MILLWORK

Fall/Winter, 2002 Copyright ©2002 Hanford Mills Museum Vol. 16 - No. 2

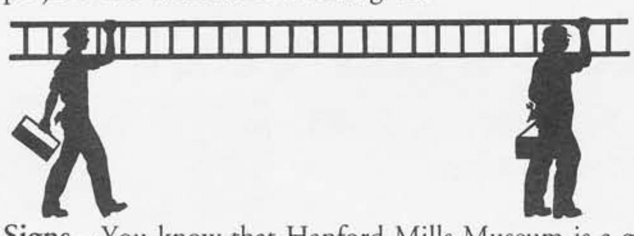
What's News?

State of the Arts
NYSCA

Museum Grants - At the end of last year, the New York State Council on the Arts, or NYSCA, awarded Hanford Mills Museum $5,400 for a collections project in 2002. Caroline de Marrais, the museum's curator, and Angela Gaffney of the Delaware County Historical Association have been working all summer on that project. The money was given to the museum to study our agricultural equipment and hand tool collections. The items have been identified and located. They will now be evaluated, researched and cataloged or deaccessioned as needed.

For 2003, the museum has requested funding from NYSCA for three new projects: another collections project that will take a close look at items acquired in the 1982 purchase of the O.D. Greene Mill in Adams, New York; a comprehensive site preservation and maintenance plan; and an interpretation plan for the new steam installation. We will know by the beginning of the year if these 2003 project were funded.

Grants, like the NYSCA grants, are very important to museums. Admissions, memberships and gift shop sales come nowhere close to paying for the operation of a museum. Federal, state, corporate and local foundation grants make up the difference (as well as donations from friends like you). The O'Connor Foundation is one of our most important funding sources. Besides the steam project, the O'Connor Foundation will be funding much of the museum's 2003 general operations. The Dewar Foundation, centered in Oneonta, New York has also donated $5,000 to projects the museum is working on.



Highway Signs - You know that Hanford Mills Museum is a great place to visit, but not everybody knows that. Of course, we realize that we are not very easy to find, especially if you are not from the area. To start addressing this problem the museum's board of trustees formed a marketing and promotions committee, chaired by Tom Mirabito. That new committee has already had its first success. Through their efforts, funding was secured from Senator John Bonacic to install signs to the museum at both exits 15 and 16 on the I-88 freeway. Further signage will be installed on county highways directing visitors to the museum. Because the government funding will not cover the whole cost, the O'Connor Foundation has elected to make up the difference. We plan to have the signs in place by the time the museum opens in May, 2003.

Hanford Mills Museum would like to thank the following people for donating artifacts and documents to the Museum's historic collections in 2002.

Kristina Abell
Cindy Anderson
Elizabeth Botting
Joi Brunelege
Charles & Christine Consler
Everett A. Gilmour
Marvin & Kay Glass
Robert Grassi
Jennifer Green
Norman Haines
George Hansen
Grace Kent
Alyce Roberts
James A. Rosiecki
Manly Shults
Thomas & Susan Sikes

In This Issue:

Director's Notes

As we look toward 2003 and consider the past year, I am proud to report that efforts to preserve our unique Mill complex and present its rich, multifaceted rural-industrial history are flourishing.

In 2002, Hanford Mills Museum offered an extensive schedule of public and school programs, and welcomed the largest number of visitors in more than five years - about 8,000 adults and children! The Museum's membership enrollment also continues to grow. There are presently more than 760 people on our active membership roles.

Outstanding special events, including old favorites like the Winter Ice Harvest, the Antique Engine Jamboree and the Sawyer's Holiday Lumberjack Festival were well attended this year. But it was not just these events that helped our visitation to grow more than 15% in the past year. Daily visitors and participants in more than a dozen intimate workshops designed to introduce audiences to a variety of traditional activities grew handsomely this year. More than 1,500 school children participated in our winter, spring and fall hands-on educational programs, and the Museum's week-long Summer Apprentice Workshop (SAW day camp) was oversubscribed.

The Museum's growing visitation and successful programming efforts can be attributed to the enthusiastic support of our members, volunteers and friends. And conversely, the Museum's growing membership enrollment means that we are offering programs and visitor experiences that people are glad to invest in and support by becoming members or renewing their membership! The number of people who invest in a membership in the museum is just as important as the number of people who visit the site.

We are not sitting back and resting on our laurels as our membership and visitation grow. The feedback from the Member Survey that we included in the Fall 2001 newsletter points to many areas that need improvement - and we are steadily working to respond to your concerns. We are eager to hear the constructive criticism, as well as the compliments, of our members and our visitors. And with your feedback and support we can work together to improve the Museum's efforts to interpret "history at work."

During our 30th anniversary celebration in 2003 the Museum will continue to host lively and interactive programs that bring history to life, and will continue to offer a variety of substantive workshops for adults, children and families.

Liz Callahan

Fighting Cabin Fever?
Come to Hanford Mills Museum's

Winter Ice Harvest

Saturday, February 1, 2003
10 am to 4 pm

~ Cut a block of ice from the pond using an ice saw

~ Take a ride on a horse or oxen drawn bobsled

~ Watch the mule-drawn ice plow on the frozen pond

Fro more information, call 1-800-295-4992 or visit www.hanfordmills.org or e-mail hanford1@hanfordmills.org

There's warm fun too!

~ Great hot soup & foods
~ Videos of historic ice harvsting

Full Steam Ahead

For a few years now, you have been reading about the museum's projected steam boiler and engine restoration. We know you have heard us say the project is moving forward, but this time it is really happening! The museum's board and staff have worked diligently on planning this project and when the museum opens in May you will see the fruits of their labor.

In 1881, as the Hanfords began to expand their mill business, they installed their first steam engine. Kortright Creek could power a seasonal sawmill, but it just did not have the necessary water supply for year round operations. The Hanfords first installed a small vertical steam engine in the basement of their mill. By 1892, they had installed another vertical engine to help the first, but by 1895 they needed more power. In that year, the Hanfords purchased and installed a larger boiler (rated for 100 pounds pressure) and a 30 or 40 horsepower Oneida steam engine. This engine was large enough to power the sawmill or gristmill. By the late 1920s, the boiler had begun to wear out and their pressure rating was reduced to 87 pounds. By the 1930s or 40s the Hanfords stopped using the engines and boiler, and they were eventually scrapped.

Today there is little evidence of their existence. However, the museum is lucky to have such an extensive original site and a well-maintained archives. We had enough evidence to consider the restoration of steam to the mill. Much work has been done since that initial decision. You may have read about some of our efforts in past *Millwork* articles. A thorough search of the museum archives turned up information that provided the engine name - Oneida; a photograph of the boiler's delivery providing us with the proper design for the manufacture of a copy; and the boiler company's plans which provided the information for recreating the brickwork. We have excavated the old boiler room, uncovering the boiler's "footprint" which matches the plans. This project also exposed a few courses of the remaining walls to show us brick laying patterns and what the iron tie-bars ought to look like.

Top: Jeremy Cozzens volunteered to pick bricks at the old D& H roundhouse You wouldn't think a volunteer could look so happy doing that. Middle: Site committee chairman Matt Kent poses by a pallet of bricks ready to go to Hanford Mills. Bottom: Board president Gordon Roberts stands at the base of the roundhouse boiler stack with more bricks picked for Hanford Mills.

