Father Truchet, the typographic point, the *Romain du roi*, and tilings

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Abstract

Father Sébastien Truchet (1657-1729) is genuinely recognized as a mathematician (especially for "Truchet tilings"); however, very few typographers know that he is the real inventor of the typographic point or even that he designed the famous *Romain du roi*, which could be considered the first digital font!

Introduction

This paper is adapted from a page on the Web[1] that was created last October for the ATypI conference held in Lyons, France. For us, this was a good opportunity to restore Father Sébastien Truchet's good name. He was born in Lyons in 1657. Even if he is genuinely recognized as a mathematician (especially for "Truchet tilings"), as an expert in hydraulics (he designed most of the French canals) and as an inventor (he invented a fantastic number of things such as sundials, guns, engines to transplant adult trees — they have been used in the Parc de Versailles, etc.) [8, 12], very few typographers know that he is the genius behind the typographic point or even that he designed the famous *Romain du roi* font.

Here are three stories about him.

Sébastien Truchet and the typographic point

In typography at the end of the 17th century, body sizes were not measured but were given names instead (just as today's bold typefaces are referred to as "heavy", "light", or "demi bold" without actually being measured). These names were often based on the title of books in which the characters were used for the first time. For example, "Cicero" was the name given to the body sizes of characters used to print Cicero's *Epistles*, while the characters known as "Saint Augustin" were used in the book *City of God*, written by this Father of the Church. Names could also derive from their appearance: the English "pica" comes from the Latin *pica* ('magpie') since the first printed book used sharply contrasted blacks and whites, like the plumage of the magpie bird. Other names stem from the origin of the characters (e.g., "Parisienne"), their function (French "Canon", English "Brevier" or German "Missal"), or from their relative size ("Petit Romain", "Gros-Canon"), since there was an implicit scale between these sizes (a "little Canon", for example, was twice as large as a "Saint Augustin"). However, sizes differed widely from one foundry to another and it was very difficult to mix types produced by different foundries — or even by a single foundry, for that matter.

Figure 1: Father Sébastien Truchet, 1657–1729; after Lery [12].

The end of the 17th century also coincided with the Age of Enlightenment. Envious of the achievements of foreign countries, Colbert, a minister to Louis XIV, decided in 1692 to prepare a compendium on existing arts, crafts and trades, and appointed four scientists to head this work: Abbot Bignon, Jacques Jaugeon, Gilles Filleau des Billettes and Father Sébastien Truchet. They began work and quickly completed several illustrated descriptions of existing trades and professions. In 1699, Louis XIV elected them to the Academy where they continued their work under the direction of Réaumur. However, in 1750 (Truchet having died by this time), even though no volume of the *Description des Métiers* had yet been published, Diderot

[1] In both French and English: `http://www.irisa.fr/faqtypo/truchet/truchet.html`

and D'Alembert announced the release of their *Encyclopédie*. This vexed the Academy, which then published seventy-three volumes and some two thousand printed plates. Complete sets of the *Description des Métiers* are very rare and this work is quite unknown.

Let us return to the year 1693, when the Bignon Commission undertook its compendium of trades and professions, beginning with: "that art which will preserve all others" — printing.[2]

Members of the commission, in particular Truchet, studied the known characters of the day (even using the recently invented microscope) and proposed three successive systems to quantify types in which a series of body sizes were defined in regular increments, based on the "line", a unit of measure used by silversmiths and equivalent to $1/12$ of the official inch.[3] Units of length then in use included the *toise*, which comprised two *aulnes* (roughly equivalent to today's metre) which comprised 3 feet; the foot (0.32484 m) was divided into 12 inches (2.707 cm); each inch was divided into 12 lines (of 2.256 mm) and each line into 12 metric points (of 0.188 mm). The problem was that these values varied from place to place. The values given here are known as king ("roi") values. To complicate matters further, the English feet and inches were slightly different!

The initial plan was conceived in 1694, based on several principles:

- Typefaces are measurable. Their measurement is based on a legal unit of length.
- The range of possible body sizes is governed by the following rule: sizes are the result of adding an increment which follows a geometric progression; these are 7.5 9 10.5 12, then 15 18 21 24, and so on. The real size of the type is 7.5 *lignes secondes*,[4] and so on.

