DESIGN CONSIDERATIONS

"Farm buildings are the farmer's factory," wrote agricultural engineer E. A. Fowler in 1913. Thirty years later one of Fowler's colleagues wrote, "adequate buildings are as essential in the efficient production of farm products as up-to-date equipment is in the factory for producing manufactured goods" (Fowler 1913: 106; Kaiser 1943: 288).

Economist Martin Primack noted in 1965, "The construction and improvement of farm buildings in the United States during the latter half of the nineteenth century was a task of farm-capital formation exceeded only by the effort to clear the land itself" (Primack 1965:114).

The planning, financing, and construction of farm buildings was a significant part of the operation of every Minnesota farm, whether the owner was a German-speaking subsistence farmer in the 1860s, or a Wadena County dairy farmer expanding into turkey production in the 1950s. One farmer wrote in 1912, "I know of no work about the farm which requires better judgement than to plan and arrange a set of farm buildings" (Henry 1912: 137). Land and buildings were the assets of highest value on most Minnesota farms, followed by livestock and then machinery (Engene and Pond 1940: 42).

Farm building designs were generally slow to evolve, in part because of the buildings' considerable expense. Because of the risk involved, farmers often built structures with which they were familiar. (This helps explain the persistence of certain building practices within particular locales.) The University of Minnesota's John Neetzel and C. K. Otis wrote in 1959, "High initial cost limits the opportunities for experimenting with farm buildings. Once constructed, a building must remain serviceable for many years to justify the cost. Consequently we hesitate to take chances on buildings that vary a great deal from accepted construction practices" (Neetzel and Otis 1959: 21).

When planning new buildings, Minnesota farmers considered factors such as the following:

Economy in Construction. Economy was almost always important as Minnesota farmers made the significant investment necessary to construct a building. Funds for building construction were also needed for feed and livestock, machinery upgrade and repair, and food and clothing for the family, so farmers had to allocate resources carefully.

"In many localities a small barn is all that is needed," wrote University of Minnesota staff in 1936. They suggested farms could begin with a 16' by 18' barn for two cows, two horses, and hay storage, and Dutch doors to provide both access and ventilation (White et al 1936: 6-7). Similar advice went out to settlers in northern Minnesota's cutover region: "The first buildings should be small, but serviceable unless the settler has a large amount of capital. There is more happiness and comfort in small quarters that are within one's means than in a large place that is not paid for" (Worsham 1920: 18). Careful planning to make the best use of limited space was important, as was learning from the experience of others (Ashby 1916: 26).

See also

Designers and Builders
Building Materials
Barn Forms and Terminology
Appendix: Focus on Farm Journalism
Appendix: Focus on U of M Programs
Appendix: Focus on USDA & Minn Dept of Ag

In the early settlement period, most Minnesota farmers built small structures that might serve for 20 years as fields were slowly created, as cash crops eventually planted, and as settlers fought drought, storms, insects, illness, and other challenges of the frontier (Brinkman and Morgan 1982; Tishler 1986; Noble and Cleek 1995: 13).

Remodeling and enlarging farmhouses, barns, and other outbuildings was very common. Many farmers built modestly at first with the knowledge that they could expand a building later as production grew. Farm experts wrote articles and drew plans that promoted this practice and described how expansions could best be accomplished. In 1933, for example, a Midwest Plan Service catalog described a modest 18′ by 32′ shed-roofed, wooden barn (designed for four horses and four dairy cows) as being “rather complete and serv[ing] as a workable unit until funds permit additions” (Midwest Farm 1933). Some plans for farm buildings clearly showed the footprint of future additions.

Minnesota farmers also cut building costs by supplying their own materials when they could. It was common to use home-sawn timbers for beams, planks, and shingles. Logs were often hauled to a local sawmill and the cut timbers or boards then hauled back. Other native materials included field rock for foundations and sand and gravel for concrete. Window sash and some types of siding such as shiplap were generally purchased. One World War I-era author advised that farmers could lower construction costs by furnishing their own gravel, stone, rough lumber, and labor, but they should expect to pay for cement, shingles, paint, nails, hardware, and some additional construction labor (Ashby 1916: 27).

Farmers built structures with salvaged materials to reduce costs. Wood, which was traditionally the most popular building material in Minnesota, was highly-reusable, as well as being readily available and easy to work. One 1961 source suggested that reusing building materials was one way farmers could mitigate the fact that some farm structures would become obsolete as systems and methods changed (Neubauer and Walker 1961: 14-15).

For reasons of economy, moving buildings around the farm was also common, as was adapting structures to new uses. In the 1910s, proponents of the new field of “farm management,” including Minnesota’s Andrew Boss, suggested that farmers redesign the entire layout of their farmsteads (many of which had evolved somewhat haphazardly) along sound scientific and modern management principles, and then slowly follow the plan and reorganize structures, roads, and fields as time and resources would permit.

The cost of labor to erect farm structures was often considerable, but many farmers reduced this cost by doing much of the work themselves (and many had more time than cash). There were other labor considerations as well: in an article about the advantages of cement staves for silos (which were introduced in 1905 and proliferated in the 1910s), one expert wrote, “Speed of erection is a big argument to the farmer’s wife who is called upon to board the men” (Kaiser 1919: 9). The need to be cost-effective in new construction drove the quest for new materials that could be assembled more efficiently. Wartime labor shortages intensified the situation and eventually led to prefabricated buildings.

One answer to economy in building was standardization, which lowered costs by simplifying construction and reducing the number of unique building materials and parts needed.

Standardization encouraged the factory production of parts and reduced "the variety of materials carried by local dealers" (Ashby 1949: 237). Standardization changed building designs in several ways. Door and window widths, for example, were standardized to allow the use of factory-made sash, and the width of cow stalls was standardized to to allow farmers to buy factory-made stanchions.

The desire to encourage standardization was one factor that compelled 12 land-grant colleges, including the University of Minnesota, to jointly create the Midwest Plan Service (MWPS) in 1932. (See this context study's "Designers and Builders.") In one barn plan developed by the MWPS in the 1930s, 75 percent of the lumber needed was standard-sized dimensional lumber that required no cutting before placement (Giese "Midwest" 1957; Giese 1943: 70).

Standardization also sped the dissemination of ideas. One agricultural engineer explained in a 1942 article on corncribs, "prefabrication of storage structures can play a much greater part in this market than it has in the past. It is much easier to demonstrate to a few manufacturers the basic requirements for corncribs, than it is to educate all the farmers who grow corn [and build their own structures]" (Malcom 1942: 83).

Standardization was largely a post-World War II phenomenon. According to farm building expert Henry Giese, there was still "comparatively little standardization in the farm building field" by the 1940s (Giese 1943: 70).

Farm Labor Efficiency. Reducing farm operating labor was another major focus of farm building design. One author wrote in 1912, "Fifteen minutes saved each morning, noon and night in doing the barn chores is an important item. . . . Forty-five minutes each day constitute 274 hours each year. At 15 cents an hour this amounts to $41.10, enough to pay six percent interest on $685" (Marsh 1912: 141; $685 translates to a loan of $12,800 in 2003 dollars).

The debate about whether dairy barns should be designed with the stanchioned cows facing in toward the center or out toward the side walls was focused on the labor of twice-daily milking. When the cows faced inward, some argued, labor was saved through better illumination of the milking process by light coming in the side wall windows. When the cows faced outward, however, the farmer could more easily move the milking stool, wash pails, and milking equipment from cow to cow across the central alley.

Technical materials on building design almost always mentioned labor efficiency. A 1916 source, for example, suggested that barns have no more than two rows of stalls to make best use of window light, that they have multiple doors so that each type of livestock could be easily let into their yard, that hay chutes and grain bins be located near feeding troughs, and that mow doors be freely accessible to wagons (Ashby 1916). A 1936 University of Minnesota source recommended that stairs, ladders, chutes, litter and feed carriers, and similar devices in buildings all helped save valuable time (White et al 1936: 4).

Building Maintenance and Operation. Lowering building maintenance and operating costs were also important design goals. Wooden farmhouses, barns, and other buildings had to be repainted frequently to prevent deterioration, for example, leading some farmers to choose brick, hollow clay tile, concrete block, and other materials that required less maintenance. Corrugated sheet metal became popular for durability as well as speed of erection. Many farmers also used masonry and sheet metal to reduce the fire loss threat inherent in wood.

Optimizing Output. One goal of farm building design was to increase production by making buildings function as well as possible for their intended purpose. Technical bulletins, magazine articles, and advertising circulars were full of examples of milk gone sour, poultry so cold they wouldn't eat, and piglets dying because of inadequate buildings. The losses hurt individual farmers and the entire agricultural industry, which was a huge part of the U.S. economy. On the other hand, technical sources were rich with examples of building improvements that easily paid for themselves in productivity gains, whether they involved labor saved, grain preserved, or gains in livestock weight.

The trend toward analyzing the specific functional requirements of each type of agriculture, and then customizing farm buildings to meet these requirements, began in earnest in the 1910s. This research accelerated considerably in the mid-century and resulted in huge productivity gains after World War II.

Livestock farmers and agricultural engineers continually sought ways to increase production by improving animal health. Hog cholera, bovine tuberculosis, and the parasites and viruses that plagued poultry were just a few of the diseases that challenged designers. Farmers experimented with concrete floors to increase sanitation, well-placed flues to increase stable ventilation, compartmentalized mangers so cows wouldn't share food, and movable poultry and farrowing houses to avoid soil-borne parasites. Farmers added guardrails to pig stalls so sows wouldn't accidently crush piglets, created cool areas in brooder houses so chicks would feather out faster and therefore not peck each other, and built wider doors in sheep barns so ewes wouldn't be injured when they all tried to enter the barn at the same time.

In cold climates like Minnesota, some experts recommended that dairy and general purpose barns be no wider than 34' so the heat generated by the animals would keep the interior temperature optimal with no supplemental heat. (Dairy cows didn't produce well if they were cold and uncomfortable.) Storing hay and straw in the mow also helped conserve heat.

Heat conservation also figured into a debate about hog house design. In the early 20th century many hog houses were built with monitor roofs incorporating a row of windows to allow light from the south to shine into the stalls during farrowing. "This was done on the assumption that the sunshine would, first, warm the house, second, keep it dry and, third, provide for an ultraviolet bath for the little pigs." Instead, farmers in northern states found that in February and March, when the sows farrowed, the sun only shone directly into the monitor windows for about two hours per day and, for the rest of the time, the monitor caused heat loss as the heat traveled upward into the monitor and out the windows. Water also condensed on the window glass and dripped into the stalls. The result was a cold, damp hog house and pig losses, rather than the warm dry house that had been sought (Strahan 1928: 3).

Attention to the particulars of building design could be quite detailed. In 1916 the American Society of Agricultural Engineers' "Subcommittee on Barn Floors" reported on their continuing study of the best materials for barn flooring. The committee agreed that most floors needed to be durable, warm, waterproof, noiseless, somewhat cushioning, and provide good traction. "Cork brick," "mastic asphalt," and poured concrete over a layer of insulating hollow tile were recommended for stall floors. Creosoted wood blocks were recommended for work floors such as in feed rooms. Poured concrete and mastic asphalt were recommended for chore alleys, and thick wooden planks or poured concrete over hollow tile were recommended for mow floors and upper storage rooms. Each material had its drawbacks for large areas: poured concrete was cold, slippery, and prone to cracking; brick was cold and hard to clean; creosoted wood was slippery and absorbed odors; wood planks warped, splintered, and were hard to clean; cork brick was too expensive; and mastic asphalt was slippery and soft in hot weather (Niemann 1916).

Response to Changing Methods. Farm building design evolved as farm methods changed. Granaries were made taller for the use of mechanical elevators. Hay mows were enlarged to accommodate hay carriers. Doors and manure alleys were widened as tractor-drawn manure spreaders replaced hand carts. Cow stalls became a standard size to receive factory-made stanchions and other fixtures. Implement sheds grew larger to house more machinery. The speed of change intensified with electrification and the labor-saving devices it brought to the farm, and increased again around World War II when labor shortages spurred the adoption of more new technology. According to one designer, buildings constructed after the war needed to assume "electric lights, water systems, milking machines, improved types of self-feeders and feed bunks, mechanical feed handling and conveying equipment, silo unloaders, manure cleaners, poultry waterers, and similar devices" (Ashby 1949: 236).

As farm mechanization increased, the need for a building to respond to shifting methods became more urgent, until finally flexibility itself became a leading design goal.

Prior to about 1930, many farm buildings were designed for permanence. Barns were expected to last for several generations, and farm couples sought to pass on to their children a collection of solid, well-made buildings. Materials were chosen to be as long-lasting as could be afforded, with many experts arguing that repair costs would be less on "the durable building" (Marsh 1912: 142). In 1935 William Boss, head of Agricultural Engineering at the University of Minnesota, argued in the pages of *Agricultural Engineering* that farmers should be building barns and homes to last 100 years or more (Boss 1935). Several months later, however, another agricultural engineer cautioned in the same publication that farmers shouldn't invest too much on structures that might eventually become obsolete. He wrote:

> We know in recent years the idea of permanence has been rather strongly emphasized, and I do not want to be understood as discarding it without further and most thoughtful consideration. . . . There are today barns built of so-called permanent materials which are so permanent that they cannot be economically rebuilt to take advantage of new and improved methods and practices. . . There is no justification in putting up a long-lived masonry structure if we have to destroy it with dynamite within a few years. In American agriculture there is no value in such ruins (Ekblaw 1935: 268).

The goal of flexibility was not completely new. For years some farmers and experts had favored wooden buildings over those of masonry because they could be remodeled more easily. And designers had tried to reduce the number of interior structural bents in barns so that interior spaces could be modified more easily (Ashby 1916: 26).

By the mid-1930s, however, the goals of adaptability and flexibility were receiving new emphasis. A 1933 advertising circular warned farmers, "Farm conditions are changing faster today than ever before . . . To meet changing conditions may require farmers to readjust building and equipment to serve such production as is most promising from a market standpoint" (Spahn 1933). A Minnesota farmer wrote in 1939, "Farming is not static. Methods, machines, and practices of today are outmoded tomorrow" and "We need to recognize the changing character of production." He then went on to describe the changes in farming methods he had seen in the nine short years he had owned his farm (Benitt 1939: 304-305).

Agricultural engineer D. Howard Doane stated emphatically in 1941, "I want short, rather than long life buildings." He argued that few in the industry could see forward 20 years, which was the average depreciable life of a woodframe building (Doane 1941: 313). He explained that he wanted his farm buildings "to have maximum, continuous, and alternate use." He suggested "Well-planned buildings with removable partitions can be used for beef cattle, horses, mules, sheep, and dairy loafing barns. . . . Alternate use makes maximum use possible" (Doane 1941: 314).

After World War II, the desire for flexibility increased, and new clear span designs, strong lightweight materials, and prefabricated and modular units met the need. In 1956 the Midwest Plan Service began to draw plans for "shells of farm buildings," including dairy barns, whose interiors could accommodate a variety of arrangements and functions (Pederson 1956).

In 1956 agricultural engineer Deane Carter explained that farm buildings were becoming obsolete because of changes in farming practice – rather than due to deterioration of the buildings – and that single-use buildings were deficient because they weren't readily adaptable to other purposes. In his view the best buildings were "so adaptable in nature to fulfill the multipurpose objectives characteristic of today's farming needs" (Carter 1956: 259).

Agricultural engineer J. T. Clayton wrote of dairy barns in 1960, "It must be constantly borne in mind that flexibility of the entire system is of utmost importance because of rapidly changing technology. A good solution last year may not be a good solution now and very likely will not be the best solution next year. It must be possible to change the facility with changing production requirements and farming methods" (Clayton 1960: 603).

And in 1955, Indiana agricultural engineer William Yaw wrote:

> Farm buildings seem to be developing in two widely varying directions at the same time. The first is the highly specialized type where buildings are used essentially for one purpose. These can be justified only when the enterprise is developed sufficiently and is large enough to warrant the overhead for such a structure. The second is the flexible type where the building is nothing more than a shell which can be adapted for a wide variety of uses, even to the point of making the shells movable (Yaw 1955: 583).

Aesthetics. The role that aesthetics should play in farm building design was a matter of frequent debate through the decades. Throughout the period covered by this context study, most farm buildings were designed and built with a single over-arching goal – that of supporting the survival or profit-making operation of the farm. Aesthetic concerns were almost always secondary. While farm buildings were often neat and well-maintained, they were not usually ornate or highly decorated.

One farm building designer wrote in 1912, "It pays to consider the appearance of a building when it is built," both for the satisfaction of the owner and for resale. But "To be beautiful to the owner or others, a building must be erected which best fits its intended use. A building that is beautiful for beauty's sake is not a satisfactory one. Architecture is a useful art, and the beauty of a structure must be a utilitarian one. Over-ornamentation is a bad mistake. Any part of a building improperly placed, and not harmonizing with other parts, is meaningless" (Marsh 1912: 143).

Farm building specialist Henry Giese wrote that practical consideration "does not infer that we should neglect beauty or harmony in design which have a very direct bearing upon morale, but that the emphasis should be put upon the securing of lower production costs by giving attention to management and fundamental [livestock] housing requirements" (Giese 1930: 3).

And a Minnesota farmer wrote in 1939, "While it may appeal to a man's vanity to have a beautiful farm factory, that in itself may not spell satisfactory returns. And beauty from a strict business point of view can justify a capital expenditure only when it brings added returns" (Benitt 1939: 303).

According to barn historian David Stephens, "most midwestern barns are not decorated." When barns were decorated, he wrote, "the most common decorative element" was "some combination of date and the name of the farm or owner," usually in paint. Other decorative elements sometimes seen on Midwestern outbuildings involved rooftop cupolas, ventilators, weather vanes, and, more rarely, special roof shingle patterns (Stephens 1995: 238-255).

Farmhouses were the building most often designed with aesthetics in mind. One early 20th century author expressed the common sentiment that farmers shouldn't think "that they cannot have a beautiful home or a convenient one, for they are entitled to both" (Henry 1912: 137).

R. Nicholson, an architect who worked for one of the Canadian government's experimental farms, addressed aesthetics in a 1927 piece in *Agricultural Engineering*. He wrote, "There are, of course, old farm buildings which possess considerable architectural merit, but the present day designers, while improving the ventilation, lighting and floor arrangements, have discarded most of the features which made the older buildings so effective in appearance" (Nicholson 1927: 113).

