

The Development of Wood Floor Construction in Finland

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Abstract

Traditionally, wood has been widely used for construction in Finland and other Scandinavian countries and has been the dominant floor material in Finland. Solid wood floors that were installed more than 100 years ago are still in service. In Finland, however, the current attitude toward using wood floorings differs from that in the past.

This review evaluates how current wood floor constructions differ from those used in the past. The review covers the period from the early 19th century, when stone-based floor construction became common in Finland, to the present. The review includes only solid wood floors.

The largest change in floor construction occurred when insulation was added below the whole boarded floor. The wood species used for the floor boards have remained unchanged, but the dimensions have decreased and become consistent and uniform over time. The insulation materials have developed from dry clay and moss to the current mineral wool. Availability of coatings has also increased remarkably. Examples of old buildings show that properly built solid wood floors provide a useful service life of more than 100 years.

Traditionally, wood has been the dominant floor material in Finland. However, the current attitude toward using wood floorings differs from the attitude in the past. Wood as a material is considered to be natural, warm, ecological, and pleasant to use but, at the same time, to have poor durability compared with other flooring materials commonly used in Finland, such as laminate and plastic membrane (Vahtikari et al. 2010).

This review evaluates how the elements of wood floor construction (i.e., structural support system, insulation, ventilation, floor boards, and the coating of wood floors) today differ from those in the past. The review covers the period from the early 19th century, when stone-based floor construction became common in Finland, to the present. The review is limited to solid wood floors for two reasons: (1) solid wood flooring was the traditional flooring used in Finland, and (2) wood flooring is currently considered to be a less desirable option. Wood laminates and other imitation wood floorings have been excluded.

Methods

This review is based on the literature. The scope of the literature search included academic and nonacademic sources. Academic sources included non-peer-reviewed publications, such as university publication series, as well

as peer-reviewed publications, such as dissertations and scientific journal articles. The nonacademic sources (e.g., documents in trade and technical journals and magazines) were originally meant to serve as additional information. Nevertheless, because academic research publications were relatively scarce, the nonacademic sources provided the most relevant information for this review.

When preparing this review, it became evident that the most relevant literature in the field had been documented in books. These books had been published by both building and wood technology associations. Their purpose was primarily to offer information to laypersons in their own language (e.g.,

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Finnish or Swedish), and they were based on the writers' working experience and complemented by research. The sources of information in the books were, for example, documentation of the old building stock in Finland that was available in the archives maintained by the National Board of Antiquities and Historical Monuments. This collection was compiled through field surveys and interviews with people living in the houses. Handbooks were also based on these collections. The books cited in this review contain many articles describing wall and roof structures, but only a few describing floors constructed of wood.

In nonacademic technical journals, the knowledge originated from architects and building contractors interviewed for the publication and, therefore, was mostly based on work experience. These journals were published by different flooring material associations. Several sources provided similar information. Nonacademic information on wood floors was found in the wood, building technology, and architecture technical publications. These publications were included to broaden the review. Information on the development of the dimensions of wooden boards and the materials used was found in the wood technology literature. Building publications and architecture literature provided information on floor assembly and coatings. Scientific sources related to wood flooring were mainly non-peer-reviewed university publications (Jokelainen 1988, Aulanko 1993). The only peer-reviewed publications in this review were the academic dissertations of Karjalainen (2002) and Jokelainen (2005).

Development of Wood Floor Construction

Early log constructions were in ground contact and, as a result, were subject to incurred moisture-related decay and insect damage. During the 18th and 19th centuries, the use of stone foundations for houses increased. In both earth-insulated and filled-base floor construction, air was present

under the floor. In earth-insulated floors, insulation was not placed inside the floor construction but, rather, next to the exterior wall, as shown in Figure 1. With earth-insulated floor construction, as shown in Figure 2, the entire underfloor area had an insulation layer (Sjöström 1905).

Ideally, the earth-insulated floors consisted of a stone foundation and an inner wooden or stone wall, with dry clay and moss being used as insulation (Fig. 1). The ventilation hole was a wooden tube that extended from the exterior wall to the noninsulated floor area, and the tube penetrated the whole foundation (Sjöström 1905). If the floor boards or the open subfloor space became wet, they dried without damage because of the ventilation and the lack of underfloor insulation. The insulated part of the floor construction next to the exterior wall, however, was vulnerable to moisture-related performance problems.

