APPENDIX C

DRAUGHTING CURVES USED IN SHIP DESIGN

Jobst Lessenich

Ship lines plans as orthogonal view drawings were first used routinely in naval architecture since the early 18th century. Draughting tools for such drawings in addition to the traditional compass and rulers evolved gradually to deal with increasingly complex and free form shapes. The shipbuilder‘s spline and the draughting curve are the most prominent and unique tools developed to produce ship lines plans accurately and neatly. The development of splines is described in Horst Nowacki’s paper Splines im Schiffbau [1].

This paper will present a documentation of the early history of draughting curves which came into wider use during the last few decades of the 18th century. Their shapes were appropriate to draw waterlines, diagonals, buttock and bow lines etc. and also the sections of the body plan after the formal compass-and-ruler design of the midship section had been given up.

Source material on draughting curves is scarce and unsystematic. For this article the available information was collected from primary and secondary sources and is presented in synoptical form. This material may serve as a reference for later comparisons with similar developments in other disciplines.

Ch. G. D. Müller

In his translation of Duhamel du Monceau’s Élémens de l’Architecture Navale [2] the translator Müller added also his own knowledge and ideas to the subjects of the various chapters. In a footnote to Chapter 4 in [2], the drawing of the body plan, he suggested the use of self-made templates to obtain a neat drawing in ink of the body plan. To make these templates the naval architect should copy the sections of the body plan separately on stiff paper, cut them out and check the contours. If the result was satisfactory the contours were transferred to thick card board and cut out carefully. Running a fingertip along the edge was the final test for the smoothness of the template.

Fig. C.1: The draughting curve under Chapman's arm, adapted by the author from contemporary engraving.

From this special solution for one lines plan it is not far to the idea of having a more universal set of templates or curves of various shapes to draw the sections of the body plan already during the process of designing the ship.

It may be assumed that the early examples of curves were cut individually by the master shipwright or naval architect following his own ideas, and that he kept his curves as concealed from the public as the other special skills of his trade. But someone must have had the idea to combine a number of curves of various size and different shapes to a standardized set, with which all contours in a lines plan of a ship could be drawn, and he manufactured such sets and they were traded like other drawing tools.

Portrait of F. H. af Chapman

A contemporary engraving with the title "F. H. af Chapman" shows him holding a pair of dividers in his right hand and a book and a curve under his right arm. As Chapman had been ennobled in 1772 the engraving must be dated to a later year. The curve is approximately 500 mm long and has a small to moderate curvature, a shape that would serve well to draw waterlines and diagonals. This particular feature of the portrait is shown in figure C.1. The role of Chapman in the development of ship design methodology is well described in a book by Harris [3].

Gerhard Timmermann

In an essay about ship design in former times, Skibskonstruktionstegningen [4], Timmermann informs the reader that the Maritime Museum in Bergen, Norway (Sjøfartsmuseum Bergen) possesses thirteen drawing templates or ship curves, which are signed "RR3". These curves were once owned by the shipwright Rasmus Rolfsen and are dated from 1779. Nine of these thirteen templates resemble the curves of the Copenhagen Set (see Fig. C.2) with the numbers 8, 12, 16, 20, 24, 30, 34, 35 and 37. With the exception of N° 8 the curves have shapes very appropriate for drawing the sections in a body plan. Curve N° 8 has some similarity with the one Chapman is holding under his arm (see Fig. C.1).

Copenhagen Set

Gerhard Timmermann writes in 1962 [4] that the oldest and still existing Copenhagen Set (Københavner-sæt) is in possession of the Danish Maritime Museum at Kronborg (Handels- og Sjøfartsmuseet på Kronborg) and had been manufactured in 1817. It once belonged to the master shipwright Rasmus Møller of Troense.

A photograph in [4] gives the impression that this set already contains nearly all the curves which will be found in the present Copenhagen Set (see Fig. C.2). Therefore it may be supposed that the first set of this kind appeared close to the year 1800.