In pondering how to improve building aesthetics, Nicholson wrote:

> In the first place all rigid ideas of symmetry must be discarded in the design as the requirements [of functional farm buildings] are so many and so varied that absolute freedom of plan must be allowed. The various buildings on a farm cannot be made to harmonize according to the accepted traditions of architectural design without seriously affecting their practical requirements. The proportions of a cattle barn, for example, are largely predetermined and the designer has little latitude in the length, breadth, or height of the various portions of the structure; these bear a certain relationship to each other governed by considerations not within the control of the designer. . . .
>
> A good plan involves the location of the various units with reference to each other in such a manner as to afford proper functioning with the least lost motion and waste of space, operation with the minimum of labor, ease of access and communication and, in some cases, allowance for expansion. . . . The result may, and often will, be a rambling type of plan in which each unit is treated according to its special requirements. . . . [Ornamental] planting, frequently neglected, will help to soften otherwise hard outlines. Ornament should be used sparingly and should be large in scale (Nicholson 1927: 113).

Nicholson also pointed out, "Molding on doors, windows, etc., should be entirely dispensed with, as well as all interior corners as no projections must be allowed which permit the lodgement of dust" (Nicholson 1927: 114). He also noted, "One of the most difficult problems of architectural treatment is the silo. If slightly separated from the barn, it might be treated as a tower and many interesting and charming examples of this may be found among the old farmsteads of France. It is, however, difficult to harmonize a tower, reminiscent of medievalism, with a modern hip-roof [gambrel] barn" (Nicholson 1927: 113).

INFORMATIONAL NETWORK

Most farmers learned of trends in building plans and materials in the same way that they learned about other technical information – through a growing informational network. Within the networks, information passed from centralized sources to farmers, from farmers to experts, and between farmers themselves (Lindor 2004). Through these channels Minnesota farmers were able to avail themselves of the steady advancements in research and technology that helped fuel a dramatic increase in farm productivity in the 20th century. (For more information on these networks see the appendices on Farm Journalism, University of Minnesota Programs, the USDA and the Minnesota Department of Agriculture, and Farmers' Organizations.)

Much of the information focused on the arrangement of farms and the design and construction of farm structures. Many Minnesota farmers considered these views when they made decisions about the physical development of their operations, and – because ideas and accounts traveled both ways – this information also served as a general reflection of what was actually being built on farms throughout the state (Lindor 2004).

Farmers' earliest sources of information included discussions with each other and with family, friends, and neighbors. This traditional way of sharing information was important throughout the period covered by this context study (Lindor 2004), and is often cited by historians when they describe the transfer of designs and construction methods within particular ethnic communities (Brinkman and Morgan 1982; Tishler 1984; Peterson 1998; Wilhelm 1995: 64-67).

During the late 19th century, the early farm press and the first agricultural societies stimulated farmers' discussions with information exchanged through meetings, publications, and fairs.

The federal government began gathering and disseminating technical information to farmers in the late 19th century by establishing the USDA (1862) and funding land-grant colleges (1862), state experiment stations (1887), and an agricultural extension service (1914). In many cases, the Minnesota Legislature preceded federal action. The Legislature established, for example, the University's College of Agriculture (1869), the State Dairy Commission (1885), Farmers' Institutes (1886), the Minnesota Experiment Station (1885), and Minnesota Extension Service (1909). Many of these agencies and institutions were placed at the University of Minnesota. Their founders and staff joined colleagues in Wisconsin, Iowa, and Illinois in becoming national leaders in various specialities within the field of agriculture.

Another important piece of the informational network was private industry. A vast array of enterprises – railroad companies, flour mills, food processors, farm equipment manufacturers, building materials makers, lumberyards, hardware distributors, seed companies, and fertilizer and chemical firms – were interested in the continued productivity of American farmers. These companies launched technical help desks, demonstration farms, immigration bureaus, research services, outreach offices, plan bureaus, magazines, radio shows, and advertising circulars, all to help farmers succeed, and to highlight the role of their company's own products in that success.

Technical information on farming was widely disseminated. Farmers' clubs and county agricultural fairs, for example, were organized in almost every county, and by the end of World War I nearly every county had a county extension agent. A majority of the state's farmers subscribed to at least one agricultural newspaper or farm magazine, and later tuned in to farm radio broadcasts.

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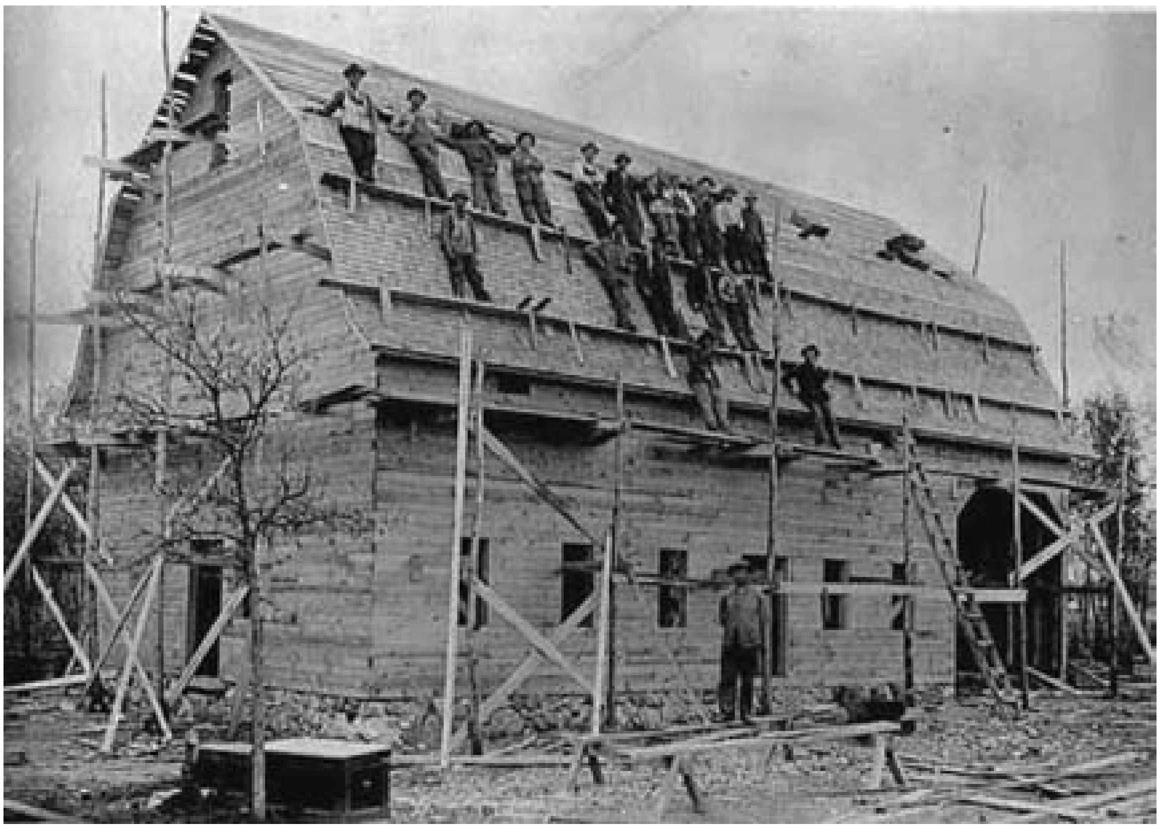


Group construction of a barn on the Johnson Farm, near Almelund, Chisago County, 1913. (MHS photo)

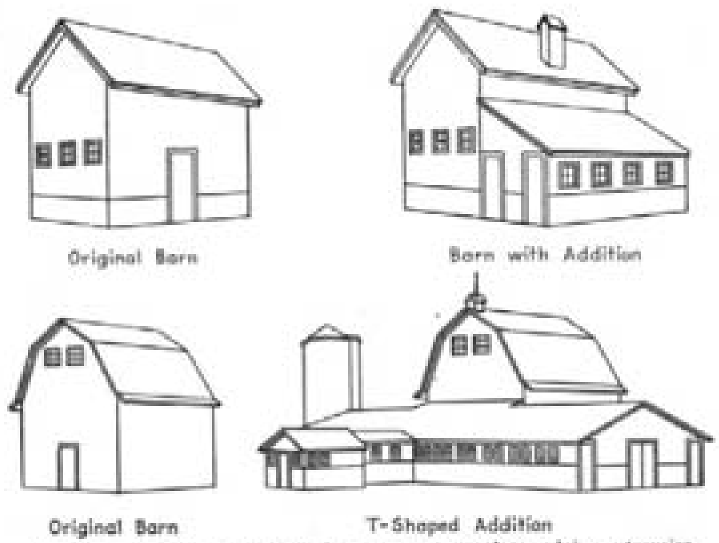
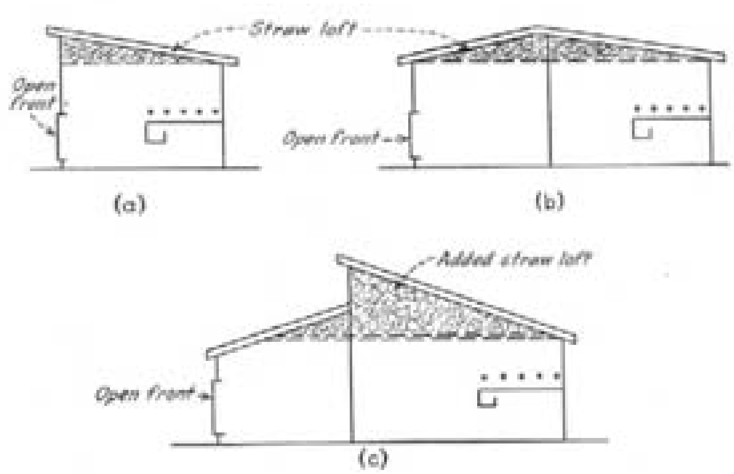


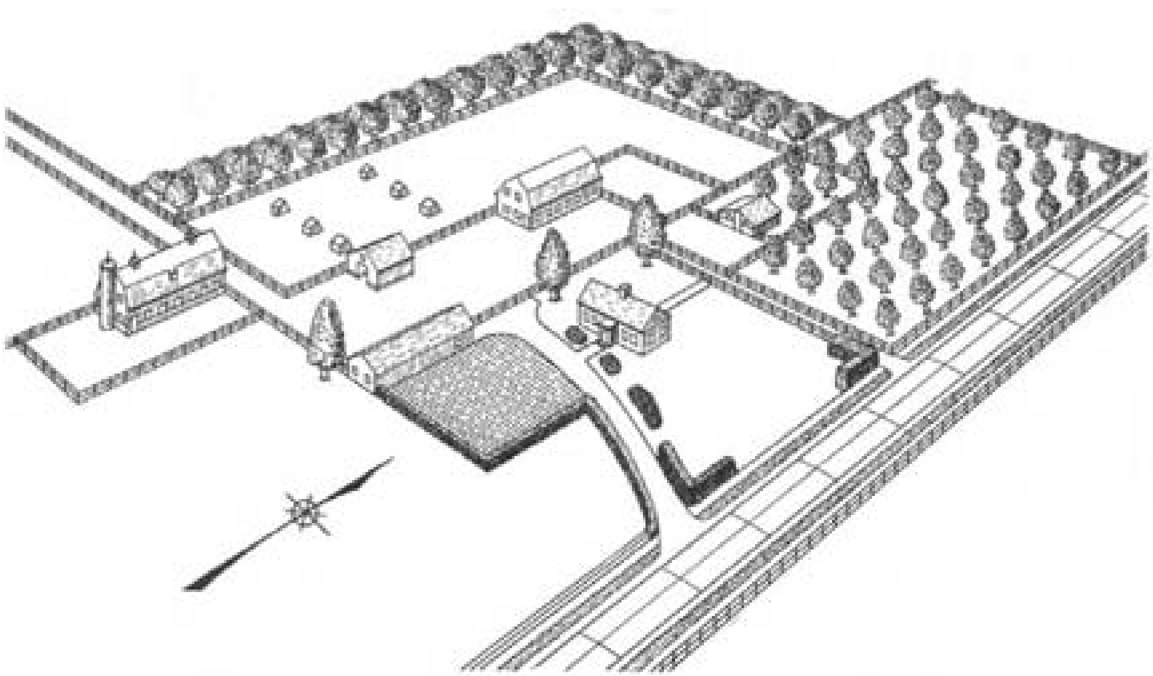
FIG. 102.—Additions to existing barns to accommodate a dairy enterprise.



Farmers commonly built only what they needed, and later added on. They also moved structures to new locations, and remodeled buildings for new uses. This illustration appeared in a 1946 farm building text by John Wooley, an agricultural engineer from the University of Missouri (*Farm Buildings* 1946).

Some experts recommended barn expansions that formed an L-shape, similar to the photo above. Location unknown, circa 1910. (MHS photo by Harry Darius Ayer)

Sanford Farm, Sanford Township, Grant County, 1983. (MHS photo)



This drawing from a 1945 text was used to illustrate good farmstead planning. The farmstead is well-organized and attractive. It has two large barns, one for dairy and one perhaps general-purpose. It has a poultry house in the orchard, hog cots near a double corncrib, and a long implement shed near the center. The yards and fields are all fenced, a northwest windbreak protects the site, and there is a large vegetable garden south of the farmhouse. Note that the "modern" public road is paved with concrete and the farm has no windmill – probably removed because the farm has been electrified (Wooley 1946).

DESIGNERS AND BUILDERS

BUILDERS

Most farm buildings were constructed by farmers themselves, often with the help of relatives and neighbors. By necessity, most farmers were good mechanics and skilled at carpentry, concrete-laying, plumbing, and welding, and many were also adept at surveying, electrical work, and brick-laying (Peterson 1983: 32; Lindor 2004). In some cases, even hardware such as hinges and latches were made on the farm if the farmer had blacksmithing skills. Window sash was often purchased.

Large buildings such as barns were sometimes erected by groups of neighbors who assembled for a "barn raising" day (Dieffenbach 1955; Rippley 1977). Historian John Fitchen, who studied the raising of timber frame barns by Dutch immigrants in New York state, wrote,

> There was a stringent limitation on the amount of time [the farmer] could ask of his neighbors to give [because they were as busy as he]. So he had to have all in readiness before they arrived to help him. The trees would have been felled, the logs cured, and then snaked to the site; so much, he could have managed himself. But unless the farmer also happened to be a skilled [joinery] carpenter, the shaping of the timbers and the cutting of mortices in accordance with a carefully laid out plan would have been the work of a professional and experienced carpenter (Fitchen 1968: 59-60).

Assembly usually happened in one long day, which Fitchen says was different from traditional practice in Europe where farmers lived closer together and could gather several times for shorter periods as needed (Fitchen 1968: 59-60). Because of the time constraint, it was important that the master builder in charge was well organized and had all barn components cut and shaped correctly.

After the turn of the 20th century, professional carpenters and building contractors were increasingly involved in farm building construction. Some builders furnished plans as well as constructing buildings (Sculle and Price 1995).

In Minnesota, the construction of specialized structures like silos and the construction of structures made of manufactured materials like cement staves or concrete blocks, was often handled by companies that worked in particular trade territories or sold specific or patented products. Farmers would hire company crews to build the structure, in part because, through their experience, the crews had become specialists in the material or equipment, and could therefore best adapt it to the particular needs of the farm (Lindor 2004; Kaiser 1953: 34).

See also

Design Considerations
Barn Forms and Terminology
Appendix: Focus on Farm Journalism
Appendix: Focus on U of M Programs
Appendix: Focus on USDA & Minn Dept of Ag
Appendix: Focus on Farmers' Organizations

DESIGNERS

Most farm buildings before World War II were designed by farmers themselves "without the assistance of an architect or engineer" (Giese 1929: 121; Kaiser 1953: 34). Professional architects were rarely involved in farm building design, "possibly because few farmers could afford the professional fees involved" (Nicholson 1927: 113).

Farmers were often influenced by what their neighbors were building, and variations in building types sometimes developed locally. Farmers were often active innovators of buildings and equipment, and as a technical problem was solved on one farm it would be spread to other farmers in the region (Lindor 2004; Marsh 1912: 141). USDA agricultural engineer Wallace Ashby explained in 1957, "The ingenuity of a single farmer in finding a better way to do a certain thing has been the starting point for many a new development. His improvement caught the attention of a neighbor, a research worker, a farm equipment salesman, or a writer for a farm magazine and thus formed a link in the chain of improvement" (Ashby 1957: 431).

Agricultural engineers bemoaned the lack of professional planning, explaining that, as a result, many buildings did not serve the farmer well, made farm work more difficult, and required frequent repairs. Designer W. G. Kaiser wrote in 1943, "Farm structures have been the stepchild of the construction industry; the architectural profession is seldom called in to design farm buildings. There are no building codes or regulations to govern farm construction – no inspection to insure structural soundness. There is no financing organization like the Federal Housing Administration which exercises a certain supervisory control over design and construction. Every farm structures engineer knows how desperately the farmer needs technical assistance" (Kaiser 1943: 287-289, 292).

In the late 19th century the void in professional design expertise, and the desire to increase national farm productivity through the design of good buildings, led government agencies such as the USDA and state agricultural colleges and experiment stations to begin to establish agricultural engineering offices, to design and promote rural road-building and farm drainage, and to draw plans for farm buildings and supply them to farmers at little or not cost.

Like most land-grant colleges, staff of the University of Minnesota drew plans for farmers. One staff member wrote in 1914, "for several months past the Poultry Section at University Farm has received almost daily requests for plans of a poultry house suitable to Minnesota farm conditions" (Smith 1914: 165). Once a successful plan was developed, it was often distributed for several years, even decades. The University of Minnesota's 1953 plan book, for example, contains plans that were drawn many years before (*Farm Building Plans* 1953).

Drawing and distributing farm building plans was an important part of the spread of "scientific agriculture." Henry Giese of Iowa State University, a founder of the agricultural engineering profession, explained: "A building plan is perhaps our most effective means of transmitting results of research to the farmer." He felt plans transferred information more readily than technical bulletins, which required "considerable ingenuity" in adapting research findings to actual construction (Giese 1943: 71). By 1929 there were more than 2,800 plans for farm buildings and equipment available to farmers from the state agricultural colleges and the USDA (Giese 1943: 69).

The need for designers who also understood farming gave rise to the field of agricultural engineering. The University of Minnesota added college-level courses in agricultural engineering in 1895, the

American Society of Agricultural Engineers was established in 1907, and the University established a Division of Agricultural Engineering in 1909. (For more information, see below and the appendices to this report.)

Materials and equipment manufacturers also disseminated drawings, although it was rare that these sources published full, detailed building plans. Much of this type of information was distributed through local lumberyards. Industry groups such as the Portland Cement Association, the Hollow Tile Building Association, the National Lumber Manufacturers Association, the Common Brick Manufacturers' Association, and the Douglas Fir Plywood Association promoted the construction of buildings using their products, established "farm bureaus," and/or published plans, as did individual companies such as Reynolds Aluminum, Louden Machinery Company, and the makers of silo materials. The Northern Pine Manufacturers' Association created the St. Paul-based "White Pine Bureau," for example, and the Northwestern Lumberman's Association published plans through Brown-Blodgett of St. Paul (see White Pine series ca. 1925; Brown-Blodgett ca. 1940).

