



THE **American Surveyor**
A FOOT IN THE PAST... AN EYE TO THE FUTURE Vol. 8, Issue 4

BILBY TOWERS

Indoor Mapping

TIMMS meets the challenge

Broadband vs GPS

Raising the threat level

Story of a Stone

A New Jersey retracement

MR. BILBY'S ELEGANT ASSEMBLY

BEING BOTH BEAUTIFUL AND SUBLIME

Isolated and alone, it is known simply as Couba. Couba resides two feet above mean sea level on a now deserted island within a swamp in sight of any tall building along the narrow streets of the City of New Orleans, Louisiana. Standing sentinel over Couba is a steel tower of a most unique design. Enduring many years of alligators, poachers, oil exploration and occupancy of a now abandoned Wildlife Management Headquarters, Couba and the tower have managed to survive. Over this time there have been eighteen hurricanes, with 11 being direct hits. Katrina did her dance and the limber looking tower remained standing. Out of sight, out of mind, and in defiance to contrary forces, Couba and it's tall lanky companion have endured nearly 40 years of nature's fury and man's foibles.

Bilby the Man

Jasper Sherman Bilby was born on a farm near Rushville, Indiana on July 16, 1864, just a few weeks before the crazy Battle of the Crater over in Petersburg, Virginia. Nine months later, the closing papers would be signed at Appomattox. One of nine children, Jasper left school after the 8th grade to help support the family. In 1884 he hired on with the United States Coast and Geodetic Survey as a laborer and carpenter assigned to a first order triangulation party. A portion of his duties was to construct wooden observation towers. His initial assignment was along the 39th parallel in Illinois. In time his direct knowledge and experience in every aspect of leveling and triangulation allowed Bilby to overcome his lack of formal education and excel with the C&G Survey.

>> By C. Barton Crattie, LS, CFM



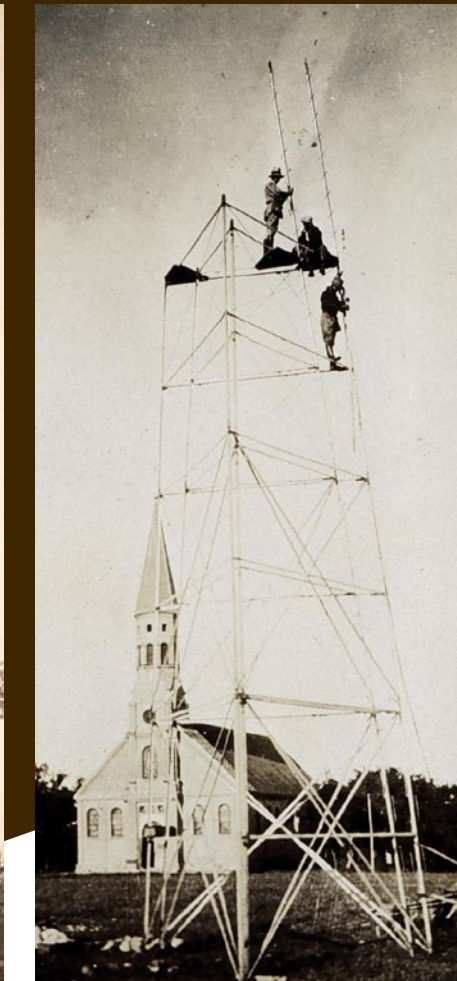
A tower is built. Relaxing, prior to a night of triangulation, these three surveyors will continue the traverse across the United States.



A 1903 photograph of Jasper Bilby atop a "guyed pole" performing reconnaissance in order to properly place a wooden tower. *Hmmm, there's got to be a better way.*

Marrying in 1891, Mr. Bilby stayed with the "Survey" for about 10 years. Around 1894 he left the government and took a job as a supervisor at a stone quarry in Holton, Indiana. That endeavor lasted less than a year, and Bilby returned to the "Survey," now as a foreman on a C&GS triangulation party. This marked the resumption of what would be a long career.

