Three-wheeled gun carriages

from the late16th-century shipwreck Scheurrak SO 1 near the Texel

J P Puype

Underwater archaeology in the Netherlands has seen a remarkable development over the last 25 years. As in many other places the first impetus came from sports divers and these still contribute a great deal to the discipline. In addition, however, a professional underwater archaeological unit has been incorporated in the Netherlands Institute of Ship and Underwater Archaeology (*NISA*), a division of the State Service of Archaeological Investigations (*ROB*) (See Maarleveld 1988, especially ch. 4). It is engaged in archaeological survey, rescue work and major excavation projects. The particular gun carriages that I want to discuss in this article illustrate these developments and the favourable preservation conditions for maritime finds in Dutch waters.

Until relatively recently gun carriages have only rarely been recovered in a more or less complete condition. Even if they did recognize the archaeological and technical value of a carriage many of the earlier divers did not want to spend the necessary time and money to recover and preserve such an object. The burning desire to get a gun – preferably a bronze one – has often caused it to be wrenched from its carriage with force resulting in predictable damage or loss of the latter as a coherent construction, along with its mounts, its tackle, etc.; the even more serious result is the uncontrolled dislocation and loss of context.

Nevertheless, many carriages are still *in situ*, underneath the guns they belong to and several wrecks are known which still have practically their entire gun battery in the original position, with gun barrels poking out from ports and resting on carriages which are in more or less complete condition, sometimes even with some or all of the original gun tackle attached. In Dutch waters, soft clay sediments and the shifting of tidal gullies are significant factors in preserving wrecks.

Recovery

The carriages discussed here were found at a wreck site to the east of the Isle of Texel in the western part of the Waddenzee, the exact area of the Texel roads of historical times. The wreck was discovered on the edge of a bank called the *Scheurrak* in June 1984 by Hans Eelman, a sports diver living on the island (see figure 2). He removed what was to become the first gun carriage – located at a gunport but no longer having its gun barrel – and several other items in the same year. These finds aroused such interest that a major excavation of the site, which was under threat of erosion, was started in 1987 (see Maarleveld 1988, 1990). The official name given to the wreck was *Scheurrak SO 1*. The project developed to a total excavation over a period of nine years. It has so far produced some 15 partial reports on specific categories of data. A second gun carriage, virtually a copy of the one found in 1984, but in a better state of preservation, was recovered in 1993 (see figure 1) and the information on it has been worked into the original text which in its first draft dealt with the 1984 find only.

Dating the carriages

A careful analysis of several shoes (see figure 3) that were also removed upon discovery in 1984 initially indicated that the ship might have gone down about 1590 (Goubitz 1985). This assumption has since been confirmed by the rest of the find material as well as by dendrochronological analysis of the hull. The ship is preserved from keel to bulwarks. The hull is double-planked and was built in the Dutch flush tradition (see Maarleveld 1992, 1994). It is assumed that the vessel was a flute-like hulk type of ship with a main cargo of corn presumed from the Baltic. It is estimated to have been built around 1580; the carriages could also be as old as that. The present consensus is that the ship probably foundered on 24 December 1593, when over 40 ships were lost on the Texel roads in a heavy storm.[1]

As mentioned before the first gun carriage was found and lifted upon discovery by Mr Eelman in 1984. Since he, like other divers dealing with wreck sites with a Dutch connection, knew that I was very interested in any evidence of (parts of) gun carriages that might be found, he immediately notified me about it, adding the most interesting news that it was designed with three trucks instead of four. I went to the island of Texel to inspect the carriage. I took a number of photographs, notes and measurements with the

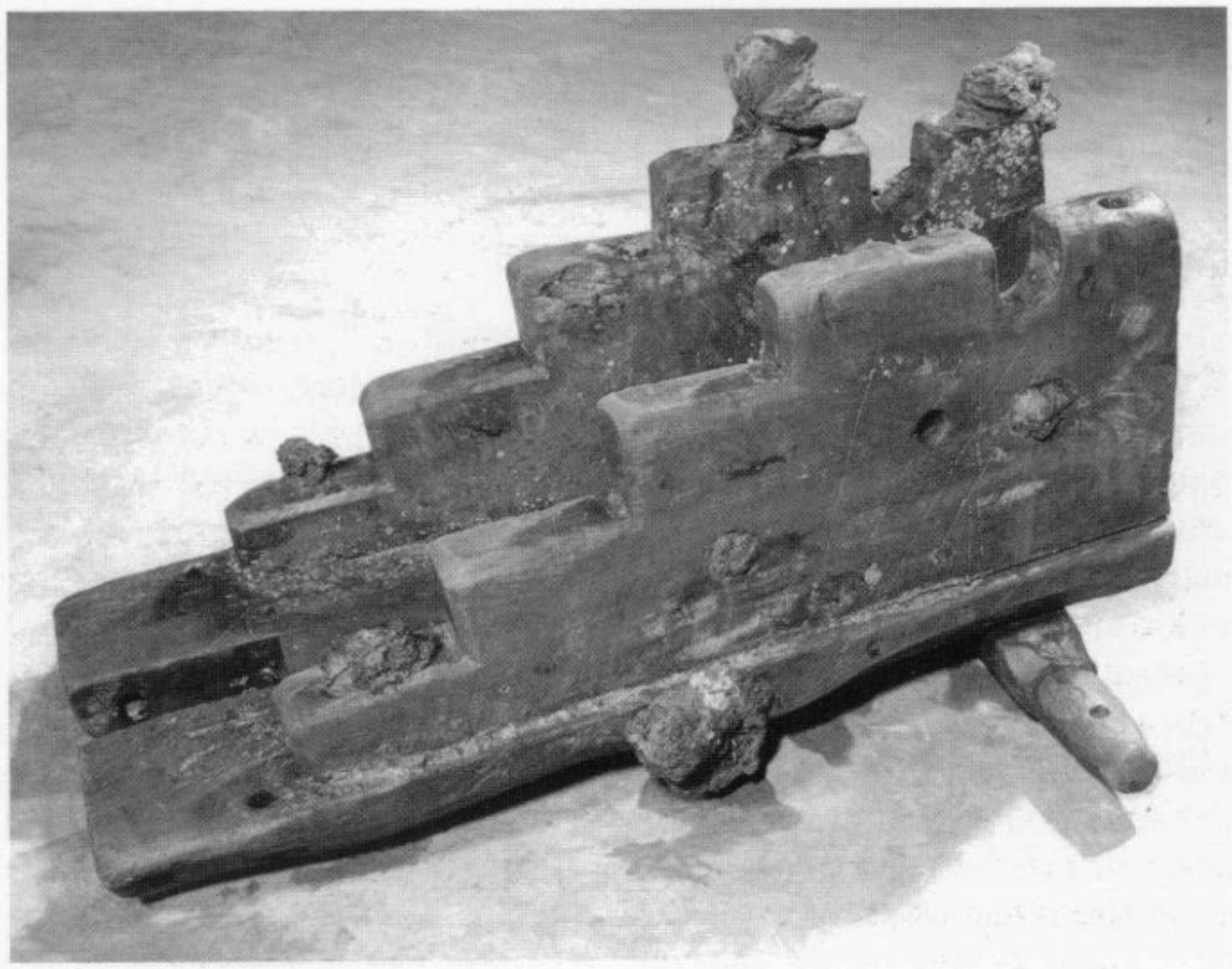

Figure 1 The second carriage recovered in 1993 in the state as it came from the wreck i.e. before conservation treatment. Find No. Scheurrak SO1/9806. Photograph by J Pauptit, courtesy of NISA.

