

Fig.12). Armed round tacked Dutch merchantman from 1600, based on the approximate 25 to 30 last size of the original *Duyfken*. Side view and rigging plan by K. H. Marquardt.

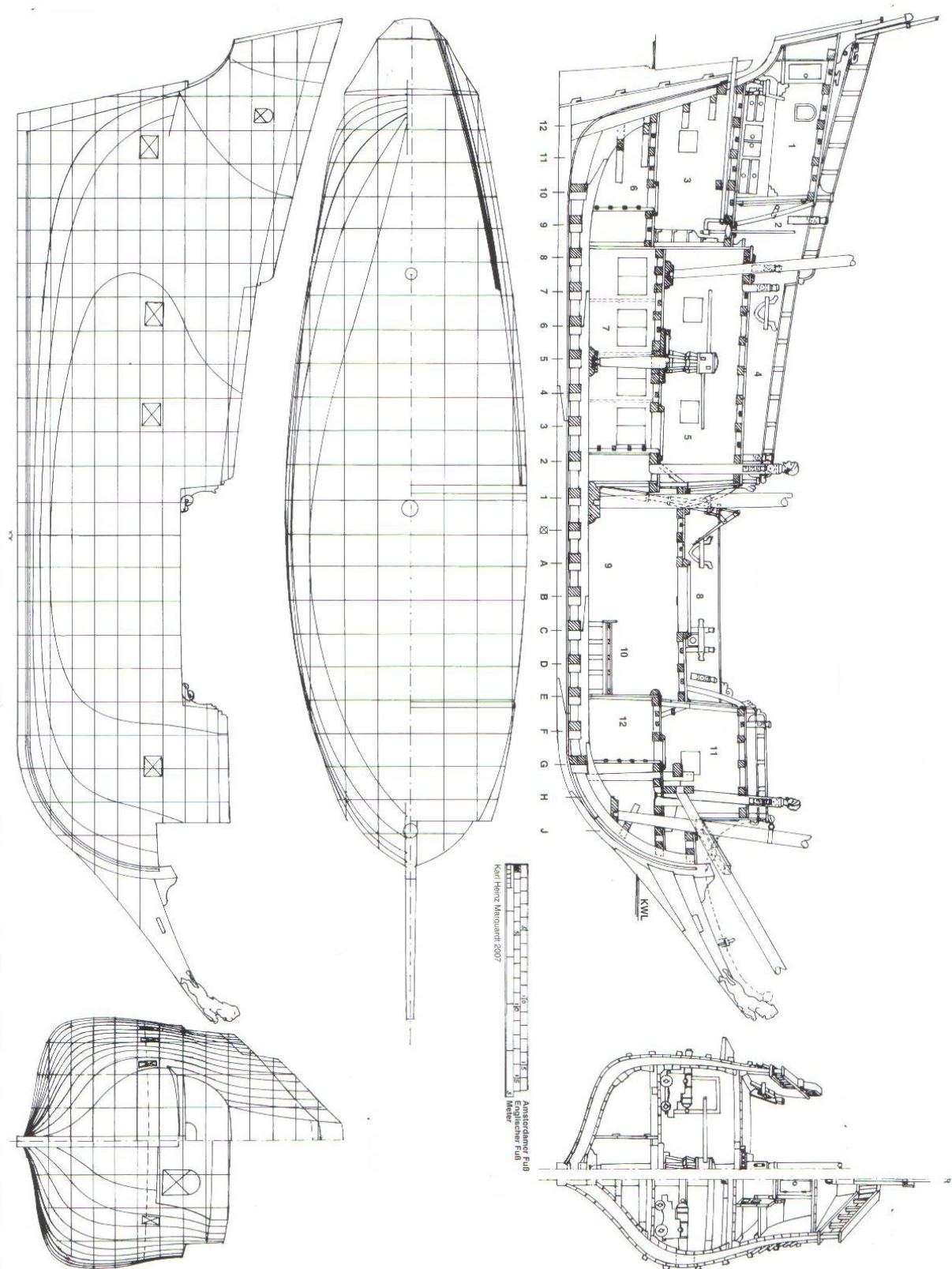


Fig.13).The longitudinal section, two rear cross-sections and three line drawings of Fig.12

