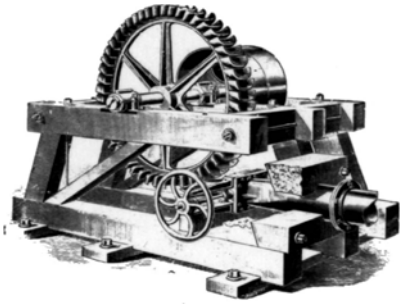


Newsletter

Samuel Knight Chapter

Society for Industrial Archeology
Issue Number 17
April 8, 2004

Contents:

The Newsletter is published in April, August, and December with special issues when they are needed.

The Chapter web site is hosted by the SIA headquarters site:
http://www.sia-web.org/chapters/knight/knight.html

Chapter News

Upcoming Event: Western Dovetail at Mare Island

Board Member John de Marchi is also a member of the Sonoma County Woodworkers Association, who have two interesting events planned that Chapter members are invited to attend.

The first is a visit to Western Dovetail, at Mare Island on Tuesday, 1 June 04 at 7:00 PM. Though a weekday event is a little problematical for some of the members, the site certainly seems worth a special effort to attend. The following paragraphs are from SCWA's Bill Andrews who is arranging both visits. If you are planning to attend, please let Jay McCauley know as space may be limited. Special thanks to John and Bill for letting us in on these fascinating visits.

Our program for this month is a tour of the Western Dovetail's facilities in the 100-year-old "Jointer's Shop" at the old Mare Island Naval Station. Western Dovetail makes solid wood dovetailed boxes and drawers for commercial customers across the country. The operation was moved from Sonoma to the current location last year. The story of the move and the adaptation of the machinery that was part of the Navy's operation will be a focus of the program. Some of these machines are almost as old as the building.

Max Hunter, the president, will be showing us his operation and telling us about the many lines of boxes and drawers that Western Dovetail supplies. He will also be talking about the 25 or so large woodworking machines that he purchased when they moved into the facility. Max is really enthusiastic about how they restored and tuned up the equipment to put it into production. He told me about most of what we will be seeing and I managed to get a few highlights: a Tanowicz bandsaw, three Tanowicz table saws, Rip saw, a Dodds dovetailer that dates to 1920, a 5-head Oliver tenoner, a 24" Northfield jointer, two 30" planers, a Madison molder with 200 original profiles that dates to the 1930's, and the list goes on.

As if that is not enough, Max is also going to get us into the adjacent Saw Mill building. This houses three Yates bandsaws that are 3 stories tall and date back one hundred years. The blades get sharpened in place up on the third floor of the building. Don't forget your camera!

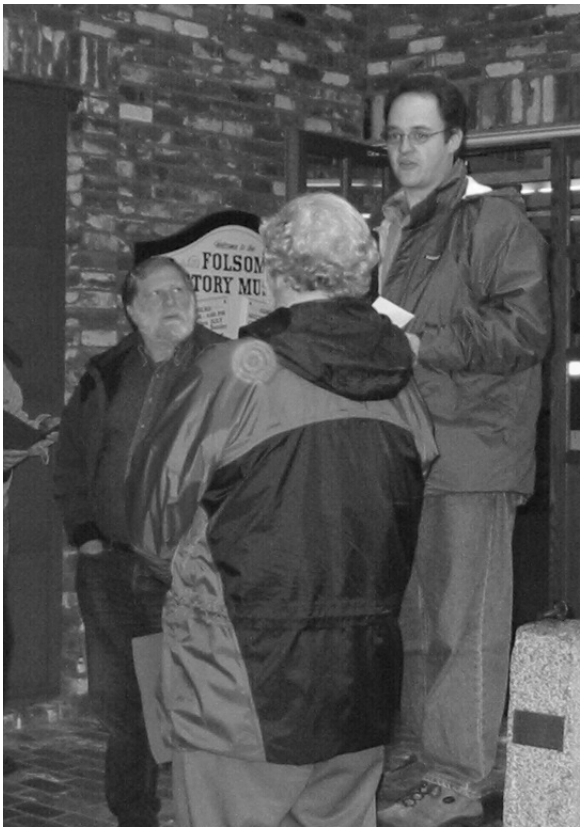
Directions: (Since folks are coming from many directions, this is just the last little bit. Start by getting to Vallejo. Wilson runs south from CA-37, and is the first/last Vallejo exit.) *Turn onto Wilson south bound and proceed to Tennessee/Mare Island Cswy. Turn right onto Mare Island Cswy, and take the bridge over to Mare Island. Just over the bridge turn left onto Nimitz Drive. Building 118 is on Nimitz exactly 1 mile from the bridge.*

Upcoming Event: Sturgeon's Mill Visit

Although it's a ways out, pencil in Saturday, 18 Sept 2004 for a visit to Sturgeon's Mill in Sonoma County. This is also a joint visit organized by the Sonoma County Woodworkers Association. Although potentially steam powered, the mill was flooded last year, and will be powered by compressed air. Issue 11 of the Newsletter (August 2002), which is available at the Chapter web site, discussed an earlier visit to the mill by a small group of Chapter members. Although the details are being worked out, the working plan is a "BYO" picnic and informal visit to the mill starting around noon. We'll be sending out details to Chapter members a few weeks before the event. *JM*

Chapter Event: Folsom Trip

Rain was the forecast for Saturday, 21 Feb 2004, the date of the Chapter's visit to IA related sites in Folsom, CA. That didn't dampen the enthusiasm of 24 members and friends, many of whom had made journeys of a couple hours or more to come to the event.