The second rule is given below in modern mathematical terms:

- Type sizes are expressed in multiples of c_i of the second line of the "king's inch" (i.e., $1/12 \times 1/12$ of an inch, today's 0.1879583 mm).
- The body sizes are defined as follows:
  $C_0 = 7.5$
  $C_i = C_{i-1} + 1.5 \times 2^{i \div 4}$

The second plan, in 1695, was based on $1/24$ of a line, while the third scheme used a far smaller unit, $1/204$ of a line, the equivalent of today's 0.011057 mm — or roughly 2,300 dpi! While this value is one to make us dream, it continues to amuse punchcasters since no mechanical tool is able to provide such high precision. Fournier [6, 14], 50 years later, used 7 parts whereas Truchet proposed 204, declaring that "these rules refer to the concept of infinitely small characters that only the imagination can attain! ... Consequently, are so many squares necessary to form an O shape which is round?". The surprising choice of 204 is perhaps related to the product of 12×17 where 12 is the duodecimal base and where 17 might be equal to the number of lines (16) encountered in the lowercase designs cast by Simonneau plus $2/2$ (two half lines for the shoulders).

However, this proposal had little immediate result — perhaps it was too "academic". All existing punches would have had to be re-cast and all types re-minted! In addition, since the system that Truchet proposed was not totally identical to the one in use at that time (that is, his system did not accurately reflect the less-than-perfect reality of the day), Truchet devised new names for character sizes, such as "la Petite Royale" (body size 12) or "Le Bourbon" (body size 36). Moreover, members of the Chambre syndicale des imprimeurs (Printers' Guild) probably had no knowledge of this research since at their request the king issued a decree on 28 February 1723 which laid down the type heights as well as the official relationships between the old names.

Pierre-Simon Fournier (nicknamed "the Younger") was familiar with the work of Truchet (since he had ridiculed it) and applied the concept of proportions but adapted the scale of typefaces to existing character body sizes. This gave rise to the Fournier point of 1737 which, unfortunately, is not based on a legal unit! Note that the Fournier point was closer to the pica than to the Truchet point.

Didot in turn incorporated Truchet's idea and standardised the typographic point in 1783 (based on $1/72$ of the French inch but with practically the same progressions as Truchet). As would have been the case with Truchet's typographic point, the punches had to be re-cast, which explains why many printers continued to use Fournier's point until the 20th century. See Boag [2] for more on the history of the point.

[2] From *Histoire de l'Académie royale des sciences... avec les mémoires*, p. 117 et seq., quoted in Jammes [10, p. 6].

[3] We're only in the 17th century and the metric system is still unknown, even though, in 1670, Father Mouton had already proposed to the Academy the *virga*, a unit of length equal to a thousandth of the distance segmented along the earth's meridian by one minute of angle.

[4] One *ligne seconde* corresponds to $1/12$ of a line. See, for example [14].

