other information required for laying the vessel off and making the necessary moulds being usually given on other drawings. The sheer drawing of the “Lord Nelson” contains the information usually given concerning the form of the ship and other features of the design required for laying the vessel off, ordering the material for her construction and afterwards erecting the same in position. In these drawings it has been necessary for the sake of clearness to reduce the number of square stations and water or level lines commonly shown in drawings of this character. The number of these lines is fixed in the preparation of the design by the necessity of accurately defining the surface of the ship so that the intentions of the designer as regards form, displacement, and what may be called the geometrical features of the ship may be realised. Ina large warship there are usually 21 square stations shown, including the forward and after perpendiculars, the distance between which defines the nominal length of the ship. The water-lines arc 3 to 4 ft. apart. Intermediate square stations and water-lines are frequently intro- duced where the curvature of the surface of the ship is rapidly altering; as at the ends and below the bilge. It is usual, and obviously sufficient in the sheer drawing as well as in the process of laying off, to show only one-half of the ship on one side of the longitudinal vertical plane of symmetry. Thus, in the half-breadth plan only the port side of the ship is drawn; and in the body plan, for greater clearness, the half ship is further divided, the part forward of the midship section, or square station at the middle of the length of the ship, being shown on the right of the middle line of that plan, and the part aft of the midship section on the left of the middle line.

*Other Drawings.—*The profile and plans and the midship section have also been described in this article. The profile and plans of H.M. yacht “ Alexandra ” are given on plates. Fig. 84, Plate X., is the profile which shows in sectional elevation all the decks, bulkheads, machinery, living spaces, store spaces, &c. ; figs. 86, 93, 94, 95 and 96, Plate X., give the plans of the promenade deck, upper deck, main deck, lower deck and hold respectively with important fittings shown upon them; figs. 88, 89, 90, 91 and 92, Plate X., give sections of the ship showing the inboard works at stations E, D, C, B and A on the profile respectively; and on fig. 97, Plate XII., is given the midship section with all the principal scantlings of the framing and plating. Fig. 98, Plate XIII., also gives the midship section of H.M. battleship “ Lord Nelson.”

Any two of the three plans of the sheer drawing may be taken to represent the “ horizontal ” and “ vertical ” planes of Descriptive Geometry, and are theoretically sufficient to define the shape of the vessel completely, but the three plans are practically necessary for the sake of clearness and are always used.

In the design sheer drawing the lines may represent the inter­sections of planes with the surface of the framing of the ship, or with an imaginary surface having a mean position between the irregularities of the surface of the ship caused by the system of plating adopted. The former system is the more usual in the drawings of steel-built merchant ships, necessitating an allowance on all measured dimensions used in calculating displacement, &c. ; the latter system is usual in warships, in which the surface represented by the sheer drawing of a ship plated with raised and sunken plates strakes as described on p. 962, would be an imaginary surface midway between the outsides of the raised and the sunken strakes. A sheer drawing on this latter system is said to show displacement lines in contra­distinction to the former system which shows “ moulded” or frame lines. In the case of vessels with a plank sheathing over the bottom the surface shown on the sheer drawing is the outside of the planking.

As the primary object of the laying off of the ship is to ascertain the shape of the frames, the surface of the outside of the frames is always that which is laid off on the mould loft floor. If displacement lines are given in the sheer drawing a preliminary process of deriving from them the moulded lines is necessary before laying off on the floor. The process, to be strictly accurate, involves setting in the requisite distance along the normal to the surface shown in the sheer drawing. This is easily done at the midship section, where the normal to the surface lies in the plane of the section and coincides with the normal to the curve of the square station in the body plan, or at the practically vertical parts of the sides of the ship, where the normal to the surface lies in the water plane and coincides with the normal to the water- line in the half-breadth plan. In other positions, however, it would be necessary to rabat a plane containing the normal on one of the planes of reference, set in the required distance along the rabatted normal, find the projections of the point in the frame surface so obtained and of other similar points, and thus obtain the projections of curves on the frame surface, which by their intersections with ordinates and water-lines would give a new set of square stations and water-lines corresponding to the moulded surface of the ship. Such a process, though simple, is more laborious than is necessary in view of the degree of accuracy required, and in practice it is customary to set in normal to each square station a distance slightly greater than the thickness of the plank and plating, the increased distance required being roughly estimated from a consideration of the obliquity of the water-lines, without producing any sensible error.