Another set, owned by the Naval Shipyard in Copenhagen (Orlogsværftet i København), is dated to 1835 and is still used (in 1962) as pattern for new sets [4]. The Copenhagen Set of the 20th century represents its status of 1835, according to Timmermann [4]. Some manufacturers

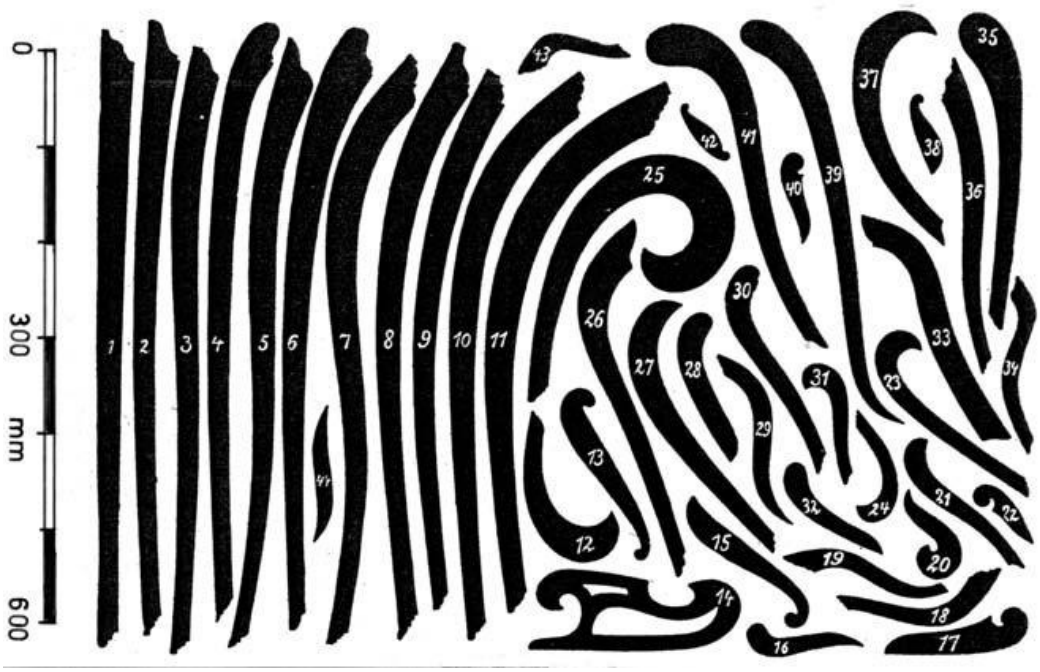

Fig. C.2: Copenhagen Set [9].

added to the Copenhagen Set the French Curve N° 4, others the French Curves N° 4 and N° 21 (see Figs. C.2 and C.7).

David Steel

In the chapter "Explanation of the terms used in shipbuilding" in The Shipwright's Vade-mecum [5, p. 118] Steel explained the term "moulds" in the familiar way as fullsize templates to cut the timbers for frames, stem etc. But then he continued that the term mould is also given to "thin flexible pieces of peartree or box, used in constructing the draughts and plans of ships, which are made in various shapes; viz. to the segments of circles from one foot to 22 feet radius, increasing six inches on each edge, and numerous elliptical curves with other figures". (There is no further description of "other figures"). In a footnote to this explanation the name of a dealer was given where "moulds, &c. of every sort requisite for marine drawing may be had". This advertisment indicates that in 1805 these moulds were already known and demanded tools and must have come into use some years earlier.

Steel never mentioned the use of these "moulds" in his description of constructing the body and the half-breadth plan (page 186 and following in [5]). He described only the old fashion of drawing the

