Treatises and Technical Texts on Shipbuilding

NADL

04. The *partison*

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What is the *partison*

- The *partison* is a method, a set of rules and instructions used to define the curves of the hulls, in particular the narrowing, widening and rising of the frames. It allows to build ships without using drawings or mathematical calculations.

- Its distinctive feature is the use of geometrical instruments, operators and algorithms to define the progressive variation in the narrowing and rising of the frames going from midship to the ends.

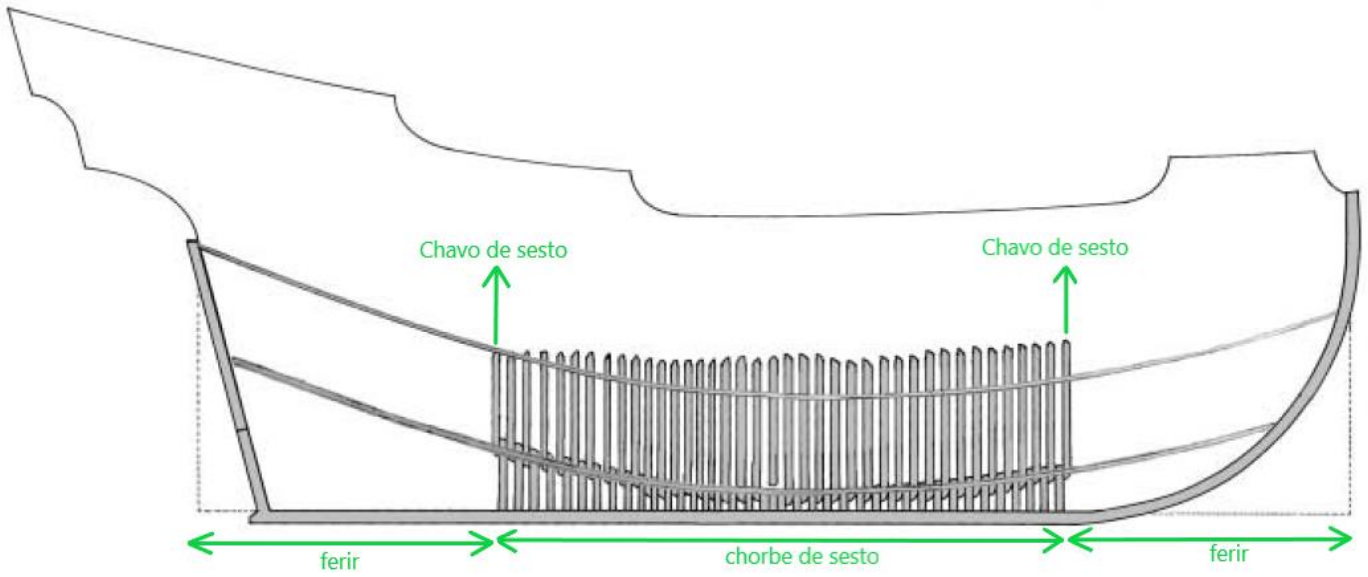
What is the *partison*

- The method was firstly documented in Venetian treatises from the XVth century and used in the Venetian Arsenal. "Partison" is indeed a Venetian word that suggests the idea of repartition, of dividing something into parts. Its first mention is found in the *Fabrica di Galere* manuscript (anonymous, 1410); other attestations of the method are found in the *Timbotta's manuscript* (by Zorzi da Modon, 1444), in the *Istructione sul modo di fare galere manuscript* (by Prè Todaro de Nicolò,1550), in the *Vision de Drachio* manuscript (by Baldissera Quintio Drachio, 1594) and in *Nautica Mediterranea* (by Bartolomeo Crescenzio, 1607)

- The same method was also used in Portugal, Spain and France, but it doesn't appear in treatises until the mid of the 16th century.

Where is the *partison* applied

- The hull is conceived as divided in a central part and in 2 end parts
- The *chavi de sesto,* the tail frames, mark the ends of the central part. They are the last molded frames attached to the keel
- The distance between the tail frames and the perpendiculars dropped at the posts of the ship is called "*ferir*"
- The frames located between the two tail frames are are where the *partison* is applied. They are called "*chorbe de sesto*"



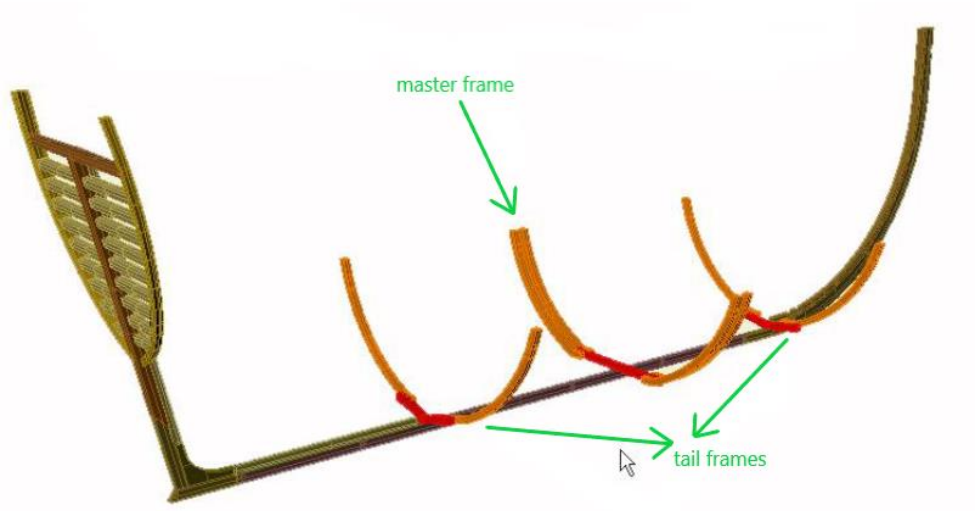
Edited drawing from "Rising and Narrowing: 16th-Century Geometric Algorithms used to Design the Bottom of Ships in Portugal", by F. Castro, in The International Journal of Nautical Archaeology (2007), 36.1: 148-154

How the *partison* works

All the *chorbe de sesto are* modelled based on the shape of the midship frame.