Scott See telling us about the day, John de Marchi listening intently

While we waited outside the Folsom Museum, Board Member Scott See handed out information packets and spoke to the group about what we were about to see. The Museum is housed in a reconstruction, using the original bricks and iron security doors, of the Wells Fargo Assay Office, where gold extracted from the American River and other nearby locations was weighed and purchased, to be sent on to the Mint by Wells Fargo stagecoach.

The site of Folsom was part of a 2000 acre purchase in1844 by William Liedesdorff, a prominent African-American owner of a shipping fleet in San Francisco, and one of the early settlers. Unfortunately, Liedesdorff died before he could do anything with his land purchase. Joseph Folsom journeyed to the Caribbean island of Dominica to attempt to purchase the land from Liedesdorff's Mother, his only surviving relative, and the heir to his estate. The transaction was swiftly completed, and in 1854 Theodore Judah, later to be the Chief Engineer for the Central Pacific, plotted out 2000 lots for the new town of Folsom. They were all sold on the first day. At the time, Judah was also the chief engineer for the Sacramento Valley RR, which terminated in Folsom.

Folsom is known for "Folsom Potatoes", potato sized and shaped river rocks that are just below the surface soil all over town. Many of these were exposed in the years of gold mining using large dredges. The principle operator of dredges was the Natomas Company which operated dredges for 135 years, ceasing operations in 1968. These enormous steam driven machines floated, sometimes in man-made ponds and literally chewed the landscape looking for gold washed down from the mother lode in the Sierra. Our last stop of the day was the site of one of these opera-

tions, a barren landscape of piles of Folsom Potatoes. The museum had a model of one of these dredges, as well as other artifacts from the Natomas Company.

Even at that, dredging was not the most destructive technique for mining gold, that dubious honor belongs to the use of monitors, large nozzles that ripped the earth with powerful streams of water. As a result of aggressive monitor mining, the State Park at Malakoff Diggings (north of Nevada City) remains a virtual moonscape, bereft of vegetation. The soil would be sent through sluices to capture the gold, with the remaining earth and rocks simply dumped into the river. After losing court cases over the flooding of Yuba City and Marysville, the practice of monitor mining was halted.

We were fortunate to see the Main Street USA exhibit, which was closing the next day. This series of exhibits illustrated the items one might find in the various stores along Sutter Street around the 1900s. Ours is a pretty eclectic group, so everybody had their own favorite store. For example, I liked the Garrett's Pharmacy, where every remedy seemed to have alcohol as its main ingredient! Other members could identify the old rifles in Rudy's Guns.

"All Aboard", Bill Anderson (back to the camera) guides the group onto the turntable

The weather cooperated as we left the Museum and went over to the railroad turntable across the parking lot. It was a wonderful surprise to find out that the metal parts in this replica, finished in 1999, were cast at the Knight Foundry! Bill Anderson, who was our guide to the turntable, had a video of the pour, including a conversation with the late Carl Borgh. The turntable is part of the Folsom, El Dorado & Sacramento Historical Railroad Association, which has a nice collection of railroad and mining artifacts. As is common with Chapter events, we had to pry members away from this captivating collection to go out to a group lunch at Yaeger's Restaurant.

The highlight for many of us was a visit to the Folsom Powerhouse State Historic Park. The energization of the 22 mile line to Station A in Sacramento on 13 July 1895 marked the first long distance transmission of commercial electric power, and heralded the triumph of AC over DC. Chapter Member Rich Harrelson was the docent for one half of the group, and did a wonderful job of explaining how the plant operated. The four generators were driven by water diverted from the American

River into a canal by a dam near the Folsom State Prison. A large forebay allowed the dirt and rocks to settle out before the water flowed into penstocks and down to the four turbines and generators. Periodically, the collected sand and rocks in the forebay were washed out over channels on both sides.

Rich Harrelson, our docent, answers a question posed by Ian Krase

One of the joys of IA for me is that you can understand 19th century technology in a way impossible with modern devices. The generators must be run at a constant 300 RPM to create 60 Hz AC. This was accomplished by an interesting speed regulator that moved the turbine assembly in and out via a gear chain regulated by a ball governor, similar to those found in steam engines. This in/out movement allowed more or less water to enter the turbine. Two smaller turbine/generators supplied the exciter current to the other generators' armatures.

The power from the generators flowed to a granite switch panel (for insulation) then through really scary looking knife switches (think Frankenstein's lab!) and on to transformers that stepped up the voltage to 11,000 volts for transmission. AC can easily be transformed from the high current, relatively low voltage produced by the generators to the high voltage, low current needed for long distance transmission with low losses. DC cannot be transformed like this, so had Edison's vision won, there'd be a powerhouse every few miles or even closer.

