Windmills in Estonia, Finland and Sweden

—Sustainable Heritage Report No. 7

Kirsti Horn, editor

Traditional Wooden and Masonry Structures in the Baltic Sea Region
Sustainable Heritage reports, 1/2015

www.sustainableheritage.eu

Windmills in Estonia, Finland and Sweden —Sustainable Heritage Report No. 7

Traditional Wooden and Masonry Structures in the Baltic Sea Region

Sustainable Heritage reports, 1/2015

Publisher: Enja Publishing, Vantaa, Finland

Layout: Michael Diedrichs

Windmills in Estonia, Finland and Sweden;
Sustainable Heritage Report No. 7 / Kirsti Horn (ed.)
– Vantaa: Traditional Wooden and Masonry Structures in the Baltic Sea Region,
Sustainable Heritage reports, 1/2015.
ISBN (PDF): 978-952-7075-01-2; (nid. / print): 978-952-7075-00-5
ISSN (online): 2342-2025; (print): 2342-2017

Windmills in Estonia, Finland and Sweden —Sustainable Heritage Report No. 7

Kirsti Horn, editor

A joint project between Novia University of Applied Sciences,
Campus Gotland at Uppsala University
and Estonian Academy of Arts.

Contents

Summary

The technique of grinding corn into flour by using wind power to turn a circular stone died long ago but the ingenuity of the machinery keeps us fascinated just like old cars or engines do. The fact that these machines are made by hand out of wood and that not two windmills are alike makes them all the more interesting. This report deals with historic windmills in Estonia, Finland and Sweden.

An interest in windmills was awakened among the participants of the 10^{th} Sustainable Heritage intensive course which took place on Gotland in spring 2014. This report is the result of student work from all three involved countries and universities, Estonian Academy of Arts, Uppsala University and Novia University of Applied Sciences. The research concerning Finnish windmills was carried out by the editor.

In the following the description of work and experiences during the intensive course in April 2014 is followed by a summary concerning windmills in Estonia and Finland, and finally, by examples of each main type of windmill that can be found around the Baltic Sea.

Preface

Windmills are truly fascinating—not only because of the famous scene with Don Quixote or because they are startling landmarks in windy places but also because they contain most fascinating engineering, i.e. developments of the first machine ever to use other than muscular energy. It took a thousand years from the first practical wind mill to the invention of steam power which then rapidly replaced the older technology at the end of the 19th century. Over the centuries details of the machinery in windmills was improved step by step, and finally the energy of the wind was made use of in a wide range of functions. The principle of sails, shafts and gears has, however, remained unchanged. This presentation will show some examples of the vast number of windmills in Estonia, Finland and Sweden.

In April 2014 students and teachers from Estonian Academy of Arts in Estonia, Novia University of Applied Sciences in Finland and Campus Gotland at Uppsala University in Sweden gathered in southern Gotland for the fourth of five intensive courses within the project **Traditional Wooden and Masonry Structures in the Baltic Sea Region.** For more details about the project and past and future courses, please visit its site on the Internet at the address www.sustainableheritage.eu.

The international cooperation within the field of building conservation was established many years ago and has already resulted in nine successful intensive weeks during the past years thanks to the Nordic Council of Ministers who have supported this **Nordplus** project financially and thanks to a motivated group of teachers. Every course has a different theme and they are hosted by the three universities in turns. Students are taught by expert craftsmen and given an academic background to each topic by teachers of the involved institutions. In addition to the pedagogical goals we cherish an idealistic wish that the performed hands–on work should contribute to the rescue and maintenance of our built heritage. This time a windmill from 1803 was given new *sails* and her *wind shaft* was restored to carry these.

As we visited some of the 80 historic windmills on the island a question arose concerning the number of windmills in Finland, Estonia and mainland Sweden.

Students were given the task to study the windmills in their own country in general and one of the three Nordic–Baltic types each in more detail. The result of these studies shows that some 550 Finnish windmills have survived through the last centuries although their machinery was out of date already a hundred years ago and although the majority of them have not been in use since the First World War. The situation of Estonian windmills is somewhat more critical.

Our thanks go to **Ph.D. Joakim Hansson,** lecturer at Uppsala University who hosted the intensive course on Gotland; and to the local builder **Tage Wickström** and his staff. We also thank **Joosep Metslang,** researcher at Rocca al Mare open air museum in Tallinn who led the building of new *sails* for Joakim's mill; and **Dan Lukas,** the doctoral student at Estonian Academy of Arts, for repairing the *wind shaft* of the mill and offering his expertise in the restoration process.

The editor's special thanks go to **Risto Känsälä,** curator of the regional museum of Southern Ostrobothnia, Finland, who pointed the direction and method for the survey of Finnish windmills which is presented in chapter 4. Many thanks to all the curators and researchers of the 22 regional museums in Finland and the Åland Islands who invested time in collecting up–to–date information of the Finnish historic windmills!

Kirsti Horn

Senior lecturer, Architect, AA Dipl.

1. Restoration work at a windmill on Gotland

1.1 INTRODUCTION TO THE RESTORATION PROJECT

The *sails* of all European windmills are attached in the front end of a horizontal *wind shaft* (which lies at an angle of a few degrees). Attached in approximately the middle of the *wind shaft* there is the big *brake wheel* which transfers the energy of the wings to a vertical shaft via a gear called *wallower*. The vertical shaft then turns the *runner stone* of the millstones either directly or via another gear. Outside at the back there is the *tail pole* which is used to turn the wings towards the wind. Depending on size, number of millstones and local materials the design of the body of the windmill varies a lot. Inside there are 1–4 intermediate floors, stairs and pieces of equipment for the handling of grain and flour.

During the intensive course within the project **Traditional Wooden and Masonry Structures in the Baltic Sea Region**, which took place in the village of Eksta on southern Gotland, new *sails* were built for the historic windmill at Sieger farm. Furthermore, the work included repairing the old *wind shaft* and the installation of the newly built *sails*.

The work was led by the local builder Tage Wickström together with Dan Lukas, the windmill expert from Estonia and Joosep Metslang from the Tallin open air museum, Rocca al Mare. With the joint effort of these three experts, helpful neighbours and 24 students the job was finished in just three days. The site had been prepared well in advance by local builders and the master of Sieger farmstead.

1.2 THE STARTING POSITION

Before April 2014 the *smock mill* at Sieger farm had stood over 60 years without *sails*. (figures 1.1, 1.3) It was built in 1803 with a body of local lime stone faced with lime rendering and a wooden *cap* with a pitched roof. A rather similar windmill stands by the neighbouring farm. It had been restored recently by its owners into working order. The model for new *sails* for the Sieger windmill was taken from here. (figure 1.2)

Figure 1.1. The masonry *smock mill* of Sieger farm before restoration. Photograph by Kirsti Horn.

Figure 1.2. The model for new *sails* was taken from the neighbouring farm. Photograph by Kirsti Horn.

Figure 1.3. The Sieger windmill dates back to 1803. Photograph by Kirsti Horn.

1.3 FIRST STAGES IN THE RESTORATION PROCESS

Before the intensive course started the decayed front part of the old *wind shaft* had been sawn off and brought down. A rough replica of the removed part with half of an open mortise and tenon joint had been made of a thick log of pine which had been seasoned for a year.

In order to make a perfect joint between the old and the new that would stand the load of the *sails* without distortion, it was decided that also the rest of the *wind shaft* should be brought down and worked on the ground.

1.4 THE DISMANTLING OF THE WIND SHAFT

First of all, the big *brake wheel* had to be disconnected before the *wind shaft* could be dismantled. (figure 1.4) The problem was that parts of the *upright spindle* or shaft which transfers the rotating force from the wheel to the *runner stone* had rusted and could not be disturbed. The *brake wheel* had to be carefully detached from the *wallower* by moving it some 10 cm in its mortices so that its cogs would not touch the *wallower*.

This was done by forcing out the very tight wedges from the mortices i.e. the junction between *wind shaft* and *brake wheel* spokes. Now the wheel could be pushed forward. Then the bolts that hold the spokes and the wheel together were undone—two wooden pegs and one metal bolt with a nut in each of the four joints. When the fastenings of the first spoke of the *brake wheel* were dislodged the shaft and the wheel were turned 90 degrees to give access to the plugs that secured the second spoke. All dislodged parts were numbered as the work went on.

Now both the *brake wheel* and the *wind shaft* were strapped to the roof structure, each one separately because the wheel was to stay inside while the shaft was to be taken out. The *brake wheel* was detached from its spokes and the spokes were pulled out from their mortices in the *wind shaft:* the great wheel was now free and hanging from the rafters.

Figure 1.4. View through the *brake wheel* towards the rear end of the *wind shaft*. One wooden peg and one bolt have been removed from each spoke while the wedges are still in place. Photograph by Kenneth Eriksson.

1.5 LIFTING THE OLD WIND SHAFT OUT OF THE MILL

So far the *wind shaft* had been resting on its bearings on the *tail beam*. Before we went further ahead with the dismantling of it we nailed a board over the *breast beam* and *neck bearing* in order to assure ourselves that we would not damage these when taking out the heavy piece of timber. Now began the job of hoisting it out. The tail end was unlocked from its bearings and lifted up so that the shaft became horizontal as it was hanging by its straps from the roof structure. Through swinging it forward and moving the straps step by step the *wind shaft* was slowly brought out through the hole in the *cap*. (figure 1.5)

When the *wind shaft* was balancing between inside and out and stuck out far enough off the wall, a log loader grabbed it and lifted it out of the mill onto the ground. The process viewed from outside can be seen on the Sustainable Heritage Channel on YouTube at http://www.youtube.com/sustainableheritage.

Figure 1.5. The *wind shaft* is on its way out. Photograph by Kenneth Eriksson.

1.6 REPAIRING THE WIND SHAFT

Once the tail end of the old *wind shaft* was on the ground, next to the new front part, a perfect joint between the two was made (figures 1.7–1.10) under the leadership of Dan Lukas. Both traditional and modern tools were used. The open mortise and tenon was secured with two sturdy wooden pegs and a custom made wrought iron clamp forged by John Friederich, a student at Uppsala University and participant on the course.

When an old and a new piece of wood are joined there is likely to occur movement as the new part is bound to shrink as it goes on drying. This is why the wooden pegs and bolts of the clamp should be tightened after a year or two.

The resinous heartwood of the old *wind shaft* is still perfect while the sapwood, like every other piece of wood in the mill, has been severely attacked by woodworm—judging from the flight holes these are Soft Wood Borers, *Hadrobregmus pertinax* and Common Furniture Beetle, *Anobium punctatum*. (figures 1.6 and 1.9)

Figure 1.6. The section of the original *wind shaft* on the right reveals the destruction by insects. Photograph by Kirsti Horn.

Figure 1.7. The making of the open mortise and tenon joint took a lot of planning and measuring, sawing, planing and fitting before the pieces matched perfectly. Photograph by Kirsti Horn.

Figure 1.8. Two students are drilling holes for the pegs while the third is making sure the drill is kept straight. Photograph by Kirsti Horn.

Figure 1.9. Two wooden pegs secure the joint between old and new parts. Wedges were forced in through their ends in order to tighten them. On the surface of the old *wind shaft* the bigger flight holes are made by Soft Wood Borers while the minute holes are made by Common Furniture Beetle. Photograph by Kirsti Horn.