The shipwright decides how much narrower and higher than the midship frame should the tail frames be

The narrowing and rising of the turn of the bilge points of the tail frames are marked off on the mold of the master frame and the shape of the tail frames is derived from there

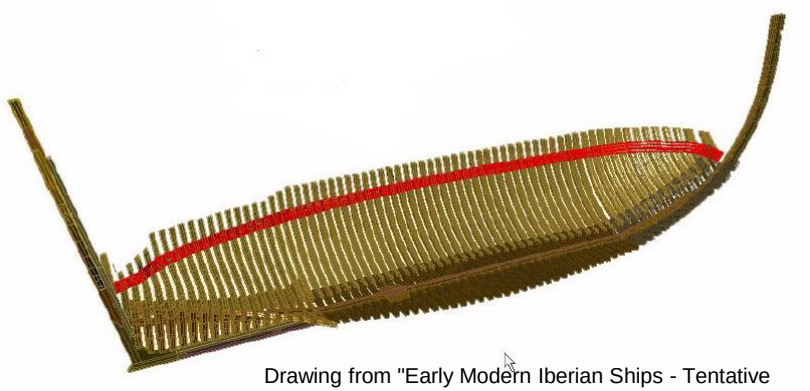


Edited drawing from "Early Modern Iberian Ships - Tentative Glossary", by Castro F., Gauthier-Berrubè M., Capulli M., Santos M., Borrero R., Ciarlos N., Molema I., 2019

How the *partison* works

The turn of the bilge points of the pre-designed floor timbers are then progressively raised and narrowed by the means of the *partison* method, going from midship until the tail frames

The part of the first futtocks that is above the *magier de bocha* is progressively widened from midship to the tail frames, in order to give more shoulders and deck space to the ship



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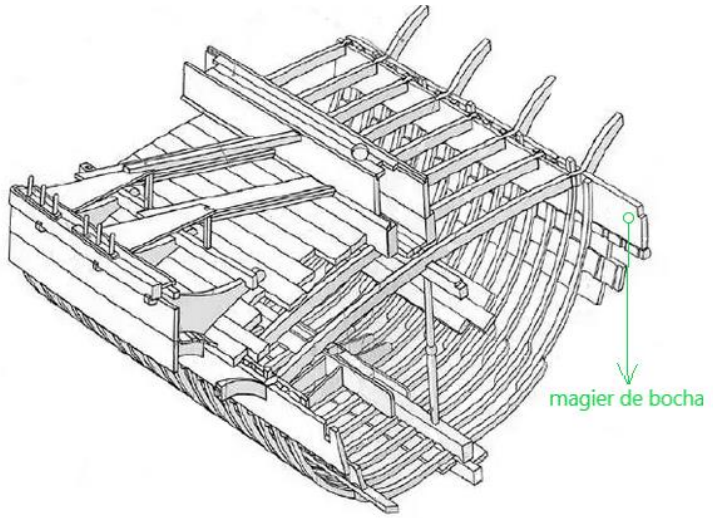


The magier de bocha is a longitudinal stringer (clamp) on which rest the transversal beams that sustain the first deck.

Edited drawing from "Boscchi, legnami, costruzioni navali. L'arsenale di Venezia fra XVI e XVIII secolo", by A. Lazzarini

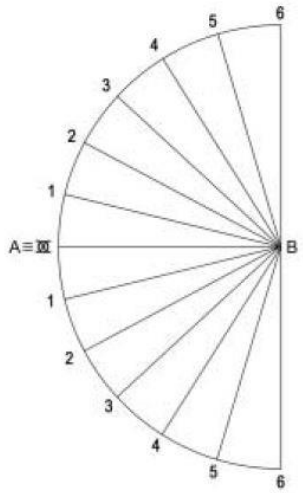
There are no instructions in the treatises on how the remaining frames (the ones going from the tail frames to the ends of the ship) should be modelled. In Iberian treatises ribbands are mentioned. These frames are V- and Y-shaped.

Graphic operators of the *partison* – The *mezzaluna*

The *partison* method consists of using graphic operators and algorithms to progressively reduce or augment some quantities (narrowing and rising floor timbers). The most attested graphic tool is the *mezzaluna,* as called by Crescenzio, or *mezo redondo,* as called in Timbotta's manuscript, or *besta* in Portuguese*,* and works as follows.

- Taking as example the procedure that controls the narrowing of the floor timbers, the shipwright decides how much narrowing he wants from the midship to the tail frames, and draws a 1/1 scale line representing the length of the narrowing.

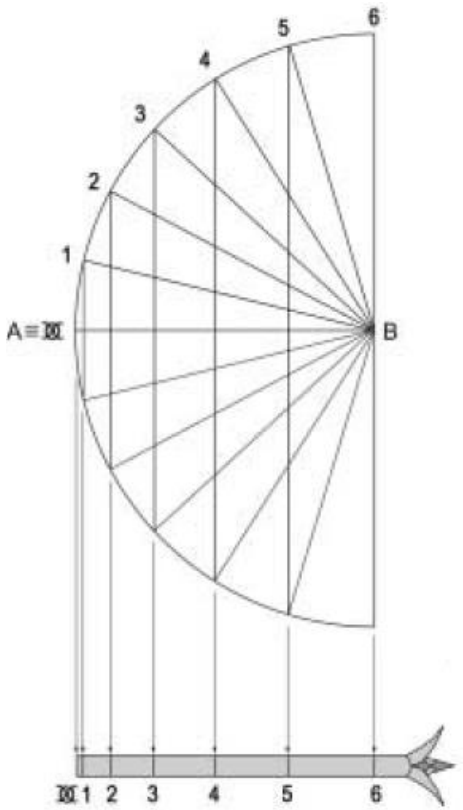
- Afterwards, he decides how many frames he wants between the midship frame and one tail frame; then he draws a semicircle whose radius is AB, the total narrowing of the floor timbers. Each quarter of the semicircle is divided in as many parts as the number of pre-designed frames wanted.



