A Replica of the South Glastonbury Congregational Church Tower Clock Movement

by Hayward Glaspell (VA)

First, some history of the Congregational Church in South Glastonbury, CT, shown above right. It was built in 1836 and, according to Church Historian Barbara Barnes, the Glastonbury church was originally built without a clock or bell. It's believed a wooden clock movement and bell were purchased from the Congregational Church in South New Britain when they had built a new building in 1865-1868. The wood movement was in the Glastonbury church until 1916 when it was replaced with a Seth Thomas clock. In 1963 the building was raised and turned to face Main Street; it's said that the Seth Thomas clock never missed a beat during the lifting and moving. In 1985 one of the Seth Thomas weights fell and landed in a pew. Fortunately, no one was hurt, and the clock was soon electrified. In 1969 the original tower clock was donated to the American Clock & Watch Museum in Bristol, CT, by NAWCC members William H. Goodwin and Nelson D. Booth (since deceased). There are no known records of who built the clock or what became of it before Goodwin owned it.

Author Hayward Glaspell (left) transported the clock from Virginia to George Bruno's (right) home in Torrington, CT. **Above.** South Glastonbury Congregational Church, High Street, January 3, 1904.

Author of the Drawings

An American horologist and antiquarian, George Bruno spent 25 years at Turner & Seymour, a Torrington, CT-based company that manufactured machine tool castings. He was principally a sales engineer dealing with tool, die, and design projects. Clearly, his exposure to a variety of tool design applications, coupled with an artistic talent, readied him for a vocation that certainly rivaled the early clockmakers.

In the early 1960s, in exchange for some outside casting work, he received his first clock: a wooden works clock. As a tool designer by trade, George was intrigued by the quality and workmanship of the early clockmakers and their ability to design and fabricate parts with limited tools and equipment.

Apparently, this first clock was the proverbial "hook," for soon afterward George learned of the existence of an early wooden works tower clock that had been removed some years earlier from the Connecticut church described above. He had hoped to acquire it, but as it turned out, the tower clock was later donated to the American Clock & Watch Museum in Bristol, CT, and George was limited to being a "viewer" and not an owner.

Still intrigued by the clock and not to be discouraged, he set about to replicate this masterpiece of design and function (in George's eyes). In July 1968 he made sketches of the movement while taking careful measurements of this still "fully-assembled" unit. Along with some delicate rubbings of certain parts and experienced estimates of difficult-to-view components, George compiled a complete set of drawings, sufficient to allow someone to reproduce this early nineteenth-century tower clock built by an unknown clockmaker. He completed the task on September 6 of the same year. While still unidentified, George speculates that the clock was made by Eli Terry or his son, or perhaps Seth Thomas.

The drawings, along with dozens of other drawings of various wooden movements, were later made available for sale at the American Clock & Watch Museum. George has created drawings for some 30 movements, including, among others, early Eli Terry, Silas Hoadley, and the Porter Contract movements. He has also prepared drawings of over 25 cases: tallcase, shelf, and banjo.

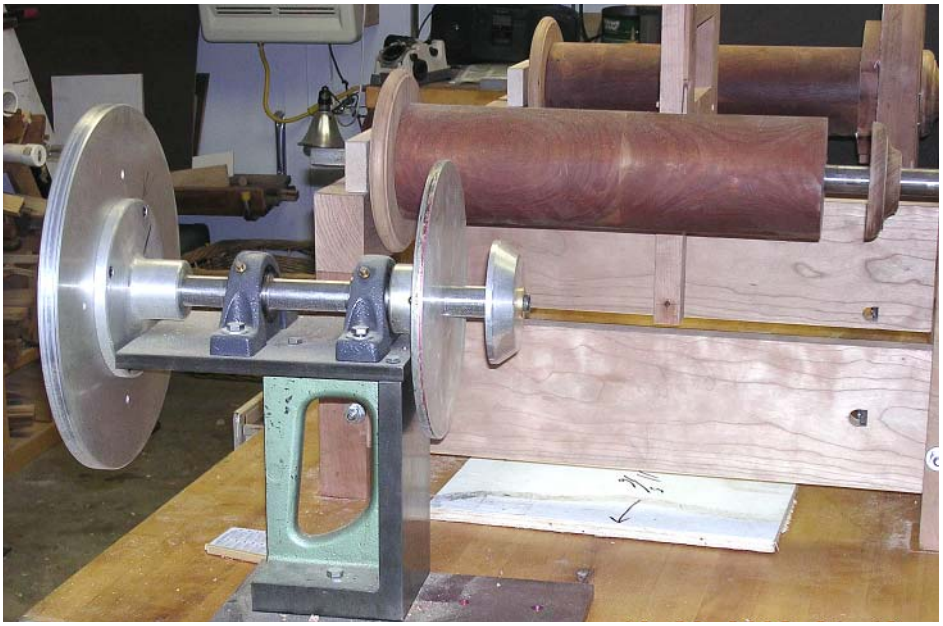

Figure 1.