Other companies that offered plans and planning services included Hunt, Helm, Ferris, and Company; James Manufacturing Company; National Plan Service; Radford Architectural Company; and Sanders Publishing Company (Sears 1981: 4).

Beginning in the early 20th century, farm buildings were also available in "mail-order" kit packages from companies such as Rilco Laminated Products of St. Paul and Merickel Buildings of Wadena. Historian Sally McMurry indicates that advertisements for mail-order farmhouses from at least four companies were published in the farm press in the early 20th century. Among the manufacturers were Gordon-Van Tine of Davenport, Iowa, and Alladin of Bay City, Michigan (McMurry 1988: 212-213).

In 2001, historic preservationist Joy Sears conducted extensive research on pre-cut, kit barns available in the Midwest from mail-order companies during the period 1900-1930. According to Sears, the popularity of mail-order architecture peaked in the 1920s, declined during the Depression and World War II, and was resurrected after the war but in slightly different form with more emphasis on preassembly and prefabrication. Barns and other farm buildings were available starting about 1910. Sears discovered that mail-order kit barns were available from several companies. Her information includes the following:

Aladdin Company of Bay City, MI, founded in 1906, offered barns in the 1910s and 1920s.

Chicago House Wrecking/Harris Brothers Co. of Chicago first sold plans for farm buildings and then entire kits. The company went out of business circa 1938.

Gordon Van-Tine Company of Davenport, IA, offered kit barns from about 1915-1940. In 1940 the company had 350 employees and five plants.

Montgomery Ward and Company of Chicago was selling mail-order kit barns by 1912. In 1918, for example, barns were available in widths of 24', 28', 32', and 36' and lengths up to 144'.

Sears, Roebuck and Company of Chicago began selling kit homes in 1908 and began selling barns about 1910. In 1918 they placed their kit farm buildings into a catalog separate from their kit houses. The farm buildings included barns, hog houses, chicken houses, and granaries. Sears, Roebuck and Company sold barns until about 1934.

According to Joy Sears, kit farm buildings were delivered by railroad, truck, or wagon. She writes, "Most of the barns offered required only a few simple tools, usually two or three people, and the ability to follow plans for assembly. Since the kits came with everything (excluding masonry materials), assembly was relatively quick and inexpensive compared to finding skilled barn builders or paying local prices for questionable dimensional lumber" (Sears 1981: 9). Kit buildings could be economical because middle men were eliminated and waste could be reduced because the customer only paid for the exact lumber needed. Some companies offered farmers credit, customized design services, and extra interior elements and equipment such as hay carriers. Sears was unable to ascertain how many barns might have actually been ordered from these companies (Sears 2001: 3, 6-9, 15).

Giese's Summary. In 1932, after a nationwide review, Henry Giese of Iowa State University indicated there were "five agencies at present functioning in the field of farm building design." His annotated list included:

Agricultural engineering staff at agricultural colleges. Furnishing plans was seen as part of the function of the colleges, although resources for drawing plans were stretched thinly.

Architects. Professional architects accounted for a small fraction of farm building design in 1932.

Building materials industry. According to Giese, "Trade associations concerned with cement, lumber, tile, brick, steel, etc., have contributed much valuable literature on farm building design. The largest part of it is in bulletin form and is intended to stimulate the proper use of specific materials." The materials industry did not generally issue complete plans, but instead produced concept drawings or partial plans.

Barn equipment industry. Giese reported, "In the field of animal housing, this industry has contributed perhaps more than any other agency to advance in matters of design. At least three of the larger companies maintain planning departments that practice in the field of farm buildings with as close an approach to professional standards as any other existing agency. . . . Fees charged range from 1 to 10 percent depending upon the type of service rendered and the size of the project."

Local contractors. "Many farmers rely on local builders for assistance in planning their buildings." According to Giese, these buildings might be structurally sound, but they were often not designed for functional efficiency, so the farmer might be stuck for years using a building that did not serve his farming methods well. "The country carpenter needs a guide, and the farmer needs an expert advisor," wrote Giese (Giese 1932).

The American Society of Agricultural Engineers. The rise of the agricultural engineering profession had a tremendous impact on the design and construction of farm buildings in the Midwest. The field was young when the American Society of Agricultural Engineers (ASAE) was founded in 1907 at the University of Wisconsin. The ASAE became the discipline's leading professional organization and a principal clearinghouse for new information on farm engineering and farm building design and construction.

ASAE members were engineers from academia, industry, and government. They lived in both the U.S. and Canada. Ironically, none of the 17 ASAE founders had a degree in agricultural engineering because it wasn't yet a recognized engineering specialty. (The University of Minnesota's Division of Agricultural Engineering, for example, was established in 1909. Its undergraduate degree was first offered in 1925, and graduate courses were first offered in 1930.) Mary A. Ives became the first female member of the ASAE in 1921.

By applying the scientific principles of engineering to farm operations, agricultural engineers aimed to increase farm efficiency, productivity, and profits; reduce the hazards of farming; remove drudgery from farming operations; and make farm life more enjoyable ("Foreword" 1957: 348). The ASAE also helped establish uniform standards for products, equipment, and building technology, and helped educate new generations of agricultural engineers.

While the ASAE provided technical information to farmers so they could build their own structures, the group also encouraged farmers to seek professional engineering advice for farm building design, land drainage systems, and other improvements.

The ASAE advocated unbiased, accurate research of farm structures. In the 1920s, for example, the ASAE stressed the need for basic research on dairy barns, poultry houses, and crop storage buildings. In 1930 one ASAE member explained the need for research by noting that agricultural extension agencies were not in a position to conduct research, that farmers themselves were "hazy" in their understanding of how to best increase productivity and profits through improved farm structures. He also explained that much of the existing information on farm buildings was of questionable value because it had been prepared by "powerful industrial organizations acting in an extension capacity," and presumably self-interested (Strahan 1930: 328).

Early in its history, the ASAE established technical committees on power and machinery, farm structures, rural electricity, land reclamation, soil and water, and education and research. The Committee on Farm Structures promoted and publicized advances in building materials, structural and mechanical systems, architectural design, and farmstead layout. The Committee on Farm Structures was instrumental in the formation of the Midwest Plan Service in 1932.

First led by Henry Giese, the Committee on Farm Structures investigated a range of farm building questions. In 1916, for example, the committee attempted to bring order to the diverse field of farm buildings by identifying 18 basic barn forms that it felt were most suited to an average farmer's needs. (See illustration in the "Barn Forms and Terminology" section of this context study.) The list of barn forms was developed by culling through thousands of buildings and plans. The committee considered factors such as functionality, cost, availability of building materials, building skills needed, and adaptability to various kinds of farming practices (Niemann et al 1919: 268-275).

After World War II the ASAE was active in efforts to mechanize crop and livestock systems and to create buildings and structures that would best support new methods and increased scales of production. In 1960, for example, the ASAE held a national conference on a new development in livestock farming – confinement housing. The ASAE's journal *Agricultural Engineering* collected research papers and related materials from the confinement conference in a "comprehensive handbook on the subject, suitable for the engineer, manufacturer, dealer, and the farmer alike" (Basselman 1960: 565).

The ASAE published conference findings in *Transactions* beginning in 1907. In 1920 it launched a monthly professional journal called *Agricultural Engineering*. The magazine became widely recognized as the major source for information on advancements in the field. It covered a broad range of topics pertaining to farm building design and construction; farm infrastructure such as water and sewage systems; field drainage, erosion control, and irrigation; and equipment, materials, and technology. Readers included professional engineers and scientists, farmers, students, university and high school faculty, county extension agents, and farm equipment manufacturers and dealers.

The ASAE had more than 5,000 members in 1957 and today has about 9,000 members. The group's headquarters are in St. Joseph, Michigan.

Midwest Plan Service. The Midwest Farm Building Plan Service, soon renamed the Midwest Plan Service (MWPS), was founded in 1932. It was a collaborative effort of 12 Midwestern universities in collaboration with the USDA and the American Society of Agricultural Engineers (ASAE). The University of Minnesota was among the founding members, which soon numbered 15 colleges. Plans to organize the service had been in the works since 1929 when ASAE members from the Upper Midwest met in Fargo and discussed the idea.

The driving force behind the Midwest Plan Service was Henry Giese, Iowa State University professor and a leader in the ASAE. The project was the first collaboration of its kind in the country. Following the MWPS model, several other cooperative farm building plan services were formed in other parts of the U.S.

Among the MWPS's goals was to improve farm efficiency and productivity by encouraging best-practices in farm building design. The Service was a response to an increasing number of requests for blueprints that were coming in to land-grant universities from farmers in the region. Member colleges hoped to reduce costs by eliminating the need to draw plans for something available in a neighboring state. They also hoped to resolve conflicting building advice being issued by various state agencies. The partnership would also help members conduct cooperative research (Giese 1930).

The MWPS encouraged standardization in farm building design, which engineers felt would simplify advice to farmers, lower costs overall, and lead to efficiencies by reducing the variables that materials and equipment manufacturers needed to anticipate. In 1936, for example, MWPS participants proposed to redraw their barn plans to only show widths of 32', 34', and 36', with variations focused on the length of the barn and its floor plan, rather than width ("Midwest Plan Book Agenda" 1936).

The Midwest Plan Service collected the best information on farm structures from its participating members (who often gathered designs from farmers themselves), prepared standardized plans and materials lists, published a catalog, and distributed this information to farmers at minimal cost. Plans issued by the Service were often based on the review of thousands of standing buildings and existing plans in an attempt to identify designs that were most cost-effective and functional. The designs covered everything from a one-seat outhouse to a cooperative creamery. Plans were also drawn for numerous pieces of equipment such as feeding racks and stock tanks. In explaining one advantage of professional plans Giese wrote, "Many of our farm building plans [until now] have been little more than suggestions for the arrangement of space, leaving structural problems at the mercy of the builder" (Giese 1943).

The University of Minnesota participated in the development and operation of the Midwest Plan Service. At the time of the 1937 MWPS catalog, for example, the University's representatives in the MWPS were agricultural engineers William Boss and H. B. White. C. K. Otis was the University's representative in 1949.

To formulate its first set of plans, the MWPS gathered existing drawings from the USDA and 12 of the 15 member states – 1,400 building plans in all. It culled the plans, modernized and redrew them, and issued its first set of 113 drawings in a 96-page catalog in 1933 (Midwest 1933). Five thousand copies were printed. The catalog was promoted by Kirk Fox, editor of *Successful Farming* magazine, in a series of eight monthly articles beginning with the June 1933 issue. Fox was an early supporter of the MWPS who also contributed financially to the publication of the catalog. The full catalog was revised and republished in 1937 with 122 plans (Midwest 1937; Gustafson 1967: 2). Catalogs issued in subsequent years focused on single subjects.

The MWPS sought wide distribution of its plans. Catalogs were furnished to each county extension agent in member states and distributed through experiment stations, agricultural schools, lumber dealers, vocational schools, building contractors, and insurance companies (Harmon et al 2004; Scharf 2004; Giese 1933). The MWPS allowed its plans to be included, with proper credit, in any agricultural extension circular ("Midwest Plan Book Agenda" 1936). Despite its desire to disseminate the plans, however, it was with some dismay that the MWPS learned in 1934 that the National Plan Service, a for-profit entity, had used about 50 of the MWPS plans in a book that was selling for considerably less than the MWPS catalog (Giese 1934).

The MWPS collaborated with building material manufacturers. For example, the MWPS apparently allowed companies to "rebind the plan book to include material showing the adaptability" of the plans to their particular product (e.g., concrete block or structural clay tile), as long as the MWPS drawings were not altered. The Weyerhaeuser Lumber Company adopted the Midwest Plan Service as its "official plan service" and distributed the catalogs to 3,500 lumber dealers (Giese "Midwest" 1957; Giese 1932; Quisno 1934). The MWPS also entered into agreements with Douglas Fir Plywood, American Zinc Institute, Reynolds Aluminum, and others for MWPS plans that would show how particular building materials could be properly used (Pederson Nov. 1956).

In a 1943 article in *Agricultural Engineering*, Henry Giese indicated that, before creation of the MWPS, agricultural colleges and the USDA had collectively drawn more than 2,800 plans to be distributed to farmers. He noted about them:

> It would seem that with so many the field ought to be thoroughly covered and little should be lacking. On the contrary there was still much to be desired. The large number of plans reflected the diversity of opinion on the part of designers and the exploitation of personal ideas not necessarily substantiated by experimental data. Widely divergent recommendations from contiguous states tended to confuse and mislead rather than to clarify and inspire confidence among the consuming public (Giese 1943).

Giese also wrote in 1943 that despite some efforts toward standardization (including the creation of the Midwest Plan Service), there was still "comparatively little standardization in the farm building field. In a maze of plans being distributed by the federal department of agriculture, state agricultural colleges, and commercial groups, the prospective builder has little to guide him in his choice or to direct his management program later" (Giese 1943).

After World War II, the land-grant colleges involved in the Midwest Plan Service renewed their pledge to cooperate and launch a new era of shared research. The goal was to avoid duplication, best use of each institution's slender resources, and position the engineers to help direct the postwar catch-up in farm building construction faced by American farms – a situation that a Wisconsin participant in 1944 called "perhaps the largest single program of capital investment that the American farmers have ever before undertaken" (Clark quoted in Giese "Midwest" 1957). The group proposed to continue to standardize plans so that manufacturers could use "mass production methods" to supply economical buildings for farmers. It also proposed to evaluate many of the new construction materials that had been developed during the late 1930s and 1940s but had not been tried on farms. The Wisconsin engineer wrote in 1944, "farmers are going to be deluged with sales promotion programs regarding the new products developed since the war began," and would need advice on their effectiveness (Clark quoted in Giese "Midwest" 1957). He later recalled, "the need was for more penetrating analysis of the factors involved [in farm building research], the development of improved designs, and their rigorous testing under closely controlled conditions. . . . New and better designs and materials, developed and tested by competent research workers, were recognized as necessary" (Clark quoted in Giese "Midwest" 1957).

After the war, the MWPS was also called into service to quickly design crop storage structures for postwar bumper crops left without storage facilities because of Depression and wartime building curtailment. An estimated one billion bushels of storage was needed. Federal funds paid the MWPS to modernize and redraw plans for grain storage structures, resulting in the 1949 MWPS catalog, *Grain Storage and Building Plans*, which was distributed with assistance from the Northwestern Lumberman's Association (Giese "Midwest" 1957; Midwest 1949). During this time, in 1948, the MWPS was more formally organized and hired full-time staff, although the Service remained chronically under-funded.

Today the Midwest Plan Service is still in operation and is still headquartered at Iowa State University in Ames, its original home. According to the group's web site, more than 2 million agricultural building plans and 1.3 million related publications have been disseminated by the MWPS.

Plans supplied by the Midwest Plan Service are believed to have been widely used in Minnesota by farmers who accessed the plans through county extension agents (Lindor 2004; Scharf 2004). No study of the influence of the service on Minnesota farm buildings is known to have been conducted.

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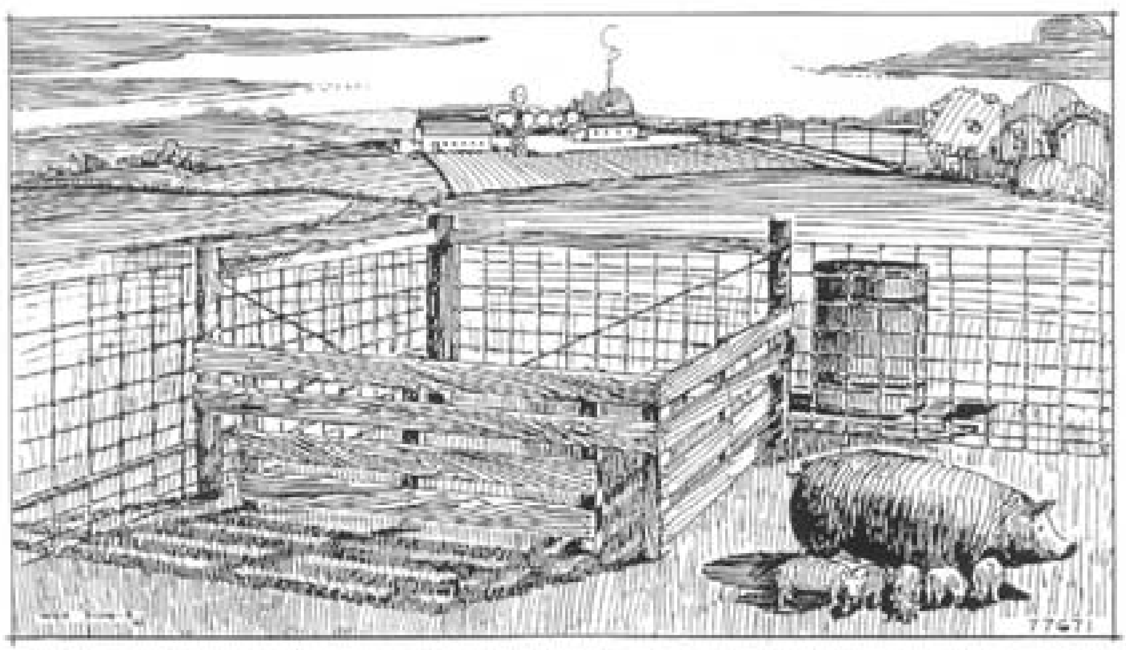
Wooden pegs and carpenter's "marriage marks" in a mortise and tenon timber frame barn built circa 1895 on a German immigrant farm. Dahm Farm, Nicollet Township, Nicollet County, 2006. (Gemini Research photo)

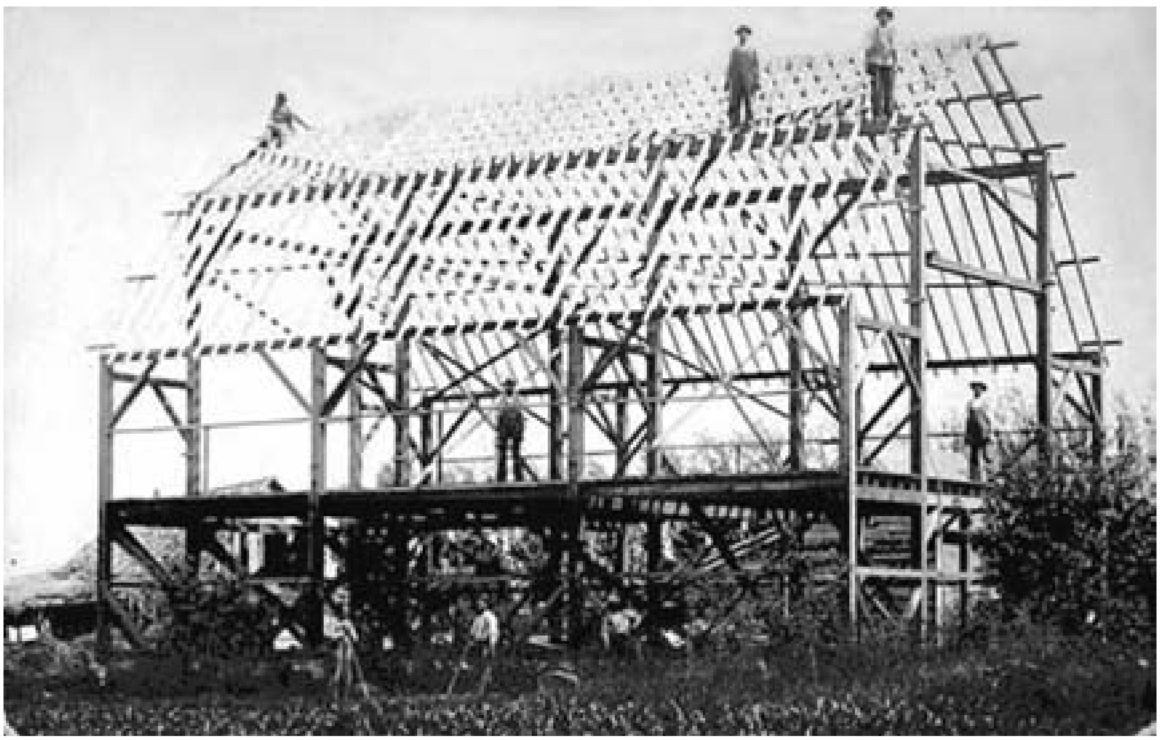
Few farm buildings were designed by professional architects. Instead, beginning in the late 19th century, designs were often influenced by agricultural engineers and other professionals working through colleges, experiment stations, the USDA, the agricultural press, and industry. Location unknown, circa 1910. (MHS photo by Harry Darius Ayer)



A page from a 1937 Midwest Plan Service catalog. In addition to a bucolic scene and plans for a creep feeder, the catalog offered a few words of advice on pig care. From Midwest Farm Building Plan Service, 1937.