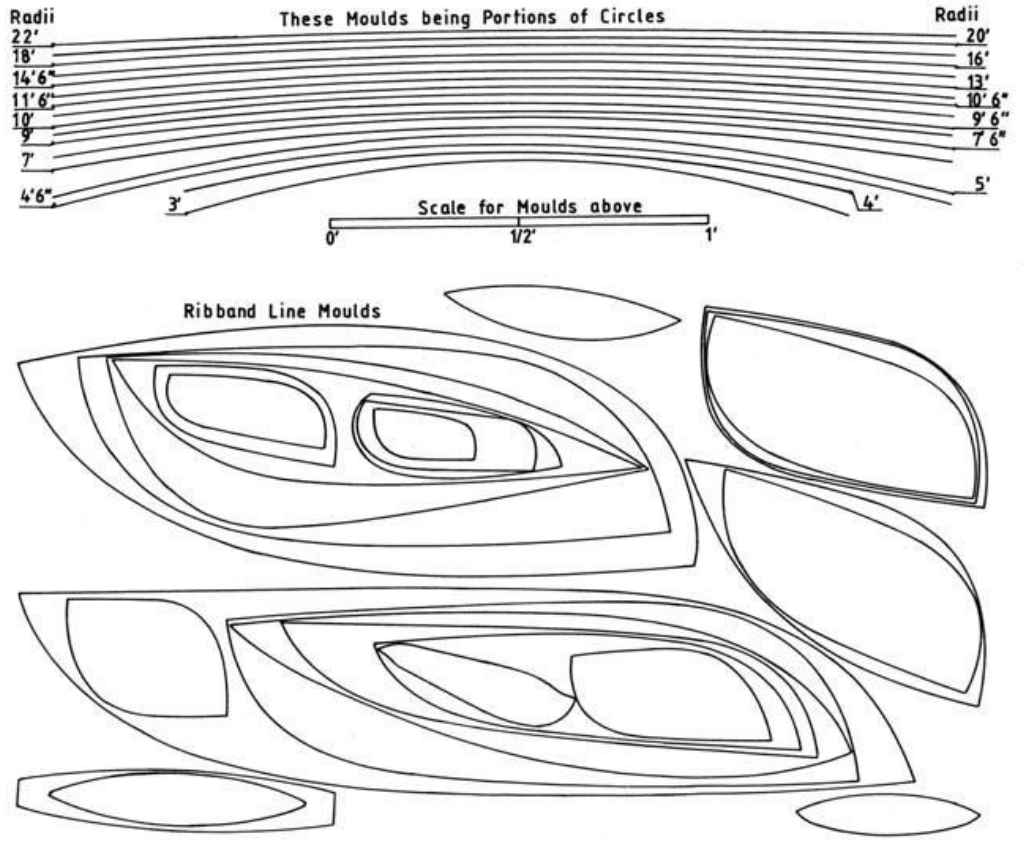

Fig. C.3: Moulds and sweeps used in ship draughting, adapted by the author from Schnellsegler [8].

frames using "arches of circles called sweeps" (see page 106 in [5]), but the drawings of a West Indiaman of 300 tons (plate XXI), a Collier Brig of 170 tons (plate XXII) and a sloop of 60 tons (plate XXVII), all reedited in Éléments et pratique de l'architecture navale 1805 [6], show that their body plans have been drawn using "moulds" of elliptical or similar shapes.

Peter Hedderwick

A plate with the title "Moulds and Sweeps used in Ship Draughting" in Hedderwick's book "*A Treatise on Marine Architecture*", published 1830 [7], illustrates David Steel's verbal description of moulds. The plate shows 17 "*Moulds being Portions of Circles*" with radii from 3 to 22 feet (not all radii mentioned by Steel are presented here) and 26 other moulds, many of their contours set into one another. Most of them show a hyperbolic shape, only few of them seem to be parts of elliptical curves.

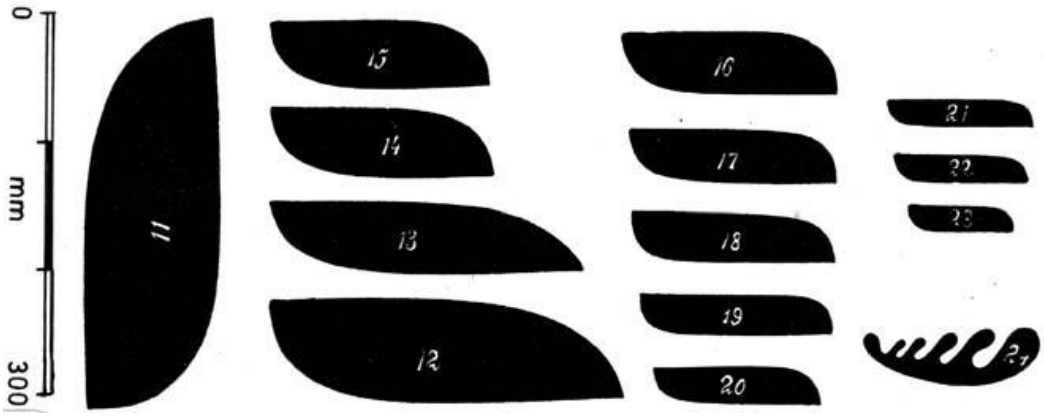

Fig. C.4: English Set [9].

