

Danish Windmill Put a New Spin on this Old Mill

Restoration Project Portfolio- February 2017

Historic photos from 1975-1976 show stages of the Mill as it was being reconstructed on its present site in Elk Horn after being disassembled in Denmark and shipped to the US in pieces.

The photos from forty years ago complement present day images help illustrate the project steps and process that will take place as the Mill is disassembled and reassembled in the current Mill Restoration Project.

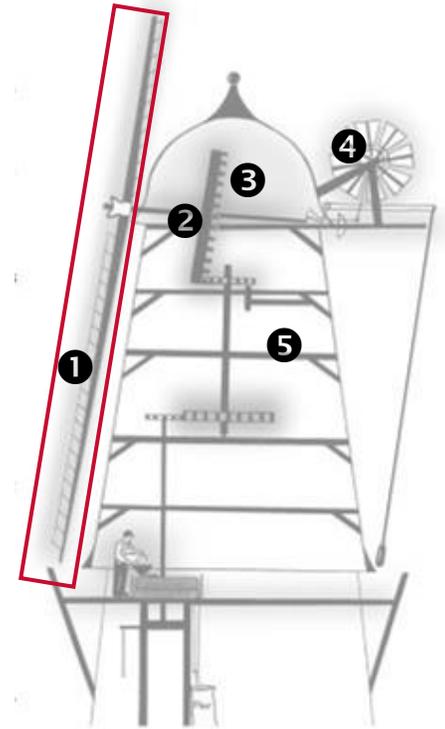
Removal of the sail stocks or cross arms (red timbers) and shutters (white) was completed in December 2016.

1 Dismantling and Removal of Existing Sails



The two 67 foot long timbers of the Danish Windmill sail cross arms weigh 3,500 pounds each and are 80 feet in the air. Wood rot in the timbers posed a major safety concern and jeopardized the integrity of the structure especially in the event of heavy snow.

The 88 white shutters were removed from the sails.



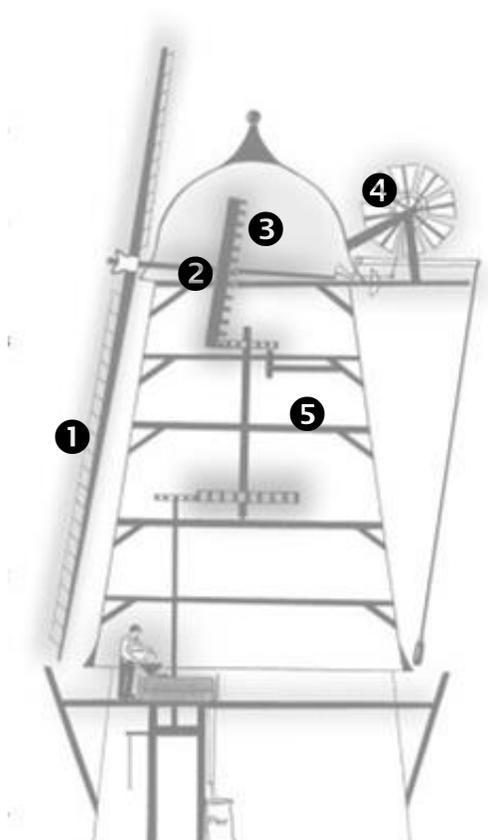
▲ The installation of the wings (sails) in November 1976 marked the completion of the Windmill's exterior restoration.

Sails -The sails date back to the Windmill's arrival in Elk Horn forty years ago. They've been repaired and patched in the past but now need to be replaced due to wood rot in the polls near the hub.