Gothic arches were introduced about 1916. This barn stood in west central Minnesota. Quaal Farm, Lac qui Parle County, circa 1920. (MHS photo by Chalmers and Son)

"This new appearing round roof building is the answer to your pole free loafing barn" according to *Merickel Buildings for Farm and Ranch*, a circa 1960 promotional piece by Merickel Buildings of Wadena. Plans and materials were available for three sizes of these metal-sided buildings. Merickel's offerings are just one example of the many labor-saving, prefabricated, modular, and kit buildings available to Minnesota farmers after World War II.



A barn under construction. Location unknown, circa 1908. (MHS photo)

BUILDING MATERIALS

Between 1820 and 1960, the period covered by this historic context, most Minnesota farm buildings were framed and sided with wood. However, a wide variety of other materials were increasingly employed as farmers sought to make their buildings durable, functional, and cost-effective. Building materials were studied, evaluated, and critiqued by individual farmers, by agricultural experts, by building and equipment manufacturers, and by industry trade groups. The development of alternative materials quickened during World War I and II when the U.S. faced shortages of traditional materials such as steel and when defense industries rigorously pursued new research and methods. After World War II several factors, including a boom in domestic construction in cities that reduced the availability of labor for farm construction, stimulated further interest in low-cost and labor-saving materials and methods.

Aluminum

Advantages: long-lasting, low maintenance, lightweight, did not need paint, construction ease, resistant to corrosion

Disadvantages: expensive, less strong than steel, less resistant to wear and abrasion

Timetable: little use on farms before World War II

Although developed in the 19th century, aluminum was not broadly used until after World War II when wartime aluminum factories sought new markets, defensive uses were applied to the domestic realm, and the U.S. faced continuing steel shortages. Aluminum house siding that resembled clapboard was developed in the late 1930s and was widely marketed after World War II (Lauber 2000: 19). Reynolds Metals, Kaiser Aluminum, and other companies made aluminum sheet roofing and siding used by industry and agriculture. Aluminum sheets were more expensive than galvanized steel sheets for farm use, but were less prone to rust and more heat-reflective (Neubauer and Walker 1961: 571).

In a 1955 advertisement in *Agricultural Engineering*, Kaiser Aluminum offered aluminum roofing in 26"- and 48"-wide sheets and materials and plans for ten one-story, aluminum-clad, pole-frame buildings: an implement shed, dairy barn, milking barn, general purpose barn, multipurpose storage shed, broiler house, broiler-layer house, and portable shelters and houses for poultry, beef, and hogs (Kaiser 1955: 440).

Aluminum panels, both triangular and diamond-shaped, were used to create self-supporting hemispherical aluminum domes (i.e., geodesic domes) on farms by 1961. Some had diameters up to 145' and heights of 50'. One source wrote in 1961, "It is possible that structures of this type may find a place in large agricultural building services" (Neubauer and Walker 1961: 574).

See also

Design Considerations
Designers and Builders
Barn Forms and Terminology
World War II & Postwar, 1940-1960

Aluminum shingles, most embossed, were also used for farm buildings in 1961. Some had interlocking edges and others were installed like asphalt shingles (Neubauer and Walker 1961: 574).

Asbestos-Cement Boards

Advantages: waterproof, acid-resistant, rot-proof, fireproof, insect-proof, non-warping, long-lasting

Disadvantages: brittle, hard, difficult to shape on site, nail holes needed predrilling

Timetable: used on farms beginning in the early 20th century

Asbestos-cement boards were made of 85 percent Portland cement and 15 percent asbestos fiber. Asbestos-cement was available in several thicknesses, textures, and colors and was sold from the early 20th century and until the 1970s. This material was one of the best fire-resistant materials according to agricultural engineers.

In 1939, factory-cut panels of asbestos-cement were being suggested for the construction of fireproof, maintenance-free one-story dairy barns (Schaffhausen 1939). Because of its acid-resistance, cement-asbestos was also recommended for interior walls for dairy barns, milk houses, hog barns, and poultry houses (Engelbach 1948: 14).

A 1940 publication by *Successful Farming* magazine illustrated "something new in the farm building field" – corncrib slats made of asbestos cement. The slats were nailed to the crib's wooden frame with leaded nails (Fox 1940: 56-57).

In 1961 asbestos-cement boards were widely used on farms for siding, roofing, and other purposes (Neubauer and Walker 1961: 576-577).

Asphalt Composition Siding

Advantages: waterproof, rot-proof, easy to install

Disadvantages: heavy, easily torn

Timetable: used on farms beginning in the early 20th century

Asphalt composition rolled roofing was available in the 1880s and almost immediately used for siding as well as on the roof. Pigmented granules were developed in the early 20th century. Asphalt composition siding – both rolled and in shingle form – was widely used to side and re-side farm buildings.

A 1924 article in *Agricultural Engineering* written by a railroad company agricultural engineer references this building material for settlers in Minnesota cutover: "One of our favorite [recommended] house plans has three rooms and sometimes a basement, and can be added on to two sides. It is 20 by 24 feet and is built of shiplap covered with heavy composition roofing on sides and roof. . . . The materials in such a house cost about $450 [about $4,800 in 2003 dollars] and it is quite roomy and comfortable judged by pioneer standards" (Ashby 1924: 28).

Brick

Advantages: durable, widely adaptable, could be glazed and therefore washable, could be highly decorative, did not need paint

Disadvantages: smaller units than concrete block or hollow tile therefore required longer construction time, was difficult to cut on site, more expensive than wood, masonry skills required

Timetable: used on farms beginning in the 19th century, less popular by the 1940s

Brick could be an economical and long-lasting farm building material if a brickyard was located nearby and if the local brick was of good quality. In a 1998 study of German immigrant farm buildings in central Minnesota, art historian Fred Peterson found that about one-third of the late 19th century farmhouses in the rural Catholic parish at Meire Grove were built of brick. Peterson described the brick-making process and noted that some farmers worked for the local brickyard during the winter months in exchange for bricks for their own houses (Peterson 1998: 66, 79). Minnesota's German immigrants, in particular, appear to have favored brick farmhouses if brick was available (Martens 1988; Peterson 1998).

Brick was most often used for farmhouses and for special-purpose or fireproof structures like silos and smokehouses. However, brick was also used for barns, milk houses, and other farm structures.

Concrete

Advantages: strong, more expensive than wood but more durable, moldable, waterproof, fireproof, decay proof, resistant to wear and abrasion, less expensive and faster to install than brick, smooth and cleanable, did not need paint, generally did not require special masonry skills

Disadvantages: heavy, reinforcing steel rods could corrode, concrete could crack and spall

Timetable: both reinforced concrete and concrete blocks were widely used after 1900, blocks with special designs were sold from 1900 through the 1930s, cement staves were introduced in 1905 and quite popular by 1920

Reinforced concrete was developed in the 1860s and 1870s, but not widely adopted until 1900. As early as 1902 experts were urging farmers to install concrete floors in farm buildings to help keep them clean, reduce loss of feed, and make work more efficient through proper design of floor slopes and gutters. A 1911 article in the *Minnesota Farmers' Institutes Annual* began, "Concrete is a comparatively new building material which few farmers have acquired the habit of using . . . " and then noted, "The intelligent farmer . . . is beginning to realize that the supply of his old-time building materials is becoming scarce and expensive, and that he must study concrete and become acquainted with its adaptability to his uses" (Arp 1911: 197; "Cement" 1902: 156).

Repeating University of Minnesota advice given at least as early as 1904, A. D. Wilson wrote in 1909, "The floor of the back porch, or at least a good large step at the back door, made of cement, is a 'joy forever' to the housekeeper. Here the slops from the milk cans, calf pails, slop buckets, and dirt tracked in from outside are all taken care of much easier and in a more sanitary way than can possibly be done on a wooden platform" (Wilson 1909: 86). Wilson also promoted building cement stock tanks, barn floors, root cellars, sidewalks, and other structures (Wilson 1909).

In 1913 the Universal Portland Cement Company built a concrete demonstration barn in Sheridan, Illinois, that was featured in a leading journal, *Agricultural Engineering.* The barn had concrete block walls and reinforced concrete floors, stalls, mow floor, and roof. The roof had a shallow gabled shape and a gable-roofed, industrial-looking monitor. The barn measured 34' x 54' and housed 8 horses and 12 cows, grain bins, alleys, and an upper mow (Fowler 1913). A monolithic concrete barn that received national coverage was built circa 1920 near Fergus Falls by the Denniston-Sprague Construction Company. The commentator estimated that a 36' x 72' barn of this type would cost about $366 to build ($3,700 in 2003 dollars) (Fenton 1921: 36).

By 1925, farmers were apparently "the most extensive users of concrete," taking advantage of "more than 500 uses for concrete on the farm and about the home," according to an industry piece published that year (quoted in Aggregate 2005). Carter and Foster wrote in 1941, "Concrete is the most widely used material for footings, foundation walls, walks, pavements, farm service building floors, and tanks for sewage disposal, milk cooling, and similar uses" on the farm (Carter and Foster 1941: 66). Many parts of barns including floors, stalls, and gutters were formed of concrete. Another common use for concrete was to plaster the insides of masonry silos and cisterns to make them waterproof and to protect the bricks from the corrosive silage.

Many Minnesota farmers made concrete using sand and gravel found on the farm.

Concrete Blocks. Concrete blocks were available in the U.S. about 1900 and became widely used in 1900-1920. Before 1915 about 75 percent were used for foundations, basement walls, and partition walls. Block sizes were standardized in 1924. Special blocks popular through the 1930s imitated cobblestone, brick, and ashlar, or had ornamental scrolls, wreaths, and roping. The most popular special shape was rockfaced (Simpson et al 1995: 83).

Cement Staves. Cement staves (called "cement" although "concrete" would be more accurate) were units about 30" long, 10" wide, and 2.5" thick. Their patented design differences generally focused on the way they were joined. Cement staves were invented in 1905 by the S. T. Playford Company (located in Elgin, Illinois, in 1919). The first cement stave structure was a circular stock tank built in 1905 in Michigan. Staves were designed for silo construction, but by 1919 were also being used for barns, hog houses, poultry houses, corncribs, granaries, milk houses, pump houses, smokehouses, and garages. Five large cement stave barns, for example, were built near Fergus Falls in 1918 by the Minnesota Cement Construction Company of Fergus Falls. The company also built 258 silos and a number of hog houses and other buildings during the 1918 season. Stave structures were fast to build and did not need the masonry expertise that hollow tile, brick, or concrete block required, or the forms needed for monolithic concrete. There were more than one dozen major manufacturers of staves in 1919 (Kaiser 1919: 41).

Fiberboard

Advantages: easily worked, lightweight, curvable, easily paintable, insulative, soundproof

Disadvantages: tended to absorb water, some types not strong, not long-lasting

Timetable: first used on farms around 1920, widely used after World War II, superceded in the 1960s by plywood and particleboard

Rigid panels of compressed wood and fiber products – called fiberboard – generally fell into three categories – insulation board, medium density fiberboard, and hardboard – none of which was readily available before the 1910s. One product, a rigid insulation board called Insulite was made in International Falls, Minnesota, beginning in 1915. The Mason Fiber Company's hardboard (called Presdwood, Tempered Presdwood, Masonite) was first made in 1926.

Shortages of money and materials during the Depression and World War II stimulated fiberboard research and application. In 1937, for example, agricultural engineers were testing and recommending structural insulation board for poultry houses, an outbuilding that especially needed to be dry and warm during the winter (Ward 1937: 44).

By the 1950s fiberboard was widely used. In 1952, for example, the Masonite Corporation was advertising Masonite Tempered Presdwood as exterior milk house sheathing. The board had to be finished with sealer and two coats of paint (Masonite 1952: 735).

By 1961 fiberboard was in common use for farm buildings as flooring, siding, roofing, wall partitions, sun shade shelters for livestock, bunker silo walls, cylindrical silos, hog and poultry houses, brooders, pecking boards, feed storage bins, lining for boxes and bins, automatic feeders, concrete forms, and interior surfaces. Asphalt-impregnated insulating boards were being used as mat liners for lakes, reservoirs, pools, canals, and ditches (Neubauer and Walker 1961: 574-577). In the 1960s fiberboard was superceded in many applications by plywood and particleboard (Gould et al 1995: 120-123).

Fiberglass

Advantages: strong for its weight, waterproof, decay proof, heat-resistant, moldable which facilitated prefabrication and reduced on-site labor

Disadvantages: thermal expansion, yellowed in sunlight, deteriorated by weathering

Timetable: developed in the 1940s, translucent sheets for roofs and windows used beginning in the early 1950s

Fiber-reinforced plastic (fiberglass) was formulated in the 1940s, although precursors were developed earlier in the century (Walker 1995: 142-143).

Corrugated, fiber-reinforced translucent sheets were first made in the late 1940s and became one of the most important uses of fiberglass in the building industry. As of 1959, these panels were nearly the sole use of fiberglass on farms. They were being used for translucent roofing, for temporary surfacing for greenhouses, on silos, and for temporary storage facilities for produce and machinery. Fiberglass in other forms was being tested for farm applications in 1959 (Aldrich and Boyd 1959: 336).

Glued Laminated Rafters

Advantages: labor savings because preassembled, precut, predrilled; allegedly four times stronger than nailed rafters therefore greater resistance to wind and snow loads

Disadvantages: some variation in lamination causing uneven moisture absorption, rafters are large and heavy

Timetable: introduced in the 1930s with farm use beginning in the late 1930s

Glued laminated wooden arches were developed in Europe and introduced in the United States in 1934 in Wisconsin. The pioneering company was Unit Structures Inc. of Peshtigo, WI, founded that year. Five years later, in 1939, the USDA issued a technical bulletin on laminated arches based on the work of the Forest Products Laboratory in Madison (created by the USDA and the U.S. Forest Service). A Minnesota leader, Rilco Laminated Products, was founded in St. Paul in 1939 as a subsidiary of Weyerhaueser Lumber Company. Another Minnesota company was Super Structures, founded in 1943 in Albert Lea by a former Rilco general manager. Steel shortages during World War II helped increase interest in structural laminated timber.

Rilco's gothic arches for farm buildings were "factory-fabricated and engineered" in standard sizes, and were sold only through lumberyards (Rilco 1948: 507). The structures were shipped as half-arches that needed assembly at the ridge. Holes were predrilled and all hardware was included. The arches were generally spaced 2′ on center, with hay hoods and provision for hay carriers offered. Conventional roofing was used. Typical spans for barns were 30′, 32′, 34′, 36′, 38′, or 40′. A 1950 advertisement suggested that a crew could erect all rafters for an average-size barn in one day. Another Rilco style, a tied arch, was designed for 30′ to 50′ spans with arches spaced 8′ on center. This shallow arch could be used in pole- or post-framed barns or in other applications (Rilco 1955: 6-7, 18).

In 1950 Rilco was advertising rafters "for every type of farm building from small hog and poultry houses to large post-free machine sheds, granaries and barns" (Rilco 1950: 91). Clearspans of 110′ or more were "commonplace" (Rilco 1948: 507). Other Minnesota sources for "glue-lam" rafter buildings included lumberyards such as Tomlinson Lumber (East Grand Forks, Willmar, Callaway, and Verndale), which in 1958 was offering pre-cut materials for a 34′ x 50′ dairy barn with a gothic-arched roof supported by three-ply rafters (Tomlinson 1958: 25).

Logs

Advantages: strong, warm in winter and cool in summer, material readily available in most parts of the state, could form the core of an eventually larger building

Disadvantages: heavy, needed special skills to build properly, hard to enlarge

Timetable: used during the early settlement phase in all parts of Minnesota except the treeless areas, use persisted in the northeastern cutover through the Depression

Many Minnesota farmhouses, barns, and other outbuildings were built of logs either left round or hewn square with a broadaxe and smoothed with an adze. The logs were often assembled into a single-pen structure with corners joined in dovetail, half-dovetail, or similar joinery style

(Brinkman and Morgan 1982; Roberts 1995). Log buildings were most often built during the early settlement period before local sawmills, rail service, and commercial lumberyards were established. They were most common in heavily wooded areas of the state.

In the northeastern Minnesota cutover, log farmhouses and outbuildings were still being constructed through the 1930s. A 1936 article in *Agricultural Engineering*, for example, discusses the use of logs to build small farm buildings in forested areas, including those where Depression-era resettlement projects were being established (Witzel 1936).