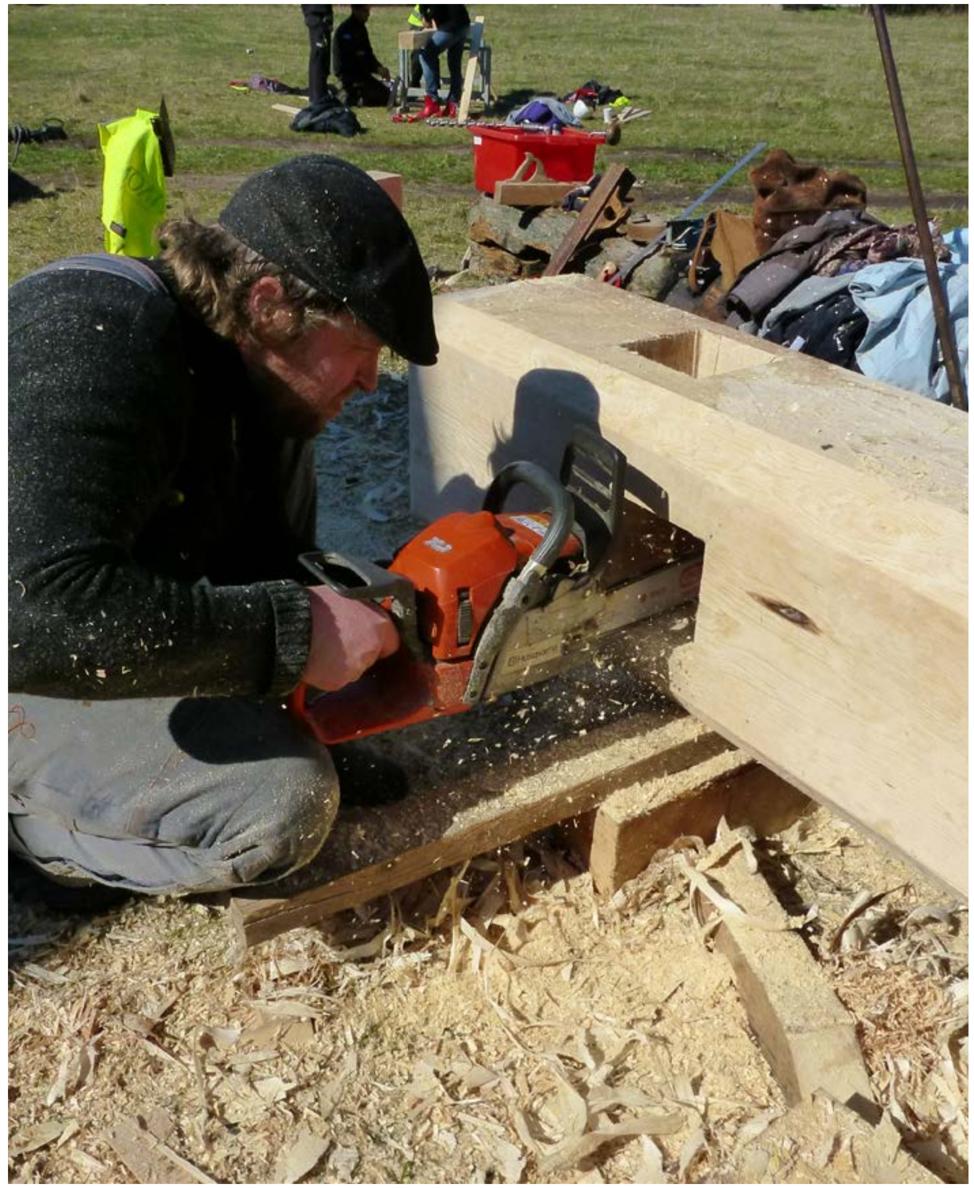

Figure 1.10. Dan Lukas is making the *sail stock mortices*. The new *poll end* is a replica of the original. Photograph by Kirsti Horn.

Figure 1.11. From left: John Friederich, Joosep Metslang and Dan Lukas are fitting the steel clamp around the joint between old and new sections of the *wind shaft*. Photograph by Kenneth Eriksson.

Figure 1.12. The surface of the new part of the *wind shaft* was planed smooth with hand tools. Photograph by Kenneth Eriksson.

1.7 LIFTING THE WIND SHAFT BACK INTO ITS POSITION INSIDE THE MILL

The log loader with its skillful driver was called for help two days later when the *wind shaft* was ready to be lifted back where it came from. As the piece was carefully and slowly maneuvered inside it was again secured with straps to the roof structure. After the log loader had to let go it was moved manually through the *brake wheel* back onto its bearings in the same manner as it was hoisted out. (figures 1.3–1.17) The lifting process viewed from outside can be seen on the Sustainable Heritage Channel on YouTube at http://www.youtube.com/sustainableheritage.

Figure 1.13. The lifting process starts with the log loader. Photograph by Michael Diedrichs.

Figures 1.14 and 1.15. The repaired *wind shaft* on its way back. Photographs by Kenneth Eriksson.

Putting back the spokes and dismantled parts of the *brake wheel* was a bit like solving a giant three dimensional jig saw puzzle where all pieces had to be joined in a specific order. At first the spokes were placed back through their holes in the *wind shaft*, pieced together onto the *brake wheel* and finally secured by the wedges that would hold them tight. In this particular case where the gear or *wallower* was jammed the wedges could not be driven back into the mortices in the *wind shaft* before the *sails* had been set up because the shaft must be turned as the *sail stocks* and the *sails* were mounted one by one from below.

Finally, after the *sails* were in place, the whole arrangement of shaft, wheel, *wallower* and spindle was reassembled as it had been since 1803.

Figures 1.16 and 1.17. Views from front and back of the *brake wheel* being attached back to the *wind shaft*. Clouds of saw dust from woodworm appeared with every beat on the wood. Photographs by Kirsti Horn.

1.8 THE BUILDING OF SAILS AND SAIL STOCKS

The students were divided into four groups with a *'sail master'* in each, to build the new *sails* for the windmill.

The task was quite a time consuming challenge because we tried to use traditional tools. Each *sail* has a frame of six bars which go through the *sail bar*. Every transverse bar is at a different angle like in a propeller. After small holes had been made with a chainsaw in the *sail bar,* chisels were used to form exact holes for the transverse bars. To complete the frames, two long bars were nailed to the ends of the transverse bars and some boarding was fixed over the four squares closest to the *wind shaft*. (figures 1.18–1.20)

Sail stocks are long pieces of wood that taper towards the ends. They are fixed through the *sail stock mortices* at the *poll end* of the *wind shaft* where they are secured with wooden wedges. Their function is to carry the *sails*.

Figures 1.18 and 1.19. Students built new sails with traditional tools. Photographs by Kirsti Horn.

Figure 1.20. The two *sail stocks* were fitted into their holes at the end of the *wind shaft* before the shaft was lifted inside the mill. Photograph by Kirsti Horn.

1.9 ATTACHING THE SAILS

The *sails* are attached to the end of the *wind shaft* via two *sail stocks*. For each *sail* there are two iron clamps and two bolts. The clamps are set in grooves in the *sail stock* and the *sail bar*. It was hard work to get the *sails* in place, but through good communication and cooperation we got them there by using ropes and muscles. (figures 1.21–1.24)

When attaching the *sails* to the *sail stocks* the original metal clamps were used which had been saved when the old *sails* had come down half a century ago. The clamps are U–shaped with threaded ends. A plate with two holes and two bolts fit the ends. (figure 1.23) The attachment is then completed with two bolts per *sail*.

Originally the *sails* of this wind mill would have been at least one meter longer than the ones made now in 2014. A shorter mock model was chosen because their weight is quite a burden on the *wind shaft* and *sail stocks* of a windmill which is standing still. To avoid future sagging of the *sails* all the attachments should be checked and tightened annually. Also, in mills whose *wind shaft* can be rotated it should be done every now and then to shift the loads.

Figure 1.21. The heavy *sail stocks* were lifted and fitted through the eyes or *sail stock mortices* at the *poll end* of the *wind shaft* and secured with wooden wedges. Photograph by Kirsti Horn.

Figure 1.22. The *sails* were lifted one by one into position and attached with the original clamps. Photograph by Kirsti Horn.

Figure 1.23. The original steel clamps were cleaned from rust before they were reused to attach the *sails*. Photograph by Kirsti Horn.

Figure 1.24. After three days of intensive work the windmill at Sieger farm was more complete than before. The performed repairs were the first steps in a restoration process where a lot more would have to be done before cereals could be ground. Even if only mock *sails* were built at least the *wind shaft* will last another century or two! Photograph by Kenneth Eriksson.

1.10 CONCLUSIONS OF THE HANDS–ON EXPERIENCE

Making new *sails* and a joint between the old and new parts of the *wind shaft* in the best way taught the students both some joinery and the correct approach to restoration work. First of all it is necessary to reserve enough time to figure out what you are supposed to be doing, and then:

- all parts of an old piece that are intact should be saved and used;
- all new parts should be made according to original models with utmost care and precision;
- only the best available material that matches the old should be used;
- traditional tools and methods give the best result.

A special treat on this course was the visit to the forge in Visby where John Friederich demonstrated his profession by making the big steel clamp for the *wind shaft*. (figure 1.25)

Figure 1.25. Visiting students admire John Friederich working in his forge in Visby. The skillful smith is beating out the big clamp for the joint between old and new parts of the *wind shaft*. Photograph by Kenneth Eriksson.

2. About windmills

2.1 THE FIRST WINDMILLS IN THE MIDDLE EAST AND EUROPE

The oldest known practical application of turning wind power into rotational energy by means of sails[1] can be traced to eastern Persia and as far back in time as to the 7th or 9th century AD. These windmills were of the horizontal type where a vertical pole is turned by several *sails* around it. This type of windmill spread east and southwards from the Middle East and Central Asia to China and India. The type was used for grinding grain and drawing up water.

It is likely that the idea of windmills was brought to Europe by the Crusaders in the 12th century. The milling technology was then spread by monasteries and the clergy at first to Southern Europe and then towards the west and the north. Mills were built by specialized masters with a good knowledge of both joinery and carpentry and the available species of timber. The vertical type of machinery with *sails* attached to a horizontal shaft is considered to be a European invention of the 12th or 13th century.

1 also called vanes or blades

2.2 THE THREE TYPES OF WINDMILLS AROUND THE BALTIC SEA[2]

Figure 2.1. Mäevälja post mill, Estonia. Photograph by Dan Lukas.

Post mills represent the oldest European type of windmill. This type of mill was probably invented somewhere in England, Holland or Flanders and then spread towards the East and North. Of surviving windmills in the North of Europe the *post mill* is the most common type while relatively few have survived in Central Europe. (figure 2.1)

2 See: APPENDIX 2 for vocabulary in Estonian, Finnish and Swedish.

Figure 2.2. Sagalund hollow post mill, Finland. Photograph by Gustaf Lindroos.

Hollow post mills, which are a Dutch 13th century development of the post mill, were used for drainage in Holland and corn milling in France. Around the Baltic Sea this type of mill is best represented in Finland and a limited area in the South West of Sweden. (figure 2.2)

Figure 2.3. A *smock mill* in Eksta, Gotland. Photograph by Kirsti Horn.

Smock mills are the latest and most common model of all surviving historic mills in Europe. They come in all shapes and sizes: in Central Europe most of them are large masonry structures with specialized industrial functions while a *smock mill* in the far North is often a slender wooden structure. Also large numbers of masonry *smock mills* can be found in Estonia and Sweden. (figure 2.3)

2.3 THE DISTRIBUTION OF WINDMILLS IN EUROPE AT THE END OF THE 19TH CENTURY AND TODAY

The European scenery was dotted with up to some 500 000 windmills in the middle of the 19th century, tens of thousands in each country. There were enormous mills that represented the industrial revolution in food production, irrigation, industries of all kinds (sawmill, paper mill, cement mill etc.) and drainage projects in the densely populated Central European countries. There were also small mills that belonged to farmers and bigger ones standing by mighty mansions and on the hills around towns. There were special mills for anything that needed to be ground: cocoa, snuff, spices, dyes, sand, oily seeds etc. And simultaneously at the other end of the scale, modest constructions were built to meet local needs in the remote countryside of Northern Europe.

Scanning through various sources shows that the number of windmills in Europe has decreased to just a fraction of their heyday in mid 19th century: from 15 000 to a few hundred in England[3], from 10 000 to 1000 in Holland[4], from 3600 in Estonia to some 480, from 20 000 to some 550 in Finland, from 2000 on Öland (Sweden) to 350, from 450 to 80 on Gotland (Sweden) and so on. This might be considered a natural development as very few of these historic machines have been used since the Second World War. Yet, most windmills are unique in their design and therefore a testimony of agricultural and industrial heritage, local craftsmanship and technical ingenuity that we should look after with pride and respect.

3 http://www.amazon.co.uk/Windmills-New-History-Colin-Moore/dp/0752454005
4 http://en.wikipedia.org/wiki/Windmill

3. Short summary of historic windmills in Estonia

3.1 HISTORICAL BACKGROUND

Grain was traditionally ground in three types of mills in Estonia: post mills, *smock mills* and watermills. Understandably, watermills were mostly used in areas with more rivers, but there are also places, where water power and wind power were used side by side (e.g. Pärnu and Narva). In Estonia the first *smock mills* were built by the gentry land owners in continental Estonia. Since the middle of the 19th century also peasants were allowed to own windmills. These were mostly post mills. The use of *smock mills* spread on the continent while *post mills* were widespread in Western Estonia. By the 1940's, there were still about 2300 *post mills* and 360 *smock mills* in Estonia.

The oldest surviving date of an Estonian windmill (1710) was found on a *crown tree* of a *post mill* in Atla village in Western Saaremaa. In her study about Estonian windmills[5] Vera Fuchs considers *post mills* to have been in use in all of continental Estonia, with a concentration on the islands and in Western Estonia, already in the 18th century. *Post mills* can also be found in the northwestern parts of the country i.e. mainly in the western areas of Pärnumaa, Harjumaa and Raplamaa. In the end of the 18th century the German–Baltic writer and theologist August Wilhelm Hupel[6] gave praise to the *post mills* on the islands and suggests that the gentry land owners elsewhere in Estonia encouraged their peasants to build similar windmills because these withstand storms better than the larger Dutch type or smock windmills.

