Grid Programmes

in Generative Design

Geviert Programme

in der visuellen Gestaltung

A composition manual for programmers, typographers and seeded machines

GEVIERT

THE GEVIERT MANUAL

The complete specification of the geviert composition library, with ten chapters, thirteen plates, a specimen section drawn from every book the library has set, the public interface in full, and the test suite by name. Every specimen prints its seed.

MIT · ZERO RUNTIME DEPENDENCIES · SEED MANUAL-1

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Followed by: the specimens; the interface; the suite, by name; the colophon.

1 FOREWORD

This volume is the complete account of a typesetting programme. The programme is called geviert. It composes pages of type, figures and grids from a story, a set of constraints and a seed, and it does so in about thirty four milliseconds per page at a length of two hundred and eighty pages. We have written this manual in the conviction that a library which enforces rules must state them. A rule that lives only in source code is an accident waiting to be discovered. A rule that is printed, numbered and defended is a working method.

The manual is addressed to programmers, typographers and seeded machines. The programmer will find here every function the library exposes, with its arguments and its refusals. The typographer will find the reasoning of Josef Müller-Brockmann carried into executable form, with page references to Grid Systems in Graphic Design wherever a decision descends from that book. The seeded machine will find a vocabulary of constraints sufficient to compose a book without further instruction.

The manual should be read in order. The sections build. The unit precedes the register, the register precedes the type area, the type area precedes the grid, and the grid precedes everything that is placed upon it. A reader who begins at the chapter on figures will encounter terms defined three chapters earlier and will have only himself to blame.

One standing instruction governs all disagreements. Where the library and this manual disagree, the library is correct, and the manual must be corrected. Where the library and Müller-Brockmann disagree, Müller-Brockmann is correct, and the library must be corrected. The manual therefore occupies the lowest rank in its own hierarchy of authority. We consider this arrangement healthy.

Finally, a convention of disclosure. Every specimen reproduced in this volume was composed by the library from a seed, and every specimen prints its seed. The same seed returns the same page forever. A specimen without its seed is an anecdote. A specimen with its seed is evidence, and this manual deals in evidence.

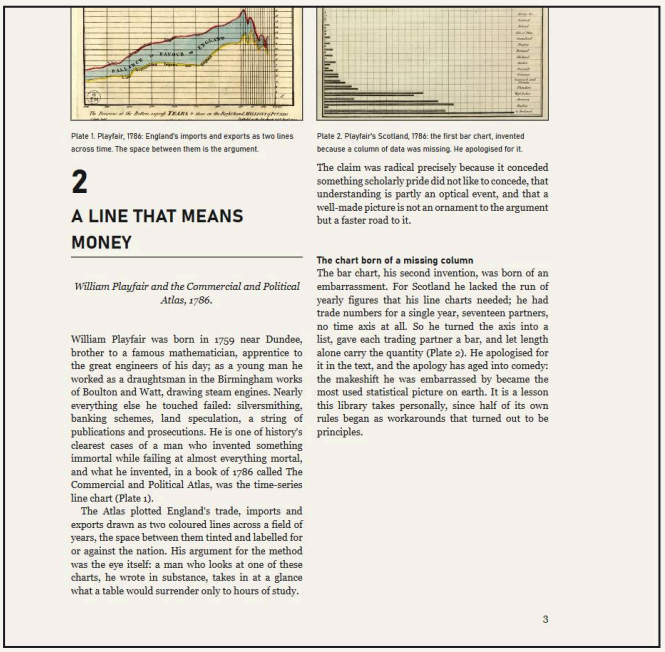


Plate 1. Playfair, 1786: England's imports and exports as two lines across time. The space between them is the argument.

Plate 2. Playfair's Scotland, 1786: the first bar chart, invented because a column of data was missing. He apologised for it.

2

A LINE THAT MEANS MONEY

William Playfair and the Commercial and Political Atlas, 1786.

William Playfair was born in 1759 near Dundee, brother to a famous mathematician, apprentice to the great engineers of his day; as a young man he worked as a draughtsman in the Birmingham works of Boulton and Watt, drawing steam engines. Nearly everything else he touched failed: silversmithing, banking schemes, land speculation, a string of publications and prosecutions. He is one of history's clearest cases of a man who invented something immortal while failing at almost everything mortal, and what he invented, in a book of 1786 called The Commercial and Political Atlas, was the time-series line chart (Plate 1).

The Atlas plotted England's trade, imports and exports drawn as two coloured lines across a field of years, the space between them tinted and labelled for or against the nation. His argument for the method was the eye itself: a man who looks at one of these charts, he wrote in substance, takes in at a glance what a table would surrender only to hours of study.

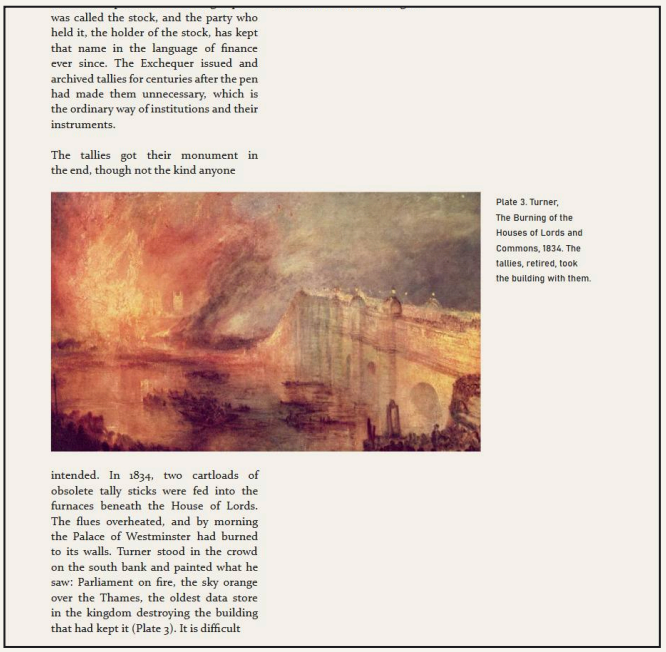
The claim was radical precisely because it conceded something scholarly pride did not like to concede, that understanding is partly an optical event, and that a well-made picture is not an ornament to the argument but a faster road to it.

The chart born of a missing column

The bar chart, his second invention, was born of an embarrassment. For Scotland he lacked the run of yearly figures that his line charts needed; he had trade numbers for a single year, seventeen partners, no time axis at all. So he turned the axis into a list, gave each trading partner a bar, and let length alone carry the quantity (Plate 2). He apologised for it in the text, and the apology has aged into comedy: the makeshift he was embarrassed by became the most used statistical picture on earth. It is a lesson this library takes personally, since half of its own rules began as workarounds that turned out to be principles.

3

Plate 1. Georgia 9 on 12, whole points throughout. From AGAINST TABLES, seed tables-1.



was called the stock, and the party who held it, the holder of the stock, has kept that name in the language of finance ever since. The Exchequer issued and archived tallies for centuries after the pen had made them unnecessary, which is the ordinary way of institutions and their instruments.

The tallies got their monument in the end, though not the kind anyone

Plate 3. Turner, The Burning of the Houses of Lords and Commons, 1834. The tallies, retired, took the building with them.

intended. In 1834, two cartloads of obsolete tally sticks were fed into the furnaces beneath the House of Lords. The flues overheated, and by morning the Palace of Westminster had burned to its walls. Turner stood in the crowd on the south bank and painted what he saw: Parliament on fire, the sky orange over the Thames, the oldest data store in the kingdom destroying the building that had kept it (Plate 3). It is difficult

Plate 2. Four roles, one register: numeral, title, body, caption. From THE NUMERAL, seed numeral-3.

2 THE UNIT AND THE REGISTER

Leading is added space

The library measures type with two numbers, and the second is the one that is misunderstood. In style(size, leading), the leading is space added between lines. The line height is the sum of the two. Thus style(9, 3) sets a 9 point face on a 12 point line. We insist on this older sense of the word because it names a physical act, the insertion of strips of lead, and because a typographer who thinks in added space thinks about the space.

Software that treats line height as a multiplier of the size invites fractional results. Fractional line heights produce registers that drift, and drifting registers produce facing pages whose lines do not back up. The library declines the multiplier entirely. Every style declares its addition in whole points, and the arithmetic of the page stays in whole numbers from the first line to the last. (Plate 1)

The line is the atomic vertical unit

All vertical measurement in the library is conducted in lines. A paragraph is so many lines tall. A title occupies whole body-line slots. Space before and after a heading is counted in whole lines. A grid field is a whole number of text lines high, and the gutter between fields is a whole number of empty lines. There is no vertical quantity in the library expressed in points that is not derived from a count of lines.

Müller-Brockmann permits no half lines in typography, and we have taken him at his word. The half line is where registers die. Once a single element sits half a line off, every element below it argues with the baseline of the facing column, and the reader, who never consciously sees a baseline, senses the argument anyway.

The register and its module

The function typeSystem({ module, roles }) establishes the register. The module is the base line height, and every role in the system must divide it or be a multiple of it. A body on a 12 point line admits a caption on a 6 point line and a title on a 24 point line. It does not admit a subhead on a 14 point line, however handsome the subhead.

When a role violates the module, the library refuses it. The refusal is not silent. The error names the nearest legal settings, so that the correction is a matter of reading rather than of arithmetic. This behaviour follows Müller-Brockmann's demonstrations on pages 59 and 66, where every subsidiary style is shown locking into the body register. A system that accepted the 14 point subhead and quietly rounded it would be lying to its typographer. We prefer the refusal. (Plate 2)

The column decides the face

The function sizeForMeasure(width) answers the oldest question in book typography from the wrong end, which is the correct end. Given a measure, it returns the largest face that holds roughly eight words to the line, constrained to the range of 8 to 12 point for book work. The column decides the face. The typographer who chooses a favourite size first and then forces a column around it has the procedure backwards.

The eight word line descends from Müller-Brockmann's account of reading rhythm on pages 18 and 57, and the book range from his sizing tables on pages 30 and 31. A line much longer tires the return sweep of the eye. A line much shorter fractures the sentence. The library holds the corridor, and within it the seed may do as it likes.

of an inch and the arch, if it is an arch, silently accepts its own weight. The nineteenth-century manuals are unanimous only in their disagreement about when to do it. Some hold that the centre should be struck the moment the spandrels are filled; others that the mortar must be given weeks to harden. The dispute cannot be settled from outside, because both parties are describing the same intolerable condition: you cannot know whether the thing stands until you

Plate 2 — The Washington Monument in its scaffold, mid-century: an unfinished shaft held by wood.

remove what is holding it, and you cannot put the frame back (Plate 2).

Here is the thesis of this essay, and it is not about masonry. Nothing stands, at first, by itself. Every made thing is held, while it becomes itself, by a structure that has no place in the finished thing. The whole art of making is the fate you choose for that structure: to strike it, to dissolve as the work. Everything else is craft, which is to say, everything else can be taught.

II. THE DOME THAT NEEDED NONE

In 1418 the wardens of the cathedral of Florence had a hole in their roof one hundred and fifty feet across and no idea how to close it. The vault they wanted could not be centred: no forest in Tuscany held timbers long enough to span it, and no scaffold rising from the cathedral floor could be trusted to carry a masonry heaven. Filippo Brunelleschi won the commission by promising the one thing nobody believed possible. He would build the dome without centering.

The reader will notice that this section of the book has no plate. There is no photograph of Brunelleschi's centring, and there is no engraving of it either, for the excellent reason that it never existed. What he built instead was a dome that supported itself at every instant of its own construction: two shells, one inside the other, tied by ribs, and between the ribs a herringbone brickwork in which each fresh course was pitched so that its weight passed sideways into the vertical ribs rather than downward into empty air. The dome never leaned on anything but itself. It rose in closed rings, and every closed ring was already a compression structure complete in itself, a finished arch, so that at no hour did there exist an unfinished span requiring a frame. It remains the largest masonry dome ever raised.

Plate 3. The golden canon scaled to its page. From THE CENTERING, modern edition.

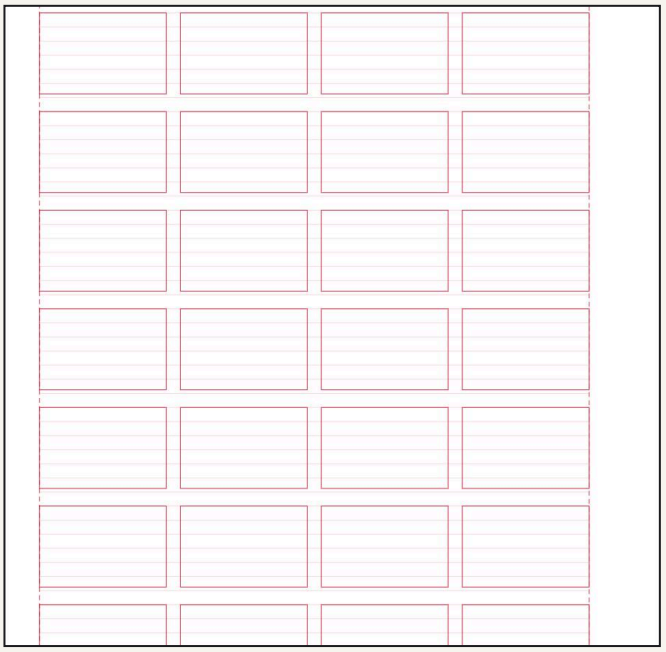


Plate 4. The 32-field preset beside its source: MB p.88, field for field.