Log Cobbling. In their circa 1980 fieldwork on historic farm structures in central Minnesota, Brinkman and Morgan encountered a combination barn built in 1874 that had what they termed a log-cobbled floor in the horse stall area (Brinkman and Morgan 1982: 124).

Metal Sheets (Iron and Steel)

Advantages: fire-resistant, long-lived, low maintenance, resistant to abrasion and wear, strong (sheet steel was stronger than sheet iron), kept out air and moisture, no special building skills needed, less overlap than wood siding therefore less material used, lighter shipping weight than wood, fast to apply, could be applied over old roofing, siding, or ceilings to renew appearance, cheaper for roofing than tin, slate, or wood shingles, slippery so less snow build-up on roofs

Disadvantages: metal's conductivity produced temperature extremes, condensation or sweating created uncomfortable and unhealthful environment for livestock and led to rust, iron rusted more than steel, required repainting every five or so years

Timetable: sheets of iron and steel (as well as iron and steel shingles) were used on farms beginning in the 1880s; used to cover entire barns by 1910, sheet steel superceded sheet iron around World War I, stamped brick and stone patterns were sold through World War II, corrugated sheets were popular from the 1880s to the present

Galvanized iron sheets were widely available in the U.S. by the mid-1850s. Galvanized sheet steel was available beginning in the late 1860s and its price lowered considerably in the 1880s, making it more popular. Corrugation became common around the late 1860s. Roofing shingles of sheet iron and steel became widespread in the 1880s and 1890s (Simpson 1999: 34-42, 47).

Galvanized iron and steel sheets could be corrugated, joined with standing seams, V-crimped, and stamped in various patterns to resemble weatherboard, beadboard, brickwork, or stone masonry. This decorative stamping was available beginning in the late 1880s and popular until World War II.

As early as 1888 an advertisement by a St. Paul company for corrugated iron sheet roofing with standing seams claimed "our roofing over shingles has been tested for the past ten years, and found to be the only practical covering for old [wood] shingles." The sheets were 8' long and 26" wide (Moies 1888).

Galvanized sheets of both iron and steel were widely used in the early- to mid-20th century to cover farm buildings, grain elevators, warehouses, and similar structures. Sheet iron was increasingly superceded by sheet steel around World War I (Bartells and Ekblaw 1932: 47-49).

Galvanized steel sheets were especially popular to resurface aging farm structures. A steel industry engineer explained in 1941, "Many cases can be cited in our own repair work where, at the expenditure of one-third to one-fourth of the renewal cost of an old weather-beaten, ramshackle dwelling slated for tearing down we have remade it into a neat, new appearing structure with a longer and more economic life than it had when new, because of the lower maintenance cost built in" (Crow 1941: 17).

Corrugated galvanized iron sheets were nailed over wooden frames to make early metal-sided buildings. A 1911 issue of the *Minnesota Farmers' Institutes Annual*, for example, contained an article on a new barn built in Minnesota of dimensional lumber that was sided entirely with 28-gauge corrugated galvanized iron sheets (Payne 1911: 211-213).

In 1922 the United States' first all-steel barn was built in Michigan. Measuring 36' x 72', it had a steel frame and 22-gauge corrugated sheet steel siding and roof (Jones 1926: 176).

Sheet steel's fire-resistance was questioned by at least one agricultural engineer who argued in 1926 that even though steel roofing wouldn't ignite if a large firebrand landed on it, the metal roof could transfer heat to the hay inside *faster* than wood, leading to ignition of the hay. The same agricultural engineer questioned the purported longevity of steel sheets compared to wood, stating that wood was long-lasting, even if unpainted (Cartwright 1926: 241-242).

In the mid-1930s steel grain bins, silos, and fencing had been in use for several years but steel hay storage buildings and all-steel barns were relatively new. In 1934 farms were the sixth largest market for U.S. steel and in 1936 the fourth largest market. About ten percent of finished steel went to farms in 1935, presumably for both building materials and implements (Anderson 1937: 164).

By 1941 metal roofing sheets were very popular for farm building roofs, especially in the southern U.S. Sheets with a factory-baked primer coat of metallic paint were also available by 1941 (Crow 1941: 15).

By 1961 aluminum-coated steel sheets were used for farm building siding and roofing (Neubauer and Walker 1961: 569).

Paint

Advantages: protected wood, renewed the appearance of buildings, whitewash could be made inexpensively from lime

Disadvantages: deteriorated in sun and rain, required regular renewing

Timetable: commercial barn paints were developed by about 1850 and widespread in the 1880s, in the Midwest painted barns were rare before the early 1860s

Barns in Pennsylvania and other eastern states were being painted by commercial painters by 1850. According to David Stephens, "Barn painting in the Midwest was rare until after the Civil War" (Stephens 1995: 238).

In Minnesota, as in the rest of the Midwest, most barns and other farm outbuildings were painted either red or white (Stephens 1995: 238-240). There are several theories explaining why barns and other farm outbuildings in the U.S. were traditionally painted red. The most frequently-given explanation attributes red barns to an early European practice of adding rust (ferrous oxide) to the mixture of linseed oil, milk, and lime used to coat barns. The ferrous oxide protected the siding against fungus and moss, and stained the wood a dark orange-red. The traditional red color was then apparently continued in commercial red barn paint, which was made with relatively inexpensive and long-lasting ferrous oxide earth pigment.

White barns, also common in Minnesota, were popular because of the low cost of whitewash, which was made from substances such as slaked lime (calcium hydroxide) and chalk. Whitewashed dairy barns were sometimes used to give the appearance of being clean and sanitary. Whitewashed walls and ceilings helped reflect light in the dimly-lit interiors, making barns easier to keep clean and improving light levels for workers as they milked and did other chores.

Painting outbuildings with a contrasting color of trim paint was a common way to "decorate" farm buildings (Stephens 1995: 238-240).

Plastic Films

Advantages: waterproof, strong, decay-proof, insect- and rodent-proof

Disadvantages: deteriorated when exposed to sunlight thereby needing frequent replacement, could be torn

Timetable: began to be used on farms in the 1950s

According to sources published in 1956 and 1961, plastic films were used on farms for mulch, vapor barriers, moisture barriers, waterproofing under floors, concrete curing, roof coverings, greenhouses and cold frames, temporary windows, machinery protection, experimental silage bags, coverings for hay stacks, trench silos, and bunker silos. and liners for tanks, ponds, and irrigation canals (Staff 1956: 741; Neubauer and Walker 1961: 577).

Plywood

Advantages: strong, rigid, lightweight, easily worked, did not split when nailed, paintable, little shrinking, swelling, or twisting

Disadvantages: not as long-lasting as other materials

Timetable: used on farms after World War II

Plywood was developed in the 19th century and the name was coined in 1919. The U.S. Forest Products Laboratory in Madison, WI, tested plywood in the 1920s and built an experimental plywood house in 1934. Plywood was being made in 4' x 8' sheets by the 1930s. A 1939 article in *Agricultural Engineering* discussed testing plywood for lightweight but strong portable brooder houses (Giese and Dunkelberg 1939). Defense needs during both World War I and II advanced plywood's development. The industry's greatest growth occurred after World War II (Jester 1995: 134).

Plywood was in common use for farm buildings by 1961. Structural uses included beams, columns, subflooring, flooring, wall sheathing, roof sheathing, and as a base for stucco. Finish uses included siding, exterior soffits, concrete forms, fences, signs, furniture, doors, and other interior work (Neubauer and Walker 1961: 574-575).

Pole Framing

Advantages: little lumber needed, easy assembly, low maintenance, economical, strong, durable, adaptable

Disadvantages: poles tended to rot at base and therefore needed chemical treatment

Timetable: developed in the 1930s, used on farms beginning in the 1930s and widely after World War II

According to barn historian Lowell Soike, a precursor to a pole barn was described in the May 31, 1889, issue of *Iowa Homestead*. The building was a tall "Midwestern hay barn" for beef producers, with optional one-story shed additions for beef housing. The central hay section could be framed either with massive, upright, square timber columns spiked to posts set in the ground, or with full-length telephone poles (Soike "Affordable" 1995: 90-91).

Harper and Gordon trace the origins of the ubiquitous pole barn to the 1930s and to agricultural use. They explain:

> The modern concept of utilizing round poles as the principal structural support for farm buildings was initially developed by H. Howard Doane in the early 1930s. Doane, founder of Doane's Agricultural Service of St. Louis, and Bernon George Perkins, his farm manager, devised a system of creosoted, pressure-treated poles as primary framing, with two-by-fours spaced four feet apart as sheathing [support] material. Perkins' pole-building design concept, patented in 1953 [many years after development], significantly reduced the amount of lumber needed and could be erected in considerably less time than traditional wood-frame buildings (Harper and Gordon 1995: 226).

The poles supporting a pole barn were usually set directly into the ground, and the building either had no floor or simply a concrete slab.

The success of pole-frame buildings was reliant on the wide availability of chemical treatments for wood and galvanized iron and steel sheets that could span the widely-spaced poles to serve as sheathing. Prefabricated, lightweight steel trusses and lightweight metal roofing materials were also important (National Frame 2004).

Doane's pole-framed, gable-roofed, steel-clad, concrete-floored buildings were useful to farmers during the austerity imposed by the Depression and World War II. They were first used as beef barns, implement sheds, hay barns, and for other crop storage. A 1933 plan by the Midwest Plan Service for a wood-sided pole building indicated that the posts could be built up from dimensional lumber. In circa 1960 Merickel Buildings of Wadena offered pole barns in three sizes sheathed with either corrugated steel, fir plywood, or shiplap siding (National Frame 2004; Midwest Farm 1933; Merickel ca. 1960).

During the 1960s pole buildings proliferated on farms and about this time began to be called "post-frame" buildings. Pole buildings spread from farms to urban areas where they were used for industry, storage, and other purposes (National Frame 2004).

Prefabricated Buildings

Advantages: less waste of materials in fabrication, less shipping of material that would be wasted, accurate fabrication in the factory, efficiency in production, minimal on-site planning and labor needed, could be designed for moving and rebuilding to maximize salvage value, presumably lower cost to farmer for the quality received

Disadvantages: sometimes not easy to modify the design

Timetable: an early use – metal grain bins – began around 1910, prefabrication was widespread beginning in the 1950s

The term "prefabrication" was variously used to describe pieces precut in factories, licensed pole frames, laminated arches and roof trusses, pieces preassembled into panels, and pieces preassembled into complete structures that were shipped all in one piece. Some structures were prefabricated at the factory and others at the lumberyard. (For more on prefabricated buildings, see also "Steel Framing" below.)

Grain bins were among the first prefabricated buildings widely used on family farms. A 1943 source indicated that prefabricated grain bins, hog houses, poultry brooder houses, and similar structures were increasingly popular at Midwestern lumberyards and other retailers (Long 1943: 8; see also Economy ca. 1940). A 1956 source stated that small hog houses, brooders, self-feeders, holding bins, milk houses, and grain storage structures were being sold ready-made. Masonry silos, pole-frame barns, and other buildings were being sold and built by the seller on the farm. Utility buildings, storage sheds, and storage bins and cribs were being sold as packages or kits. Also available in various prefabricated forms were laying houses, chopped hay storage, feed bins, corncribs, hay drier-feeder combinations and numerous portable animal shelters and equipment including feeders, chutes, brooders, holding bins, and sun shades (Carter 1956: 258-259).

After World War II several factors favored the spread of factory-built structures to farms. Construction labor was scarce in rural areas and construction wages were high. Technical advances had been made during the war in treated wood, structural steel, steel and aluminum sheets, plywood, laminated framing, timber connectors, and millwork. Industrial structures built during the war were being copied or modified for farm use. And wartime defense industries had proven the efficiency of mass production (Carter 1956: 259).

Stran-Steel, Armco, Kaiser Aluminum, and Butler Manufacturing were among many companies offering prefabricated buildings after the war. In 1949 Blaw-Knox's "Universal" buildings, for example, could be made of preassembled steel wall panels in three heights for easy assembly of buildings. The wall units came either with or without windows, rolling or sliding doors, and walk-in doors. Roofs were gently-arched half trusses that were bolted in the field to form clear spans 24′, 32′, 40′, or 60′ wide. Roof ventilators and skylights were offered. The buildings were faced with 26-gauge steel sheets. One size of bolt was used throughout to simply construction. The buildings were used on farms for warehouses, poultry houses, seed-processing plants, feed storage, machine sheds, dairy barns, crop-drying sheds, and farm shops (Erdner 1949: 477-478).

One agricultural engineer predicted in 1943: "It may safely be stated that prefabrication in the farm field is here to stay. It will not supplant conventional construction, but it will prove a worthy competitor . . . "(Long 1943:10). In 1956 the prefabricated or factory-built farm building industry was "still very young" with most farm buildings still built conventionally with home or local labor (Carter 1956: 260).

Steel Framing

Advantages: strong, fire-resistant, did not shrink or warp, lightweight, resistant to decay, adaptable to various exterior sheathing materials, could provide post-free interiors or larger open storage area than wooden bents, could be enlarged in modular fashion, facilitated factory-made buildings

Disadvantages: lack of local design expertise, corrosion (which could be reduced somewhat by painting, providing a dry atmosphere, or encasing the members in another material), required welding experience and an electric arc welder in the field, more expensive than wood, materials not widely available

Timetable: early use in grain bins began around 1910, first all-steel barn made in 1922, quonset-type buildings were introduced to the U.S. in 1941 and became common on farms after World War II, deeply-corrugated and frameless and trussless arched buildings apparently became common in the 1950s

Cylindrical steel grain bins were one of the first agricultural uses of steel framing (also called "light-load" steel framing). The Butler Manufacturing Company of Kansas City, for example, sold its first steel bins in 1907. Three years later the company sold its first Butler building, a metal garage built of corrugated steel culvert sheets bolted together (Butler 2004).

In 1922 the country's first all-steel barn was built in Michigan. Measuring 36′ x 72′, it had a poured concrete foundation, steel frame, and 22-gauge corrugated sheet steel siding and roof (Jones 1926: 176). Many early steel-framed buildings used studs, beams, joists, rafters, etc. that were similar to dimensional lumber components and used accordingly.

Steel's advantages as a framing material, including its reputed fire-resistance, were questioned by agricultural engineers. One argued in 1926 that steel would lose strength in a fire and that reinforced concrete was the only material that allowed a building to be reused after a fire (the best definition of fire resistance in his opinion). The same engineer explained that steel framing was prone to deterioration from dampness and did not have wood's ability to be chemically treated against rot (Cartwright 1926: 241-242).

In the 1920s and 1930s steel-framing was used on farms for a variety of buildings and structures including garages, machine sheds, grain bins, corncribs, brooder houses, chicken houses, crop warehouses, hay barns, hog houses, two-story barns, and one-story dairy and beef cattle barns (Parsons 1927: 112; "New Steel" 1933; Driftmier 1938: 159).

In 1941 the University of Wiconsin, Madison, built a one-story, gable-roofed, steel dairy research barn, attached milk house, and "experimental site-welded silo" in cooperation with Carnegie-Illinois Steel Corporation. The project was designed as a significant test of steel's use as a building material as well as an experiment of various dairy management practices. The study found the steel satisfactory after ten years, except where used for a warm, insulated barn where condensation became a problem (Witzel 1945: 415; Witzel and Heizer 1946; Witzel and Derber 1952). Butler Manufacturing and other companies increased research and production of steel frames during World War II.

Steel-framed Quonset buildings – "Quonset" being a trademark of Detroit's Great Lakes Steel – became widely available after World War II. They were sometimes called hangar-type buildings. In 1948 the Stran-Steel division of Great Lakes Steel was advertising a popular 40' x 100' building called the "Quonset 40" which was a grain storage building that could serve as a machine shed at other times of the year. Using the slogan "There's a Quonset for Every Job on Your Farmstead," Stran-Steel also sold the Quonset 16 [meaning 16' wide], Quonset 20, Quonset 24, and Quonset 32 for machinery storage, livestock housing (both loose and stanchioned), farm shops, hay barns, feed and seed houses, and utility buildings. Stran-Steel had a regional office in Minneapolis (Stran-Steel 1948; Stran-Steel 1957).

In 1946 another company, Flintkote, was offering Quonset-type buildings "from brooder pens to dairy barns." Flintkote reduced the problems of condensation and coldness that were common to all-steel buildings by using fiberglass insulating wool, interior insulation board, and an exterior asphalt emulsion coating (Flintkote 1946).

A 1948 advertisement in *Agricultural Engineering* for U.S. Steel's site-welded steel buildings indicated they were "a new development," that "approximately 60" U.S. Steel Site-Welded Buildings had been built the previous year, and that "materials are as yet available only in limited quantities." They were available in standard sizes such as 24' x 60' and 36' x 60' with the first dimension varying in multiples of 12' (Carnegie 1948).

A "recent" development in 1961 was the "trussless, deeply-corrugated sheet-metal arch." It was commonly either parabolic or circular. The arches were available, for example in spans of 30' to 60' and of 18- to 20-gauge steel. The 2' wide arched pieces were bolted together side to side to create a building with no columns, trusses, or tie rods (Neubauer and Walker 1961: 568).

Stone

Advantages: durable, readily available in many areas, low cost materials if gathered on the farm, work could be done slowly as time allowed, long-lasting

Disadvantages: slow construction, units were heavy

Timetable: stone construction began during the early settlement period, especially 1850s-1870s; cobblestones used chiefly in the 1910s-1940

Local stone was one of the first building materials available to settlement-era farmers. Throughout the state, field stones were gathered and used in small quantities for building foundations and similar purposes. Entire stone buildings were constructed in southern Minnesota where soft workable limestone was locally available, and less often in other parts of the state.

Interest in building with cobblestones or small round field stones rose in the 1910s-1930s with the popularity of the Craftsman Style. Articles on field-collected cobblestone buildings in 1928 and 1932 issues of *Architectural Engineering* feature a poultry house, brooder house, milk house, barn, and farmhouses built of stones (McPheeters 1928).

Straw

Advantages: inexpensive, materials readily available, could be temporary

Disadvantages: needed annual repair, impermanent although could last several years

Timetable: built throughout Minnesota from the early settlement period through the 1950s, special interest during building material shortages of World War II

Buildings made of straw – either fully or partially – were used throughout Minnesota from the early settlement period through at least the 1950s. The West Central Experiment Station in Morris, for example, erected at least two successive large straw buildings for feeder cattle in the 1950s (Hanke 2004). During World War II there was special interest in straw buildings in Minnesota while building materials were in short supply.

Straw buildings were inexpensive to construct, warm in the winter, and cool in the summer. Some were built to last for several years (although they needed annual repair), while others were built for temporary or emergency purposes (Cleland 1941: n.p.).