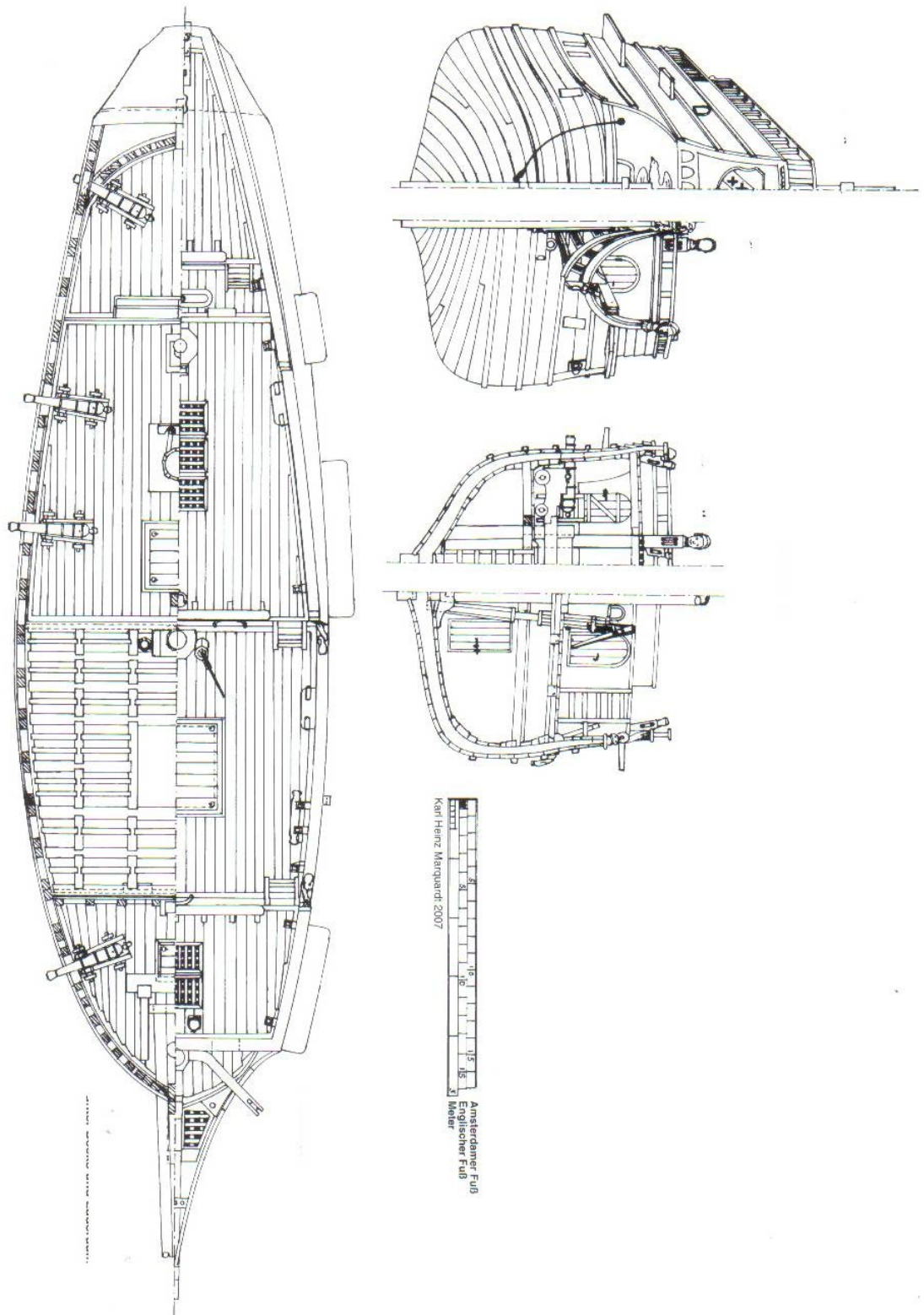


Fig.14) Two deck, a stern and a bow view, a mid ship as well as forecastle cross-section

