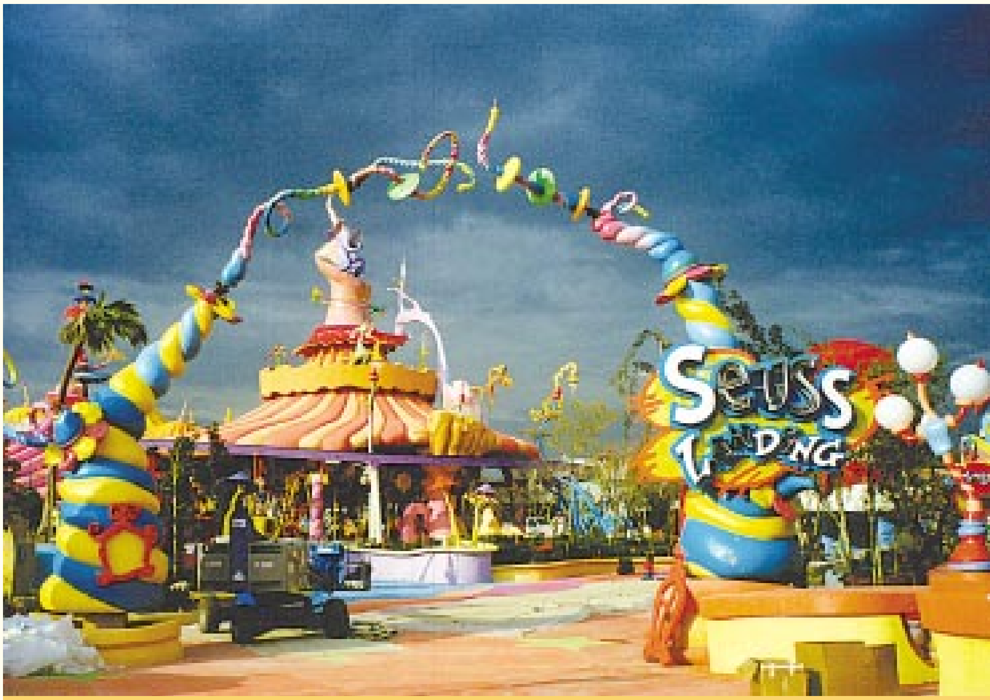
It's Steel for Real!

Brian Caudle, P.E.

The imaginary worlds of Dr. Seuss are brought to life through the use of structural steel at Universal Studios' Seuss Landing attraction in Orlando, FL.



The Caro-Seuss-el as seen from the main entry to Seuss Landing. The Caro-Seuss-el is a merry-go-round where park guests ride on animals fashioned after the characters from the books of Dr. Seuss.

Virtually every American child has delighted in the imaginary worlds depicted in the books of Theodor Seuss Geisle, better known as Dr. Seuss. In his worlds, Dr. Seuss stirs the imagination with thoughtful stories set in physical environments that could not naturally occur. Plants grow in impossible shapes, rocks are precariously balanced one on top of another, buildings are supported on crooked columns too spindly to stand up. Now, thanks to the way a creative multi-disciplinary design and construction team shaped structural steel, children of all ages can actually visit these fanciful places. All eight facilities in Seuss Landing, a new themed island developed by Universal Studios at their signature park in Orlando, use structural steel in highly unusual ways to bring to life the curving, off-balance, abstract worlds that Dr. Seuss illustrated in his books. The strength, flexibility and economy of structural steel made it the only practical solution to replicate Dr. Seuss's illustrations.

In order to faithfully recreate the fantasy worlds of Dr. Seuss, the design team immersed itself in Seussian lore. All of Seuss' 44 books were suggested reading, with several of the books being on a "must" reading list including *The Cat in the Hat*, *Green Eggs and Ham* and *If I Ran the Circus*. The project challenged the combined creative talents of an extraordinary design and construction team that included not only architects, engineers, contractors and tradesmen, but also artists, set designers, show vendors and ride vendors.

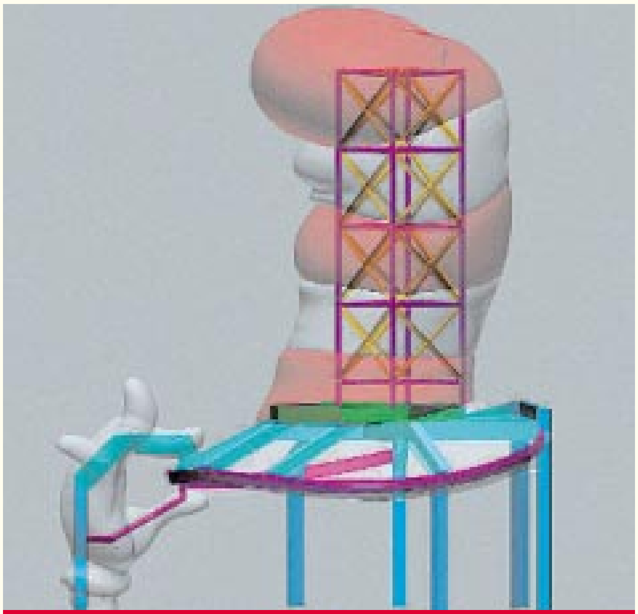
Conventional wisdom says that structural steel members are meant to be straight. Steel columns once bent are predisposed to buckle. Floor beams are commonly cambered but in their desired final configuration, they are straight to allow for flat floors. In drawing buildings, bridges and other structures, Dr. Seuss never once drew a straight line. He conceived columns and supports so twisted and thin that conventional wisdom would say they would never stand up in real life.

