The timber frame house

A brief introduction to timber frame construction

Assembly instructions for Teaching and Learning Kit No. 1

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Modellbau Quedlinburg Detlef Rohnstein

The timber frame house

Many cities and villages are rightfully proud of the numerous and varied types of timber-frame
dwellings which give them their unique character up to this day. Our forefathers used this method of construction to build houses everywhere where wood was available as a relatively inexpensive building material. The diversity of building styles developed as a result of the widespread use of timber framing in different regions. Nevertheless, they all employ the same basic construction principles because the skeleton of the dwelling is always made of wood. The empty spaces between the framing members were in-filled with wattle and daub, wood or stones depending upon the purpose and availability of raw material near the building site. The diverse types were also a result of the long period of time in which timber-frame dwellings were built.

Timber-frame dwellings were built for many purposes. The most impressive are the large farm buildings in rural areas or the magnificent burgher houses of wealthy merchants in towns. Despite, or simply because of their diversity, all timber-frame houses have one thing in common: They demonstrate the close ties of the builders to their homeland and the remarkable way they lived in harmony with their natural surroundings.

Even though these old houses often no longer meet modern standards of comfort, can only be maintained at great expense and loving care, and adapted to the needs of today's owners, they still deserve to be protected and respected. For all of these reasons we decided to put together this teaching and learning kit along with this booklet as a small contribution to preserving the knowledge and techniques of timber-frame construction.

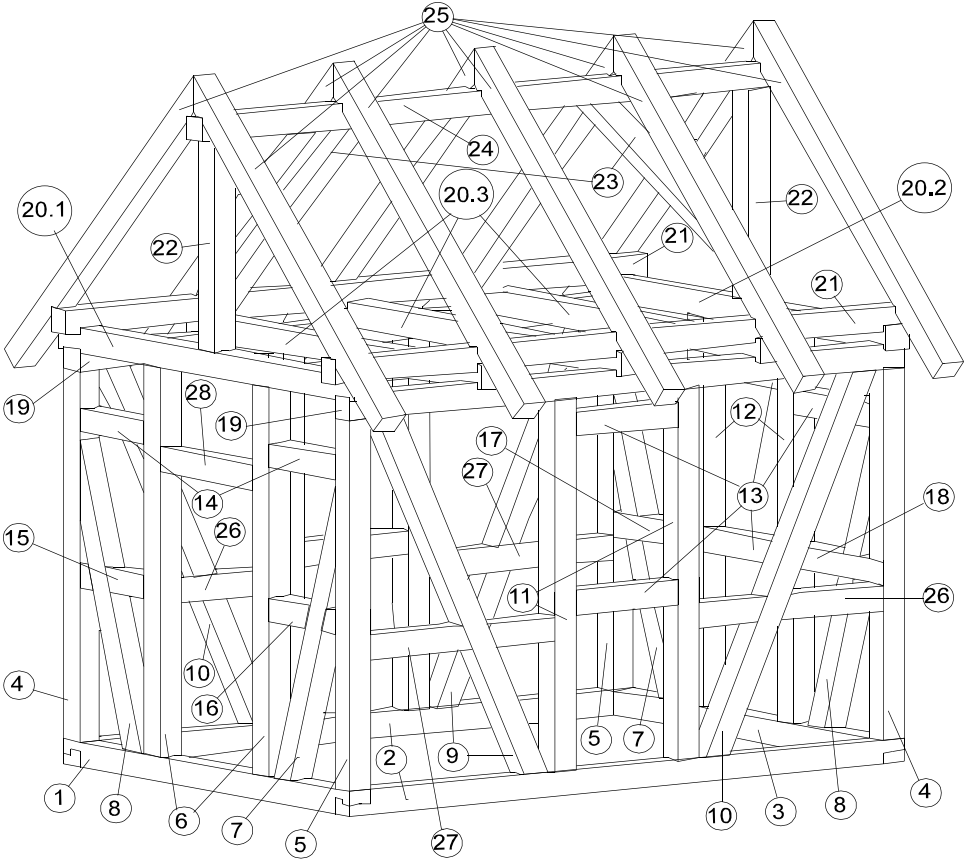
Assembly of this timber-frame house is tricky but follows a logical sequence. The terms used to designate individual parts are the same as those commonly used by carpenters. The knowledge as well as the logical relationship to building physics and the mechanics of stress and load are thus acquired in an interesting and educationally meaningful way - quite 'incidentally' - and one realizes why this house was built this way and could only have been built this way.