3 THE TYPE AREA AND THE GRID

The canons of the margin

The type area is the region of the page that carries text, and the margins are the silence around it. The library ships two canons of proportion for that silence. The first divides the margins in the ratio 1:1.5:2:3. The second is the golden canon, 3:5:5:8. Both descend from the classical tradition that Müller-Brockmann inventories on page 51, and both place the type area high on the page with the largest margin at the foot.

A margin is not residue. The reader's thumbs live there, the page numbers live there, and in this library the captions may live there. A canon guarantees that the four silences stand in a stated relation, and a stated relation is one that can be enforced by a test. The library carries 104 of those.

The area fraction

The function marginsForAreaFraction scales a chosen canon until the type area is exactly a stated fraction of the paper area. The canonical fraction is one half. The proportions of the canon are preserved throughout the scaling, so the margins keep their ratio while the type area arrives at its size. Müller-Brockmann observes on page 51 that a type area of about half the paper produces a page that is both economical and calm, and the 1:2 relation of type to paper is the library's default position.

We note the discipline this imposes. A typographer may choose the canon and may choose the fraction. The margins themselves are then a consequence. The library computes them to the point and will not accept a hand-adjusted spine that breaks the canon.

The spine of a thick book

The spine margin deserves a separate paragraph because thick books punish those who neglect it. As a book gains bulk, the paper curves into the binding, and a spine margin adequate for eighty pages swallows the first words of every line at four hundred. The canon's inner value must therefore be read as a minimum for slender work. For thick books the typographer widens the spine and lets the canon scale around the decision.

The library accommodates this by treating the canon as a proportion to be scaled rather than as a table of fixed millimetres. The relation among the four margins is the law. Their absolute size answers to the paper and to the binding. (Plate 3)

The grid and its fields

The function grid() divides the type area into fields. The height of every field is a whole number of text lines, and every gutter between fields is a whole number of empty lines. The grid is therefore an arrangement of the register rather than a drawing laid over it. A field boundary is always a baseline, and text entering any field sits on the same register as text in any other.

Three presets accompany the function. mb8, mb20 and mb32 reproduce the dimensioned A4 grids that Müller-Brockmann publishes on pages 73, 77 and 88 of Grid Systems, field for field and gutter for gutter. A reader may set this manual's specimens beside the book's diagrams and measure the agreement. (Plate 4)

What cannot be expressed

We close the chapter with a specification item that is easily mistaken for an omission. The library contains no syntax for an off-grid position. There is no coordinate argument, no offset parameter, no escape hatch by which an element may be nudged three points to the left of its field. Every placement in the library is a placement into fields, and the fields are made of whole lines.

This absence is deliberate and is to be maintained. A grid system with an exception mechanism is a suggestion system. The moment one caption may sit off the grid, every caption is a negotiation, and the programme returns to the condition of manual paste-up that it was written to end. What the syntax cannot say, the page cannot do.

4 SETTING TEXT

The breaker

Geviert breaks paragraphs with the Knuth-Plass algorithm by default. The algorithm considers the paragraph as a whole and selects the set of breakpoints whose total badness is the least, escalating its tolerance in passes when a strict setting cannot be found. In practice this means a loose line early in the paragraph may be accepted so that four tight lines later on become possible. A greedy breaker sees only the line before it

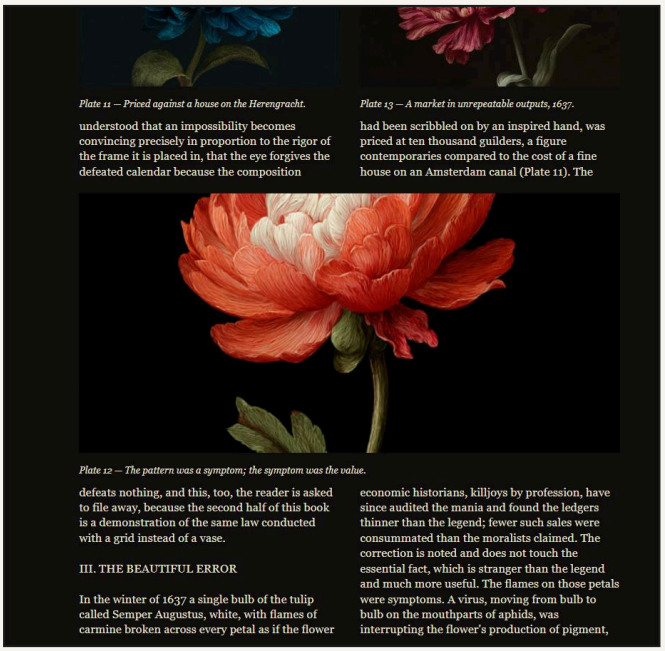


Plate 5. The measure changing where the plates intrude. From STILLEVEN, seed stilleven-essay-1.

and cannot make this trade. We regard the difference as visible at reading distance and decisive at arm's length.

Total badness is a number, and the reader never sees it. The reader sees its absence: word spaces of even colour, a right edge without craters, paragraphs that end where they intend to end. When the manual speaks of a well set page it is speaking of a minimised sum.

Greedy setting

A greedy breaker is available on request. There are compositions, chiefly those regenerated at interactive rates, in which the paragraph-global optimum is a luxury. For these the optional peer pretext accelerates greedy breaking by a factor of about thirty, with line-for-line agreement verified by an included eval script. We permit this. We do not celebrate it.

The grid-aware measure

The breaker in geviert is grid-aware. Where a figure intrudes into the column, the measure changes for exactly those lines, and the breaker knows the changed measure before it breaks. Text does not collide with pictures and then apologise; it is set to the space that exists. The measure of each line is a fact of the grid, and the paragraph is composed against the facts. (Plate 5)

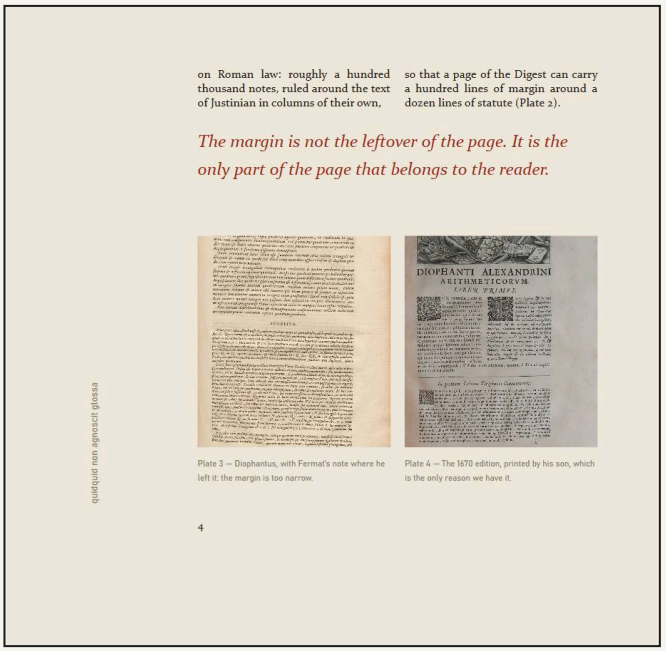


Plate 6. A dropped initial with its derived well. From THE MARGIN.

Hyphenation

Hyphenation is provided through the optional peer hyphen, which applies Liang's TeX patterns. Without it the breaker sets unhyphenated text and accepts the looser fit this implies. With it, word division becomes one more degree of freedom in the minimisation.

One rule stands above the tolerance passes. The ladder rule is hard: consecutive hyphenated line endings beyond the permitted count are refused, whatever the badness cost of avoiding them. A ladder of hyphens down the right edge of a column is a typographic defect that no arithmetic can excuse, and the library does not negotiate on the point.

Justified setting

Justification in geviert is performed by elastic word spaces. Each space may shrink to 0.55 of its natural width and may stretch to 4.0 times it. Both limits are overridable, and both

defaults are the product of deliberation; the practitioner who widens them should be prepared to defend the resulting colour.

A line that cannot be justified within these limits is left ragged. We consider a single ragged line in a justified paragraph a lesser evil than a line of gaping or crushed spaces, and the library enforces this preference without consultation.

The last line of a paragraph is never justified (p.80). It ends where the words end. A final line stretched across the full measure announces that a machine was present and unsupervised; geviert declines to make the announcement.

Paragraph devices

Müller-Brockmann admits a small number of devices for articulating paragraphs (p.34), and geviert implements them as options rather than habits. The empty line separates paragraphs by one whole line of the register; the vertical rhythm is preserved because the separation is a line, and lines are the unit.

The first-line indent is one em, that is, one geviert, and paragraphs that open a column or follow a title are set flush. An indent after a heading indents nothing that needed distinguishing, and the library omits it there as a matter of course.

The dropped initial (p.36) is sized from a whole number of body lines of cap height. Its well is derived from the ink width of the letter plus one sidebearing, measured rather than estimated, so that the text stands off the initial by a constant optical interval whatever the letter. A W and an I receive different wells because they have different ink. (Plate 6)

The centred axis

Setting on a centred axis is available (p.79). Müller-Brockmann records the axis as a historical form of dignity and a present form of inconvenience, and this manual takes the same view. Centred text resists the grid's left edges and forfeits the reader's fixed point of return. The library sets it correctly when asked. The manual notes that it is asked less often by those who have read Chapter 3.

Setting right to left

The library sets right-to-left scripts. Under direction rtl the reading order of the text columns runs right to left across the page, the ragged edge falls on the left, the first-line indent falls on the right, and the elastic spaces of justified setting stretch by exactly the arithmetic of the preceding sections. Measurement is performed on shaped text through the browser's own engine, because the width of a joined Arabic word is a property of its joining and no table of isolated forms can know it. The first book set this way was Arabic, and its colophon states its seed.

5 TITLES AND THEIR APPARATUS

Roles

A paragraph in the story may carry a role. The role selects its style from styles[role], and the typographic system of Chapter 2 has already guaranteed that this style is legal: every role's line height divides the module or is a whole multiple of it. A title therefore occupies whole body-line slots on the register. The

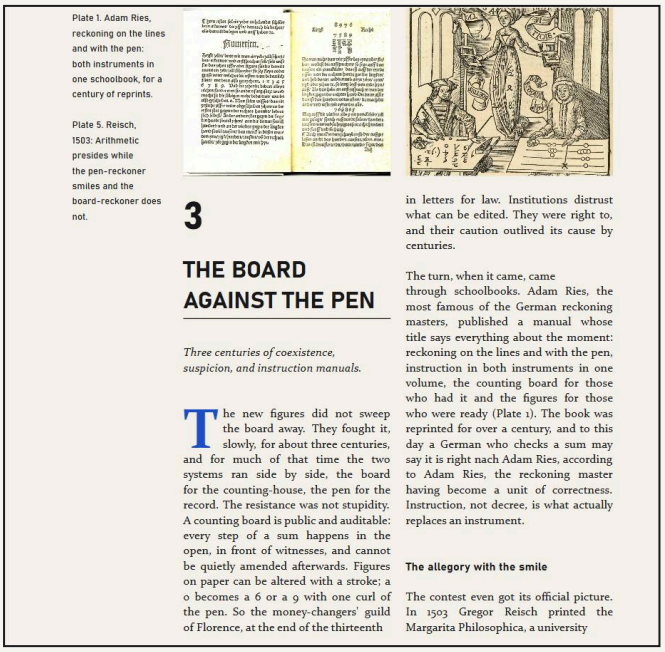


Plate 1. Adam Ries, reckoning on the lines and with the pen: both instruments in one schoolbook, for a century of reprints.

Plate 5. Reisch, 1503: Arithmetic presides while the pen-reckoner smiles and the board-reckoner does not.

3

THE BOARD AGAINST THE PEN

Three centuries of coexistence, suspicion, and instruction manuals.

The new figures did not sweep the board away. They fought it, slowly, for about three centuries, and for much of that time the two systems ran side by side, the board for the counting-house, the pen for the record. The resistance was not stupidity. A counting board is public and auditable: every step of a sum happens in the open, in front of witnesses, and cannot be quietly amended afterwards. Figures on paper can be altered with a stroke; a 0 becomes a 6 or a 9 with one curl of the pen. So the money-changers' guild of Florence, at the end of the thirteenth

in letters for law. Institutions distrust what can be edited. They were right to, and their caution outlived its cause by centuries.