An earth-insulated floor construction was usually 90 cm thick (the exterior wall under the floor), which was somewhat wider than the stone foundation. The ventilation holes were on opposite sides of the building to allow cross-ventilation. The flooring was greater than or equal to 6-cm-thick wooden boards; the width of the boards ranged between 12 and 15 cm. Earth-insulated floors were in common use until approximately 100 years ago, despite the moisture-related performance problems (Sjöström 1905).

In filled-base floors, the insulation (e.g., moss, clay, and sawdust) was at least 30 cm thick (Fig. 2). Coating of the floorings began in the late 19th century, and putty was used to seal the between-board gaps. These actions were taken to prevent water from entering the insulated floor construction. Ventilation was more essential than in the earlier systems because of the use of insulation. Handbooks recommended tongue-and-groove joints in floors during the early 20th century (Sjöström 1905). According to Gudmundsson (2002), the distance between the floor joists was larger in filled-base floors (140 to 160 cm) than today, but the floor

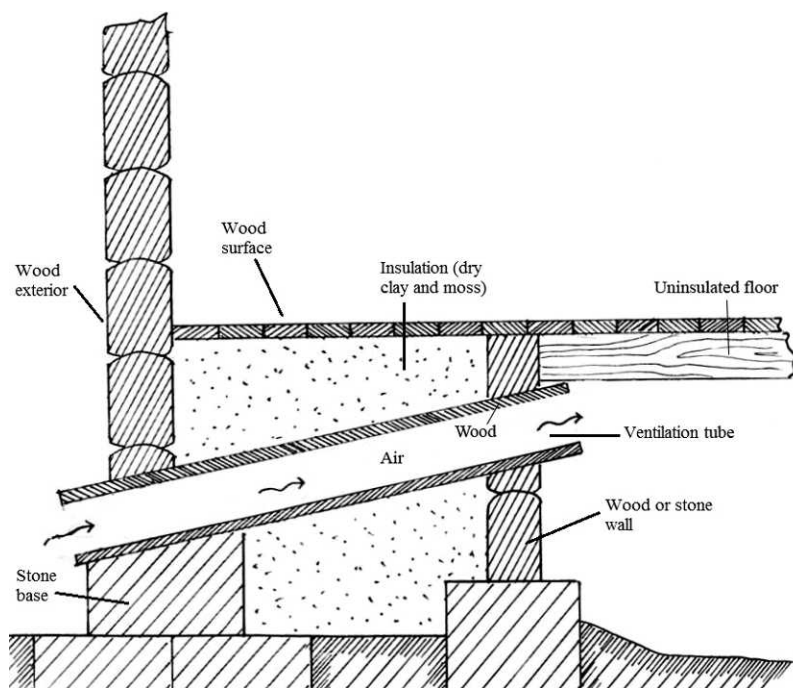


Figure 1.—An ideal model of a Finnish earth-insulated floor construction at the beginning of the 20th century. (Illustration based on Sjöström 1905.)

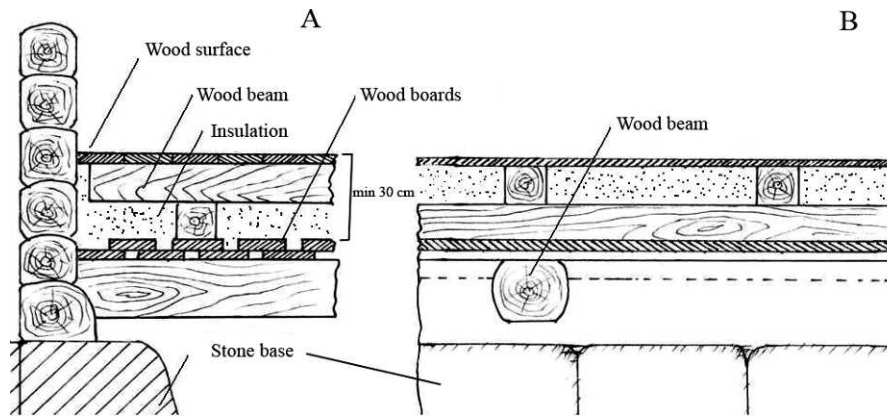


Figure 2.—The construction of a Finnish filled-base floor at the beginning of the 20th century. View A is 90° to view B. (Illustration based on Sjöström 1905.)

construction was still stiff enough due to the greater board thickness. Floor board nailing was stopped 20 to 30 cm from the end of the board to minimize end splits.