The joinery used to connect the timber corresponds in detail on a scale of 1:15 to the joints commonly used by carpenters.

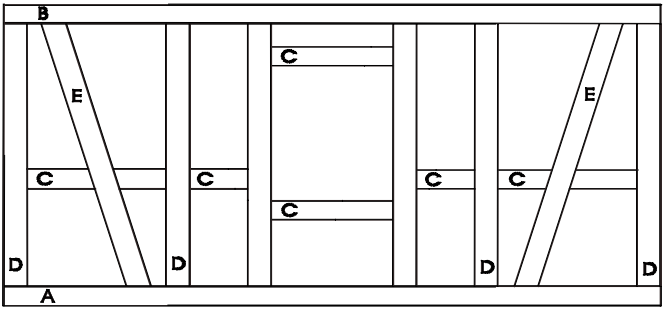
This timber-frame model will introduce you to the building history of your homeland using a practical example and stimulate close ties to the local, traditional art of building as well as teach polytechnic ways of thinking. Knowledge of the complicated, complex technology and techniques which our forefathers used to build houses over many hundreds of years is thus gained almost without effort.

List of Parts

Part No	Qty	Description
1	1	Front sill
2	2	Side sill
3	1	Back sill
4	2	Corner post 1
5	2	Corner post 2
6	2	Door frame
7	2	Brace 1
8	2	Brace 2
9	2	Brace 3
10	2	Brace 4
11	2	Side wall stud
12	4	Rear wall stud
13	2	Tie 1
14	8	Tie 2
15	2	Tie 3
16	1	Tie 4
17	1	Tie 5
18	1	Tie 6
19	1	Girts
20	5	Ceiling joists (total)
20.1	1	Ceiling joist 1
20.2	1	Ceiling joist 2
20.3	3	Ceiling joist 3
21	2	wallplate
22	2	King post
23	2	Knee or wind brace
24	1	Ridge pole
25	10	Rafter
26	2	Tie 7
27	2	Tie 8
28	1	Tie 9
	98	Wooden pegs



Terms und Function of the Timbers



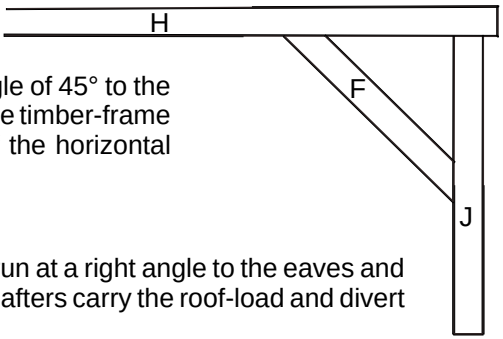
A) Sill timbers
The lowermost horizontal beams of a timber-frame wall that rest on the foundation are called sill timbers or soleplates.

B) Girts
Girts or top tie-beams form the upper end of a timber-frame wall and support the floor joists of subsequent stories or the roof.

C) Ties
The small horizontal timbers that divide the wall along its height into suitably sized spaces for in-filling the frame are called ties. They also prevent bowing of the posts and corner posts.

D) Studs
Vertical timbers which divide the timber-frame wall lengthwise are referred to as studs, posts or corner posts depending on their use. They are generally joined by mortise and tenon on the one end with the sill beams and on the other end with the girt. In exceptional cases, they end also in wall struts or ties. They are called corner posts, intermediate posts, door and window frames or jambs as well as principal posts depending on their location. The latter serve to integrate the inner wall partitions into the outside wall.