The plate (see Fig. C.3) has been redrawn from a small reproduction in Schnellsegler 1775–1875 [8] and a scale in feet has been added to the circular moulds. There is no scale given for the other 26 moulds nor is it known if all of them are of the same scale.

Other sets of the 20th century

The various sets of curves for the special purpose of drawing ship lines shown here (Figs. C.4, C.5 and C.6) are taken from a catalogue of a dealer and manufacturer of drawing tools [9]. They represent the status of these traditional drawing tools which they had reached by the beginning of the 20th century and which lasted as long as these curves were manufactured. The numbering of the curves is arbitrary and serves only as identification for ordering single curves out of a set. A scale in millimeters is added at the side to give the approximate size of the original curves. These curves were originally cut out of thin bords of steamed wood of the pear-tree, the box-tree or white beach. By steaming the wood warping was avoided. Later in the 20th century various plastic materials, transparent or coloured brown, were used.

English Set

The English Set (Englischer Satz, see Fig. C.4) looks like a subset of the 26 moulds Peter Hedderwick presented in his book [7] (see Fig. C.3) and which Steel [5] described as “numerous elliptical curves with other figures”.

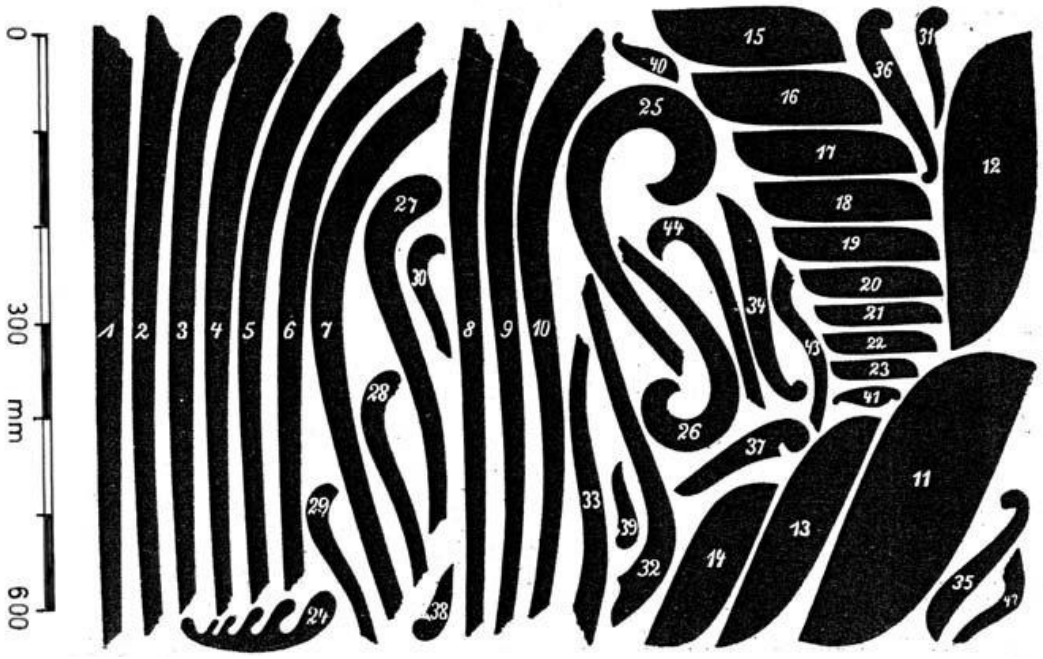

Fig. C.5: Hamburg Set [9].

Hamburg Set

The English Set and part of the Copenhagen Set were obviously combined to form the Hamburg Set (Hamburger Satz, see Fig. C.5). At least one "new" curve N° 26 was created for this set by reducing in scale curve N° 25.

German Set

The youngest set is the German Set (Deutscher Satz, see Fig. C.6). It seems that this set was a combination of several curves from the Copenhagen Set and the Hamburg Set to which about twelve new curves were added (see lower part of Fig. C.6). Timmermann wrote [4] that these new curves had been adapted to the change in geometry of iron and steel hulls.