During the Soviet era most of the private windmills were demolished in three stages. In the years 1940–41, in order not to get deported[7] many owners of mills pulled

5 Fuchs V. 1971. *Vanad Eesti pukktuulikud.*

6 Hupel, A. W. 1774-1782. *Topographische Nachrichten von Lief- und Ehstland.* Bd. 1-3. Riga: Johann Friedrich Hartknoch.

7 Estonian citizens were forcibly transported to Siberia during the Soviet occupation of their country in 1939-41 and 1949-1994. Two massive waves of deportation were carried out in 1939-41 (over 10 000 people) and again in 1949 (20 000 people). Special emphasis was placed upon the elimination of the nation's cultural, business, political, and military elite in addition to minorities such as Jews. source: http://estonia.eu/about-estonia/history

them down. Later in the beginning of the new era after the war even the bravest men seized their mills. Finally, in the years 1950–1970 the Soviet officials banned personal means of production. Land owners were told to dismantle their remaining mills and an order was given to kolkhoz's members to make surviving windmills unusable. *Wind shafts* and *sails* were cut to pieces and mills were dragged down from their posts with tractors.

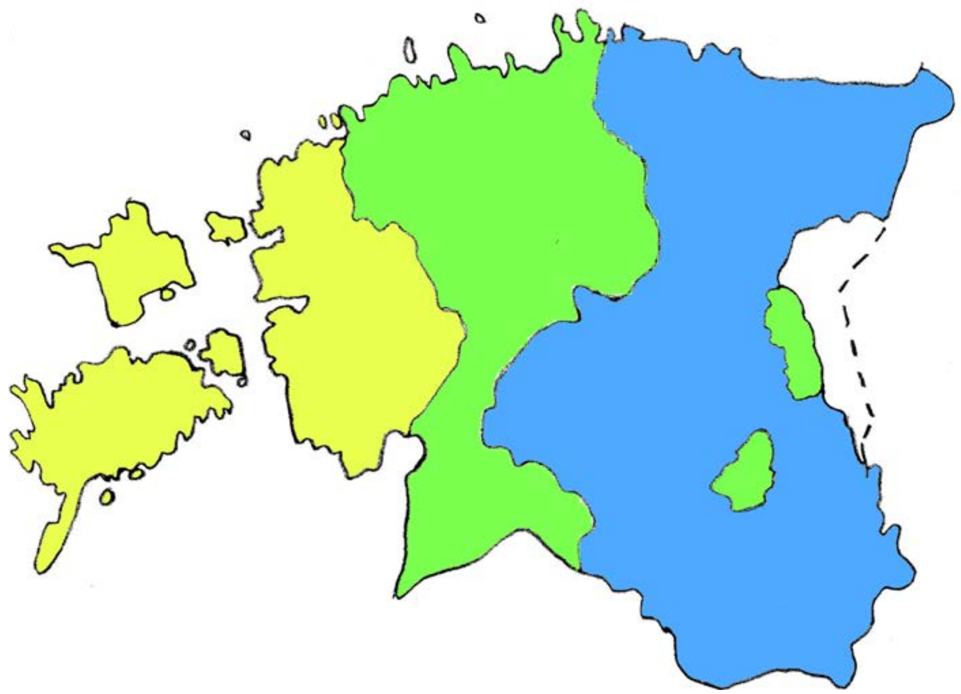

Figure 3.1. Map of Estonia with the spreading of mills according to Juske and Raesaar: Tuulikud läbi aegade. This map shows the spreading of the two types of windmills in pre Soviet Estonia: *post mills* in the west (yellow) and *smock mills* (blue) in the east meet in the middle (green).

3.2 POST MILLS IN ESTONIA

The first mention of *post mills* dates back to 1330 in Livonia on the Eastern coast of the Baltic Sea. The early windmills were built by the gentry but since the middle of the 19th century also peasants were allowed to own windmills. These were mostly wooden *post mills* that were used parallel to watermills, *smock mills* and steam mills up to the 1950's. The (newest) latest two *post mills* were built on Saaremaa in 1946 (Kareda village) and in 1947 (Metsaküla).

More than half of the surviving 122 Estonian *post mills* are in great danger of collapsing today. Most of these are on the islands of Saaremaa (86) and Hiiumaa (32), and only 4 on the mainland, i.e. in Läänemaa (2), Pärnumaa (1) and Harjumaa (1). Thanks to a recent interest in the matter several windmills have been restored. (figures 3.2–3.5 and 5.2)

Figures 3.2 and 3.3. Harju *post mill* before (2005) and after restoration (2009). Photographs and restoration by Dan Lukas.

Figures 3.4 and 3.5. Kukka *post mill* before (2005) and after restoration (2011). Photographs and restoration by Dan Lukas.

3.3 SMOCK MILLS IN ESTONIA

There are approximately 360 surviving *smock mills* in Estonia, dating from the 18th to the 20th century. 61 one these are wooden, while the rest have a masonry body, made out of limestone, granite or bricks. About 100 of these have a roof, some 60% of all are about to collapse or in ruins. Some *smock mills* are protected by the Estonian Heritage Board. (figure 3.6)

Figure 3.6. The grand *smock mill* at Seidla manor has been restored beautifully into working order. It is protected by the Estonian Heritage Board. Photograph by Kirsti Horn.

4. Short summary of historic windmills in Finland

4.1 BACKGROUND

The Finnish participants of the intensive course on Gotland were surprised to find that there was no overall information of the many windmills in their own country. The only documents with a general view are two maps—with few accompanying facts and figures—by Toivo Vuorela in his books *Atlas of Finnish folk culture* (1976) and *Etelä-Pohjanmaan kansanrakennukset* (1949). The first gives a graphic view about where the different types of windmills could be found in Finland before the First World War. The second illustrates the number of windmills in the year 1830.

For fresher information a request for a survey was sent by the editor of this report to all regional museums in the country. The aim was to count the surviving historic windmills and get an idea of their state of repair. A conclusion of the attained information is presented in chapters 4.3, 4.4 and APPENDIX 1.

Windmill technology was brought to Finland from Sweden[8]. Windmills were mentioned for the first time in 1463 in this eastern province of the kingdom. Towards the end of the 16th century their number is known to have grown to about 400. Over the centuries the technology spread from the southwest through the whole country. Water–powered mills always dominated in areas with waterways but windmills were built in great numbers over the next three centuries where fast flowing rivers and rapids are scarce.

8 Finland was part of the Swedish kingdom until the turn of the 19th century.

4.2 THE 3 TYPES OF WINDMILLS IN FINLAND

Figure 4.1. Post mill in Närpes; *hollow post mill* in Uusikaupunki; *smock mill* in Uusikaupunki. Photographs by Kirsti Horn.

There are three types of windmills in Finland: *post mills* represent the oldest type; *hollow post mills* represent a type that dates back to the second half of the 18th century; and *smock mills,* which are called *mamselli* in Finland according to mademoiselles who wore the smocks, were also introduced in the late 18th century. Most of the surviving mills were built in the 19th century. (figure 4.1)

According to Hirsjärvi & Wailes[9] "smock mills were used by the manors; hollow post mills were built by the larger farmers, and post mills by smallholders". All Finnish windmills are made of wood with one exception. Today most of them are painted with red earth paint[10], and indeed, this is known to have been the tradition since long at least in the western and central parts of the country.

Post mills of the Turku archipelago in Varsinais–Suomi are known to have been constructed in a similar way as the Estonian *post mills* with a wooden frame and vertical boarding on the outside. The floor measured generally some 3m x 3m and the walls were often widening upwards thus giving the mills a rather graceful and well

9 Authors of four booklets called *Finnish Mills* which were published in London by the Newcomen Society in 1968-73.

10 See: *Plank Roof and Traditional Paintwork; Sustainable Heritage Report No. 5* at http://www.sustainableheritage.eu/publications

proportioned appearance[11]. Elsewhere in Finland the construction technique varies, and because no comprehensive and exact studies of this have been made, the following generalizations are results of what can be seen in old and new photographs and scattered inventories that have been carried out in the regions.

In mainland Finland *post mills* are usually constructed of interlocking logs and this is the most common structure of the surviving post mills. The lower bodies of *hollow post mills* are also log constructions. The latter have two types of upper bodies: the high and narrow tops are built with a structural timber frame and boarding on the outside while the cubical tops are made of logs. The slanting walls of *smock mills* were usually built with a wooden frame and facades of boards while the turning top was often made partly or wholly of horizontal interlocking logs.

As the stability of a log construction relies on gravity it must be supported from below. The majority of Finnish *post mills* are therefore not carried on a *post* and *crown tree* (compare chapter 6.2) but instead, their weight is carried on a collar (often but not always fitted with iron) above the sub–structure. The post around which the mill turns also gives stability to the structure. The post is supported by the *foot* of the mill and rises up through the frame of the second floor.

Any log construction is fairly light and easy to transport. Dismantling and re–erecting log constructions was a standard procedure in old days as buildings or parts of them were moved and reused many times over. After the logs and frames are marked they can be taken down, transported and built up again. A windmill was generally personal property and that meant that it was moved along with the owner or could be sold like any private belongings. This tradition of moving windmills also explains why so many open air museums have a windmill among their collection of buildings; few of them stand on their original site.

Moving mills goes on still today: on the Åland Islands there is a great demand for old windmills as they have become something of a status symbol. Also the tourist brochures market Åland as the land of windmills. According to Göran Dahl, the authority on windmills on Åland, windmills are moved about in such numbers that heritage authorities find it difficult to keep track of them.

11 *Tuulimyllyt Turun asumusrannikon maisemassa* by Paavo Kallio.

4.3 THE NUMBERS AND DISTRIBUTION OF THE DIFFERENT TYPES OF WINDMILLS IN FINLAND

By Kirsti Horn

In the 1830's some 5000 windmills were counted[12] and according to Ilmar Talve[13], professor of ethnography at University of Turku, there is likely to have been up to 20 000 windmills in Finland at the turn of the 20th century. Right after the First World War there were still numerous windmills all over the country but after a few decades most of them were lost in one way or another. For instance some 250 windmills were counted in the coastal archipelago of Turku in 1919, but in 1937 only 80 survived[14]. Today the number of windmills in the whole Varsinais–Suomi region is 46 (the archipelago being part of this region). Likewise the number decreased rapidly in all of Finland towards the end of the 20th century. 556 windmills are known to have existed in 1947[15] on mainland Finland and now, 68 years later, the number is down to about 350. (figure 4.2)

In regions where farms stood far apart each one would have had a mill of its own while in more densely populated areas mills were often owned and operated by a group of farms together. These cooperated in maintaining the structure, the machinery and the road to the mill. They also shared the taxes and the cost of the miller's services. Many mills were used by their owners in turns without the aid of a miller.

The technique of using wind power became redundant after easier sources of energy, like steam and electricity, were available. At the same time Finland among others was industrialized and the great land reform which was carried out during the 18th and 19th centuries split the ancient village structures and slowly also the tradition of cooperation. Yet, a few mills were in operation still after the Second World War. Of the some 550 remaining windmills today (mainland and Åland together) only a handful are in working order but many of them have their machinery and *sails* in place and hardly any are beyond repair. The present day situation can be read in APPENDIX 1 and on the Internet at http://www.sustainableheritage.eu/windmills.

12 *Etelä-Pohjanmaan kansanrakennukset* by Toivo Vuorela.
13 *Suomen kansankulttuuri* by Imar Talve who was born in Estonia 1919; died in Turku, Finland 2007.
14 *Tuulimyllyt Turun asumusrannikon maisemassa* by Paavo Kallio.
15 *Suomen kansankulttuuri* by Ilmar Talve.

