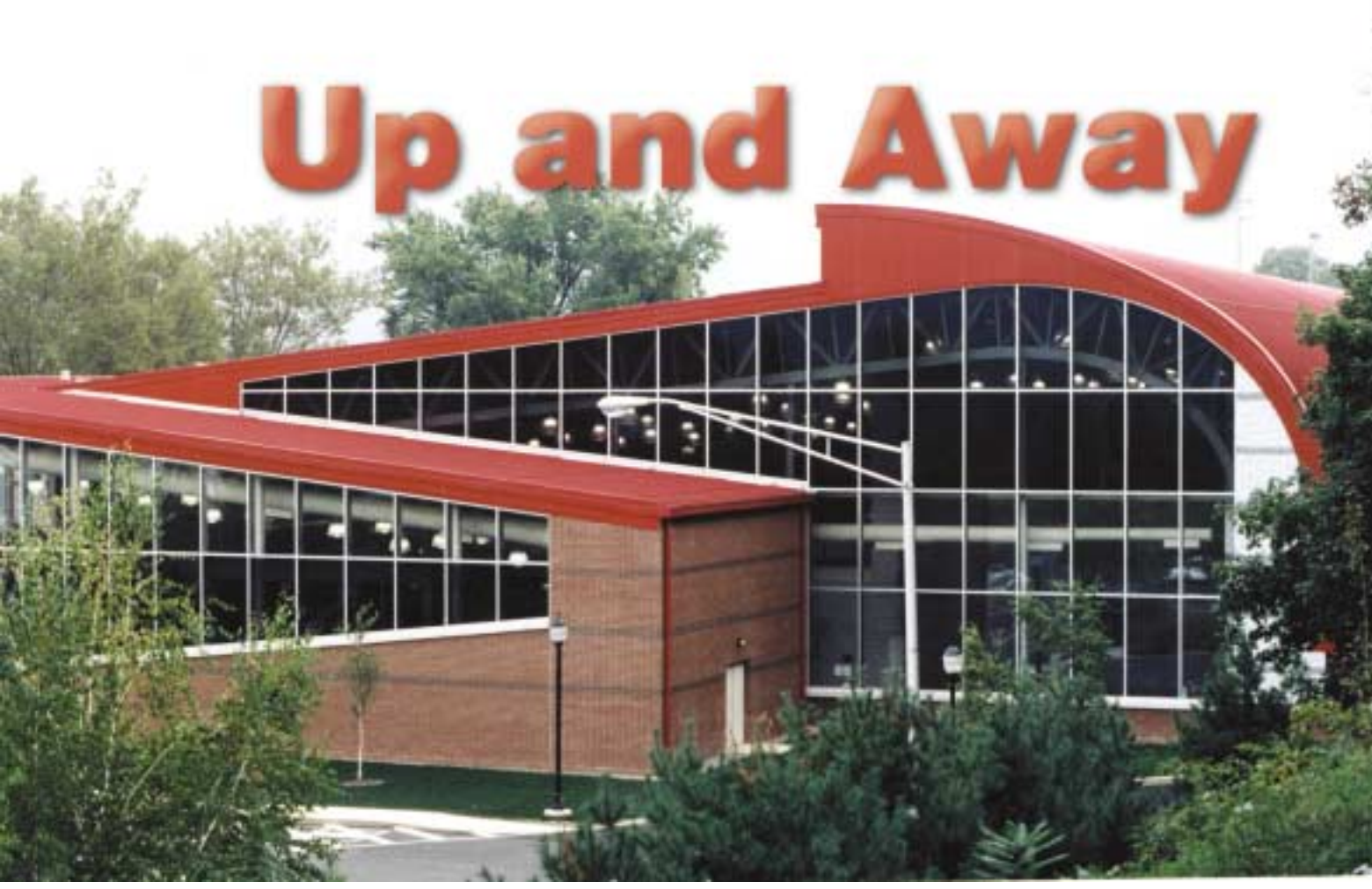
Up and Away



Inspired by the legendary Piper Cub airplanes manufactured in Lock Haven, PA, the design for a new student recreation center at Lock Haven University emulates the sleek profile of an airplane wing using structural steel.

165-acre Lock Haven University is located near the geographic center of the state, on the edge of the scenic Allegheny Plateau. To support continued growth in student enrollment, the university saw a need to provide additional space for on-campus recreational activities. University officials hoped to construct a distinctive building that would relate well to existing campus architecture. This culminated in a new 41,000 square foot recreation facility.

The program included providing facilities for basketball, rock climbing, volleyball, weightlifting, wrestling, running tracks, racquetball, aerobics and dance. Given these programmatic requirements, the design team was able to pursue a unique design strategy for the Lock Haven facility that resulted in a symbolic building form closely tied to this region of the state.