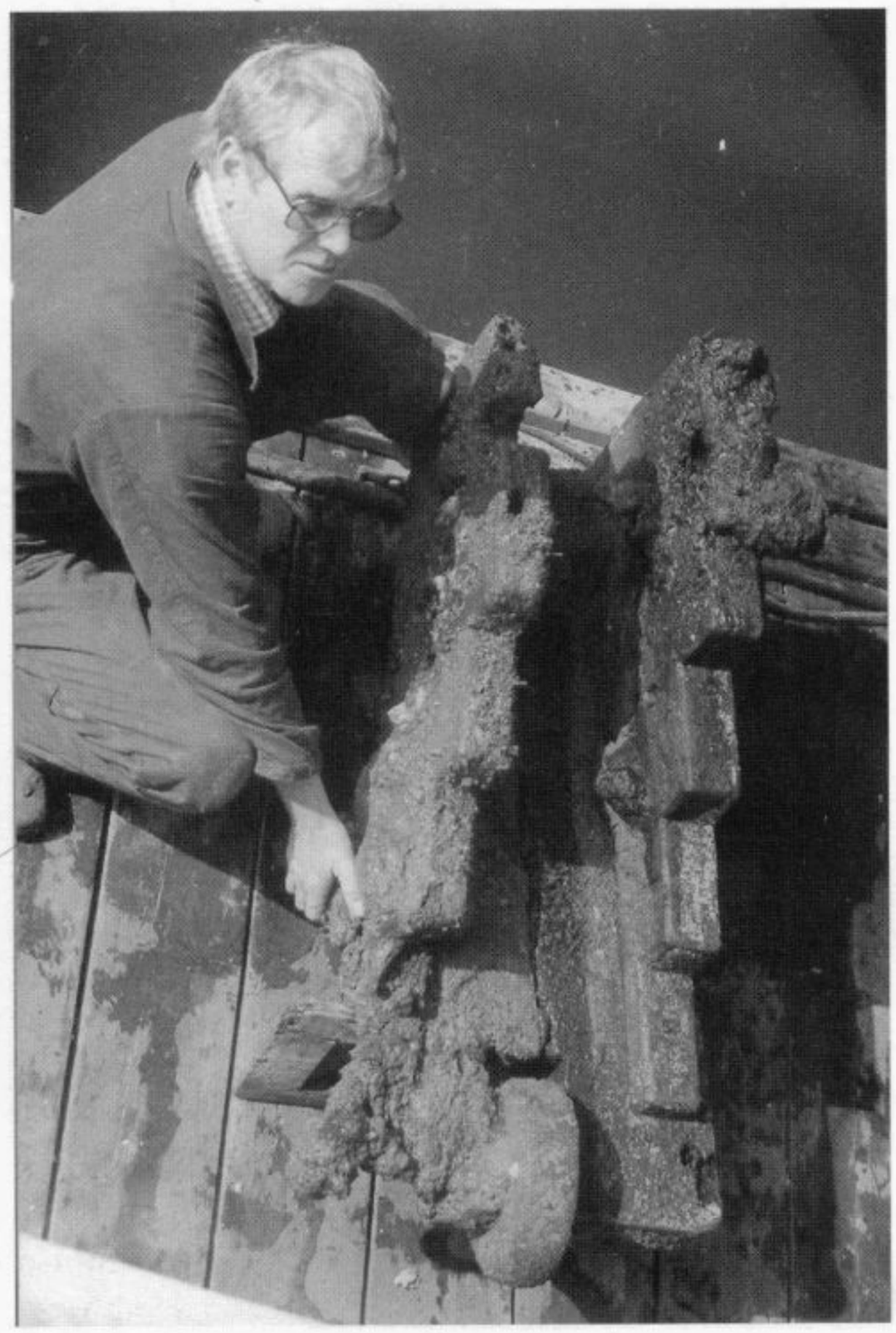

Figure 2 The first carriage and its finder, Hans Eelman, sports diver and leader of the Texel diving team 'Phileas Fogg', in August 1984. Photograph by J P Puype.

assistance of Mr G J van Gortel, then one of my colleagues at the Nederlands Scheepvaartmuseum, Amsterdam. Another colleague at the time, Ton van der Horst, later assisted with the working sketches. The 1993 carriage, which was given the official Find Number 9806 by Thijs Maarleveld and his crew, was studied and measured in detail in that year. I was later assisted in this by Mr Paul J W M Schulten, director of Archeoplan in Delft, a conservation firm with a laboratory that specializes in archaeological material, where the carriage was temporarily under treatment.

Figure 3 Four shoes recovered from the wreck, after restoration by Mr O Goubitz of the State Service of Archaeological Investigations (ROB) in Amersfoort, Netherlands. Drawings from Goubitz (1985: fig.1).