Staff and board members have explored other steam power sites, talked to experts, scoured the countryside for a replacement engine and even taken steam operation workshops. The museum staff found a vertical steam engine similar to the Hanford's first engine. That machine now sits where the original sat in the mill basement.

The museum's site committee has been especially busy working this summer with a steam engineer, putting the finishing touches on a restoration plan that a contractor could use to recreate the mill's steam powered system. Not only did the site committee work with paper and plans, they also got their hands dirty. The boiler installation needed approximately 18,000 bricks and Wayne Treffeisen offered brick from the roundhouse boiler that stood in the historic rail yards of Oneonta, New York. All we had to do was pick them up - one at a time. So board members Matt Kent, Gordie Roberts, Jim Ferrari, Ken Kellerhouse, Jerry Pellegrino and family and friends spent many a damp weekend morning in September and October picking bricks. The bricks are now neatly stacked on the museum site.

In October, the site committee contracted with Steve Seitz and the Briarwood Company of Otego,

Con't. on page 4

Steam - con't. from page 3

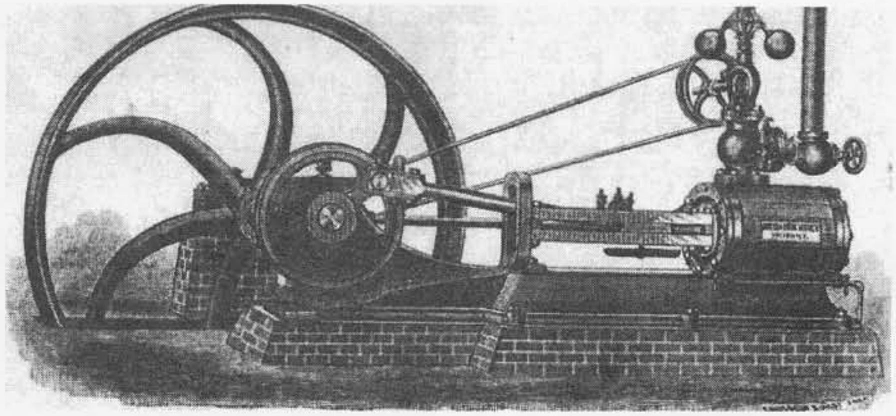
New York, and even as you read this newsletter, bricks are being laid for the boiler. Both Matt Kent, the site committee chairman, and Robert Grassi, mill foreman, have been spending many hours on all aspects of this project to make sure that it proceeds smoothly. Much of the funding has come from the O'Connor Foundation, a family foundation based in Hobart, New York, the Robinson-Broadhurst Foundation of Stamford, New York, and from members like you.

This winter, Briarwood will lay enough bricks so the boiler (built by Troy Boiler Works of Troy, New York) can be set in place, hopefully in January. The brickwork will be fitted with iron castings based on the archive's historic boiler plan. George Haynes of Bloomville, New York will make these castings from patterns produced by Matt Kent and Robert Grassi. By spring the boiler should be completed and a smoke stack in place.

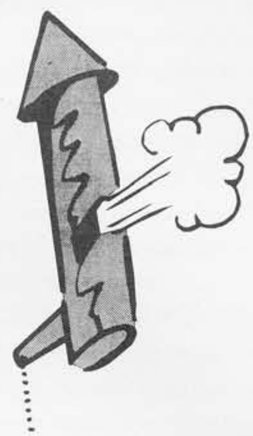
Hanford Mills Museum needs only two more things to complete this project. First, and foremost, we need the proper steam engine. We need a horizontal steam engine with 30 to 40 horsepower that will fit on the original, existing engine piers. We prefer an Oneida engine, but know that such an engine will be difficult to find. If you know of a likely engine or someone who can help us, please give us a call.

Hanford Mills Museum also needs further funding to complete this very ambitious project. We have enough to complete the boiler installation, but still need funding to do any restoration work that may be necessary on the engine and to run steam pipes from the boiler to the engines. Once we have found the proper engine and have the funds to finish the project, the museum will be able to operate under the power of live steam.

Thank you to everyone who has made this project possible. We continue to work on the boiler, the engine and funding in the hopes that East Meredith will soon hear the call of the mill steam whistle again.



This is an illustration of the type of Oneida steam engine the Hanfords installed in the mill in 1895. If you know of anyone who could help the museum in locating another or similar engine, please let us know.



Museum board members and staff stand ready to help as the steam project gets under way. L. to R.: Robert Grassi, Jerry Pellegrino, Ken Kellerhouse, Caroline de Marrais, Grace Kent, Dick Meyer, Liz Callahan, Steve Seitz of the Briarwood Company, and Matt Kent. Photograph curtesy of Gordon Roberts.

"Water is Nice Power, But it is Not Cheap" -

The Cost of Water Power - by Caroline de Marrais

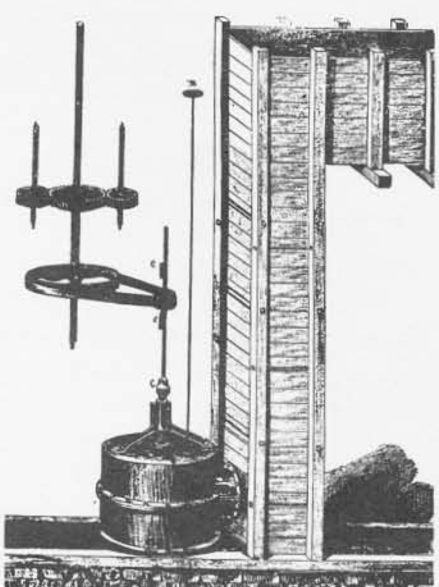
This year Hanford Mills Museum has been challenged by the realities of trying to install a historic steam power system in a modern world of regulations and high expenses. Some might wonder why we want to restore an expensive steam system when we have all the free water power we could want. Many visitors come to the museum thinking that we run the mill on a good, cheap power source. However, expenses are hidden in the use of water power and they are not cheap. Gerald Greene of the O.D. Greene Lumber Company of Adams, New York once said, "It's something people don't think about associated with water power. They see the water flowing and think that's all there is to it. You get a wheel there and its turning. Water is nice power, but it is not cheap."

What *are* the costs of water power? The obvious place to start would be the waterwheel, itself. It is likely that Jonathan Parris, the first owner of Hanford Mills, built his own waterwheel in 1846. That doesn't sound like it would cost much, does it? All he would need were a few boards and a bit of metal, but there is more to it than that. The builder had to consider what type of wood he would use. Oak was good for waterwheels and pine was thought acceptable. Some considered cypress the best wood, but in the Northeast it was a very expensive wood to obtain. No matter what type of wood he used, almost every part of it (except, maybe the main shaft) probably had to be replaced in five to ten years because of the wear caused by the operation and the impact of the water on the wheel. Besides the cost of the wood, the following had to be considered: the time spent building the wheel, the skills that he had to have or hire, and the tools he needed. A waterwheel was not something banged together in an afternoon.

PRICE LIST
--OF THE--
Gibbs Turbine Water Wheel,
AS REDUCED JULY 1st, 1876.

12 INCH WHEEL.	
No. 1	$40
" 2	45
" 3	50
" 4	55
" 5	60
18 INCH WHEEL.	
No. 1	$80
" 2	85
" 3	90
" 4	95
" 5	100
24 INCH WHEEL.	
No. 1	$135
" 2	145
" 3	155
" 4	165×
" 5	175
30 INCH WHEEL.	
No. 1	$225
" 2	240
" 3	255
" 4	270
" 5	285
36 INCH WHEEL.	
No. 1	$350
" 2	365
" 3	380
" 4	395
" 5	410

This price list comes from the White Turbine Company of Delhi, NY. They sold the Gibb turbine the Hanfords purchased in 1884. Note the small "X" likely put there by D.J. Hanford, marking his turbine choice.



