



# Newsletter

The Samuel Knight Chapter  
The Society for Industrial Archeology  
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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>

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# Chapter News

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## Membership Renewal Time

It's time to renew your Chapter membership for 2004. Chapter membership is on an annual basis, to simplify recordkeeping, 1 Jan to 31 Dec. We've had a surge in membership this year, with the total now over 60! A membership renewal form is on the next to last page of the newsletter. If the mailing label is correct, just check the box on the form and mail it in. We'd like to use email to send out renewal acknowledgements, event notices and other short notes. If you wish to receive these by email, please put your current email address on the form. The Board voted to never disclose email addresses. We will still send out hardcopy to anyone who does not wish to use email. The newsletter itself is too large to email to members with dialup connections, so still will be distributed in hardcopy to our members and friends. The newsletter is put up on our web site shortly after hardcopy distribution.

Those of you who joined in the later part of 2003 have already been extended to cover all of 2004. The mailing label on this newsletter indicates when your membership expires, e.g. *Member through 2003*.

The membership voted in 2002 not to seek IRS 501(c) 3 status, so membership dues and other contributions are not tax deductible.

Renew your membership today, and join us in the exciting program planned for 2004! *JM*

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## Annual Meeting

The Chapter's Annual Meeting was held on 25 Oct 03 at the California State Railroad Museum in Sacramento, CA. The turnout was outstanding with 33 members and friends present. The meeting started with a tour of the Southern Pacific's Sacramento Shops hosted by Chapter Member Kyle Williams Wyatt, Curator of History and Technology for the Museum. The Shops tour is discussed in a separate article.

Chapter President Anthony Meadow convened the meeting. Secretary/Treasurer Jay McCauley presented a report on Chapter membership, we had at that time 57 members, and a financial report (available on request). The Chapter Officers and Board Members have all agreed to serve for another year, so were nominated by various members, and elected by acclamation in a unanimous vote. Your 2004 Officers and Board are:

- President: Anthony Meadow
- Secretary/Treasurer: Jay McCauley
- Board Member: R. Scott Baxter
- Board Member: John de Marchi
- Board Member: Noel Kirschenbaum
- Board Member: David Lindquist
- Board Member: Scott See

The Chapter Bylaws permit up to nine Board members, so if you would be interested in joining the Board, please contact Anthony Meadow or Jay McCauley.

Chapter Member Margaret Mills, who is on the Board of the Knight Foundry Corporation (along with Member Kyle Williams Wyatt), presented an update on the status of the Knight Foundry. Negotiations by the Corporation to purchase the

Foundry are in progress, but are somewhat complex. Until these are completed, the Foundry has been unable to utilize portions of the Save America's Treasures grant, after the completion of some planning studies. Although the Chapter spun off the efforts to preserve Knight Foundry, many of us remain interested in the project and are contributors to the effort.

We already have several events in the planning stages for 2004. We are trying to arrange a plant tour on Tuesday, 30 Dec 2003, but one of our candidates was unavailable. We will notify the membership if we are able to set this up. In February/March we plan to visit the Folsom Power House and other IA sites in the Folsom, CA area. In a bit of serendipity, new Member Richard Harralson is a docent at the Power House, and will be helping with planning and the visit, along with Board Members Scott See and Scott Baxter. In May, we hope to visit Sturgeon's Mill in Sonoma County, CA. There are several other possible events for later in 2004.

The successes and membership growth in 2003 have lead the Board to begin investigation of possibly hosting the 2006 National Fall Study Tour. The Members voted to continue these investigations, headed by Jay McCauley.

After the meeting was adjourned it was great to see various members engaged in lively discussions of past and future events.

The Chapter thanks Cathy Taylor, Director of the California State Railroad Museum and Cheryl Meyer, Event Coordinator, for helping set up the meeting, and for the use of the Leland Stanford Gallery for the meeting. Special thanks to Kyle Williams Wyatt, for an engaging, fascinating look at one of the most significant IA sites in California. *JM*

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## Sacramento Shops Tour

by Jay McCauley

*A primary source for the information in this article is the Historic American Engineering Record (HAER) report on the Shops prepared in August 2002 by Carolyn Dougherty P.E., and available online at*

<http://www.intemperance.net/carolyn/haer.html>

*Kyle Williams Wyatt and other CSRM staff members and friends contributed to the HAER reports.*

One of the most important IA sites in California is the former Southern Pacific Sacramento Shops. The first buildings in a complex that would eventually include over 90 major structures, were constructed in 1863. Today, only a handful of the buildings in the complex survive, although historians have access to plans and the foundations of many of the buildings on the site. The Shops were active until 1999, a remarkably long period.