The turn, when it came, came through schoolbooks. Adam Ries, the most famous of the German reckoning masters, published a manual whose title says everything about the moment: reckoning on the lines and with the pen, instruction in both instruments in one volume, the counting board for those who had it and the figures for those who were ready (Plate 1). The book was reprinted for over a century, and to this day a German who checks a sum may say it is right nach Adam Ries, according to Adam Ries, the reckoning master having become a unit of correctness. Instruction, not decree, is what actually replaces an instrument.

The allegory with the smile

The contest even got its official picture. In 1503 Gregor Reisch printed the Margarita Philosophica, a university

Plate 7. A title over its hairline, placement example 8. From THE NUMERAL.

ratio between a title line and a body line is an integer because the system refused every configuration in which it was anything else. The composer does not check this at page time. There is nothing left to check.

Conduct of the title

A title is never split across a page boundary and is never justified. The first rule is structural: a heading exists to bind itself to what follows, and a heading orphaned at the foot of a page binds itself to nothing. The second rule is typographic: display sizes expose every irregularity of space, and elastic justification at 24 point is a public confession. Titles are set ragged on the grid's axis and are moved whole or left whole.

The hairline

The option rule: true draws a hairline beneath the title. This reproduces placement example 8 of Müller-Brockmann's survey of title positions (p.47). The hairline is an instrument of separation, thin because separation requires presence rather than weight. The library draws exactly one, at exactly the measure. (Plate 7)

Space before and after

Space around a title is specified by spaceBefore and spaceAfter, in whole lines (pp.69-70). Fractional space above a heading would break the register for every line beneath it on the page, and so the syntax does not admit fractions; the practitioner cannot request what the practitioner must not have.

We call the resulting interval the rest zone. The space before a title is customarily greater than the space after it, so that the title adheres to its own text and stands apart from the preceding matter. Both values are the designer's decision. Their wholeness is not.

The fresh leaf

The option pageBreak opens a fresh leaf before the title. A chapter that begins mid-page begins in another chapter's residue. Where the hierarchy warrants it, the library ends the page, whatever the cost in white paper. Paper is the cheapest material in the book.

The eight placements

Pages 46 and 47 of Grid Systems exhibit eight canonical placements of title, subtitle and text. This manual treats the eight as a sample space. A seed drawn through Rand(seed) may select among them, and a programme in the sense of Chapter 8 may enumerate them as one axis of the morphological box. Müller-Brockmann drew eight diagrams; we observe that eight diagrams constitute a distribution, and we sample it.

Plate 9. Marginal captions, top edges level with their plates. From THE CENTERING.

Plate 8. Six figures placed by the beam under the stated weights. From STILLEVEN.

6 FIGURES ON THE FIELD

Anchoring
Every figure in geviert is anchored to a phrase in the story. The anchor declares the sentence to which the picture belongs, and the composer's obligation is to place the figure near the place where that sentence falls. A picture placed by page number is placed by accident; text reflows and the accident travels. A picture placed by phrase follows its subject through every recomposition. The anchor is the figure's citizenship in the text.

The size vocabulary
Figure sizes are expressed in whole fields. A figure is one field, or two by two, or three wide by two deep; it is never 1.4 fields, because the grid has no syntax for 1.4 of anything. Müller-Brockmann prescribes a few graded sizes rather than a continuum (p.11), and the library enforces the prescription by construction. A book set with four figure sizes reads as designed. A book set with forty reads as assembled.

The beam search and the harmony weights
Placement is decided by a beam search over candidate pages, scored by the harmony weights. The weights are institutional policy and the manual states them in full: newSize 1.2, sameBand 1.0, sharedEdge 0.35, stacked 0.25, adrift 0.8. A new size on the page costs 1.2; repetition of the current band costs 1.0; a shared edge between figures costs 0.35; direct stacking costs 0.25; distance from the anchor is charged as adrift at 0.8.

These numbers were arrived at by looking at pages, and they are amendable through the options, and the practitioner who amends them assumes responsibility for the pages that result. The beam is a search. It finds good pages and does not claim the best page, and the manual considers this honesty a feature of the specification. (Plate 8)

anchorPull
The weight anchorPull, presently 0.45 and measured from the figure's centre, has a history that the manual records with regret. The pull was once a law. Under the law, every picture was drawn so forcibly toward its phrase that the entire figure population settled into a single column, page after page, in defiance of the whole apparatus of Chapter 3. The incident is documented. The law was demoted to a preference, weighted, and rebalanced against the harmony terms, and the columns have been mixed ever since. A rule that produces one outcome is a bug wearing a uniform.

Dispositions
Each page receives a seeded disposition: a band row assignment drawn per page, with heroChance 0.3 governing whether one picture is permitted to dominate the page. Müller-Brockmann allows the dominant picture explicitly (p.70), and the type area floats high on such pages in accordance with p.51. The disposition is drawn from the seed, so two runs of the same book quarrel about nothing.

Drift

The report returned by composeDocument states the drift of every figure: the distance between the figure as placed and the phrase to which it is anchored. Drift is not an error. It is a measured concession, and the composer confesses it per

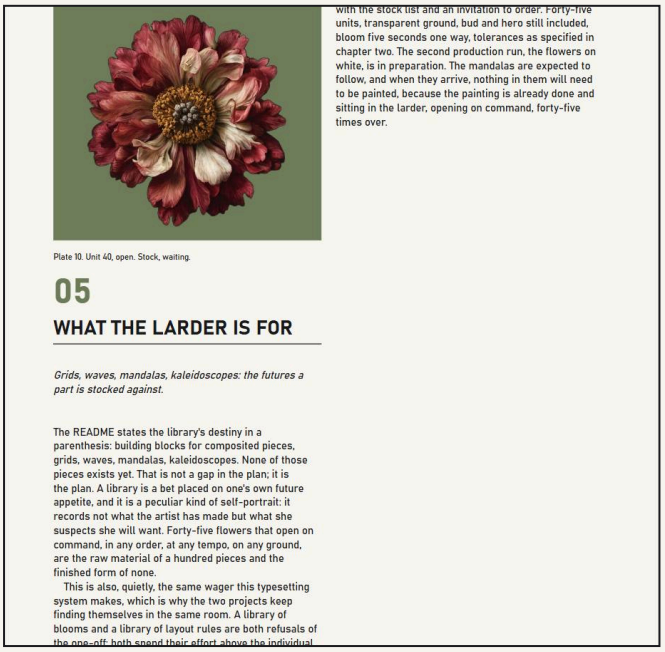


Plate 10. The cut-out apparatus: overprint and tint on one spread. From FODDER, seed fodder-2.

figure so that the designer may audit the concessions rather than hunt for them. (Plate 9)

The cut-out apparatus

For photographs freed from their rectangles, Müller-Brockmann prescribes an apparatus (p.98), and geviert implements its four devices. tint lays a colour area beneath the cut-out, sized to whole fields. border draws a line border with the field's dimensions. bracket sets rules at the top and bottom limits of the figure. overprint lays colour over the photograph in multiply. Each device restores to the irregular silhouette a stated relation to the grid. A cut-out without apparatus floats; a cut-out with apparatus stands.

Captions

A caption may sit under its picture, growing the band by whole lines (p.64), or it may sit in the margin column when the text span leaves one, beside the picture with top edges level, mirrored with the spine (pp.55, 63, 87, 120). The mirroring is enforced: a margin caption on a verso and its counterpart on a recto face one another across the fold. Captions are text and therefore live on the register, whatever their proximity to pictures.

Charts

A figure may carry chart data. The bars are then drawn whole text lines tall (pp.14, 58-59), so that a chart is legible against the adjacent column the way two rulers are legible against each other. Labels are set beneath the axis in the caption style; values stand one line above each bar. Müller-Brockmann drew his statistics on the same module as his prose, and the library sees no grounds for a second module.

Pull quotes

A pull quote occupies fields and is sized to fill them, to a ceiling of 2.2 times the display size, with leading at 28 percent, centred in the reserved rectangle. The quote is an object of the grid before it is a sentence of the text, and its size is derived from its container rather than asserted against it.

fullPage, bleed, duotone

Three closing instruments. fullPage surrenders an entire page to one figure. bleed carries the image past the trim, where the grid's authority ends at the knife. duotone renders the photograph in two inks, executed in SVG through feColorMatrix, with unique clip ids so that two duotones on one spread do not inherit each other's edges. Used together on a chapter opening, the three constitute the library's loudest permissible gesture. (Plate 10)

7 THE DOCUMENT

What goes in

composeDocument(story, figures, grid, styles, seed) is the whole ceremony. The story is the text, already divided into paragraphs, some of them carrying roles. The figures are anchored to phrases in that story and sized in the whole-field vocabulary of Chapter 6. The grid is a grid() object whose field heights are whole text lines. The styles map roles to registered faces. The seed is a string. Five arguments enter. A book comes back.

What comes back

The return value is the pages and a report. The report contains fits, leftoverWords, and the drift of every figure measured from its anchor. This manual wishes to be clear about the character of that report. It is not an advertisement. If the story did not fit, fits is false and leftoverWords counts the words that were left standing outside the building. If a figure was placed far from its phrase, the drift figure says so, per figure, in units that do not flatter. A composition system that reports only its successes is a marketing department. Ours files an honest return.

The book is bound

A document is composed for a bound book, and a bound book has a spine. The margins therefore mirror. What is the inner margin on a recto is the inner margin on a verso, and the canons of Chapter 3 are applied with the spine as the axis of reflection (p.51). A layout that looks correct on a single floating rectangle and wrong across a gutter has been designed for a screen and printed by mistake. (Plate 11)

Folios

Page numbers are placed according to the same discipline as everything else. A folio occupies a defined position relative to the type area and mirrors with the spine. It does not wander. The reader who consults the folio is asking the book a question, and the book should answer from the same place every time.

The margin column travels with the text

When the text span leaves a marginal column free, captions may stand in it, beside their pictures, top edges level, mirrored with the spine. This column is an arrival of the text span rather than an invention of the caption apparatus. Where the span widens and consumes the column, the caption returns beneath the picture and grows the band in whole lines. The two placements are the same law observed under two conditions.


and his daughter arranged flowers in his cabinets of preserved wonders before she ever signed a canvas. One does not wish to overwork the inheritance, but one notices it. She painted for more than six decades and signed her age, eighty-three, under the flowers she finished in 1747, an inscription that reads less like a date than like a boast, and was entitled to be one (Plate 8). Her contemporary Jan van Huysum, the other summit of the late manner, guarded his procedures like a man who believed method itself was property: he painted alone, locked the studio against his own brothers, accepted in his whole life a single pupil, and drove her out when her work grew good enough to frighten him. Art historians report this with disapproval. Every generative artist who has ever declined to publish a seed will read it with a flicker of fellow feeling (Plate 9).

What the secrecy protected was not a trick but a discipline: the patience to build a flower out of glazes the way the flower had built itself out of days. And here the tradition's deepest habit comes into view. The study held the bloom outside its season. The dark ground held it outside its room. The glaze held it outside its hour. At every scale the practice is the same practice, the preservation of the perishable by translation into a system that does not perish (Plate 10). The anatomist did it with spirits and wax, the daughter with oil, and the difference between them is smaller than the difference between either and doing nothing, which is what time proposes.

Plate 10 — Preservation by translation into a system.

It is worth pausing on what the studies were not. They were not sketches, in the modern, forgiving sense; they were specifications. A tulip study recorded the number of petals, the exact syntax of the break, the particular candor of that bloom on that morning, at a resolution sufficient for the flower to be reconstructed decades later by a hand that had never seen it. The portfolio was, to say it plainly, a format. It could be inherited; sons and workshop assistants painted their fathers' tulips long after the originals had composted, and the Bosschaert dynasty ran on exactly this inheritance, three sons and a brother-in-law compositing from the family stock like a studio sharing an asset library, because that is what they were. When the same anemone appears in two bouquets twenty years apart, art history calls it workshop practice. An engineer would call it a dependency, and both would be right.

One should also say a word for the vase, the least regarded and most instructive object in the genre. It is the constraint. Everything else in the picture is free, impossibly free, seasonally free, and the vase is the one thing that must be obeyed: the stems must enter it, the pyramid must rise from it, the weight must balance over it. The masters understood that an impossibility becomes convincing precisely in proportion to the rigor of the frame it is placed in, that the eye forgives the defeated calendar because the composition defeats nothing, and this, too, the reader is asked to file away, because the second half of this book is a demonstration of the same law conducted with a grid instead of a vase.

5

Plate 11. A bound spread with mirrored margins. From STILLEVEN, edition B.