E) Braces
Braces are beams that are integrated into the sill and the girt, or in some cases into the sill and a post, and stand at an angle of 70-75° to the sill. These braces prevent movement of the wall out of the set angle. At least two such braces must be positioned in each wall as opposing pairs.



F) Knee braces

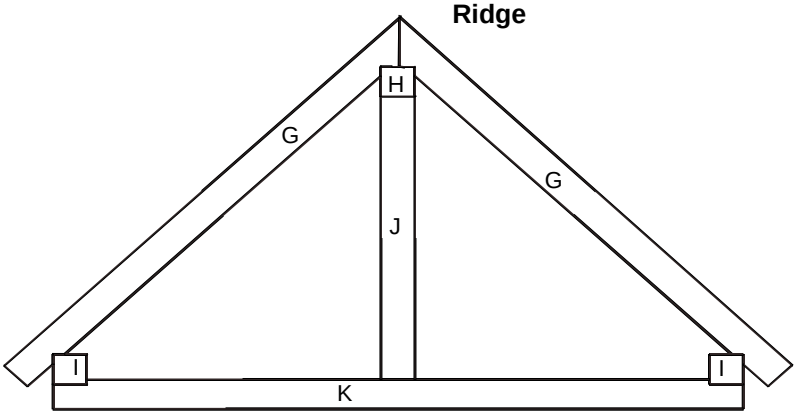
Knee braces are positioned at an angle of 45° to the other timbers and serve to reinforce the timber-frame structure as well as resist bowing of the horizontal timbers.

G) Rafters

Rafters are major roof timbers which run at a right angle to the eaves and provide support for the roof battens. Rafters carry the roof-load and divert it to the ridge pole and wallplates.

H) Ridge pole

The ridge pole runs parallel to the eaves of the roof and provides an upper supporting surface for the rafters. The load-bearing capacity of the ridge pole can be increased by using knee braces which are also called wind braces.



eaves of the roof

I) Wallplates

Wallplates support the base of the rafters and distribute the weight of the roof evenly over the stories below.

J) King posts

King posts support the ridge pole and divert part of the roof-load to the ceiling joists.

K) Ceiling joists

Ceiling joists form the ceiling and support the framework of the roof with its plates, posts, knee braces and rafters.

Timber Frame Joinery

a) Mortise and tenon
The mortise and tenon joint connects the end-surface of one timber to the side of another timber. The type of mortise and tenon joint can vary depending on the purpose. Straight tenons are used for tie beams that are positioned horizontally whereas angled tenons are used for braces or knee braces. The thickness of the tenon (the projecting part or tongue that is cut on the end of a timber) is normally one third of the thickness of the timber.

b) Cross halving joints
Cross halving joints are used to connect two pieces of wood so that both pieces cross without a break and finish flush on the top and bottom which prevents buckling of the joint.

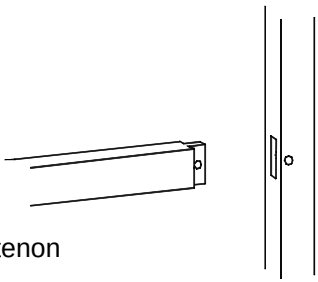
c) Hooked lap joint
This type of joint is used primarily on the ends of sill timbers at the corners of a timber-frame wall. It has a stepped, mitered cut-out or 'hook' to prevent mutual shifting of the beams.

d) Simple dovetail
This joint is used to give the ceiling joists resting on the girt sufficient support and prevent opposing walls from pulling away from each other.