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Danish Windmill—Restoration Project Portfolio

Anatomy of the Windmill & Project Elements



2 3 Wind shaft and brake wheel—Replace Timbers for wind shaft and repair brake wheel

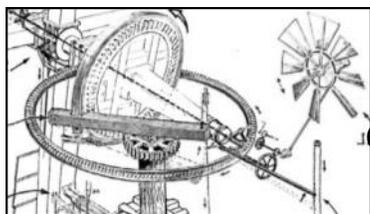
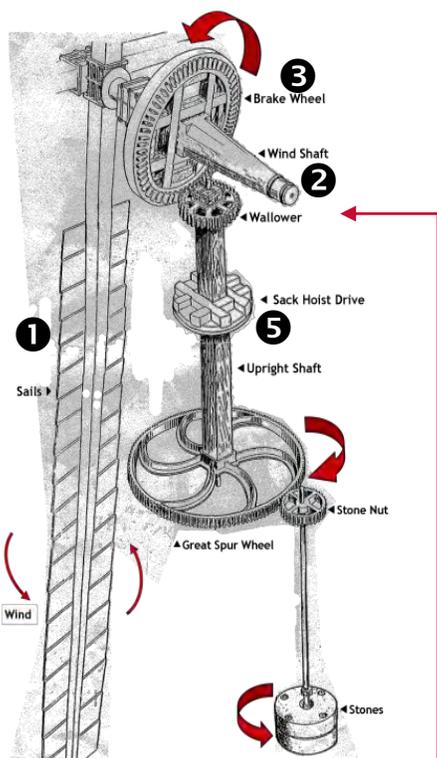
The old wind shaft was removed and a new one will be constructed for installation in the spring.



4 Fan tail and frame and Cap frame—Repair the fan tail, treat cap frame for rot

The fan tail was removed in December along with the sails. Fortunately the cap frame did not need to be removed. The Mill was secured for winter.

5 Sack Hoist — (illustration only, no photo) Replace friction drive pulley for sack hoist



Project Element and Order of Operations	
<input checked="" type="checkbox"/>	Assessment and inspection
<input checked="" type="checkbox"/>	Order new sail materials and transport to Kentucky
<input checked="" type="checkbox"/>	Dismantle and remove existing sails
<input checked="" type="checkbox"/>	Remove wind shaft, poll end and gears
<input checked="" type="checkbox"/>	Remove fantail
<input checked="" type="checkbox"/>	Secure cap frame for winter
	Construct new sails
	Construct new gear components
	Complete new wind shaft
	Repair fantail and frame
	Install new components in cap and tower
	Fit new sails and shutters



Shown above- Harvey Sornsen inspects the wind shaft when it arrived from Denmark forty years ago.

This project is supported in part by the State Historical Society of Iowa, Historic Resource Development Program.

Current Restoration Need: To Put a New Spin on this Old Mill

There is a need to make immediate repairs to the Windmill because it has not been turning for more than a year.

Summer's extreme heat, followed by a harsh Iowa winter, took a serious toll on the Mill. It shifted the mechanical structure of its sails and the brackets that hold the shutters bringing the mill to a standstill for safety reasons.

The Mill is a very old machine and we needed a millwright with expertise in historic restoration and preservation to get it turning again. We reached out to world-renowned Danish and American historic mill experts that we have relied on to perform similar work over the years such as the initial maintenance plan, blueprints and rebuilding of the Mill's cap frame in 1995.

In August 2015 their Danish machinist came and spent 3 days on the Mill. In addition to working on the iron gearing and adjusting the fan tail mechanism he also found rot in some of the timbers of the 67 foot long sails. He prepared a report for the Danish millwrights based on his inspection.

The American millwright, Ben Hassett, who we planned would do the work, was not able to fit us into his busy schedule until April 2016. Hassett, who is a Council Bluffs native, worked on our project in 1995 as the millwright's apprentice and is now owner of B.E.Hassett-Millwrights, Inc.

He came to Elk Horn and inspected the Mill on April 25-26, 2016 and concurred with the Danish inspection report. He submitted a conditions report, work plan and estimated cost for the repairs. The time for performance is four months from commencement of the project.

Based on consulting with them we determined that the project would consist of two phases—1) inspection and assessment of damage and 2) making the repairs. We have completed Phase 1 and are ready to move to Phase 2 with your help.



DANISH WINDMILL RESTORATION PROJECT OVERVIEW

PHASE 1 | INSPECTION AND ASSESSMENT OF DAMAGE

The project consists of two phases—
a) inspection and assessment of damage and
b) making the repairs.

World-renowned Danish historic mill expert, Lise Andersen, and millwright, Michael Jensen planned to come to Elk Horn to address the repairs and while here present an historic mill maintenance seminar. This will help us better understand how to strategically plan for the Mill's preservation needs. Due to travel complications, they were not able to make the trip.