Composition is final

We state this once and expect it to be remembered. Resizing a rendering re-draws. It never re-composes. The pages returned by composeDocument are the document. A renderer may scale them, and the SVG renderer scales them without loss, but no renderer is permitted to reflow a paragraph, relocate a figure, or renegotiate a page break in response to a window. A document whose line breaks depend on the width of the reader's browser is weather.

Cost

A composed page costs approximately 34 milliseconds at 280 pages. The manual reports this figure so that the reader does not mistake determinism for expense. Rigour is fast when it is specified.

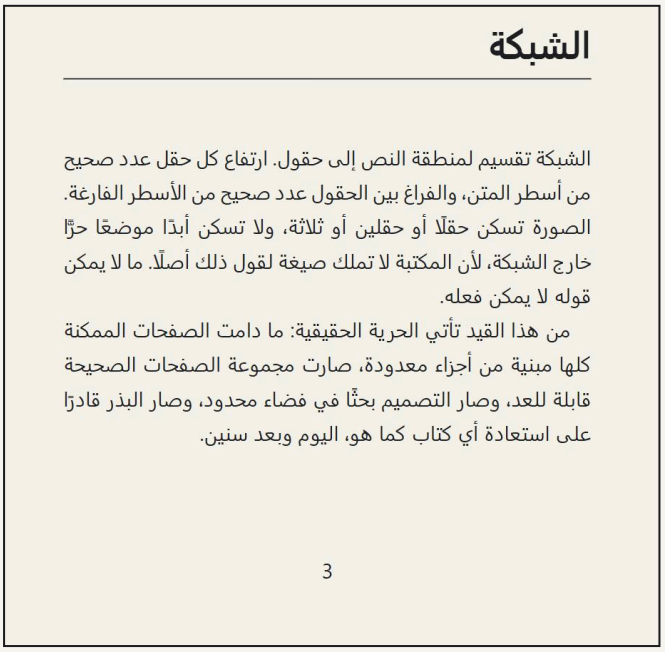


Plate 12. Measured, shaped, right to left. From THE GRID (Arabic), seed shabaka-1.

8 RENDERING AND MEASUREMENT

Two renderers
The library ships two renderers and no third. The SVG renderer produces a self-contained file. The DOM renderer produces live text in a browser. Both draw the same composed pages, because Chapter 7 has already established that composition is finished before either of them is consulted. A renderer in this system is a draughtsman. It holds no opinions about layout.

The SVG conventions
The SVG output is self-contained. Duotone treatment is performed with feColorMatrix inside the file. Clip paths carry unique ids so that two plates pasted into one page do not clip one another's pictures, an accident this manual regards as beneath discussion. With embed, registerFontFile carries the face itself into the output, so the file renders identically on a machine that has never heard of the font. (Plate 12)

The DOM renderer
The DOM renderer sets live text. The reader may select it, copy it, and search it. This is a courtesy the SVG file cannot extend and the DOM renderer must therefore extend perfectly: the live text sits on the same baselines, to the same measure, as the composed page dictates. The worst measured deviation is 0.013 pixels. The typical deviation is 0.002. We publish these numbers because the next section explains why we are entitled to them.

The doctrine of measurement
Nothing is computed that can be measured. This is the standing doctrine of the rendering layer and the reader should treat it as such. Font metrics, as reported, describe a font. They do not describe what a particular browser did with that font at a particular fractional size on a particular afternoon. Browsers quantize. Metrics files do not know this. The renderer therefore places a hidden probe into the document, sets a glyph, and measures where the baseline actually landed. The measured value is used. The computed value is not consulted.

The 0.505 pixel incident
The doctrine was not always in force. In an earlier state of the library the baseline was computed from font metrics, and every line on every page landed 0.505 pixels from where it belonged. The error was constant, invisible in isolation, and cumulative in effect: every rule, every figure edge, every caption sat a half pixel off the register it claimed to honour. This manual records the episode with regret. A register that is wrong by a constant is wrong. The baseline is now measured by the probe, and the numbers of the preceding section are the result.

useBrowserFonts
Where the composition must agree with what a browser will draw, useBrowserFonts measures the fonts through canvas. The advance widths used by the line breaker are then the advance widths the browser will use, and the paragraph that was composed is the paragraph that appears. The alternative, composing against one set of widths and rendering against another, produces lines that are almost correct, and almost correct lines are the signature of systems that trusted a table.

registerFontFile
registerFontFile turns any TTF, OTF, or WOFF into a measurable font in one call. It reads the file through the optional peer opentype.js and, from the face's PANOSE classification, chooses the appropriate CSS fallback stack, so that a document degrades toward a relative rather than a stranger. One call. The manual sees no reason a font should require more ceremony than a paragraph.

Optional peers and the zero-dependency rule

The core carries zero runtime dependencies. This is a rule, and it stands. opentype.js is an optional peer for font registration. hyphen is an optional peer for Liang's TeX hyphenation patterns. pretext is an optional peer that accelerates greedy breaking by about thirty times with line-for-line agreement, verified by an included eval script. Each peer extends the library. None is required by it. A composition system that cannot compose without its accessories has confused itself with its accessories.

9 THE PROGRAMME LAYER

The founding instruction

Gerstner's thesis is the founding instruction of this layer and we restate it in his spirit: the designer's task is to describe the programme and let the programme produce the solutions. A grid, correctly specified, is the set of all layouts that obey it. The programme layer exists to make that set addressable. The designer states constraints. The machine enumerates what satisfies them. Taste, which Chapter 10 will formalise, selects among the survivors.

The constraints DSL

Constraints are written in a small DSL over grids. The vocabulary is deliberately narrow, because Chapter 3 has already established that the grid admits no off-grid position

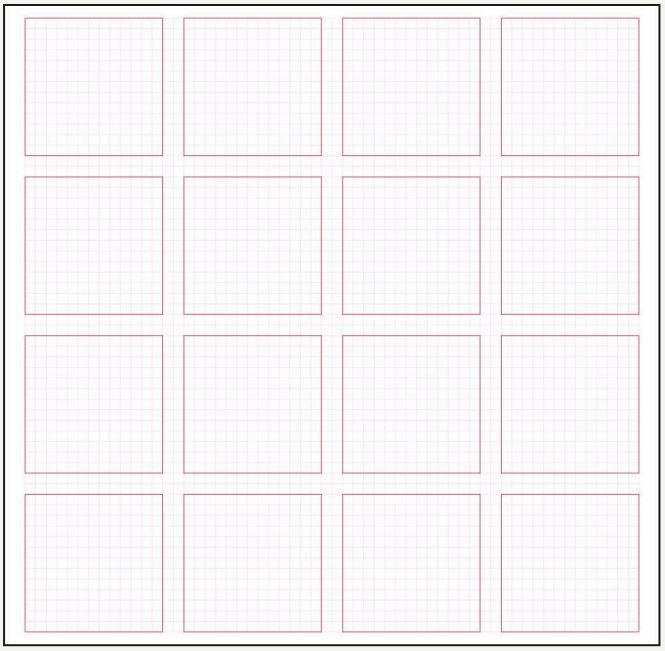


Plate 13. The mobile grid at 58 units, computed. After KG pp.58-61.

and the DSL inherits that austerity. A constraint names what must hold. It does not suggest. The solver beneath the DSL is an exhaustive backtracking solver: it visits the space of placements, prunes what violates a constraint, and returns solutions that are correct by construction. A solution from this layer does not need to be checked. It needs to be looked at. (Plate 13)

The sampling discipline

When the space of solutions exceeds the pool, the solver samples. The manual must here relate a failure. An earlier implementation drew its pool as a truncated depth-first prefix of the search tree. The prefix was deterministic, and it was also a prefix: across 20,000 pooled solutions, certain item placements never varied, because the truncation fell before the branches that would have moved them. The pool was large and it was unrepresentative. The remedy is seeded randomised restarts. Each restart enters the tree at a seeded angle, and the pool now covers the space it claims to sample. The reader designing a solver is invited to learn this at our expense rather than at theirs.

layout(seed) and locks

The working interface is layout(seed). A seed produces a layout from the pool, deterministically and forever, per the doctrine of Chapter 10. reroll produces another. Elements the designer wishes to keep are locked, and the reroll then varies only what remains free. This is the correct division of labour: the machine proposes within the constraints, the designer fixes what has become right, and the space contracts around the fixed points until a page remains.

The mobile grid and the number 58

Gerstner's mobile grid admits simultaneous divisions of one square area. The least area that takes every division from one through six with a two-unit gutter is 58 units, and the library computes this through gerstnerNumber rather than reciting it, because a constant that could have been a function is a small dishonesty. Fifty-eight is a modest number. It is, as Gerstner demonstrated, a sufficient one.

The morphological box

The morphological box (KG p.59) is treated by this layer as an enumerable parameter space: axes of variation, each with discrete values, whose Cartesian product is the space of designs. The box is a data structure here. The programme layer walks it, the constraints prune it, the seed indexes into what survives. Gerstner drew the box by hand and filled its cells by judgement. We have mechanised the walking and left the judgement where it was.

10 ON DETERMINISM AND TASTE

Seeds
A seed is a string. The reader may use a word, a date, a sentence, or the name of a client. Rand(seed) hashes the string through xmur3 and feeds the resulting state to sfc32, and we name these functions the way an engineer names the machinery in a plant room, because that is what they are: the hash that seats the state and the generator that turns it over. Every random decision in the library, from the beam's tie-breaks to the per-page figure dispositions to the programme layer's restart angles, draws from this stream and from no other source.

The guarantee
Same seed, same book, forever. There is no version of this guarantee with conditions attached and the manual will not manufacture one. No clock is read. No machine identity is consulted. The composed book of a given seed on a given input is a mathematical object, and it can be reproduced next year, on other hardware, by other hands, page for page. Where behaviour changes between releases, the release notes say so, because a silent change to determinism is a broken promise with good manners.

Taste as a disclosure requirement
The beam that places figures is scored by harmony weights: newSize 1.2, sameBand 1.0, sharedEdge 0.35, stacked 0.25, adrift 0.8, with anchorPull 0.45 measured from the figure's centre. This small object of named numbers is the taste of the system, and the manual's position is that publishing it is a disclosure requirement. Every layout engine has preferences. Most keep them in the walls. Ours are printed in the specification, may be overridden, and appear in this chapter so that the reader knows precisely whose judgement is operating when a picture settles where it does. Preferences with weights can be argued with. Laws in the walls cannot.

The beam is a search
The beam finds good pages. It does not claim the best page. The space of placements is large, the beam is finite, and a system that announced optimality over a space it had not exhausted would be reporting a feeling. The report of Chapter 7 states what was achieved and the weights above state what was sought. The reader may inspect both.

Closing
The reader now possesses the complete specification and is expected to compose accordingly.

THE SPECIMENS

What follows reproduces 129 pages from the books the library has composed to date, two to a leaf, in their published order. Each is a real page from a real volume, printed here at reduced size with its source and seed. None was made for this manual. The manual regards prior work as the only admissible portfolio.

FODDER

Notes toward a catalogue of forty-five flowers, with the apparatus for tying them down.

GEVIERT · FIVE CHAPTERS AND TEN PLATES · SECOND PRODUCTION RUN PENDING

bloom/fodder-00.svg · seed fodder-2

01

THE PART, NOT THE PICTURE

A library of forty-five flowers, considered as a parts catalogue.

There is a folder on a studio machine in which forty-five flowers are blooming. Each one blooms alone, on nothing: a painterly flower head, cut out against a transparent ground, opening from bud to full flower in about five seconds, and then stopping, ready to do it again for whoever asks. They are not pictures. Nobody will ever frame bloom-17. They are parts, in the strict industrial sense: components manufactured to tolerance, stocked in quantity, and meaningless until a design orders them into something (Plate 1).

This document is therefore a parts catalogue, and it is set like one on purpose. The typographic register it borrows was perfected for exactly this job: the postwar Swiss designers built their grids to carry industrial matter, machine parts ranged in fields, specifications in columns, and when Josef Müller-Brockmann needed a demonstration photograph for the cut-out apparatus in his grid manual, he reached for a pair of Eames chairs. A chair, a flower head: the apparatus does not care. A cut-out is a cut-out, and it needs the same tying-down.

The library began as eighty source paintings, flower heads in the Dutch manner on black grounds. Forty-five of them have so far been through the mill, and mill is the right word: each was relieved of its stem, flattened onto pure black, grown a bud it never had, and taught to open. A second set, painted on white, waits its turn in another folder. The catalogue you are holding documents the first production run.

Plate 1. Unit 02. One part, transparent ground, awaiting an order.

2

bloom/fodder-01.svg · seed fodder-2

Plate 3. Unit 17 in the line border, device two: a drawn edge where no photographic edge exists.