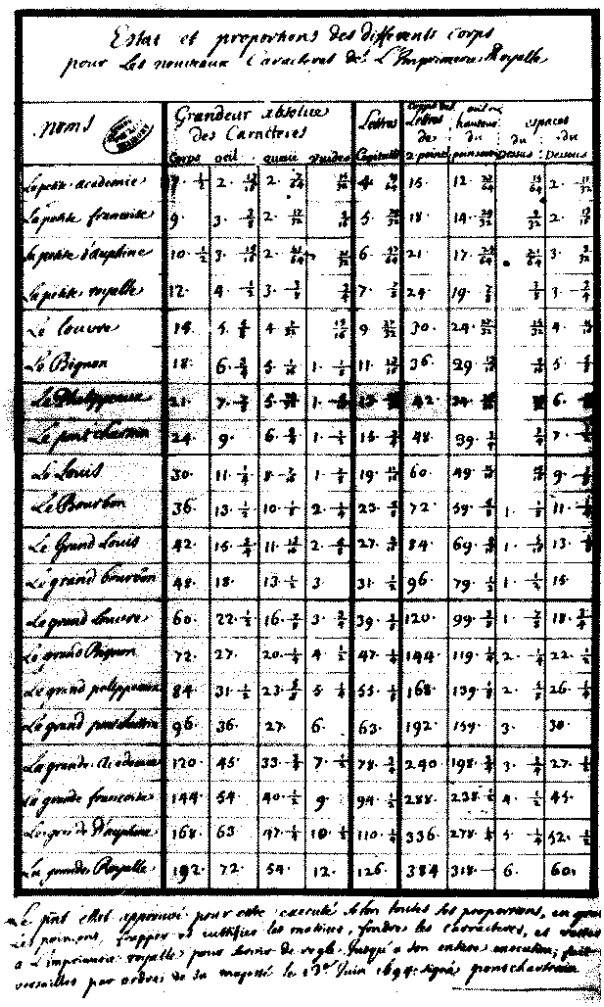

Figure 2: Proposed new range of types and metrics, including cap height, x-height, descenders, ornamental initials (in Truchet's hand) — after Jammes [10].

Le Romain du roi, bitmaps, outlines and hints in 1695

The Bignon Commission now turned its attention to existing characters used in printing. Three of its members (Truchet, Jaugeon and Des Billettes) undertook to design "new French letters that we have endeavoured to render as agreeable as possible to the eye".[5] These characters broke with the Garamond tradition. Their originality, explained by Stanley Morison [13] and later by André Jammes [10], lay in the premise that "printing was not a branch of handwriting but a branch of engraving".[6] These three academics produced characters for printing plates (engraved by Simonneau) in the *Romain du roi* font that Grandjean later punched[7] for *Médailles sur les principaux événements du règne de Louis le Grand* in 1702.

Although usually attributed to Jaugeon (the only member of the Bignon Commission with a typographic background), the contribution of a "technician" such as Truchet was without doubt decisive. Indeed, all the manuscripts that have been preserved were written by Truchet (see figure 2). Their study is attributable to André Jammes [10] and James Mosley [14]. While Simonneau's printing plates have been reproduced many times, Truchet's hand-written notes are little known. Yet these are the equivalent of today's AFMs (Font Metrics) and even hinting instructions!

These researchers who lived three hundred years ago were unquestionably geniuses:

- They invented the notion of the "vectorial font" by defining characters in terms of outlines with approximation by arcs of a circle (interpolation by arcs of a circle was still used by Bitstream just ten years ago, before Bézier splines). Characters had already been drawn with a ruler and compass since the 15th century by such people as the Italian Félice Feliciano and later Albrecht Dürer and Tory (Morison [13] published a study on the subject). The innovation came from the use of a fine grid (roughly equivalent to a resolution of 2300 dpi).
- They invented the concept of the bitmap.
- They invented the notion of the "slanted" character (the *Romain du roi* has no italic form; instead, the characters are slanted geometrically by deforming their axes, as seen in figure 4).
- They connected these glyphic specifications with a number of tables or commentaries which are the equivalent of today's AFMs (FM as in Font Metrics), and even hints!

The *Romain du roi* typeface includes all the features of today's digital typefaces — but it is three hundred years old!

Truchet tilings, patterns and ornaments

Just as very few mathematicians, even among those who are concerned with tiling systems or symmetry theory, know the genuine Truchet tilings, typographers are not always aware that ornaments owe much to these patterns.

[5] *Ibid.*

[6] Cf. *The typographic art, two lectures by Stanley Morison*, London, 1949, pp. 27 and 59, quoted by Jammes [10, p. 12].

[7] This character was recently digitised by Frank Jalleau under the name of Grandjean-IN.

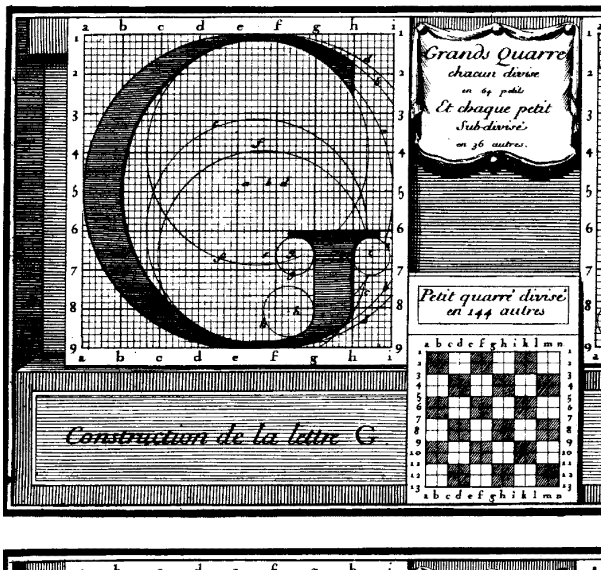

Figure 3: Cartoons of Romain du roi "G", using outlines with circle arcs (design by Truchet; engraving by Simonneau, 1716) — after Jammes [10].