Flooring friezes were used in both single-family log homes and apartment buildings (Keinänen 1925, Gudmundsson 2002). Flooring frieze boards were usually the same width as the floor boards and attached to the floor (Fig. 3). The frieze boards were placed to facilitate the easy access, for example, to fill in empty space under the floor due to the settling of insulation material, such as sawdust (Gudmundsson 2002).

Today, the base floor is usually constructed of concrete or wooden joists. When planning the floor assembly, the main issue is to avoid the movement of the base and to ensure that the base floor space and subfloor space remain dry (Siikanen 2008). Currently, there are many different ways to build a wood floor. An example of a typical wood-based floor assembly is shown in Figure 4. The two layers of crossing floor joists support the wood flooring, and mineral wool is used as insulation. Using mineral wool is common in

Finland. Between the insulation and the surface is a vapor barrier layer.

Wood floor construction has also been used as intermediate floors in multistoried buildings. At the beginning of the 20th century, the intermediate floors in apartment buildings were mostly supported with strong wooden floor joists. The intermediate floors were fastened to the walls. The easiest way to finish the ceilings was to use wooden tongue-and-groove boards, but the more common way was to plaster the wooden ceiling surface (Fig. 5). Moss and straw were used for the floor insulation, and the floor surface was usually made of wood boards. The width of the boards was usually 20 cm and the thickness 5 cm, but as in single-family log homes, the board thickness and width have diminished over time (Neuvonen et al. 2002).

Currently, the intermediate floors in multistoried buildings are made with various materials. A wood-based construction was chosen for this review to show how the use of wood in floor construction has evolved. Based on a review of the literature (Sjöström 1905, Gudmundsson

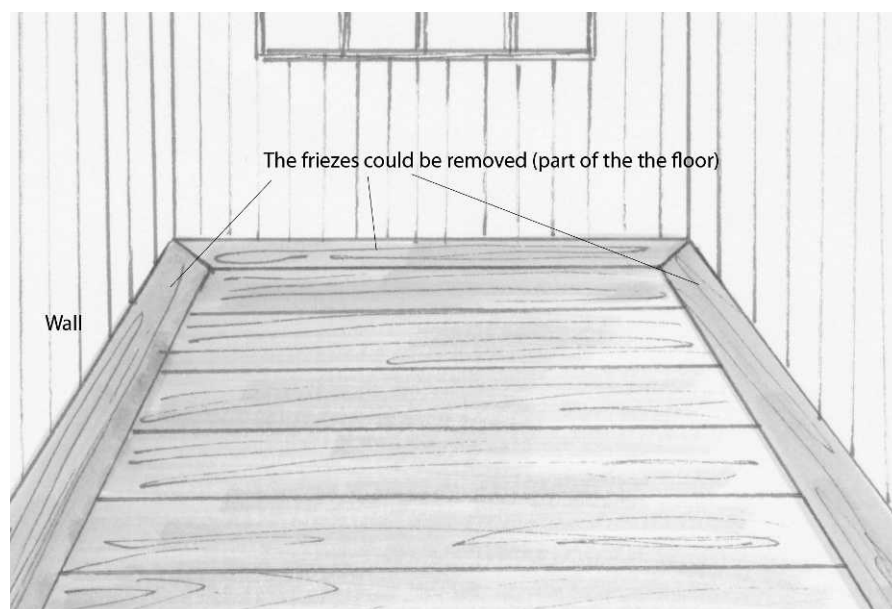


Figure 3.—An example of flooring friezes used in a room.