The plant operated for a remarkable 57 years, closing in 1952 after a fire knocked out one of the generators and construction of the new Folsom Dam required removal of the diversion dam. Upgraded to produce approximately 3 MW, the Powerhouse was rendered obsolete by the massive, but essentially similar hydroelectric plants on nearly all of California's major rivers, and other generation stations. It is fascinating that the oldest hydroelectric plant in the country was still "on the grid" nearly sixty years after it first started producing electricity.

Switch Panel. Who wants to throw one of the big knife switches in the center?

Thanks to Scott See and the other members who helped plan and organize this excellent event.

Good Luck Scott!

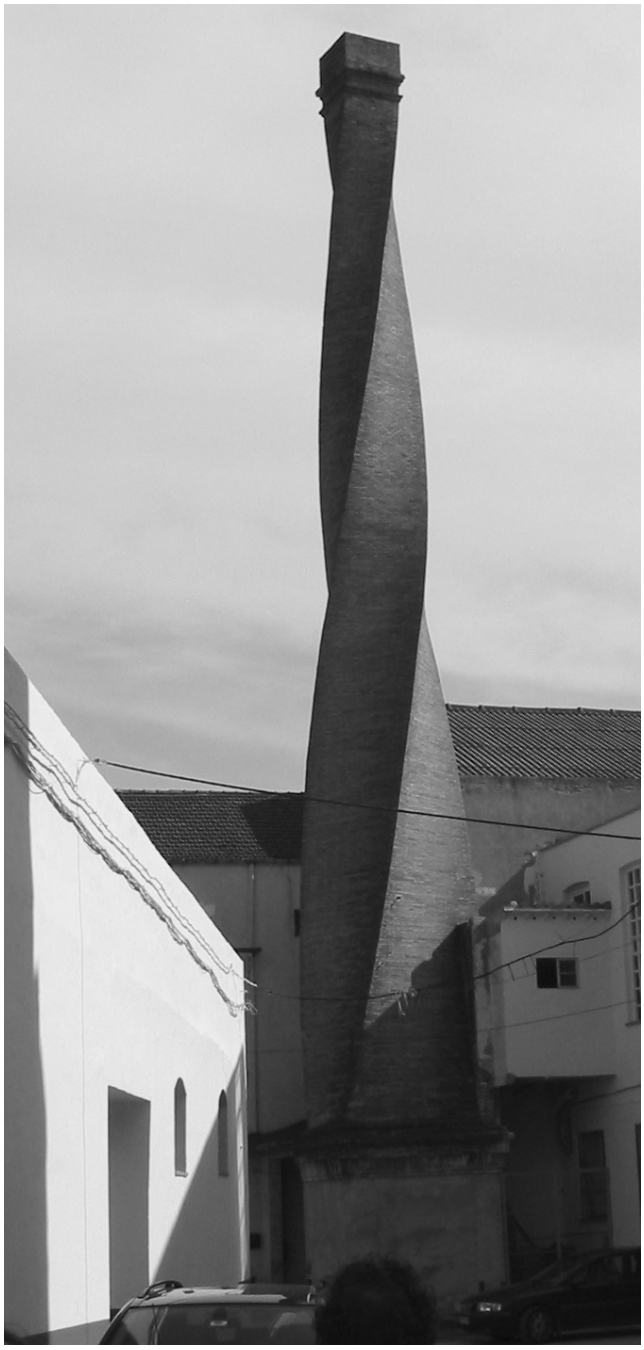
The Folsom trip was likely the last Chapter event for Scott See, who is turning a hobby into a career, by enrolling in the Industrial Archeology program at Michigan Technological University in Houghton, MI. We wish Scott and his family, including their newly arrived (12/29/03) daughter, Cassidy Lynne, all the best and thank him for his contributions to the Chapter. *JM*

SIA Spring Study Tour – Catalunya's Industrial Heritage

Chapter members Jay and Sharon McCauley and Noel Kirschenbaum participated in the SIA Spring Study Tour to Barcelona, Spain from 29 Feb through 6 Mar 04. Noel also participated it the pre- and post-tour supplemental activities. Organized by MTU Professor Pat Martin and a local industrial archeology consultant, James Douet, the tour had over 40 participants. The tour was assisted by Museu de la Ciencia I de la Technica de Catalunya (mNACTEC). mNACTEC is the center of a group of industrially themed museums throughout Catalunya. The tour visited a number of these smaller sites as well as the main mNACTEC site in the industrial area of Terrassa, just outside of Barcelona. mNACTEC is located in former woolen mill featuring a unique Catalan vault roof. (Out of space here, look for additional images on the web pages.)