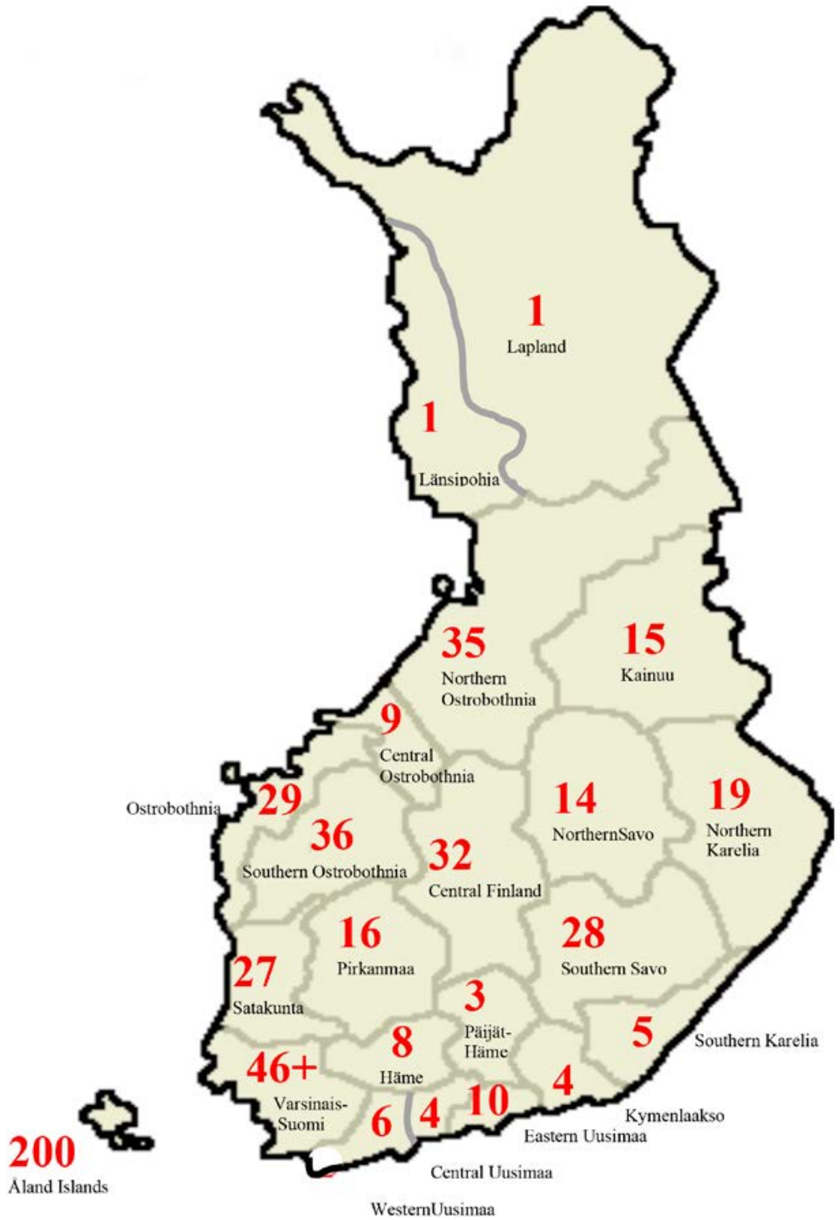

Figure 4.2. Map of all windmills in Finland in the year 2014 according to reports from the 22 regional museums. Drawing by Lucas Mondino, Kirsti Horn.

Historically there was a higher concentration of windmills in the southwestern and western parts of the country where there was a denser population and a more developed agriculture and prosperity than elsewhere, but more importantly a lack of water power. The map of the present day situation (figure 4.2) and the fairly complete list of Finnish historic windmills in the year 2014 (see http://www.sustainableheritage.eu/windmills) show that these areas still pride with the biggest numbers of windmills. It is worth noting that there is water power in the lake districts inland, and along the rivers that lead to the sea in the south, while the flat lands of Ostrobothnia in the west, the islands and coastal regions in general only have an abundance of wind power.

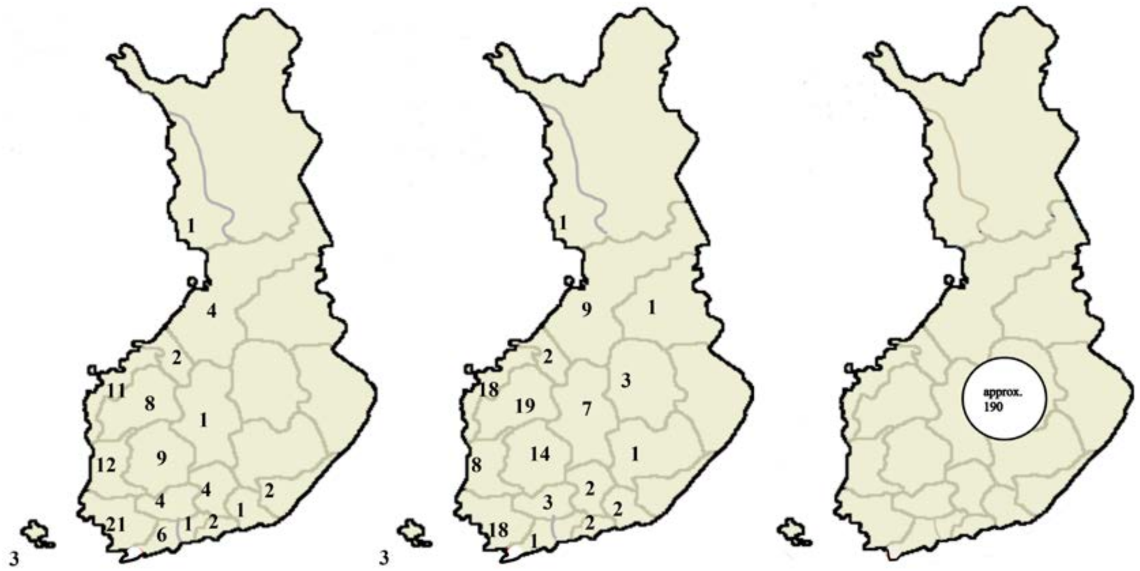

Figure 4.3. Maps of Finland showing the distribution of the three types of windmills 100 years ago. The numbers refer to **parishes** where windmills could be found before the First World War according to the *Atlas of Finnish Folk Culture* by Toivo Vuorela in 1976: 92 **parishes** with *smock mills* (left), 114 with *hollow post mills* (center) and ca. 190 with *post mills* (right). The exact number of individual mills is unknown but it is estimated by Ilmar Talve to have been around 20 000. Blank areas in the map by Vuorela seem to suggest that there was no reliable evidence for every parish to go by when the map was drawn in the 1970's. The conclusion is that it is likely there were more parishes with windmills than it appears from this information. Drawing by Lucas Mondino, Kirsti Horn.

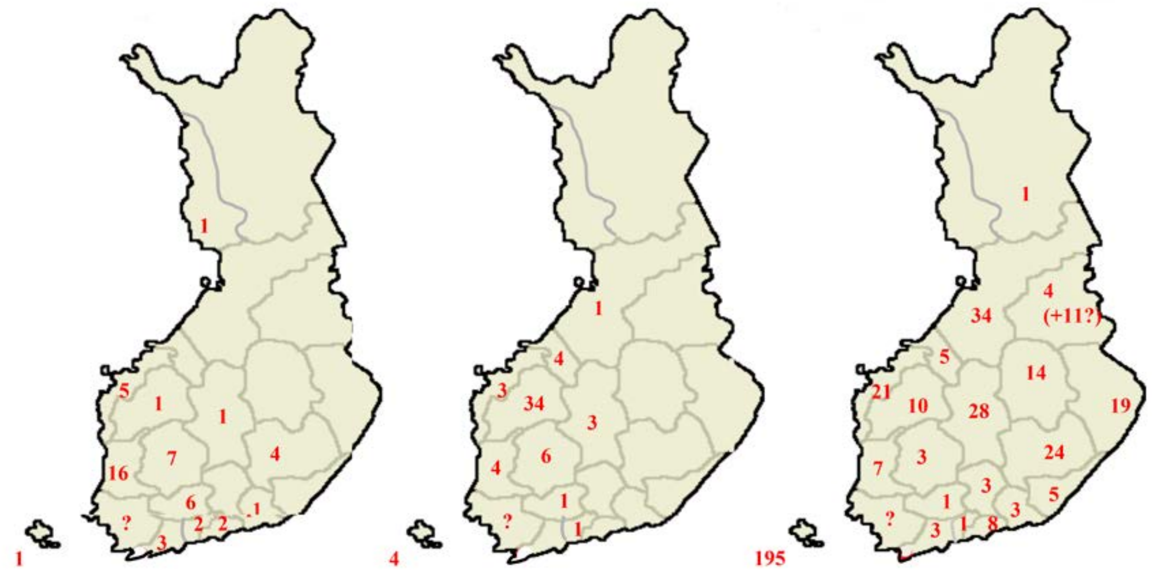

Figure 4.4. Maps of Finland with numbers of surviving **individual** *smock mills* (left), *hollow post mills* (center) and *post mills* (right) in the year 2014 according to reports from the 22 regional museums. (From Varsinais–Suomi only the total number of windmills could be attained.) The numbers for some regions are not 100% accurate but the general trend is obvious anyhow: in 2014 there are 383 surviving post mills, 53 surviving hollow post mills, 51 surviving *smock mills* and 63 unclassified windmills. Drawing by Lucas Mondino, Kirsti Horn.

A comparison between the old and new maps in figures 4.3 and 4.4 describes the drastic decrease of windmills over the past century. However, Finns still have a fine collection of some 550 historic windmills they ought to be proud of. It is obvious that every one of the surviving mills should be saved. Those that are museum mills and the ones that stand in open air museums are likely to be looked after. Most of the over 300 private windmills are also in very good hands (at least 130 mills on the mainland and assumed 180 on the Åland Islands). But there are mills that are falling into pieces as well. A strategy is needed for the rescue of this heritage. Particular attention should be paid to the rare *hollow post mills*.

The Finnish historian Auvo Hirsjärvi (1909–1998) together with Rex Wailes (1901–86), the English engineer, historian and expert on mills made a study of Finnish mills between the years 1968 and 1973.[16] Their learned analysis and inventories of selected samples are accompanied by lists of mills of which there are drawings or photographic evidence. Information about the situation as a whole in the early 1970's is, however, missing. A comparison of their inventories to the present day information shows that most of the mills they visited and described still survive.

The discussion of means to save the remaining Finnish windmills is beyond the scope of this study. Yet, it is worth noting that countries where there are mill associations, web sites about mills, interested historians, authors, publications and private enthusiasts are more likely to keep their mills than others.

4.4 THE PROTECTION OF HISTORIC WINDMILLS IN FINLAND

By Kirsti Horn

A limited number of buildings and milieus are protected by law in Finland but, on the other hand, the protection of historic monuments is organized through protection orders in land use planning. Farm buildings stand generally in areas that have no detailed plans and therefore no protection orders either. Consequently, many of the Finnish windmills are not protected. Yet, all kinds of building activity require permission from the authorities. Since heritage authorities are generally involved in the decision making about building and demolishing applications, they play a key role in the protection of cultural milieus and individual buildings.

16 The four papers by Hirsjärvi and Wailes about Finnish mills were published in the Transactions of the Newcomen Society, London, volumes XLI, XLIII, XLIV and XLV.

On the Finnish mainland more than half of the historic windmills stand by private farm houses and are looked after by their owners. Approximately 40% of the some 350 windmills in mainland Finland have been rescued to future generations in open air museums. There are 300 open air museums run either by heritage associations[17] or local authorities and more than 1/3 of these museums have a windmill or two, and several windmills serve as museum objects on their own without the supporting farm buildings. The communal effort and interest has generally made it easier to maintain these monuments of old fashioned, but extremely interesting technology. The museum mills are mostly intact while the upkeep of private mills has often proven too much of an economic burden. Yet, many owners of windmills take pride in maintaining and restoring their inheritance and some even manage to keep their mills in working order. Let us hope that all the numerous owners of historic windmills understand their cultural value and feel motivated to maintain them. Support in the form of practical knowhow would be of great help. Listing, detailed surveys, and general interest by museum authorities, education to craftsmen, publicity in the media and financial support could also inspire owners of old mills to look after the heritage with love and care.

17 There are some 700 Finnish heritage associations. Their central organization can be viewed at http://www.kotiseutuliitto.fi

5. An example of a post mill[18] in Estonia

5.1 BACKGROUND

Estonian *post mills* have not been classified under different names although they differ greatly in construction and proportion. It is very hard to find two identical mills of this type. In the inventory of *post mills* of Hiiumaa 27 different *post mills* were recorded and the subsequent analysis confirmed that not two of these were identical. However, *post mills* are divided into two main groups depending on their age and size. Old mills are usually smaller and less complex than newer mills. Although the construction elements and details have been continuously developed during the history of *post mills,* the name and main building principles have remained the same. (figures 5.1–5.5)

A glossary of windmill terminology in English, Estonian, Finnish and Swedish can be found in APPENDIX 2.

18 Pukktuulik in Estonian; jalkamylly in Finnish; stubbkvarn in Swedish.

Figure 5.1. Vilivalla *post mill* in Saaremaa before restoration in 2005. The interior is revealed through the decayed roof and facade. Photograph by Dan Lukas.

Figure 5.2. Vilivalla *post mill* in Saaremaa after restoration in 2008. Photograph and restoration by Dan Lukas.