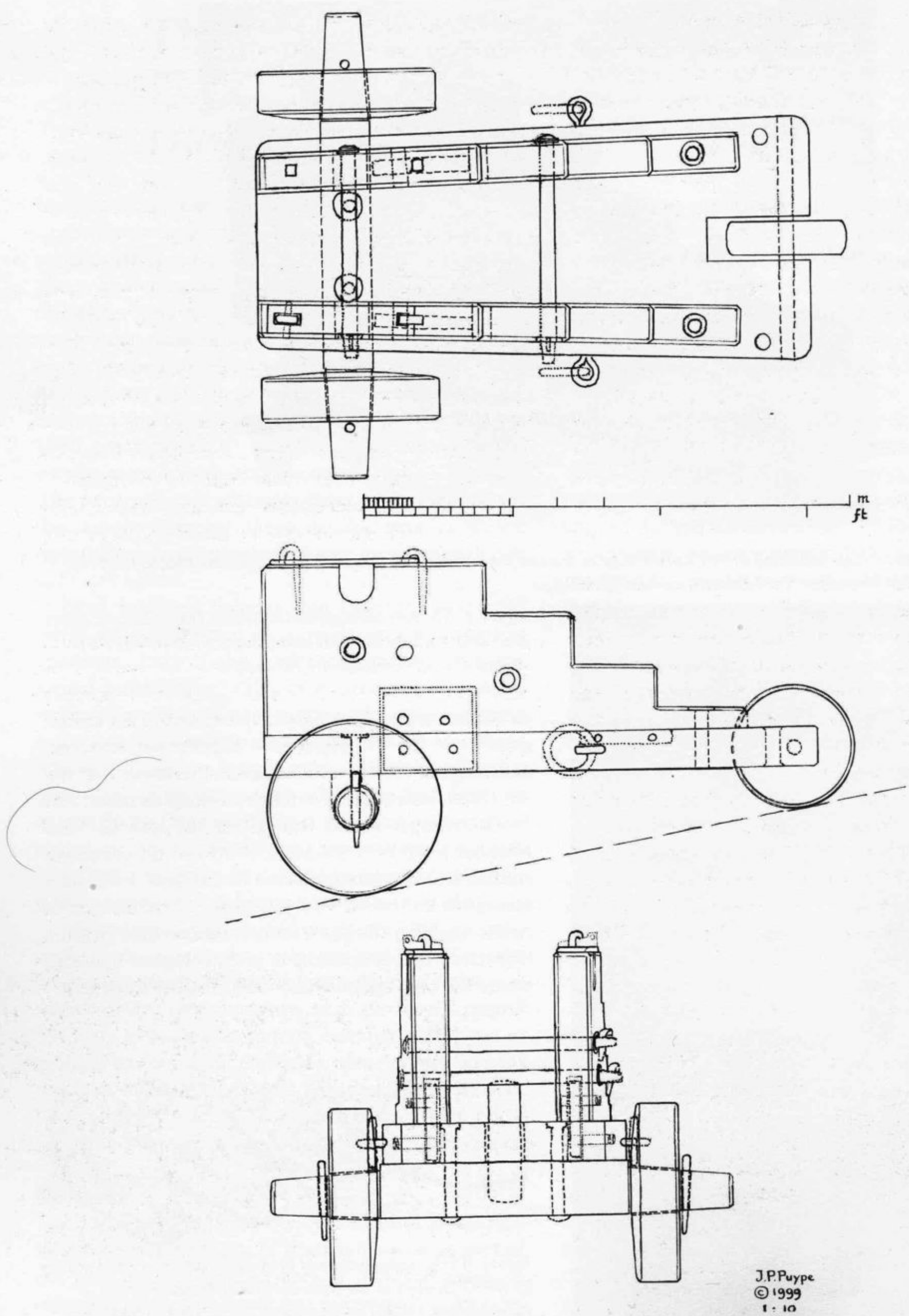

Figure 4 Three-view drawing of the second carriage. Drawing by J P Puype.

The carriages: construction

Both carriages are in surprisingly complete condition. The example recovered in 1984 has lost its left front truck and the left-hand cap-square, i.e., the iron strip over the trunnion-bed. All three trucks were recovered with the 1993 example. All ironwork holding the carriages together has partly disappeared through corrosion. At present, the 1984 carriage is kept submerged in a conservation tank, while the 1993 carriage is on display at the *NISA* in Lelystad.

Apart from their axles, which are of an as yet unidentified type of wood, the carriages are entirely made of oak. All corners to the cheeks and the bed are chamfered to about 7 mm. Traces of white lead on the 1984 example perhaps suggests an original paint layer. Nearly all the remaining iron mounts have corroded into an almost unrecognizable condition and the original shape of several of them can only be partially or tentatively reconstructed. My three-view scale drawing is based on the working sketches. It does not purport to be an archaeological drawing but is a mere presumption based on educated guesses as to the original complete construction in any case (see figure 4). The measurements given below are those of the 1993 carriage, those between brackets of the 1984 carriage. If only one measurement is mentioned, the measurements do not differ among the carriages.

The bed

The construction begins with a 1140 mm long bed with a thickness of 80 mm. It tapers in plan from 405 (420) mm at the front to 560 (500) mm at the rear. It consists of a single slab of wood, on the 1984 carriage the bed is broken along its central axis. In the middle on each side of the bed is a ring bolt. The ring, which is fact a loop, lies in the horizontal plane and has an exterior diameter of 50 mm. Both ring bolts each held a large, movable iron ring with an exterior diameter estimated at about 110 mm and a thickness of 18 to 20 mm. The two rings may have served for the side tackles since the carriages do not show evidence of hooks or so-called ram's horns such as were found, for instance, at the front of the carriages of the *Wasa*. On the 1984 carriage only the ring on the right-hand side is preserved and it has the remains of roping through and around it. This may suggest that the gun was secured for heavy weather prior to the foundering of the ship. In both rear corners of the bed a vertical hole with a diameter of 20 (30) mm is drilled. These holes may have served for endless strops used to affix rear ropes by which the piece was hauled in-board. Normally one would expect to find ring-bolts in this location, but there was no trace of corrosion remains in the holes. Incidentally, it is unlikely that on this relatively light carriage proper rear tackles, i.e., ropes with blocks, were used.

The cheeks

Standing on top of the bed and running parallel to, and about 20 mm from, its edges are two brackets or cheeks which as a consequence are also in a tapering position when seen in plan. They are each about one metre (950 [995] mm) long, 345 (350) mm high and 75 (74) mm thick at the front to 90 (80) mm at the rear. Both cheeks are provided with a circular hole of 30 (38) mm diameter situated underneath the first step of the cheeks at half height. These holes served the breeching-rope.

They are affixed to the bed in the following manner. At the front and immediately behind the axle, the

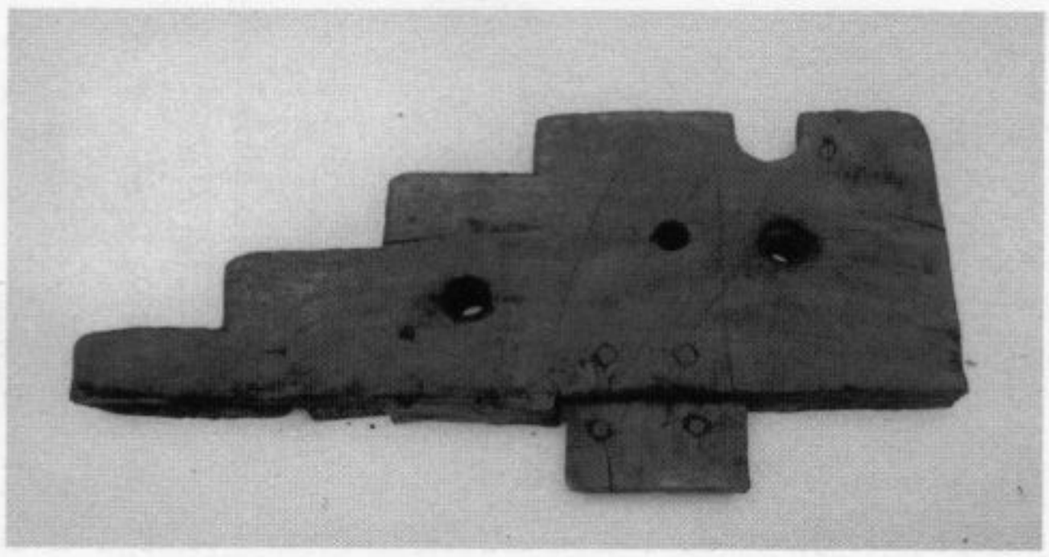

Figure 5 Exterior of the right-hand cheek of the second carriage with the tenon plate in place and the other tenon, forming a fixed part of the cheek, behind it. Photograph by P J W M Schulten, courtesy of Archeoplan.

Figure 6 The mortises in the right-hand side of the carriage-bed. Photograph by P J W M Schulten, courtesy of Archeoplan.

Figure 7 The mortise slot for the tenon plate in the right-hand side of the carriage-bed, seen from underneath. Photograph by P J W M Schulten, courtesy of Archeoplan.