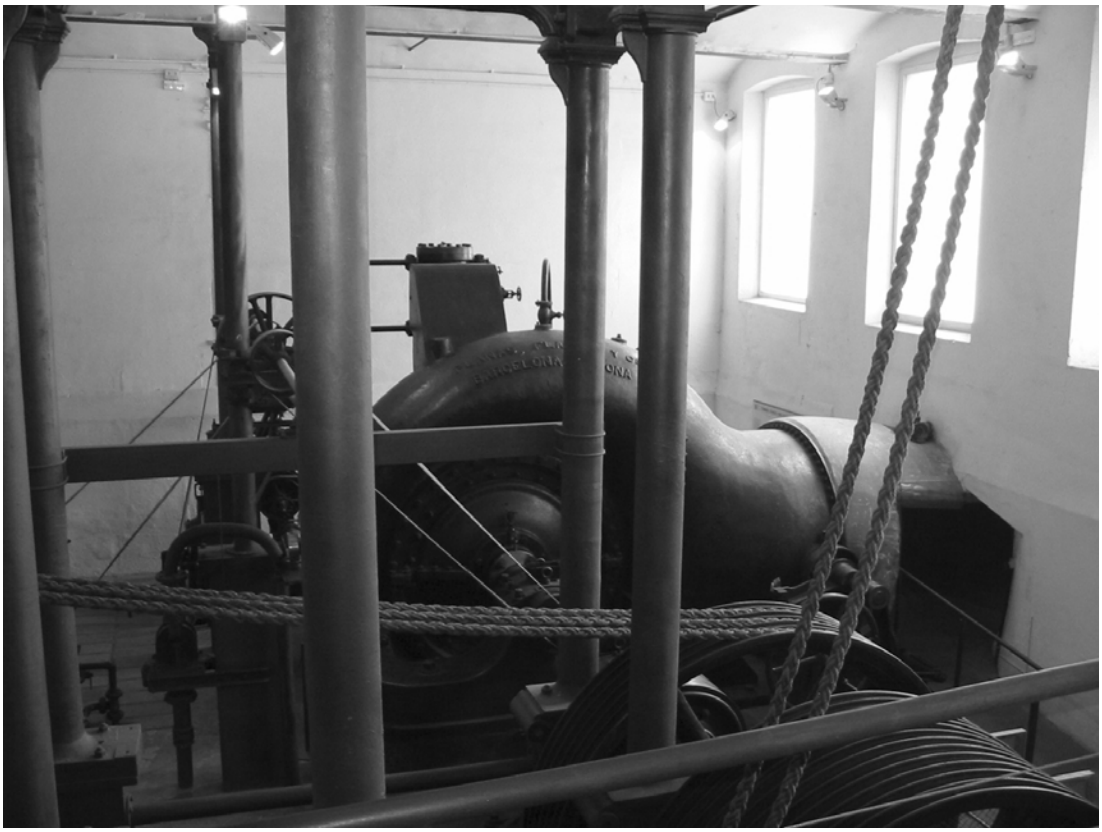
The tour is described at the SIA web site: http://www.siahq.org/tours/Studytour2004/cataloniaarchive.html and in a forthcoming article in SIA Newsletter. Rather than duplicate this more detailed material, let me give some of the highlights for me.

The central theme of the tour was the transition to an industrial society that occurred in Catalunya in the latter part of the 1800s through the 1920s. Many factors contributed to this transition occurring later in Spain than in other parts of Europe and the US. One was a lack of energy. Spain has very small coal reserves and the local rivers around Barcelona are fairly small. Extensive efforts to exploit water power, and to avoid the labor unrest that plagued Barcelona lead to the establishment of self contained *colónias* initially along the rivers where there was enough elevation change to power water wheels and, later, turbines. Some of the later mills did use imported coal to power steam driven complexes, allowing *colónias* to be located anywhere.



Spiral Chimney at Colónia Sedó

A typical *colónia* was *Colónia Sedó* which we visited on Wednesday, March 3. At its peak, over 3,000 workers were employed producing corduroy cloth. Like many other *colónias*, *Sedó* was powered by water that flowed in a canal from a diversion dam several kilometers upstream. The resulting 30 meter head powered a 1,400 HP Francis turbine, at the time, the largest turbine in Spain. The power was transmitted by an elaborate system of line shafts, pulleys and belts to the spinning and weaving machines. This system is just like Knight Foundry (and every other 19th century factory), but on a huge scale. The *colónia* also had steam power with a distinctive spiral chimney (as far as anyone could tell, the spiral shape served no purpose other than aesthetics) for the bleaching factory. Approximately 1,800 people lived at the site in modest apartments. The site is now being converted to mixed small industry and offices.



Francis Turbine at Sedó, also shows rope drive to main line shaft

No visit to Barcelona could be complete without seeing the unique work of Antoni Gaudi and the other *modernista* architects. Gaudi created distinctive, flamboyant structures using new techniques in reinforced concrete. His work also often features decorations made from colorful pieces of broken ceramics. The tour visited a number of Gaudi buildings, including *Colónia Güell* built for Gaudi's most important patron Eusebi Güell as a textile *colónia*. Their collaboration also produced *Park Güell*, a collection of buildings and fanciful sculpture on the edge of Barcelona. Eventually, Gaudi fell out with most of his patrons, and spent the remainder of his life designing and constructing the still unfinished *Sagrada Familia* church. The ongoing work at the church has made use of the latest techniques in computer graphics and CAD to help visualize and do the detailed design from Gaudi's sketches and plans.