Drawings from "Rising and Narrowing: 16th-Century Geometric Algorithms used to Design the Bottom of Ships in Portugal", by F. Castro, in The International Journal of Nautical Archaeology (2007), 36.1: 148-154

Graphic operators of the *partison* – The *mezzaluna*

- Afterwards, lines are traced horizontally to connect the respective points, which are then passed and engraved on a wooden gauge (kind of a ruler), that was on 1/1 scale



- The gauge was then used to mark off the decreasing width of the floor timbers on the mould of the main floor timber. The same procedure was adopted with the rising of the floors (the progressive rising of the bilge points was marked off on a gauge and on the mould of the miship frame) and all the predisegned frames were then created from the main frame.

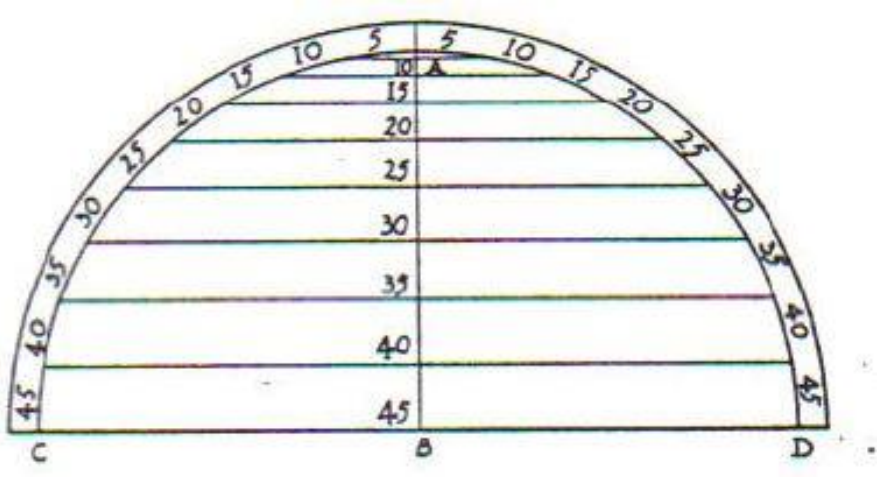
The distances among the points on the gauge represent how much one predesigned frame is narrower than the other.

Point A represents the midship frame and point 6 the tail frame. So for example the segment 2-5 on the gauge represents how much frame 5 is narrower than frame 2, the segment 5-6 how much the tail frame is narrower than frame 5 etc..

Drawings from "Rising and Narrowing: 16th-Century Geometric Algorithms used to Design the Bottom of Ships in Portugal", by F. Castro, in The International Journal of Nautical Archaeology (2007), 36.1: 148-154

Graphic operators of the *partison* – The *mezzaluna*

Probably the shipwright worked out a separate design for every fifth frame (not for every frame).



Drawing from "ITALIAN NAVAL ARCHITECTURE about 1445", by Anderson R.C., in The Mariner's Mirror, 11:2, 135-163, 1925

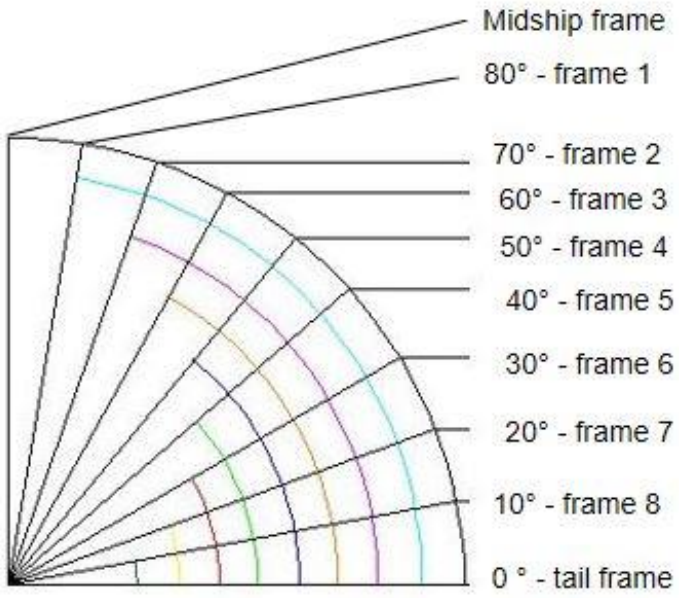
The drawing is a reproduction of the *mezzaluna* described by Crescenzio in Nautica Mediterranea; it is related to the partison of a ship having 45 floor timbers between midship and one tail frame.

We can see that the mezzaluna is divided in 9 parts corresponding to the frames going from the midship frame (frame 0) to the tail frame (frame 45) and that the narrowing of the floors takes place every 5 frames.

Mathematical significance of *mezzaluna*

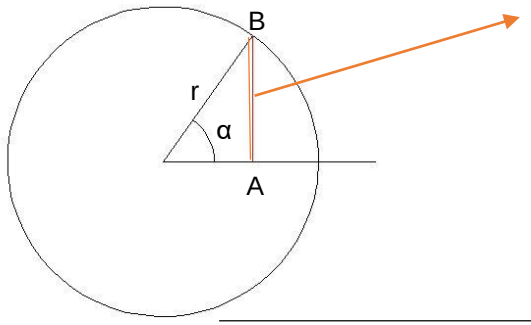
The way the mezzaluna implements the progressive narrowing (widening, rising) of the floor timbers can be described mathematically

- In this example there are 9 predesigned frames located between midship and one tail frame (tail frame included), so the mezzaluna is divided in 9 equal parts by the radius.



