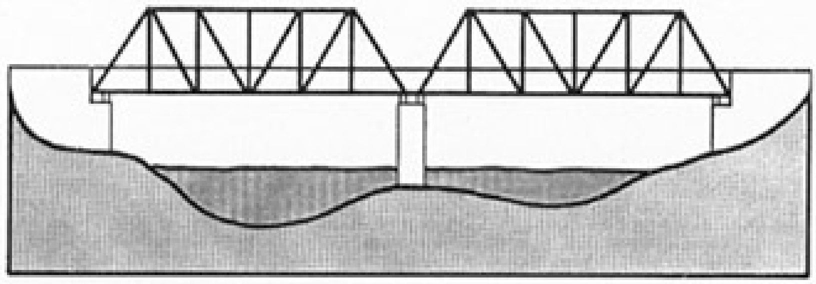
PLATE 5: **Typical Metal Pratt Through Truss Bridge: Bridge Crossing the South Branch of the Patapsco River at Henryton**

SOURCE: MDOT Photographic Archives (Hughes Co. Photographers, circa 1930)

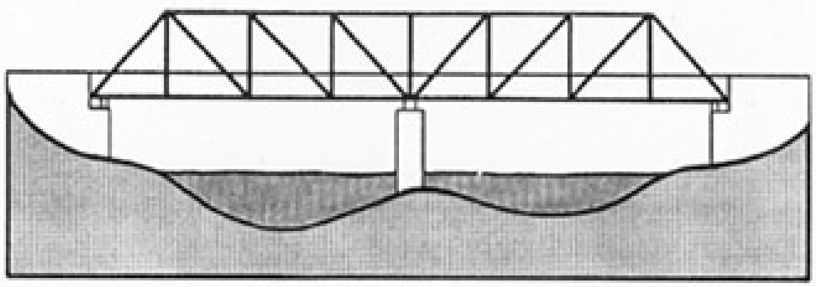
Truss bridges of all forms typically include vertical members and diagonal members located between two horizontal components called chords (upper and lower, or top and bottom). Both wooden and metal truss bridges are categorized by their specific design, which varies considerably according to the shape of members and whether they are placed in compression or tension. Trusses may also be grouped according to the relation of the deck, or roadway floor, to the rest of the superstructure. If a truss bridge carries its deck level with its bottom chord, it is a through truss, and usually has overhead bracing including portal braces between its two sides. A pony truss is a type of through truss where there are no lateral braces connecting the top chords of the superstructure. By contrast, a deck truss carries traffic on a level with the top chord, with the truss positioned below the deck (Figure 12; Plates 6 and 7).

In the United States, timber bridges built between 1800 and 1900 incorporated various wooden truss designs including the simple king-post, the queen-post (lengthened version of the king-post), the Burr arch truss (where a wooden arch combined with a multiple king-post or other wooden truss forms to produce great strength), and the Town lattice (a dense system of intersecting wooden diagonals with no vertical members). In 1840, seeking to market his design to the emerging American railroads, including Maryland's Baltimore and Ohio, William Howe patented a truss bridge that was a key transitional form between the exclusive use of wood and the iron and steel trusses of the late nineteenth and early twentieth centuries. Howe's technological advance was to employ iron rods as verticals in tension, but the Howe truss retained the older usage of wooden diagonals in compression. The 1830-1840 period also witnessed construction of composite, timber and iron trusses on the B&O under Benjamin Latrobe and Army engineer Stephen H. Long, whose Long truss was patented in 1830 (Vogel 1964; DeLony 1993:42-43).

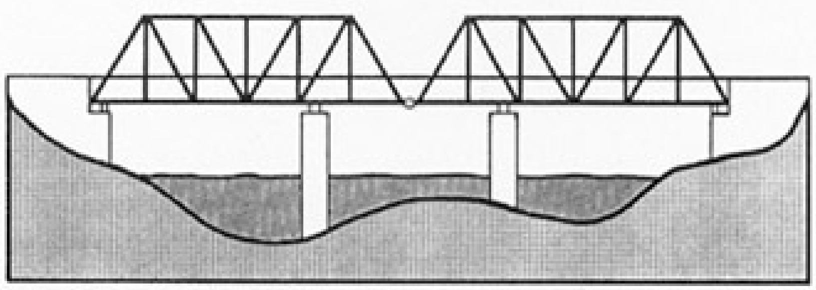
In his 1847 *Work on Bridge Building*, Squire Whipple moved truss technology a step further toward all-metal construction by his understanding of the structural properties of cast and wrought iron (Pennsylvania Historical and Museum Commission, and Pennsylvania Department of Transportation 1986:111). Cast iron was typically formed in a blast furnace where it was difficult to reduce a high carbon graphite level that induced brittleness. Wrought iron, however, was iron run through an additional "finery," or hearth, and with its reduced carbon content could be forged and would bend cold without cracking (Chard 1986:4-7). Whipple, who had built some of the earliest all-iron small bridges over the Erie Canal in the 1840s, suggested that cast iron, which fractures on impact and cannot carry tensile loads, be utilized for compression members in trusses, while the ductile wrought iron be reserved for tension members (Pennsylvania Historical and Museum Commission, and Pennsylvania Department of Transportation 1986:111). Herman Haupt's 1851 treatise *A General Theory of Bridge Construction* also promoted metal truss bridges as practical, durable alternatives when properly engineered (Tyrrell 1911:166).