Gaudi Lizard Fountain at Park Güell

The final day of the main tour took us to the foothills of the Pyrenees, where we visited the museum at the former Asland Company cement plant at Clot del Moro and a museum at Cercs dedicated to the coal mining industry. The cement plant had been partly torn down, so it reminded me of a ruined castle or the laboratory of a mad scientist (that seems to be a theme in this newsletter ;-). The cement dust must have been frightful, as all the beams and other surfaces were coated in a layer of cement, as if it had been sprayed on deliberately. The coal mining museum included a mine tour. It highlighted how desperate Spain was for coal, as hundreds of miners worked in difficult conditions to mine coal seam only a few feet thick.

Sharon and I spent a couple days wandering around Barcelona seeing some of the things we'd missed on the first day, then took the *Trenhotel* overnight sleeper train to Granada. For us, the trip ended on a scary note as we were staying very close to Atocha Station in Madrid and were awakened by the terrorist explosions, one of which was only a few hundred yards away. Fortunately, there was no harm to us or the hotel. Our hearts go out to the families and friends of the victims of this wanton act of violence.

Even with the scary ending, the trip was marvelous! It was quite interesting to spend a week with a bunch of folks who were knowledgeable and passionate about IA. I learned a great deal. Special thanks to Pat and James for all the hard work and planning that made this trip a success. *JM*

Notes and Tidbits

Stationary Steam

by Jay McCauley

"… Oh, and by the way, there's a big steam engine there," said my daughter, Erin.

I was immediately interested in knowing more. Erin is engineer working for California Water Services Company, the operator of a number of water distribution systems throughout California. She has had projects a various water districts all over the State, and was telling us about one of her latest tasks. In the course of a modernization project, the district staff had shown her the old steam driven pumping

plant, long out of service, but still largely intact. We continued to chat as I tried to find out more about this remarkable piece of technology. Erin didn't know much more about the steam system, as she had been quite busy with her real projects in the district.

"Gee, Dad, if you're really that interested, let me see if I can arrange a visit for you."

A few weeks later I got email from the district staffer, Eric Mar, with whom Erin had been working, inviting me for a visit the next week. In my reply, I indicated that I'd like to write an article for the newsletter. His reply indicated that this wouldn't be a problem. However due to security considerations, and the fact that the site is not open to the public, they'd prefer to not give a specific location in the article, which I've tried to respect here. He also wrote that one of the operators had collected some old articles on the pumping station and its history, further whetting my appetite for the visit.

So, on a bright late March day, I made my way to the site, to be warmly greeted by Eric, the local Production Superintendent. We walked over to the ornately decorated reinforced concrete building housing the pump system. Passing through some offices, we entered the pump hall. It was covered in white tile, and even though no longer in use, one could see how it could be kept spotless, befitting the source of the community's drinking water. A shiny brass railing surrounded the deep pit housing the pump systems. Eric joked that if staff members gave him trouble, he could always make them polish the railings. The notes Eric gave me were fascinating. They consisted of newspaper and magazine articles about the plant and its predecessors at the same site. I learned that there had been a great emphasis on how fireproof the building was. An earlier pumping station had a disastrous fire. Only heroic efforts by the staff kept the water flowing to the city. This material also explained how everything in the then new (ca. 1916) plant was built in pairs, allowing the water to keep flowing even in the face of component failures or planned repairs or additions.

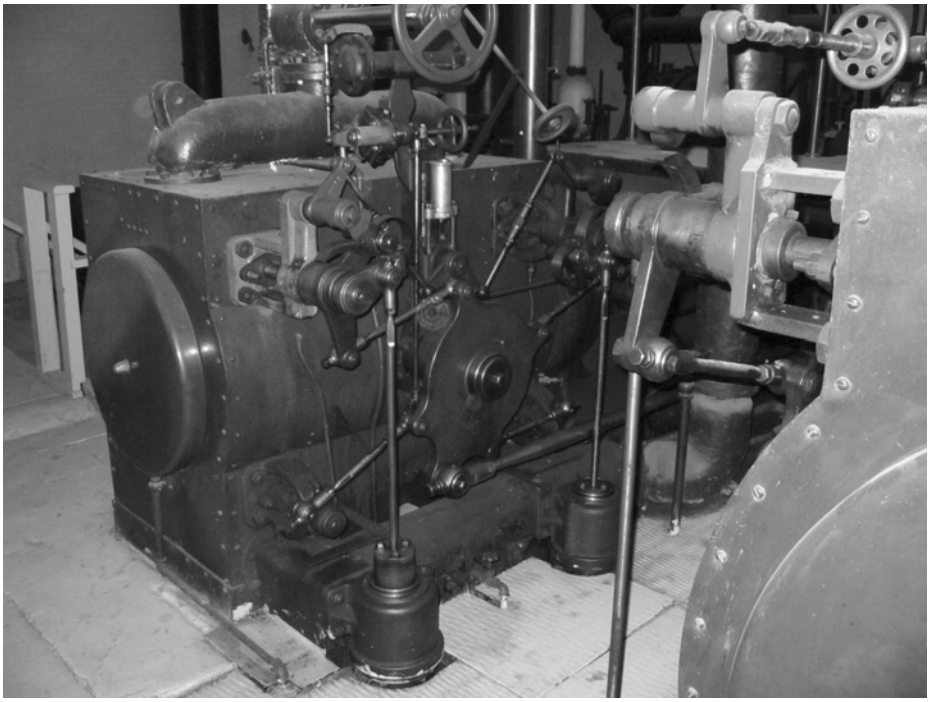
The steam engine and the pumps are in a deep pit. The center of the pit was dominated by a massive two cylinder horizontal steam engine driving two large pumps. A huge flywheel was hidden under a cover between the two sets of connecting rods. In the promotional material, this system is described as:

> … Holly-Gaskill superimposed, compound, condensing, crank and fly-wheel, duplex double-acting pump; steam cylinders 14 inches x 28 inches; water plunger 17 inches x 24 inches; revolutions per minute 31; … rated capacity in gallons per day, 4,000,000.