5.2 STRUCTURE AND MECHANISM

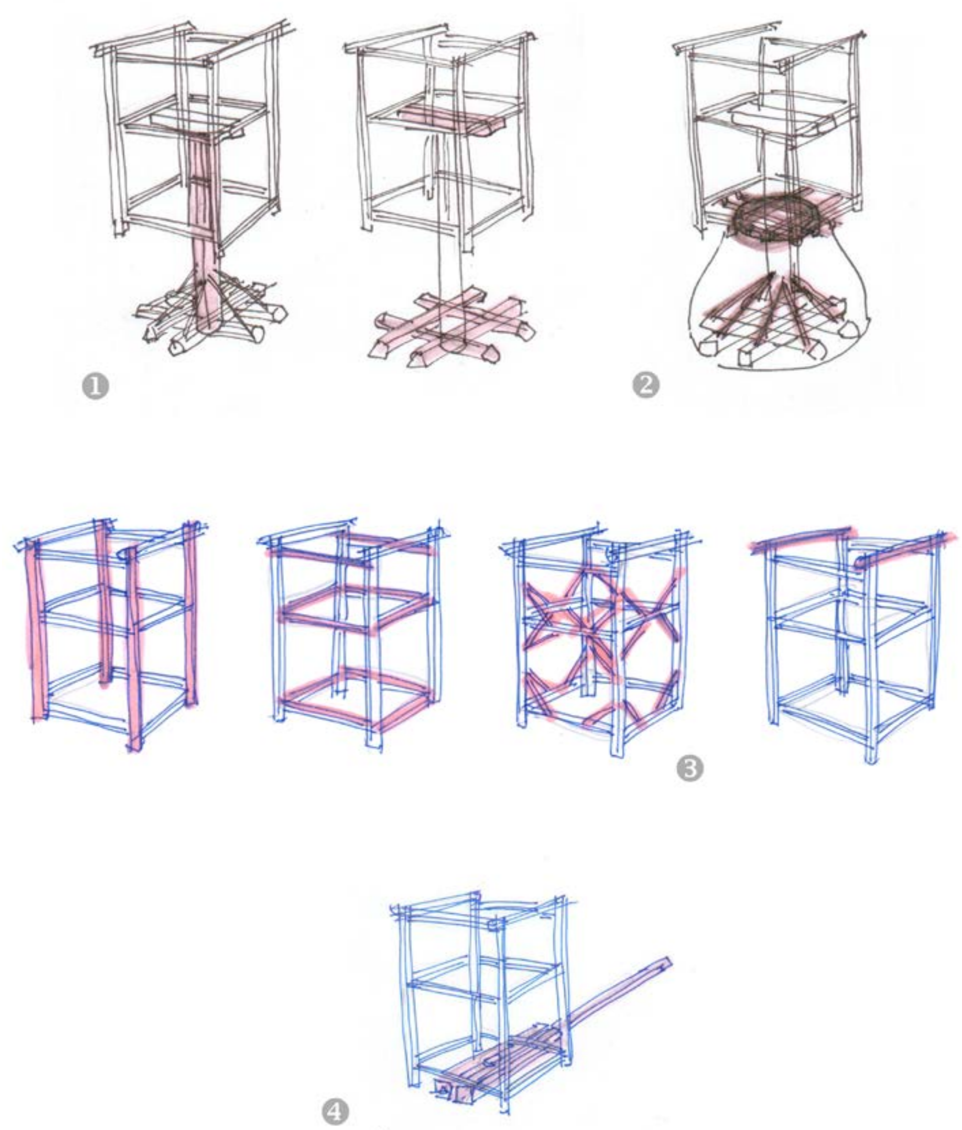

Figure 5.3. Structural analysis of a *post mill:* (1) *post* and *crown tree;* (2) support of the body: *foot* or *trestle;* (3) structure of the *body;* (4) *tail pole* and *deck*.

Post (1)

The body of the *post mill* with all its structural parts and grinding mechanisms is supported by the post. The top of the post is capped with a bearing that permits rotation. A sturdy beam i.e. the *crown tree* is placed on top of it to take the whole load of the body of the mill and its machinery.

Foot or trestle (2)

The construction that supports the post, is called the *foot* or the *trestle,* and it is composed of, the *foot* sill, *foot* braces, stone *foot* and log *foot*. Of course, larger mills have bigger *feet* than the smaller ones. The diameter of a stone *foot* is proportional to the layout of the body and the body itself covers the *foot* with its constructions from the environment. The height of stone *feet* varies—a higher *foot* makes it possible to have bigger *sails* and thus make better use of the wind. Four different types of *foot* can be distinguished. The following are translations of Estonian names for the structures: bare *foot,* closed stone *foot* with *foot* sills and *foot* braces, a log *foot* and a ventilated stone *foot* (with ventilation holes for preserving the wooden parts).

Body (3)

From the outside perimeter, the body is supported from underneath by a turning wheel or a collar, and the *crown tree* carries the body via the two middle side girts. While the post is immovable the whole body could be turned around it according to the direction of the wind. The construction of the body forms a rectangular timber frame consisting of four corner posts, ten girts, a *breast beam* and a *tail beam* on top and braces at the corners. The body contains all the milling machinery.

Tail pole (4)

The tail pole is used for turning the whole body of the *post mill* so that the front or breast with the *sails* catches the wind. The tail pole also gives support against the thrust of the wind from the opposite side.

Deck (4)

The tail pole with girts attached on either side make a sort of a steering device to help turn the mill. Together they form a deck or part of the bottom floor of the body. A deck includes also details like deck tenons, girt tenons, main post tenons, tail mortise and a

balcony with stairs on the outside.

Roof

The roof construction of a *post mill* has three pairs of rafters with collar ties and battens. The roofing is usually made of wooden boards. Estonian *post mills* have pitched roofs. Some have a hipped gable on the breast to allow for free movement of the *sails.* Both versions were used since the end of the 18th century. The practical difference between the two is the length of the protruding end of the *wind shaft* which of course, is shorter below a hipped roof. Also the angle of the *wind shaft* depends on the shape of the roof and the mill's centre of balance.

Wind shaft

The *wind shaft* which transfers the power from the *sails* to the machinery sits on the *breast beam* and the *tail beam*. Shafts are generally made of pine or oak. The *wind shaft's* neck i.e. the *journal* leans on a *neck stone* on the *breast beam* and the back end on bearings on top the *tail beam*. The *journal* is fitted with strips of iron plates in order to withstand friction and wear. *Neck stones* are made of granite or limestone, sometimes of metal plate or a block of oak or ash. In order to reduce friction the *neck stone* and *journal* were greased with fat and tar.

Sails are attached to the cross eyed protruding end of the *wind shaft*. The big *brake wheel* is attached in the middle of the shaft inside the mill. Similarly to all mills, the grinding mechanisms of *post mills* consist of various gears, *wallowers,* brakes, mill stones, *hoppers,* tubes, boxes and other such items. These come in many types and shapes as the mechanisms were constantly developed. Newer *post mills* have also stone pincers, sieves, ventilating hatches, sack hoists, elevators and other interesting apparatus for facilitating the miller's work.

Sails

Post mills generally have four *sails*. In newer types of mills these are attached to two *sail stocks* that go through the eyes at the front end of the *wind shaft*. The *sails* prevalently turned counter–clockwise in old *post mills* and in newer ones clockwise, but there are many exceptions.

The arrangement of the machinery

The axonometric projection (figure 5.4) and the section (figure 5.5) show the principle according to which all windmills work.

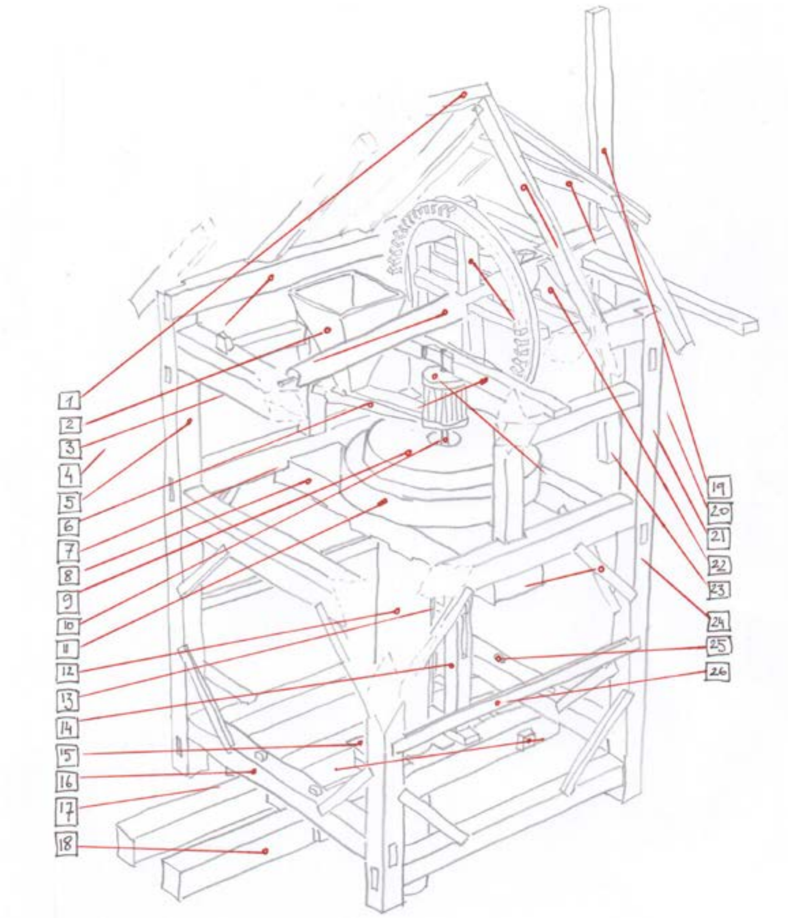

Figure 5.4. An axonometric projection of a *post mill:* ridge purlin (1), *hopper* (2), beam or girt (3), plate (4), post (5), *trough* (6), beam that holds the upright shaft (7), *crown tree* (8), *runner stone* (9), upright shaft (10), bed stone (11), post (12), brace (13), upward spindle (14), main post tenon (15), beam or girt (16), girt tenon (17), girt (18), *sail* or wing stock (19), halved hip of the roof (20), rafter (21), *breast beam* (22), *brake wheel* (23), *wallower* (24) and deck tenon (25).

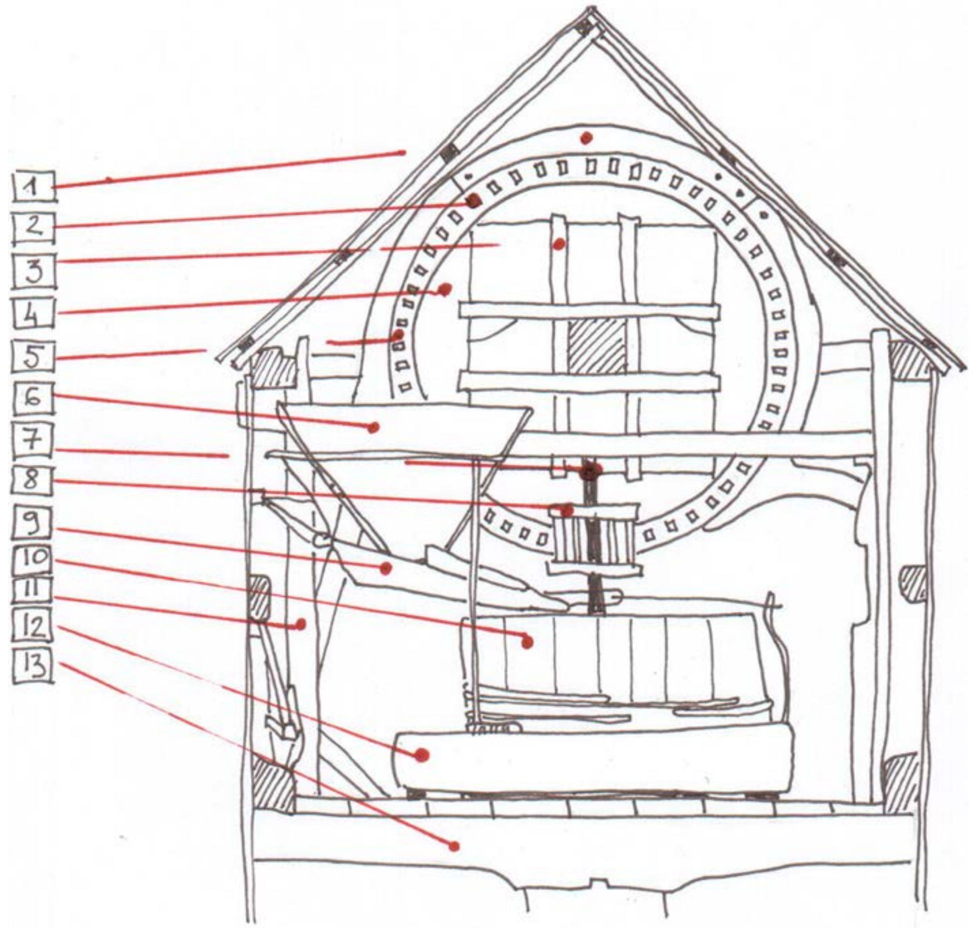

Figure 5.5. A section of a *post mill:* brake band (1), *brake wheel's* cog (2), element of the *brake wheel* (3), element of the *brake wheel* (4), element of the *brake wheel* (5), *hopper* (6), *upright spindle* (7), *wallower* or lantern pinion (8), *trough* (9), *runner stone* (10), brake (11), bed stone (12) and *crown tree* (13).