This illustration from an 1869 Leffel catalog shows a wooden flume bringing water down to a turbine, which in turn operates shafting, gears, belts and pulleys.

The other choice was to buy a waterwheel. When the Hanfords built their first addition to the mill in 1868/69, they chose to purchase a water turbine to run the new gristmilling equipment. Deciphering what they paid is impossible since they were buying other metal parts for the gristmill from the same manufacturer. Although we do not know what the Hanfords spent, we do have prices from the time period. James Leffel & Company was (and still is) a well-known manufacturer of quality water turbines. Their 1868 prices ranged from $275 for a small turbine to $1,500 for their largest turbine. These prices were higher than local manufacturers', the Hanfords purchased a 24-inch turbine in 1884 for $165 (though it is likely by the 1880s that turbine and construction technology had improved causing prices to go down).

Even if we compare the cost of the cheapest wheel to what an average millworker was making at the time, it would have taken over half a year to pay for a turbine. Despite the cost, by 1900, the Hanfords had three turbines of various sizes operating in their mill.

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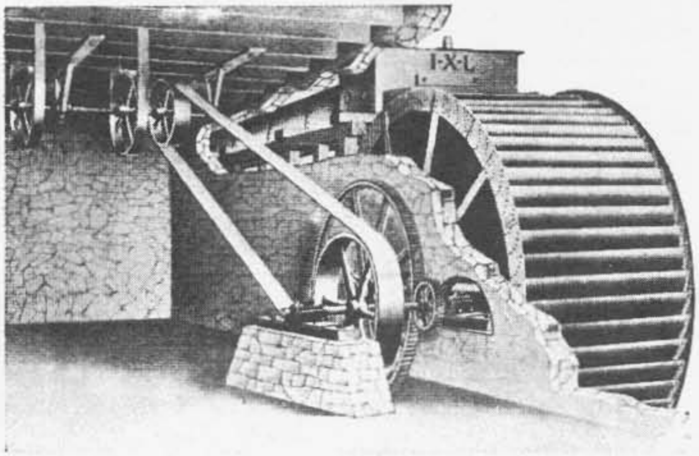
Not Cheap - con't. from Page 5

Unfortunately, metal waterwheels or turbines also wear out. In 1917, the Hanfords wrote the Leffel company looking for two used turbines that would replace their aging wheels. Leffel wrote back, quoting a price of $600 for a pair of new turbines, as they had no used ones to sell. The Hanfords decided to limp along, repairing their old turbines.

Instead, the Hanfords decided to purchase the museum's present overshot waterwheel from the Fitz Water Wheel Company of Hanover, Pennsylvania in 1925. The Hanfords were quoted a price of $1,706 less 3% for winter purchase. That brought the cost down to $1,654.91. Even for Merritt Barnes, making the highest salary as the mill's bookkeeper, it would have taken him more than two years to pay the cost of this water wheel. Of course, none of the expenses mentioned here include the cost of installation.

These prices also do not include the cost of maintenance and replacement. Throughout the 1890s and into the 1900s, the Hanfords were paying for turbine repairs every few years. The costs are hidden in the mountain of Hanford business papers. We do know that they relied almost exclusively on N.L. Greene of Edmeston, New York (see "'All Well as Usual' - N.L. Green at Hanford Mills" in Fall, 1996 edition of *Millwork*, vol. 10, no.2). Mr. Greene not only made and repaired turbines, but also sold gristmill equipment. He even helped the Hanfords with their steam engine installation.

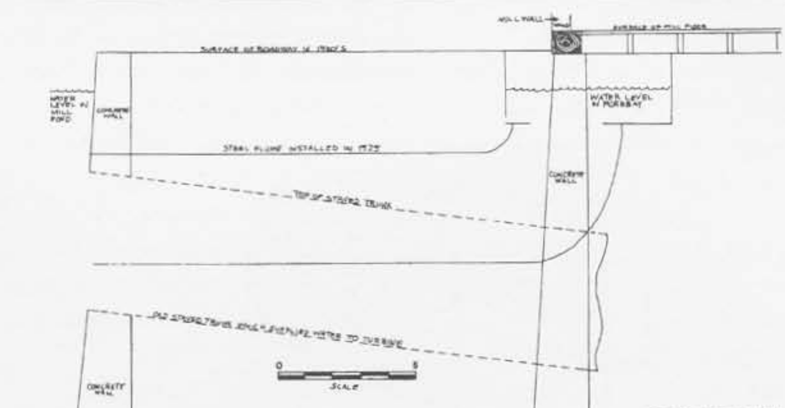


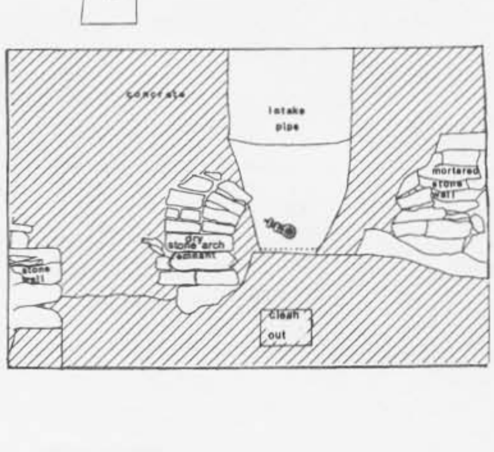
SPUR MASTER WHEEL ON END OF WATER WHEEL SHAFT

This illustration from the Fitz Waterwheel catalog shows the basic waterwheel set-up the Hanfords ordered for their mill.

By 1984, when the museum began to seriously consider operating the mill again, the last Fitz waterwheel was in sad shape. Mill owners had not maintained it since the 1930s or 40s. The wheel needed a complete overhaul. The outer buckets had to be replaced, the original axle and spokes restored to running condition, and the whole coated with a rust retarding paint. The wheel that cost the Hanfords nearly $1,700 to purchase, cost a little more than $31,000 to restore. While Hanford Mills Museum does not operate the wheel nearly as much as the Hanfords did, we still have maintenance expenses. The Museum has replaced the wheel supports and will soon have to repaint the wheel.

Once the water wheel was in place, the total bill was still not complete. Water had to get from the source (usually a creek and/or pond) to the waterwheel – and it needed a way to be diverted from the mill once it had been used. The system for bringing water to the mill changed over time. Unfortunately, we do not know what it cost, but we can imagine the expense when the work is described. The first flume we have evidence for was probably built to carry water to an early mill waterwheel. A dry laid stone arch was built over a wood-staved pipe.





Drawings from archeological excavations show evidence of the mill's early water power delivery systems. The top drawing shows the wood staved flume's location and the bottom shows what remained of the masonry arch.

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Not Cheap - con't. from Page 6

This work required excavating below ground level by hand (remember, there were no backhoes in the mid-1800s) and, of course, required a knowledgeable mason to do the arch work. The wooden pipe also required special skills to build.