The City of Sacramento donated 20 acres of a slough to the Southern Pacific in 1863. Soon the railroad built three buildings, a warehouse, a car repair facility and a locomotive repair facility. From a very modest beginning, just 15 employees initially, the Shops would grow to be the largest industrial complex west of the Mississippi.

Initially the Shops were used for maintenance and repair. Steam locomotives require nearly constant maintenance. In the early days of railroading, the road crew did much of the day-to-day maintenance of their locomotive. By the 1870s, this work was done in the Shops by other employees. Locomotives also require periodic major overhauls, "backshopping", also done in the Shops. The wide variety of locomotives in the early days of the Central Pacific meant that it was often easier to fabricate a needed repair part than to maintain a complex stock of parts. Thus, the Shops soon developed all the skills and equipment needed to construct locomotives.

Unlike modern steel cars, the wooden cars of the era also required periodic maintenance, such as replacing roofing and siding materials which would deteriorate. Ad-

ditionally, there were repair activities on cars damaged in accidents, but deemed repairable. The Shops soon developed a substantial woodworking capability.

By 1870, the railroad began to construct its own cars at the Shops. The Shops began to construct locomotives in 1873. Locomotives being backshopped also frequently had improvements added to them. Master Mechanic Andrew Jackson Stevens was a prolific inventor of improvements for locomotives, including the Stevens valve gear.

The skilled employees and specialized equipment at the Shops allowed the railroad to be nearly self-sufficient. Quoting from the HAER Report:

The shops also built desks, tables and chairs, cast iron stoves, hand trucks, clipboards, restaurant silver services and even moustache curlers. The sheet metal shop turned out step stools, buckets, garbage cans, and drinking fountains...

The Shops grew over the years. Eventually the Shops occupied a site of over 200 acres and employed as many 7,000 workers in three shifts (including over 2,000 women in a wide variety of positions) during World War II. The introduction of diesel power dramatically reduced the maintenance needs of the railroad. Construction of new facilities in Roseville and elsewhere on the line continued to erode the workforce at the Shops. In 1999, the Union Pacific closed the Shops.



**Crossing the UP Mainline, Boiler Shop and Erecting Shop in the Background**

Today, only a few buildings remain standing. After a short walk from the Museum, crossing the still very active Union Pacific mainline, Kyle led the tour into the former Boiler Shop. Today, it houses the maintenance and restoration activities of the Museum. The Museum operates the Sacramento Southern Railroad, a short line/excursion railroad running South from the Museum along the river. They do handle a modest number of freight cars for wayside businesses, in addition to the primary mission of providing tourist excursions. The restoration team recently completed the first of two passenger cars to be used in excursion service. Current projects include the re-construction of a 1880s wooden boxcar to be used at Col. Allensworth State Historic Park near Bakersfield.



### Boiler Shop

The restoration staff also recently completed a transfer table that operates between the Boiler Shop and our next stop, the Erecting Shop. The transfer table allows the Museum to move more of its collection indoors in the Erecting Shop.

In the Erecting Shop, workers “erected” (assembled) locomotives. This is a magnificent industrial building, reminiscent of a cathedral. Indeed, the Museum has had an exhibit on the Shops and the workers entitled *Cathedrals of Labor*. The Erecting Shop was initially constructed in 1869, but has been extended several times to its present size. There was a wealth of utilitarian, but interesting architectural details.

It was a busy day for the Museum staff, as they were training a new group of volunteer docents. All too quickly we had to leave this marvelous site.

The overall site is being redeveloped, including realignment of the mainline, which will simplify the Museum’s railroad operations. The Shops are planned to become an integral part of the Museum and of the redeveloped site. Although still in the future, someday all of the Museum’s visitors will be able to visit the shops, as we were privileged to do.

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## SIA Fall 2003 Tour – Northeast Montana September 26<sup>th</sup>-29<sup>th</sup>

by Scott See

Described in the tour brochure as “one of the most out-of-the-way parts of the lower 48”, the 2003 SIA Fall Tour took place in northeastern Montana and western North Dakota. 56 SIAers attended the tour, which traveled many miles to explore the widely dispersed industrial, agricultural and natural resources of the area. The weather generally cooperated with us by providing windy, partly cloudy days and chilly nights. Sponsored by the Klepetko Chapter, Fred Quivik and Brian Shovers did an excellent job sharing the organizational and interpretive responsibilities for the tour.