In Minnesota straw buildings were used as shelter for lambs, calves, or hogs being fattened; as farrowing and lambing barns; as poultry houses; for wintering young cattle, sheep, and brood sows that were outside the rest of the year; for dairy cows; as multipurpose or general barns; and as summer shade for pastured animals (Cleland 1941: n.p.).

The framework of straw buildings was usually built of wooden poles or planks. To build the walls, some farmers simply piled loose straw over the frame. Sturdier walls, or walls that could withstand animal damage, could be made with two layers of poles (or poles and wire mesh) with straw packed or tramped between them. Walls were also built of straw bales that were sometimes secured or reinforced with wire fencing. Roofs were built of loose straw or conventional building materials. Some straw buildings had movable doors and windows. Most straw buildings had dirt floors. If used for poultry, however, the building needed a raised floor to keep conditions dry, and a roof that did not leak (Cleland 1941: n.p.).

Farmers also used loose straw as insulation above the ceilings of woodframe poultry and hog houses. Many farmers banked straw bales around buildings to keep out cold drafts. Straw bales were also used for windbreaks in stockyards.

Structural Clay Tile

Advantages: could be glazed or unglazed, waterproof, fireproof, smooth and washable, contained an insulating airspace, long-lasting, lightweight, more economical than brick, did not need paint, attractive, easy to build

Disadvantages: brittle, difficult to cut on site, made by fewer manufacturers than common concrete block therefore freight costs could be higher than for block

Timetable: use began in the first decade of the 20th century, still popular in the 1940s

The first curved tile silo was built in 1908 at Iowa State College in Ames. A 1910 source mentioned that "a few" corncribs had been built of tile, as well as houses, barns, storage buildings, elevators, chicken houses, hog houses, and smokehouses. The author recommended hollow tile particularly for small to medium sized buildings (King 1910: 48). In a follow-up article in 1916, the author indicated that the clay block "Iowa silo" had become "a standard" and "the most uniformly successful type of silo that has ever been developed." The corncrib he described in 1910 had become standard, and circular grain bins were in "common use" (King 1916: 62).

A promotional booklet published by the Structural Clay Products Institute in 1941 showed numerous examples of clay tile houses, garages, a 22'-diameter grain bin, silos, other crop storage structures, various barns, milk houses, implement sheds, water tanks, cisterns, and numerous smaller structures. Many were built in the 1910s and were still in good condition in 1941. According to the Institute, "The leading dairy farmers throughout the Midwest are using tile almost exclusively for barn walls" (Structural Clay 1941: 13). Clay tile was also commonly used for foundations.

During World War II structural clay tile was an unrestricted building material and some farmers used it to repair or replace first-story barn walls, leaving the wooden upper mow walls and roof intact.

Because of the reduced danger of fire, buildings built of hollow tile could be sited closer together, even sharing common walls, to increase efficiency (Structural Clay 1941: 10).

In 1941 Carter and Foster wrote that most hollow clay or structural clay tile used in farm buildings was 5" by 8" by 12" and used to form 8"-thick walls. Curved tanks, grain bins, milk houses, and other small buildings were made from curved and radially cut tiles, sometimes called silo tiles. Hollow tile was also utilized for floors for barns and poultry and hog houses. Clay tile was extensively used for subsurface field drains (Carter and Foster 1941: 73).

Tar Paper

Advantages: inexpensive, waterproof, quickly applied, readily available, another siding could be added later

Disadvantages: impermanent, easily torn, absorbed heat, flammable

Timetable: popular during the early settlement phase, especially in western and northern Minnesota

Tar paper, also called roofing felt or saturated felt, was a common material for siding and roofing during the early settlement phase in several parts of the state. Tar paper covered many "claim shacks" on many new farms, was used for the roofs of log houses, and was used to improve sod houses. (A layer of tar paper beneath the sod on a roof, for example, could make the roof more watertight.)

Tar paper was usually applied to woodframe buildings with strips of lath or large-headed tacks. A layer of more permanent siding could be applied over it as finances allowed. Tar paper seems to have lasted longer as an exterior sheathing in forested areas where trees helped block the wind. Asphalt composition (sold in both shingle and roll form) was a more durable alternative.

In their 1999 study of farmsteads in Minnesota's cutover counties, Henning, Henning, and Roberts wrote, "Tar paper emerges as the material of choice in the later years of [cutover] settlement. A county history for St. Louis County noted that whereas in 1900 log houses were the typical material for a settler's first house, 'the homesteader of today, however, favors the tarpapered shack for the first year or two of pioneer effort'" (Henning et al 1999: 51).

Wood (Heavy Timbers and Dimensional Lumber)

Advantages: stronger by weight than steel or concrete in tension and flexure, timbers readily available in wooded areas, timbers available in large units, dimensional lumber readily available in many sizes once railroads were built, thin planks or boards could be sandwiched together to make stronger units, wood could be worked by semi-skilled laborers, wood was salvageable and reusable, could be worked into fancy shapes such as shingles, trim, and millwork

Disadvantages: timber framing required special joinery skills, timbers were heavy, dimensional lumber could warp, wood was flammable, could deteriorate if wet

Timetable: very popular during the period of this context study, 1820-1960

Wood was the most common farm building material in Minnesota during the period covered by this study. See standard sources including those listed below. See also this context study's "Planning and Building Farm Structures: Barn Forms and Terminology."

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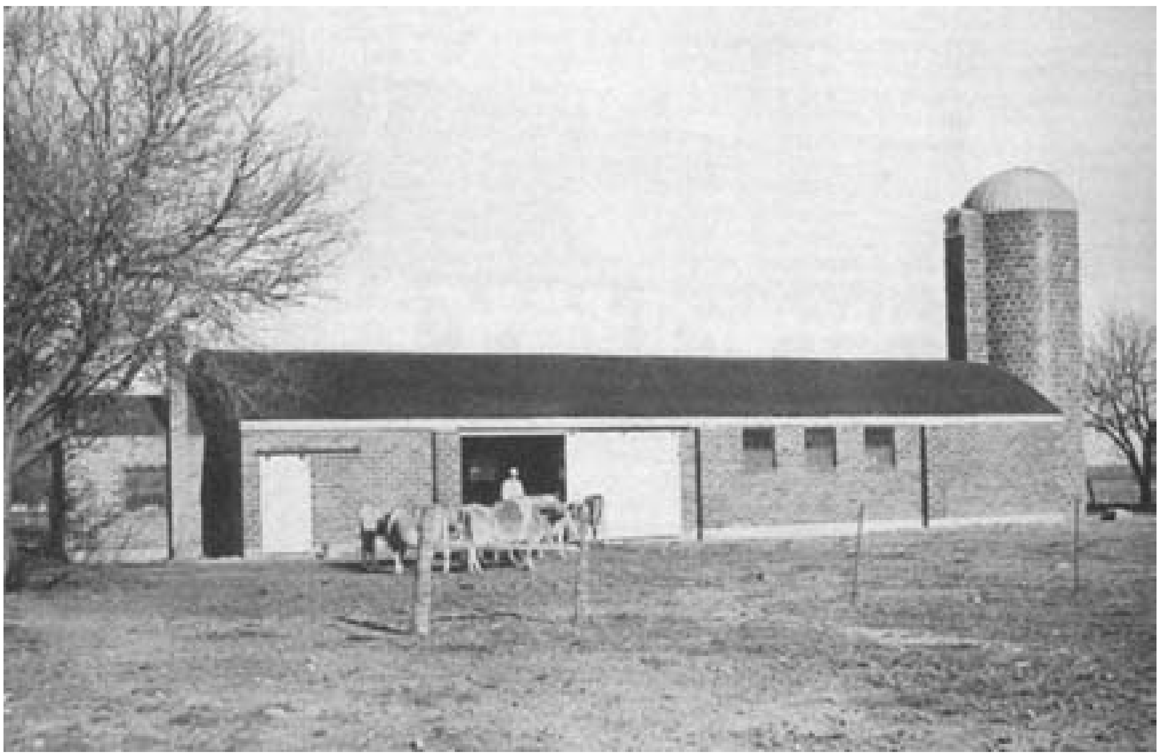
A stone barn in Houston County with a corrugated metal roof. Photographed in 1976. (MHS photo)

The first cement stave structure in the U.S. was a stock tank built in Michigan in 1905. This photo of a cement stave stock tank was taken circa 1910 on the Savage Farm, presumably in Minnesota (location unknown). (MHS photo by Harry Darius Ayer)



A one-story dairy barn and attached silo, both built of structural clay tile. Tile was usually glazed on one side to provide a sanitary, waterproof, cleanable interior for the barn, milk house, and silo. From *Dairy Cattle and Milk Production* by the University of Minnesota's Clarence H. Eckles (1950).

Straw buildings were used in Minnesota for housing all types of livestock and poultry, including shorthorn cattle (shown here). They were built early in the 20th century, during wartime when building materials were scarce, and well into the 1950s. Photo location unknown, circa 1910. (MHS photo by Harry Darius Ayer)

This farm building was sheathed in steel sheets stamped with a rockfaced masonry design – the most popular special pattern. The roof of the building was covered with a corrugated version. Iron and steel sheets were widely used to renew the appearance of woodframe and wood-sided buildings, and were sometimes the original exterior material. Grove Township, Stearns County, 2004. (Gemini Research photo)

A poured concrete bridge (reinforced with iron) that carries a narrow farm lane over a stream in Stearns County. 2004. (Gemini Research photo)

A farmhouse with asbestos-cement siding. Kathio Township, Mille Lacs County, 2003. (Gemini Research photo)

The roof of this gothic arch barn is comprised of a series of glue-laminated rafters made by Rilco in St. Paul. The mow has maximum unobstructed space. West Central School of Agriculture and Experiment Station (now University of Minnesota, Morris), Stevens County, 2004. (Gemini Research photo)

BARN FORMS AND TERMINOLOGY

BARN FORMS

Minnesota barns passed through some evolution over time as farming shifted from a small-scale subsistence endeavor – which might require only a simple one-room log barn – to an increasingly specialized, mechanized, and capital-intensive industry. Early barn forms were more likely to be influenced by ethnic traditions, local practice, and responses to native conditions and materials, while later barn forms were more likely to be influenced by the field of agricultural engineering, published plans, and the development of prefabricated materials, components, and equipment.

In a study of barns in southern Ontario, geographer Peter Ennals describes a succession in barn forms that appears to be applicable to Minnesota. Most of the first farmers in southern Ontario first built a log barn. According to Ennals, "This barn usually had a life expectancy of up to 30 years, by which time it would have deteriorated and a second more permanent [timber] frame barn would be built." The second barn's form depended on the region and era in which it was constructed. In the earlier-settled areas Ennals studied – perhaps comparable to southeastern Minnesota – the second-phase barn was a threshing barn suited to wheat monoculture. The farm's few animals were usually kept in other small shelters. In areas settled later, the second-generation barn was a general purpose or combination barn. This form was chosen because, by the time the log barn had deteriorated, farming practices had diversified to include livestock and dairying. The second-generation barns were often modified or enlarged as dairy herds grew. Ennals found that specialized dairy barns, including the "Wisconsin" dairy barn form, were built as third-generation barns when the second-generation barns began to deteriorate. On farms where the second-generation barn was still in good condition and continued to suit its purpose, the third phase of barn-building might be delayed until a one-story pole barn was built after World War II (Ennals 1972: 267-268).

An overview of the structural development of Minnesota barns includes the following types:

Single-Pen (e.g., Log) Barns. The term single-pen barn usually describes a simple form comprised of four walls enclosing one rectangular room or pen. These barns were often built on subsistence-level, settlement era farms, and were often topped by a gabled roof. The upper level interior was sometimes used as a small storage loft. In much of Minnesota, single-pen barns were built of logs during the early settlement era. Sometimes a log single-pen barn was originally built as a log dwelling and later used as a barn.

Timber Frame Barns. Timber framing was used for all types of buildings during the 19th century, and on Minnesota farms timber framing is found in barns, granaries, and a few other types of structures. Timber frame barns often superceded earlier, smaller subsistence-level barns or outbuildings, serving as the second-generation barn on the farm. Timber frame barns were most

See also

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Appendix: Focus on USDA & Minn Dept of Ag

often built in the southeastern quarter of the state. By the time farms farther west and north needed large (i.e., non-subsistence-level) barns, railroads had been built, pre-cut dimensional lumber was available from commercial trackside lumberyards, and new framing styles were in use.

The superstructure of a timber frame barn was comprised of a series of bents (e.g., four to six) that were typically pre-assembled on the ground and tipped up into place on a stone foundation to support the barn. The barn's gabled roof was often built of rafters made of rounded logs flattened on one side. It was common for structural timbers to be long, locally-felled logs that were hewn square with a broadaxe or hauled to a nearby sawmill to be squared off. Large timbers ranging from 8" x 8" to 12" x 12" in cross-section were used as principal elements, and smaller timbers were used for braces, girts, and other components. The timber frame was generally assembled with mortise and tenon joints fastened with wooden pegs. Joints were either custom-cut into unique mortise and tenon pairs (in rare cases, using scribe carpentry) or, if very even saw-cut timbers were available, joints could be mass-cut into mortise and tenon units that were more interchangeable. A few timber frame barns in Minnesota – usually found in ethnic enclaves – display framing styles and carpentry techniques that represent very late examples of medieval European traditions. These techniques include scribe carpentry, the use of curved timbers, long diagonal braces, and "fachwerk"-style square panel wall framing (Tishler 1984; Tishler 1986; Witmer 1983; Perrin 1981; Upton 1981). (See illustration on page 5.76.)

Timber frame barns had several advantages, including their strength. Cash-strapped farmers could cut wood on their own land and hew it themselves. Mortise and tenon joints required a skilled barn-builder, but the farmer and neighbors could comprise much of the semi-skilled crew.

The bents in timber frame barns were usually set a regular distance apart, creating a set of evenly-sized interior bays. The **three-bay barn** – formed from four bents – was common in southeastern Minnesota and in states farther east. Three-bay barns are sometimes called English barns. They were also sometimes called **threshing barns** because before mechanical threshers were used (e.g., before the 1850s and 1860s) the central drive of three-bay barns was used as a floor for hand-flailing or threshing grain. Large doors on either side of the central bay could be opened so the wind blew through to help winnow the chaff. Three-bay barns often functioned as general purpose or combination barns that housed oxen, horses, cows, other livestock, bedding, and crops. Crops were stored in wooden bins, straw or hay could be stored in bins or in loft platforms above one or both outer bays, and wagons or machinery could be stored in the central drive. As farm productivity grew, three-bay barns could be expanded by the addition of more timber bents, thereby creating additional bays.

If the farm had more than a few animals, it was common to place a three-bay barn on a stone basement, creating what some historians call a **raised three-bay barn**. (See illustration on page 5.81.) The basement usually served as the cow and horse stable. A typical form of raised three-bay barn was the **bank barn** (sometimes called the side-hill barn), which was built against a hillside so that both basement and upper level could be entered with wagons. If the farmstead wasn't hilly, an earthen drive could be built to the upper level. **German or forebay barns**, in which the barn's upper level projected out (extended over) the lower level, were generally not built in Minnesota, although they were constructed in Wisconsin, mostly by German immigrants.

Timber frame barns were built in Minnesota at least through the 1920s. While by then timber framing had largely been superceded by lighter framing techniques, some farmers preferred to fell their own trees to reduce cash outlay on purchased lumber (or to obtain a strong barn in an area where pre-cut lumber wasn't yet commercially available) (Perrin 1981: 42; Visser 1997: 21-22).

Plank and Balloon Frame Barns. Although they were strong and large, timber frame barns had some disadvantages, including the fact that long straight timbers were unavailable in many parts of the state. Many timber frame barns also had limited storage lofts. As farms diversified and dairying increased, it became important to maximize storage capacity for winter feed such as hay and to accommodate the labor-reducing mechanical hay carriers that were becoming common by the 1870s.

By the turn of the 20th century, Minnesota farmers were increasingly substituting plank framing and similar techniques for heavy timber framing. A new development in the 1880s, the **gambrel roof**, created barns with greater storage capacity via a large interior mow accessed by an endwall hay mow door. Gambrel roofs could be supported by newly-developed plank frames, in which long relatively thin planks were combined to form supporting elements. (See illustration on page 5.80.) The Shawver truss, developed in Ohio in the late 19th century, became an important model, as did the Iowa or Clyde truss, developed around 1920, which had the advantage of requiring fewer very long pieces of lumber than did the Shawver version (Soike "Within" 1995). Barn historians Harper and Gordon explain:

> A standard 36' by 48' barn constructed of plank framing could be put up faster than, and required only half the lumber of, a conventional braced-frame [timber frame] barn. Since every rafter was made to form a truss, no scaffolding was needed, and the trusses could be bolted and assembled on the ground or in the haymow. In essence, the truss created a self-supporting arch which, when completed, formed a rigid structure as strong or stronger than mortise and tenon framing. Moreover, the size of the loft could be increased without building the barn higher at the plate or ridge. According to the *Ohio Farmer*, the substitution of plank for square timbers was the greatest advance made in barn framing during [the] period [1890-1930] (Harper and Gordon 1995: 222).

A further development, the balloon frame barn, depended not on a few very heavy bents or plank trusses but on many closely-spaced rafter trusses that worked together to share structural support. The **gothic arch roof**, offering slightly greater storage capacity and faster assembly than the gambrel roof, was developed around 1920 using built-up or laminated rafters that were also light and self-supporting. Beginning in the 1930s, some gothic arched and **rounded arch roofed** barns (sometimes called **rainbow arched**) were made with rafter systems that were **glue-laminated**, rather than nailed. Most glue-laminated rafters were factory-made.

Gambrel, gothic, and rounded arched roofs were sometimes used in barn remodeling to replace earlier gabled roofs, thereby expanding storage capacity. Some remodeling projects also included replacing wooden first story barn walls with strong, cleanable hollow tile or concrete block that helped support the new roof (Harper and Gordon 1995).

Another type of modern barn form common in Minnesota is termed by barn historians Noble and Cleek the **midwest three-portal barn** or **three-alley barn**. (See illustration on page 5.82.) It was a plank or balloon frame barn with a central aisle flanked by enclosed side aisles, all covered by an encompassing roof, usually gabled. Noble and Cleek write, "Sometimes [the side] aisles are later additions and often result in a broken roofline. Early gable roofs have sometimes been replaced with gambrel roofs, and in the 20th century barns were built with original gambrel roofs spread to cover the side aisles. This barn was standard in the south-central United States in the late 19th and early 20th centuries. It often has a hay hood and large gable-end loft doors. Plank frame versions are usually called feeder barns as they house livestock." Midwest three-portal barns usually have separate doors leading into the central aisle and the side aisles. Some gambrel roofed examples are apparently smaller than those with gabled roofs (Noble and Cleek 1995: 74-75; Noble 1984: 64).