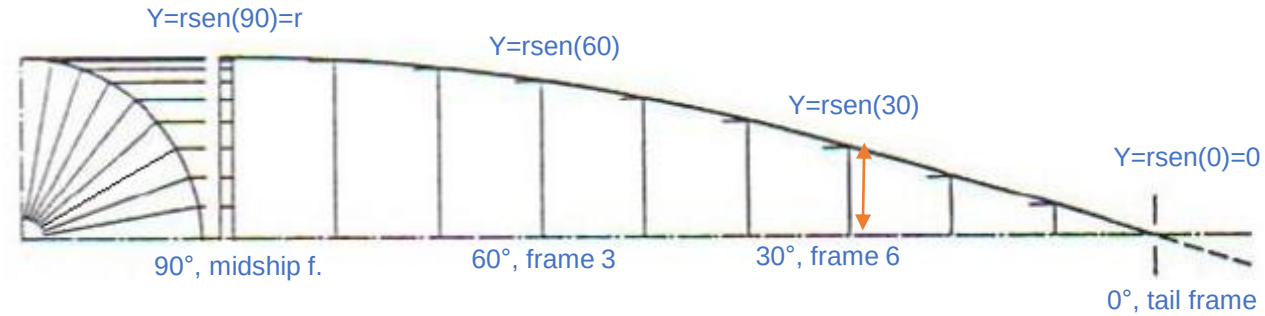
- Each angle formed by the radius and the x axis is related to one frame. So the tail frame (frame 9) corresponds to angle 0, frame 8 corresponds to angle 10, frame 7 to angle 20..and the midship frame to angle 90.

Mathematical significance of *mezzaluna*



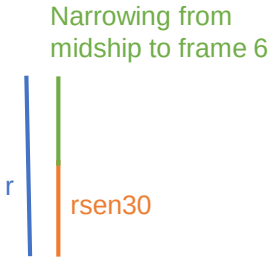
We know from trigonometry that AB = rsen(α)

The curve below connects the 10 points found with the *mezzaluna* when they are expressed in function of the angle enclosed between the radius and the x axis: it represents the function y = rsen(α). So on the x axis we have the 10 angles corresponding to the ten frames on which the narrowing is applied and on the y axis their corresponding value y= rsen(α).



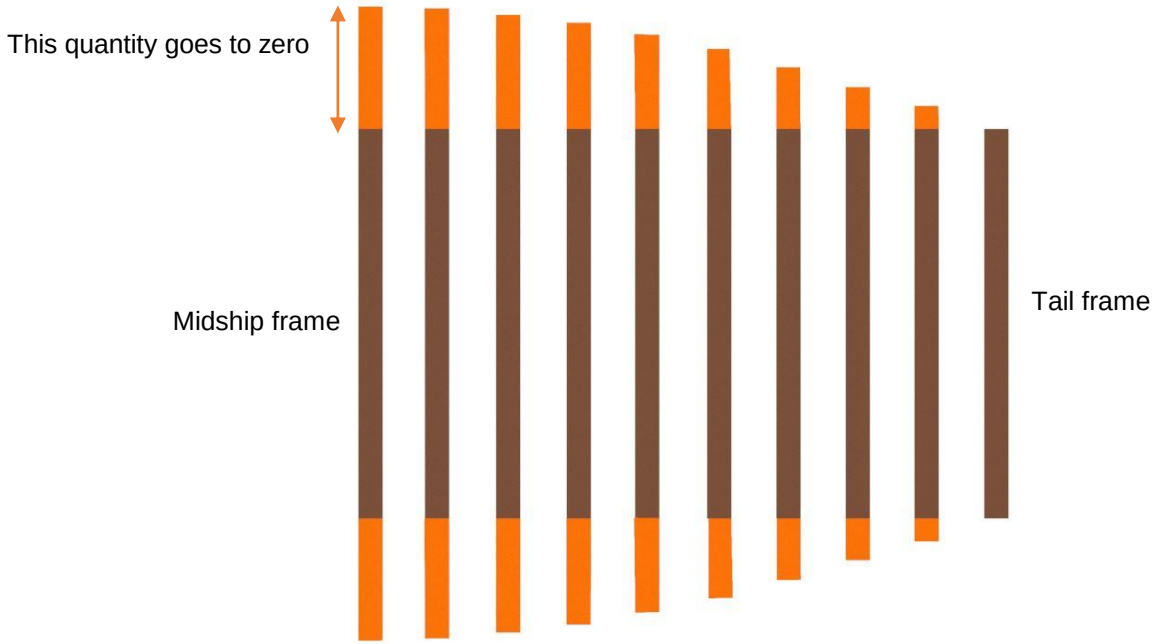
The value y=rsen(a) represent how much the corresponding frame is wider than the tail frame. We have for example that frame 6 is rsen(30) feet wider than the tail frame, where r is the total narrowing between midship frame and tail frame

The progressive narrowing going from midship to the tail frame, that is what is marked off in the gauge, can be then easily calculated for every frame with the formula $Narrowing_{(i)} = r\text{-}rsen(a_{(i)}) = r(1\text{-}sen(a_{(i)})$. So for example if we want to find how much frame 6 is narrower than the midship frame, we have that Narrowing(from midship to frame 6) = r(1 –sen(30))



Mathematical significance of *mezzaluna*

We can see that the mezzaluna is used to progressively reduce a quantity to zero. In this specific case the quantity reduced to zero is how much a floor timber is wider than the tail frame, as it can be seen below in the topview of the floor timbers



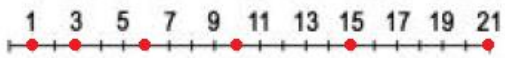
The progressive decrease of that quantity can be described by the function y = rsen(a), the sinusoid timed the radius, where the radius is the total narrowing between midship and tail frame initially chosen by the shipwright.