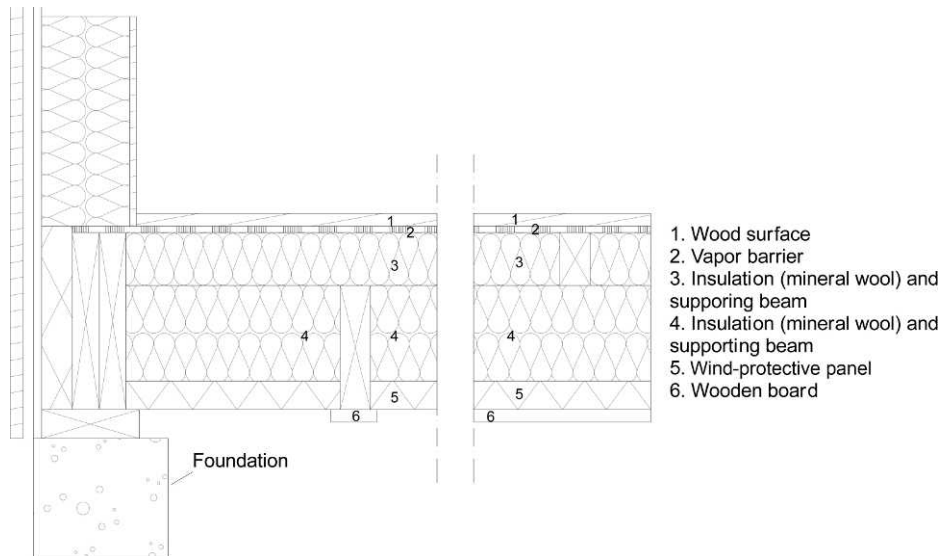


Figure 4.—Finnish wood-based base floor construction at the beginning of the 21st century. (Illustration based on Rakennustieto 2005b and Rakentaja.fi 2010.)

2002, Karjalainen 2002), the greatest difference between old and new assemblies appears to be the fastening system, floor joists, and use of steel. The principal components of the floor assembly have remained the same, as Figure 6 shows. Currently, the intermediate floors in wood-framed apartment buildings usually consist of three layers. The function of the flooring above the reinforced concrete is to improve the impact sound insulation and to allow easier electrical installations and pipe laying. The uppermost unit (walking surface) can be varied, and in Figure 6, it is massive wood (Karjalainen 2002).

Development of Board Dimensions and Use of Wood Species

In the 18th century, floor boards were usually uncoated, split round timber or boards. This technology was gradually replaced by industrial sawing, which produced boards in standardized and more uniform dimensions. The change in the manufacturing process influenced the floor assembly and the choice of wood species (Metsälä 1997).

Common species were spruce (*Picea abies*) and pine

(*Pinus sylvestris*) (Metsälä 1997). Building antiquary Gudmundsson (2002) writes that the boards were usually the same width as the log (35 to 40 cm) and the thickness was 5 cm. In the latter half of the 19th century, steam sawmills became a common method for producing sawn timber in Finland (Carlson et al. 1964). As a result, the dimensions of the boards were consistent and uniform. To take better advantage of the whole log so that material losses during the sawing were minimized, dimensions decreased. Initially, the width and thickness were reduced to between 18 and 20 cm and 3 and 3.5 cm, respectively. Toward the end of the 19th century, the board width was reduced to between 12 and 14 cm (Gudmundsson 2002). At the end of the 19th century, when industrial sawing became common, the width of the boards decreased again and remained at 7 or 9.5 cm, and some of them were sawed as feather boards (Metsälä 1997). Since the middle of the 20th century, the dimensions have remained the same, but the boards were sawed mostly from sapwood. Heartwood was used for the larger dimension members, such as beams (Wegelius 1953). Thus, the way of quartersawn boards (radial grain) was not

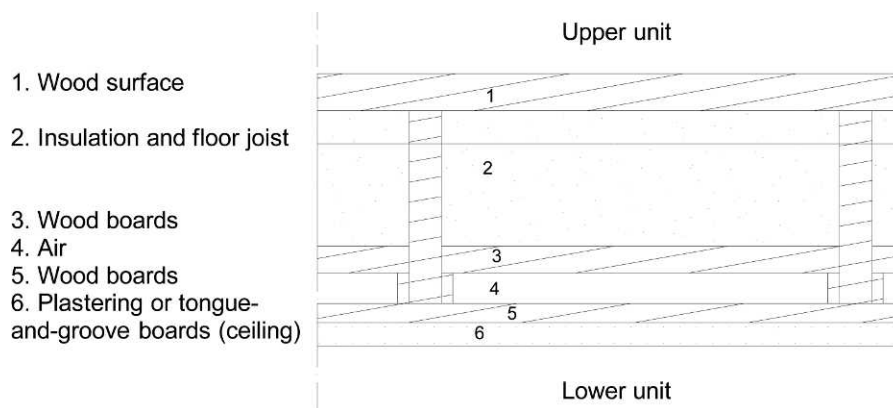


Figure 5.—An example of an intermediate wood floor construction in an apartment building at the beginning of the 20th century. (Illustration based on Neuvonen et al. 2002.)