**Snowden Bridge** (photo by Scott Andrews)

We started our day in Williston, North Dakota and drove west toward Montana. Our first stop of the day was at the **Snowden Bridge**. When it was built in 1913 it was the longest vertical lift bridge in the world with a lift-span section measuring 296 feet. The bridge was designed by Waddell and Harrington and built by the American Bridge Company. Designed to allow the trains of the Great Northern Railroad to cross the Missouri River, while still enabling boat traffic to pass underneath, it was built during the twilight years of shipping on the upper Missouri. In fact, the railroad's dire prediction that the bridge would never be used almost came true – the lift span was only operated 6 times. Today the bridge is still used by the railroad but the lift section has been welded into place.

After about an hour at the bridge we drove into Sidney, Montana to tour **Sidney Sugars**. The sugar beet processing plant at this location was built in 1925 by the Imperial Holly Sugar Company and is now owned by American Crystal Sugar. The plant processes about one million tons of beets annually, which in turn produces 2.7 million 1 lb. bags of sugar. The plant employs 110 workers year-round but increases the workforce to almost 300 workers during the peak harvest and production time (late September through February). We were given a thorough tour of the facility and given an opportunity to taste the beets and the sugar at various stages of processing.

The next stop was the **UDSA Northern Plains Agricultural Research Lab** in Sidney. The lab employs 40 people and is focused on conducting scientific studies that provide valuable research and development input to companies producing various agricultural and pest mitigation products. Our visit included presentations by entomologists, irrigation experts and beet pathologists. We were also treated to a tour of the impressive laboratory facilities and environmental control areas where insects and microorganisms are grown for scientific study.

We then drove north to the **Montola Growers** oilseed plant in Culbertson, Montana. The plant produces a variety of oils including safflower, crambe, wheat germ and avocado. There was quite a bit of discussion about the avocado oil as it's re-

portedly considered an aphrodisiac in Japan. When asked how the product was used, our tour guide claimed ignorance and quickly changed the subject. The plant was built in the 1950's and the cooking oil refinery equipment was added in the 1970's. The current owners purchased the plant in 1997. Our visit was timed early in the harvest season and the plant wasn't operating during our tour. Fortunately, our guides were able to show us the machinery and give us a thorough description of how the plant worked.

We left Culbertson and headed west to the Fort Peck Indian Reservation for our last tours of the day. We visited two tribal businesses – **A&S Tribal Industries** and **West Electronics**. The two businesses are located on the reservation and primarily employ tribal members. While there are several non-Indian employees, it's generally understood that these positions are temporary until qualified tribal members can be found or trained. A&S is currently producing medical chests for the military while West Electronics recently secured a contract to package fuel supply systems for the Army.

After an interesting day of tours, we continued west to the town of **Fort Peck** where we would spend the night. After a hearty buffet dinner at the Fort Peck Hotel, we moved onto the evening program where Fred Quivik described the history of the town of Fort Peck.

**September 27<sup>th</sup>**



**Fort Peck Dam Power House**

On Saturday morning we made a quick stop at the Fort Peck Theater before heading to the **Fort Peck Dam**. The dam is an immense structure that dominates the surrounding landscape. Built between 1933 and 1938, it is 4 miles long and 3/4 of a mile wide at its base. The dam was one of the first large projects undertaken by the Public Works Administration and was constructed by the Army Corps of Engineers. The major accomplishments of the Corps included: using hydraulic means to move 122 million cubic yards of fill, installing a 10,000-foot-long steel wall within the dam, building a mile-long spillway and constructing four diversion and intake tunnels that are 25 feet in diameter and more than a mile long

Our tour of the facility included visits to both powerhouses and their respective turbines. The dam produces 185 megawatts of electricity when running at full capacity. This is roughly enough power for a city of 800,000 people, or nearly the entire state of Montana! Each of the 5 tanks, one for each turbine, is 148 feet tall and has a capacity of 4.5 million gallons. Our final stop at the dam was to view the massive spillway constructed just east of the dam. A celebrity of sorts in its own right, a Margaret Bourke-White photograph of the spillway under construction was used for the very first cover of *Life* magazine in 1936. Most of the tour group took the opportunity to get their own pictures of this famous landmark.

Leaving the dam and the town of Fort Peck behind, we made a 2-hour drive to an oil well just outside Froid, Montana in the **Medicine Lake Oil District**. Bruce Crane, who maintains the oil well for the current owners, met us at the well and gave us a fascinating explanation of oil exploration and drilling techniques. Bruce brought various pieces of well casing and drilling equipment to show the group how the well had been originally drilled.



**Bruce Crane Explaining the Mechanics of Oil Drilling**

Driving back to Culbertson, Montana, our next stop was the **40<sup>th</sup> Annual Culbertson Threshing Bee**. With over a 100 tractors participating, and numerous farm implements on display, there was something for everyone. An announcement was



made over the loudspeaker welcoming the Society for Industrial Archeology and informing us that the tractor parade was about to begin. One by one, the tractors came to life and drove in a parade circle in front of the makeshift grandstands. All too quickly it was time to get back on the bus and head back into North Dakota for dinner.