When the Hanfords installed the Fitz water wheel in 1926, they installed a metal pipe flume covered in cement. This was not included in the purchase price of the wheel, and again, the hole was dug by hand and almost all evidence of earlier systems removed before they installed the new flume. By the time the museum opened as an operational mill, the metal flume showed signs of deterioration so they inserted another metal pipe into the original flume as a sleeve in the 1980s. Finally, in 1993 during dam restoration (see below), we uncovered the 1926 flume one more time and replaced it. The cost of that work will be mentioned below when we deal with water impoundment systems.

As the water went over the wheel, it could not be left to lay on the ground. It had to be diverted away from the building and back into a stream. This was called a tail race. The first mill owners probably had a short, hand dug tail race, but over the years the Hanfords dug their tail race longer. This was most likely to keep the Kortright Creek from backing up into the mill during periods of high water. Again this meant there was the expense of hand digging. They also lined the area closest to the mill with dry laid stone. This was a job for a mason who knew what he was doing since there is an art to laying up stone to minimize the effect of frost heaves. Even with a well-laid stone wall, the museum had to have the work done again in the early 1990s. And since the mill has essentially been sitting in water since it was first built in 1846, the supporting wooden posts also had to be replaced during mill restorations in the 1970s.

In 1993, we could use a backhoe to remove dirt from around the dam and to install the new flume pipe. The work was begun during the Winter, so the project would be completed by Spring. The museum hopes to have the pond dredged before its May opening in 2003.

As is the case at most sites, Hanford Mills needed a water impoundment system. This usually consisted of a pond held in place by a dam, plus in the case of Hanford Mills, a head race (basically a stream) to bring water from the creek to the pond. The builder of the mill had to dig out a pond and head race by hand, though he may have also used horses or oxen. Anyone familiar with the rocky soil in the East Meredith area can guess what a tremendous undertaking that would have been.

Besides a pond, they also built a stone dam to hold the water in place. Again, we do not know what this would have cost; the records no longer exist, if they ever did, that show the expense of this work. Over time, the pond and dam were patched with cement, but in 1993 the dam had become so leaky that the museum had to replace it. Unfortunately, in this modern world of government regulation, replacing the dam was no longer feasible. Instead, the museum had a new dam built in front of the old. It reduced the total amount of water available for use, but it was a small amount and the museum does not run full-time like the business did. The cost for emptying the pond, building a new dam and restoring the water wheel's forebay came to a total of nearly $59,000.

A hidden cost related to millpond maintenance is silt removal. As water enters the pond, it carries silt that settles. Over time the silt build-up reduces the depth of the pond. It is difficult to say how often a pond must be dredged – it depends on the amount of heavy rain received each year. The amount of silt in a pond can be monitored by testing the water depth. The Hanfords certainly had to dredge their pond from time to time. Again mill records are silent on the cost, but when the museum did it in 1978 (an admittedly large job since it had not been done in years and the Pizzas had been trying to fill the pond) it cost nearly $10,000. Since 1978, the pond has become approximately

Con't. on Page 16

Hanford Mills Museum Welcomes New Staff Member

In August of last summer, the museum's educator/gift shop manager, Sara Sikes, left to continue her education. Since the present staff could handle fall school groups in the interim, we had time to consider what we wanted in a new educator.

Unfortunately, the museum could not afford a full-time educator. That is why Sara was also our gift shop manager. Still, we wanted someone who wouldn't be sidetracked by other, unrelated jobs. The Delaware County Historical Association (DCHA) had the same problem, so we decided to try a unique approach and share an educator and programming coordinator. This approach allowed us to offer a competitive salary that one or the other organizations could probably not offer on their own. The new educator will spend 60% of their time at Hanford Mills Museum and 40% at DCHA, which is in Delhi, New York, not far away from East Meredith.

In September, Hanford Mills Museum and DCHA advertised for a shared position. We were looking for someone with either an education or museum education background or, preferably, both. We were surprised at the response we received - more than 70 applications from across the United States, as far away as California and Arizona! It took some time for the staffs at both museums to sort through all the applications. In November, we brought in four of the top applicants to interview. Each applicant toured both sites and met with their directors and staff.

In the first week in December a choice was made and we would like to introduce you to the new Education and Programming Coordinator for Hanford Mills Museum and the Delaware County Historical Association. His name is Tim Duerden. Some of you may already know Tim - especially if you visited Hanford Mills Museum between 1990 and 1992. He actually worked as a tour guide in the mill for a few summers.

Tim was born in England, but has spent much of his life in the United States. When he came to Hanford Mills, he had a bachelor's in history from the State University of New York (SUNY) at Plattsburgh. After his experience here at the mill, he went on to work on a master's in history from Temple University in Philadelphia, Pennsylvania. Once he received his degree, Tim returned to the area, first to work as editor of the *Delaware County Times* newspaper, and later as an adjunct instructor at the SUNY Morrisville, Norwich Campus.

Tim has ties to Delaware County. His wife, Xina's family lives in the area, and together they have two children, Cedric who is 5 and Stella who is 3. They live in Franklin, New York which is situated nicely for working both at Hanford Mills and DCHA.

Tim will be starting his new job in the beginning of January. He has many good ideas and is looking forward to coming back to Hanford Mills and working in the museum field. So if you come to Hanford Mills Museum's Winter Ice Harvest be sure to stop and welcome him to the staff. Tim will also be looking for judges to help out with History Day (a history version of science fair for junior high and high school kids), so let him know if you can help.

Each year the museum has events where people bring in homemade foods. And each year everyone remarks on what great cooks you folks are. Invariably the next sentence is: "Hanford Mills Museum ought to make a cookbook." Well, we've listened to you and now we want your help. To produce the "Friends of Hanford Mills Museum Cookbook" we need your favorite recipes. Don't be afraid to send us more than one. We are looking for all types - main dishes, side dishes, desserts, vegetables, breads, etc. Along with each recipe, please tell us the story behind it - you got it from your grandmother, you made it up, when you go to potlucks people ask for it - tell us why your recipes are special. Please neatly type or write up your recipes with their stories and send them to Louise Storey at Hanford Mills Museum, P.O. Box 99, East Meredith, NY 13757. Don't put this off - do it as soon as you finish reading *Millwork*. We really hope to get this project done, but we can't do it without you!

Thanks for Your Input

The staff at Hanford Mills Museum would like to thank everyone who responded to last year's "Museum Survey." We were very interested in what you had to say, and we thought you would also like to know what fellow members felt. Here are a few highlights.

Forty-two people answered the survey. We found out that most people visited the museum about two to four times a year, and they visited for special events or with out-of-town guests.

We asked what people thought of the museum's web site. Only about half of those who responded answered this question and a third of those people had no computer access. Most people liked the web site, but a few found problems. Some pointed out that we had not included the museum's web address in either the survey or the newsletter. We are sorry about that, and if you check the last page of this issue, you will find it listed in the lower right corner with the museum's ground mail address. We are now making a conscious effort to put the web address and/or related e-mail addresses on most of the museum's publications. Thank you for pointing that out.

Also thank you to the person who noticed that the calendar of events on the web site was out of date. We fixed it as fast as we could. When we complete plans for the 2003 calender, we will make sure it gets on the Internet right away. People also wanted more information and illustrations on the site. We hope to expand the web site in the future and will let you know when we do.

We asked people to rate the importance of various membership benefits. Most people thought that free admission and the museum's newsletter and publications were the most important benefits of being a museum member. We would like to thank all the people who commented so positively on the *Millwork* newsletter - thank you! Evidently, we also missed another very important membership advantage, since nearly 20% of respondents also added that being able to support the museum's work was a very important benefit.