6. An example of a hollow post mill[19] in Finland

6.1 BACKGROUND

The type of windmill where the machinery is separated from the millstones in two structures on top of each other is rather rare. It looks like a *post mill* on top a house but really, it is a *post mill* divided into two. The post around which the body is mounted is hollowed out, to accommodate a drive shaft of iron. This makes it possible to drive machinery below or outside the top body while still being able to rotate the body into the wind. The mechanism that transforms wind energy to rotational energy is housed in the body while the millstones (France, Finland, Sweden…) or drainage apparatus (Holland) is in the house below. (figure 6.2) The design was developed already in the early 15th century. To Finland it arrived 300 years later and was adapted to local materials and building technique.

Most of the 53 remaining *hollow post mills* in Finland date back to the 19th century, only a few are older. Eight of these have lost their top and machinery and can hardly be called mills any more. The example here is a *hollow post mill* at the Sagalund open air museum on the island of Kemiö, off the south coast of Finland. (figure 6.1)

6.2 THE SAGALUND MILL

The *sails* of the Sagalund mill are fixed in pairs through the end of the *wind shaft*. This is a good example of an old type of arrangement without *sail stocks* (compare with the example of post mill, chapter 5 and the Sieger mill, chapter 1). It is considerably more difficult to assemble and repair such *sails* as two long poles carry a *sail* at each end. Similarly to all windmills the *sails* could be made larger by adding panels or cloth in their lattice when the wind was weak. The top body can be turned in the direction of the wind to achieve maximum effect while the bottom is immovable. The milling mechanism follows the principles of a post mill. (figures 6.2–6.4)

19 Holkkvarn in Swedish, *harakka*mylly in Finnish.

The *hollow post mill* got its Finnish name *harakka* from the bird magpie. All wind mills have a long *tail post* but the tails of *hollow post mills* are often up in the air and therefore make these mills resemble the bird.

Figure 6.1. The 18th century *hollow post mill* at Sagalund open air museum had been moved twice before it was brought to the present site in 1911. Photograph by Gustaf Lindroos.

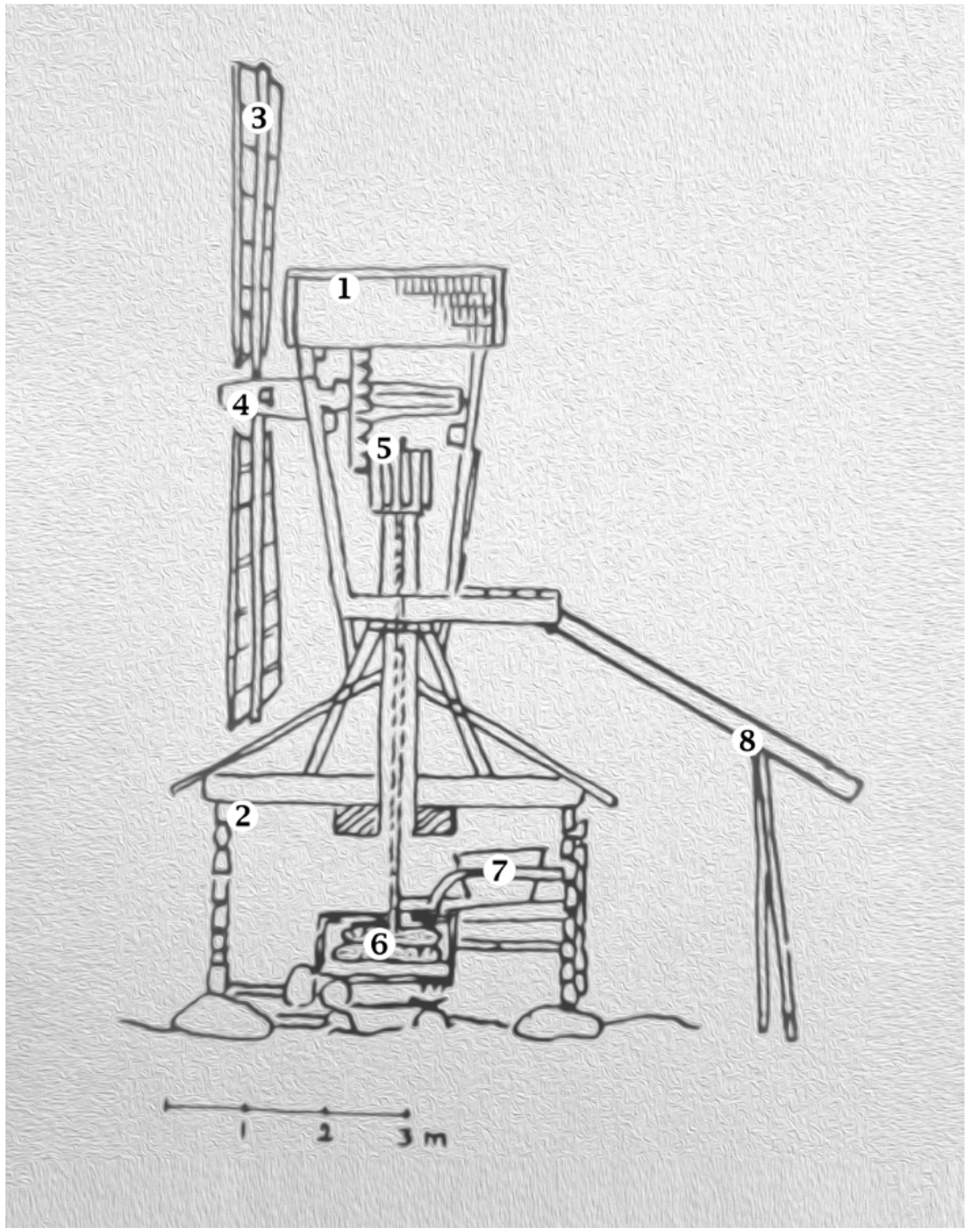

Figure 6.2. A copy of the Sagalund museum brochure shows the section of the hollow post mill: top body (1), stone chamber (2), *sails* (3), *wind shaft* (4), *wallower* (5), mill stones (6), *hopper* and *trough* (7), and *tail pole* (8).

Figure 6.3. The ancient *hopper* and *trough* were designed to lead the grains into the eye of the *runner stone*. Photograph by Gustaf Lindroos.

Figure 6.4. The upright hollow post inside which the upright shaft of iron is fitted enables the turning of the top while the lower part of the mill is immobile. Photograph by Gustaf Lindroos.

Figure 6.5. A close view of the *sails*. Photograph by Gustaf Lindroos.

7. An example of a smock mill[20] in Finland

A typical Gotlandic masonry *smock mill* is presented in chapter 1. Because 61 smock mills in Estonia, 50 in Finland and an unknown number in Sweden are built of wood it is appropriate to present also a wooden example in this study. These do not differ so much from the masonry mills in terms of function or shape but they certainly differ in terms of character.

The example here is from the open air museum in Helsinki. It is such a remarkable mill for Finnish conditions that Hirsjärvi and Wailes devote half a page to its story and construction in their paper about Finnish *Smock Mills:*

"In 1890 Mr. Antti Koski (1860–1954) of Koski Farm, Makkarkoski village ('sausage rapid') Oripää parish, visited Turku, saw the mill there and decided to build a mill himself on the same principles. This he did with a little outside assistance and commissioned it on 13 June, 1894. The stones are of Säkylä sandstone shaped on the spot by a retired local farmer called Pruuni. A local black smith, Iisakki Wahlroos, forged the wrought iron parts and the cast iron components came from Kauttua iron works nearby. The cap of the mill is hemispherical with a rounded dormer at the tail to allow for a full length wind shaft. The tower is cross braced with triangular windows as at Chesterton mill, Cambridge, and is levelled up on rocks; both cap and tower are shingle covered. There were six sails on a coffin cross (figure 7.1: exterior). The cap is mounted on a shot curb with an iron rack (figure 7.6); hand winding is effected by a hand crank with an iron pinion and wheel on a vertical wooden shaft on the stone floor (figure 7.2). This passes up to a clasp arm spur wheel at floor level on the second floor (figure 7.3); this drives a wooden pinion on a second wooden shaft that terminates in the final drive—a wooden pinion engaging with a wooden inward–facing rack to the cap circle (figure 7.4)."

"There is a clasp–arm brake–wheel braced in front to the wooden wind shaft and driving a small wooden bevel wallower built up from segments and mounted on the upright shaft (figure 7.7); the brake is of wood with ratchet and pawl to hold it.

20 Hollandi tuulik in Estonian ; *mamselli*mylly in Finnish; holländare in Swedish.

The large great spur wheel drives wooden stone nuts supported by wedged wooden bridgetrees. There are two pairs of underdrift stones on the first floor, one pair for peeling whole grain has a light upper stone (figure 7.8); both upper and lower have slightly curved grooves; while lands in between are pitted. The other pair, used to grind rye meal for bread and oats for feed, are similar but not pitted. A skew–built ladder leads down to the ground floor. In a gale in August 1948 two sails were blown off and the other four were removed, but the rest of the mill was in full working order. In 1970 the mill was bought by the National Museum of Finland and will eventually be moved to its Open Air museum at Seurasaari, Helsinki."

Figure 7.1. The Oripää *smock mill* has stood on a wooded hill in the Seurasaari open air museum of Helsinki since 1971. The *sails* and the exterior which is made of shingles will be restored in the near future. Photograph by Kirsti Horn.

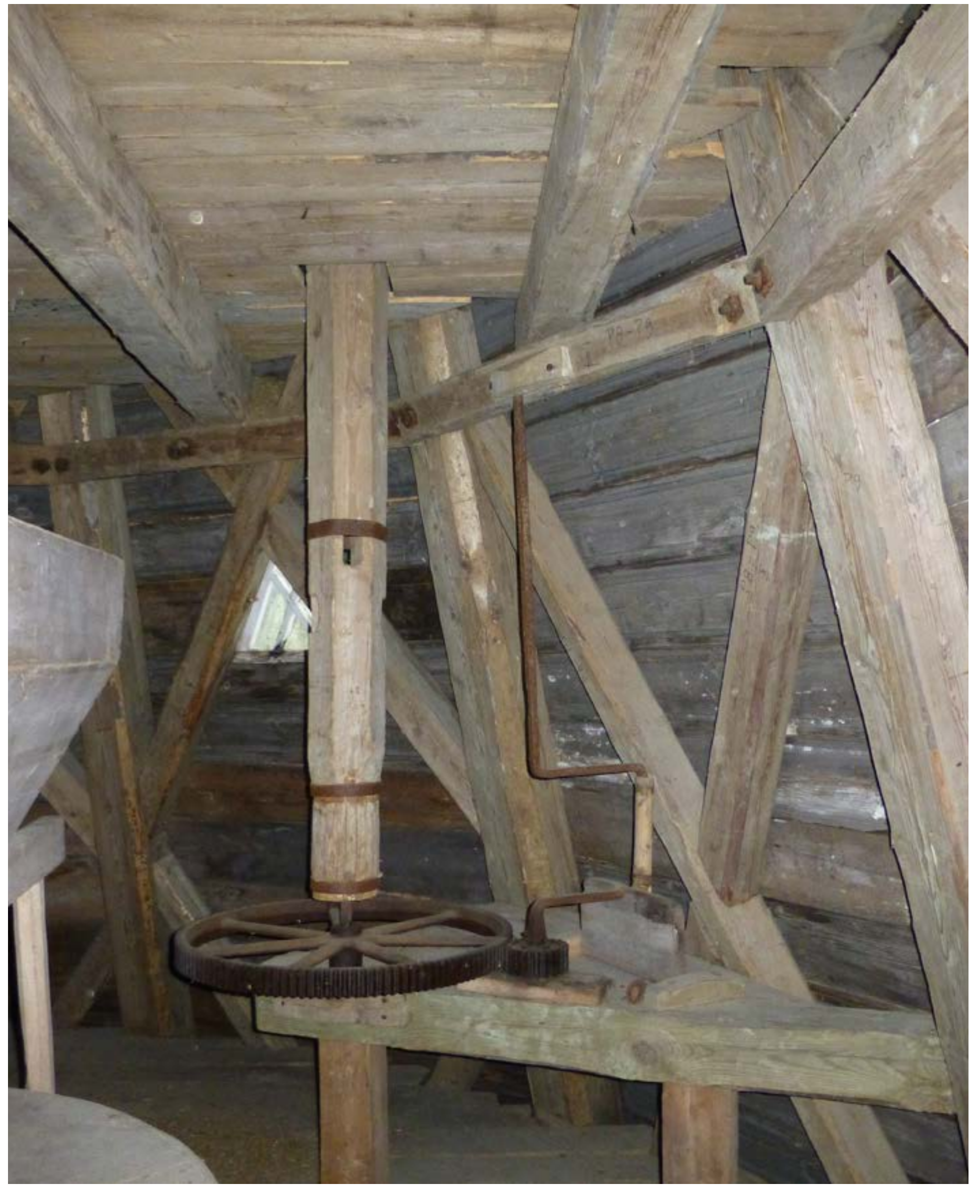

Figure 7.2. View of first floor or stone floor behind the two pairs of stones. The hand winding to turn the *cap* was done from here with the help of the iron crank which turned an upright wooden shaft next to it via an iron pinion and wheel. Oripää mill, Seurasaari, Helsinki. Photograph by Kirsti Horn.