Saturday's dinner was held at the **Fort Union National Historic Site**. John Jacob Astor's American Fur Company originally built Fort Union in 1828. The fort was a thriving operation until 1837 when a smallpox outbreak decimated much of the local Indian population. The fort was eventually sold to the Northwest Fur Company and finally purchased by the Army in 1867 who then dismantled it for building supplies. The fort that is seen today is a reconstruction built on the original foundations by the National Park Service between 1985 and 1991.

### **September 28<sup>th</sup>**

There was frost on the car windows as we left the hotel and headed to our first stop at the **Confluence Heritage Center**. The center housed an impressive display interpreting Lewis and Clark's journals as they had passed through this portion of North Dakota as well as displays describing the daily rituals of Indian and early frontier life. Our group spent our short visit viewing the displays, taking pictures and inspecting the souvenirs and books available in the gift shop.

After leaving the Confluence Center we drove past the **Fort Buford State Historic Site**. The US Army had claimed the area in the vicinity of the confluence in 1860 for the construction of a fort. As mentioned earlier, the Army bought the remains of Fort Union in 1867 in order to obtain materials to begin the construction of Fort Buford. The Fort Buford that can be seen today includes the original officer's quarters, an officer of the guard building and the powder magazine.

Our next stop was the **Fairview Bridge**. Spanning the Yellowstone River, it is a virtual twin to the Snowden Bridge except that its lift span is slightly shorter at 275 feet. Like its sister bridge, it was designed by Waddell and Harrington, built by the American Bridge Company and completed in 1913. Unlike its sister bridge, it was never lifted for river traffic. The bridge was only lifted once as part of a demonstration and it took 30 minutes to raise the lift span 43 feet from its base. It also differs from the Snowden Bridge in that it is no longer in use. The last train crossed the bridge in 1986. The tracks were subsequently removed and pedestrian guardrails were installed to allow the bridge to become the center of a county park.



**Lewis and Clark Power Station**

From the bridge we drove back into Sidney, Montana to the **Lewis and Clark Station of Montana Dakota Utilities**. This 49-megawatt power plant was built in 1958 and was designed to burn lignite coal or gas. Although using lignite was described by some frustrated operators as “trying to burn dirt”, it is the primary fuel that the plant uses due to the abundant local sources and because it is cheaper than gas. Our tour started in the coal piles where we learned that the plant keeps about a 10-day reserve of coal onsite as well as an additional two-week supply held at a nearby coal mine. During the rest of our visit we were able to view the base of the smokestacks, the settling ponds, the water pump house, the generator room and the control room.

Our last stop of the day was a rock formation along the banks of the Missouri River called the **Garden of the Gods**. Access to the formation required a lengthy hike along the river and then a climb almost to the top of the bluffs overlooking the river. Several photos were taken of the hardy few that had ventured the entire trip, but it was soon time to return to the bus so that we could get a number of people back to Williston in time to catch the evening train heading east.

The group returned to the bus only to find that we had a dead battery and that the bus would not start. After connecting two cars to the battery banks of the bus we were able to get the bus started. Everyone quickly climbed aboard and we raced back to Williston arriving at the Amtrak station a half an hour ahead of the scheduled departure time for the train. With that adrenaline-pumping adventure behind us, the remaining group headed back to the hotel for dinner and a good night’s rest.

### **September 29<sup>th</sup>**

With the tours completed, Monday was reserved for travel home. Our exploration of the historical and modern industries of the region provided a glimpse into the strength, determination and pioneering spirit required to make a living on the Northern Plains. The many industrial accomplishments became even more significant when one considered the bitter cold winters and the remoteness that are all just part of living in “one of the most out-of-the-way parts of the lower 48”.

Thanks to correspondents Joe Seeley, Bill McNiece and tour coordinator Fred Quivik. This article is an abridged version of an article set to appear in the Winter Issue of the SIA Newsletter.

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# Notes and Tidbits

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*Just in time for your holiday gifts or wish lists, here are reviews of several IA related books. Thanks to John, Ed and Bob for their reviews. Shameless plug: we'd love to have more reviews! JM*

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## Book Review: *The Last Lone Inventor*, by Evan I. Schwartz

reviewed by John de Marchi

Once started this is a difficult book to put down, as the story reads like a mystery or spy thriller. It is the story of a gentle quiet genius who without a university education created a complete television system in his mind while very young and still on the farm. The rest of his life was spent developing his creation while the RCA Corporation tried to circumvent his invention and patents and through many devious means tried to take credit for his brilliance. It is only in recent years that the true story has emerged from the curtain of dis-information and lies that David Sarnoff and RCA had created over the years. I went to some of my reference books and an extensive bibliography of science and technology, and I was amazed to find that the falsehoods were repeated in the scholarly books and it was also stated that Farnsworth worked for Sarnoff while Sarnoff was inventing TV?