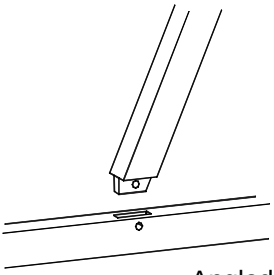
e) Joist housing
The joist housing serves the same purpose as the dovetail joint above except that the surfaces of the beams resting on one another are cut out to a depth of 2 centimetres. On our model the joints are used to connect the wallplates to the ceiling joists.

f) Bird's mouth rafter seat
The bird's mouth rafter-seat serves to support the rafters on the ridge pole. The rafters are additionally secured with an iron rafter-nail to prevent them from slipping out of place.

a) **Mortise and tenon**

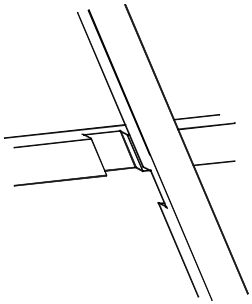


Straight tenon

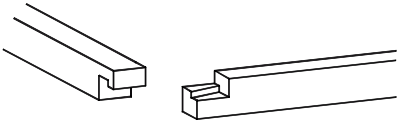


Angled tenon

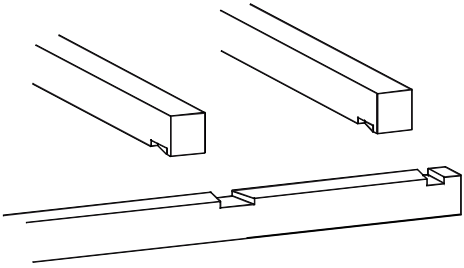
b) Cross halving joints



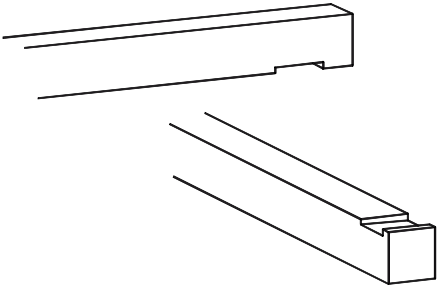
c) Hooked lap joint



d) Simple dovetail

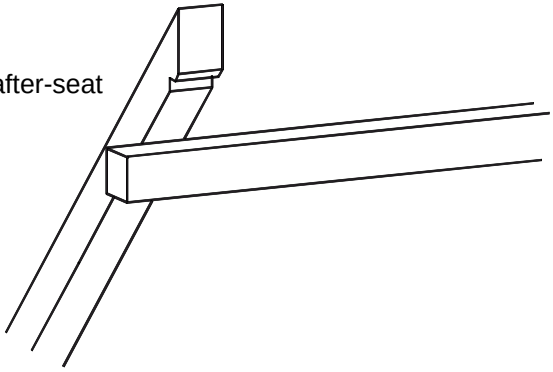


e) Joist housing

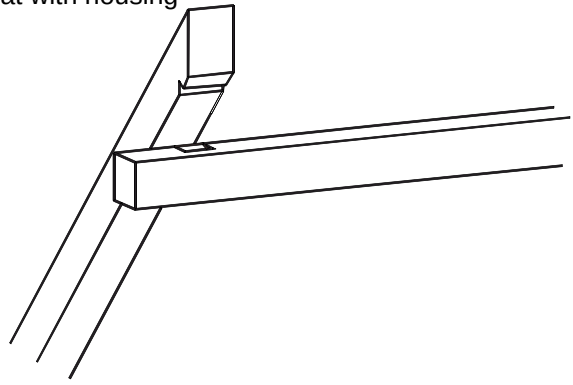


f) Bird's mouth rafter seat

Simple bird's mouth rafter-seat



Bird's mouth rafter-seat with housing



The design of timber frame houses

Utility value and economic viability of the construction were the primary factors in determining the design of the actual timber-frame dwelling. Last but not least, aesthetics and the representational needs of the builders also played an important role.

Flat, elongated buildings with low-lying eaves which could better withstand the effects of wind and weather thus emerged in the rural areas of the north. In comparison to the rest of the house, however, the front side or face of the building had a decorative gable with numerous braces and elaborate ornamentation.