Figure 7.3. On second floor the pinion on top of the shaft turned a second upright shaft via a wooden clasp arm spur wheel. Oripää mill, Seurasaari, Helsinki. Photograph by Kirsti Horn.

Figure 7.4. On third or top floor yet another pinion turned the *cap* which is fitted with cogs at the bottom edge. Oripää mill, Seurasaari, Helsinki. Photograph by Kirsti Horn.

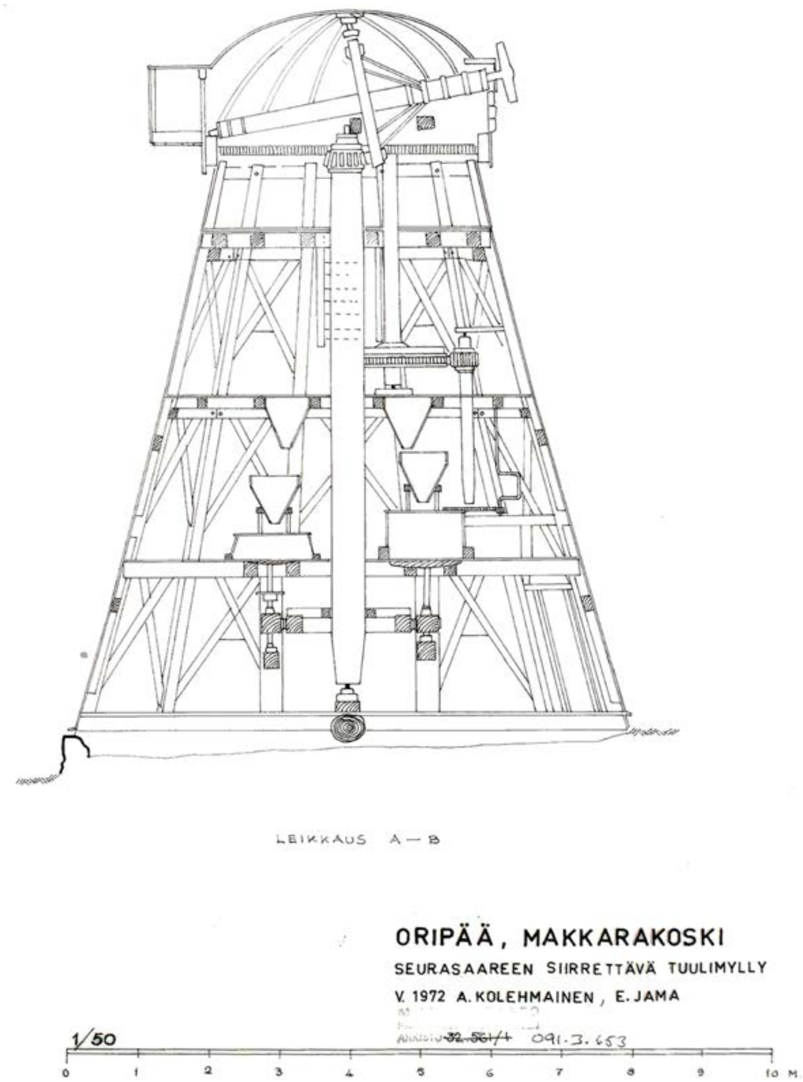

Figure 7.5. Section of the Oripää mill, Seurasaari, Helsinki. The drawing shows the *iron crank* on first floor (to the right from the millstones) and the system of vertical shafts, wheels and pinions between the top three floors for turning the cap. These are illustrated in detail in figures 7.2–4. Detail of a measured drawing by A. Kolehmainen and E. Jama 1972. Finland's National Board of Antiquities/The Archives.

Figure 7.6. The curb between the body of the mill and the *cap* is fitted with small wheels. Today all the metal parts of the mill would need a thorough cleaning before the machinery or *cap* would move again. Oripää mill, Seurasaari, Helsinki. Photograph by Kirsti Horn.

Figure 7.7. The *bevel wallover* on top of the upright shaft is made of sections that could be replaced when they wore out. The *brake wheel* in the background is unfortunately not properly attached to the *wind shaft*. Oripää mill, Seurasaari, Helsinki. Photograph by Kirsti Horn.

Figure 7.8. The two pairs of stones with their *hoppers* and *troughs* on either side of the sturdy upright shaft. Oripää mill, Seurasaari, Helsinki. Photograph by Kirsti Horn.

Conclusions

There are three different types of historic windmills in Estonia, Finland and Sweden. Like all over Europe, vast numbers of windmills are known to have existed in Scandinavia and the Baltic countries 120 years ago, but only a few percent of these have survived till today. The Nordic and Baltic vernacular mills were mainly used for grinding cereals, but in some instances wind power was also made to drive saws or draw water from a dock, polish stone etc. Practically all urban windmills have been pulled down since the industrial revolution to make way for the growing population in towns. Surviving windmills are to be found in the countryside where they generally are a striking element in the scenery. There is special reason to keep them from falling into ruin because of this scenic, not to mention historic and technical value they represent. It is also high time to collect their individual histories, information about their builders and their use.

In all three countries there are heritage associations, enthusiasts and concerned owners of mills who recognize the value of these machines and take responsibility for them. But it is surprising to note how little literature or other information there is about windmills around the Baltic Sea. Windmills are not a popular topic among researchers either. There is even a country where, until recently, nobody had an idea of how many historic windmills have survived within its borders.

Windmills must be protected from the elements like any other building. Fairly straight forward and regular maintenance is all that is needed in the north but south of Helsinki and Stockholm there is always a problem with wood boring insects. Repairs on damaged parts of the grinding apparatus should only be done by skilled carpenters with a thorough knowledge of the structure, function and tradition of mills and their use.

Regardless of shape, size and home country, every old windmill is a technical wonder with its handmade machinery and beautiful *sails*. May this report spread interest, knowledge and respect for the various aspects historic monuments represent in general, and windmills in particular.

Figure 8.1. Group picture of authors. Photograph by Stefan Haase.

Student authors:

Dan Lukas, Grete Nilp, Meelike Naris, Heli Nurger, Grete Ots, Kristiina Ribelus, Maarja Ruut, Hanna Selvet, Veiko Tamme, Helen Volber *(Estonian Academy of Arts)*.

Kenneth Eriksson, Sandra Heinström, Karolina Kaivola, Gustaf Lindroos, Lucas Mondino, Linda Sundström, Michelle Wickström, Simon Öst *(Novia University of Applied Sciences)*.

References

Estonia

Fuchs V. 1971. Vanad Eesti pukktuulikud

Hupel, A. W. Topographische Nachrichten von Lief– und Ehstland. Bd. 1–3., Riga: Johann Friedrich Hartknoch. 1774–1782

Juske, A. and Raesaar, P. Tuulikud läbi aegade 2008, Tallinn

Finland

Auvo Hirsjärvi, Rex Wailes. Finnish Mills, Part I: Watermills, Part II Mamsel or *Smock mills,* Part III Hollow Post Mills and Part IV: Post Mills. The Newcomen Society, 1968–73, available at: http://www.maneyonline.com/action/doSearch?AllField=finnish&SeriesKey=het

Toivo Vuorela. Suomen kansankulttuurin kartasto 1 — Atlas of Finnish Folk Culture SKS 1976, ISBN 951-717-099-8, ISSN 0355-1768, old map of windmills available at: http://www.helsinki.fi/kansatiede/histmaatalous/maanjaot/kartta_tuulimylly-tyypit.htm

Toivo Vuorela. Suomalainen kansankulttuuri 1975. ISBN 951-0-07190, 951-0-07190-9.

Toivo Vuorela: Etelä-Pohjanmaan kansanrakennukset 1949.

Timo Jokelainen. Lakeuden tuulimyllyt. Oulun Yliopiston julkaisu C65, ISBN 951-42-4981-X, parts of this are available at: http://www.kirjastovirma.net/lakeudentuulimyllyt

INTERNET SOURCES

http://www.helsinki.fi/kansatiede/histmaatalous/maanjaot/voimakoneet.htm

http://museovirastorestauroi.nba.fi/muut-kohteet/tuulimyllyt

http://urn.fi/URN:NBN:fi:amk-200911266150

Sweden

INTERNET SOURCES

Stefan Haase. Kvarnar i Lau, available at: http://www.lau.se/uploads/images/lau/artikelbilder/kvarnar/kvarnar_i_lau.pdf

Links

http://www.molinology.org/

http://www.sustainableheritage.eu/windmills

APPENDICES

APPENDIX 1: SUMMARY OF FINNISH WINDMILLS 2014

This is the summary of the complete list of Finnish windmills which is presented online at http://www.sustainableheritage.eu/windmills

The condition of each windmill was evaluated very roughly in three categories: A, B, C as follows:

- condition A = Good; structure, sails and machinery intact
- condition B = OK; faults in roof or walls, eg. sails missing or machinery incomplete
- condition C = bad; unsound or incomplete structure, sails and machinery missing

The information about the number and state of the historic windmills in Finland was collected by the following curators and researchers at the regional museums:

- Paula Hautala, Lapin maakuntamuseo, Rovaniemi
- Minna Heljala, Tornionlaakson maakuntamuseo, Tornio
- Teija Ylimartimo, Pohjois-Pohjanmaan museo, Oulu
- Rauni Laukkanen, Kainuun museo, Kajaani
- Pirkko Järvelä, Keski-Pohjanmaan maakuntamuseo, Kokkola
- Kaj Höglund, Pohjanmaan museo, Vaasa
- Risto Känsälä, Sirkka-Liisa Sihvonen, Etelä-Pohjanmaan maakuntamuseo, Seinäjoki
- Päivi Andersson, Keski-Suomen museo, Jyväskylä
- Marianna Falkenberg, Kuopion kulttuurihistoriallinen museo, Kuopio
- Ulla Härkönen, Pohjois-Karjalan museo, Joensuu
- Jorma Hytönen, Savonlinnan maakuntamuseo, Savonlinna / Harri Kaipainen, Etelä-Savon ELY-keskus

- Anu Salmela, Pirkanmaan maakuntamuseo, Tampere
- Liisa Nummelin, Satakunnan museo, Pori
- Juha Vitikainen, Kanta-Hämeen maakuntamuseo, Hämeenlinna
- Päivi Siikaniemi, Päijät-Hämeen maakuntamuseo, Lahti
- Miikka Kurri, Etelä-Karjalan museo, Lappeenranta
- Eija Suna, Turun museokeskus, Turku
- Vesa Kiljo, Länsi-Uudenmaan maakuntamuseo, Tammisaari
- Sari Saresto, Keski-Uudenmaan maakuntamuseo, Helsinki
- Synnöve Bergholm-Kullström, Juha Vuorinen, Porvoon museo, Porvoo
- Timo Lievonen, Kymenlaakson museo, Kotka
- Carola Boman, Ålands museum, Mariehamn
- Göran Dahl, Åland, Saltvik

APPENDIX 1

Historic Windmills in Finland 2014

Summary compiled by Kirsti Horn
according to information from
all Regional Museums in Finland

	private mills	mseum mills	unknown ownership	postmills	hollow post mills	smock mills	unknown type of mill	condition A	condition B	condition C	unknown condition	total sum of windmills in the region
Lapland			1	1				1				1
Länsipohja			1			1				1		1
Northern Ostrobothnia	19	16		34	1			16	13	4	2	35
Kainuu	4		11	4			11				15	15
Central Ostrobothnia	2	6	1	5	4			1	7		1	9
Ostrobothnia	3	23	4	16	4	5	5	12	1	2	15	30
Southern Ostrobothnia	19	17		10	25	1		19	5	10	2	36
Central Finland	15	7	10	28	3	1		14	3	8	7	32
Northern Savo	3	11		14				8	2		4	14
Northern Karelia	10	9		19				8	2	2	7	19
Southern Savo	10	7	11	24		4		4	2	1	21	28
Pirkanmaa	9	7		3	6	7		12	1	1	2	16
Satakunta	19	8		6	4	17		11	7	3	6	27
Häme	4	4		1	1	6		3	0	2	3	8
Päijät-Häme		2	1	3				1	1		1	3
Southern Kareilia	3	2		5				2	1		2	5
Varsinais-Suomi			46				46				46	46
Western Uusimaa	3	3		2		4					6	6
Central Uusimaa	1	3		2	1	1		2			2	4
Eastern Uusimaa	9	1		8		2		1	3	2	4	10
Kymenlaakso	2	3		3		1	1	1	1		3	5
The Åland Islands			200	195	4	1					200	200
result	**135**	**129**	**286**	**383**	**53**	**51**	**63**	**116**	**49**	**36**	**349**	**550**

APPENDIX 2: WINDMILL GLOSSARY ENGLISH; ESTONIAN; FINNISH; SWEDISH

The glossary of windmill terminology is based solely on the available literature and Internet sources. Despite its limitations it should help those who are inspired to go on studying the subject in these languages.

