also contained too high an oil content to be used."

"We wanted a Model T type extractor," Boyer says. "One which an individual farmer could operate so that in the summer he could work his farm and in the winter could run the extractor."

Ford's production-line outlook was seeking a way for the farmer to use profitably all his time.

The Ford extractor—which could be run by one man—was the result. The horn-angle flaker, for which Ford and Boyer received the patent, may yet be used commercially, Boyer says. The extractor could process six tons of beans a day.

Was the experiment profitable for the automotive firm?

"The enamel base paint paid for all the research all by itself," Boyer says. "Before that, all finishes were lacquer requiring several coats with hand polishing. It was a costly and time-consuming process."

Work on the meal yielded window frames, gear shift knobs, distributor parts and other uses. While soybean plastics cost more than steel per pound, finishing costs for steel were higher, thus making the soybean parts cheaper over-all. Efforts to develop a soybean plastic steering wheel failed—but that enamel paint covered the steering wheel.

In 1940, Boyer was cited by the U.S. Junior Chamber of Commerce (now the Jaycees) as one of the ten outstanding young men in the nation.

The Edison Institute continued its work into 1943 when was production requirements led Ford to shut it down. At its peak, the institute had 100 persons on the staff with perhaps 20 key staffers, Boyer estimates. The soybean research section was purchased by the Drackett Co. in Cincinnati. Boyer stayed with Drackett until heirs of the owner decided to disband the research unit.

Ford's efforts, however, had commanded nationwide publicity, even international through World's Fairs. The continuous solvent extraction process was among the first in the United States for commercial purposes, even if it was on a limited scale by today's standards. ●