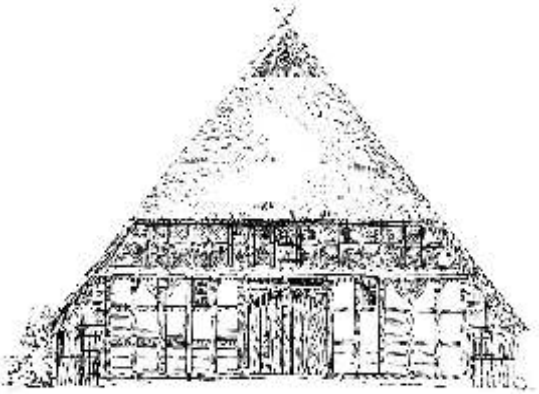
In the various regions of middle Germany, where villages and individual farmyards are often protected by a range of hills and flat valleys, houses emerged which were built several stories high, often with steep roofs, but on a smaller ground floor area because the space available in densely populated towns was limited.

In the south of Germany, on the other hand, compact buildings with flat roof-forms can be found. The reason for this was the fact that these buildings were often located on slopes and had to be protected against the extreme weather conditions in the mountains.

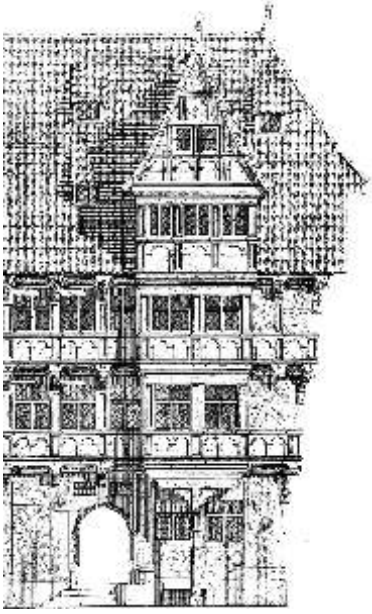
In the case of city dwellings, however, we generally find tall, multi-storied types of houses built on small ground floor areas, often with multi-storied lofts. In the cities special attention was often paid to the design. Facades with numerous braces and elaborate ornamentation thus emerged. The reason for a pompous façade was to show everyone how affluent and influential the owner was.

What has been mentioned thus far naturally applies, with slight variations, also to all of the other timber-frame regions of Europe and to all of the countries where immigrants from northern Europe settled and brought their methods of construction with them. This is why houses built in nearly the same style can be found in different countries around the world.