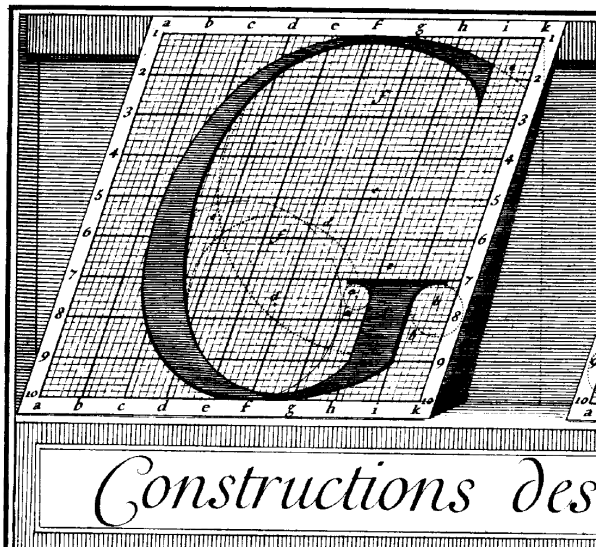

Figure 4: Cartoons of Romain du roi penché (slanted) "G", using geometric deformation of the roman G (design by Truchet; engraving by Simonneau, 1716) — after Jammes [10].

At the beginning of the 1700s, Truchet returned to his main field of specialisation: hydraulics. He worked on the Orléans Canal project and wrote, "During the last trip I took to the Canal d'Orléans by order of His Royal Highness, in a château called

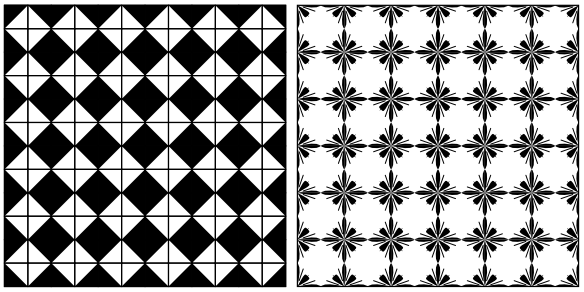

Figure 5: Truchet tiling (left) and a new design using ornaments à la Fournier (right).

Motte St Lyé, 4 leagues this side of Orléans, I found several ceramic tiles that were intended for tiling the floor of a chapel and several other apartments. They were of square shape, divided by a diagonal line into two coloured parts. In order to be able to form pleasing designs and patterns by the arrangement of these tiles, I first examined the number of ways in which these tiles could be joined together in pairs, always in checkerboard array." [17]

After some study, in 1704 Truchet published his findings in *Comptes-rendus de l'Académie des Sciences* [18]. This idea of tiling (*pavage*) was not new, but Truchet was the first to publish a systematic study of all combinations of a tiling.

This concept has today become commonplace: if you look closely you will recognise his designs in bathrooms, on kitchen slab floors, in certain decorative elements on monuments and churches, on beehives, and on various articles of clothing. Once again, it was only when mathematicians began to take an interest in the subject — from the middle of the 19th century — that accurate definitions and classifications were established, resulting in a theory. However, the intuitive definition is enough to grasp what the concept of "tiling" entails: composition of a surface by assembling basic parts without blank spaces and without overlapping, using a minimal number of different constituent parts (sometimes just one — think of the tiles in our bathrooms or the cells of honeycombs).