Two people suggested that Hanford Mills Museum work on joint memberships with other museums. You will be glad to know that the museum's board has identified this as a project in its five-year strategic plan. In the future we hope will be able to offer special joint plans with other museums.

We also asked respondents to rate various aspect of their site visits. Thank you for giving us mostly high ratings in exhibits, mill and house tours, accessibility, grounds, gift shop and staff. There is definitely room for us to improve the house tour, which is in its infancy, and the gift shop. Only the staff elicited additional comments. Most were positive, but one person found the staff not friendly. We hope that was an isolated problem, but please let the museum's director (Liz Callahan) or assistant director (Caroline de Marrais) know when you have a bad experience. We would like to solve any concerns before they become big problems.

Where the museum really has some work to do (and thank you to everyone for being so polite) is in the area of food service. We have already taken steps to improve the quality of the food that we offer. We are also exploring other ways of providing food service, such as using local fire departments and other not-for-profit community organizations to provide food for special events. When you experience good food service at the museum, please let us know, so we know when we are doing it right.

Finally, we asked you to rate our special events. It is obvious from the answers that your favorite events are the Winter Ice Harvest, Antique Engine Jamboree and the Sawyer's Holiday Lumberjack Show. Most of the other events had more good ratings than outstanding ratings. That means we have to work to make them better. A few people even found the other events to be fair or poor. At least one person missed the events that featured draft horses. We miss them too, but unfortunately, the draft horse club that made these events possible has disbanded. This makes it much more difficult to schedule events with multiple teams of horses.

One of the great points that this survey showed us is that both you and us, the museum staff, have identified many of the same problem areas. We hope that in the next few years we can address all your concerns and make your visit to Hanford Mills Museum an even better experience. And please continue to let us know what you think. We want to hear when we are doing something right and we also want to hear when we are doing something wrong. Thanks for letting us know.

Water as a Power Source

The Development and Use of the Waterwheel - by Robert Grassi

Many of us today take water for granted as a potential power source. It is common knowledge that early industries such as flour/gristmills, sawmills, iron works (foundries and forges), oil (linseed) and fulling mills relied on water power for centuries. These industries remained quite small in scale. It was not until the early to mid-19th century that water power developed into a viable power source for driving large factories and heavy industry.

An early Greek style waterwheel powering a gristmill. *Illustration from Stronger than a Hundred Men by Terry S. Reynolds.*

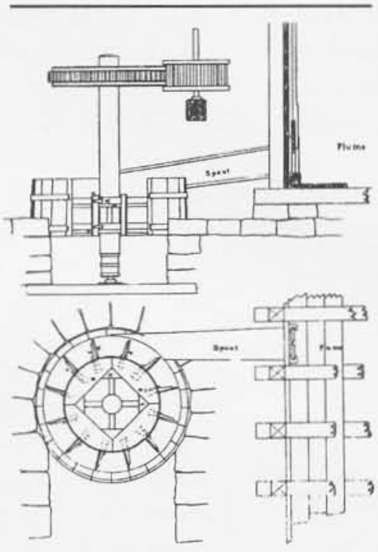
Water power was and is not without its limitations, but it did prove itself invaluable as a power source and contributed heavily to the growth of the Industrial Revolution. Only in the late 19th century would steam power seriously challenge water power as the prime mover in industry. Today, water power continues to be used in hydroelectric plants providing electrical power to many homes and industries throughout the world.

Early Waterwheels

The earliest use of water as a power source dates back more than two thousand years. The oldest known references to water wheels date from the third century B.C. in Byzantium (formerly Constantinople, now Istanbul). These vertical wheels were not designed for producing power but were more than likely utilized to hoist water for irrigation purposes.

Around 85 B.C. the Greeks were documenting the use of water power to drive their millstones to grind grain into flour. Not long after the Greeks, around 11 B.C., the Roman architect Marcus Vitruvius documented the use of water power in grinding grain as well.

Before and during this time period, except in urban areas, the production of flour was largely a domestic industry left up to the individual household. Manual labor was the accepted power source. Grinding grain by hand was laborious, hard work. Due to spoilage, flour had to be ground often and in small quantities. Large commercial bakeries in urban areas often operated mills as an integral part of their business providing their own bread flour for baking.



The tub wheel.

Many utilized animal power (and slave power as in the Roman Empire) to drive their millstones, but the application of water power was to ultimately change the industry forever. Water power provided a steady power source that never tired, never talked back and did not need to be fed. Water power was here to stay.

The Greek mills were of the simplest design and utilized what many of us today refer to as a Greek or Norse waterwheel for power. These waterwheels had horizontal open carved wooden paddles (floats) mounted onto a wooden vertical shaft. This type of wheel was powered by the force (or impact) of the water striking the paddles as it was released from a spout directed at the wheel. The vertical waterwheel shaft also served as the spindle to drive the top (runner) stone in a working pair of millstones. There was no gearing or belting.

These horizontal wheels were not very powerful but served well on small waterways with a good fall (or head) of water. Most of these mills were very small scale with one waterwheel directly driving one pair of small diameter (thirty-six inch or less) millstones. There were many advantages to these small mills in that they were simple and cost efficient to construct and maintain. Many were built and operated without the use of a mill pond or even a dam or weir.

The Scandinavians adopted the Greek water mill. It was well suited to their rugged terrain and waterways. Their climate was far different from the warm Mediterranean and required a waterwheel that would

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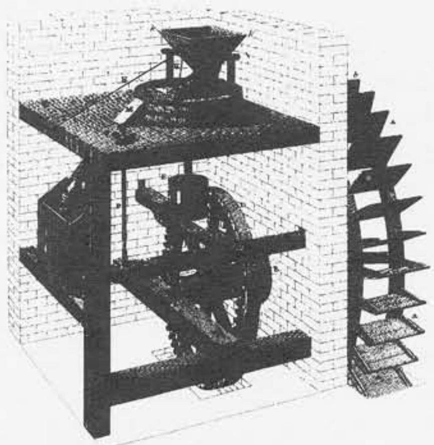
be protected from the damaging effects of winter. The floats were straightened and angled to better shed ice. This type of wheel was eventually enclosed in a vat or case and later became what we refer to as a tub wheel.

The tub wheel use survived well into the 20th century in Europe and Latin America as well as the United States. In this country it was in use in remote areas of the Appalachian Mountains to drive millstones in gristmills not unlike the Greek mills more than two thousand years earlier.



A Roman style vertical waterwheel with gristmill.

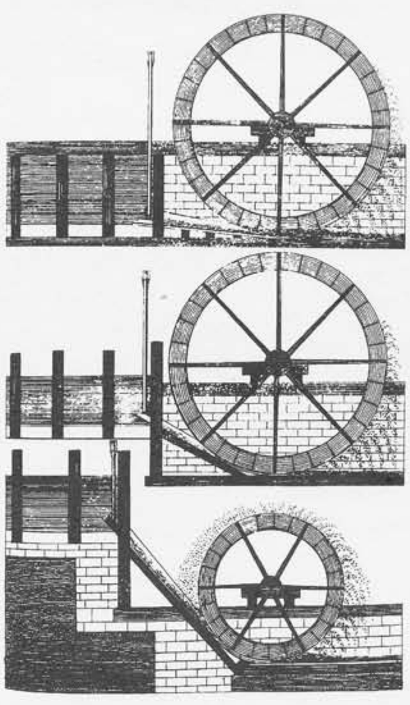
The Vertical Waterwheel

It is difficult to determine exactly when the first vertical waterwheel came into common use. The Romans were using them by 11 B.C. Unlike the horizontal waterwheel of the Greeks, the Roman mill utilized gearing from a horizontal waterwheel shaft to drive a vertical millstone spindle. A large wooden face gear on the waterwheel shaft engaged a much smaller lantern pinion gear driving the millstone spindle. This stepped up the speed of the drive and also produced a mechanical advantage over a direct driven system.