Graphic operators of the *partison* – The *brusca*

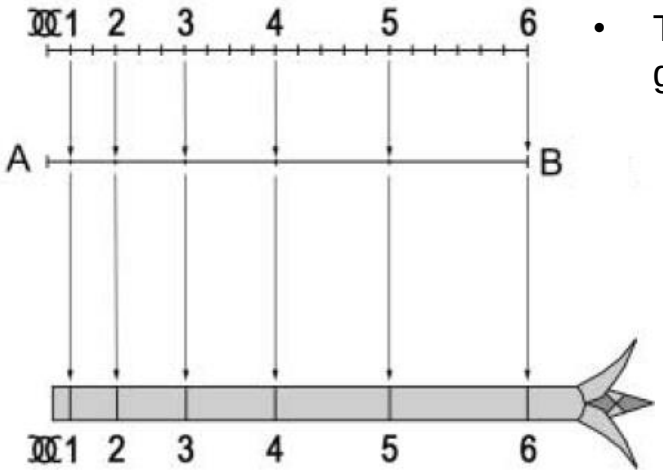
Another geometric instrument mentioned in the treatises to define the progressive narrowing or rising of the frames is the *brusca.*

- The brusca method consists of drawing a line as long as the total wanted narrowing (or rising) of the frames.

- After drawing the line, an arithmetical progression is chosen, one of the most used ones being $N_{(i+1)} = N_i + i$. Starting with $N_1 = 1$, we have $N_2 = 3$, $N_3 = 6$, $N_4 = 10$.. If the ship has for example 6 premolded frames, the progression will continue until N_6, resulting in 1,3,6,10,15,21.



- The brusca is then divided in as many equal parts as the last number of the progression, in our case 21



- The progression (1,3,6,10,15,21 in this case) is marked off and the points obtained are passed on a gauge

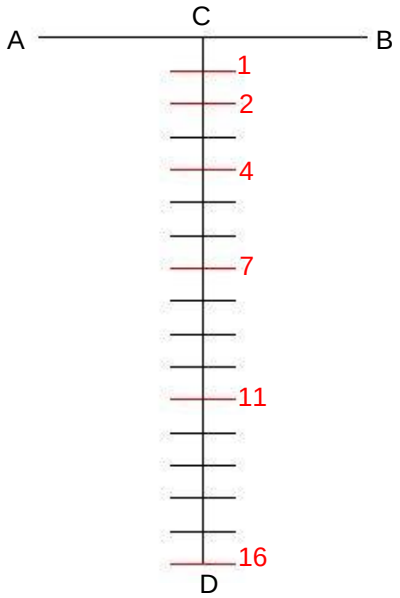
Drawings from "Rising and Narrowing: 16th-Century Geometric Algorithms used to Design the Bottom of Ships in Portugal", by F. Castro, in The International Journal of Nautical Archaeology (2007), 36.1: 148-154

- Number 1,2,3,4,5,6 correspond to the predesigned frames, so that frame 1 is the first frame after the midship frame and frame 6 is the tail frame. The distances among them correspond to their narrowing

Graphic operators of the *partison* - The incremental triangle

Another geometric tool is the incremental triangle. It is mentioned in Timbotta's manuscript and it looks a variation of the *brusca.* It works as follows:

- A horizontal segment ($\overline{AB}$) is drawn, representing the total narrowing or rising of the frames.



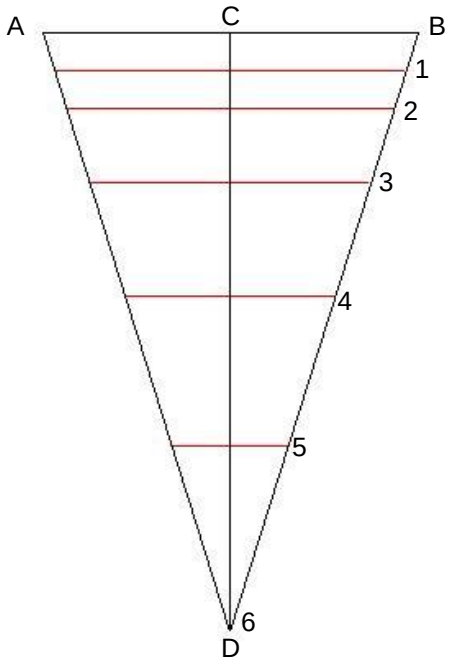
- A progression is chosen. In this case we use the progression found in Timbotta's manuscript when describing this method: $N_{(i+1)} = Ni + (i-1)$, resulting in 1,2,4,7,11,16..

- A vertical segment ($\overline{CD}$) is drawn and divided in the number of parts required by the progression and by the number of frames located between midship and the tail frame. In this case, there are 6 predesigned frames, so the progression goes on until N(6) = 16. The vertical segment will be then divided in 16 equals part.

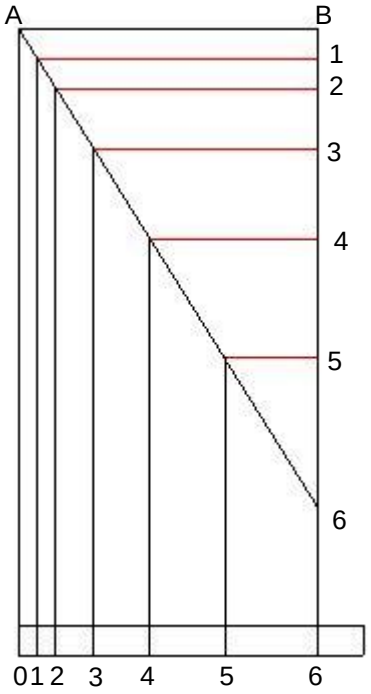
It doesn't matter how long $\overline{CD}$ is drawn, the results found will be the same at the end for whatever length of the segment.

Graphic operators of the *partison* - The incremental triangle

The apex ABD are joined and horizontal lines are traced passing by the points of the progression. The numbers indicate the corresponding frames.