This fundamental principle is nonetheless full of possibilities, especially when several pieces are combined and when they are coloured in a given order. This can produce results that are both visually pleasing and fascinating. This is why from the dawn of time until the present day, and in all civilisations, craftsmen and decorators have made extensive use of these effects. Arab artists, in particular, achieved supreme mastery in this art, only to be equalled in

our modern age by the famous engraver Escher [15]. As Islam forbids the depiction of animate objects, the Arab artists and craftsmen turned their hand to producing varied and attractive decorative objects through the sole means of geometry.

While such effects please the eye, it is only because they obey precise mathematical laws, even if these latter were being applied before they'd been discovered! This was a field in which practice took a lead of several centuries over theory. True, Greek scholars had already established a few simple rules on the subject. More importantly, the Greek scholars had grasped certain key principles such as the issue of the discrete or continuous structure of matter, which triggered a famous dispute between Plato and Aristotle known as the "atomism debate". This debate related to the filling of (three-dimensional) space with regular shapes, an extension of the problem of tiling a given (two-dimensional) surface. These questions were barely touched on again until the modern era, except by a few pioneers, most notably the great astronomer Kepler, who devoted fruitful research to it at the beginning of the 17th century. However, the findings of his research were completely forgotten for three hundred years! These early discoverers included Father Truchet, as we have already mentioned.

Only at the end of the 19th century, with the growth of crystallography, did mathematicians take an interest in these issues by applying the theory of groups founded a few decades earlier by Évariste Galois. A major fact that became increasingly apparent at the beginning of the 20th century is that "the geometry of tiling underlies all atomic structures" [11, p. 6]. Throughout the present century, crystallographers and mathematicians, by a kind of process of cross-fertilisation, have advanced the theory of tilings. In the mid 1980s, this theory provided the key to understanding the existence of quasicrystals, which hitherto were thought to be either nonexistent or inconceivable [9, 11, 16].

However, in this rich and complex field many questions, some of which may be written in a single line, remain unanswered. Nevertheless, the findings of tiling theory are used today in a range of different fields: from computer science to image processing, from micro typography to statistical physics, from biology to the creation of lattices for numerical modelling.

Here, too, Father Truchet was a leading, although neglected, forerunner. So let us return to him, or rather, to Fournier: when Truchet was commissioned to work on the Park of Versailles project, his work was continued a few years later by another monk, the Dominican Douat, who published a book (*Méthode pour faire une infinité de desseins différents...* [3]) that Fournier read ten years later.

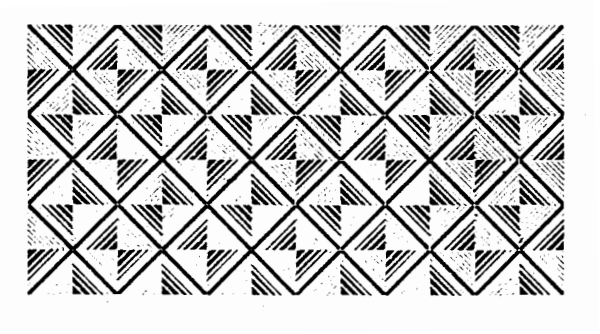

Figure 6: *Tarotée*, based on a Truchet tile (symmetry D) — Fondry Schelter & Giesecke, Leipzig, 1876.

Fournier, originally a wood engraver, developed an interest in ornaments which had hitherto been engraved mainly on wood [4]. Fournier's contribution was three-fold:

- Drawing inspiration from Luce and Douat-Truchet, Fournier divided each element of a large ornament into small elements known as "combinational" ornaments or *vignettes*.
- He made punches from these basic elements (instead of using wood).
- He studied (probably in association with his definition of the point), the strict metric measurements needed to combine these differently sized ornaments.

Apart from a few pages in his *Manuel*, Fournier seems to have made scant use of these ornaments to produce "tiles". On the other hand, Truchet's principle (square tiles divided into two colours by a diagonal line) are present in Luce's ornaments and Fournier's *Manuel* (one third of these 165 ornaments exhibit this symmetry), as well as in the work of Bodoni, Caslon, Peignot, etc.

If some *tarotées*[8] (such as the ones by Jean-François Rosart [1, pages 123–125]), are set with type (instead of using engraving techniques) they are not real Truchet tiles. However, modern *tarotées* (engraved on copper plates) are sometimes real Truchet tiles, like the ones in figure 6 and in specimens from the Laurent and Deberny or Peignot foundries.