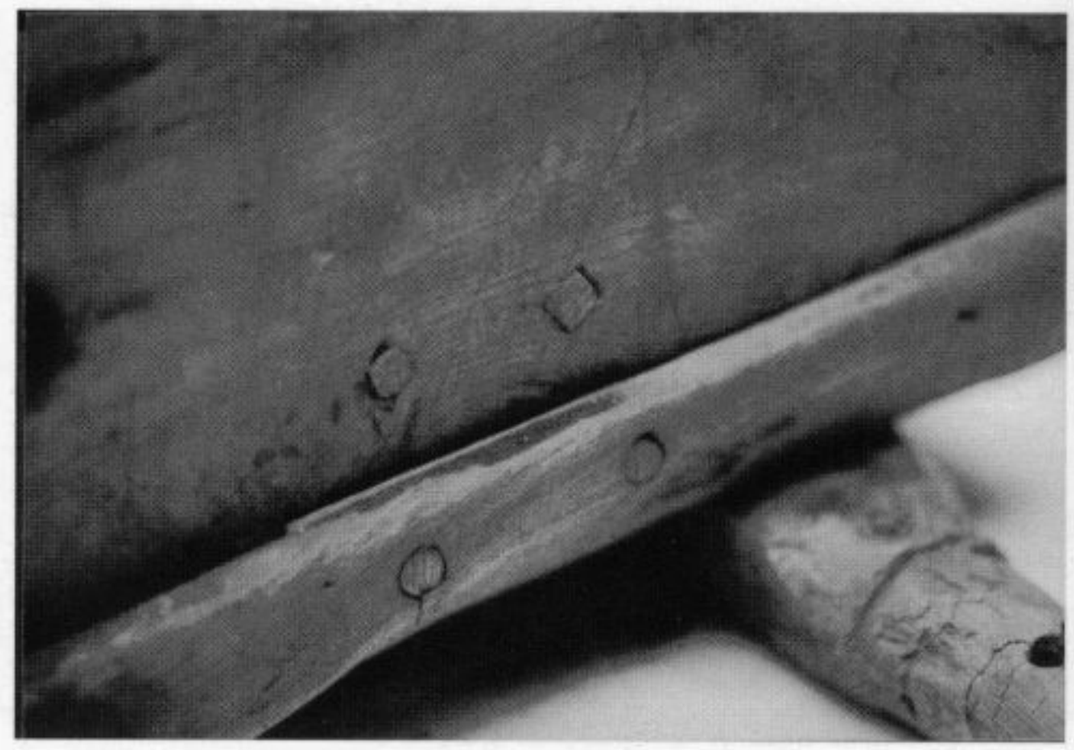

Figure 8 The dowels holding the tenon plate on the right-hand side of the carriage. Photograph by P J W M Schulten, courtesy of Archeoplan.

cheeks are fitted to the bed by a mortise-and-tenon joint. The tenon part of the cheek is a separate, vertically placed, rectangular plate of wood mounted internally (see figure 5). It is dowelled in corresponding mortises (cavities) in the bed and inside the cheek. The mortises in the bed are in the form of slots penetrating the full thickness of the bed. These slots enabled the carpenter to insert the tenons from underneath when he was assembling the carriage (see figures 6 and 7). The measurements of the entire (bed and cheek) cavity are 190 x 205 (175 x 200) mm. Each plate is affixed by four transverse wooden plugs or dowels, flush with the outer surfaces of the wood, two in the cheek and two in the bed (see figure 8). This type of internal fixing is a variation of the more or less standard mortise-and-tenon joint (see below) and it is also observed in contemporary timber house construction.

At the rear, each cheek is affixed to the bed by an iron bolt passing vertically through the lowermost side-step at the rear and the bed. Since both bolts have corroded away on each carriage, it is now not clear how (and how far) they emerged at the top and the bottom. That they were secured by a separate ring (over which the head was burred) on either end is proven by sunken fields in each case, wider than and concentrically with the channel. These fields provided space for the rings.

The bed-and-cheeks construction is further strengthened by another pair of mortise-and-tenon joints. However, unlike the aforementioned separate tenon plates dowelled both into the cheeks and in the bed and which are located exactly opposite of each other, the second pair of joints is staggered. The joint on the right-hand side is located immediately behind the plate and the one on the left-hand side is further aft. Furthermore, both these joints are 'standard' ones in that the tenons are block-shaped protrusions from the bottom edge of the cheeks and the mortises are corresponding cavities chiselled out of the bed's upper surface. Both these joints, too, are affixed by dowels. The two dowels on the right-hand side of the bed can be seen in figure 1 where they are located to the left of the concretion surrounding the movable side-tackle ring. All internal joints mentioned can be observed in figure 9 in which the carriage parts are shown in an exploded view.

Lateral strength to the cheek assembly is provided by two substantial, horizontal iron transom bolts (of

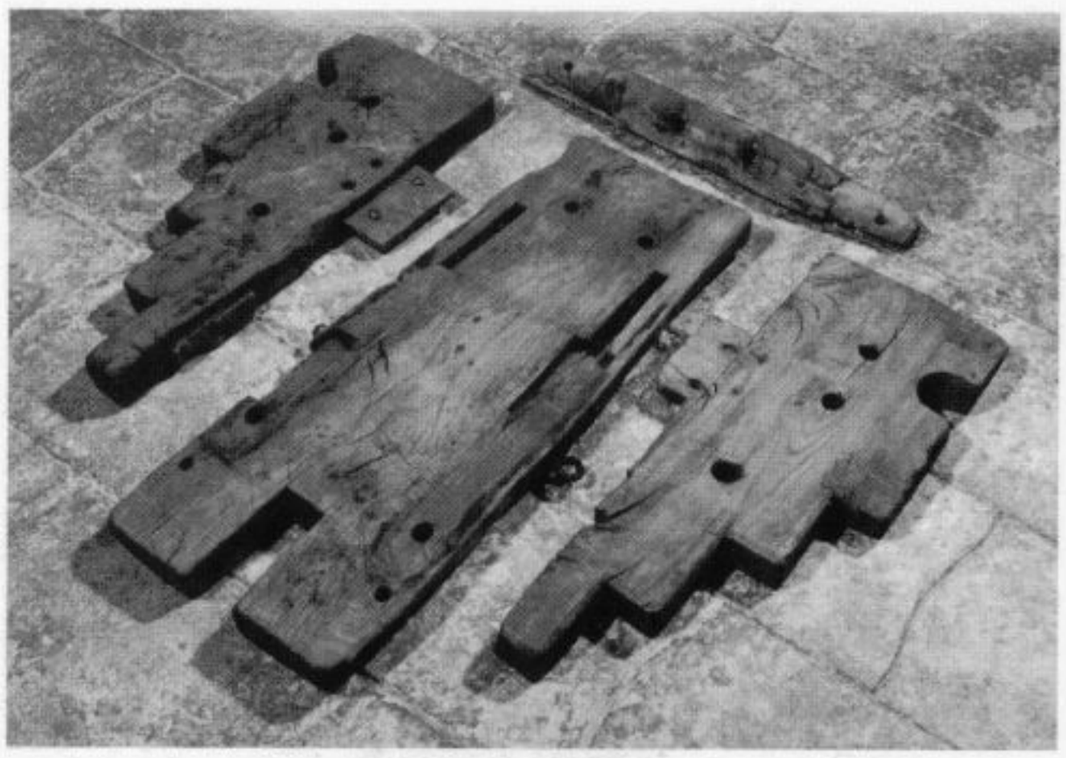

Figure 9 Exploded view of the second carriage showing the different mortise-and-tenon joints. Photograph by J Pauptit, courtesy of NISA.