The barn forms that superceded timber framing were predicated on lumberyard-distribution of standard-sized sawn boards and machine-made nails. The new types of barns did not require skilled joinery craftsmanship, were faster to build, and required less wood than timber frame barns, which tended to be over-built. Most of the new barn forms also represented the influence of agricultural engineers and farm experts. By drawing and publishing barn plans and working through the agricultural press, the USDA, agricultural colleges, experiment stations, extension services, and agri-businesses, these professionals promoted barn designs that accommodated more livestock, more efficient use of labor, increasing mechanization, greater emphasis on animal health, and similar factors.

The new framing techniques not only made barn-building easier, increased mow capacity, and allowed mechanical hay carriers to be installed, but they also revolutionized barn floor plans. Farmers operating within older timber frame barns had to work around the heavy bents necessary to support the structure. In barns with plank frames, balloon frames, and laminated rafters, much of the weight was supported by rafter trusses and the first-story side walls. Stable floors could now be freely arranged for maximum efficiency, with rows of stalls, feed alleys, cleaning alleys, manure gutters, and other mechanical devices installed to reduce labor and support more livestock. Barns could also be built with more windows, which improved ventilation and animal health, and provided more interior light for milking and barn cleaning. The **Wisconsin Barn** or **Wisconsin Dairy Barn** was an important dairy barn style (also used for general purpose or combination barns) that was developed around the turn of the 20th century and incorporated many of the best features made possible by the new light barn framing including maximum loft size, numerous windows, thoughtfully-planned stall rows and chore alleys, and an attached silo.

In 1916 the American Society of Agricultural Engineers' subcommittee on farm structures identified 18 basic barn designs that were most suitable to meet the typical farmer's needs. (See illustration on page 5.79.) The 18 were culled from a reported 10,000 buildings and plans, most then in use in the Midwest. The designs were chosen for flexibility in building materials and adaptability to various kinds of farming practices. They represented compromises between the amount of lumber needed and barn capacity. They used dimensional lumber, which was widely available and weighed less than heavy timbers. Some barns were designed with driveways into the mow or main floor, while others had a second-story mow accessible only by ladders and a hay mow door. Various truss styles were used. Because most originated in the Midwest, the 18 designs may be a fair reflection of barn forms in use in Minnesota at the time (Niemann et al 1919: 268-275).

Quonset Roof Barns and Pole Frame Barns. The strong, lightweight, self-supporting advantages of glue-laminated rafter systems were also achieved with quonset-style and pole frame buildings. First promoted during the 1940s, quonset-style buildings typically had a rounded-arched roof – often made of corrugated steel – that extended to the ground thereby also creating side walls. Pole frame buildings, first developed in the 1930s and very popular after World War II, were based on a framework of widely-spaced wall posts (e.g., wooden telephone poles treated with preservative) that supported a shallow-pitched gabled roof made of lightweight rafter trusses. Both roof and walls were often covered with corrugated sheet metal. Both quonset-style and pole frame buildings provided open, post-free interiors that supported flexible and changeable floor plans, loose housing of livestock, and increased mechanization. Both types of buildings were quickly erected and available in pre-fabricated (or ready to assemble) form, which helped farmers obtain cost-effective buildings in the time of rural labor shortages during and after World War II.

BARN TERMINOLOGY

The glossary below is designed to serve only as an introduction to barn terminology. Many good glossaries, some with illustrations, are available in sources such as Arthur and Whitney's *The Barn: A Vanishing Landmark in North America* (1972), Ensminger's *The Pennsylvania Barn* (1992), and Noble's *To Build in a New Land: Ethnic Landscapes in North America* (1992). Barn components are also described and illustrated within the text of many works like Noble and Cleek's *The Old Barn Book* (1995). The information below was drawn largely from these sources.

Alley. A longitudinal walkway or drive, often perpendicular to the stalls, that allowed the worker to deliver feed, remove manure, and bring in milking equipment. Animals were walked down the alley to go outside or to a milking parlor. Alleys often ran down the center of a barn and along the outer walls. Sometimes called a feed alley, litter alley, chore alley, or cleaning alley. See illustration on page 6.112.

Balloon Frame Barn. A barn in which the major weight of the roof superstructure is shared by many pairs of rafters and wall studs, rather than being carried by a few heavy bents or trusses. Built with dimensional lumber. See illustration on page 5.77.

Bank Barn. A two-level barn with ground access to both levels. Bank barns were often built into a hillside so the upper level was entered from the side of the hill. If the terrain was flat, an earthen ramp often accessed the upper level. The upper level usually stored crops, haw, straw, and some machinery (e.g., in the central alley), while the basement level housed animals. Sometimes called a side hill barn or a basement barn. See illustration on page 6.109.

Barrel Arch. See Rounded Arch.

Basement Barn. A barn with a basement. Often a bank barn.

Bay. A portion of a building that is defined by repeated structural elements such as bents or window openings. A barn with three interior bays could be created with four bents – two bents holding up the outer walls and two interior bents – that were usually spaced a regular distance apart. See illustration on page 5.75.

Beam. A heavy horizontal timber element, often made from a squared log or tree trunk. See illustration on page 5.75.

Bedding. Loose material such as straw used to cover the floor in stalls or stables. Sawdust, wood chips, and other materials were used if inexpensive and readily available. See illustration on page 6.111.

Beef Barn. A barn primarily used to raise or fatten beef cattle. Also called a feeder barn. The Midwest Three-Portal Barn was a common form. See illustration on page 5.82.

Bent. A heavy timber unit comprised of vertical posts, horizontal beams, and other supports and braces. The bent was tied to other bents with longitudinal sills and plates to create the barn's structural framework. See illustration on page 5.75.

Brace. A piece of wood, usually diagonal, placed between posts and beam in a bent to stiffened the structure. Often used in matched pairs. A brace could be relatively short, or extend the entire height of the story (e.g., from plate to sill or floor). Sometimes called an angle brace, knee brace, or strut. See illustration on page 5.76.

Carpenter's Marks. Simple marks (such as hatches) made on timbers with a carpenter's tool to help the builder keep track of which timbers would be fit together when the building was assembled. Most often used in timber frame joinery in which mortises and tenons were custom-cut to fit in unique pairs. Also called marriage marks. See illustration on page 5.28.

Clerestory. An upper portion of wall rising above the main roof, usually to provide additional high windows. Also called a monitor. See illustration on page 3.87.

Clyde or Iowa Truss. A gambrel roofed barn framing system developed circa 1920 as an improvement over timber framing. See illustration on page 5.77.

Collar Beam. A horizontal beam that connected opposing principal rafters in a roof system. Often located at the rafters' half-way point.

Combination Barn. See General Purpose barn.

Cross Beam. A heavy horizontal beam that ran transversely through a structure (i.e., perpendicular to the center line). For example, a cross beam could run from end post to end post in a bent. Sometimes called a tie beam. See illustration on page 5.75.

Dairy Barn. A barn primarily used for the housing (and usually milking) of dairy cattle. See illustration on page 6.107.

English Barn. Also called Connecticut, New England, or Yankee barn. See Three-Bay Barn.

Feed Bunk. A livestock feeding station or trough. Sometimes also called a manger or trough. See illustration on page 6.28.

Feed Carrier. An elevated mechanical track, usually metal, that extended along the stalls of a stable. Feed was loaded into the carrier's buckets or baskets and distributed to the livestock.

Feeder Barn. See Beef Barn.

Forebay or German Barn. A two-story barn with a projecting or overhanging upper portion that extended out over the lower level on the eave side. Commonly built by German immigrants in Pennsylvania, Ohio, Wisconsin, and other states; believed very rare in Minnesota.

Gambrel Roof. A roof whose two opposing sides were each formed by two slopes. See illustration on page 5.80.

General Purpose or Combination Barn. A barn in which a variety of livestock were housed. This was the most common functional barn type on Minnesota farms, housing dairy cows, horses, and perhaps hogs and a bull. See illustration on page 6.232.

German Barn. See Forebay Barn.

Girt. A horizontal framing member that connected posts at a level below the plate and above the sill. See illustration on page 5.75.

Glue-Laminated Rafter. Used in a lightweight, self-supporting barn form in which the rafters, often curved, were sandwiched together with glue, rather than nails. See illustration on page 5.62.

Gothic Arch. An arch with a point at the top. A gothic arch roof has an arched shape and a ridge at the top. See illustration on page 5.31.

Gutter, Manure. A channel in the barn floor designed to collect manure and urine (often called liquid manure). Usually built of concrete and located below floor grade, perpendicular to the ends of the stalls. Gutters were often cleaned by hand with shovels. A gutter cleaner (also called a barn cleaner) was a mechanical device, usually made with chains and metal paddles, that moved through the gutter gathering the manure. See illustration on page 5.80.

Hay Carrier or Track. A mechanical device installed longitudinally within a mow, usually near the peak of the roof. Used to move hay or straw along the length of the mow where it could be dropped on the mow floor for storage. Hay or straw was hoisted into the barn with the carrier's system of ropes and pulleys. See illustration on page 6.103.

Hay Chute or Drop. An opening in a hay mow floor, often framed with wood, down which hay (or straw) was dropped from the mow to the stable below.

Hay Hood. An extension of the peak of a gable or gambrel roof over a hay mow door. Built to protect hay carrier equipment and the mow door from weather. See illustration on page 6.110.

Iowa Truss. See Clyde Truss.

Joists. A set of horizontal members extending from wall to wall to support a floor or ceiling.

Lean-to. A common form of barn addition with a shed (i.e., single-pitched) roof. Sometimes called a shed addition. See illustration on page 5.13.

Litter Carrier. An elevated mechanical track running through a stable and often out into the yard. Manure could be shoveled into the carrier's buckets, moved out of the barn, and dumped into a wagon or manure spreader to be hauled to the fields. A feed carrier operated in a similar fashion.

Loafing or Pen Barn. A barn in which livestock such as dairy cows were housed "loose" rather than confined in stalls. The barn often had large door openings, or one side entirely open, so the animals could freely move outside. See illustration on page 6.114.

Hay Loft or Mow. Upper level of a barn in which hay (or less often straw) was stored. In three-bay barns, which lacked full-sized mows, smaller loft platforms located in the outer bays could provide limited hay storage. See illustration on page 5.62.

Manger. A container from which livestock ate food. Usually built of wood, metal, or concrete. Sometimes also called a feed bunk or trough. See illustration on page 6.104.

Marriage Marks. See Carpenter's Marks.

Midwest Three-Portal Barn. A plank or balloon frame barn, usually gable roofed, with a central aisle flanked by enclosed side aisles, all with separate doors. Sometimes called a beef barn or feeder barn. See illustration on page 5.82.

Monitor. See Clerestory.

Mortise. The slot or hole in a piece of timber into which a tenon (a projection or tongue on the end of another piece of timber) was inserted. Mortise and tenon joints were often secured with a wooden peg or pin. See illustration on page 5.28.

Mow. See Hay Loft.

Pen Barn. See Loafing Barn.

Plank Frame Barn. A barn in which long, built-up, plank supports served a purpose similar to the heavy bents in a timber frame barn. See illustration on page 5.80.

Plate. A longitudinal horizontal timber, usually placed on top of the bents, that supported the ends of the rafters. Sometimes a plate, like other long timber elements, was made of two timbers spliced or "scarfed" end-to-end. Also called a roof plate. See illustration on page 5.75.

Pole Frame Barn. A barn, usually gable roofed, whose framework consisted of treated wooden wall posts supporting a low pitched roof made of lightweight rafter trusses. External roof and wall sheathing was usually corrugated metal.

Post. A heavy vertical support. See illustration on page 5.76.

Principal Rafter. A heavy rafter located at the bent in a timber frame. (The rafters located between the bents were called common rafters.)

Purlin. A horizontal timber placed longitudinally beneath the rafters (for example, half-way between the ridge pole and the plate) to help support the rafters. See illustration on page 5.77.

Raised Three-Bay Barn. A three-bay barn on a basement. See illustration on page 5.81.

Ridgepole or Ridge Board. A horizontal timber or board against which the ends of the rafters butt at the peak or ridge of a roof.

Rafters or common rafters. Boards extending from the ridgepole to the eaves to support the roof. See illustration on page 5.80.

Rainbow Arch. See Rounded Arch.

Roof Plate. See Plate.

Rounded Arch. A semi-circular arch (as opposed to a gothic arch, which has a point at the top). Sometimes called a barrel arch or a rainbow arch. See illustration on page 6.110.

Quonset. A name brand of prefabricated building, made by Great Lakes Steel (Stran-Steel) Corporation, in which the corrugated metal roof (usually rounded arched) also created the side walls. The term was sometimes used informally to refer to all buildings of this type, not just Stran-Steel's. Generally pre-fabricated. See illustration on page 5.84.

Queen Posts. Short vertical support posts used in pairs within a bent to support purlins, which in turn supported rafters. The queen posts rested on a tie beam (which connected a pair of opposing principal rafters near their lower ends) and supported the rafters at a point somewhere between the apex of the roof and the tie beam. (This differed from a king post, which was used singly, and supported the roof at its apex.) The tops of the queen posts were sometimes joined with a horizontal tie piece or straining piece. Queen posts could be angled outward. See illustration on page 5.77.

Saltbox Roof. A two-sided roof form in which one of the two opposing sides was longer than the other and therefore extended farther toward the ground. The roof was therefore asymmetrical in cross-section. See illustration on page 6.314.

Shawver Truss. A gambrel roofed barn framing system developed in the late 19th century as an improvement over timber framing. See illustration on page 5.80.

Sill. A heavy horizontal timber, often resting on a stone foundation, that supported the vertical end posts of a bent at the outside wall. See illustration on page 5.75.

Single-Pen Barn. A simple barn generally consisting of one room beneath a gabled roof. See illustration on page 3.13.

Stanchion. A wood or metal device that closed around a dairy cow's neck, against her shoulders, to restrain her movement in a stall. See illustration on page 6.104.

Stall. A rectangular area, sometimes boxed with wood, in which livestock were kept, either individually or in small numbers (e.g., a matched team of horses). See illustration on page 6.104.

Stable. The part of a barn that housed livestock.

Tie Beam. A horizontal beam in a timber frame. Often used to connect a pair of end posts or a pair of opposing rafters at their ends. See illustration on page 5.75.

Tenon. One half of a mortise and tenon joint. A tenon was a projecting shaft in the end of a length of timber that fit into a corresponding mortise or slot in another length of timber. See illustration on page 5.28.

Three-Bay or English Barn. A timber frame barn form comprised of four bents forming three bays, usually about even in size. The central bay was usually a drive-through space, historically used for threshing. Often set on a basement to create a raised three-bay barn. Sometimes also called a threshing barn. See illustration on page 6.496.

Three-Portal Barn. See Midwest Three-Portal Barn.

Threshing Barn. See English or Three-Bay Barn.

Threshing Floor. Often the central bay of a three-bay barn on which grain was hand-threshed. The threshing floor was also used to store wagons and crops. See illustration on page 6.496.

Timber Frame Barn. A barn whose superstructure was supported by bents of heavy squared timbers, generally assembled with mortise and tenon joints. See illustration on page 5.76.

Trough. See Manger.

Truss. An assembly of two opposing rafters and other components (e.g., a tie beam or a set of braces) that formed a rigid framework to support a roof. See illustration on page 5.77.

Wisconsin Dairy Barn. A dairy or general purpose barn form based on light roof framing, a large mow, abundant windows, an attached silo, and a floor plan with stalls and alleys arranged for maximum efficiency. See illustration on page 6.110.

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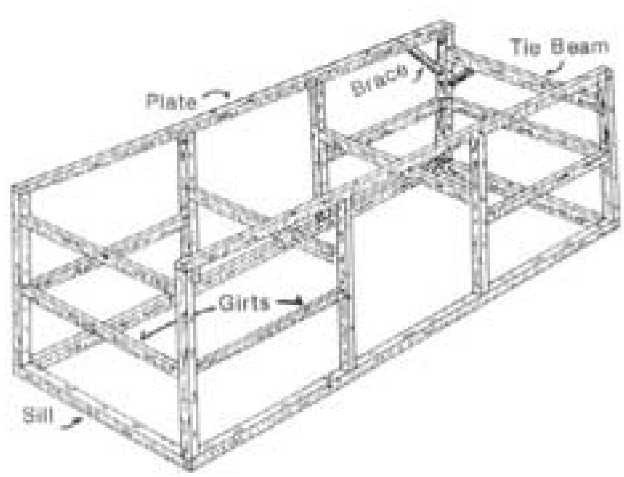


Fig. 3.1 The basic structure of a timber frame barn.