While it has been over 40 years since George created the drawings for this tower clock, in the interim he has repaired, reproduced, and helped to rekindle an interest in wooden works clocks for a fraternity of "cog counters" for whom the name and legend of George Bruno is well known. And at age 85, the vitality in his step and the enthusiasm in his voice for these early makers of wooden works clocks are as strong as ever.

After using George's drawings to make an Eli Terry 30-hour time and strike shelf clock and a Silas Hoadley 30-hour movement with an Early American case, I found his drawings to be very accurate to the original clocks and a pleasure to work with. I purchased his set of drawings for the Glastonbury Congregational wooden tower clock with the intentions of making a scaled-down working model. While studying the drawing, I realized a full-size replica would be a challenging project. Having a machinist and a model-making background, how to make the clock was not the problem. My shop equipment is small, and machining the large wooden clock wheels for the movement was the problem. I have a tabletop milling machine with a 16" x 8" table, a 6" x 9" lathe table, a 12" band saw, drill press, and self-made clock wheel cutter. The first hurdle was the first wheel strike, which has a diameter of 15-7/8" and is the largest. The second problem was not having a wood lathe big enough for some of the largest turnings. The larger clock parts were made by making some fixtures and tools; this will be further explained in this article.

Before investing money and time in this project, I had to know for certain that the largest wheel (the first wheel strike) could be made on my equipment. There were two choices for construction of the clock wheels. One was to lay out the profile of the wheel teeth on the wheel blank and use a band saw, and the second choice was to use an indexing device on a milling machine to saw the tooth profile. Choosing the latter, an indexing fixture was built and mounted on a ½" steel plate (Figure 1), which extended the width of my milling machine table. Using scrap lumber, a test piece was made for the largest wheel by gluing up a blank piece. The indexing fixture worked, and by finishing a few gear teeth on the largest wheel, this let me know that all the clock wheels could be made on my milling machine

The clock is constructed mostly of cherrywood and maplewood. The frame and wheels were made of cherry lumber with the pinions made of maple. The clock's frame was constructed with mortise and tendon joints held together with wooden pegs, wood screws, and bolts—no glue joints. It was difficult to find 2"-thick rough-sawn cherry lumber over 16" wide needed to make two great wheels. The rest of the lumber was found in local lumberyards. The lumber was purchased, first rough sawn oversize, and allowed to stabilize in my shop for awhile before being finished. The clock frame was first constructed using mortise and tendons joinery on the legs and side rails. Cross members and upright rails were fastened to the sides with bolts and screws.

Making the Pinions

The pinions were made of maple. The stock for the pinions was sawn and planed into square blanks with the ends finished to length. Drilling bushings were set up in V blocks and aligned with each other with the pinion spindle blanks clamped down in between them. This was done so the drilled holes for the pivot steel would be aligned. Pivots were inserted in the drilled holes with a press fit with the diameters left oversized. The pivots were machined to size in the lathe, causing them to be concentric to each other. Pinion blanks were once again put in the lathe with the outside profile turned. The pinion contours and bosses (where the wheels were to be mounted later) were finished to size, but the diameter where the pinion teeth were to be machined later was left 1/16" oversized.

The time and strike trains each have three pinions, and each had to have a cutter made for the profile of each pinion tooth. The cutters were made with W1 tool steel, hardened, and tempered after machining all. These pinion cutters were made by turning the profile of each to its correct size and profile on a lathe. Next, the cutters were put on the milling machine, and excess metal was removed to make a two-fluted router bit. The cutting edge relief was put on by hand with files, hardened, and blue tempered. The final sharpening was accomplished with slip stones. I have found prior to hardening, that if you wrap each cutter in wire, preheat to just under red heat, then dip the cutter in boric acid powder to coat it, the borax melts and acts as a flux to stop decarbonizing or scaling during the hardening process. The pinion teeth were machined on my milling machine. A fixture was made with a spin indexer and a homemade tail stock. The indexer was modified so I could make and use my own direct index plates. The indexer and tail stock were mounted to my milling machine with a steel plate longer than the machine table because the pinions were just about as long as my milling table (Figure 2). During the machining of the pinion teeth, the spindles were mounted by their pivots. The pinion teeth were machined to size, and the finish was so good that very little sanding was required.