This pump system was installed in 1894, and continued to operate into the 1950s. The building around the pump was rebuilt in reinforced concrete, replacing the original brick structure.

Each of the cylinders was controlled by a complex rotary valve setup with two inlet valves at the top and two exhaust valves at the bottom of the massive cylinders. The four valves were all connected to a metal plate driven by the rest of the valve gear. As one might expect in an 1890's steam engine, there were an amazing number of adjusting cranks and wheels to control the engine. Eric said he understood that the engineers operating the steam engine had to constantly wander around with oilcans lubricating all the moving parts. I didn't see any of the classic glass and brass oil reservoirs, though pieces like that do tend to disappear.

Eric told me that the steam was raised by crude oil in a boiler room adjacent to the pump pit. An oil tank stood outside the plant, but had been torn down long ago. The boiler system had been removed and the boiler room had been turned into a water meter repair facility after the steam operations ceased. Now even that activity has slowed way down as it's cheaper to throw away a modern meter than to fix it.



Valve gear on left cylinder

The large reciprocating pumps had their own complex arrangement of valves to control the flow of water to the city. The steam engine pumps had long been disconnected from the city water mains, but one could still see the huge holes where the mains left the plant. Each pump sucked water in from the well field, which was connected to the pumps by an underground network of tunnels, then the pumps forced the water out to the city as spring loaded inlet check valves closed on the pressure stroke. These pumps were drawing water from fairly deep, artesian, wells (225-1100 feet deep) in a field surrounding the plant. In addition to the suction from the pumps, the plant also used compressed air to raise the water farther than suction alone could. Eric pointed out the large concrete tank outside the plant and the site of the now torn down high steel tank that provided pressure sufficient for the tallest buildings then in town.

On the left side of the steam engine was a centrifugal pump system. I learned later that when this pump system was installed it had both a steam turbine and an electrical motor powering it. Normally the electric motor did the work, but in the event of power failures, the steam turbine could be quickly activated.

A second reciprocating steam engine was originally on the right side of the larger engine, but this had been replaced by a second centrifugal pump system powered exclusively by electric motors. Advances in the efficiency of both motors and pumps meant that these newer systems could pump as much water as the large reciprocating engine in about 1/6 the floor space.

We concluded our visit by walking to the front of the building, where a formal façade showed the pride of the company in its modern water plant when it was opened early in the 20th century. A fountain also graced the entrance. At one time the area was landscaped with an elaborate rose garden, but the pressures of providing modern water service at regulated prices made this too expensive to maintain.

It's rare to find such an artifact still intact, let alone in such good shape. Although it's a long way from being operational, there is very little visible rust and the brass parts still shine. One can only hope that the company will be able to retain this wonderful example of early 20th century water distribution as part of our industrial heritage.

I'd like to thank Eric Mar, Erin and their employer, California Water Services Company, for a fascinating visit.

Travel Tip: Wonderful Willits – Roots of Motive Power, Inc. and the Mendocino County Museum

by John de Marchi

Several weeks ago while returning from Mendocino, Fort Bragg area I had the chance to stop and visit the Mendocino County Museum in Willits. The last visit I had made to Willits was a couple of years ago, and I knew that there had been a good deal of growth to the museum and to the Roots of Motive Power Section, which adjoins the main museum. Willits is 100 miles north of Petaluma, so as much as I enjoy steam powered equipment, I do not get to Willits often. After spending a short time at the museum and seeing the new three story train shed built of large new timbers and just beautiful constructed, I was very impressed. The museum staff informed us that being Sunday it was a workday for the volunteers of The Roots of Motive Power and we were welcome to walk over to their new building and yard. I was amazed at what this small group of dedicated volunteers had accomplished in two years. They had erected a very large salvaged industrial building and it was quickly becoming filled with all manner of steam and industrial equipment. They have acquired many acres of land next to the museum and they are in the process of laying a very large loop of track to run their two restored locomotives and other rail equipment.

Two years ago they had more than 30 pieces of steam and associated equipment and several times a year they had steam days where much of the equipment was on display working under steam. With their new huge yard and building, the donations have been pouring in at a good rate and the amount of equipment and machinery and engines is growing at a good rate. They do have a web site www.rootsofmotivepower.com , which I have just glanced at, but is full of plenty of information. I do think it would be a great site to visit on one of the many steam days. It is a distance, but the area is full of many places to visit, just down the street is the eastern terminal for the Skunk Railroad, which will be back in operation soon. It is great to see steam machinery working under steam once again, along with the sounds and smells and the sight of gears and levers and cranks and cams and such moving and clanking. Lets have a visit there one of these days????