Examples of timber frame design in different regions



Holstein

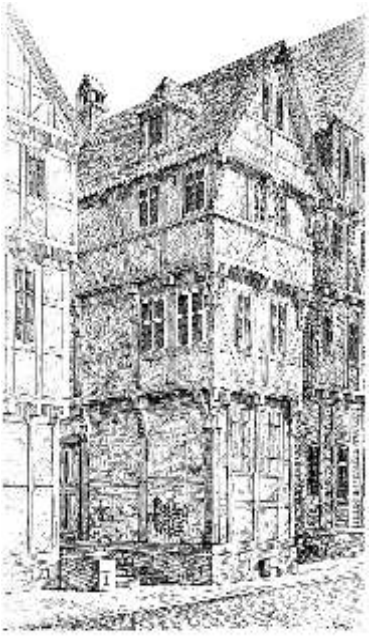


Harz Mountains and surrounding countryside

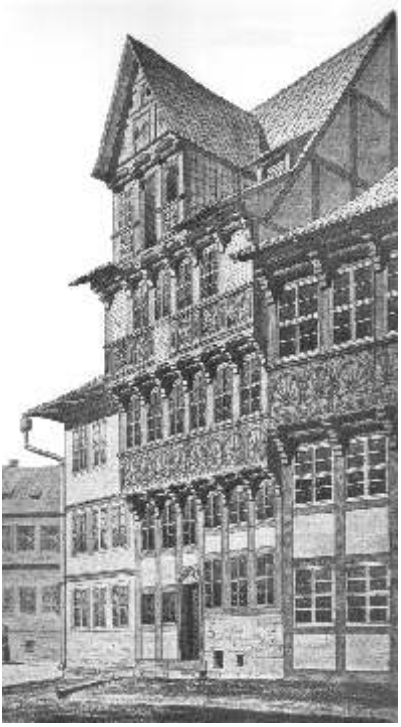
Oberlausitz

Bavaria

Timber frame in different centuries



Gothic timber frame, 15th century



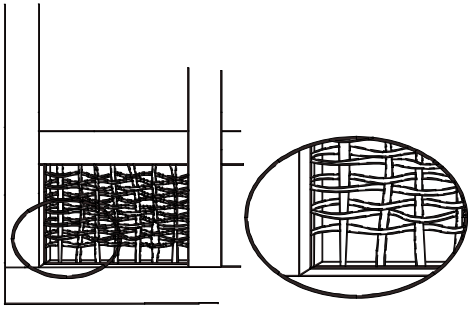
Renaissance timber frame, 16th century

Modern timber frame, 19th century

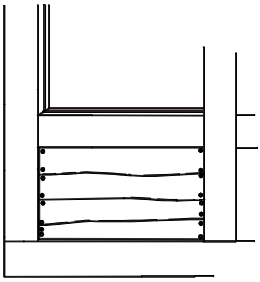
Construction und design of the open spaces

Open spaces are those spaces in the skeletal frame which are not closed in by doors or windows. The type of timber-frame infill is determined by the intended use and the availability of building material in a particular region.

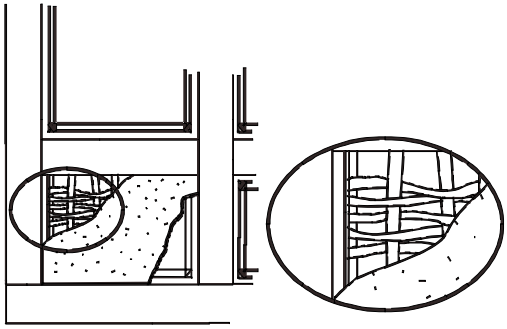
The open spaces of timber-frame barns used for storing and drying material were thus infilled with wattle or laths which allowed movement of air. The spaces could additionally be stuffed with straw, twigs or heather to make it difficult for insects and small animals to intrude. The open spaces of dwellings that had to be protected against wind and weather such as houses, stalls or silos were infilled with daub, stones, or wood panelling, material which was not only selected because of its availability but also because of design aspects.