Though the creation of Dr. Seuss' worlds could have become a nightmare for both designers and fabricators, a co-operative and clever team approach was used to avoid problems. The design team used modern techniques and teamwork at every step to develop an innovative and iterative design method to faithfully capture the spirit of Dr. Seuss at Seuss Landing.

First, Universal Studios artists created renderings of the structures from the illustrations and verbal descrip-

An ironworker prepares connections on the Caro-Seuss-el roof canopy tension ring. The roof canopy is an inverted funnel that appears to be flattened.

A fabric roof supported by free form trusses will shade guests waiting for the Sylvester McMonkey McBean's Very Unusual Driving Machines ride. In Seuss Landing, even the top and bottom chord truss bracing is curved.



AutoCAD 3D was used to graphically build this model of the structural steel inside of the skin of the hand and the hat of the Cat in the Hat.

The completed 48' tall red and white striped hat is suspended above park guests as they enter the Cat in the Hat Ride at Seuss Landing.

tions in Dr. Seuss books. Then the architects and engineers used the renderings to produce two- dimensional design development plans and elevations, so the structures met functional requirements. Next, model builders used the design development drawings and the renderings to create scale models of each structure at 1/24 of actual size. The scale models were scanned to create digitized, three-dimensional models that were converted to AutoCAD electronic files. The three-dimensional AutoCAD files became the basis for detailed construction drawings for the superstructure and building cladding that were produced by the architects and engineers. During construction, the scale models aided the team in visualizing the projects.

This design method allowed the design team to take the fun aspect of the park to an extreme. Unexpected elements spring from the walls and roofs of the structures to delight park visitors.

An example is the "Whozey-whatzit" that rises from the roof canopy of the Caro-Seuss-el, (a merry-go-round where park guests ride on animals fashioned after book characters) to tug at the skirt around the top of the structure. AutoCAD 3D was used to graphically extrude straight pipe sections inside of the model of the skin of the Whozeywhatzit. Whenever

The Whozeywhatzit meanders skyward to the right of the Caro-Seuss-el roof canopy. Straight pipe sections welded together twist and turn in three dimensions to stay within the skin that was originally sculpted by the artists of Universal Studios.

the pipe section begins to violate the skin, a new straight pipe section is welded onto the previous pipe turning in a new direction. Thus, the Whozeywhatzit snakes its way upward changing directions in three dimensions, changing cross-sectional size and shape and sometimes branching into two sections like a tree. At one point, the turns are so radical that the pipe sections are only a few inches long. And in one area, the cross section is so narrow that only a 3 ½″ diameter pipe will fit inside the skin.

In order to supply the steel fabricator with the information required to construct the Whozeywhatzit, a table listing the member sizes and beginning and ending coordinates in three dimensions was prepared. Pipe sections were used for the interior support of the Whozeywhatzit to eliminate the variable of member orientation. The pipe sections were welded together at the splice points. One of these tables and a schematic drawing of the element were provided for each of these fun, three-dimensional elements.

Where the twists and turns of an element were gentle enough, the internal support members were bent to a radius. Examples of this are the supports for Sylvester McMonkey McBean's Very Unusual Driving Machines, the elevated monorail ride that winds its way through Seuss Landing. Steel members were extruded in AutoCAD to fit within the skin. The changes in direction were gradual enough to allow for the rectangular box shapes to be bent on a radius, but all the curved members are in different planes. Rectangular box members are used in lieu of pipes because of the large forces imposed on the arches from the ride.

The monorail ride track itself is a continuous ribbon of steel over a mile in length and without an expansion joint. The stiffness of every arch, column and building supporting the ride track were analyzed using a 3D model to understand the behavior of the ride track as it is subjected to ride loads, hurricane force winds and thermal movements. Loops in the track and flexibility in the arches and columns allow the track to "breathe" with the expansion of the steel under the Florida sun. The arches, columns and buildings supporting the McMonkey ride track are designed and detailed to resist the fatigue stresses from the ride with over 2,000,000 loading cycles over its useful life.

The most recognizable symbol of the Dr. Seuss legacy is the Cat in the Hat. His signature is boldly stamped upon Seuss Landing with the 48′ tall red-and-white-striped hat that is suspended above the entry to the Cat in the Hat Ride. Once again, AutoCAD 3D was utilized to mold the structural steel within the undulating brim of the hat and within the Cat's hand. The Cat's white gloved hand supports over half of the giant hat with a wide flange shape that winds its way from wrist to index finger to support the hat from the top of the brim. Structural steel W-sections were sculpted to fit in the wrist, index finger and the hat brim to support an X-braced tower inside the top of the hat. A thin pipe section goes through the Cat's thumb to add more stability. Curved trusses support a fabric roof that covers the platform where riders wait to board the ride, and a curved cross bracing provides stability for the trusses.

Bright colors, improbable characters and unnatural shapes so captivate the imagination of park guests that there is no time for them to wonder about the

amount of planning, design and artistry that went into creating Seuss Landing. Fortunately, the strength and flexibility of structural steel knows almost no bounds. Shaped by the skill of talented designers, steel proves that even the "impossible worlds" of Dr. Seuss can be achieved.

Brian Caudle, P.E., is a Principal with Walter P. Moore. He was the project manager for structural engineering for Seuss Landing.

Photos courtesy Walter P. Moore, Houston, TX.

This Seussian arch supports the ride track for Sylvester McMonkey McBean's Very Unusual Driving Machines, an elevated monorail. The connection for the ride track can be seen on the top of the box sections that were built-up from curved steel plates.

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DESIGN SOFTWARE
AutoCAD Release 14