The book was very well researched and gives a very detailed view of the developments and the creation of the first TV system located in a lab on Green Street in SF. The notebooks and lab journals of Philo T. Farnsworth still exist and were used by the author to recreate that magical time of invention and experimentation. The author, Evan Schwartz, was also able to interview Philo's widow Elma "Pem" Farnsworth who was involved in the lab work from the start. Some young engineers who would later become the founders of Silicon Valley were fresh graduates and recruited by Farnsworth to help develop his invention. The lab on Green Street was an active place and survived a fire and was rebuilt and in time a fully functional TV system was developed. A patent was carefully generated and submitted by patent attorneys and then the push was on to introduce this miracle to the world.

David Sarnoff had a great interest in TV and the development of a viable system. He soon got word about this young upstart and his creation of a TV system, which was much better than an antiquated system that Sarnoff and his engineers were trying to develop. Soon the head engineer from RCA and even Sarnoff went to San Francisco to meet Farnsworth and to see this unbelievable invention. They were well received and they were shown everything and even shown how the tubes were constructed and coated! They rushed back to the RCA labs and quickly reproduced what they had been shown at Green Street, by Farnsworth and his team.

Now RCA raced to catch up to this upstart and to make the invention of a true TV system their own. Much of the book is devoted to the maneuvering of RCA and Sarnoff to claim the invention of TV and to try and convince the courts of prior invention. The book reads like a spy thriller, as the giant corporation tries to destroy the tiny Farnsworth Company. In one wonderful chapter dealing with a court fight where RCA was try to show that it was impossible for a hick like Farnsworth to create such a complex system the Farnsworth team had Philo's high school science teacher as a witness. As he was being grilled he told how the young Philo had drawn out on the black board a complete TV system for him and then how he tried to explain this all to his teacher. The teacher was very amazed although he did not understand much of what Philo had drawn out. His teacher was so impressed by his young student that he made a copy as best he could from the drawing on the black board and saved it. Years later here was this high school teacher from a small Midwestern town standing in front of the corporate lawyers from RCA. He pulled an old tattered piece of paper from his pocket that was the drawing he made of Philo's black board diagram of the invention of TV made long before RCA could claim any sort of prior idea! Later Sarnoff would claim that Farnsworth was just someone who

worked for him? Sarnoff also claimed to be the telegraph operator who was on duty when the Titanic sank and that he stayed at his post for three days and nights relaying messages that saved many lives. The truth is that he was nowhere near a telegraph during that time.

I was much surprised when I went to several recent reference books about science and invention and I discovered that all these falsehoods were there in these important books! They stated that Sarnoff and his engineer were the inventors of TV and Farnsworth worked for Sarnoff and Sarnoff was at the telegraph key for three days during the Titanic disaster. I never make marks in my good books but my pen was busy on my reference books correcting the recent history of the invention of TV. It is very unfortunate but during the first half of the last century many wonderful inventors were destroyed by or spent much of their lives in court fighting the giant corporations of the day. This awful fight between the lone inventor and the major corporation marred much of the early history of radio and electronics.

The story is sad but Philo T. Farnsworth emerges as a noble and kind and gentle lone inventor and an original thinker. Later in life Philo got to speak with Albert Einstein at length over the telephone and they understood each other and they had great respect for each other. I think at some point Philo felt content and vindicated with his invention but he was disappointed with how TV was being used, he had higher dreams for his invention. This is a very hard book to put down once you are pulled into this amazing story of invention and deceit and intrigue.

Published by: HarperCollins, NY, 2002, ISBN 0-066-21069-0

Philo Taylor Farnsworth 1906 – 1971

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## Book Review: *The Lunar Men: Five Friends Whose Curiosity Changed the World*, by Jenny Uglow

reviewed by Ed Wishart

The subtitle of Jenny Uglow's *Lunar Men* for its English printing is: *The Friends who made the Future*. Other references to them claim they *jump started the industrial revolution*. These phrases convey some of the impact this group of enlightened and optimistic friends had on society. To share their toys, scientific instruments, inventions, ideas, philosophy they formed a society that met each Monday evening nearest the full moon; hence the *Lunar Society*. This was so they could find their way home after a long evening of talking, eating, and drinking. The core group was centered around Birmingham, England, during the years from 1760's to the early 1800's, but they remained in contact with letters when living in different parts of England and the world.