French Curves

"French Curves", in the narrower sense of the word as it is used in Britain, indicates that these drawing tools originated in France where these curves were called "pistolets à dessin". Both names are linked to

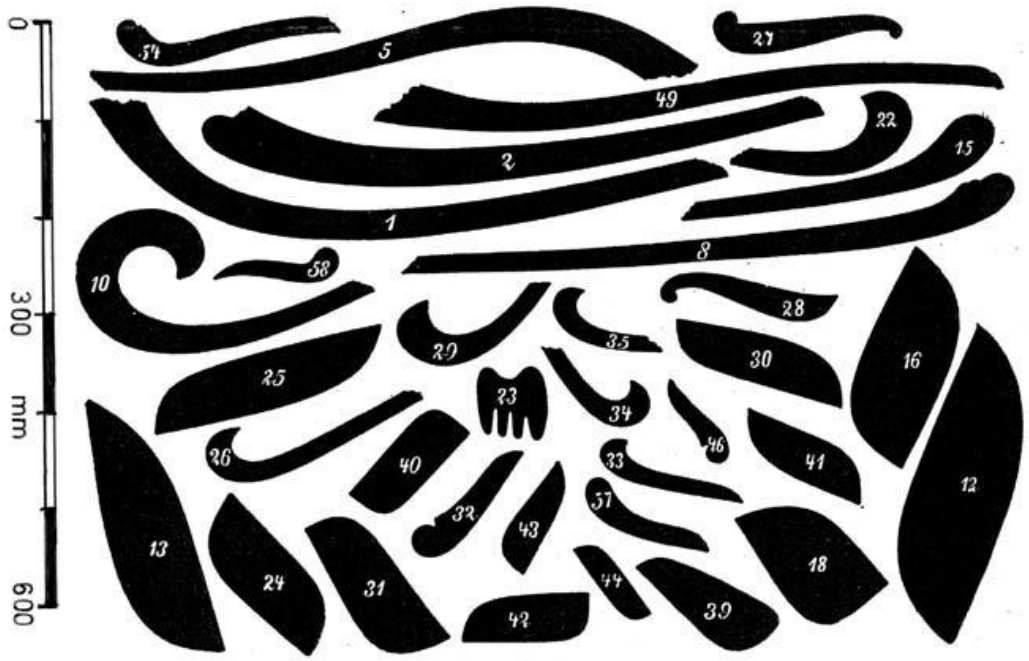

Fig. C.6: German Set [9].

the same type of curves, a selection of which is shown here in Fig. C.7 [9]. Other French Curves are shown in Drawing Instruments 1580–1980 [10] on page 103.

The definition of "French Curve" in The Random House Dictionary [11] shows a curve very similar to N° 15 of Fig. C.7 and the Dictionnaire usuel illustré [12] gives as examples for "pistolets à dessin" three curves similar to N^{os} 4, 7, and 17 of Fig. C.7.

French Curves were first manufactured in the early 19th century in France and sold in sets. The material was pearwood, lime or other similar stable wood. Later in the 20th century vulcanite, celluloid or acrylic were used [10].

The outlines of French Curves were not derived from geometrical curves as ellipses, parabolas or hyperbolas but cut, as it is stated in the Grand Larousse [13], following curves of fantasy ("découpé suivant des courbes de fantaisie"), ending in spirals, curls or corner points. French Curves were used in architecture and any other design or decorative work; their use in naval architecture, specially to draw the body plan of a ship, had been described by d'Étroyat in Traité élémentaire d'Architecture Navale [14]: The French Curve (he called it simply "pistolet"), cut out of thin bord, served to draw lines with a strong curvature which could not be achieved with an ordinary spline. He pictured only one sample of a French Curve (planche I, Fig. C.5 in [14], similar