Lock Haven's history inspired architects and engineers on the team. In the late 1930s, the town of Lock Haven was home to what would become the famous Piper Aviation Company, the manufacturer of the legendary Piper Cub airplane. Lock Haven's new recreation center mirrors the Piper Cub. A 230-foot curved exterior envelope begins at ground level and extends vertically at the rear of the building. It continues into a curve as it reaches the roof plane, and finally extends over the full width of the interior athletic courts.

At the crest of the standing-seam metal roof is a continuous clerestory, which draws natural light into the athletic courts. The pitched roof, which covers the fitness training room, is angled toward the entry to increase the building's visibility from the street. In contrast to the bold rooflines, the material designated for the walls matches the university standard, a combination of brick and architectural-faced concrete masonry.

A CUSTOM FRAMING SOLUTION

The structural engineers at Greenman-Pedersen Inc. (GPI) were challenged to promote the aesthetic features of the architect's design, while

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With a roof shape similar to an airplane wing, Lock Haven University's new student recreational facility pays homage to the Piper Cub aircraft once manufactured nearby.

The fourth roof truss (of seven) is lifted into place.

providing an economical and effective solution. The architectural arrangement of the programmed spaces, created by the Hillier Group, resulted in a complicated integration of several large volumes clad by masonry-cavity wall and glass curtain wall construction.

Much of the steel structure is exposed on the interior. Seven custom-designed and detailed long-span steel trusses, which are seven feet deep, provide a clear span of over 125 feet. The trusses begin at the ground floor and rise approximately 15 feet vertically, at which point they enter into a compound curve, constructed from segments of 22 foot and 38 foot radii. The 38-foot radius merges with the main roof that slopes six degrees from the horizontal.

Six of the trusses are spaced 30 feet on center. The northern-most truss is skewed five degrees from the east/west axis of the building. Here, the main body of the building also merges with a two-story fitness and training center that has a lower roof. The skewed truss design and detailing were complicated by the geometry of the building design. Another factor was the additional weight of the smaller building's roof and a glass curtain wall above the low roof.

Due to shipping and fabrication constraints, each truss was fabricated and delivered to the site in three sections. This required a complicated rigging and shoring strategy by the steel contractor that involved the implementation of temporary supports for each section of truss while the splice connections were assembled.

CREATING A VAULTED SPACE

A running track at a mezzanine level is also partially supported from the trusses via 2 in. diameter hanger rods. The hanger rods are attached to the bottom chord of each truss at a truss panel-point and are skewed from the vertical by approximately 20 degrees away from the edge of the mezzanine. The hanger rods tie into a continuous upset channel that forms the inside edge of the running track.

The structural engineers also needed to create a continuous clerestory above the trusses. They introduced a series of curved W-shapes spliced into the top chord of the trusses. This created vaulted space above the plane of the truss top chords for the construction of the clerestory.

Lateral resistance against wind and seismic forces is provided by a combination of concentrically braced frames and rigid moment frames. The braced frames in an ancillary building on the east side that houses mechanical equipment actually provide lateral stability for the trusses against gravity loads. This is because the trusses are pitched toward the east side of the building and the truss support points are modeled as pinned connections. Wide-flange beams and girders are used to frame the ancillary portions of the structure. Double-angle shear connections, fully restrained welded moment connections and through-plate shear connections were employed throughout the building by the steel contractor/erector.

The structural engineers used RISA-3D computer software to perform a finite element analysis for the trusses. In addition, RAM Steel was used for general gravity load design, and RAM Frame for seismic and wind. RISA Base and RISA Foot were also used for some parts of the footing and foundation design.

A 3 in. Type NA acoustic 20-gage galvanized roof deck was utilized for the gymnasium to reduce noise, and a $1^1/_2$ in. composite 20-gage galvanized floor deck was used for the mezzanine.

Another challenging structural aspect of the project was the geology of the site. Poor soil conditions prevented engineers from pursuing conventional spread footings. Instead, a deep foundation system was needed. Also complicating the situation was a high water table. Because of the presence of water, concrete drilled piers were not considered. This was due to the high cost of permanent casing that would be required to protect the excavation from caving in, and to allow for 100% downhole inspections. Steel proved to be the best solution in satisfying cost and constructability issues. Ultimately the entire superstructure was supported by driven HP 12×53 steel piles, cast-in-place concrete pile caps and grade beams.

The project was completed in spring 2002, providing an effective program-

The seven roof trusses provide a clear span of 125'.

matic and structural solution within a landmark building for Lock Haven University.

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ENGINEERING SOFTWARE
RISA-3D, RISA Base, RISA Foot,
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The elevated running track allows joggers and walkers to get a close-up view of the exposed steel roof framing.