This book tells a lovely story about a group of “renaissance” men and their wives, families, science, religions, explorations, businesses, successes and failures, but most of all about their friendships. Some of the themes that are carried through the book: the ceramic/pottery/porcelain industry that Josiah Wedgwood (1730-1795) and Matthew Boulton, (1728-1809) carried to new heights of perfection, the partnership of James Watt (1736-1819) and Boulton to develop the steam engine using Watt's separate condenser, Joseph Priestley's (1733-1804) investigations of gasses (“airs” in his day) that led to the isolation of oxygen and Antoine Lavoisier's paper that combustion was rapid oxidation, the entrepreneurial building of canals in the Midlands of England, Erasmus Darwin's (1731-1802, father of Charles) work in botany and evolution. The collecting and science that the Lunar Men did (Wedgwood made almost 5,000 recorded experiments in his pottery endeavors) is most impressive and substantiates the respect they earned. Benjamin Franklin was known to all and hero to some and joined their meetings from time to time. The ups and downs of local and world-wide economies as well as politics also played a big role in their lives.

As an example of politics then, as now, Watt's patent in 1769 for his separate condenser for a steam engine was, at William Small's suggestion, was purposely vaguely written so that Watt could later claim rights to almost any type of steam engine. Watt also went to London and successfully lobbied Parliament to extend his patent an additional 25 years so that he and Boulton could enjoy a longer period of income.

Steam engines play a central roll in the book as they should since they created the source of power to take the industrial revolution from water and wind power to coal power. Since they are also a passion of mine, I will summarize Chapter 21 where we learn about the convoluted and difficult road it took for James Watt to build a full sized engine utilizing his separate condenser. The step from his model engines (using medical syringes as cylinders and pistons) to an engine to do useful work was a long and hard one. He set out to add his separate condenser to an existing beam engine near Kinneil where he lived for some time away from his family. He had two children and his wife ran the family instrument shop in Glasgow. Unsuccessful in sealing the piston, tragedy struck from two fronts. First a depression hit in 1772 and the owner of the mine at Kinneil went bankrupt. This allowed Boulton to buy the Kinneil engine and have it shipped to his factory at Soho near Birmingham. Then Watt's wife died in 1773 and he tried to drown his grief in surveying work in Scotland. Boulton had the engine, but not the man and after some time he was able lure Watt to Soho and to finish work on the Kinneil engine. The original cast tin cylinder failed and a new one was cast in iron by John "Iron Mad" Wilkerson. Wilkerson believed iron was the solution to everything and had an iron boat made and well as his coffin. He also had just patented a new boring machine where the boring head rode along a central, stationary shaft to keep it true. From then on, Wilkerson cast all cylinders for the Boulton and Watt partnership. The new cylinder allowed the engine to be finished successfully and after a trial run at a mine it was declared a success. It then received the name, *The Parliament*. It still exists in Birmingham in their science museum and it still runs. Engines were big deals in these days and many received names. Other mine owners had been watching and waiting and when success finally came there was pent-up demand for the new and more efficient pumping engines. The separate condenser and better cylinders made the initial Boulton and Watt engines three times as efficient as Newcomen's engines. Watt and Boulton did not sell their engines, but instead took their profits as a third of the mine owner's fuel savings. Also critical to the success of the engine endeavor was William Murdock, a talented millwright who spent years in Cornwall erecting their engines. The story goes that he was hired by Boulton when he showed up for an interview wearing a hat turned from wood on a lathe of his making. [These early pumping engines grew to huge machines; the Kew Bridge Steam Museum in London has a working Cornish engine with a 90-inch diameter cylinder, the largest in the world. <http://www.kbsm.org>]

Later the pair went on to build rotative engines with Watt's sun and planet gear taking the place of a crank. Surprisingly, Watt never did embrace steam used expansively and it was Trevithick who pioneered the use of high pressure steam in Watt's time.

This is a big book, 40 chapters, 500 pages plus 80+ pages of notes, indexes, and a chronology, so it is difficult to summarize it. Uglow covers an awesome range of technical topics, political issues, human relationships, impacts of world events, financial upheavals. Uglow's depth of research is impressive and I am reminded of Dana Sobel's research into Harrison's work on the first chronometer, in *Longitude* as well as her research in writing *Galileo's Daughter*.

I found the book not an easy read and at times the excursions into the non-technical aspects of society and the Lunar Men's lives distracting. I still highly recommend it as a worthwhile effort for those interested in the history of technology.