Today, fonts offer wood ornaments and fleurons that do not give full justice to this particular art.

[8] Playing cards with grilled or checquered backs. *Tarot* is also the name of a card game: see `http://www.netlink.co.uk/users/pagat/`.

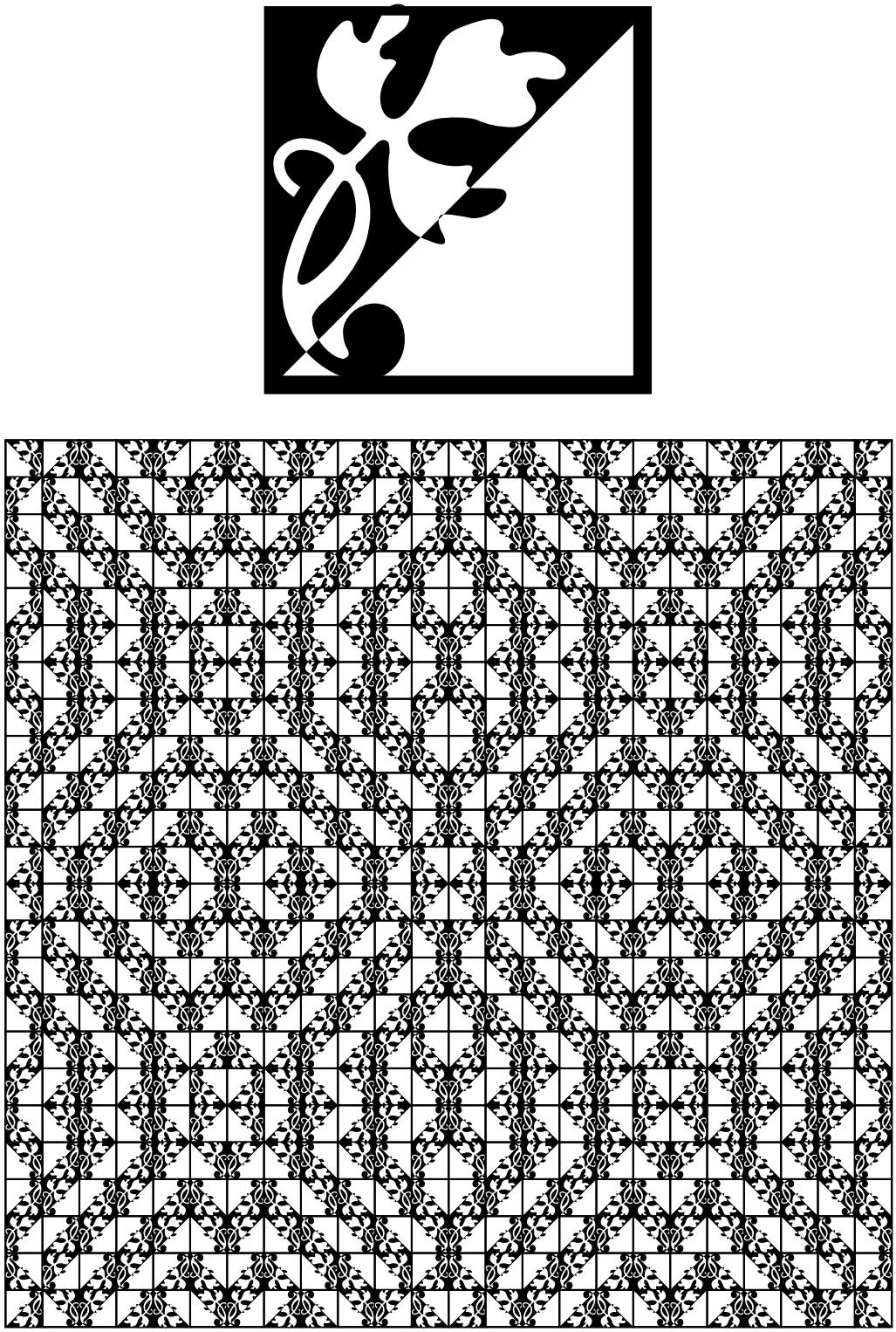

Figure 7: Bottom: a Truchet tiling (n° 64) executed with (at the top) modern ornamentation (Adobe Wood Ornament).