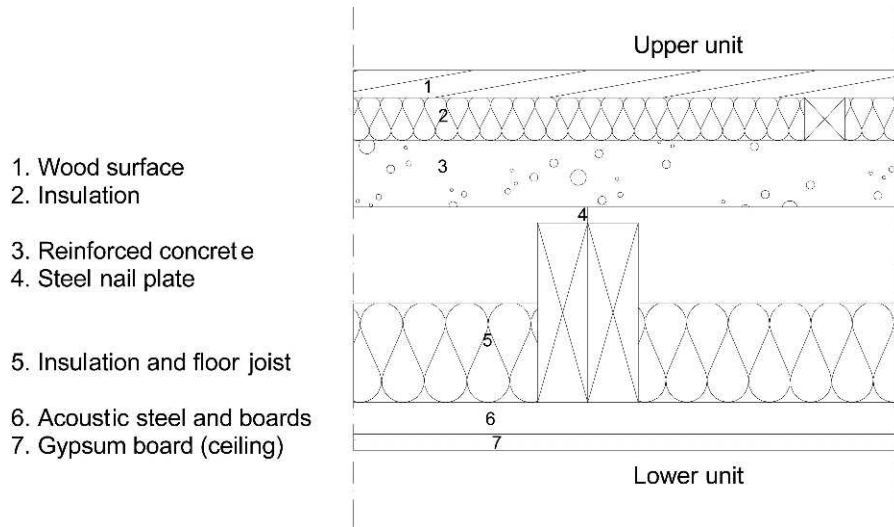


Figure 6.—An example of an intermediate floor construction in a wood-framed apartment building at the beginning of the 21st century. The load-bearing layer in the middle consists of insulation and floor joists (4 and 5), the overlaying sound insulation layer consists of blinding and supporting rails and surface layers (1 through 3), and the underlying layer (ceiling) consists of supporting rail, steel bone, and board layers (6 and 7). (Picture based on Karjalainen 2002.)

prioritized anymore, and the boards became splintered as a result of the plain sawing method (Gudmundsson 2002).

Spruce has been a popular flooring material in western and southern Finland. It was favored because of its light color and durability. Before coating became common, floors were often scrubbed with water, and spruce was easier than pine to scrub white because spruce is a softer material. On the other hand, spruce and pine have different knot patterns and spruce boards are never knot-free. Using hardwood in floors has been unusual in Finland, because the species available, such as aspen (*Populus tremula*), are porous and become dirty easily (Metsälä 1997). Both Jokelainen (1988) and Peltokorpi (1991) report that the most common material for wood flooring in Finland is now pine, but small amounts of spruce, birch (*Betula pendula*), and oak (*Quercus robur*) are also used even though spruce is not as hard as the other species mentioned. A flooring installer stated that in the past, if wood was used, the availability and price were the

most important criteria for choosing the wood species (Nord 2007). Today, the boards are usually sanded and the surface is finished with coating before installation, but the surface can also be left unfinished. Even today, boards are usually installed pithside upward, which might follow from the old splitting tradition. Installing heartwood upward produces better durability and dimensional stability for the boarded floor (Metsälä 1997).

Coated Flooring

Coating is the traditional way to protect a wood surface. It is difficult to determine when applying coatings to floorings started. This tradition varied depending on the type of flooring, location (rural vs. urban), and the wealth of the owner (Niiranen 1981, Kaila 1989, Keitele 2006).

Coating with linseed oil was already common in the 18th century in homes owned by wealthy individuals, and by the end of the 19th century, it was common in all homes. The type of coating varied, but the purpose was always to make



Figure 7.—Finnish wood floors from the end of 19th century (A) to the beginning of the 21st century (D). The two oldest floors on the left (A and B) do not have any surface treatment. The floor in C is painted, and the floor in D is finished with lye and oil.

the floorings look better and more expensive. The coatings included linseed oil, varnish, and oil coatings (Gudmundsson 2002). Linseed oil was expensive, somewhat limiting its use. Even as late as in the 1950s, coatings were often self-made using materials that could be easily found (Rakennustieto 2005a, Kujala 2007). In addition to these common coatings, floorings were also scrubbed with fat linseed oil soap, which created a more soil-repellent surface. A lye treatment made the color of the surface lighter. Treatment with milk or sour milk also made the color of the flooring lighter and created a soil-repellent surface (Rakennustieto 2005a).

During the second half of the 20th century, the lacquers and other coatings currently used became more popular than linseed oil coating. In addition to linseed and lacquer, waxes and varnish were used. Waxing of parquets was popular from the end of the 19th century until the middle of the 20th century. Waxes were also used for boarded floors. Oiling treatment later replaced the waxing of floors (Gudmundsson 2002).