The Greek mill's output was extremely limited. Their small waterwheel with its direct drive limited the size millstones they could operate effectively. Larger millstones would deliver more finished product per hour.

Using the vertical waterwheel design, they could construct a more powerful waterwheel to drive larger millstones. The mechanical advantage these vertical water wheels had over their horizontal counterparts provided other attributes. They could be used in applications with less fall or head of water. They were also more efficient in water usage for the amount of horsepower generated (but they still required a generous amount of water to operate).

These first verical wheels were undershot water wheels. Period drawings of these early wheels up to the 16th century are depicted with open wood floats or paddles. Attached to wood arms mortised into a wooden waterwheel shaft, these floats were straight not angled or curved. These wheels were similar in design to the paddle wheels utilized on the steamboats of the 19th century. As in the Greek or Norse wheels, water was released from a gate on a flume and the impact of the water striking these floats powered the wheel.



Different styles of undershot waterwheel.

Most of these early vertical waterwheels powered mills that were still quite small with very limited output. Many mills contained only a single pair of large diameter millstones (four to six feet). To drive more millstones you needed more horsepower. It required around ten to twelve horsepower to operate one pair of forty eight-inch diameter millstones at full feed achieving maximum output (one thousand pounds per hour of fine wheat flour). Larger millstones required even more horsepower. Many of these early wheels were fortunate if they could develop ten horsepower. It was this need for more power and increased efficiency that lead to improvements in waterwheel design. By the late 17th to early 18th century, water power efficiency became ever more of an issue in the construction of waterwheels.

Improvements in Vertical Wheels

As mills grew in size and required more horsepower, water usage and economy was one of the key issues in the proper development of a watermill site. The best use of the water available was crucial to the success of any mill business. Dams and mill ponds were constructed to assist in better control of the waters' seasonal fluctuations and to provide a consistent steady flow to the wheel.

The vertical waterwheel evolved over many years of use and developed into a more efficient machine. As stated previously, the early vertical wheels were undershot.

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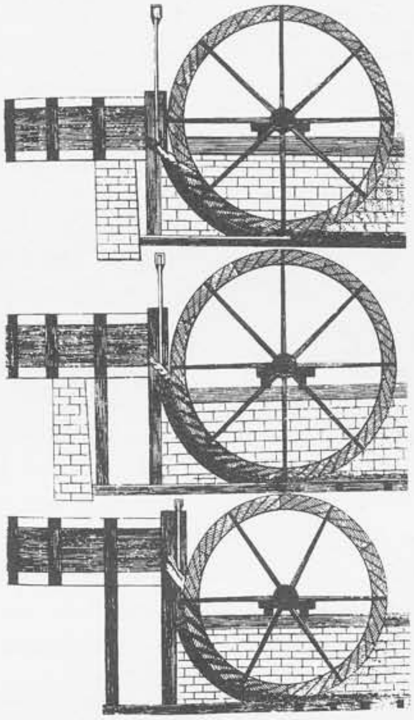
Water was conveyed through a gate on the flume to the underside of the wheel and it was the force of the water striking the floats on the wheel that gave it motion. Millwrights soon added rims (or shrouds) to these wheels and eventually sole planking to the insides of the shrouds. This boxed in the spaces between the floats creating a sealed space, or bucket, to better contain the water. Water was held captive in this space and not allowed to splash through, providing less waste and greater efficiency.



Top to bottom: Low, mid and high breastshot waterwheels.

Another improvement was the addition of a chute or apron underneath and surrounding the shrouds of the wheel from the flume. This addition also helped better hold the water on the wheel, preventing it from splashing out around the sides of a wheel while under operation. These improvements lead to the development and use of the breast shot wheel.

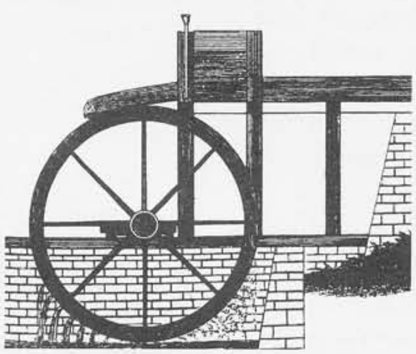
The Breast Shot Wheel

The breast shot wheel not only utilized the force of the water striking its floats, it also used the weight of the water for power. This type of wheel also had floats and sole planking, as in the modified undershot wheel, creating a trough or bucket. The floats (or bucket divisions) of this wheel were now angled allowing the buckets to better carry and hold the water longer in its cycle on the wheel before being dumped into the tail race. Thus, the weight of the water was utilized.

There are three types of breast shot wheels depending on the head available at the mill site: *low* where the water entered the wheel at its lower third, *mid* where the water was conveyed to the middle third, and the *high* where water was conveyed to the top third. High breast shot wheels were the most efficient of the three, better utilizing the available weight of the water.

Overshot & Pitch Back Wheels

With available heads of ten feet or more, the overshot and the pitch back waterwheel could be used with great success. These wheels both use only the weight of the water to produce power and are both considered the most water efficient of all the vertical water wheels.



The overshot waterwheel.

As the name suggests, the overshot received water above the wheel (on or just slightly forward of its center line) and the water was captured in its buckets and conveyed over the wheel. The pitch back wheel also received its water from above but slightly behind its center. With its buckets full, it revolved in the opposite direction of the overshot (the same direction as the breast and undershot wheels).

All of these vertical water wheels were used to power early industry. The particular type of water wheel used and its diameter/width were determined by the horsepower requirements of the mill, the available head and the amount of usable water at each particular site. Naturally, each and every mill site was unique. It is not difficult to appreciate the challenges faced by the millwrights in constructing these early water powered mills.

Vertical Waterwheel Limitations

As useful and as efficient as the vertical waterwheels became by the 18th century, they were not without their shortcomings. All of the vertical wheels had great difficultly operating in high tailwater or backwater. Backwater, a perpetual problem caused by flooding, had always been a problem at all water power sites. Depending on the severity of the backwater, some mills could not operate at all and had to sit idle until conditions improved. This could lead to much financial loss.

These early waterwheels were also extremely limited by the materials available for their construction. For many centuries, wood was the material of choice in mill machinery construction. Waterwheels, shafting, gearing and machinery were nearly all constructed entirely of wood. Before the 19th century iron was not only scarce, it was costly and difficult to

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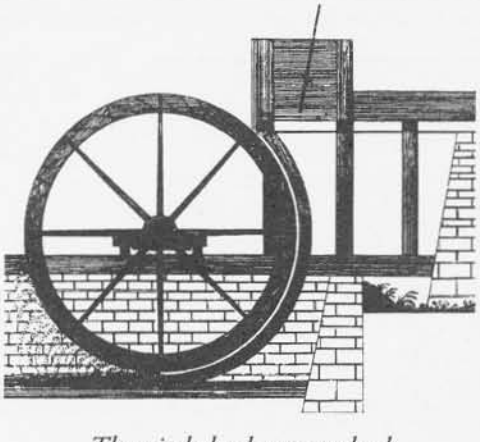
work. Wood on the other hand was easily worked and readily available.