When commenting these plans, *Duyfken* replica's chief-designer had to say that: *Aside from the flat decks and lack of drag to the keel (stuurlast) the striking thing about Marquardt's design is the tiny hold. It is very unlikely that such a ship could stow 25 or 30 lasten of anything with less density than bricks and with that loading it would trim very low in the water.*¹⁶ These words left him wide open to the very question; did he understand how to calculate the size of a ship of that period and even later and how a ship is loaded? It was not loading capacity, neither bricks nor feathers, but a rough calculation of the whole ship which provided the 25 to 30 lasts and it was loading weight, independent from the type of materials carried, which determines loading depth. The use of *trim* in this connection underlines the questioning of his statement. Trimming a ship means to place the loading weight equally over the whole length of the keel to provide best sailing condition.

Next will these seven points I mentioned be answered:

1.) Size of *Duyfken* replica

How does the replica's size compare with the 25 to 30 Amsterdam Last of our original *Duyfken*? Ships of that period and up to the 18th century, not only English but of various nations, were measured according to a simple formula: Length of keel for tonnage x extreme breadth x depth in hold : 100 for warships.¹⁷ The divisor would change to 95¹⁸ or 94 when dealing with more full-bodied merchantmen. The length of keel for tonnage was the length between stem and sternpost minus the overhang of stem and sternpost.

The metric length of *Duyfken* 'replica' is given as:

Length between stem and sternpost as 20 m or 70.75 Amsterdam feet

Width as 5.6 m or 19.8 Amsterdam feet

Depth in hold as 9 Amsterdam feet

The assumed length of keel for tonnage for this calculation would have been 16.2 m or 57.3 Amsterdam feet

Tonnage or Last (2 t) is $\frac{57.3 \times 19.8 \times 9}{100} = 102$ tons or 51 lasts

By using divisor 95 = 107.5 tons or 53.75 lasts

By using divisor 94 = 108.6 tons or 54.30 lasts.

In all cases is the 'replica' by more then 80% too large.

Puzzled by these dimensions, 17th and 18th century drawings of vessels of similar size and from several nations were consulted for this alternate design, also one of the oldest (1620) Treatises of Shipbuilding: *The breadth is arbitrary, the depth must never be greater then half the breadth nor less (than) a third, and the length never less then double nor more then treble the breadth. The length is meant of the keel, excluding the rake of the stern and sternpost;*¹⁹ The oldest Dutch book on shipbuilding by Nicolaes Witsen expressed 1671 in different words the same²⁰.

Concluding that by a length of 59.6 Amsterdam feet between stem and sternpost, a length of keel of 48.8 Amsterdam feet, a breadth of 18.1 Amsterdam feet and a depth in hold of 6.3 feet a 25 to 30 last vessel could be achieved.

$\frac{48.8 \times 18.1 \times 6.3}{100} = 55.64$ tons or 27.82 last.