so-called tie-bolt type) of 30 mm diameter with broad rounded heads on the outer face of the right-hand cheek. One is positioned underneath the trunnion-beds, the other near the corner of the second and third side-steps. Concentric cavities around the holes for the bolts on both cheeks indicate that a separate ring underneath each bolt head was used. The bolt ends on the right-hand cheek were simply burred over the rings. The bolt ends emerging from the left-hand cheek are tapering and each has a slot which takes a wedge plate. In order to hammer this wedge-plate home it needed a strong support. This was provided by, again, a ring. The typical transverse plank at the front, the transom, known from practically all gun carriages, is not part of the design of these examples. They are open at the front.

Trunnion-beds and cap-squares

The trunnion-beds are semi-circular at the bottom and worked with care. Across the open tops are the remains of flat iron cap-squares. These are corroded almost beyond recognition, but are obviously not affixed to the cheeks by means of long vertical eyebolts penetrating the bed and the full height of the cheek, and often penetrating the front axle-tree as well, as commonly encountered on (mostly later) ship's carriages. But on these two carriages the cap-squares are affixed by two tapering nails about 110 mm long of square section (11 x 11 mm), probably with serrated corners to provide a better seating, an eye-nail at the front and a joint-nail at the rear. The latter term implies that the nail terminates in a loop on which the cap-square can be hinged rearwards. The eye-nail at the front took a wedge-plate or a key-pin as usual, in order to secure the cap-square in place. It is possible that post-conservation treatment could reveal its impression in the incrustation so that we may derive its original shape.

Barrel-elevating means

A stool bed and/or a quoin was not present on either carriage. These are practically never recovered since they were usually not part of the fixed construction of carriages. They would have floated away during the sinking or afterwards. It might be questioned, though, whether such barrel-elevating means would have been used on these particular carriages since the rather precise arrangement and shape of the steps could also have enabled the use of a simple wooden bar resting on them. Such a bar would have given excellent support to the barrel in the three positions provided by the steps. The barrel could even have been put in a fourth position, i.e., with the bar removed whereby the base-ring of the gun would rest on the carriage's bed. Maybe the third carriage, which is still *in situ* will provide the answer to this.

Front axle

The axle at the front is affixed underneath the bed by two short iron tie-bolts of which the heads emerge immediately next to, in fact against, the inner side of the cheeks. The protruding lower ends may have had the same sort of heads. These bolts, too, have corroded away. The total length of the axle, that is axle-tree and axle ends or arms included, is 850 (950) mm. The 550 (500) mm long axle-tree is of rectangular section, height 100 (110) mm, width 80 (100) mm. It stands on its narrow side and the lower half is rounded. The two axle ends are circular in section and taper downwards to the exterior, their diameter of initially 80 (100) mm, eventually becoming 55 (70) mm. In them a hole is drilled vertically for the linchpins, which are made of an as yet unidentified hardwood. The one still in position in the right axle arm of the 1984 carriage is 160 mm long.[2]

Front trucks

The front trucks are plain and unshod slices of the trunk of an oak tree and have a diameter of 360 mm. That is why they should properly be called trucks instead of 'wheels'. As on most other parts of the carriage, the edges of the treads are chamfered (bevelled). As noted before, only the right-hand truck of the 1984 carriage is preserved whereas the 1993 one still has both. The former has a 90 mm wide tread, the chamfer included, flat like the outer face. Its corners are chamfered. The inner face of the truck is slightly convex (domed) so that the its thickness is 100 mm near the central axle hole. The 1984 trucks were not measured.

Rear truck

The 250 (245) mm rear truck has flat faces, but a convex tread of 68 (about 70) mm width. Its axle is presumed to be iron given the evidence of corrosion in the spots where it appears in the bed's sides. On the 1993 carriage, the diameter of the axle hole was measured at 32 mm. Apparently the axle, in order to be inserted or extracted, penetrated the entire width of the bed at the rear. This is suggested by 30 mm wide holes located in the edges of the bed, their centreline

being at 45 (40) mm from the bed's rear edge.

The gun barrels

With regard to the gun barrels, at least one is still on the wrecksite, but it has not yet been recovered. I would like to state first of all that owing to the relatively narrow distance between the cheeks the carriages can only have served light cannon barrels, perhaps three-pounder demi-sakers or falconets. The third carriage still has its gun barrel. A recent publication on the Texel wreck has a report of '...at least four cast-iron cannon [barrels] and the remains of at least five wooden supports [=carriages] for them' (Manders 1998:79). I am unable, however, to corroborate this information. The barrel with the third carriage is certainly of iron, very probably cast. The presence of a fourth carriage is suspected, but it has actually not yet been found. Judging from the shape of the trunnion-beds, the guns may be different among themselves. The trunnion-beds of the 1984 carriage are semi-cylindrical whereas on the 1993 carriage they are strongly tapering in plan with a difference of 15 mm in width between the exterior and the interior. Traditionally, it was a rule that the thickness of the parts of a carriage were either similar to the calibre (diameter of bore) of the gun or had measurements relative to it. With the two Texel carriages there is little to go on in this respect, but both the thickness of the cheeks and and the distance between them would already suggest a 2- or 3-pounder gun barrel. These had bore diameters of about 68 and about 77 mm respectively.

The inner side of the right-hand cheek of the 1984 carriage has near the upper step and the joint-bolt for the cap-square two wide grooves touching each other. This pair of grooves begins at the upper edge of the cheek and runs downwards for about 80 mm, gradually decreasing in depth until it disappears. These grooves certainly originate from the chafing of decorative rings or astragals round the barrel which was apparently either a bit oversize for this carriage or had a slightly offset position in plan caused by dissimilarity of the trunnions or of the beds. The shape of the twin grooves suggests a double decorative ring around the barrel behind the trunnions. Because of heavy barnacle growth and marine incrustations, the presence of any similar grooves on the inner side of the left-hand cheek could not be established by me at the time. There are no such grooves on the cheeks of the 1993 carriage. That there must have been a difference in size between the guns is indicated by the fact that the slightly wider 1984 carriage has the chafing grooves whereas that of 1993, which is narrower between the cheeks, has not. It could also be that both guns were of equal calibre, but of different design having mouldings differing in arrangement and size. It should be added that several kinds of shot and other projectiles have been recovered from the wreck and that these included 1,2, 3 and 4-pounder shot.[3]