Plate 4. Unit 11, hero still, normalised to 88 per cent and centred.

Plate 2. Unit 40 in four states, bud to open. The bracket rules are device three.

02

FORTY-FIVE TOLERANCES

Stem removed, ground flattened, head normalised to 88 per cent, centred.

Every part in a catalogue is a stack of tolerances, and a flower is no exception. The specification for one unit of this library reads as follows. The stem is removed, because a stem is a location: it roots the flower in a place and a direction, and a part must have neither. The background is flattened to a single value, so the matte can be pulled clean. The open head, the hero still of each unit, is normalised to 88 per cent of frame and centred, because a compositor reaching for flower thirty-one must be able to trust that it occupies the same field as flower seven (Plate 3). Uniformity of this kind is not aesthetic timidity. It is what makes the parts interchangeable, and interchangeability is the entire point of a library.

The mill itself is a short chain of machines. An image model does the surgery, taking the stem off and closing the wound as a painter would, in the flower's own manner; the same model manufactures the bud, a closed version of a flower that was only ever painted open, which is to say it invents each flower's own past (Plate 2). A video model then grows the bud into the painted head, and an interpolator smooths the growth into about five seconds of bloom. The whole production run, forty-five flowers from surgery to finished stock, cost roughly twenty dollars of machine time, a number quoted here in the honest tradition of the catalogue, which always prints the price.

bloom/fodder-02.svg · seed fodder-2

The hero still

Each unit ships in three states: the bud, the open head, and the bloom that connects them. The open head is the one the catalogue photographs, the way a chair is photographed assembled rather than as a bag of screws (Plate 4). But the working asset is the motion between the states, and the motion was manufactured to a specification as strict as the framing. It runs one way. It does not loop, does not hold, does not ease at the ends. That austerity is the subject of the next chapter, because it is the most deliberate tolerance in the whole specification.

bloom/fodder-03.svg · seed fodder-2

Plate 5. Unit 61. Five seconds, one way, stop.

Plate 6. Unit 19. The asset stays mute so the artwork can speak.

03

ONE WAY ONLY

The bloom runs from bud to open and never back. This is a decision.

It would have been easy to make these flowers loop. Every tool in the chain would rather they did; a looping bloom is a finished, satisfying object, a little screensaver of a thing you can watch forever. The library refuses, and ships every bloom as a single one-way run, bud to open, five seconds, stop (Plate 5). The refusal is the most important engineering decision in the folder, and the reason is written in the README with the bluntness of a datasheet: timing, holds and looping are controlled downstream, in the actual piece.

What that sentence understands is the difference between a part and a performance. A looping flower has already decided its own choreography: when it breathes, how long it rests, what its tempo is. Put twelve of them in a grid and you have twelve soloists ignoring one another. A one-way bloom decides nothing. It is pure potential motion, a phrase that the composition downstream can play forward, backward, held, staggered across a wave, or frozen at any instant, in whatever time signature the piece demands (Plate 6). The asset stays mute so that the artwork can speak.

There is a name for material like this in every art that has it. Music calls it a sample; architecture calls it a module; the kitchen calls it mise en place. The generative arts have not quite settled on a word, and the folder under discussion uses the unglamorous one that this essay has taken for its title. What the word lacks in dignity it repays in accuracy: fodder is what you lay in so that some future appetite, whose shape you do not yet know, will find the larder full.

bloom/fodder-04.svg · seed fodder-2

Plate 8. Unit 38 under an overprinted tint, device four: dominant.

Plate 7. Unit 05 on its colour area: tied into the grid, aligned in depth and on the sides.

Plate 9. Unit 73. The fixture aligns; the part is untouched.

04

TYING THE CUT-OUT DOWN

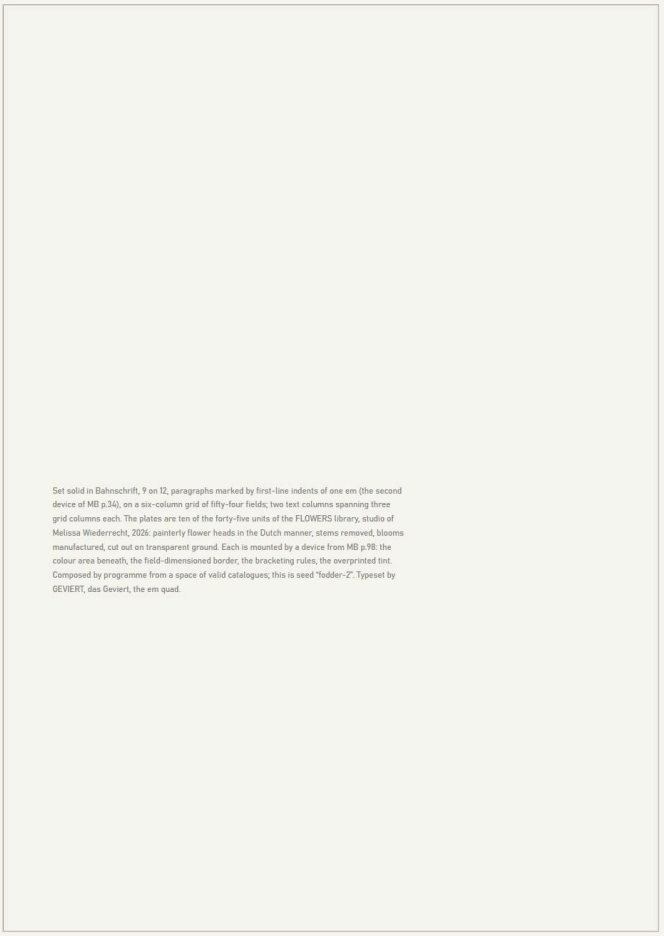
Four devices from the grid manual, demonstrated on their own illustrations.

A cut-out has no edges, and that is its problem. A photograph that fills a rectangle is tied into the grid by its own boundary; every side agrees with a field line, and the page holds it. A silhouetted flower touches the grid nowhere. Left alone on the page it floats, optically unmoored, related to nothing, which is precisely the fault the grid exists to prevent. Müller-Brockmann, writing about industrial advertising, prescribed the remedies, and every picture in this chapter is taking its own medicine.

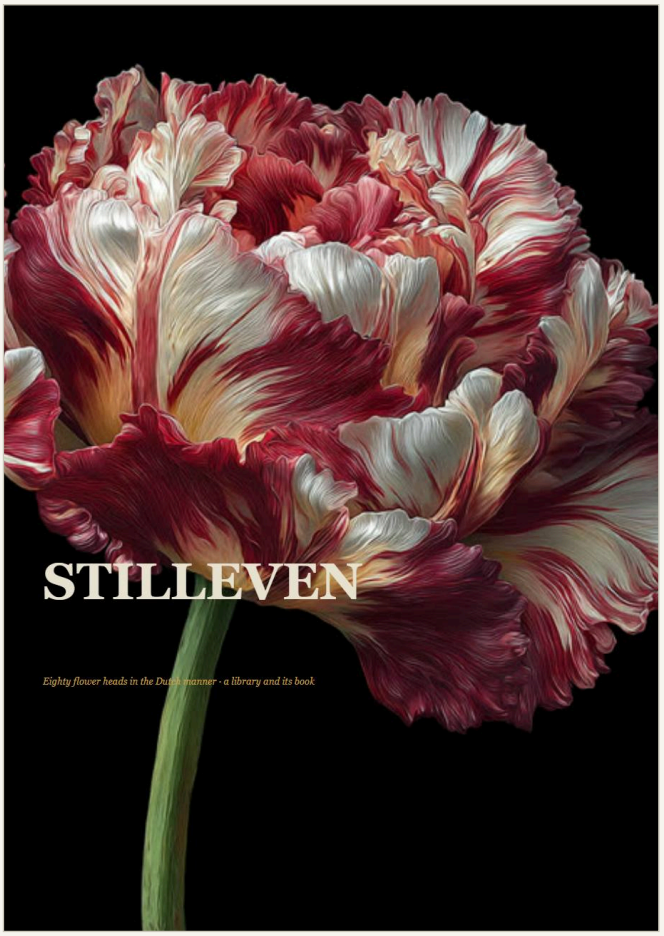
The first device is the one under most of the plates in this catalogue: an area of colour laid beneath the cut-out, sized exactly to grid fields. The colour area has edges where the flower has none, so the field takes hold of the colour and the colour takes hold of the flower, which is, in his words, firmly tied into the grid and aligned with it in depth and on the sides (Plate 7). The second is the line border drawn to the field's own dimensions, a drawn edge where no photographic edge exists. The third brackets the field with rules above and below, a shelf for the part to sit on (Plate 2 sits on one). The fourth is the loudest: an area of colour printed over the photograph itself, to make it stand out and look dominant (Plate 8). He adds, with the economy of a man pricing a print run, that where four-colour reproduction is too dear, a solid tint is the next best solution. The catalogue register again: even the aesthetics come with a cost column.

Notice what all four devices have in common. None of them touches the flower. The surgery of chapter two changed the part; these change only its mounting. That distinction is the whole discipline of the grid in one small lesson: the page does not ask its contents to deform, it builds them a fixture, and the fixture is what aligns (Plate 9).

bloom/fodder-05.svg · seed fodder-2



bloom/fodder-07.svg · seed fodder-2



book/book-00.svg · seed stilleven-essay-1

The flowers in this book do not exist. Neither did the flowers in the bouquets of the Dutch Golden Age. When Ambrosius Bosschaert arranged tulips beside roses beside fritillaries in a single vase, he painted an impossibility: those blooms never open in the same month, and no table in Middelburg ever held them together. The bouquet was assembled in the studio, flower by flower, from studies made in different seasons — a composite of attentions, not a record of an afternoon. The painting of flowers was, from the beginning, a generative practice (Plate 1). The tradition kept its conventions close. The ground is black or near-black, so that each petal carries its own light. The light itself is patient and comes

Plate 1 — The impossible bouquet begins with one head.

from the left. Every head is rendered at the peak of its particular bloom, even though the peak of one is the decay of another. Rachel Ruysch, who painted into her eighties, would hold a finished spray of blossom in suspension against the dark for weeks of working time; Jan van Huysum guarded his methods so jealously that he let no visitor into the studio while the dew drops dried (Plate 2). A tulip in 1637 could cost more than a canal house, and the paintings knew it. The striped and feathered petals that commanded those prices — the breaks, the flames — were the work of a virus nobody had named. The most valuable patterns were symptoms. It is hard to imagine a better parable for generative art: the collectors paid for the algorithm gone wrong, for the rare seed, for the output that could not be commanded twice (Plate 3). The eighty flower heads gathered here were painted in that tradition by a different kind of studio. Each was grown from a text prompt asking for a single head in the Dutch floral manner, isolated on black, and each came out carrying the conventions honestly: the leftward light, the black ground, the bloom at its peak (Plate 4). They were never meant to hang alone. Like Bosschaert's studies, they are stock for future bouquets — building blocks for

book/book-01.svg · seed stilleven-essay-1

Plate 4 — A prompt in the Dutch floral manner.

composited works, for grids and waves and mandalas and kaleidoscopes not yet made (Plate 5). Every head in the library has been taken further. The stems were removed and the grounds flattened to true black, so that each flower floats free and can be placed against anything (Plate 6).

Plate 2 — Patient light, from the left, against the dark.

For every open bloom, a closed bud was regenerated in the same palette and the same light — a beginning invented for an ending that already existed (Plate 7). Between bud and bloom, motion was interpolated: each flower in the library opens, on a transparent ground, in a loop that can be composed like a note of music (Plate 8). What the seventeenth century did with pigment and patience — hold every flower at its best hour forever — the library does with video. But the deeper kinship is in the method. The Dutch painters kept books of studies and assembled impossible bouquets from them on demand. A library of eighty blooming heads is exactly such a book of studies, waiting for its arrangements (Plate 9). The arrangements will be many, because the parts were made to recombine: the same rose can anchor a mandala, drift in a wave, or multiply into a kaleidoscope without being repainted (Plate 10). The pages of this book were not laid out by hand. A grid was chosen, a type system, a handful of permitted plate sizes; the text was written with its plates anchored in place, and a programme composed every page — placing each flower as near its mention as the fields allow, flowing the text around it column by column, mirroring the margins page by page,

Plate 3 — The break in the petal: the algorithm gone wrong.

book/book-02.svg · seed stilleven-essay-1

counting the folios. Instead of solutions for problems, programmes for solutions (Plate 11). It is right that it should end with a single head against the dark, the way the tradition began: one flower, one light, one long attention. The rest — the bouquets, the seasons that never met, the arrangements still to come — is composition (Plate 12).

Plate 5 — Stock for bouquets not yet made.

Plate 7 — A bud invented for a bloom that already existed.

book/book-03.svg · seed stilleven-essay-1

Plate 6 — Stem removed, ground flattened to true black.

book/book-04.svg · seed stilleven-essay-1

Plate 8 — Between bud and bloom, motion.