In those days a nationwide network of highly accurate control stations was being established by a literal army of dedicated surveyors. While transit and steel tape were the tools used in some cases to establish this network, the preferred



Thought to be the first Bilby Tower, this one is shown under construction in Indiana in 1927.

method was triangulation, through repeated angles turned from station to station, then moving up the line the next night, again turning rep angles from station to station to station.

From a historical perspective, a paper titled "Field Assignments of Jasper S. Bilby, Chief Signalman of the U.S. C&GS; September, 1884-December 31, 1937" is a meticulous listing of every assignment and location of Mr. Bilby's surveying chores spanning 53 years. He was truly the field man's field man. He coauthored a pamphlet titled "Precise Traverse and Triangulation in Indiana." Other than this, his one duty was to expand the "survey."

In a letter from the Chief of the Division of Geodesy, Bilby's abilities were extolled in a near embarrassing fashion:

"In your letter of December 30, 1929, announcing that the end is in sight of the long campaign from Cairo (Illinois) to New



How did they center a 95-foot tripod over a point? Carefully plumbed, a vertical sighting device was used to center the transit mount high overhead.

Orleans, was no surprise to me. In fact I long since became immune to surprises, as far as your successful accomplishments of any undertaking is concerned... Many years ago I learned that all that was necessary to assure the success of a project was to place it in your charge and that neither heat nor cold, fire nor cyclones, flood nor drought would be able to impede your progress seriously." A field man's field man, indeed.

In late 1926, after 42 years of service and experience, Mr. Bilby decided to design and build a simple, portable and functional tower to achieve line of sight for First Order triangulation surveys. Cutting line and building wooden towers was far too time consuming, expensive and wasteful (being abandoned at the site following the one night of observations). Many a barn was built with salvaged Government lumber.

HIGHLIGHTS

OF JASPER SHERMAN BILBY'S 53-YEAR CAREER



Day after day, year after year, these towers were erected and disassembled only to be moved 20 miles the next day (in most cases) to begin the process anew.

Therefore, working with Aeromotor Windmill Company (which to this day is still making windmills), Bilby sought to design and construct a tower that could satisfy his three basic requirements: *“the tower must have rigidity and stability against vibration and against twist in azimuth; the tower must be so constructed that it can be readily erected and taken down; and that the total weight of a completed tower should preferably be light enough that a single moderate-sized truck can transport it from station to station.”* By April 1927, both Bilby and Aeromotor had exceeded all his original expectations. For the next 50+ years, the “Bilby Steel Tower for Triangulation” was one of the most

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Graduated 8th grade
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Constructed wooden observation towers along 39th parallel in Illinois and Indiana
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Undertook First Order work in Alabama, Mississippi, Louisiana, work in Indiana, Ohio, Kentucky and West Virginia
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Assistant to the astronomic party on the Mexico/US boundary
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.....
Triangulation projects in Maryland, Delaware, South Carolina, Kansas, Oklahoma and Texas
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Early 1900s: Triangulation in Puerto Rico, then back to Kansas.
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Late 1900s: On a First Order triangulation survey between Beaufort, South and Augusta, Georgia, Bilby acted as signalman in charge of reconnaissance. (Daunting photos of the trees he shinnied up in order to establish a tower location serve as reminders of the dangers they faced).
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Under various titles with various responsibilities, Bilby worked along the Atlantic coast in North Carolina, then to Nebraska, South and North Dakota, Minnesota, Texas and Florida.
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He worked extensively on the “California-Texas arc.”
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In one year performed triangulation from Salt Lake to Needles, California, and from Huntsville, Alabama to Little Rock, Arkansas.
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In 1918 he was “busy harvesting, thrashing and planting the new wheat crop in accordance with war plans.”
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Passing through Idaho, he ended up in Ketchikan, Alaska in 1921, serving on the U.S./Canada boundary around the Lake of the Woods.
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Late 1922 to early 1923, assisted on a survey of a 20-mile base line in California that turned out to be the most accurately surveyed line ever run to date (used by Professor A.A. Michelson to determine the velocity of light).
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A composite pencil drawing by the author.





Left: All in a day's work, three men—one on top, one on the platform, and one in the ladder rungs—get ready to turn some angles.