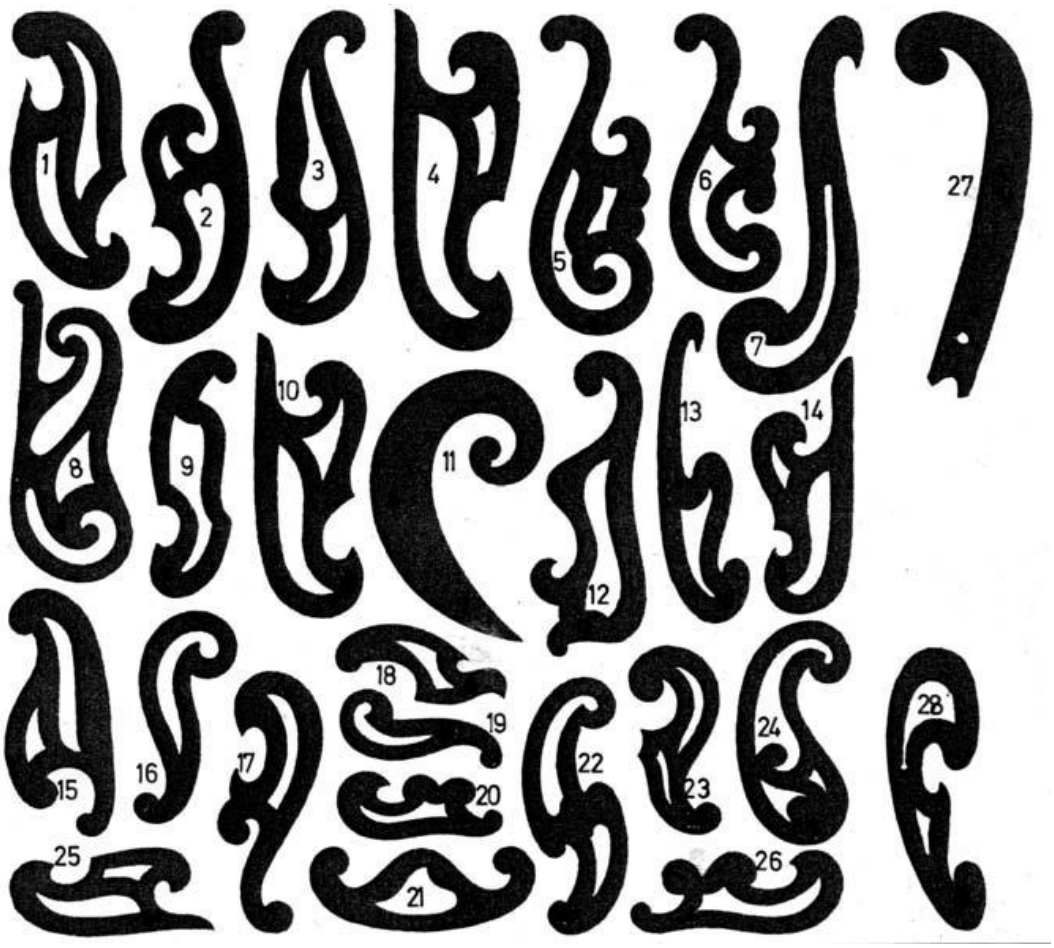

Fig. C.7: French Curves (not on uniform scale!) [9].

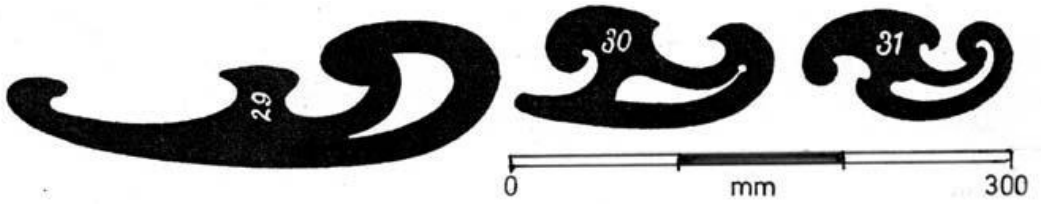

Fig. C.8: Burmester Curves [9].

to N° 26 in Fig. C.7 above) to show form and use of these curves. For further information he referred to the trade where perfectly cut French Curves of various contours and sizes ("…pistolets variés de contours et de grandeurs, parfaitement decoupés…") could be purchased. The way d'Étroyat dealt with this subject indicates that the use of French Curves in naval architecture had been a routine matter by 1850.

Burmester Curves

What seems to be a subset of three of the French Curves is in reality a special mathematical variation of these and was developed by Professor Ludwig Burmester (1840–1927), a mathematician from Munich [10]. Each of these three curves (see Fig. C.8) consists of a number of different quarter-ellipses blended into each other [9]. These curves serve a great variety of applications and are still available.

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