Making the Wheels

First the lumber for the wheels was milled down to the thickness needed for each wheel. Wheels had either a 1" bore or 1-3/16" bore in the center; this operation was done first. The outside diameters were scribed about 1/4" oversize with the wheel center being located with a metal plug put in the center bore. Once the wheels were set up on my indexing fixture, the crown radius was milled first using a form fly cutter, also finishing to outside diameters size (Figure 3). Next, a saw was mounted on an arbor in the milling machine spindle. By positioning the saw vertically, the flanks of each tooth were sawed to the proper angle in reference to the center of the wheel (Figure 4). When the two saw cuts intersected, a chunk of wood fell away, leaving the profile of each tooth. The flanks of each tooth were also cut tangent to the crown radius. You will notice that the angles of the tooth flanks are not equal, because wooden clock gearing has less friction when the straightest side of a tooth engages the

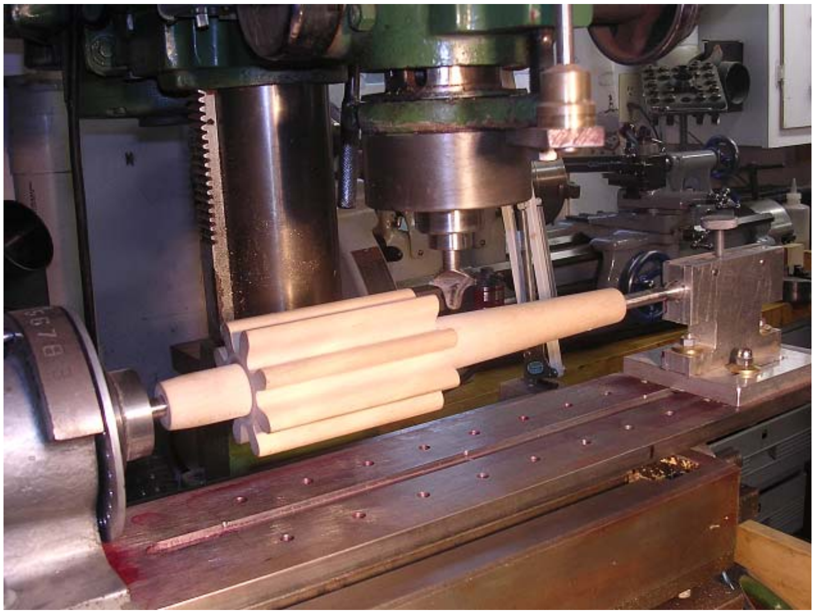

Figure 2.

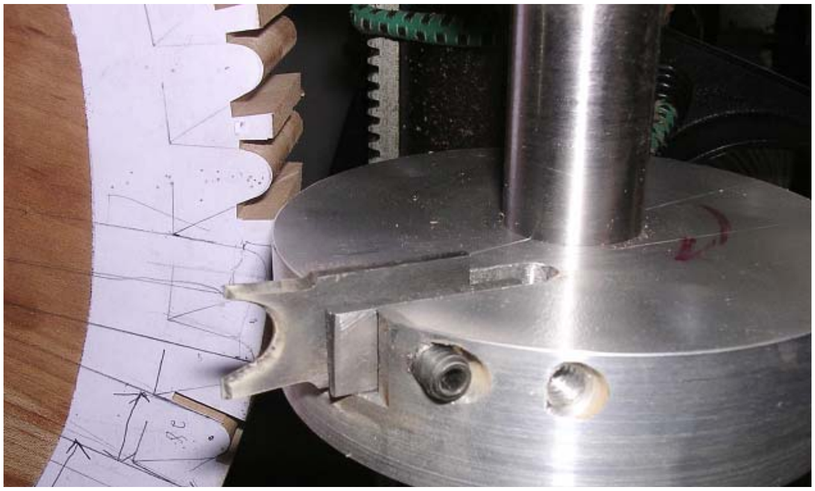

Figure 3.