Right: The man on the signal level of the tower is aiming four lights in four directions. The night would be spent turning “rep” angles to four other stations. Note the open framework just beneath the canvas at instrument level. The canvas could be pulled down on any side to protect the transit from wind.

In all, a 1937 document claims the total miles of travel over Mr. Bilby's career to be 511,400 miles, 16,000 miles being on foot, 87,500 by wagon or buckboard, 22,500 on a horse or mule's back with the remainder being via ox, boat, railroad velocipede or motor automobile. It is estimated that he measured 47,950 miles of line. He passed away in his home state of Indiana in 1949, just a short distance from the 39th degree of latitude where he began his career; 85 good years and 2 good days of measuring and innovating on this earth.

Bilby the Tower

In order to achieve line of sight on the earth's surface (sans vegetative and geographic obstructions) and to compensate for curvature and refraction, imagine a plan to make a transit sight over 20 miles of that surface. If a tower were to be constructed on each end of our line of sight, each tower would need to be a minimum height of 58 feet at each of the two triangulation stations. If only one tower were to be built under the same conditions, one fellow would be solidly grounded on the earth's surface and the other fellow would need to be 230 feet above that same surface. Your mission would be to establish a highly precise triangular set of baselines everywhere Woody Guthrie sang about in “This Land is My Land” (which was written, by the way, long before Alaska and Hawaii became a part of “my land.”)

Transit and tape surveying methods are rife with inherent error and require much numerical hocus-pocus for error correction to be consistently dependable for a good and true answer. This is

widely used surveying tools worldwide. They'd pop up like mushrooms in the evening and be gone the next morning.

Mr. Bilby's true contribution to the American people was finally solidified with the universal adoption of his tower.

With his tower being a success, Mr. Bilby returned to his duties on the “survey.” His first task back was using the tower to triangulate from South Dakota east to La Crosse, Wisconsin, thence north from Albert Lee to Royalton Base in Minnesota. His duties included mapping the Gulf Coast from Corpus Christi, Texas eventually to Naples, Florida, thence east to Miami and Jacksonville. He then headed west to New Orleans, taking a right in a northerly direction proceeding through Louisiana, Mississippi, Kentucky and Illinois, on to St. Louis, Missouri. His work during those years centered around the Mississippi River and valley. In all, his work experience from year to year fills 11 single-spaced typewritten sheets.

In September of 1927 Secretary of Commerce Herbert Hoover officially recognized the innovation and importance of Mr. Bilby's invention. Hoover was a civil engineer by trade and the world renowned rock star engineer

of his time. In a personal letter, future President Hoover wrote “The accelerated progress of the work (the survey), accomplished by the reduction in its costs, is highly gratifying to me and justifies the commendation which this letter conveys.”

A document entitled “Cost Record of the Bilby Steel Tower” spanning June 1927 until June 1932 (the Depression years) concludes by stating the tower had been used on about 4,000 triangulation stations. A wooden tower took five to six days to build, leaving about \$650 worth of lumber on site when abandoned. A 103-foot Bilby steel tower could be erected in five to six hours, and torn down in 2½ to 3 hours. The bottom line: Mr. Bilby's elegant assembly saved the U.S. government about \$3,072,000 in Depression dollars over this short five-year period.

In the depths of the Depression of the 1930s, Congress established a mandatory retirement age for government employees. President Hoover exempted Bilby from the compulsory retirement requirement. In addition, Bilby received a salary raise in July 1932. He worked on the “survey” for 53 years until his voluntary retirement in 1937 as “Chief Signalman” for the “survey” at the age of 73.



A visit to the Louisiana swampland simply isn't complete without savoring some of the bounty of the sea.

“Couba”—one of two known remaining Bilby Towers—has occupied the same station in Louisiana since 1972. It just may make a return to Jasper Bilby’s hometown in Indiana.

a level that made it possible to mount a survey instrument.