The deficiencies of wood lie in its lack of strength and its tendency to warp, decay and shrink. This is especially evident when used in construction of machinery such as a water wheel. Wood has from one-fourth to one-tenth the strength of wrought iron, depending on the species.

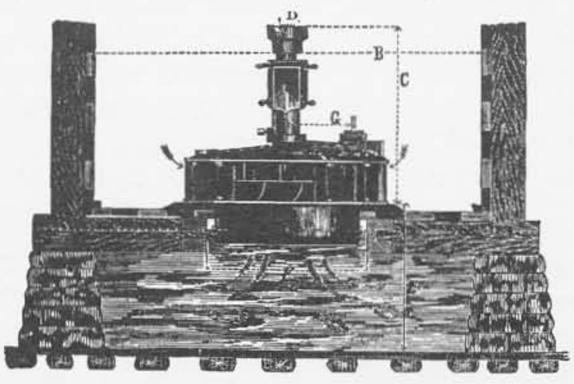

The pitch back waterwheel.

To make up for its lack of strength, wooden parts were built large and consequently were quite heavy. Waterwheel shafting two feet in diameter was common. A sixteen-foot diameter by nine-foot width waterwheel dry weighed approximately ten and a half tons. The loss of horsepower by friction from the wheel and gearing was phenomenal. Typically, the loss was about a quarter or more of what was generated. The 19th century brought more iron components into mill construction. The use of metal/wood combinations and all metal waterwheels and gearing in mills enabled them to be constructed far more efficiently.

The Hydraulic Turbine

Toward the end of the 18th into the first quarter of the 19th century, both the French and the United States governments sought out a more satisfactory water wheel to operate in backwater conditions. Through practical application, the tub wheel (the Norse horizontal wheel housed in a vat or tub) was the only wheel proven to operate effectively in high water. Unfortunately these wheels were inefficient machines and could not be applied to drive larger factories requiring large amounts of horsepower.

Developed during the 1830s in France, the hydraulic turbine was quickly accepted and adopted throughout Europe. It was first introduced in the early 1840s in the United States and it rapidly gained use in the next two decades to become the prime mover of industry by the end of the 1860s. For nearly half a century men from both the United States and France contributed significantly to the development of the water turbine.



The hydralic turbine.

Most notable are James Rumsey, Calvin Wing, Zebulon Parker and Samuel B. Howd of the United States, and Jean Victor Poncelet, Claude Burdin, Arthur Morin, Benoit Fourneyron and Feu Jonval of France.

Tub wheels are powered by the force or impact of the water striking the floats. Turbines are powered differently. These early turbines can best be described as achieving motion from a combination of both pressure and reaction of the water as it passes through the buckets (blades) leaving the wheel. They were adaptable to a wide range of working heads from six feet upwards.

Constructed of iron, turbines could be built significantly smaller than their vertical waterwheel counterparts. This lead to economies in space, construction of wheel pits and mill foundations. At a mill site with fourteen feet of usable head available, a turbine thirty and a half inches in diameter could produce thirty horsepower. An overshot wheel of more than ten foot diameter by twelve foot width would be needed to produce the equivalent horsepower.

Iron construction made for far fewer maintenance concerns. Though initially more expensive to manufacture, turbines were more cost effective to operate over the duration. In typical service, wooden waterwheel parts would have to be replaced every seven to ten years. Nearly daily maintenance requirements were routine in wooden waterwheel operation. Labor and materials added to the daily costs of operation, which also included the loss of income because of downtime caused by equipment repairs.

Turbines typically operated at higher revolutions per minute. Higher speeds made possible a reduction in the amount of gearing required to achieve operating speeds. Less gearing lowered repair and maintenance costs and reduced power loss due to friction.

Another issue troubling vertical water wheels was winter icing in

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northern climates. Turbines were nearly unaffected by icing.

By the third quarter of the 19th century demand for water turbines was high and many foundries/ ironworks began to manufacture them. This brought the purchase price down significantly and within many mill owners' budgets. Even many established small rural mills discarded their vertical water wheels in favor of water turbines.

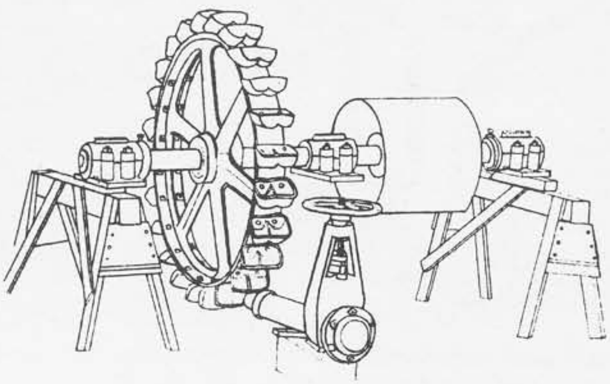
It is interesting to note, even though the turbine was efficient and effective, some of these mills (with limited water supply and low heads less than twenty feet but more than ten) were disappointed with their turbine results. Some even returned to the use of vertical water wheels. Companies such as the Fitz Water Wheel Company offered an all steel and iron overshot water wheel that sold well, particularly in the eastern half of the United States.

The "Hurdy-Gurdy" Wheel

While the development and use of the hydraulic turbine in the eastern half of the United States was growing during the last quarter of the 19th century, the mountain regions of the West were developing an entirely different type of water wheel.

The mining of precious metals required a tremendous amount of power not only for the mines themselves, but for the processing of the ore. The scarcity of fuel to power steam engines made waterpower even more valuable. This region with its limited precipitation and high heads (provided by the mountains) looked for an alternative to the standard water turbine for power.

The problem the turbines encountered was twofold. They typically operated at a higher revolutions per minute and had to be geared down extensively for use in the pumping, hoisting and stamping mills. This added to the cost and brought down efficiency. The other problem was one of maintenance and replacement costs. The sand and silt in the waters of the West caused heavy wear and extremely limited the working life of turbines. With high maintenance/replacement and frequent repair costs, the water turbine lost favor quickly.



A Pelton waterwheel shown mounted on temporary trestles.

The tangential (or "hurdy-gurdy") wheel was developed and soon proved itself invaluable. Named after the musical instrument it resembled, this vertical wheel was constructed mainly of wood. It generally was no more than ten feet in diameter and less than one foot in width. It utilized numerous buckets at close intervals a few inches in depth and width and enclosed by shrouding. It was powered by a jet of water, under considerable head and pressure, from a nozzle directed tangentially against the periphery that struck the buckets. Minimum head requirements were around twenty feet. As the need for more power arose, heads were increased. These early "hurdy-gurdy" wheels were quite crude and soon improvements were made, dramatically increasing their efficiency.

Most notable was an 1880 patent by Lester Pelton for a shaped metal bucket with a center division or splitter. The Pelton wheel was born. Efficiency improved from around forty percent of the "hurdy-gurdy" wheel (which is considered an impact wheel similar to an undershot) to around eighty five percent with the new Pelton wheel (which not only used the impact of the water but also the reactive force as it was leaving the bucket).

Simplicity in construction, maintenance and installation made them extremely popular. The revolutions per minute were simply controlled by the size of the wheel. The horsepower generated by these wheels was outstanding and quite comparable to the best of the high pressure turbines of the day. Under one hundred and fifty feet of head, with several jets directed on one Pelton wheel ten feet in diameter, three thousand horsepower was developed.