Published by: Farrar, Straus and Giroux, 2003. xx + 588 pp., illus., diagrams, maps, abbreviations, sources, notes, chronology, index. \$30 US. ISBN: 0-374-52888-8

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# Book Review: *The Difference Engine, CHARLES BABBAGE and the Quest to Build the First Computer* By Doron Swade

reviewed by John de Marchi

If you have any interest in Charles Babbage and the Difference Engine and Analytical Engine which he designed but was only to build small sections of, then this book is a must read. The author is the Assistant Director and Head of Collections at the science Museum in London, and he also headed the six-year project to construct a Babbage engine from the 19c designs and drawings. The book is in two parts; the first part is about the life and struggles of Charles Babbage and his creations and his life long pursuit of building a complete engine. The second part concerns the modern struggle to build a complete and accurate 19c Babbage Difference Engine No. 2.

There is no doubt that Charles was brilliant and it was apparent from an early age and while in University at Cambridge, it is also clear that he had what today we might call an attitude problem at times. He graduated in 1814 with an “ordinary degree” due to some conflicts while a student. He came from a prosperous family and money was a concern but he was well off by the standards of the day and he was well connected and knew many of the famous scientists of the day. There was a fundamental problem during this period with mathematical tables used for navigation and insurance purposes and such; they contained mistakes that could have terrible consequences. Human computers (people who did the mathematical calculations by hand) were prone to making errors and finding those errors took more time than creating the tables. Many correction sheets were issued which only added to the confusion. It was felt that if a mechanical method could be devised to generate these tables it would reduce the cost tremendously and the machine would not produce errors. By 1822 Babbage had a small working model of his first design!

The mechanical device or computer that Babbage conceived is so complicated and interwoven that it has taken scholars and mechanical engineers years to sort it out and to try and understand just how it all worked. Babbage had all that complex information and understanding in his head and even though many very precise drawings of the engine and its parts were made, there was much that was not disclosed. The Difference Engine would not only generate the tables automatically once programmed but in the complete plan it would also print out the pages or produce the matrix for the printing presses of the day. This whole device was conceived without a piece of hardware being created until after Babbage had the whole idea in hand or more accurately in his head!

The making of the Difference Engine taxed the ability of the machines and technology of the era. The famous engineer Joseph Clement (1779-1844) who had worked for Maudslay and eventually left to set up his own works in 1817 was responsible for much of the early and very outstanding work on the Engine. One of the little known but very important effects of work on the Engines was that it necessitated the creation of new machine tools and process to try and achieve the necessary accuracy for the thousands of parts that needed to be made. Joseph Clement worked on the Difference Engine for a number of years but in the end he and Babbage parted after a major dispute regarding money and also charges of deceit.

Babbage with the help of friends in high places was able to secure a sum of money from the British government for the development of the Difference Engine to be used to generate a variety of tables for use by the government. This government grant became a major source of distress over the years for Babbage and in the end after the great expenditures a functional Engine was never realized. During the many years of development and the production of various parts of the Engines, Babbage kept redesigning the Engine and the various parts and the functions it could perform. The Engine was always a work in process and that is part of the reason that after more than a hundred years it took years to figure out what Babbage had designed and how it functioned.

The book is well researched, no easy task since Babbage produced many thousands of pages of writings both published and unpublished. There are also many sheets of drawings and a variety of collections all over the world that needed to be reviewed. There are also a number of Babbage myths and some modern rewriting of history that are dealt with in the book and the truth is exposed in the process. If you have ever had any interest in Babbage and his Engines, this book is a must read. Charles Babbage emerges as a brilliant and complex character and I think in the end also a tragic character who had no direct influence on the development of the electronic computer. He represented the mechanical genius of the 19c with a complex and amazing mechanical marvel that was a technological dead end and did not become a complete functional machine until the end of the 20<sup>th</sup> century. The Difference Engine and the Analytical Engine were technological breakthroughs that never lived up to their great potential for a great variety of reasons. A complete Engine was never realized, only portions were built which were mostly used to amaze and amuse the upper class in the drawing rooms of 19<sup>th</sup> century London. In the end it seems that the greatest lasting influence Babbage and his Engines had was in the area of machine tool design and processes. The Engines pieces and parts were to become mechanical curiosities on display in museums for many decades, but thanks to the efforts of some decanted people there was renewed interest in Babbage and his work and finally an Engine was built and to Babbage's credit it does function as advertised.

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## Book Review: *To Conquer the Air, The Wright Brothers and the Great Race for Flight*, by James Tobin

reviewed by Robert W. Piwarzyk

*In addition to being the Chapter's expert on bricks and related industries, Bob's career was in flight test engineering. This article which includes information from Tobin's book, is in recognition of the 100<sup>th</sup> anniversary of the Wright brothers' flight. JM*

Of all the discoveries and inventions of mankind, only four come to mind as being the most significant: fire making, floating a heavier-than-water boat, the wheel, and flight. There are many other useful ones, but I feel that flight is the most significant of all.