Book Review: *Henry Maudslay & the Pioneers of the Machine Age* By John Cantrell & Gillian Cookson

reviewed by John de Marchi

This is primarily a series of monographs by various authors dealing with Henry Maudslay and six engineers that he greatly influenced. These are some of the men who were very influential in creating the mechanical wonders of the Industrial Revolution, and who also developed and built many of the basic machine tools which we still use today in more modern forms.

The first part of the book addresses the state of the engineering industry in London in the very early 19c. and Maudsly's workshop and influences in those early years. The life of Maudsly and what is known of his youth and heritage is also covered. The body of the book is devoted to the life and work, and connection of six important engineers to Maudsly and his workshops. Those engineers are, Richard Roberts, David Napier, Joseph Clement, Joseph Whitworth, James Nasmyth, and William Muir. Any person or student interested in the engineering and mechanical history of the 19c. should be familiar with several of these persons. At one point or another they were employed by Maudsly in his shops, which were the most advanced in England at the time, and where they learned about the newest and best technology of the period. The last chapter, "Maudsly, Sons & Field, 1831 – 1904", describes many of the great engineering works they worked on, and the development of the compound steam engines and bigger and better machine tools.

The book is 184 pages and well written by a variety of contributors and it is well illustrated with many images that I have never seen before. Because the topic is so

large and the pages are so few I was left with a hunger for much more. It is sort of a sampler platter of an important topic and era and I wish that the book at been maybe three times larger and had much more depth to it. I am very happy that it was written and I am pleased that there is a lot of new information and that it is all in one slim volume. For any one who has an interest in 19c. engineering and those who created it, this book is a great introduction to the topic.

Publisher: Tempus Publishing Inc. 2002 ISBN 0 7524 2776 0

Book Review: *The Measure of All Things* by Ken Alder

reviewed by Ed Wishart

Map of the survey, pg. ii

Subtitled "The Seven-Year Odyssey and Hidden Error That Transformed the World," this book is a history of the effort to define the meter by measuring the distance from Dunkirk through Paris to Barcelona and then extrapolate to a quarter of the circumference of the Earth: from the north pole to the equator. The meter was defined to be one 10-millionth of this distance. This effort took place during the period from 1792 to 1799. Originally envisioned as a year-long project, it took seven years to complete. During this time the French Revolution took place and Alder weaves the history of this scientific undertaking with the impact of the Revolution and French culture - both the urban culture of Paris and the peasant culture of rural villages - and such a contrast.

The reason for this effort, was to create a uniform unit of measure that would unite the rural country with Paris and also bring the rest of the world on board. By making the unit of length based on a natural phenomenon, rather than a man-created artifact, it would "belong to all of humanity". National pride, jealousies and mistrust made widespread adoption of such a unit happen very slowly. Surprisingly, France, having created the measure, was one of the first nations to reject it because of the failure and turmoil of the Revolution. It was not readopted in France until the middle of the nineteenth century with parts of countryside using measures of the Ancien Régime until the twentieth century. A competing standard was the length of a one-second pendulum - but agreement could not be reached on where this was to be measured. It is different at different locations on the earth's surface.

The three major protagonists were astronomers: Jean-Baptiste-Joseph DeLambre, Pierre-Francois-Andre Méchain and Joseph-Jerome LaLande. DeLambre was to lead the measure of the northern half and Méchain the southern half. LaLande ran the program from Paris. The basic plan is straightforward: lay out a series of large triangles from Dunkirk to Barcelona so that every triangle shares a side with another triangle, measure the angles of all triangles and the side of 1 triangle. Then trigonometry gives the lengths of all the sides and more trig can find the length of lines cutting these triangles and hence the distance from Dunkirk to Barcelona. The measure of the angles was done with a new, cutting-edge, scientific instrument invented by the French physicist, Jean-Charles De Borda: *the repeating circle*. With this instrument, an astronomer could take repeated measurements of an angle, and the instrument would keep track of the sum of the angles measured so the final answer was the sum divided by the number of times he repeated the measurement.

In reality, this task is extremely difficult, and in fact, cannot be done with the accuracy they envisioned. And that, is the irony of the whole scientific campaign. They knew the earth is not a sphere, but an oblate-spheroid and worse its imaginary, sea level surface is not smooth, but wrinkled. So a meridian through Paris will not be the same length as one through Philadelphia. After 7 years, an international scientific conference was convened in Paris, the data was examined and the anomalies were discovered.

So, the standard meter was based on an earlier interim standard that was developed on an estimate of the Earth's circumference by Cassini in 1740. And this is the standard we rely on today, being refined, but no longer tied to the circumference of the earth nor to a physical artifact. The current definition, adopted in 1983, is the distance that light travels in a vacuum in 1/299,972,458 seconds. [By the way, our Anglo-American unit of length, the inch, is *defined* in terms of the meter: 1 inch is 2.54 cm exactly.]