Plate 9 — A book of studies, waiting for arrangements.

6

book/book-05.svg · seed stilleven-essay-1

Plate 10 — Made to recombine.

Plate 12 — One flower, one light, one long attention.

7

book/book-06.svg · seed stilleven-essay-1

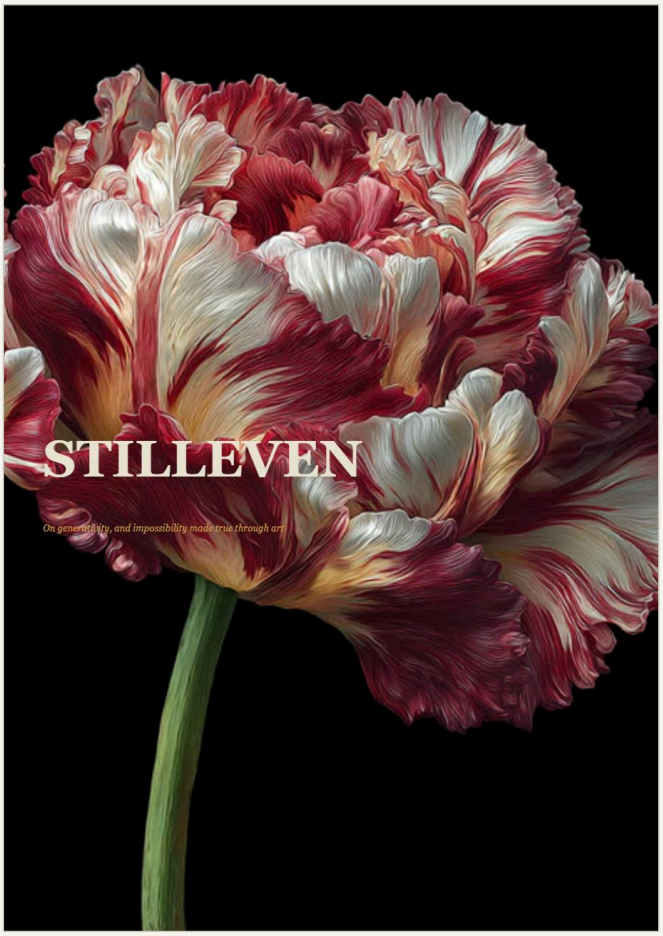
Plate 11 — Programmes for solutions.

8

book/book-07.svg · seed stilleven-essay-1

Set in Georgia, 10 on 13, on a two-column grid of twelve fields with mirrored margins, composed entirely by programme: figures placed by their anchors, text flowed by whole lines, folios on the fore edge. Typeset by GEVIERT — das Geviert, the em quad — seed "stilleven-1". Flowers from the studio library of Melissa Wiederrecht, 2026.

book/book-08.svg · seed stilleven-essay-1



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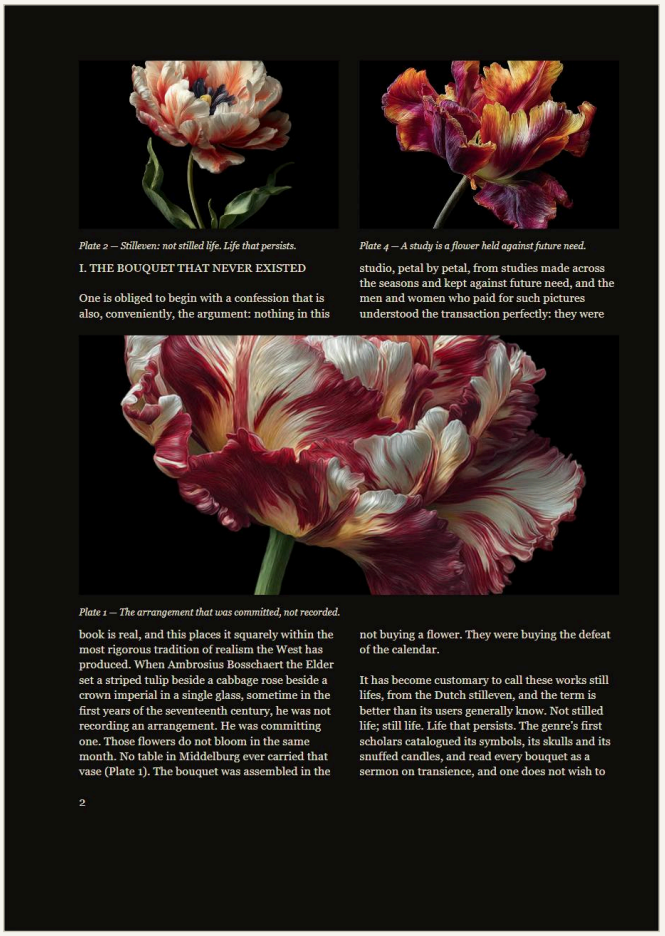

Plate 2 — Stilleven: not stilled life. Life that persists.

Plate 4 — A study is a flower held against future need.

I. THE BOUQUET THAT NEVER EXISTED

One is obliged to begin with a confession that is also, conveniently, the argument: nothing in this book is real, and this places it squarely within the most rigorous tradition of realism the West has produced. When Ambrosius Bosschaert the Elder set a striped tulip beside a cabbage rose beside a crown imperial in a single glass, sometime in the first years of the seventeenth century, he was not recording an arrangement. He was committing one. Those flowers do not bloom in the same month. No table in Middelburg ever carried that vase (Plate 1). The bouquet was assembled in the studio, petal by petal, from studies made across the seasons and kept against future need, and the men and women who paid for such pictures understood the transaction perfectly: they were not buying a flower. They were buying the defeat of the calendar.

Plate 1 — The arrangement that was committed, not recorded.

It has become customary to call these works still lifes, from the Dutch stilleven, and the term is better than its users generally know. Not stilled life; still life. Life that persists. The genre's first scholars catalogued its symbols, its skulls and its snuffed candles, and read every bouquet as a sermon on transience, and one does not wish to

2

book/essay-01.svg · seed stilleven-essay-1

be unkind to the iconographers, who were doing their best (Plate 2). But the pictures themselves argue the opposite. Every one of them is a machine for refusing transience. The tulip of April and the rose of June stand together in a perpetual

Plate 3 — An impossibility, rendered with conviction.

season that exists nowhere on the calendar and everywhere on the canvas, and the water in the glass never clouds. To have seen such a picture in 1620 was to have seen an impossibility rendered

Plate 5 — A library, a system of rules, an act of selection.

with more conviction than most painters could bring to the possible (Plate 3).

The method deserves closer attention than it usually receives, because the method is the point. The painter kept a library. Studies of single blossoms, drawn or painted from life in the weeks they could be had, were held in books and

Plate 6 — The eighteenth century discovers the dark.

portfolios for years and consulted like scripture; a tulip observed in one decade reappears, petal for petal, in bouquets painted in the next (Plate 4). The composition was a selection from this stock, governed by rules that were nowhere written down and everywhere obeyed: the light patient and from the left, every head at the exact crisis of its bloom, the tall imperials crowning, the roses ballasting the base, the whole pyramid consenting to an order that no gardener has ever been able to impose on actual stems. A library of parts. A system of rules. An act of selection. The reader is invited to notice that this is a complete description of a generative system, and that it was in productive operation on the Zeeland coast four hundred years before anyone thought to call it one (Plate 5).

The economics of the arrangement confirm what the method implies. A flower painting was, by the standards of the objects it depicted, cheap; in the feverish years a good picture of tulips could cost

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less than one of the tulips, a fact that has amused every commentator who has ever repeated it and instructed almost none of them. Consider what was actually for sale. The bulb offered one season's performance, weather permitting,

II. FLOWERS HELD OUTSIDE TIME

The ground behind these flowers deserves its own chapter in the history of ideas, and has generally received a paragraph. Bosschaert's generation set

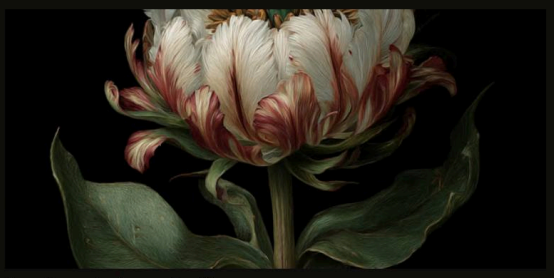

Plate 7 — To remove time, first remove the world.

followed by the usual descent into foliage. The painting offered the performance in perpetuity, weather irrelevant, at the exact peak, in the best light the Netherlands had ever manufactured. The

Plate 10 — Preservation by translation into a system.

market, given a choice between the flower and the render, priced the render lower and should not have. Time has since executed the correction, and we will come to it.

its bouquets against daylight: pale niches, arched windows opening onto polite Flemish distances. It was the following century that discovered the dark (Plate 6). In the mature manner of Rachel

Plate 8 — Ruysch signed her age, 83, beneath the flowers.

Ruysch the ground goes to a blackness that is not the absence of setting but the removal of the world, and each petal carries its own light into it, the way a thing remembered carries its own light

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Plate 9 — Van Huysum locked the studio against his brothers.

into the middle of the night. The flowers in this book are painted on that blackness, and belong therefore to her strain of the tradition, the severe strain, the one that understood that if you wish to hold something outside of time you must first take the time out of the picture (Plate 7).

Ruysch knew more than most about holding things outside of time; she had grown up inside the problem. Her father, Frederik Ruysch, was the most celebrated anatomist in Europe, famous for preparations that kept the perishable in a state of permanent presentability, and his daughter arranged flowers in his cabinets of preserved wonders before she ever signed a canvas. One does not wish to overwork the inheritance, but one notices it. She painted for more than six decades and signed her age, eighty-three, under the flowers she finished in 1747, an inscription that reads less like a date than like a boast, and was entitled to be one (Plate 8). Her contemporary Jan van Huysum, the other summit of the late manner, guarded his procedures like a man who believed method itself was property: he painted alone, locked the studio against his own brothers, accepted in his whole life a single pupil, and drove her out when her work grew good enough to frighten him. Art historians report this with disapproval. Every generative artist who has ever declined to publish a seed will read it with a flicker of fellow feeling (Plate 9).

What the secrecy protected was not a trick but a discipline: the patience to build a flower out of glazes the way the flower had built itself out of days. And here the tradition's deepest habit comes into view. The study held the bloom outside its season. The dark ground held it outside its room. The glaze held it outside its hour. At every scale the practice is the same practice, the preservation of the perishable by translation into a system that does not perish (Plate 10). The anatomist did it with spirits and wax, the daughter with oil, and the difference between them is smaller than the difference between either and doing nothing, which is what time proposes.

It is worth pausing on what the studies were not. They were not sketches, in the modern, forgiving sense; they were specifications. A tulip study recorded the number of petals, the exact syntax of the break, the particular candor of that bloom on that morning, at a resolution sufficient for the flower to be reconstructed decades later by a hand that had never seen it. The portfolio was, to say it plainly, a format. It could be inherited; sons and workshop assistants painted their fathers' tulips long after the originals had composted, and the Bosschaert dynasty ran on exactly this inheritance, three sons and a brother-in-law compositing from the family stock like a studio sharing an asset library, because that is what they were. When the same anemone appears in two bouquets twenty years apart, art history calls it workshop practice. An engineer would call it a dependency, and both would be right.

One should also say a word for the vase, the least regarded and most instructive object in the genre. It is the constraint. Everything else in the picture is free, impossibly free, seasonally free, and the vase is the one thing that must be obeyed: the stems must enter it, the pyramid must rise from it, the weight must balance over it. The masters

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Plate 15 — The type specimen of its own kind.

and the interruption is what the connoisseurs prized. No grower could command the break. It arrived, or it did not, in patterns that could not be repeated, and the rarest patterns commanded the

Plate 14 — Extinct in the ground; permanent in paint.

greatest prices. Nobody would isolate the cause for nearly three centuries; the mechanism was finally identified in the 1920s. The collectors of the Golden Age were bidding, without knowing it, on the outputs of a random process running inside their merchandise (Plate 12).