Repair and Restoration

Ben Hassett has extensive knowledge of mills and completed many historic mill restorations across the country.

He is highly regarded for his craftsmanship and expertise in the techniques used in constructing and restoring old mills. In 2015 he received the Harry H. Mellon Award of Excellence in Job Order Contracting for Colvin Run Mill, Great Falls, Virginia.

Hassett will carry out repairs and restoration work of the windmill, with a view to repair instead of replace, in order to preserve as much of the original fabric of the structure and machinery as possible.

PHASE 2 | MAKING THE REPAIRS

The aim of repair is to retain and maintain as much as possible of the existing structure and machinery in order to preserve the historical and technical integrity of the mill.

Where replacement of any part is deemed necessary, the replacement will be carried out using appropriate and comparable materials. If possible the original part will be used as a pattern, so that the design of new parts is in keeping with local tradition and practice.

Old parts removed and replaced may be preserved as part of the museum because of their historical or technical interest. Since the goal is for the Mill to work, we'll make sure that the machinery is set up to run as smoothly, efficiently and safely as possible.

We promote the museum as a "working-example of life in an earlier time". Our goal is to repair the mill so it can be turning in the wind again.

PROJECT NEEDS: VOLUNTEER, CASH & IN-KIND SUPPORT

- Equipment Rental
- Boom truck
- Trucking the mill parts to and from Hassett's workshop in Kentucky
- Travel expenses for millwrights — transportation, lodging, food, etc.
- Supplies —from specialty lubrications to new timbers

Conditions Report –Danish Windmill Restoration Project Estimate | April 2016 B.E. Hassett Millwrights

Conditions Report- Danish Windmill April 2016-

Note: The following items were evaluated and deemed necessary for repair/replacement during my Inspection of the Mill on April 25/26th.

1 Sails- Rear Sail Stocks have significant rot at the poll end (hub) and are in need of replacement.
The existing sails are approximately 40yrs old and have seen past repairs. The overall length of the sails is nearly 67ft, tip to tip.

The condition and weight of these timbers pose a safety risk to both persons and property in their present condition.

It is recommended that a plan be put in place to remove the sails from the mill by disassembly and wholesale removal so as to utilize the existing sail stocks as patterns.

It is further recommended that both of the sails be replaced at the same time, when funding is available to do so. Though the forward sails do not appear to be in as bad of condition as the rear set, it is likely they would need to be replaced in the near future given their age and exposure.

2 Wind Shaft- Existing wind shaft has been repaired/patched at critical areas in the past.

A basic inspection shows rot and decay present at critical areas including the areas supporting the Poll end and Gudgeons. I currently have a wind shaft timber at my shop that was tapered and bored for the replacement of the existing shaft.

With the weight of the poll and sails, and if the mill is to be operated, it is highly recommended that the current shaft be replaced. New sails should not be installed utilizing the old shaft for support.

3 Brake Wheel- The Brake wheel is the large gear in the cap that is mounted to the wind shaft and is the primary drive for all the mechanics in the mill.

Additionally, the brake wheel, as the name implies, is the one of the primary components that keeps the sails from turning in the wind, when the Mill is not in use.

The arms of the brake wheel that secure the Gear to the shaft are rotten in critical areas at the clasp arm hub and arm ends. The arms of the gear need to be replaced.

The cogs of the brake wheel were replaced in the last 20yrs. The cogs are reusable and it is possible that the main gear can't components could be repaired and reused, though it would require full dismantling of the gear to do so.

It should be discussed if the DWC would like to keep the original gear in service or if it should be removed intact, preserved and displayed on lower floors and a new brake wheel put into service.

For the purpose of this report, I am quoting for removal of existing brake wheel for preservation and construction and installation of a new brake wheel.

4 Cap and Frame- The Cap frame was replaced in 1995. Interior timbers look to be in very good condition.

A majority of the exterior timbers look in decent condition though a few have areas that are going to require rot treatment and repair. This will require partial dismantling of the fantail drive components to accomplish.