As early as 1844, dual towers of 30-45 feet were being constructed in the Chesapeake region. As part of the surveys around the Great Lakes, four-sided towers were being constructed of steel gas pipes during the 1850s. Many tower designs developed later. An excellent resource can be found at: http://celebrating200years.noaa.gov/survey_towers/welcome.html#background

Every tower had its disadvantages, many insurmountable. Mr. Bilby satisfied a demand for a practical tower. Bilby towers were made of galvanized steel with standard stove bolts having 1/2” and 9/16” square heads. The inner tower served as the tripod, and was approximately ten feet shorter than the outer tower. The inner tower was the “red” tower, with all parts having a painted red band and an individual stamped number. The outer tower was the blue tower, with standard heights of 24, 37, 50, 64, 77, 90, 103 and 116 feet. The light standard on the outside tower was ten feet higher

especially so when traversing great distances over extremes of topography and temperatures. Done correctly, triangulation eliminates many of the mechanical and human errors that plagued surveying in the early stages of the Government’s efforts. For the most part, answers are from direct observations, not from some derived numeric conclusion. Triangulation allowed a crew to traverse a mountain top, a body of water and even a swamp, never placing the sole of their boots on the ground.

There were drawbacks to the triangulation methods. Any land not having hills or peaks required an artificial and physical method for overcoming

curvature, refraction, geography and any of Nature’s other obstacles. *Ergo*, towers. The first practical towers used around the mid-1800s were made of wood. The tallest wood tower was built in the Philippines and reached an impressive 239 feet. Because the observing instrument needed to be stable and void of any movement, two independent towers needed to be built (more on this later).

In their quest to find a “tripod” that stood as high as the tower and to save on materials, there is evidence of towers being built around trees with their branches removed. The outer occupancy tower was built around the living tree. The top of the living tree was cut off to



Grasping the wire rungs designed by Bilby, the author wonders just how high he'll get.



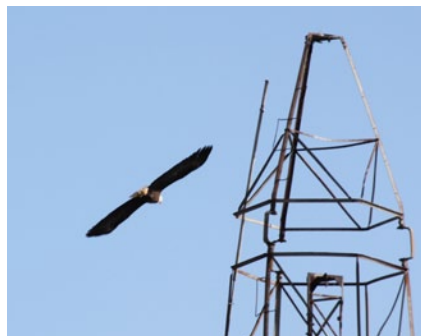
Wishing to save the tower (front to rear, left to right): Roger Woodfill, IN; Sue and Jeff French, IN; Raymond Impastato, LA; Gerald Fussell, LA; Ralph Gipson, LA; Brian Yuhasz, LA; Milton Denny, AL; Shane Granier, LA; Lance Fontenot, LA; Craig Woodfill, LA; James Vidrine, LA.

than the inner tower. An entire 90-foot tower weighed about 5,300 pounds.

To build it, a winch drum was designed for the rear wheel of the haul truck in order to rig the heavier pieces as the tower gained height. On a leisurely day, a crew could assemble a tower, observe at night, then disassemble the tower and move it 20 miles or so to renew the process. A trained crew of five with the right equipment could set four survey marks and construct both inner and outer towers in one day. Disassembly was even faster.

Amazingly, there were very few injuries, but one such sad story related by Jerry Price, a former government surveyor now living in Tennessee, tells about Jake Arnold, a light keeper in downtown Philadelphia who fell from a Bilby tower while Jerry was observing from beneath William Penn's statue at City Hall. Time hasn't lessened the impact of this terrible accident on those involved. The poor fellow never fully recovered and eventually took his own life. (More details of the tragic story can be found in Jerry's article "I See Survey Control" in the exclusive online-only area of AmeriSurv.com.)

Bilby's tower was built to serve one purpose: surveying. Sporting names such as spaghetti, wishbones, follies, a-board, etc., were given to the features designed to satisfy Mr. Bilby's objectives. Because



An American bald eagle, symbol of our great country, wings like a silent guardian over the Louisiana Bilby.

wind blowing on guy wires cause vibration, the tower is designed to be self-supporting ideally. As in the case of Couba, with a soft subgrade, guy wires are sometimes required. Pouring concrete is unnecessary for anchoring. However, one is required to dig a three to four-foot-deep hole to accommodate the ingenious system of underground support.