However, from a basic ornament it is easy to create a large number of Truchet tiles by "geometric" composition. These many be easily "programmed" through languages like PostScript or pst-fill [7, 5].

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References

[1] *The type specimen of Jacques-François Rosart, Brussels, 1768.* A facsimile with an introduction and notes by Fernand Baudin and Netty Hoeflake. Amsterdam: Van Gendt & Co., 1973.

[2] Andrew Boag, "Typographic measurement: a sequence of events from Moxon to 1992", *Typography papers*, vol. 1, Reading University, 1996, 105–121.

[3] Dominique Douat, *Methode pour faire une infinité de desseins differents avec des carreaux mipartis de deux couleurs par une ligne diagonale : ou observations du Pere Dominique Douat Religieux Carmes de la Province de Toulouse sur un memoire inséré dans l'Histoire de l'Académie Royale des Sciences de Paris l'année 1704, présenté par le Reverend Sebastien Truchet religieux du même ordre, Academicien honoraire*, imprimé chez Jacques Quillau, Imprimeur Juré de l'Université, Paris, 1722.

[4] John Dreyfus, *Aspects of French Eighteenth Century Typography — A study of type specimens in the Broxbourne Collection at Cambridge University Library.* [Printed for presentation to members of The Roxburghe Club, Cambridge.] Cambridge, University Printing House, 1982.

[5] Philippe Esperet and Denis Girou, "Coloriage du pavage dit 'de Truchet'", *Cahiers GUTenberg*, num. 31, decembre 1998, 5–18.

[6] Pierre-Fournier dit le jeune, *Manuel typographique utile aux gens de lettres, et à ceux qui exercent les différentes parties de l'Art de l'Imprimerie*, chez l'auteur, Paris, 1764. New English edition: *The Manuel Typographique of Pierre-Simon Fournier le jeune together with Fournier on Typefounding, An English translation of the Text by Harry Carter in facsimile, With an Introduction and Notes by James Mosley*, three volumes; Darmstadt, 1995.

[7] Denis Girou, "pst-fill — a PSTricks package for filling and tiling areas", *TUGboat* 19(2), June 1998, 101–112.

[8] Denis Girou and Jacques André, "Pavages : de Truchet à Escher", *Cahiers GUTenberg*, to appear.

[9] Branko Grünbaum and Geoffrey C. Shepard *Tilings and Patterns*, New York, Freeman and Company, 1987.

[10] André Jammes, *La naissance d'un caractère : le Grandjean — la réforme de la typographie royale sous Louis XIV*, Librairie Paul Jammes (1961) and Promodis, 1985.

[11] Christian Janot and Jean-Marie Dubois, "Les quasicristaux. Matière à paradoxes", *Les éditions de physique*, Paris, 1998.

[12] Edmond Lery, "Le P. Sébastien Truchet, Membre honoraire de l'Académie des Sciences (1657–1749)", *Revue de l'histoire de Versailles et de Seine-et-Oise*, 1929, 220–241.

[13] Stanley Morison, *Letter Forms, Typographic and Scriptorial: Two Essays on Their Classification, History, and Bibliography*, Hartley & Marks Publishers Inc. (2nd printing), 1996.

[14] James Mosley, "French academicians and modern typography: designing new types in the 1690s", *Typography papers*, The University of Reading, 1997, vol. 2, pp. 5–29.

[15] Doris Schattschneider, *Visions of Symmetry: Notebooks, Periodic Drawings, and Related Works of M. C. Escher*, New York, Freeman and Company, 1990.

[16] Marjorie Senechal, *Quasicrystals and Geometry*, New York, Cambridge University Press, rev. ed., 1996.

[17] Cyril S. Smith and Pauline Boucher, "The Tiling Patterns of Sebastien Truchet and the Topology of Structural Hierarchy", *Leonardo*, vol. 20, num. 4, 1987, 373–385.

[18] Sébastien Truchet, "Mémoire sur les combinaisons", *Mémoires de l'Académie Royale des Sciences*, 1704, 363–372. (Some plates and a part of this text appear (in English) in [17].)

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