Simple Spans



Continuous Spans



Cantilever Spans

Span Types

FIGURE 12: Types of Metal Truss Spans

SOURCE: Pennsylvania Historical and Museum Commission and Pennsylvania Department of Transportation 1986

PLATE 6: **Typical Metal Multiple-Span Pratt Pony Truss Bridge: Bridge Crossing Winter's Run at Edgewood**

SOURCE: MDOT Photographic Archives (Hughes Co. Photographers, circa 1940)

PLATE 7: **Typical Metal Double-Intersection Pratt Truss Bridge: Bridge at Havre de Grace**

SOURCE: MDOT Photographic Archives (Hughes Co. Photographers, 1927)

Under the initial impetus of the expansion of American railroads, the period between 1840 and the Civil War saw the patenting and introduction of the majority of the earliest metal truss forms seen in the United States, including the popular Pratt (1844) and Warren (1848) types as well as Squire Whipple's bowstring truss (1841), his modified, "double intersection" Pratt (1847), Albert Fink's distinctive truss with long diagonals (1851), and the combination Burr arch and Pratt truss patented by Herman Haupt (1851) (Pennsylvania Historical and Museum Commission, and Pennsylvania Department of Transportation 1986:109-126). An event of signal importance in Maryland's bridge building history was Wendel Bollman's patenting of the Bollman truss in 1852; Bollman's truss, as described below, was utilized extensively on railroads and roads in the state, although the Bollman truss bridge at Savage Mill in Howard County is the only known surviving example in the world (Vogel 1964).

Bollman also evidently suggested the design for what became the popular Phoenix column, a cylindrical vertical member manufactured and marketed extensively by the Phoenix Bridge Company of Phoenixville, Pennsylvania. Based in Baltimore, Bollman's Patapsco Bridge Company and its rival, the Baltimore Bridge Company, run by distinguished engineers Benjamin and Charles Latrobe and Charles Shaler Smith, were significant early bridge building firms selling to railroads and local governments in Maryland and elsewhere (Vogel 1964).

The latter four decades of the nineteenth century brought improvements in metal truss technology to a peak, as an increasing number of "bridge works" and "iron works" in the eastern United States were able to fabricate built-up truss bridge members in the shop then ship them by rail to prospective bridge sites by prior arrangement with local officials, who in many cases had filled out order forms describing the type, size, and location of the desired spans (Pennsylvania Historical and Museum Commission, and Pennsylvania Department of Transportation 1986). Historical research and previous historic resource surveys of Maryland bridges have identified some twenty-five to thirty bridge companies that built, or may have built, truss bridges in the state between 1850 and 1920. (See below, under "Metal Truss Bridges in Maryland," for further discussion of these companies and bridges they are known to have built in Maryland.)

Refinement of mathematical analysis of truss design, as well as empirical observation of the bridges in the field, led to a large variety of modifications to the basic early metal truss types during the late nineteenth and early twentieth centuries. Significant modified varieties included the Baltimore truss, a Pratt with added strength derived from sub-struts or sub-ties that was used extensively on the B&O Railroad. Cantilevered truss construction methods, in which sections of a truss bridge were built out from piers with sometimes complex anchorage systems holding back the upper parts of the unfinished span, were also pioneered in the late nineteenth century, by a significant Baltimore-based engineer. Charles Shaler Smith, founding partner of Smith, Latrobe & Company and its successor the Baltimore Bridge Company during the 1870s, designed and built the world's first high cantilevered truss, carrying the Southern railway over the Kentucky River in 1876-1877 (Schodek 1987:362). In 1939-1940, cantilevered truss construction methods were employed by the J.E. Greiner Company to build the Governor Harry W. Nice Memorial Bridge carrying U.S. 301 over the Potomac River (J.E. Greiner Company 1938:98-101).

The following short descriptions summarize the most important metal truss types developed during the nineteenth and early twentieth centuries in the United States, including transitional, modified, and some "hybrid" forms. Brief references are given to known structures in Maryland exemplifying each type (general sources for truss type information are Pennsylvania Historical and Museum Commission, and Pennsylvania Department of Transportation 1986 and P.A.C. Spero & Company 1991). No early transitional truss structures constructed of wood and iron appear to have survived in Maryland judging from research and previous survey information. Further discussion of significant Maryland metal truss bridges, their approximate numbers and distribution, and highlights of their history may be found below in the subsection entitled "Metal Truss Bridges in Maryland."