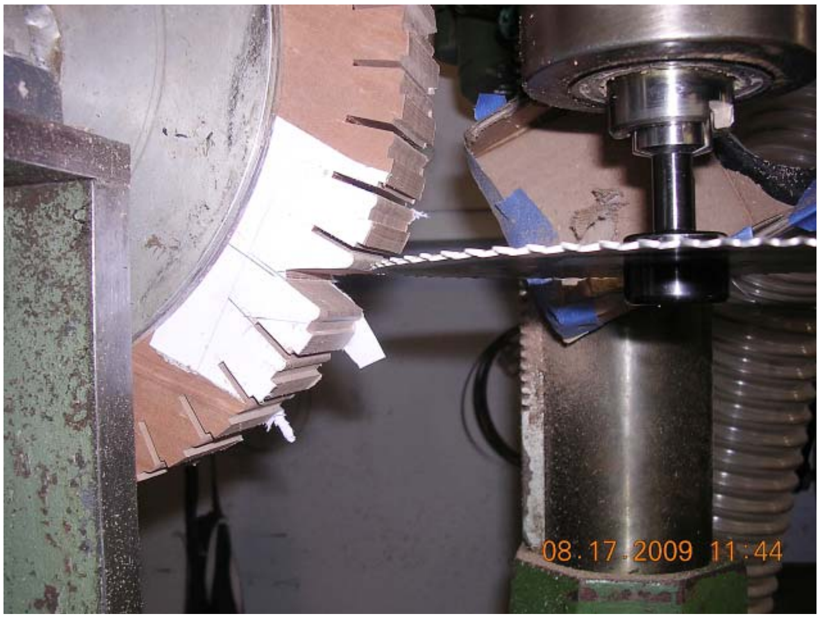

Figure 4.

Figure 5.

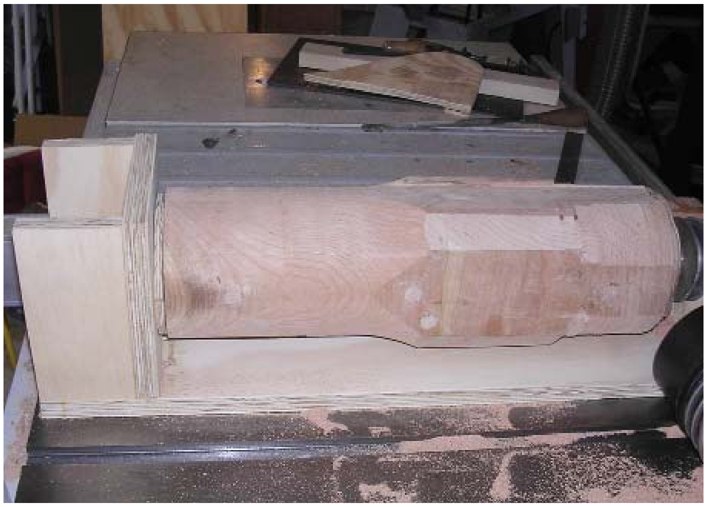

Figure 6.

pinion tooth first. All the wheels, including the motion works teeth, were finished on this fixture, and the next operation was turning the decorative work on the sides of each wheel. Not having a lathe with a large enough swing to turn the sides of the wheels, I had to improvise once again. I bought an old cast-iron tabletop saw and lengthened the slot where the saw stuck through to accept the diameter of the largest wheel. Mounting a 1" shaft on the table with two pillow block bearings provided for a spindle onto which to turn the wheels. With an old motor to drive the shaft and some homemade turning tools, the wheels' sides were turned and sanded (Figure 5).

Winding Drums

The winding drums were also made of cherry. The shaft was made from 1" square steel bar stock with the ends turned round to run in bearings. On the end of each shaft a tapered square was also machined to receive a crank handle. Wood was built up around the square shaft and secured with wood screws with the heads counter sunk below the drum diameter and covered with plugs. Still not having a large enough lathe to turn the drums' outside diameter, the drum shaft was mounted in wooden bearings on a sled made of plywood. The sled was centered over the table saw blade and slid back and forth along, the table saw fence. While turning the drum shaft by hand and taking fine cuts while at the same time moving the sled back and forth over the saw blade, the outside diameter was then made (Figure 6).