Properties of the three-wheeled carriages as gun mounts

The side view of the carriages suggests that the gun and its carriage if placed on a horizontal plane must have leaned backwards at quite a substantial angle. Of course the main and well-known reason for this phenomenon was to compensate for the camber of the deck, i.e., its roundness athwartships so that the barrel might lie more or less horizontally. This camber was especially strong on the upper decks, which was indeed the usual location for such light guns, irrespective of the presence or not of a proper gundeck closer to the waterline.[4] In any case it has been established that the wreck in question must have been a fairly substantial vessel with two complete decks (Maarleveld 1990: 106). The side view drawing also shows that the trunnion-beds would be almost perpendicularly positioned over the front axle if the carriage's bed were placed horizontally. The strong rearward inclination of the gun mount may also be linked with the desire to have the greater part of the barrel weight behind the front axle in order to prevent the piece from toppling

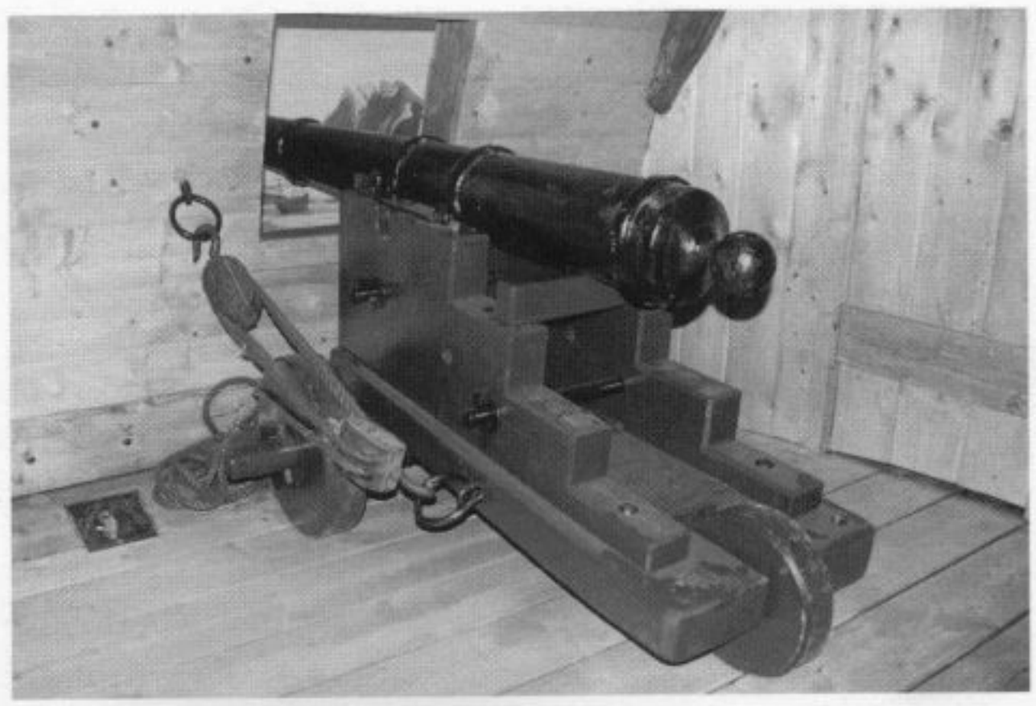

Figure 10 A full-scale reconstruction of the three-wheeled carriage from the Texel wreck of 1593. Reconstruction made in 1996 as a permanent museum display in the rebuilt interior of the exploration ship of William Barentsz of 1596. Photograph courtesy of Museum 't Behouden Huys at Terschelling.

towards the front when the ship was taking a downward roll on the gun's side. A more direct reason might have been to increase the gun's weight on the single rear truck and so further the braking resistance. A full-size replica of the entire gun mount based on the 1984 carriage, is shown in figure 10.

As far as the tactical properties of the three-wheeled carriage are concerned, if theoretically they provided such advantages, one might wonder why one almost invariably observes four-wheeled sea carriages. A three-wheeler should have been less dangerous to operate for the gun crew which in the agitation of action would constantly risk having their feet crushed by one of the rear trucks running across them. Since the greater weight of a gun barrel rests on the front trucks rather than on the rear ones, the stability of a three-wheeler would in practice be about the same as that of the standard four-wheeler or, it is true, of a two-wheeler which also rested on four points. Besides, a three-wheeler would be much easier to train than a four-wheeler since three trucks would give less friction on the deck than four.

Practical reasons why the three-wheeled carriage was not widely adopted are not difficult to find, however. To help in stopping the recoil, four trucks would give better friction than three. Theoretically, three trucks would be prone to wear quicker than four. The braking distance of a three-wheeler would be longer than that of a carriage fitted with four trucks and its recoil would have been more boisterous. Especially with such light guns, which used to jump in-board with much more violence than the more massive heavier guns, this was an important tactical consideration.

Documentary evidence

There is documentary evidence for three-wheeled gun carriages at sea; apparently, they were not unknown in land or fortress warfare either. Three-wheeled carriages appear in a Dutch manuscript on artillery of 1657 preserved in the Swedish war archive in Stockholm.[5] This deals both with sea and land artillery and the captions to the two illustrations depicting the three-wheelers (see figure 11) unfortunately do not disclose for what use they were intended. The guns are named 'clockwise pieces', which is confirmed by their conical chambers. Both of bronze, the upper cannon is named a 'half clockwise quarter piece firing six pounds of iron', the lower a 'clockwise drake firing three pounds of iron'.[6]