While building a tower, an average-sized fellow could comfortably reach from one level to the other tightening bolts and handing steel to his work mates. While the instrument operator and the note keeper were performing their observations, ten feet above their heads was a stack of lights or high-powered lanterns, each pointing toward other towers that were observing theirs.

Mr. Bilby considered just about everything in his design, with form following function. He had the foresight

to design around a potential "beer leg" 90 feet above the ground. Between the observation level and the signal level of the tower is a U-shaped piece of flat steel. At each end of the "U" is a swivel bolt. After the tower was occupied and in use, if a backsight or foresight signal tower happened to be in direct line of sight with one of the three tower legs, one simply gave the "window" or "glass" a good kick, swinging it out of the way. No structural integrity was compromised.

2010 Rendezvous in New Orleans

"Are we still looking for a Bilby tower?" <http://www.flickr.com/photos/12262796@N06/3533218157/>

So came the link and the note from Richard Leu, chairman of the Surveyors Historical Society on November 12, 2010. That began an adventurous quest, replete with great fun, food and knowledge. It seems Leu had found an intact Bilby Tower. Many individuals with SHS have devoted a great deal of their personal time and funds over many years seeking a single elusive structure such as this. In its day, the towers were plentiful. Anywhere there was a government high

precision transit, there was a tower not too far behind, ahead, above or below.

Following Richard Leu's revelation, much e-mail chatter commenced between members of SHS and others. I was able to obtain the NGS data sheet for Couba. Using lat and long, it appeared our new friend Couba sat low atop an island just north of Lake Salvador in southern Louisiana. Aerial photos showed it surrounded by structures far out on an isolated stretch of swamp ground. In the photos, the actual tower isn't readily apparent, but its shadow jumps out at you like a rattler while cutting line. At that time, all we had were coordinates (useless) and pictures (also useless). Time to leave the computer screen, hit the ground and find Couba.

A little detective work led me to a fine fellow, Shane Granier with the Salvador/Timken Wildlife Management Agency. BINGO! Shane had direct knowledge of the location, condition and status of the Couba Bilby but was initially unaware of its importance. He was the treasure chest we were seeking.