	Estonian	Finnish	Swedish
TYPE OF MILL			
postmill	*pukktuulik*	*jalkamylly, varvasmylly*	*stubbkvarn, stolpkvarn, fotkvarn*
hollow post mill		*harakkamylly*	*holkkvarn*
smock mill, Dutch mill	*Hollandi tuulik*	*mamsellimylly*	*hättkvarn, holländare*
MACHINERY			
sails, sweeps	*tiivad*	*siivet*	*vingar*
sail bar		*siiven varsi*	*kvarnarmar*
wing stock, sail stock, middling, main spar	*tiiva ige, ike*	*siiven apuvarsi*	*hjälparm*
wind shaft	*võll, võlv*	*siipiakseli, siipitukki*	*gångås, drivaxel*
bearing		*laakeri*	*lager*
journal, neck	*kaela tits*	*siipiakselin kaula*	*axelns hals*
poll end, canister (cast iron)		*siipiakselin etupää*	*kvarnhuvud, storände*
tail end		*siipiakselin takapää*	*lillände: axelns bakända*
brake wheel	*suurratas*	*suuri hammasratas / hammaspyörä*	*kronhjul, storhjul*
cog	*hammas*	*hammas*	*kugg*
spokes	*ardam*	*rattaan puolat*	*ekrar*
brake	*pidur*	*jarru*	*broms, pass, trög*
wallower	*värkel*	*lyhty, trälli*	*trellan, drevet, lyktan*

	Estonian	Finnish	Swedish
upright shaft		*pystyakseli, tantari, mäntä*	*kvarnaxel*
spindle	*pill, harkpill, argiraud*	*neularauta, väkirauta*	*trellnål, spindel*
GRINDING APPARATUS			
hopper	*(vilja)kolu, korv*	*suppilo, tuutti*	*tratt för korn*
trough	*king, küna*	*porsas, ruuhi, karistin*	*ränna*
millstones: *runner stone* *bedstone*	*veskikivid:* *kivitörs* *kivikrants*	*myllynkivet:* *päällyskivi* *aluskivi*	*kvarnstenar:* *löparen* *liggaren*
stone casing, stone furniture	*kiviraam*	*kivilaatikko, kahna*	*mjölkar:* *låda kring, kvarnstenarna*
meal spout		*jauhotorvi*	*rör för mjöl*
meal bin	*jahukirst*	*jauholaatikko, kahmalo, jauholaari*	*låda för mjöl?*
STRUCTURE			
body	*kere*	*myllyaitta*	*kvarnhuset*
tail pole	*veskisaba, sabapuu, vehmer*	*häntäpuu*	*vindhäst, kvarnhäst*
breast beam *weather beam*		*siipiakselin etupäätä* *kannattava palkki*	
tail beam		*siipiakselin takapäätä kannattava palkki*	
porch, balcony		*kuisti*	*bro*
post	*sammas, emapuu, post*	*tukki, tammi*	*stubbe, stolpe*
hollow post		*pystypatsas*	
crown tree	*pöörpakk, söömer, ematala*	*niskahirsi*	*hjärtstocken*
trestle	*raampakud*	*jalka*	*fot*
ladder	*trepp*	*tikkaat / portaat*	*stege / trappa*
floor, deck	*lava*	*silta, lattia*	*brogolv*

	Estonian	Finnish	Swedish
		kelkkaset	*brostockar*
collar (or bearing) above the sub-structure that carries the body		*kääntölaakeri*	*sadel*
cap	*müts*	*hattu*	*hätta*

About Estonian Academy of Arts

Established in 1914, the Estonian Academy of Arts is the only public university in Estonia providing higher education in fine arts, design, architecture, media, visual studies, art culture, and conservation.

FACTS AND FIGURES

- Students: 1300
- Academic staff: 450
- Student teacher ratio: 3:1
- Academic staff: Professional designers, architects, artists, scholars
- Networks: Erasmus, Cumulus, Nordplus, KUNO, ELIA et al.
- Partner universities: approx. 150 top universities in the world, including RISD, Rietveld, Udk, Emily Carr, RMIT, Angewantte, Aalto et al.

The Estonian Academy of Arts is a leading national and international center of innovation in visual culture. In addition to active study and research, the EAA also offers lifelong learning opportunities through the Open Academy.

Currently, the 1200 students enrolled at the Estonian Academy of Arts are taught by 83 professors, associate professors, teachers and lecturers. Additionally, 38 workshop managers are on hand to assist students. The Estonian Academy of Arts prides itself on their small student to professor ratio, which allows personal and one–on–one attention for the instructor and learner. Studies take place in small groups of carefully selected students.

Many of the students participate in exchange programmes at partner international universities during their studies. The EAA cooperates with almost 100 universities abroad and belongs to several international higher education networks. Annually, students are recognized in international design competitions.

ESTONIAN
ACADEMY OF ARTS

Estonian Academy of Arts / Eesti Kunstiakadeemia

Estonia pst 7 / Teatri väljak 1

EE–10143 Tallinn, Estonia

Phone +372 626 7301

Fax +372 626 7350

Email artun@artun.ee

EAA Skype: kunstiakadeemia

www.artun.ee

About Campus Gotland, Uppsala University

Quality, knowledge, and creativity since 1477 — world–class research and first–rate education of global use to society, business, and culture. Uppsala University's goals:

- Conduct research and provide education of the highest quality.
- Be broad–minded and open to change.
- Take an active role in global society and promote development and innovation.
- Strengthen its position as a world–leading university and contribute to a better world.

Uppsala University is the oldest university in the Nordic countries, with a living cultural environment and fantastic student life. There are 40,000 students here, and they are seen, heard, and noticed everywhere. World–class research and high quality education pursued here benefit society and business on a global level. The University is characterized by diversity and breadth, with international frontline research at nine faculties and limitless educational offerings at undergraduate and master levels.

- One the world's 100 highest ranked universities
- International orientation and position
- Peer culture of quality review and academic freedom
- Diversity and breadth—research and education in nine faculties
- Broad educational offerings at undergraduate and one– and two–year master's levels
- International master's programmes
- Student exchange and research cooperation with universities throughout the world
- Key collaborative partner for business and society
- Active, systematic quality improvements
- Superbly equipped, purpose–designed, modern, interdisciplinary campus areas

- Oldest university in the Nordic countries with living cultural settings
- Fantastic student life
- Academic traditions and festivities
- Unique cultural offerings
- Carl Linnaeus, Anders Celsius, and Olof Rudbeck are some of the famoushistorical Uppsala figures.

UPPSALA UNIVERSITET

Uppsala University – Campus Gotland / Uppsala universitet – Campus Gotland

Uppsala University

S:t Olofsgatan 10 B, SE–753 12 Uppsala, Sweden

Phone +46 18 471 0000

Campus Gotland

Cramérgatan 3, SE–621 57 Visby, Sweden

Phone +46 498 29 990

www.campusgotland.uu.se

About Novia University of Applied Sciences

A high–class regional university

Novia University of Applied Sciences acts along the Swedish–speaking parts of the Finnish coastline. With over 4000 students and a staff of 360, Novia is the largest Swedish–speaking university of applied sciences in Finland. High–class and state–of–the–art degree programs provide students with a proper platform for their future careers.

Novia University of Applied Sciences offers

- Bachelor’s degree studies in youth and adult education in Swedish
- Bachelor’s degree studies in English
- Master’s degree studies
- Adult education and specialization studies

At Novia you can receive the following Bachelor’s degrees

- Bachelor of Health Care
- Bachelor of Social Services and Health Care
- Bachelor of Beauty and Cosmetics
- Bachelor of Construction Management
- Bachelor of Engineering
- Bachelor of Natural Resources
- Bachelor of Culture and Arts
- Bachelor of Marine Technology
- Bachelor of Humanities
- Bachelor of Hospitality Management
- Bachelor of Business Administration

At Novia you can receive the following Master’s degrees in Swedish

- Master of Technology–based Management
- Master of Health Care
- Master of Natural Resources
- Degree Programmes in English

Some degree programmes run entirely in English, Energy and Environmental Engineering in Vaasa, Nursing in Vaasa and Maritime Management in Turku. We also offer one degree programme as adult education, Sustainable Coastal Management. In addition to this, we offer two degree programmes as Master’s Degree: Natural Resource Management and Leadership and Service Design

Novia University of Applied Sciences / Yrkeshögskolan Novia

Wolffintie 33, FI–65200 Vaasa, Finland

Phone +358 6 328 5000 (switchboard)

Campus Ekenäs: Raseborgsvägen 9, FI–10600 Ekenäs, Finland

Phone +358 19 224 8000

www.novia.fi

About Traditional Wooden and Masonry Structures
in the Baltic Sea Region

The project *Traditional Wooden and Masonry Structures in the Baltic Sea Region* is a partner project in Building Conservation involving Campus Gotland at Uppsala University, Sweden, the Estonian Academy of Arts in Tallinn, Estonia, and Novia University of Applied Sciences in Ekenäs, Finland. This is a follow up of an earlier, very successful project called *Sustainable Heritage* during which both publication series and an online project site were established. The strategy is a course structure spanning over five years, 2012–2016, to cover a sufficiently wide area of valuable objects of study and thereby forming an entirety. There will be one intensive course arranged annually with wood and masonry as themes. The intensive courses are tailored for students of *Construction Engineering and Construction Management* at Novia UAS, *Building Conservation and Objects Antiquarian Programmes* at Uppsala University and *Architectural Conservation and Conservation of Artefacts* at Estonian Academy of Arts in Estonia. These courses are hosted by the three partner universities in turns and they are designed to widen the scope of the standard curriculum in each school. The Nordic–Baltic Network is financed by the *Nordic Council of Ministers* through Nordplus funds and its cooperation is run by Novia UAS. The course programme consists of a wide range of themes which concentrate on the two main building materials of our region: stone and wood. The aim is to learn how these are to be preserved in the best manner and how traditional building and decorating techniques can be applied in modern building.

Network coordinator:
Novia University of Applied Sciences – Campus Ekenäs, Finland
Raseborgsvägen 9, FI–10600 Ekenäs, Finland
Phone +358 19 224 8000
office@sustainableheritage.eu

www.sustainableheritage.eu

There are over a thousand historic windmills in Estonia, Finland and Sweden. This report is about the three different types of windmills and about the work that was done in the process of repairing the wind shaft and the sails of a smock mill on Gotland.

The project Traditional Wooden and Masonry Structures in the Baltic Sea Region is designed for students of building conservation, conservation of artefacts, structural engineers and site management from three universities in Sweden, Estonia and Finland in order to give them the opportunity to learn about the traditional materials in different parts of buildings. From the conservation point of view they learn how constructions and surfaces made of these materials are to be preserved in the best manner.

Please, help yourself to more reports and views of the hands–on activities at various historic sites at www.sustainableheritage.eu

NORDPLUS

UPPSALA UNIVERSITET

ESTONIAN ACADEMY OF ARTS

NOVIA

ISBN (PDF): 978-952-7075-01-2; (nid. / print): 978-952-7075-00-5
ISSN (online): 2342-2025; (print): 2342-2017