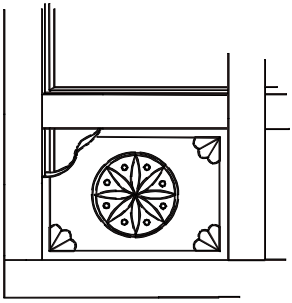
Wattle infill



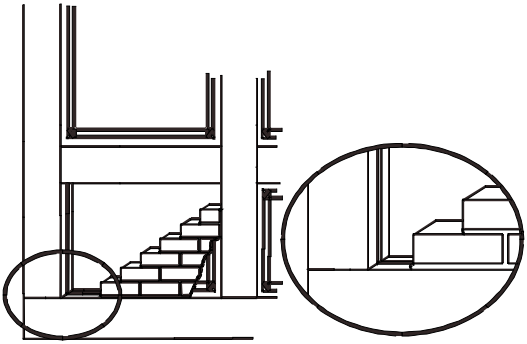
Infill with laths



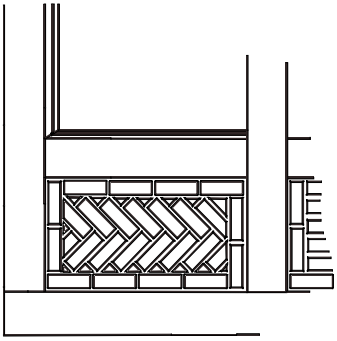
Wattle and daub



Wood panelling with ornate carvings



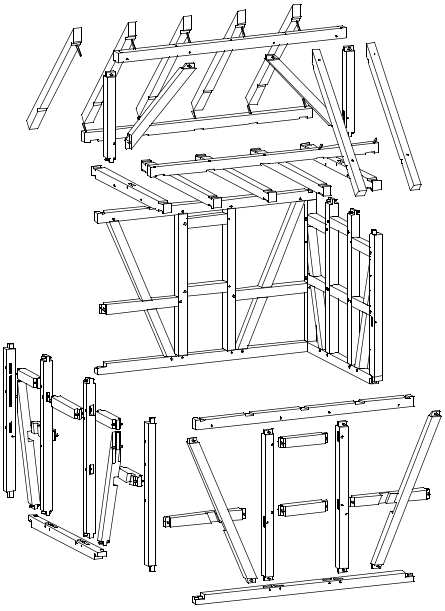
Clay bricks with plaster



Brick nogging

Assembly of the model

Since construction and joinery of our model have been copied from an original timber-frame house, the model has to be assembled exactly as the original building.
Unpack the crate and sort the individual parts according to size. Sand any burrs carefully with the sandpaper included with the kit.



Start with the assembly of the gable walls without the corner posts. Lay the posts, ties and braces on a flat surface and join them together. (Caution: The ties of both gable sides have different lengths because of the different widths of doors and windows.)

Now the sills can be inserted.

Assemble the side walls by joining all of the posts (including the corner posts), ties and braces with the sill timbers, as with the gable walls.

When all of the walls have been assembled, they can be joined together and the girts seated in the side walls.

After properly raising all of the side walls, secure them with the wooden pegs provided. The wooden pegs may vary somewhat in thickness, so more pegs than required have been packed with the kit.

To assemble the roof, lay down the ceiling beams and join the king posts with the knee braces and the ridge pole. Now attach the plates and the king posts to the ceiling beams and secure them with wooden pegs.

The final step involves seating the rafters. They are fixed with wooden pegs on our model, but with metal rafter-nails on the original building.

For the most part, our models are handcrafted. Delicate, intricate and complicated building elements are manufactured with computer-controlled CNC-machines. Nevertheless, variations in temperature and humidity could mean that some joints will seat somewhat tighter than normal. In this case you can carefully rework the affected area with the sandpaper provided with the kit.

When all of the work has been properly completed, you have an original, genuine timber-frame house before you on a scale of 1:15.

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  - Handicraft technology
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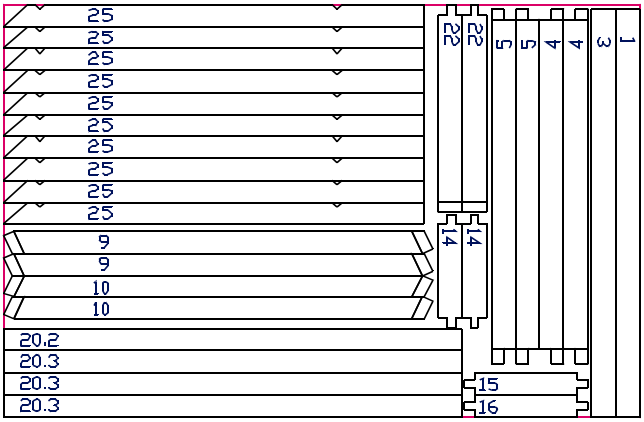
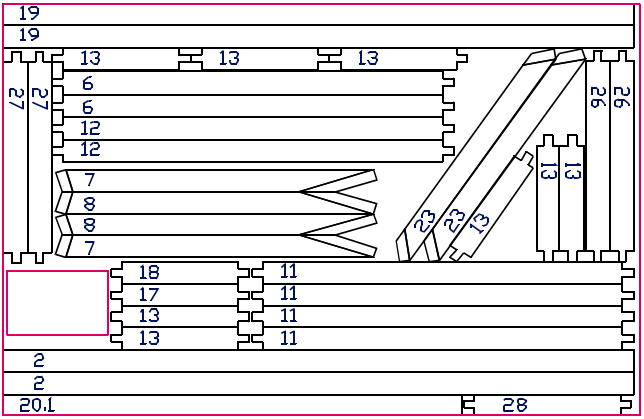
Packaging plan