The Escapement and Verge

The escape wheel is 4-7/16" in diameter with 40 teeth and made of hard brass. I borrowed a 40/1 dividing head from a friend for this operation. I mounted the brass blank on a machined mandrel, which was mounted in the dividing head's collect chuck (Figure 7). The profiles of the escapement teeth were machined with a fly cutter to the finish depth. The wheel was crossed out by hand and filed and sanded to a nice finish. The escape wheel was mounted to the third pinion with three round head wood screws equally spaced on a bolt hole circle. The verge was machined on a turntable working from an aluminum subplate bolted to its surface. Centers for the verge's radius were machined working from a dowel pin in the subplate on the turntable's center axis. A height gauge was used to lay out the verge's profile on 3/8" W1 tool steel. Centers for the radius points were drilled to fit the dowel pin on the subplate. Machining was accomplished by clamping the verge down to the subplate over the center dowel pin and rotating to correct the angles. After machining it was polished and the pallet ends hardened.

Figure 7.

The steel parts were all forged on the original movement, which included the pendulum impulse lever, strike detent rod, make-ready lever, warning rods, the count wheel detent, and a hoop wheel detent. I built a small natural gas forge from an old Freon bottle. Templates were laid out for each part on sheet metal to use a guide while forging. A hot roll steel bar was used to make the forgings. When the hot work was done, forged parts were cleaned up by filing and color finished with a cold gun bluing.

The cherry pendulum rod was sawn out, shaped with a spoke shave, and sanded to a smooth finish. A flanged brass fitting was made and put in a slot in the pendulum rod to receive the impulse lever. The 8-3/8" in diameter and 1-1/2" thick pendulum bob was made of cast iron. A wooden pattern and a core box were built for the bob to be cast. The pendulum bob has a cored rectangle shaped hole through the center. A wooden pattern was also made that was used to make a plaster core box (see patterns, Figure 8). I sent the pattern and core box out to a small cast-iron foundry for casting. When I received the rough casting, it was finished by sanding its surface smooth by rotating in a lathe. Black epoxy appliance paint from a spray can was used to provide a nice glossy finish on the bob. The pendulum hanger was machined from steel and fitted with a steel suspension spring.

All the other parts were made in a similar fashion with machine tools and hand tools. The count wheel's outside diameter was finished on a turntable, and the slots were cut on my clock wheel-cutting machine. All of the pivot bearings were made of maple and mounted to the frame with screws. Before assembling the clock, all the wood parts were finished by sanding and left in their natural color. The final finish was with penetrating

Figure 8.

Same Plans, Different Maker

Editor's Note: Hayward Glaspell's article was submitted in June 2010, the same month that Frank Del Greco won the 2010 Annual Craft Contest People's Choice Award at the NAWCC National Convention for the same design—working from another set of George Bruno's drawings. Here Frank describes some differences in his clockmaking methods.

I am excited to see that someone else has also made this clock. At the 2007 Eastern States Regional, I told George Bruno that I would like to build a wooden works tower clock. I had my mind set on building a Samuel Terry, since drawings were available through the Cog Counters, but George told me about the prints of the Congregational church clock that he created in 1968. I asked him for a set. He said, "No one has ever asked me for a set."

Glaspell's article demonstrates that there is "more than one way to skin a cat." I used a number of techniques different from that shown in his article. For example, Figures 3 and 4 show that Hayward used on a vertical mill a custom-ground rounding up fly cutter to round over the tips of the wheel teeth, and then used a slitting saw to cut the space between the teeth. I used a fly cutter on a mill to create the entire space between two teeth in one pass. My custom-ground cutters were V-shaped with rounded wings to remove the space between two teeth and to round over the tips.

I own a 16" gap bed wood lathe so I was able to decorate the sides of the wheels and turn the drums on that tool.

Glaspell used custom-ground fly cutters to form the pinions. Rather than grinding more cutters, I used a series of commercially available router bits in the mill. First, I used a round nose bit to cut the gullets. Then I switched to a quarter-round (round over) bit sized to create an elliptical form on each side of the tooth. That left a ledge at the bottom of the roundover bit's cut. I switched back to the round nose bit and used the straight portion to blend the bottom of the tooth form with the gullet. That's a trial-and-error adjustment; you have to take your time and "sneak up" on it.

The toughest part for me was making the three strike control levers. Unlike a shelf clock where the levers are bendable wires, the prints called for 3/16" flat stock 3/4" wide. These aren't bendable, so they have to be perfect as made. I made the levers first out of wood; then I installed them and filed, trimmed, and sanded them until they functioned perfectly. Then I reproduced them in steel.