Using divisor 95 = 58.57 tons or 29.29 lasts

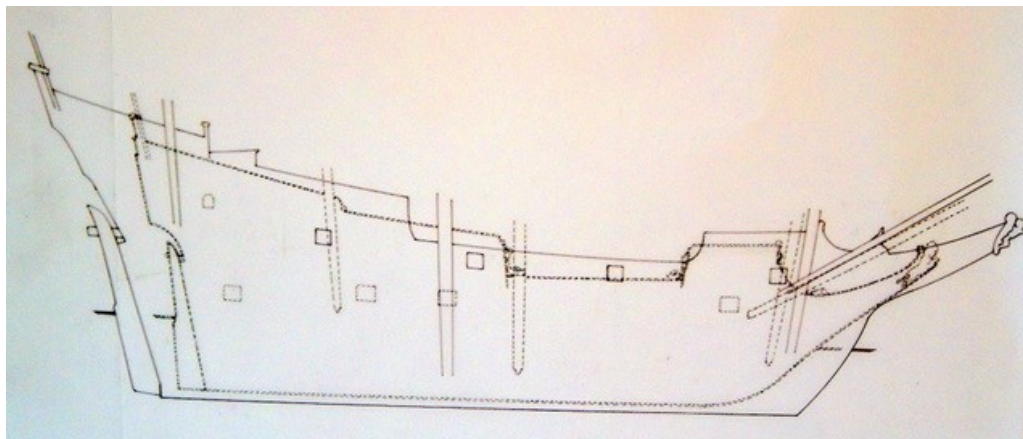
And divisor 94 = 59.2 tons or 29.60 lasts

All three calculations provide dimensions within the range of 25 to 30 lasts.

The alternate drawings were established from these dimensions and the following comparative hull outlines of the replica (full lines) and the alternate approach (dashed lines) (Fig.15) will clarify any size difference better than a written text can. It will also lead to a better understanding of the stem and sternpost situation to be discussed next.

Fig.15) Comparison sketch of *Duyfken* replica and the smaller alternative

The use of other then Dutch shipbuilding instructions was strongly opposed by the 'replica' designers²¹, however Dutch shipbuilding was not so distant from that of bordering nations, except for



a flatter and fuller frame for sailing in low water compared to those sharper frames of deep-water harbour nations. Having accepted after 1550 for certain types the southern (Spanish/French) style of square tuck construction, coastal conditions remained the same. General dimensions would not alter very much, no matter whether one consults English treatises or e.g. J. Furtenbach's *Architectura Navalis* from 1629, which deals mainly with Mediterranean ships, but also with a Dutch merchantman. With no printed Dutch work on shipbuilding available for that early period of the 17th century, it would be wrong to reject general dimensions and certain other rules from Non-Dutch sources, especially when slightly later (1650) Dutch drawings and Witsen's work (1671) corresponds with them.

2.) Stem and Sternpost

The second controversial part, the replica's stem, is strongly defended by the designers but still very wrong. It is a stem of the earlier 18th century and the following chapter proves it. We read in the *Treatise on Shipbuilding from about 1620* in regard to rake of stem and sternpost: *The raking both of the stern and stem, by a circle forward on, by a right line afterward on, is the overhanging of the work afore and abaft the keel.*

Further: *To the fore part of the keel B raise the perpendicular C, B which shall be parallel to the midship line E, D, upon which line will be the centre of the sweep that draws the stem. The semidiameter thereof must never be more than the whole breadth nor less than $\frac{3}{4}$ thereof: the best proportion is as 7.125 foot to 9 foot of the breadth. If then the breadth be 36 the semidiameter shall be 28.5 foot, which being taken of the scale with your compasses set one foot in B, extend the other to C and draw a circle up to a quadrant for the rake of the stem in the outside of the timber. [...]* Let the rake of the stern post never recline from the zenith more than an angle of 22 degrees nor less then 18 degrees...²²

Another work from 1627, Capt. John Smith' *A Sea Grammar* speaks of the stem: *At one end is scarfed into it (the keel) the Stem, which is a great timber wrought compassing (curved in an arc), and all the butt-ends of the planks forwards are fixed to it.*

*The Rake forward is neere halfe the length of the keele and for the Rake aftward, about the forepart (fourth part) of her Rake forward; but the fore Rake is that which gives the ship good way, and makes her keep a good wind.*²³