The work would need to be scheduled when the cap frame would be removed from the tower and on ground level. This work would coincide with the replacement of brake wheel and wind shaft.

Additionally, components in the fantail mechanism should be dismantled, inspected and repaired accordingly, while these components are easily accessible from ground level.

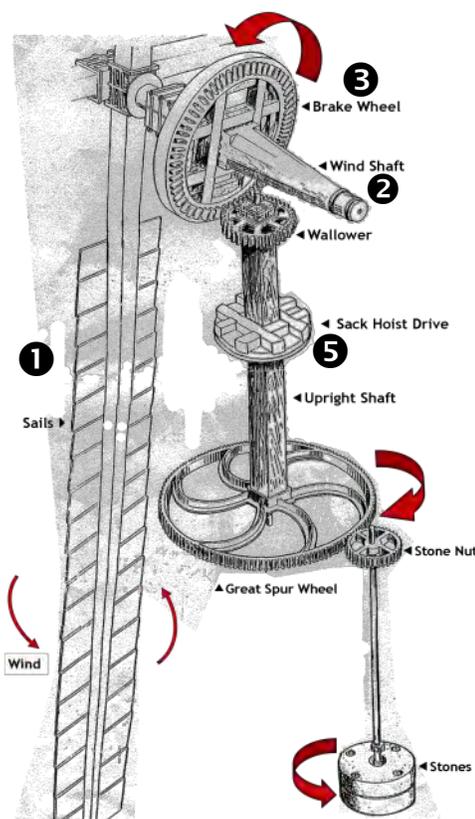
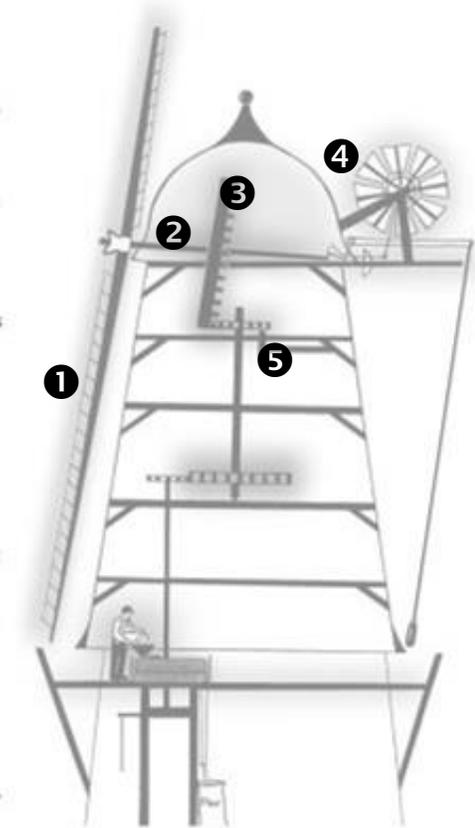
5 Friction Drive for Hoist- Located beneath the curb level of the tower is the friction drive for the hoist mechanism. This Drive Mounts to the vertically shaft and provides power for the hoist mechanism.

The pulley has long suffered from rot and decay, likely dating back to its origins in Denmark. The friction pulley is decayed beyond the point of being salvageable.

It can be treated and put on display, but should be removed before the mill is returned to operation, to prevent the pulley "fragmenting" when the mechanism is in motion. For budget purposes, I am including a cost for replacement of the friction Drive pulley.

Suggested Order of Operations-

1. Dismantling and Removal of Existing Sails.
2. Order New Sail material.
3. Construct New Sails (Prior to Removal of Cap Frame)
4. Construct New Gear Components.
5. Remove Cap from tower.
6. Remove shaft, poll end and gears.
7. Repairs to Fantail and Frame
8. Complete new Wind shaft.
9. Install new components in cap and tower.
10. Reinstall Cap onto tower.
11. Fit New sails.



-ESTIMATED COSTS FOR REPAIRS-

Danish Windmill

Elk Horn, IA-
May 7, 2016

1. Sails- Supply New set of timber sails. Main stock lengths are 67' in length and 12x12 In section.

A long lead time is required on the purchase of these timbers. Additionally the timbers will be dried at my shop to an "air dried" moisture content, then treated with preservatives.