Finnish wood floors from different periods are shown in Figure 7. In the past, floor boards were wider and thicker, and the surface was often unfinished. Floors were then subject to harder wear, shoes, animals, and working indoors, all of which left their marks in the floors. Today, the flooring in Finland is so smooth that you can walk on it without shoes.

Discussion

The basic idea of floor construction has remained largely unchanged after filled-base floors replaced earth-insulated floor construction. The importance of ventilation evolved when insulation was added below the floor. Filled-base floors are less permeable to air than earth-insulated floors. Proper base-floor ventilation has been the solution to keep the insulation and other components dry. The use of ventilation openings in stone foundations has remained unchanged. Flooring friezes could also be practical now, because they would allow the condition in the structural support system to be checked without removing the entire floor.

The dimensions of the floor boards have decreased during the time frame reviewed. Thinner floor boards cannot be sanded as many times as the larger dimensions used in the past, which may result as a shorter service life. However, less material is required to cover the same floor space. The development of sawn timber production has extended the range of products and standardized the product quality and dimensions but, at the same time, distanced the end-users from the wood material. In the past, the building materials were procured and produced close to the location where they were to be used. The origin of the floor materials was clear. Today, consumers seldom know where their floor materials were produced. Also, the expectations for the appearance of wood surfaces can be unrealistic. People may consider the natural grain of the wood surface to be a defect.

Demands for the surface of the flooring as well as the use of wood floors have changed. People used to wear shoes at home, because heating was expensive and floors, especially earth-insulated floors, were cold. Today, central heating keeps the homes warm, but simultaneously, it decreases the relative humidity of indoor air during winter, which may result in increased gaps between the floor boards because of the change in relative humidity between heated and unheated times. Stabilizing the moisture of floor boards

before installation is important year-round. In the past, domestic animals were kept in the houses in Finland, and this caused heavier wear on the flooring.

Despite the lighter wear, uncoated wood floors are currently not common. Oiling and waxing along with lacquer are the most popular modern finishes for wood floors (Jokelainen 1988). Earlier, the natural grain of wood was not preferred; therefore, painting was used to improve the appearance of the flooring. Today, people prefer the natural look of wood. Non-film-forming finishes conserve the haptic properties of wood, but they often require more care than other common flooring materials (e.g., plastic and laminate). Currently, people appreciate materials they consider to be low maintenance (Vahtikari et al. 2010).

A typical claim concerning wood flooring in Finland today is that it is more difficult to clean than, for example, laminate flooring. One reason for this could be the availability of information regarding wood floors. When doing the literature research for this review, it was revealed that in Sweden and Norway, *Golvbranschen* (a floor interest group) and *Treteknisk* (a wood research interest group) arrange workshops for and disseminate information to interested parties about how to install and maintain wood flooring. This information can easily be found on the Internet, in the literature, and by calling these groups. In Finland, the same information undoubtedly exists, but it has neither been collected extensively nor published. A lack of academic research concerning the maintenance needs of wood flooring is prevalent in Finland and elsewhere.

Examples of old buildings demonstrate that properly built solid wood floors provide a useful service life of more than 100 years (Jokelainen 2005). The benefits of wood and wood floors, such as the possibility to renew the appearance of the wood flooring, should be more strongly promoted when discussing wood floorings. Carefully built wood floors have been in use for decades, and similar floors can be built today as well. The quality of installation and of the material is the key for prolonging the lifetime of solid wood floors. However, it is acknowledged that the examples presented in this review are model examples, from either well-preserved floors or textbooks. In both sources, the floor constructions presented were well designed by experienced actors in the field. The common belief that the quality of construction and installation was better in the past than today is misleading, however, because only the best floors have survived. We do not have any examples of poorly built houses from the past as they have already perished.

Conclusions

Based on findings of this review, the largest change in floor construction occurred when insulation was added below the floor. The wood species used for the floor boards have remained unchanged, but the dimensions have decreased, both in width and in thickness, and have also become consistent and uniform over time. The insulation materials have developed from dry clay and moss to the mineral wool commonly used in Finland today. The availability of different types of coatings has also increased remarkably.

Examples of old buildings show that properly built solid wood floors provided a useful service life of more than 100 years. Carefully built wood floors have been in use for decades, and similar floors can be built today. The quality of

installation and of the material is the key to extending the useful service life of solid wood floors.

Acknowledgments

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