These two early English works describe what drawings of other nations demonstrate also. Around 1600 the common stem shape of ship or vessel was a semi-circle and the length of keel not more then 3 x extreme breadths. That this was a very closely adhered to principle can even be seen on models and drafts of large V.O.C. ships e.g. *Prins Willem* of 1649²⁴, a Dutch two decked 68 gun ship of 1660/70²⁵ and ship *Boekenrode*²⁶ of similar size of 1729. Declaring these English instructions as of no use for the reconstruction of a Dutch ship has already been proven strange by the three mentioned examples; even more so with these in defense of the replica presented extracts of contemporary Dutch documents, providing stem dimensions and depth of curvature:

- 1.) A 73 feet long 1594 vlieboat with 28 feet long stem, **5 feet depth of curvature** and a 13 feet or more rake,
- 2.) A 85 ½ feet long 1593 pinas with a 28 feet long stem and **5 feet depth of curvature** by 15 feet rake
- 3.) A 65 ½ feet long 1598 buss with a 26 ½ feet long stem, having a 16 feet rake and **6 feet depth of curvature**.

When reading the **depth of curvature** correctly, all three describe a semi-circular stem as cited in the ‘*of no use*’ English instructions. This lack of early written Dutch evidence let them forget that even by not having such; Dutch mid-seventeenth century drawings and Witsen’s first Dutch book on shipbuilding of 1671 followed the same circular rule. Yet by being in possession of and although talking of it, however disregarding not only one but three contemporary written affirmations of stem depth of curvature (Depth of curvature can be measured by drawing a line from the stem’s heel to its head and take at right angle the largest distance from that line to the rabbet curvature) on Dutch vessels of slightly larger size from the end of 16th century, (A 1593 pinas of 85 ½ feet length with a 28 feet long stem and **5 feet depth of curvature** by 15 feet rake would have given them the right idea) and Witsen page 66: *Tot het vallen van de voorsteeven neemt men 28 negen en twintigste deel, van de hoogte van de steven, in de winkel. De voor-steeven heeft bucht 5 voet,* (For stem rake shall 28 / 29th of the stem’s vertical height be taken. The stem has a depth of curvature of 5 feet. (Translation by Author)), That these time documents were a proof of the replica stem’s correctness by stating that the dimensions of the 1999 yacht *Duyfken*, 70 feet long: *the stem post 16 feet 3 inches high [not long] with 2 feet depth of curvature... the fall [rake] 7 ½ feet, are similar to those of the vlieboat and pinas* is therefore way of the mark. This again expresses lack of knowledge by not recognizing the significance of depth of curvature in these documented dimensions. *Duyfken* ‘replica’ was built as a pinas and they should have looked for pinas documentation where the given

dimensions point to a semi-circular shaped stem. The second designer’s claim in regard to curvature was even more interesting: *We did not design DUYFKEN’S stem until a strongly curved oak tree trunk had been acquired.*

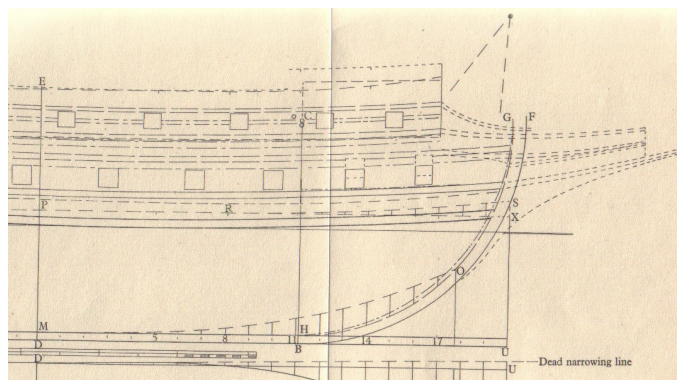


Fig.16) This draught detail is of an English ship of 100 feet length of keel; the drawing part of the Treatise on Shipbuilding from 1620.