The horizontal lines represent how much wider than the tail frame the corresponding frames are



The points are passed on the gauge. The distances between the points on the gauge represent the amount of narrowing between the frames; for example the distance from 0 to 4 indicates how much narrower frame 4 is than the midship frame

The 4 venetian *partison*

The Visione di Drachio manuscript attests four types of partison:

- The *partison de fondi*, that controls the narrowing of the floor timbers from midship to the tail frames
- The *partison del ramo,* that controls the widening of the futtocks from midship to the tail frames
- The *partison de la stella,* that controls the rising of the frames from midship to the ends of the ship
- The *schorer,* that controls the haleing down of the futtocks

The 4 venetian *partison*

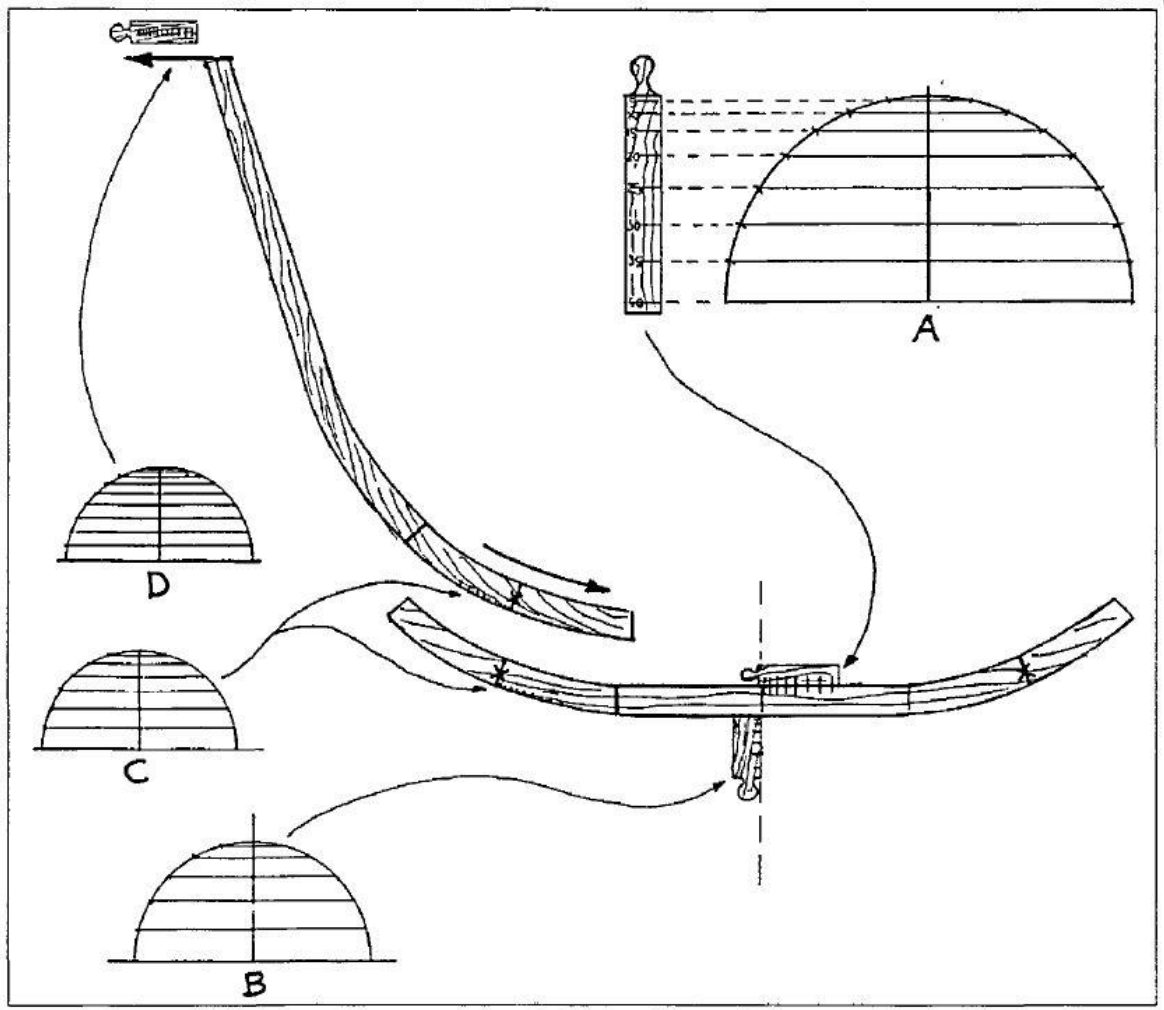


Fig. 4. The four 'Partison' in use in Venice and the use of the half moon. A Narrowing of floors (*fondi*). B Rising of floors (*stella*). C 'Haleing down' of futtocks (*scorer del sesto*). D Widening of futtocks (*ramo*).

"The ancient methods of designing hulls", by S.Bellabarba,
in The Mariner's Mirror, Vol 79, No. 3 (August 1993), 274-292

The *partison de fondi*

- The *partison de fondi* is referred to by Timbotta's and Pre Todaro manuscripts simply as *"la partison"*, "the partison". This probably means that it was the first one to be worked