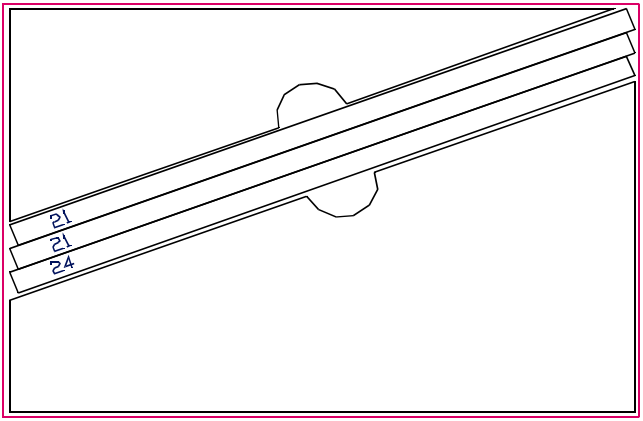
Lower layer



Middle layer



Upper layer



Source material:

-Verband deutscher Architekten- und Ingenieurvereine
(Association of German Architect and Engineer Societies)
"Die Holzarchitektur Deutschlands vom XIV bis XIII Jahrhundert"
(The Wood-Architecture of Germany from the XIV to the XIII Century)
Berlin, 1883.
-Verband deutscher Architekten- und Ingenieurvereine,
(Association of German Architect and Engineer Societies)
"Das Bauernhaus im Deutschen Reiche und seinen Grenzgebieten"
(The Farm House in the German Reich and its Border Regions)
Dresden, 1905.
-Opderbecke, Adolf: "Der Zimmermann" (The Carpenter), Leipzig, 1913.

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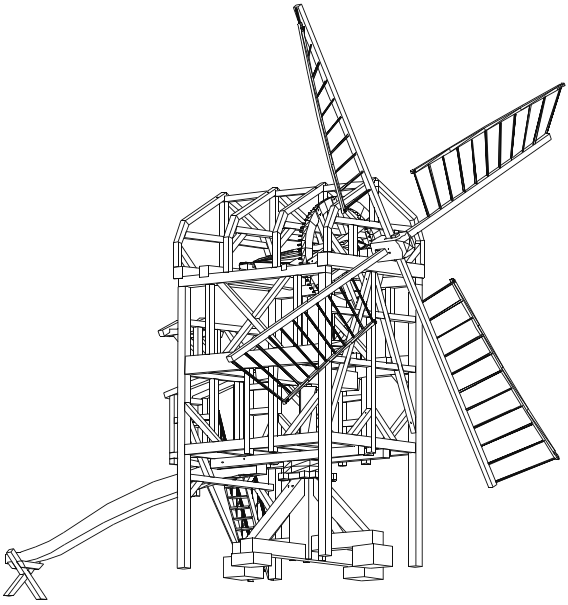
Translated from the German by Dennis Molchan, Berlin.



Modellbau Quedlinburg
Dipl. Ing. (FH)
Detlef Rohnstein
Ditfurter Weg 49 D
06484 Quedlinburg
Tel. : ++(0) 3946 91 95 90
Fax.: ++(0) 3946 91 95 93
detlef.rohnstein@t-online.de
www.modellbau-quedlinburg.de