The frame lines having been obtained, it is customary at some shipyards to “fair” the body on paper on a larger scale than that of the sheer drawing, before laying off on the floor. This saves a certain amount of labour in fairing the full-sized body on the floor, the errors in the body as first copied on the floor, which it is the object of the fairing process to correct, being proportional to the increase in scale in first copying. The process is similar to the full-sized fairing which is described below.

A straight line is drawn on the floor parallel to a fixed straight batten nailed to the floor a short distance from the wall of the building to represent the load water-line in the sheer and body plans and in such a position that the whole depth of the ship can be drawn with regard to it within the limits, on the floor and clear of the batten, the inner edge of which becomes the base-line of the sheer, half-breadth and body plans. The fore and after ρer- pendiculars of the sheer and half-breadth plans are drawn at right angles to this line and the fixed batten in convenient positions near the ends of the floor, the fore perpendicular on the right and the after perpendicular on the left as in the sheer drawing, and so as to allow the extreme outlines of the stem and stern to be drawn upon the floor together with not less than one-fifth of the length of the sheer and half-breadth plans at each end of the ship. A line perpendicular to the water-line and the fixed batten is drawn, usually near the middle of the floor, to represent the middle line of the body plan. The middle line of the half-breadth plan is usually taken as coinciding with the base-line, the inner edge of the fixed batten. The level or water lines shown on the sheer drawing are drawn in on the floor parallel to the load water-line so as to serve for both the sheer and body plans. Ordinates representing those given in the sheer drawing, which correspond to the sections in the body plan, are drawn in the sheer and half-breadth plans and others are added where desired, so also are additional water-lines between those shown on the sheer drawing and above the load water-line, so that in full-sized drawing on the floor the sections and stations may be sufficiently near for fairing the whole of the external form of the ship. If, as is usually the case, the ship is too long to be laid off in one length on the floor the midship portions of the sheer and half­breadth plans are drawn superposed over the forward and after parts, and are usually contracted longitudinally as will be described presently.

The distances from the middle line along each water-line in the body plan of the original sheer drawing, or of the enlarged body when the process of preliminary fairing has been adopted, to the intersection of the water-line with each section are measured to scale and tabulated. At the lower parts of the body, in the vicinity of and below the“ bilge,” where the water-lines cut the square stations very obliquely and the points of intersection become somewhat indeterminate, diagonal lines as shown by 1D, 2D in fig. 99 are drawn in the sheer drawing in such positions as to intersect as many as possible of the square stations approximately at right angles, and the corresponding diagonal lines are drawn on the floor. The distances from the middle line of the body plan in the sheer drawing along the diagonal lines to their intersections with the sections are measured and tabulated. It is usually desirable, especially in ships with a great extent of practically flat bottom, to draw bow and buttock lines to include this portion of the surface, such as 1B in the figure, as the diagonals approach more or less closely to bow and buttock lines and shorter measurements are required in transferring the lines; the heights of their intersections with the transverse sections above the base-line being measured and tabulated. The draught of water of the ship at the forward and after perpendiculars is given in the specification enabling the underside of keel in the sheer plan to be drawn in on the floor between the points where the rise of keel commences at the extremities. The flat part of the keel is generally uniform in width for the greater part of the length of the ship, and tapered at the extremities. The line representing its side must be drawn on the floor in the half-breadth plan. The height of keel-line above the base-line at each station in the sheer plan and the corresponding half siding of keel are the co-ordinates of the lower extremity of the corresponding transverse section in the body plan. The lower extremities of the sections are at once fixed in the body plan by the intersections of their horizontal and vertical ordinates transferred from the half-breadth and sheer plans. For the upper endings of the transverse sections in the body plan a level line is generally drawn on the body of the sheer drawing just above the projection of the upper deck edge and the sections at the square stations produced to meet it. The intersections of this water-line with the sections are measured and tabulated.

The whole of this process of measurement and tabulation is frequently done in the drawing office, and the "loftsman” or person who conducts the laying off on the floor is not supplied with the sheer drawing, but only with these tables of “ offsets,” and similar tables for the lines in the sheer and half-breadth. The process, however, is the same in either case.

The tabulated measurements for the sections of the body plan are then set off full size by means of long measuring staffs on the lines on the floor, corresponding to those in the sheer drawing on which the measurements were taken, and thus give points whose co­ordinates are to those of the corresponding points in the drawing in the ratio of 48:i, if the drawing from which they were taken was to a scale of ¼ inch to the foot as is usually the case. A suitable wood batten is then bent or “ penned ” as nearly as possible through the