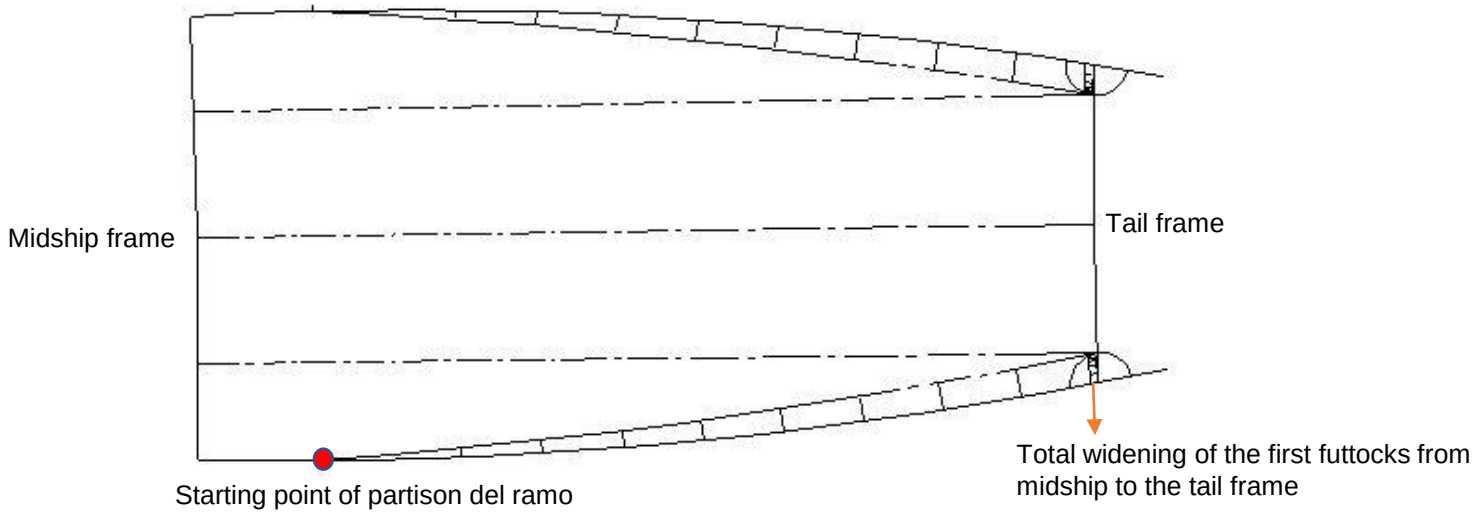
- It starts at midship and ends at the tail frames

- The total narrowing of the frames going from midship to the tail frame is decided by the shipwright. It is usually proportioned to some other dimensions of the ship, usually to the *bocha,* that is the the beam of the ship, its width at the hold. For example, Drachio states that *partison* of a light galley (the total narrowing of the floor timbers) should be 1/6 of the beam

The *partison* del ramo

- The *partison* del ramo controls the widening of the first futtocks going from midship to the tail frames at the height of the first deck, compensating the narrowing of the floor timbers and giving shoulders to the ship

- The widening of the first futtocks starts at some frames afore and abaft the midship frame, and terminates at the tail frames. For example, Todaro de Nicolò instructs to start the *partison del ramo* at the fifth frame counting from midship when someone wants to build a galleon propelled by oars, that has 25 frames between midship and one tail frame

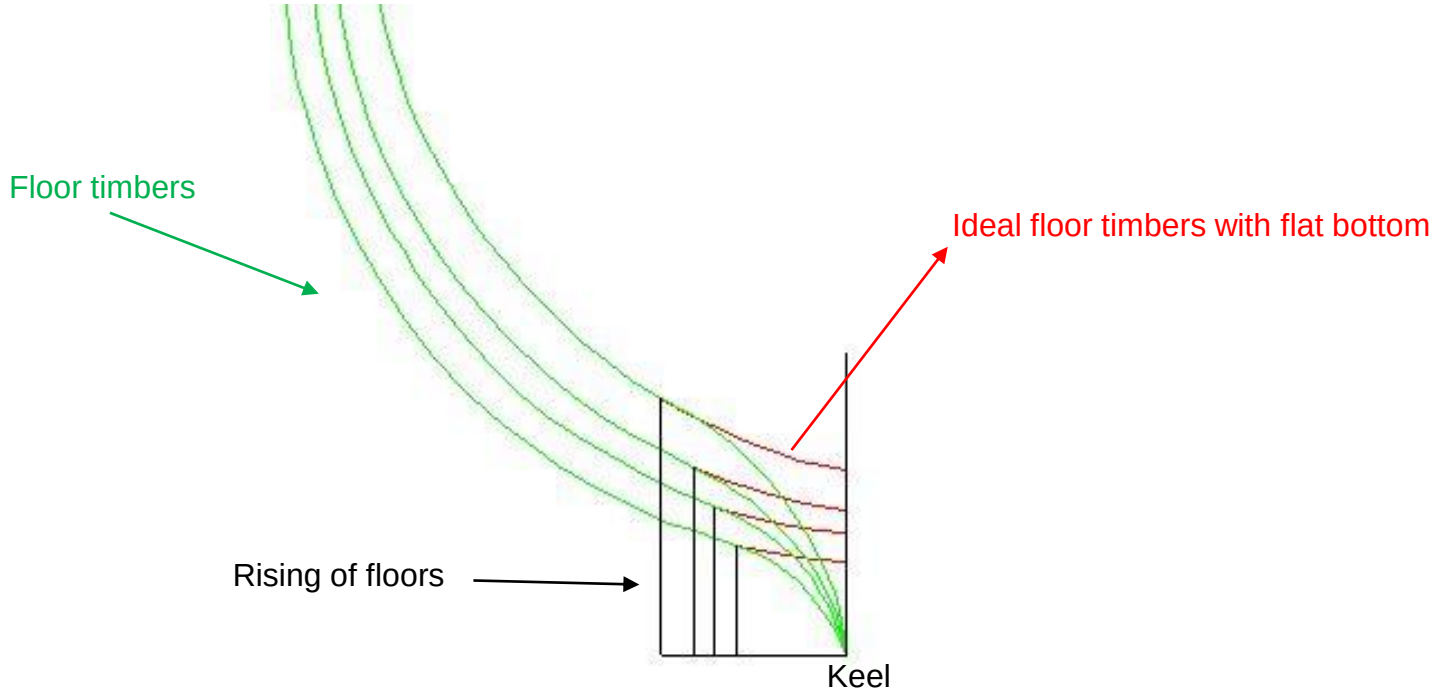


- The total widening of the first futtocks *(legno in ramo)* measures from 1/3 to ¼ of the total narrowing of the floor timbers and is greater at the prow.