One of the amazing themes to this story, however, was the great skill and effort put into this endeavor by all concerned. Corrections were made for altitude, refraction of the atmosphere, spherical surface on which the measuring was done and extreme care with which the *savants* went about their tasks. Crews had to build targets to take sightings against, towers had to be erected, local villagers had to be placated (these were not astronomers, but spies for the enemy), people had to be fed and housed. This was done against the political chaos centered in Paris: governments rose and fell, 25,000 heads fell into baskets, wars were won and lost, budgets came and went.

The main theme of the book is the personalities of the three major protagonists. Méchain was a control freak, but with great abilities as an astronomer. He triangulated to Barcelona over a period of years and when he got there he took latitude measurements with the repeating circle in a vertical plane. Measurements were taken of several stars and from two places less than a mile apart. He discovered that the measurements did not agree; the error was on the order of 3.2 seconds of arc. [Each second of latitude is about 100 feet.] Try as he would, he could not discover the source of the error, he became obsessed with it and this drove him into depression or worse. He would not return to Paris for 7 years, he would not answer letters nor send back data he had collected.

On the other hand, Delambre was the epitome of scientific correctness: he took all his data in logs with numbered pages, dated and time stamped with observations re weather and other peripheral matters. These logs were part of the permanent record for all to see. He spent years deferring to the senior Méchain and trying to coax him to finish his work and return to Paris so they could bring closure to the expedition that was long over due. Finally, Méchain returned to the international conference and gave summary data only.

Later, when Méchain did turn over incomplete and rewritten logs of his work, Delambre spent great effort to put them into publishable form. In doing this he discovered how Méchain had fudged his data to make it appear that his results were consistent and Méchain's skills were impeccable. Delambre also discovered the error that had driven Méchain mad, but rather than exposing Méchain for his folly, he careful hides this in sealed documents that Alder has uncovered. I find this loyalty of Delambre to his senior colleague, Méchain, now dead, to be one of the amazing themes of the book.

Other themes that Alder writes about (and that I enjoyed) were the philosophical implications of measurement, error, precision and accuracy. About this time, the English had discovered that each scientist often gives a regular bias to his observations; they may have high precision but may not be accurate! To eliminate this, the measurements of several scientists had to be combined. And how this is done leads to statistical questions of averages and how to perform them. And finally, there is no ultimate definition for a meter - it will always have an error, no matter how small, e.g. the definition today is estimated to have a relative uncertainty of 2.5×10^{-11}.

Ken Alder's used primary sources in writing this book and did the translations into English himself. He also rode the route from Dunkirk to Barcelona on a bicycle so he could observe the places he wrote about up close. Like the *Lunar Men*, this well written history gives insight into life 200 years ago from many perspectives: science, politics, economics, human relations and daily life. I highly recommend it.

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Book Review: *Rider in the Sky – How an American Cowboy Built England's First Airplane* by John Hulls

reviewed by John de Marchi

In 1908 Henry Ford sold the first Model T automobile and in England Samuel Cody made the first airplane flight in England. How did someone who became famous for putting on wild-west exhibits become the first to solve many of the practical problems of flight in Europe and build and successfully fly several generations of flying machines? In 1913 Cody crashed and died in *Cody VI.* The story is rather amazing and many of the facts and documentation exist but some questions still remain and may never be answered. The book is well written and very well researched, and has many wonderful vintage photographs along with excellent illustrations by David Weitzman. The book is about 100 pages in length, and a good read, and it is full of much new information and great vintage photos.

I had known for many years that Samuel Cody was the first to fly in England but how that took place and the story behind that first flight was scarce or non-existent. For Cody the path into the air was with kites, man and woman lifting kites that were, by his design, also controllable in many ways. Even if Cody had never built and flown an aeroplane his work with large controllable lifting kites would be very impressive. The fact that he also designed and built several fully functional aeroplanes is rather amazing and impressive.

In 1901 Cody applies for a kite patent, and demonstrates his kites to the British Army. 1902 Cody's wife goes aloft in a kite, probably the first woman aloft in such a craft. 1903 Cody flies from a Royal Naval vessel and starts naval aviation. In 1905 Cody becomes the British Army kiting instructor, and the students are able to fly up and down the guide line for several thousand feet, with complete control. Cody devised a whole system of several lifting kites which were attached to the main line, which the man lifting kite rode on. Part of the system was a winch system, which could pay out wire rope and then reel it back in. His experiments with control systems for letting the man kite fly up and down the main line also gave him the information he needed when he devised his control system for his first aeroplane. His aeroplanes were very successful and he was able to fly cross-country record breaking flights by 1909. Cody also built a few gliders that were also very well engineered and flew well. In 1907 Cody and Colonel Capper flew a balloon airship to London (40 miles away), and from the papers of the day it was a tremendous event. The ship "Nulli Secundus" was designed and engineered and built by Cody and his sons, and it worked and it worked well. The author points out that many persons, including himself, have never been able to discover the roots of Cody's ability to design and build such advanced and complex systems. Nothing has ever been found in his history that would give a clue as to where his aeronautical talents may have sprung from. But Cody did fly, and he was the first in England to fly and this cowboy was a great, maybe natural aeronautical engineer of the early days of flight. In the end he did die at the controls of one of his aeroplanes doing what had became his passion. A big story in a small book, and a very good read for anyone interested in the early days of flight.

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