A century ago, on December 17, 1903, two brothers conquered the air. But was it really the first flight, or for that matter their first flight? Surely birds and insects, as well as pterodactyls, and several gliding animals flew first and inspired men to do the same. This October marked two hundred and twenty years ago that men first flew --- in a balloon. However, like with recent rocket flights with apes, dogs, and mice the first into space, the first into the atmosphere were also passengers: a sheep, a rooster and a duck. It was a big step for men to board, untether the balloon from the ground, and float away in free-flight. Altitude was controlled up and down with heat and ballast, and direction was at the mercy of the winds; but it was flight. These gas-filled, lighter-than-air craft created lift from buoyancy, ruling the skies, and evolving into powered airships --- dirigibles and blimps.

So, what exactly was this flight 100 years ago? It was the first untethered, piloted, controlled, powered, sustained, fixed-wing, heavier-than-air craft to fly successfully. Tethered, unpowered, manned and unmanned flights had already been made. In fact, the brothers had used this method to develop and confirm the lift and controllability of their kite-like craft their first year at Kitty Hawk. The very first man to fly may have been one on a kite in ancient China.

Gliders were unpowered airplanes. Many were flown in the race to be first, and many an aspiring pilot lost his life. "Fixed-wing" differentiated the craft from those that flapped their wings. Many fearless adventurers died jumping off of cliffs, buildings and the Eiffel Tower; flapping their wings all the way to the ground!

This concept goes all the way back to Leonardo de Vinci. Lacking modern, strong, lightweight materials only his models flew. But emulating the birds was a popular approach and observing them gave the Wrights many answers. Man-powered flights have now been achieved using bicycle-like propeller-driven, fixed-wing craft. Not so long ago a robot, remote-controlled, wing-flapping pterodactyl actually flew --- an awesome sight. More recently a man glided across the English Channel using strap-on wings, which are becoming popular with skydivers. And a model airplane was flown across the Atlantic Ocean, taking only a few more hours than Lindberg.

I prefer to say “the Wrights’ first flight.” Both Orville and Wilbur flew that day, and one also crashed, but the craft was repaired and a total of four flights were made. As they were an amazing team, they should have equal recognition. (When twins are born it doesn’t matter who was born first.) Also, the important role their sister, Katharine, played must be recognized. In addition to being the “mother” of the family she was supportive in many other ways. She bolstered her brothers when they were down and celebrated their successes; always encouraging them on. They were all very close. In fact, the three had made a sibling pact to not marry until they had flown! It was she who held down the shop at home while “the boys” were off doing their thing in Kitty Hawk. It was she who sewed the skin for “The Flyer” out of French sateen. (The plane’s name was given some time after the first flight.) And when sateen proved to hamper the desired wing-bending, used to control the craft, she recommended muslin and set about sewing the skin again. Later, she was one of the first woman passengers to fly.

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## Book Review: *Railway Car Construction* by William Voss

Reviewed by Jay McCauley

This book is a time machine. It takes you back to 1892 for a definitive discussion of how railway cars of all different types were constructed at the time. Subtitled: *A work Describing in Detail and Illustrating with Scale-drawings the Different Varieties of American Cars as now Built*, the book is packed with detailed drawings and descriptions of car building practices.

The 1890s were the peak of wooden rail car construction. By the early 1900s, steel cars had begun to enter service, and by teens, wooden rail cars were being recycled as railroad buildings.

This book was purchased as part of working on aspects of the Allensworth car reconstruction at the California State Railroad Museum, mentioned above. I wanted to see how cars were constructed so I could understand what was going on in the reconstruction effort. The book has information on wooden freight cars that are very similar to the Allensworth cars. The first fourteen (of twenty six) chapters are devoted to freight cars, with passenger cars covered in the remaining twelve chapters. Every aspect from the roof to the trucks is covered in detail, with line drawings supporting the prose.

If you are at all interested in railroading in the 1890s this book offers a fascinating insight into the practices of the day.

Originally published by R.M. Van Arsdale, New York, 1892, republished by the Orange Empire Railway Museum, 1999, ISBN: 0-933562-24-8. Available at the California State Railroad Museum.



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## Contact Information

### **President**

Anthony Meadow  
30 Pine Hills Court, Oakland, CA 94611  
Home: 510 531 3416, Work: 510 834 5387  
Email: tmeadow@sbcglobal.net

### **Secretary/Treasurer** – Memberships, Newsletter Editor, Webmaster

Jay McCauley  
1350 Vance Drive, San Jose, CA 95132  
Home: 408 926 2312  
Email: mccauley3@sbcglobal.net