Timbers will be a select, dense grade Doug Fir, similar to what is currently in place. Existing sail bars will be reused where ever possible.

Shutters will be evaluated and replaced with Marine Grade Plywood. Hinge and Pivot components will be inspected and repaired/bushed accordingly.

All element of the spider coupling that opens and closes the shutters, will be inspected and refurbished. The below costs include removal of old sails, and installation of new.

2. Wind Shaft- Removal of existing shaft. Supply new white oak wind shaft. Fit Poll end, and install Back into Cap frame. This component of the proposal also includes the reassembly of the spider coupling and mechanism.

3. Brake Wheel- Removal of Existing Brake wheel. Install new gear. Set up and adjustment of brake band. New brake wheel will utilize existing cogs if possible. Gear will be constructed in my shop and fitted to new wind shaft and periphery of gear "trued" to insure proper and effective operation of brake band.

4. Cap and Frame- Remove Cap Frame from tower, Remove roof section from cap frame. Build temporary roof for tower while Cap is removed. Repair Fan tail spars and horizontal timbers. Rot repair to rails. Reinstall flashing, reassemble Fantail mechanism. Replace/refurbish worn bearings. Assemble roof and set Cap and new components

5. Friction Drive for Hoist- Removal of existing friction drive pulley. Build new pulley and install on vertical shaft. True Pulley on shaft and verify proper operation.

Total Estimated Cost for the above Including:

Crane Service/equipment rental, Labor and Materials- \$146,740.00

Time of Performance- 4 months from commencement.

Progress as of February 2017



▲ **New Wind Shaft**—The existing wind shaft has been repaired/patched at critical areas in the past. Knowing that at some point it would need to be replaced, we purchased the timber and had it tapered and bored to be ready when it was needed and that time is now.



▲ **New Sail Cross Arms**—A long lead time is required on the purchase of the new set of timber sails so they were ordered in May. Main stock lengths are 67' in length and 12x12 In section. The timbers were transported from Oregon to Kentucky in August where they are being dried at Hasset's shop to an "air dried" moisture content, then treated with preservatives.

B. E. HASSETT MILLWRIGHTS

A native of Iowa, Ben Hassett began his career with an apprenticeship from British millwright expert Derek Ogden. It was during his apprenticeship that he came to work on the Danish Windmill cap frame replacement project in 1995.

Hassett says that when he was working for Derek, he knew that was what he wanted to do. He stayed with Derek for four years then began his own company. Hassett Millwrights is one of a very few companies that do what they do in the U.S. and that is, to work on genuine mills.

B.E. Hassett-Millwrights is a full service, traditional Millwrighting company serving as a resource for repair, maintenance, restoration and reconstruction of Wind and Water powered agricultural and early industrial historical sites.

His experience ranges from maintenance and millstone dressing, to reconstruction of period machinery and gear trains, to major structural repairs.

Some of his projects include:

- Reconstructed Flowerdew Windmill in Hopewell, Virginia; relocated to American Wind Power Center in Lubbock, Texas (Flowerdew Hundred Plantation is the site of the oldest windmill in the US)
- Colonial Williamsburg, post windmill, Williamsburg, Virginia.
- Wolf Pen Branch Mill. Reconstructed water mill, Louisville, Kentucky.
- Evans-Mumbower Mill. Gear for water mill, Ambler, Pennsylvania.
- Rock Mill. 26 foot water wheel, Lancaster, Ohio.

Awards

2015 Harry H. Mellon Award of Excellence in Job Order Contracting for Colvin Run Mill, Great Falls, VA

2014 Ida Lee Willis Memorial Foundation Preservation Project Award for Wolf Pen Branch Mill, Sallie Bingham, Louisville, KY

2014 Clarke County Historic Preservation Commission, Historic Preservation Award, Certificate of Merit for Lockes Mill, Jon and VA

2013 Napa County Landmarks, Award of Merit for Bale Grist Mill, Napa Valley State Parks, CA

2012 Governor's Historic Preservation Award for Bale Grist Mill, Napa Valley State Parks Association, Saint Helena, CA

2007 California Preservation Design Award for Challenge Double Header Wind-Engine, Harden Foundation, Salinas, CA