The *Partison de la stella*

- The partison de la stella defines the rising of the floor timbers: the points of the turn of the bilge of a ship rise progressively from midship to the ends

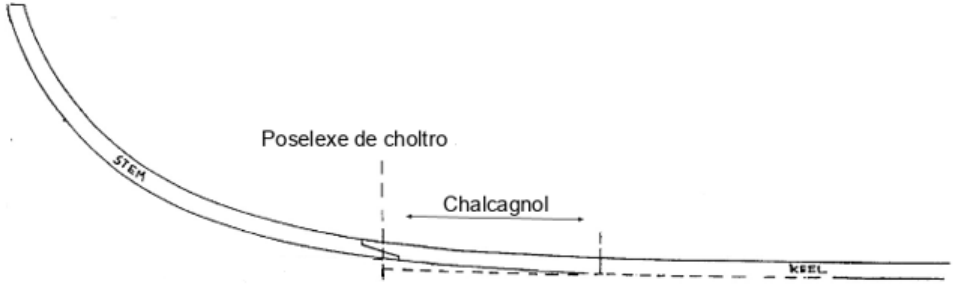
- Quoting Bellabarba, the raising of the floor timbers means the gradually increasing distance, starting from the centre of the ship and moving towards its extremities, between the upper face of the keel and the lower face of an ideal floor timber, cut with a flat bottom



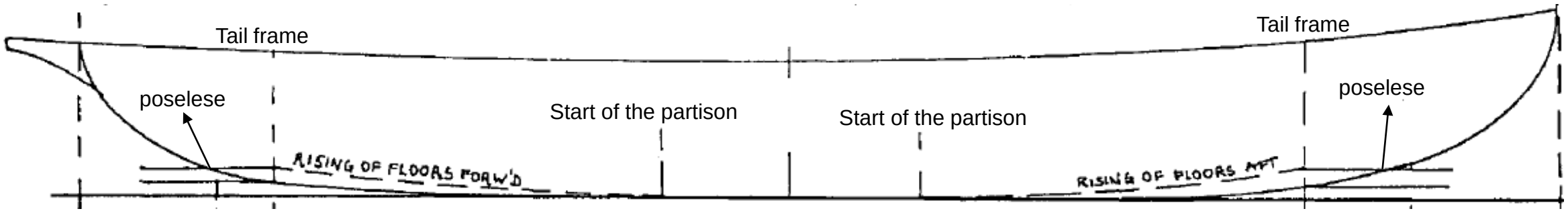
The *partison de la stella*

- The rising of the frames is generally greater forward and it is always less than the narrowing

- The partison de la stella starts at some frame afore and abaft the midship frame and terminates at the *poselese de choltro*, the scarf joint located between keel and *chalchagnol,* that is a timber that connects the keel to the posts



Edited drawings from "The ancient methods of designing hulls", by S.Bellabarba, in The Mariner's Mirror, Vol 79, No. 3 (August 1993), 274-292



References

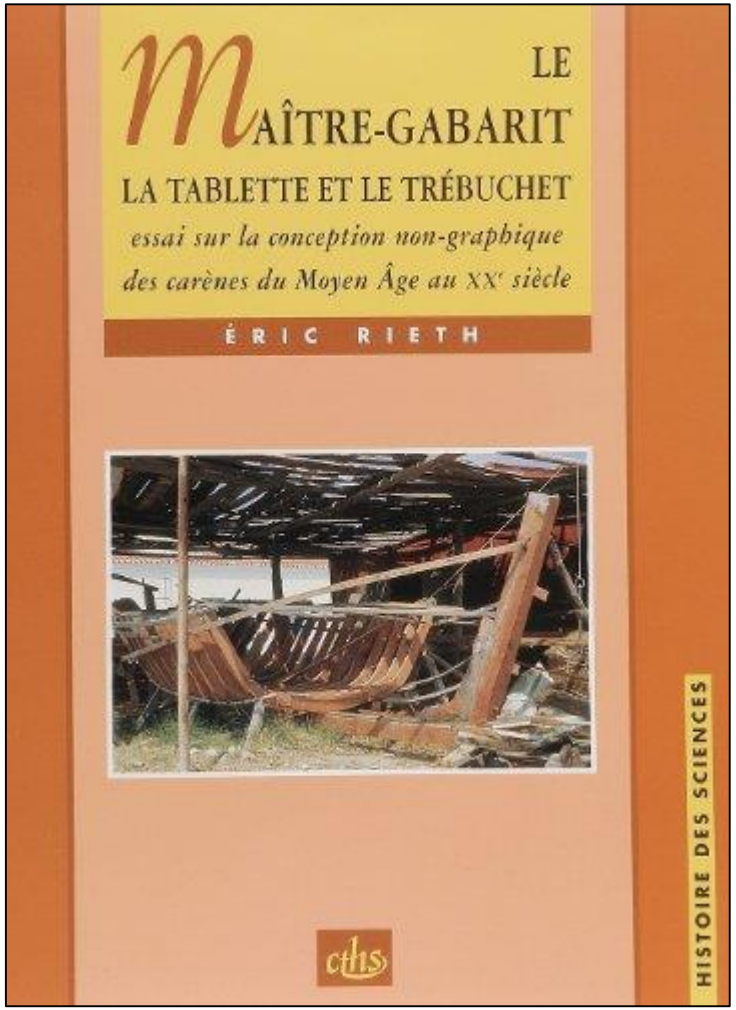
This presentation summarizes what 3 works say about the *partison* method and its graphic instruments. These works are:

- "The ancient methods of designing hulls", by S.Bellabarba, in The Mariner's Mirror, Vol 79, No. 3 (August 1993), 274-292

- "Rising and Narrowing: 16th-Century Geometric Algorithms used to Design the Bottom of Ships in Portugal", by F. Castro, in The International Journal of Nautical Archaeology (2007), 36.1: 148-154

- " Le "Ragioni Antique" dell'architettura navale", by A. Chiggiato, in "Ragioni antique spettanti all'arte del mare e fabriche di vaselli", Venezia, 1987

Further Reading



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Further Reading

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Further Reading

Archaeological Examples

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Castro, F., and Gomes-Dias, D., 2015. "Moulds, Graminhos and Ribbands: a pilot study of the construction of saveiros in Valença and the Baía de Todos os Santos area, Brazil." *International Journal of Nautical Archaeology*, 44.2: 410-422.