Hayward estimated that it took him 400 hours to make his clock. I don't know how many hours I spent on mine (everyone asks me), but it took me two and a half years, working on it as time permitted. It's the first clock I ever made from scratch, and it was a real learning experience.

From George's comment I was under the impression that I was the only person ever to build that clock from his prints. (Later, I found out that the drawings were being sold in the gift shop of the American Clock & Watch Museum in Bristol, CT.) Congratulations to Hayward on a job well done!

For those interested, there is a DVD in the NAWCC Library of a presentation I made about how I built the clock. It's titled "Construction of a Wooden Works Tower Clock," program no. 896.

—*Frank Del Greco* (OH)

oil (Bush Oil). For display purposes the motion work, which normally would be mounted to the back of the dial, was mounted to the clock frame and fitted with a set of hands. Nothing was known about the bell arrangement on the original clock when it was in the church. A large brass bell was purchased and mounted under the frame. A bell hammer was forged and actuated by a steel cable connected to the strike hammer spring. The clock rests on a 36" high stand made of cherrywood, built with the same style and joinery as the clock frame. The actual ways, procedures, and tools the clockmaker used over a century ago to make the original movement are with him forever. By using some modern tools and machinery and approximately 400 hours over a two-year period, we both achieved a similar clock that keeps the same time.

Acknowledgments

I was only able to build this tower clock because of George's interest and talent to make the drawings from the original clock. For this I thank him. I thank Richard Huck from NAWCC Chapter 148 for interviewing George Bruno at his home in Torrington and for writing George Bruno's story; Barbara Barnes, church historian for the Congregational Church in South Glastonbury, for pictures and history of the church where the original movement was located; and Cathy Evans for typing this article.

About the Author

Hayward Glaspell retired in 1985 as an engineering technician from NASA Langley Research Center in Hampton, VA. He worked as a machinist and model maker; he also cast metals with sand and lost wax methods and has heat-treat metals. Since his retirement he has had an interest in building reproductions of the early wooden works clocks. His fascination with clocks began as a child while watching his grandmother wind her 30-hour OG Waterbury mantel clock every afternoon. As a hobby, Hayward has repaired and restored clocks for over 35 years. He makes most of his own clockmaking tools as well. Glaspell has been a member of NAWCC since 1985 and has recently joined the local chapter of NAWCC Old Dominion Chapter 34. He currently resides in Seaford, VA.

October 20-22, 2011

Cincinnati Airport Marriott, Hebron, Kentucky
Pre-registration deadline: September 29, 2011.
Cutoff date for NAWCC-rate hotel discount: September 29, 2011.

The 2011 Ward Francillon Time Symposium will focus on the activities of the clock and watch industries in Ohio. The Symposium opens on Thursday evening, October 20, with the **James Arthur Lecture by Philip Morris**. Friday and Saturday lectures will feature various topics related to Ohio clocks and watches. There will also be an **on-site Ohio horology display**. A **visit to the American Watchmakers-Clockmakers Institute** (AWCI) training facility, research library, and museum is included in the Symposium program. The Symposium will conclude with a **banquet on Saturday evening**

Program details are available online at nawcc.org. Hebron is located in northern Kentucky, just south of Cincinnati, Ohio. The Symposium site/hotel is 5 miles off I-75, on I-275 Exit 4A. Air service is available through the Greater Cincinnati International Airport. A free shuttle service is available from the airport to the hotel and from the hotel to local shopping and dining.

See this issue of *Mart & Highlights* or nawcc.org for the schedule of events and registration form.

Speaker Highlight

Lee Horrisberger will present "Spending Time with Dueber-Hampden." This session will include background information about the Dueber-Hampden Watch Works, primarily the history of the watch company, including the early years as well as the start of Dueber Case Company in Newport, Kentucky. The Canton era and the watch models introduced during this time period, the legacy of Dueber-Hampden after the company dispersed to Russia, the remains of Swiss-Hampden Watches, and the Dueber-Hampden Service Department will be discussed.

The research project is an ongoing history of the Dueber-Hampden Watch Works, how the company changed life in Canton, and the Dueber-Hampden move to Russia.

Lee Horrisberger joined Walsh University in 2000 and serves as an Associate Professor of Communication and Fine Arts. Lee earned her B.A. from the Ohio State University and M.A. from the University of Akron. Lee was awarded an Individual Artists Grant from Arts in Stark (Canton County, OH). The grant has helped to fund Lee's digital story and blog focusing on Dueber-Hampden.

Symposium information continues on page 381.