With the increasing demand for electricity in the early 20th century, electric plants powered by hydraulic turbines and Pelton wheels became increasingly popular.

Today in the United States water is still a viable power source, but remains behind nuclear and fossil fuels. In Canada, portions of South America, and Eastern Europe it contributes heavily in the production of electricity. Water power has survived into the 21st century to supply our ever increasing demand for electrical power.

Hidden Hercules

by Bob Naske

Editor's Note: Bob Naske was this year's William O'Dell, Jr. Volunteer of the Year for his work with the museum's engine collection. Bob not only works with engines, but also writes for Gas Engine Magazine. *He wrote this article for their December, 2002 issue. It is reprinted with that magazine's permission and is shortened to fit this space.*

July 3, 1919. It is most likely just another day for the farmers of Delaware County, N.Y. The first cut of hay is done, the corn should be knee high in the fields and life goes on for the area's dairy farmers.

But it's not just a regular day at the Joe Roberts dairy farm; for this is the day the Roberts are getting a shiny green 5 HP Hercules Model E, purchased at the Hanford Bros. store in East Meredith, N.Y., for $145. Included in the price is a 20-inch pulley to run a lineshaft and a vacuum pump for their milking machines. A concrete foundation for the engine has already been built in the barn, and a section of 2-inch cast iron pipe is ready to be plumbed to the engine to carry exhaust gases outside. New windows set in the walls of the room will let some light in, and outside the engine room a shiny, glazed brick silo glistens in the sun.

Year after year the Hercules engine does its work. Like any machine it requires attention once in a while, and for reasons unknown the mixer is replaced. The old mixer is tossed into a corner of the engine room.

The years go by, and one day electricity comes to the farm. It eventually replaces the Hercules, rendering it obsolete, motionless. The farm passes to new owners, but the Hercules remains, its 6-inch flat belt, although a little tired, still attached and ready to work.

The years continue to slip by, the farm animals are sold and the milking equipment disappears, but the Hercules remains. The Hanford Bros. store where the engine was bought finally closes. The farm is neglected, pastures return to woodland, but the Hercules still sits on its concrete foundation. Somebody removes the vacuum pump from the foundation and sets it on the floor where it will remain for years. Over time the engine room windows get broken, the shiny silo starts to crack, and the oiler glass on the Hercules gets broken. But nothing else is disturbed.

And then a new owner, Marvin Glass, takes over the farm. Marvin carries out some structural repairs to the neglected barn, and he finds the old Hercules sitting in the engine room, just as it has been for many years, its belt still attached, seemingly frozen in time.

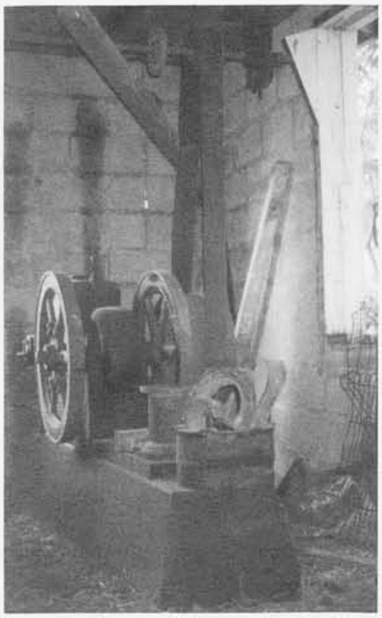
Inspecting the engine, he decides to donate it to the Hanford Mills Museum. The museum gladly accepts the donation, agreeing to remove the Hercules and to add it to their collection of antique gas engines, joining two other, smaller, Hercules engines.

Aug. 16, 2002. It is most likely just another day for the remaining farmers in Delaware County, N.Y. The second cut of hay is being gathered, corn is being harvested, but life goes on for the dairy farmer.

But it's not just a regular day for the Hanford Mills Museum, because this is the day a well-used, non-running Hercules engine will be delivered - the rusty and stiff 5 HP Hercules Model E that was sold by the Hanfords on July 3, 1919. Included is a rusty 20-inch pulley to run a rusty line shaft the engine once powered.

A week prior to that day preliminary measuring, planning and clearing of a path for the removal of the engine are done. While moving some small, discarded items on the floor, a Hercules mixer is found mostly buried in the dirt. The original oiler is found in a like manner. Two of the museum's staff, Rob Grassi and John Anderson, and a volunteer unbolt the engine, rolling it on pipes out of the barn and onto a waiting trailer. Before lunch, a 1919 5 HP Hercules, serial number 186627, is back at the very location where it was sold 83 years earlier.

The museum is happy to have the engine, especially since they have original documentation of the sale from 1919. They thank Mr. Glass for the donation. Over the course of the next several months it will be evaluated for work needed to get it operational again, but leaving it as original as possible.



The Hercules waits to return to Hanford Mills. Photo by Bob Naske.

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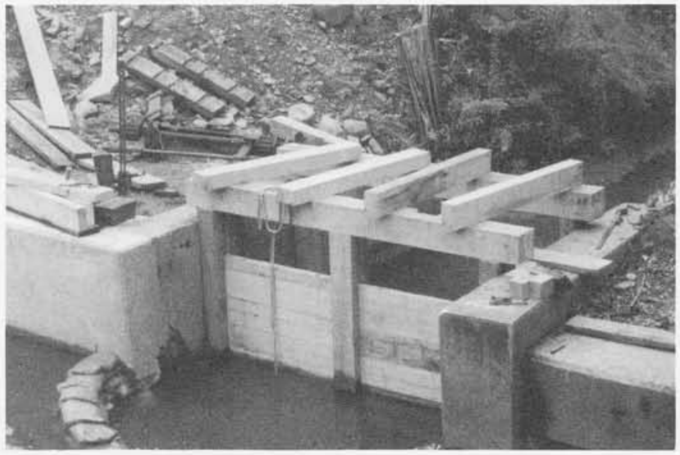
three feet shallower. An emergency dredging had to be done after the January 1996 flood. In that situation, most of the silt was dropped at the pond entrance, blocking further water from entering. The cost of that mitigation work was about $3,000.

Today, the museum is faced with the knowledge that we must dredge again. A bad situation was made worse last year when bridge construction near the mill caused accelerated silt built-up in the pond. At today's prices, the pond's next dredging will cost approximately $14,000.

Finally, mill owners must pay to build structures to divert water into their millponds. The Hanfords had a wooden headgate that regulated the water coming into the pond and a low dam in Kortright Creek to direct water to the headgate. We have replaced both more than once in modern times. We last replaced the diversion dam in 1999 and the headgate in 2001, both at a cost of approximately $15,000 each. Both items had been restored or rebuilt when the museum first opened and undoubtedly were often reworked by the Hanford and Pizza mill owners.



Here is the headgate under construction in 2001. While a metal headgate might last longer, the museum must restore it as best as we can to the orginal.

In the end, there is more to water than a free flowing stream. Water power is *not* cheap. Instead of smaller, monthly bills, a mill owner gets larger, more infrequent bills. If a mill is to stay in business, the owner must plan for these expenses. Many are predictable – the Hanfords first looked into buying new water wheels in 1917, but did not make an actual purchase until 1925. Still, in the end, water power is not free like many people think.

Today, the museum staff works to anticipate water power expenses and build them into museum budgets. But in the end, as Gerald Greene said, "[Water power] is not cheap," but it "is nice power."

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