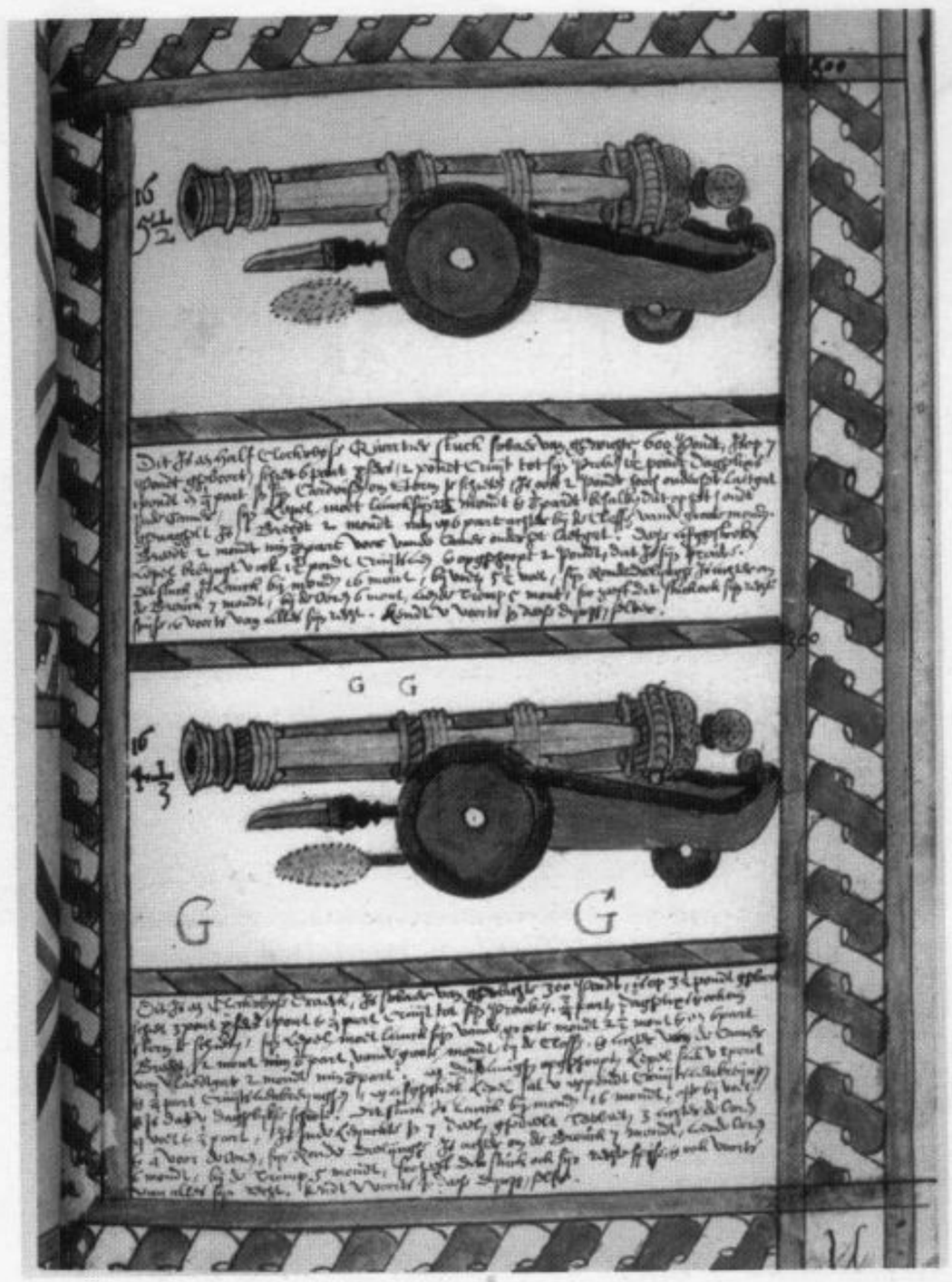

Figure 11 Two three-wheeled carriages, probably for use aboard ship, as pictured on fo[42] of the MS Ars tormentorum Aeneorum *of 1657, by Gerrit Gerritsz van Essendelft, preserved in the Krigsarkivet in Stockholm. The upper piece is captioned as a 'half clockwise quarter piece firing six pounds of iron', the lower as a 'clockwise drake firing three pounds of iron'. Photograph courtesy Krigsarkivet.*

Although elsewhere in the Stockholm manuscript are depicted the more or less standard four-truck sea carriages, I am fairly sure that the aforementioned three-wheelers could have been intended for use aboard ship. It also appears that they were designed as three-wheelers from the outset since the third truck does not seem to be a transport wheel of some sort. Besides, for land or fortress guns the tail of the carriage would not need to be quite so constricted as shown in the drawing.

Comparable to the three-wheelers are those four-wheel carriages on which the two rear trucks or wheels are closely placed together underneath the centre of the rear axle and these were in use in some navies during the 19th century. Blackmore (1976: 65–6, pl. 74) illustrates some miniature ship's guns on truck carriages made in 1638 for the Prince of Wales (later Charles II). It is true

Figure 12 The arrival in Flushing of the Elector Palatine and his spouse Elisabeth Stuart aboard the English man-of-war Prince Royal *in 1613 (centre left). Oil painting executed in 1623 by Hendrick Cornelisz Vroom in the Frans Hals Museum in Haarlem. In the mid foreground is the yacht of the Stadtholder, Maurice Prince of Orange. firing a salute from one of its bow guns. Photograph by Tom Haartsen. Courtesy of Frans Hals Museum.*

that plate 74 shows a two-wheel carriage with two semicircular chocks underneath the bed at the rear. These chocks, however, are placed very closely together suggesting the outline of a third truck and it is worthwhile to add that the shape and contour of the entire carriage is most similar indeed to that of the three-wheelers from the Texel. Elsewhere in this *Yearbook*, Robert D Smith writes about a cast-iron cannon and carriage at Windsor Castle which he tentatively dates to the end of the first half of the 17th century. The reader is invited to compare this carriage with those of the Texel wreck and he will no doubt establish that there are many similarities.

In 1783, the Admiralty of Amsterdam evolved a carriage on which the rear axle and its trucks had been replaced by a single 36-pound shot in a ring bearing mounted underneath the bed at the rear. This carriage, for an 18-pounder gun, was tried on board the frigate *Castor*. The experiment went favourably and the gun could be trained with ease and speed and yet there is no evidence that it was ever officially adopted.[7] Very probably one of the main reasons for this was the fact, mentioned before, that the breaking effect was too much reduced and the gun would run inboard too quickly when fired. Besides, the cannonball would have to be kept well greased, and leave smears on the deck, much to the wrath no doubt of both the ship's bosun and the first mate. A more serious disadvantage would have been the fact that the ball would have allowed the rear end of the carriage to sway sideways by itself too easily when the ship was heaving in a rough sea.

The Vroom painting

A near-contemporary iconographical piece of evidence for the actual use of three-wheeled carriages on board is provided by the well-known very large painting executed in 1623 by the sea painter Hendrik Cornelisz. Vroom on display at the Frans Hals Museum, Haarlem.[8] On this painting (see figure 12), which depicts the arrival in Flushing of the Elector Palatine in 1613, an English fleet with as flagship the then largest man-of-war afloat, the three-decker *Prince Royal*, approaches the town. One of the Dutch ships present on this occasion, the official yacht of the Stadtholder Prince Maurice of Orange, lies in the mid foreground. On the foredeck of this yacht two bronze guns lying on three-wheeled carriages can clearly be observed (see figure 13). These guns are obviously of much heavier calibre than the cannons supposedly carried by the Texel wreck, but their carriages are unmistakably of the same shape as the Texel carriages and for all intents and purposes very similar to them in a number of details. The front trucks, however, are extremely large and noticing the low gunport through