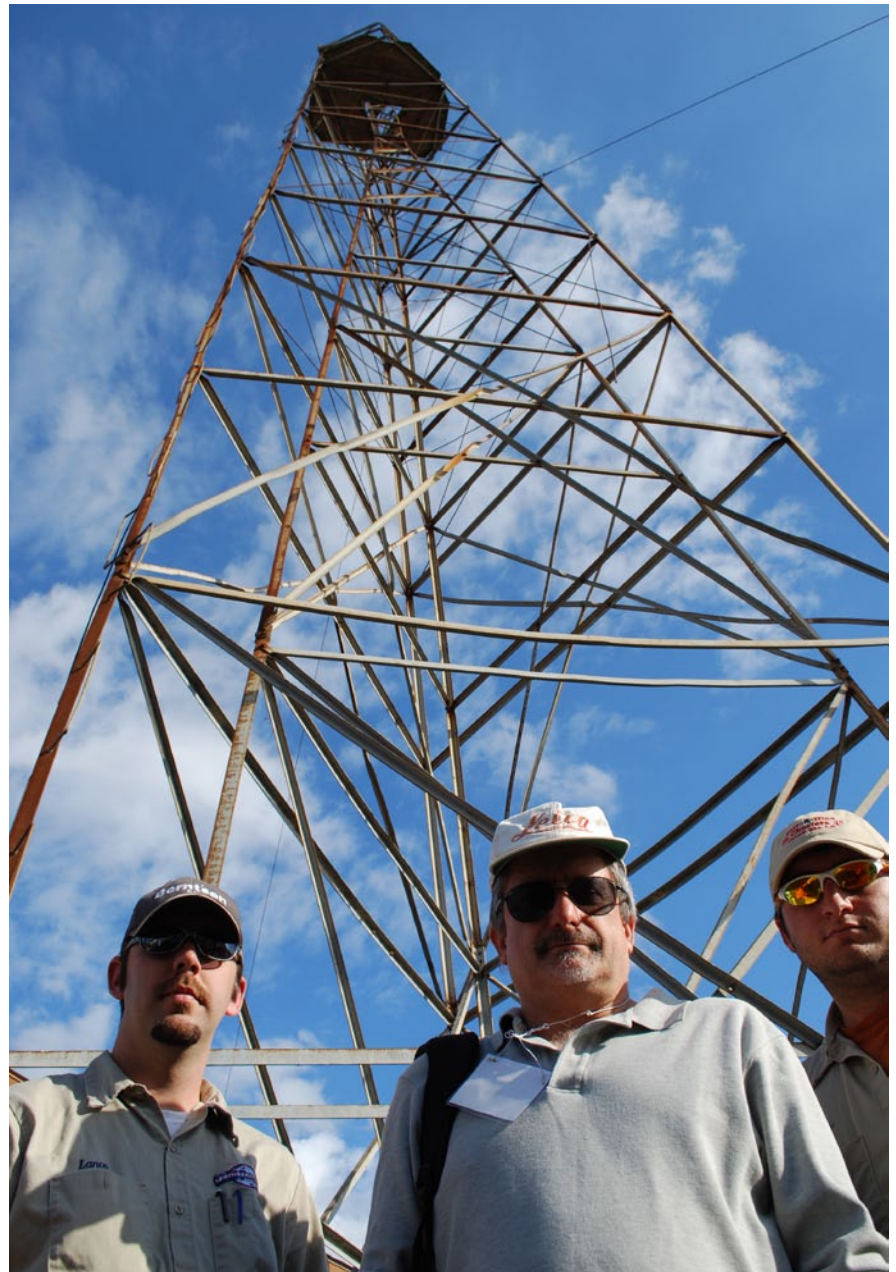
Meanwhile, SHS Board of Directors member Chas Langelan of Maryland and SHS Executive Director Roger Woodfill had been researching the pedigree of this Bilby. Chas learned that Couba was erected in 1972 and never used again. It turned out the source of the original contact photo on flickr was a retired NGS employee, who had visited Couba sometime in 2009. (See the Nov 2009 issue of *The Buzzard*, a newsletter published by the U.S. Coast and Geodetic Survey Heritage Society at: <http://home.comcast.net/~CGS.Heritage.Society/cgs/Buzzard.2009.November.pdf>.) Their discovery was our bounty.

In December 2010, the snowball, so to speak, began rolling. In a quick flash, NGS made no claims on the Couba tower. Contacts were made and road trips were planned. Roger Woodfill had already done a tremendous amount of research on Jasper Sherman Bilby. Woodfill has communicated with many a fellow Hoosier, including members of J.S. Bilby's family and acquaintances. In the Spring 2003 issue of *Backsights*, published by SHS, reference is made to Woodfill's article "Jasper Sherman Bilby's Tower." Roughly 95% of the

research material for this article was supplied by Woodfill and his kindness in sharing his valuable material cannot be recognized enough.

Once initial contact had been made, it was decided early on that Woodfill was the guy to take charge. His organizational skills resulted in a marvelous conclusion to our December trip.

Woodfill made arrangements with the State of Louisiana personnel and others for a group visit to Tower Couba on December 16, 2010. We all were to rendezvous at a boat launch within the confines of Bayou Segnette State Park, just across the Mississippi River from New Orleans. I left the Chattanooga area in a freezing rain heading for Tuscaloosa,



Fontenot, Gipson and Vidrine are employees of CH Fenstermaker and Associates, which graciously provided a boat on this trip and has offered to aid in the future relocation of the tower.



Under the halo of the sun, reflecting on his fellow Hoosier, Woodfill lives his dream to climb a Bilby.

Alabama to pick up fellow surveyor Milton Denny. Freezing rain seemed to be outpacing my windshield wipers and defroster, and I worried I might miss the excursion. With persistence, I eventually got below the “gnat line” and out of the bad weather. Milton and I met up with Roger and his son Craig in Hattiesburg, Mississippi that evening. Over supper, Roger presented us all one of his beautiful bronze coins commemorating the Bilby tower. We plotted strategy.