One tries to say this carefully, because it sounds like wit and is in fact history: tulipomania was a market in generative art. The bulb was the algorithm. The virus was the seed. The bloom was the output, unrepeatable, authenticated by its own strangeness, and priced according to the improbability of its pattern. The Dutch, who are supposed to have invented modern finance in the same half century, had also invented the economics of the rare output, and they did it while believing they were buying flowers (Plate 13). And the parable has a second act, which is the one this book exists to tell. The virus that painted the Semper Augustus also weakened it. Each daughter bulb carried the infection deeper; the line sickened generation by generation, in inverse proportion to its beauty, and at some point in the eighteenth century it failed to come up at all. The most valuable flower in recorded history is extinct. It survives in exactly one form: in the paintings (Plate 14). The impossible bouquet turned out to be the durable one. The image did not merely outlast the flower; the image is now the flower, the sole remaining instance, the type specimen of its own kind. Whoever wishes to see

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the reader of the first chapter has already seen. The prompt is the commission. The model is the portfolio, trained on the tradition's whole surviving stock the way an apprentice was trained, by copying. The output is a study: one

Plate 19 — Bloom, held at its best hour, indefinitely.

head, one light, held against future need. Eighty of them together are not eighty pictures. They are a library, and a library is a claim about the future. It says: arrangements will be required (Plate 17).

Plate 20 — Stock, awaiting arrangement.

The library has since been taken further than the seventeenth century could take its portfolios, and in precisely the direction the seventeenth century was straining toward. Every head has been separated from its stem and its ground, so that it floats, placeable against anything, a study in the pure state (Plate 18). For every open bloom a closed bud has been made in the same palette and the same light, which is to say: the flower has

Plate 18 — The study in its pure state.

been given a past it never had, a beginning invented to suit an ending that already existed, and if that operation strikes the reader as illegitimate, the reader is reminded that Bosschaert gave his tulips whole seasons they never had, and is honored for it. Between the invented bud and the actual bloom, the opening itself has been interpolated, so that each flower in

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the library performs its own becoming, on a transparent ground, in a loop. Van Huysum spent summers in Haarlem waiting for particular flowers to open. The library does not wait. It holds bloom the way Frederik Ruysch held tissue: indefinitely, and at its best hour (Plate 19).

V. COMPOSITION

It remains to say what the flowers are for, and the tradition has already answered: they are stock. The studies existed for the bouquets. The library exists for the arrangements, the grids and waves and mandalas and kaleidoscopes into which these heads will be composed, each arrangement a bouquet in the strict Bosschaert sense, an assembly of parts that never shared a season, made true by composition. The impossible bouquet was never a genre. It was a procedure, and the procedure is portable (Plate 20).

This book is the procedure's most recent output, and the reader is entitled to know that it practiced what it printed. No hand drew these pages. A grid was chosen, in the Swiss manner, two columns and twelve fields with the margins mirrored page against page; a system of type was locked to a module so that every size keeps the same register; the plates were graded to a few permitted sizes, because the fewer the differences in the size of the illustrations, the quieter the impression created by the design; and the essay was written with its plates anchored in the text, each one instructed to stand as near its mention as the fields would permit. Then a programme composed every page, flowing the words around the flowers by whole lines, mirroring, counting. Instead of solutions for problems, said Karl Gerstner, in 1964, in the sentence this book's typesetter regards as scripture: programmes for solutions. Change one word of the seed and every page rearranges, correct again, different again, another bouquet from the same stock. The edition in your hands is one selection from a space of valid books, and it does not mind telling you so; the Semper Augustus never minded being a symptom.

So the argument closes where the tradition opened, on a single head against the dark, one light, one long attention. Painting held the flower outside its season. The library holds it outside its death. Composition, now as in Middelburg, makes the impossible arrangement and then makes it again, and what survives of any of it, bulb, bouquet, book, is the generated thing: the image that could not exist, and therefore had to be made, and therefore remains. The rest is composition.

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Set in Georgia, 10 on 13, on a two-column grid of twelve fields with mirrored margins and folios on the fore edge, composed entirely by programme from a space of valid books; this is seed "stilleven-essay-1". Twenty plates from a library of eighty flower heads in the Dutch manner, studio of Melissa Wiederrecht, 2026. Typeset by GEVIERT, das Geviert, the em quad. The bouquet that never existed is the only one that still does.

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Plate 19 — Bloom, held at its best hour, indefinitely.

12

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Plate 20 — Stock, awaiting arrangement.

13

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Set in Georgia, 10 on 13, on a two-column grid of twelve fields with mirrored margins and folios on the fore edge, composed entirely by programme from a space of valid books; this is seed "stilleven-essay-1". Twenty plates from a library of eighty flower heads in the Dutch manner, studio of Melissa Wiederrecht, 2026. Typeset by GEVIERT, das Geviert, the em quad. The bouquet that never existed is the only one that still does.

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STILLEVEN

On generativity, and impossibility made true through art

Second edition · seed stilleven-5×7 · twenty plates

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I. THE BOUQUET THAT NEVER EXISTED

One is obliged to begin with a confession that is also, conveniently, the argument: nothing in this book is real, and this places it squarely within the most rigorous tradition of realism the West has produced. When Ambrosius Bosschaert the Elder set a striped tulip beside a cabbage rose beside a crown imperial in a single glass, sometime in the first years of the seventeenth century, he was not recording an arrangement. He was committing one. Those flowers do not bloom in the same month. No table in Middelburg ever carried that vase (Plate 1). The bouquet was assembled in the studio, petal by petal, from studies made across the seasons and kept against future need, and the men and women who paid for such pictures understood the transaction perfectly: they were not buying a flower. They were buying the defeat of the calendar.

It has become customary to call these works still lifes, from the Dutch stilleven, and the term is better than its users generally know. Not stilled life; still life. Life that persists. The genre's first scholars catalogued its symbols, its skulls and its snuffed candles, and read every bouquet as a sermon on transience, and one does not wish to be unkind to the iconographers, who were doing their best (Plate 2). But the pictures themselves argue the opposite. Every one of them is a machine for refusing transience. The tulip of April and the rose of June stand together in a perpetual season that exists nowhere on the calendar and everywhere on the canvas, and the water in the glass never clouds.

Plate 1 — The arrangement that was committed, not recorded.

Plate 2 — Stilleven: not stilled life. Life that persists.

Plate 3 — An impossibility, rendered with conviction.

2

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To have seen such a picture in 1620 was to have seen an impossibility rendered with more conviction than most painters could bring to the possible (Plate 3).

The method deserves closer attention than it usually receives, because the method is the point. The painter

Plate 4 — A study, a flower held against future need.

kept a library. Studies of single blossoms, drawn or painted from life in the weeks they could be had, were held in books and portfolios for years and consulted like scripture; a tulip observed in one decade reappears, petal for petal, in bouquets painted in the next (Plate 4). The composition was a selection from this stock, governed by rules that were nowhere written down and everywhere obeyed: the light patient and from the left, every head at the exact crisis of its bloom, the tall imperials crowning, the roses ballasting the base, the whole pyramid consenting to an order

Plate 5 — A library, a system of rules, an act of selection.

that no gardener has ever been able to impose on actual stems. A library of parts. A system of rules. An act of selection. The reader is invited to notice that this is a complete description of a generative system, and that it was in productive operation on the Zeeland coast four hundred years before anyone thought to call it one (Plate 5).

The economics of the arrangement confirm what the method implies. A flower painting was, by the standards of the objects it depicted, cheap; in the

Plate 6 — The eighteenth century discovers the dark.

feverish years a good picture of tulips could cost less than one of the tulips, a fact that has amused every commentator who has ever repeated it and instructed almost none of them. Consider what was actually for sale. The bulb offered one season's performance,

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Plate 8 — Ruysch signed her age, 83, beneath the flowers.

Plate 7 — To remove time, first remove the world.

Plate 9 — Van Huysum locked the studio against his brothers.

weather permitting, followed by the usual descent into foliage. The painting offered the performance in perpetuity, weather irrelevant, at the exact peak, in the best light the Netherlands had ever manufactured. The market, given a choice between the flower and the render, priced the render lower and should not have. Time has since executed the correction, and we will come to it.

II. FLOWERS HELD OUTSIDE TIME

The ground behind these flowers deserves its own chapter in the history of ideas, and has generally received a paragraph. Bosschaert's generation set its bouquets against daylight: pale niches, arched windows opening onto polite Flemish distances. It was the following century that discovered the dark (Plate 6). In the mature manner of Rachel Ruysch the ground goes to a blackness that is not the absence of setting but the removal of the world, and each petal carries its own light into it, the way a thing remembered carries its own light into the middle of the night. The flowers in this book are painted on that blackness, and belong therefore to her strain of the tradition, the severe strain, the one that understood that if you wish to hold something outside of time you must first take the time out of the picture (Plate 7).

Ruysch knew more than most about holding things outside of time; she had grown up inside the problem. Her father, Frederik Ruysch, was the most celebrated anatomist in Europe, famous for preparations that kept the perishable in a state of permanent presentability,

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III. THE BEAUTIFUL ERROR

In the winter of 1637 a single bulb of the tulip called Semper Augustus, white, with flames of carmine broken across every petal as if the flower had been scribbled on by an inspired hand, was priced at ten thousand guilders, a figure contemporaries compared to the cost of a fine house on an Amsterdam canal (Plate 11). The economic historians, killjoys by profession, have since audited the mania and found the ledgers thinner than the legend; fewer such sales were consummated than the moralists claimed. The correction is noted and does not touch the essential fact, which is stranger than the legend and much more useful. The flames on those petals were symptoms. A virus, moving from bulb to bulb on the mouthparts of aphids, was interrupting the flower's production of pigment, and the interruption is what the connoisseurs prized. No grower could command the break. It arrived, or it did not, in patterns that could not be repeated, and the rarest patterns commanded the greatest prices. Nobody would isolate the cause for nearly three centuries; the mechanism was finally identified in the 1920s. The collectors of the Golden Age were bidding, without knowing it, on the outputs of a random process running inside their merchandise (Plate 12).

Plate 11 — Priced against a house on the Herengracht.

Plate 12 — The pattern was a symptom; the symptom was the value.

Plate 13 — A market in unrepeatable outputs, 1637.

One tries to say this carefully, because it sounds like wit and is in fact history: tulipomania was a market in generative art. The bulb was the algorithm. The virus was the seed. The bloom was the output, unrepeatable, authenticated by its own strangeness, and priced according to the improbability of its pattern. The Dutch, who are supposed to have invented modern finance in the same half century, had also invented the economics of the rare output, and they did it while believing they were buying flowers (Plate 13). And the parable has a second act, which is the one this book exists to tell. The virus that painted the Semper Augustus also weakened it. Each daughter bulb carried the infection deeper; the line sickened generation by generation, in inverse proportion to its beauty, and at some point in the eighteenth century it failed to come up at all. The most valuable flower in recorded history is extinct. It survives in exactly one form: in the paintings (Plate 14). The impossible bouquet turned out to be the durable one. The image did not merely outlast the flower; the image is now the flower, the sole remaining instance, the type specimen of its own kind. Whoever wishes to see a Semper Augustus must go and look at art. This is what is meant, in this book, by impossibility made true: the picture began as the one thing that could not exist and ended as the only thing that does (Plate 15).

Plate 14 — Extinct in the ground, permanent in paint.

Plate 15 — The type specimen of its own kind.

The mechanism deserves its dates, because the dates are the joke. The break was prized by 1620, priced by 1637, and explained in 1928, when Dorothy Cayley at the John Innes Institution demonstrated that the patterning traveled with transferred tissue and named the culprit a virus; three centuries of connoisseurship had been, unknowingly, virology conducted at auction. And the aesthetics survived the diagnosis intact, which is the part the moralists never predict. Knowing the flame is a symptom subtracts nothing from the flame. The Rembrandt tulips sold today are stable imitations, bred to counterfeit the disease without carrying it, the way a print reproduces a brushstroke: the market for the beautiful error outlived the error, outlived the mania, outlived the moral. Beauty is indifferent to the respectability of its causes, and the seventeenth century, to its credit, never pretended otherwise.

There is a temptation, having said all this, to declare the Dutch prophets and stop, and the temptation should be resisted, because the resemblance runs the other way. They were not anticipating generative art. They were doing it, fully, with the only processor then available, which was a trained hand executing a system held in a portfolio and a skull. What has changed since is not the method but the substrate: the library has moved from paper to weights, the selection from the

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wrist to the seed, the rules from the guild to the constraint file. The act, assembly of the impossible from a stock of the held, is identical, and it is identical because it is the only act that has ever produced a still life. To paint a flower that outlasts the flower is already to have conceded that the image is the durable form

Plate 16 — Commissioned in words, delivered in convention.

and the organism the fugitive one. Everything after that concession is engineering.

IV. THE LIBRARY

The eighty flower heads gathered in these pages were painted in the tradition's manner by an instrument the tradition did not foresee, though it would have recognized the commission instantly. Each was asked

Plate 17 — A library is a claim about the future.

for in words, a single head in the Dutch floral style, isolated against black, and each arrived carrying the conventions like a passport: the leftward light, the crisis of bloom, the dark that removes the world (Plate 16). It is no longer interesting to be scandalized by this, and it was never interesting to be triumphant about it. What is interesting is the shape of the practice, which the reader of the first chapter has already seen. The prompt is the commission. The model is the portfolio, trained on the tradition's whole surviving stock the way an apprentice was trained, by copying. The output is a

Plate 18 — The study in its pure state.

study: one head, one light, held against future need. Eighty of them together are not eighty pictures. They are a library, and a library is a claim about the future. It says: arrangements will be required (Plate 17).