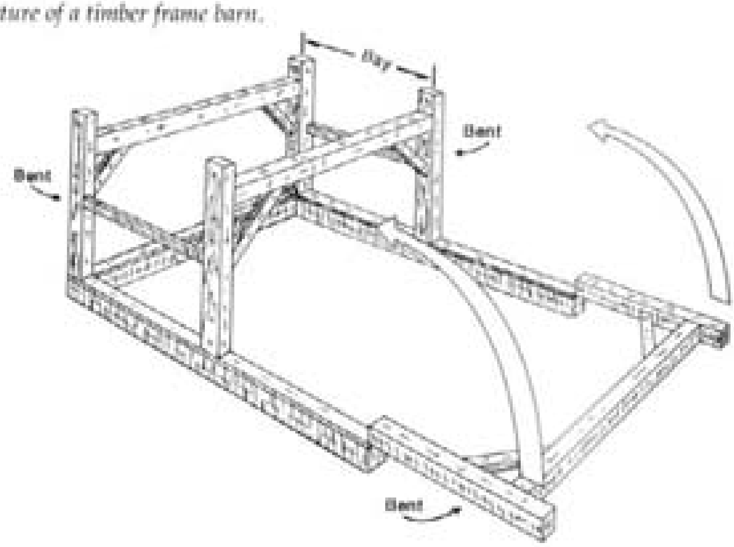
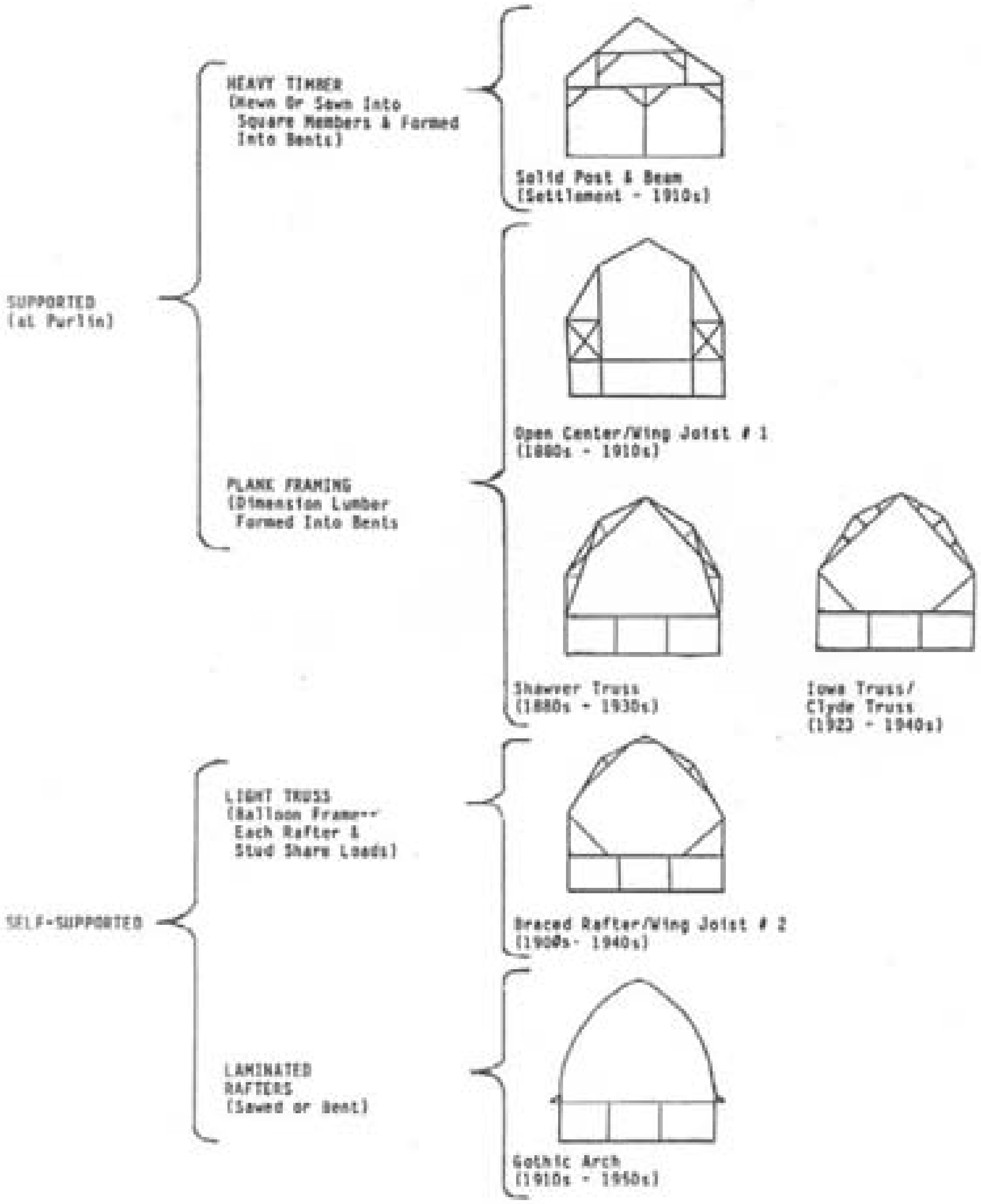


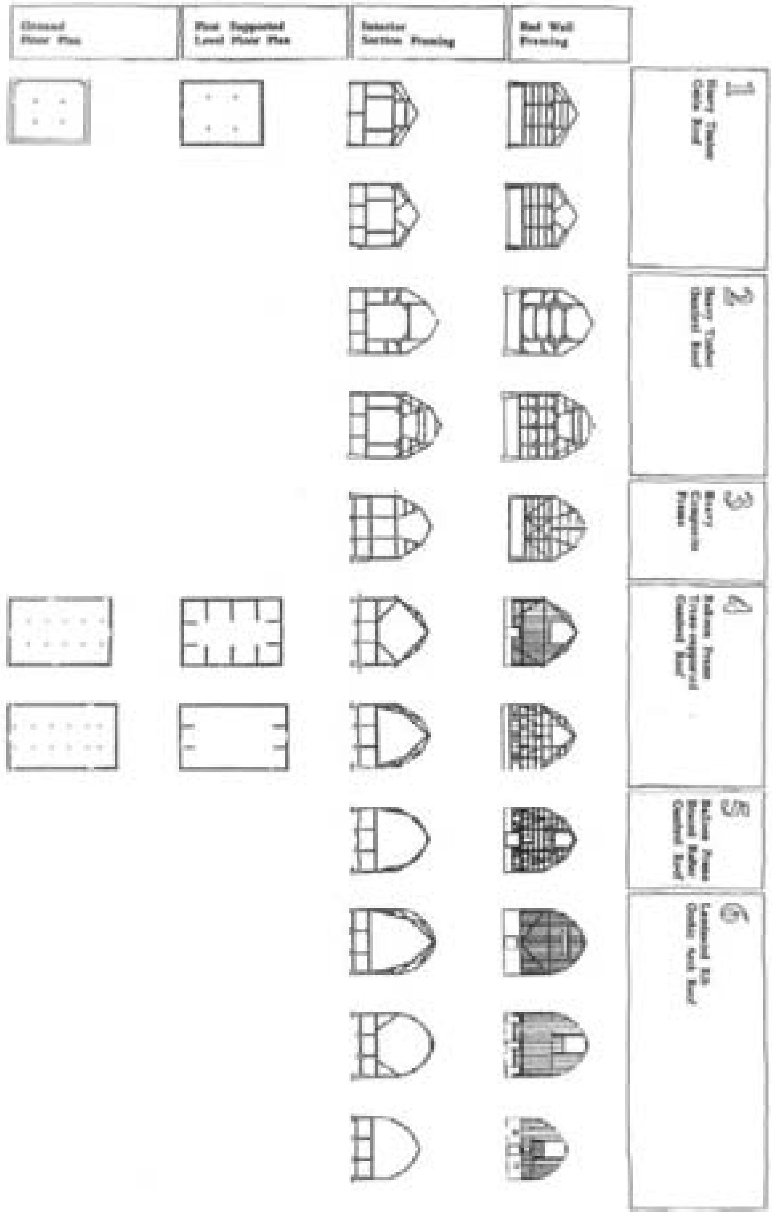
Fig. 3.3 Bents and bays of a timber frame barn, suggesting the method of erecting the frame of many barns.

Components of a timber frame, as illustrated by Allen G. Noble and Richard K. Cleek (with M. Margaret Geib) in *The Old Barn Book* (1995).

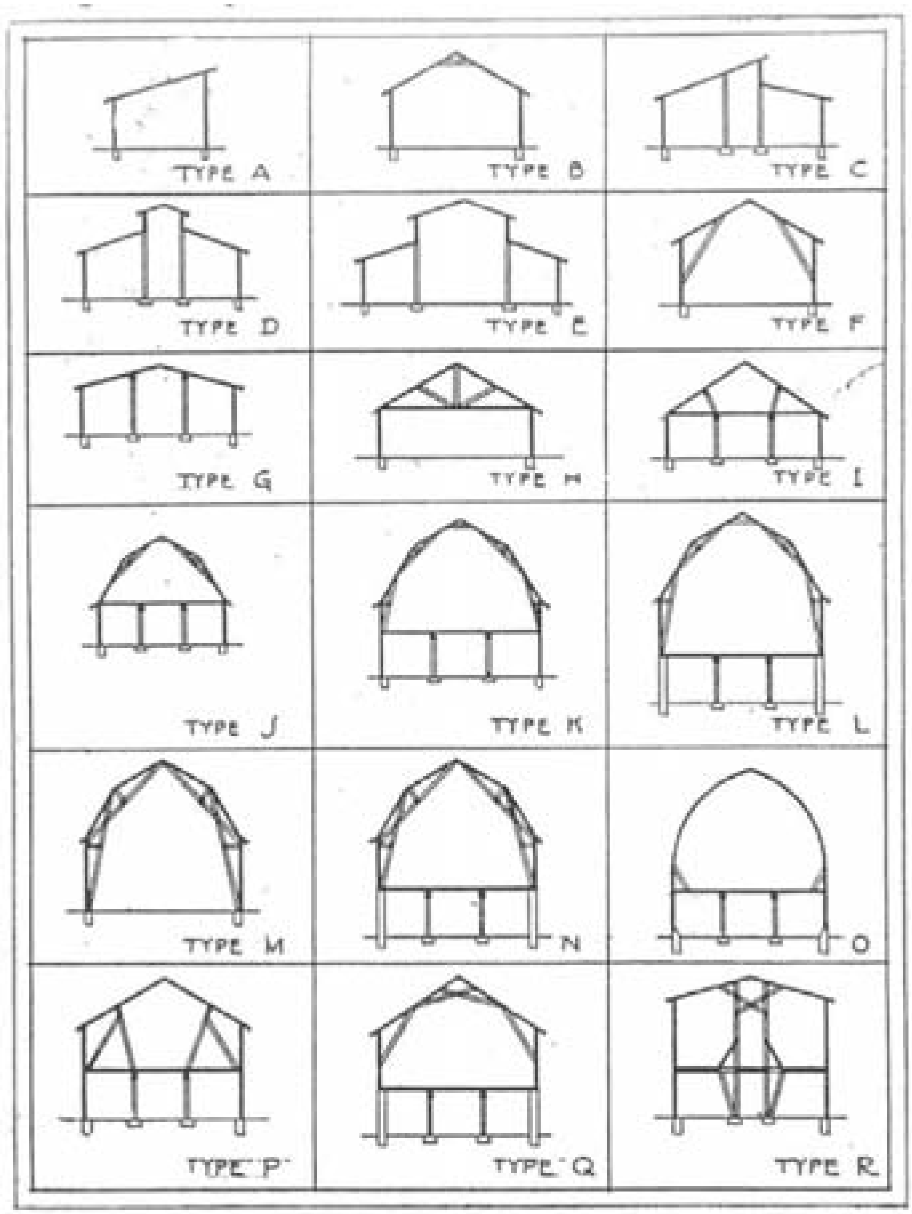
A circa 1880 timber frame barn built on a German immigrant farm in Nicollet County. The barn displays rare Old World construction techniques including plate-to-floor diagonal braces, use of curved timbers, scribed joinery, and fachwerk-style square framing of the exterior walls. Seeman Farm, Courtland Township, Nicollet County, 2005. (Photo by Daniel R. Pratt for Mn/DOT)



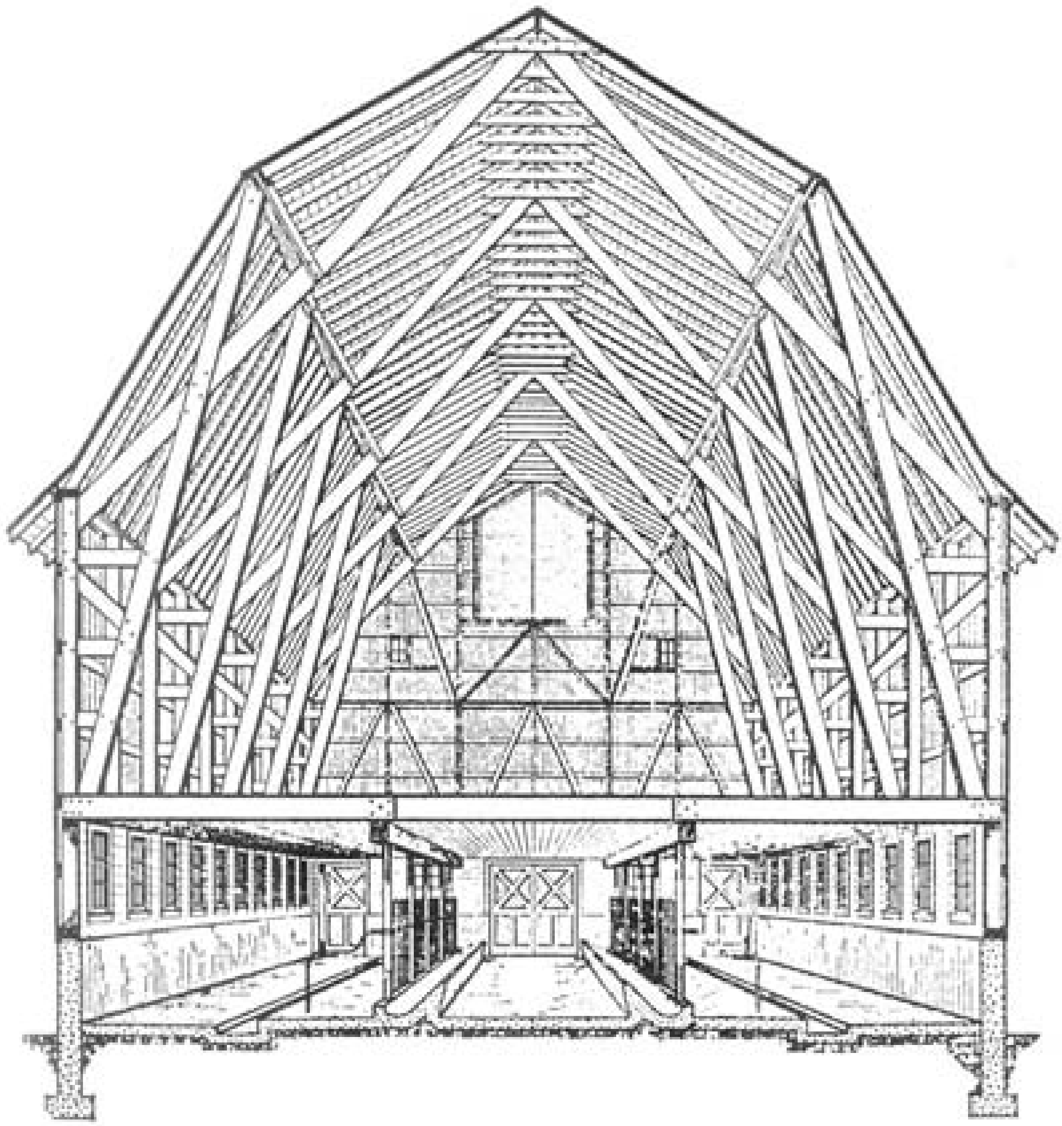
Iowa barn expert Lowell Soike used this illustration of the evolution in barn roof framing in a recent discussion of barn types in the Midwest. From Soike's "Within the Reach of All: Midwestern Barns Perfected" (1995).



Dandekar and McDonald included this chart in a 1995 article on Midwestern barns to help illustrate the evolution in barn design from heavy timber framing to increasingly lighter structural systems. The authors drew their information from agricultural extension bulletins. From Dandekar and McDonald's "Preserving the Midwestern Barn" (1995).



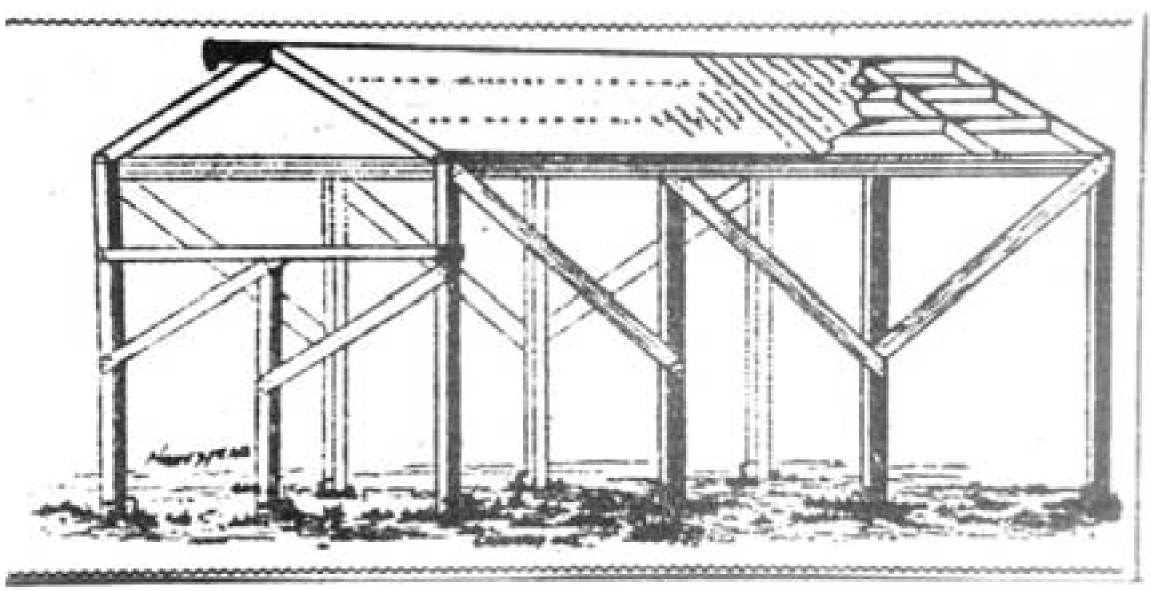
In 1916 these 18 basic barn designs were identified by the American Society of Agricultural Engineers as being most suitable to meet the typical farmer's needs. The designs were reportedly drawn after reviewing 10,000 buildings and plans. The 18 designs were flexible in building materials and adaptable to various farming practices. From Niemann et al "Report of Committee on Farm Structures" (1919).



This 1946 illustration of a Shawver truss plank-frame barn appears in a recent essay by Glenn A. Harper and Steve Gordon on the 20th century development of Midwestern barns. According to the authors, "In the 'modern' plank-frame barn, roofs were supported by purlins which, in turn, were supported on specially designed, self-supporting trusses, or the roofs themselves were self-supporting" (1995: 217).

A raised three-bay barn of typical form. It had a gabled roof, central entrance, a long narrow transom window above the door, and few other windows. Placards on the gable end read "1892" and "Hazel Hurst Farm." Location unknown, circa 1900. (MHS photo)

This type of barn has been called a "midwest three-portal barn" by historians such as Noble and Cleek (1995). The side aisles were often added later, sometimes resulting in a "broken" roofline. There were usually doors leading into each of the three aisles, as well as a hay mow door. Walsh Barn, North Hero Township, Redwood County, 1978. (MHS photo by Gimmestad)



Barn historian Lowell Soike discovered this precursor to the 20th century pole barn in a May 21, 1889, issue of *Iowa Farmstead*. It was a hay storage barn for cattle feeders that could be supported by either massive, upright, square timber columns spiked to posts set in the ground, or with full-length telephone poles. Cattle housing and manure storage sheds could be added around three sides. From Soike's "Affordable Barns for the Midwest: Beginnings" (1995).

A quonset-type dairy barn, offered by the Flintkote Company in a 1946 issue of *Agricultural Engineering*. The advertisement also listed other materials sold by Flintkote including asbestos-cement shingles and siding, asphalt shingles and roll roofing, damp-proofing materials, decorative insulation board, and asphalt coated sheathing. From *Agricultural Engineering* (Sept. 1946: 435).