Morning broke with shirt sleeve temperatures and a glorious day. The only ice was in our soft drinks. A leisurely drive took us into and out of New Orleans. Just east of the entrance to Bayou Segnette State Park is a culinary wonder of the world, a fish market with crabs, fish, shrimp and other bounty from the local waters. Prior to disembarking, Milton and I maneuvered over to a back table in the corner of a little shop and treated ourselves to some delicious boudin and shrimp po-boys. A great start to the day, and the best was yet to come.

The four of us met at an assembly point, joining up with 13 others and three boats. It was time to pool our knowledge and do some swamp trekking. Raymond Impastato and Brian “Squirrel” Yuhasz work with the State of Louisiana on the leasing of oyster beds (\$2/annually/acre). Surveyor Jeff French and his wife Sue, a gifted photographer, traveled from Osgood, Indiana. Gerald Fussell, who had worked on Bilby towers in the 1960s, was the only one in our group to have had the pleasure of “sinking his fingerprints” into an actual tower. One of

the generous providers of a boat was the New Orleans surveying and engineering company, C.H. Fenstermaker and Associates. Representing Fenstermaker were Ralph Gipson (also representing the Louisiana Society of Professional Land Surveyors), Lance Fontenot, and James Vidrine. Their participation was invaluable. Thanks to the State of Louisiana, Mr. Granier and Squirrel provided both their work boats. We boarded and set out for about a 20-minute boat ride through bayous, an open lake, canals and swamps.

Heading south and coming to port through what appeared to be another canal, there stood a Bilby in all 64 feet of its gleaming glory (74 feet to the signal plate). And if that weren’t good enough, a proud bald eagle sat perched at the top, as if to welcome us 13 crazy old surveyors who were beaming from ear to ear.

I started out climbing the thin ladder rungs. About half way up, with the wind blowing like the dickens, though the tower was stable, I regained a level of sanity and decided to return to terra firma. Woodfill continued to climb and climb. Although he didn’t make it to the top, he did walk the steel. You could see the look in his eye lamenting never being on a Bilby crew in his career. We gawked and poked around. Much like visiting the Grand Canyon, after looking, it’s time to go. Reluctantly we returned to the boats, then headed for New Orleans. Was it just me, or did old Couba nod and return a smile when we left?

The Louisiana Tower (Couba)

Plans are underway to disassemble Tower Couba. Those concerned wish the tower

to undergo minor restoration and be relocated to the aforementioned Osgood, Indiana. Jeff and Sue French are engaged with the Reynolds Foundation, having as its primary goal the relocation of a real Bilby tower. Osgood, Indiana was Bilby’s hometown and the foundation wishes to have a tower residing in the City’s park, commemorating this great man. The National Geodetic Survey, the State of Louisiana, Fenstermaker and Associates and the Surveyors Historical Society all join the French’s in this goal.

Throughout this entire fabulous endeavor, riding at least a thousand miles thoroughly enjoying our great land learning history, meeting new folks, celebrating a birthday on Bourbon Street with wonderful colleagues, all the while paying respect to this long-forgotten, elaborate Erector Set-style assembly of the Couba tower. The sublime image of her standing proudly far out there in that swamp brought to mind something the eccentric German philosopher Arthur Schopenhauer wrote: *“Many objects of our perception excite the impression of the sublime; by virtue both of their spatial magnitude and of their great antiquity and therefore of their duration in time, we feel ourselves reduced to naught in their presence, and yet revel in the pleasure of beholding them.”* **A**

This article is dedicated to Jake Arnold, USCG&GS Light Keeper.

Author’s note:

Publication 62-3 from the Environmental Science Services Administration, Coast and Geodetic Survey entitled “Bilby Steel Tower for Triangulation” is an excellent resource for the minute details of a tower and its construction. Various editions of the publication were produced over the period of the use of the Bilby tower. A PDF version of the 1965 edition is available online at: http://docs.lib.noaa.gov/rescue/cgs_specpubs/QB275U352no62-3.PDF

Bart Crattie holds a BFA degree from Murray State University and is a licensed surveyor in Georgia and Tennessee. He currently serves on the Board of Directors for the Surveyors Historical Society.