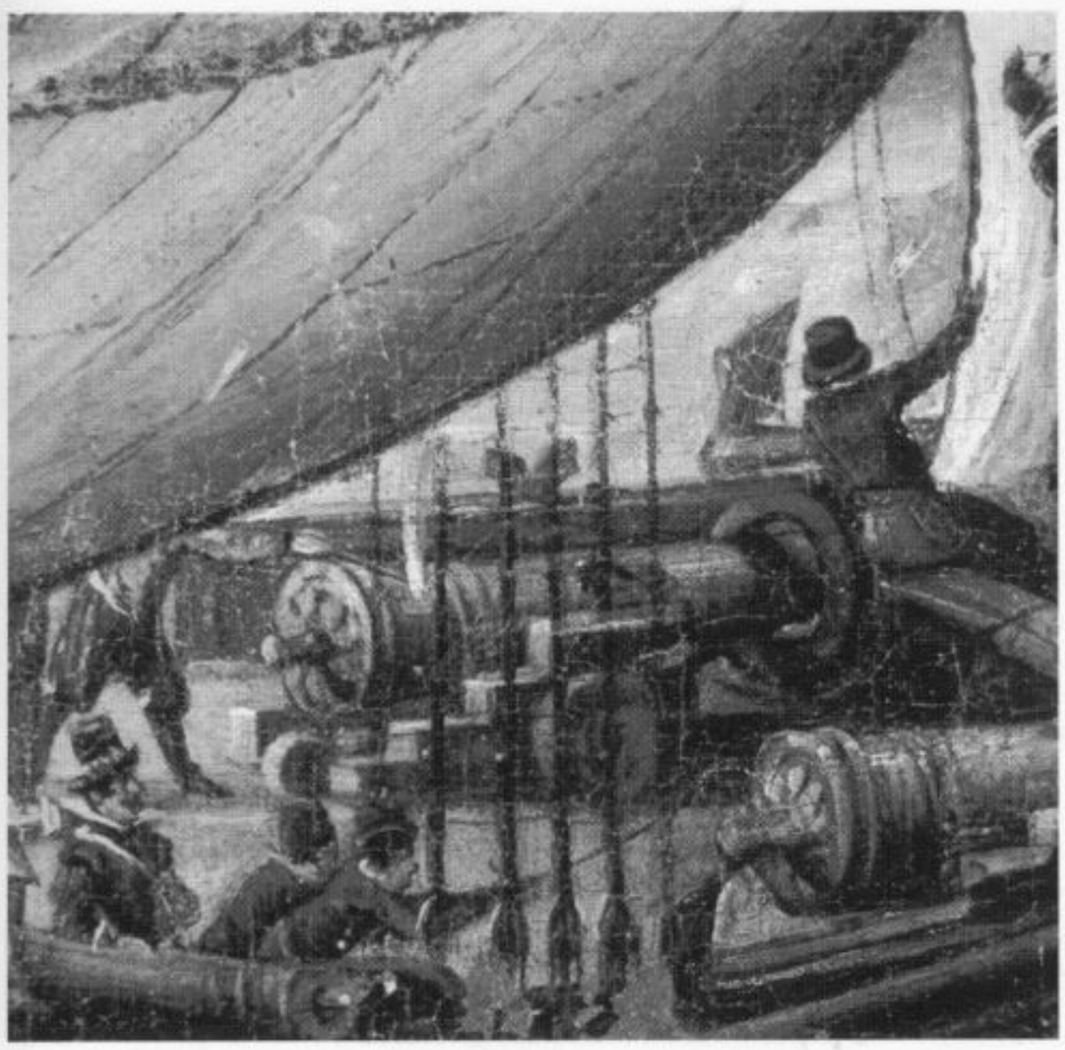

Figure 13 Close-up of Prince Maurice's yacht in the painting by Vroom, showing medium to heavy bronze guns on three-wheeled carriages. Photograph by Tom Haartsen, courtesy of Frans Hals Museum.

which the left-hand gun is just being fired as well as the necessary lowness of the carriage, the only way that such large trucks could have been fastened would be by an axle situated *on top* of the bed and penetrating the cheeks. We have seen the same peculiar construction on a number, though not all, of the truck carriages recovered from the *Mary Rose*.[9]

Conclusions

The carriages from the wreck *Scheurrak SO 1* provide a number of interesting points, some of the most pertinent of which are the use of three trucks, the use of some internal joints and the indication of rope-securing means for the gun tackle such as rings and holes. A number of questions still remain and the author invites anyone interested in early European shipboard technology to bring forward comments and, ideally, comparable pieces.

Acknowledgements

This article is a revised version of a paper presented at the Royal Armouries, H M Tower of London, at the annual conference of the Ordnance Society on 26 October 1990. Unfortunately plans to publish the proceedings came to nothing. The difficulties of having an unpublished interim report on an archaeological site where continuous work is going on will be appreciated. In my particular case, however, the delay enabled the inclusion of a second carriage recovered in 1993, which was in better condition than the first.

I am grateful to Angus Konstam, at the time employed at the Royal Armouries, for his help in making the original paper possible, and to John Penna, then photographer at the same institution, for having transformed my set of mediocre snapshots into slides of commendable quality. Thanks are further extended to Dr Th J Maarleveld, then director of the Underwater Archaeological Department (now named the Netherlands Institute of Ship and Under Water Archaeology (or NISA) for his kindness, support and also his indulgence in reading and amending the typescript at least twice, and in bringing the references up to date. I am also grateful to Dr Maarleveld for allowing me to publish on two of the many interesting finds.

I am also indebted to Dr D P Snoep, until November 2000 director of the Frans Hals Museum, and to his staff for providing the photograph of the painting and the close-up of Prince Maurice's yacht as well as for his permission to use these as illustrations in this article.

Notes

1 For a general article on the ship and its contents see Manders (1998). The three-wheeled carriages are discussed on p. 80, including a three-dimensional view which, however, does not reveal the internal joints.

2 On discovery of the site in 1984 the divers also retrieved a separate axle of similar construction as the front axle of both carriages and of about the same size. There is also a pair of trucks with it, but these are clearly of larger diameter than the front trucks on the carriages, being nearly 400 mm with a tread of 85 mm and a centre width of 115 mm. One of the two linchpins is still present, this time, remarkably, of iron. We may be dealing here with a spare axle for the carriages. The suggestion put forward at the time to the author by Hans Eelman, that this axle could be a transport axle of some sort, should perhaps be discarded.

3 As inspected and measured by the author in May 1998 in a NISA depot at Hoogwoud in the province of North Holland.

4 It is presumed that the ship in question did not have a gun deck and that the three-wheelers as 'upper guns' constituted its only armament.

5 Gerrit Gerritsz van Essendelft, *Ars tormentorum Aeneorum*, a manuscript dated 1657, preserved in the collection of the Krigsvetenskapsakademien, vol. 11, deposited in the Krigsarkivet, Stockholm.

6 This could imply that the term drake (*draeck* in the MS) was only reserved for light cannon with a narrow

chamber. This seems to be confirmed by Blackmore (1976: 228–9). It is true that Wilson (1988) provides proof that the gun he describes is a 'culverin drake' and that it is practically as large as a true culverin, but it is possible that the denomination 'culverin' was added because of its shape and not necessarily its size.

7 Preserved in the Algemeen Rijksarchief, The Hague, Map Room, drawings nos VTHR 301–21 A–F inclusive. The wash drawings are signed and provided with comments by the inventor, Cornelis Redelijkheid.

8 Frans Hals Museum, cat. 300. This painting is referred to in many works, but special attention to its maritime and technical aspects is given in Vreugdenhil (1951: 181–2, 256–8) and Howard (1979: figs 139–41). The fullest account, albeit in a more or less popular form, of the contents of this painting in all its aspects, is given in Biesboer *et al.* (1983).

9 There are also interesting points of technological similarity between the carriages of the Texel wreck and the four-wheeled carriages recovered from the *Mary Rose*, which went down in 1544. Of the latter, two different types have been identified, one with the axle-trees mounted on top of the bed, the other with the axle-trees underneath it. Both carriage types share the following details with their counterparts from the Texel wreck: first, there is the same extensive use of mortise-and-tenon joints; second, there is the lack of a transom piece between the fronts of the cheeks; third, the cap-squares are affixed by short strong nails and not by long bolts running from the tops of the cheeks to underneath the axles; and fourth, the trucks have the same peculiar domed inside faces. The author is grateful to Dr Alex Hildred of the Mary Rose Trust for providing him with details about the construction of the ship's carriages.

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