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The library has since been taken further than the seventeenth century could take its portfolios, and in precisely the direction the seventeenth century was straining toward. Every head has been separated from its stem and its ground, so that it floats, placeable against anything, a study in the pure state (Plate 18). For every open bloom a closed bud has been made in the same palette and the same light, which is to say: the flower has been given a past it never had, a beginning invented to suit an ending that already existed, and if that operation strikes the reader as illegitimate, the reader is reminded that Bosschaert gave his tulips whole seasons they never had, and is honored for it. Between the invented bud and the actual bloom, the opening itself has been interpolated, so that each flower in the library performs its own becoming, on a transparent ground, in a loop. Van Huysum spent summers in Haarlem waiting for particular flowers to open. The library does not wait. It holds bloom the way Frederik Ruysch held tissue: indefinitely, and at its best hour (Plate 19).

V. COMPOSITION

It remains to say what the flowers are for, and the tradition has already answered: they are stock. The studies existed for the bouquets. The library exists for the arrangements, the grids and waves and mandalas and kaleidoscopes into which these heads will be composed, each arrangement a bouquet in the strict Bosschaert sense, an assembly of parts that never shared a season, made true by composition. The

Plate 19 — Bloom, held at its best hour, indefinitely.

impossible bouquet was never a genre. It was a procedure, and the procedure is portable (Plate 20).

This book is the procedure's most recent output, and the reader is entitled to know that it practiced what it printed. No hand drew these pages. A grid was chosen, in the Swiss manner, two columns and twelve fields with the margins mirrored page against page; a system of type was locked to a module so that every size keeps the same register; the plates were graded to a few permitted sizes, because the fewer the differences in

Plate 20 — Stock, awaiting arrangement.

the size of the illustrations, the quieter the impression created by the design; and the essay was written with its plates anchored in the text, each one instructed to stand as near its mention as the fields would permit. Then a programme composed every page, flowing the

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words around the flowers by whole lines, mirroring, counting. Instead of solutions for problems, said Karl Gerstner, in 1964, in the sentence this book's typesetter regards as scripture: programmes for solutions. Change one word of the seed and every page rearranges, correct again, different again, another bouquet from the same stock. The edition in your hands is one selection from a space of valid books, and it does not mind telling you so; the Semper Augustus never minded being a symptom.

So the argument closes where the tradition opened, on a single head against the dark, one light, one long attention. Painting held the flower outside its season. The library holds it outside its death. Composition, now as in Middelburg, makes the impossible arrangement and then makes it again, and what survives of any of it, bulb, bouquet, book, is the generated thing: the image that could not exist, and therefore had to be made, and therefore remains. The rest is composition.

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Edition B. Set in Bahnschrift (DIN 1451), 9 on 15, with captions in Arial Narrow, 7 on 10, three of which stand to two lines of text: the register is kept on a thirty-point module. Six columns, four field rows, landscape, deep at the head and shallow at the tail; text runs three columns wide, plates one, two or three columns, each preferring the span nearest its own square proportion. Nothing here was placed by hand. The same essay, the same twenty plates, the same programme, a different constant set: seed 'stilleven-B-7'. Compare edition A and observe that neither is the original. Typeset by GEVIERT. Flowers from the studio library of Mariska Wiedemeijer, 2026.

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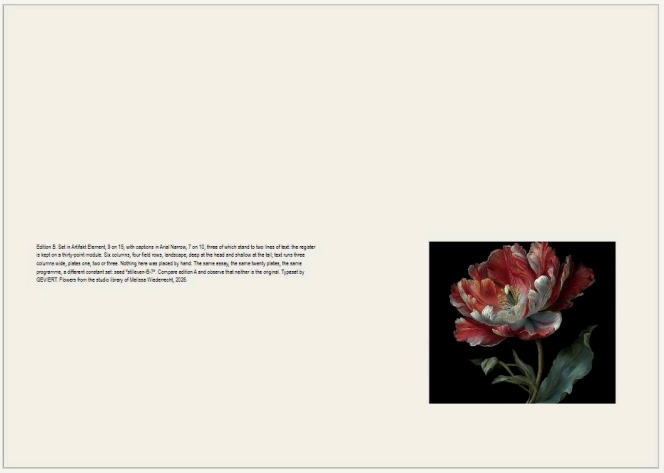

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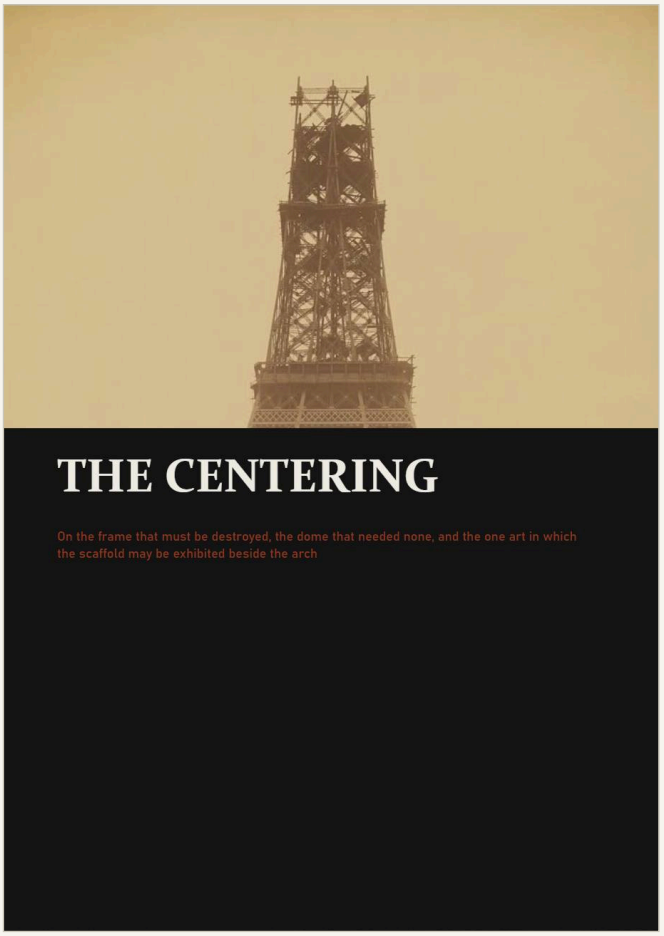

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I. THE FRAME THAT MUST BE DESTROYED

An arch, until its last stone is in place, has no strength at all. This is not a figure of speech; it is a

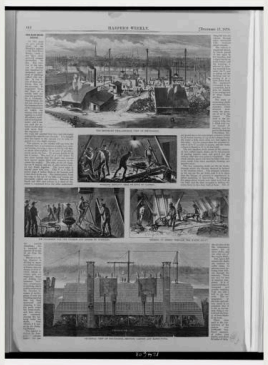

Plate 1 — Falsework: the timber frame of the East River caisson, built in order to be destroyed or buried. Harper's Weekly, 1870.

statement about masonry. Each voussoir in an unfinished arch is a wedge of stone in the act of falling, and it falls unless something holds it exactly where it will one day hold itself. That something is a temporary wooden frame, curved to the intended intrados, built by carpenters and destined for destruction. The trade calls it the centring, or the centering, and it is the most eloquent object in the history of building. Nobody visits it. It appears in no photograph of the finished bridge. It exists in order to be taken away (Plate 1).

The taking away has its own name, its own tools, and its own long argument. To strike the centering is to drive back the wedges beneath it, evenly, so that the frame descends by fractions of an inch and the arch, if it is an arch, silently accepts its own weight. The nineteenth-century manuals are unanimous only in their disagreement about when to do it. Some hold that the centre should be struck the moment the spandrels are filled; others that the mortar must be given weeks to harden. The dispute cannot be settled from outside, because both parties are describing the same intolerable condition: you cannot know whether the thing stands until you remove what is holding it, and you cannot put the frame back (Plate 2).

Here is the thesis of this essay, and it is not about masonry. Nothing stands, at first, by itself. Every made thing is held, while it becomes itself, by a structure that has no place in the finished thing. The whole art of making is the fate you choose for that structure: to strike it, to dissolve it into the work, to seal it inside, or to let it stand as the work. Everything else is craft, which is to say, everything else can be taught.

Plate 2 — The Washington Monument in its scaffold, mid-century: an unfinished shaft held by wood.

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Plate 4 — The statue under assembly. The scaffold outside will go; the skeleton inside will not.

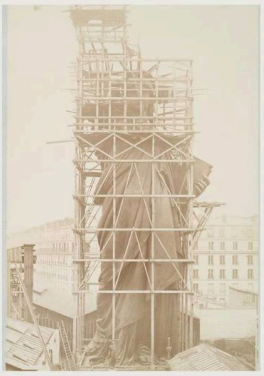

Plate 3 — Paris, 1882: the copper skin rising, plate by plate, on Eiffel's iron armature.

II. THE DOME THAT NEEDED NONE

In 1418 the wardens of the cathedral of Florence had a hole in their roof one hundred and fifty feet across and no idea how to close it. The vault they wanted could not be centred: no forest in Tuscany held timbers long enough to span it, and no scaffold rising from the cathedral floor could be trusted to carry a masonry heaven. Filippo Brunelleschi won the commission by promising the one thing nobody believed possible. He would build the dome without centering.

The reader will notice that this section of the book has no plate. There is no photograph of Brunelleschi's centring, and there is no engraving of it either, for the excellent reason that it never existed. What he built instead was a dome that supported itself at every instant of its own

Plate 5 — Falsework and figure, indistinguishable at this hour.

construction: two shells, one inside the other, tied by ribs, and between the ribs a herringbone brickwork in which each fresh course was pitched

centering/centering-02.svg · seed centering-modern

Plate 8 — A scaffold being scaffolded. When the timber came down, nothing changed.

Plate 6 — The head, exhibited in a Paris park before shipment: frame and skin visible at once.

so that its weight passed sideways into the vertical ribs rather than downward into empty air. The dome never leaned on anything but itself. It rose in closed rings, and every closed ring was already a compression structure complete in itself, a finished arch, so that at no hour did there exist an unfinished span requiring a frame. It remains the largest masonry dome ever raised.

One should be careful about the moral, because it is not the obvious one. Brunelleschi did not dispense with structure; he moved the structure inside the work, distributing it into the courses themselves, and paid for it in a complexity of method that he guarded so jealously that scholars are still reverse-engineering his brickwork today. The scaffold does not vanish when you build without one. It is dissolved into the thing, and the thing becomes harder to make in exactly the measure that it becomes free to stand. Any artist who has ever replaced a page of rules with a single sufficient idea knows this trade, and knows its price.

Plate 7 — The tower rising: a scaffold that carries only itself. Louis-Émile Durandelle, 1888.

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III. THE SCAFFOLD THAT STAYED

Now the third possibility, which the nineteenth century discovered almost absent-mindedly and then could not stop exploiting. In a workshop in Paris in the early 1880s a copper woman was assembled in pieces around an iron skeleton designed by Gustave Eiffel: a central pylon carrying a secondary armature of flat bars, so that the skin might ride on springs of iron and move in the wind without tearing (Plate 3). The skeleton was scaffolding of a kind, and it was never struck. It is inside her still (Plate 4). Visitors climb through the falsework of a national symbol and photograph it, believing they are looking at the inside of a statue, which they are (Plate 5).

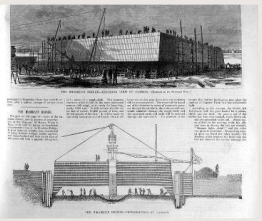

Plate 9 — The caisson driven into the mud, and buried beneath the tower it holds up.

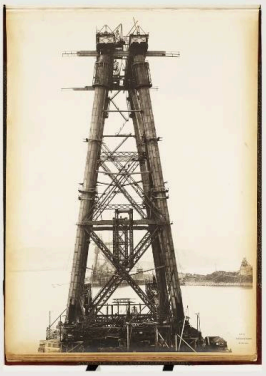

Plate 11 — An arm reaching for a partner not yet arrived.

Before she was shipped she was exhibited in pieces, and Paris queued to see a head sitting in a park, at the scale of a house, resting on a plinth of scaffold planks (Plate 6). It is the only moment in the statue's life when her frame and her skin were both visible at once, and the photographs of it are the most disquieting images in this book, because they show a monument in the condition every

Plate 10 — The Forth cantilevers: self-supporting at every stage, because no centring could be built in that estuary.

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monument is in before it is finished: held up by wood, indifferent to the crowd.

The same engineer then built, on the Champ de Mars, a structure that is nothing but its own falsework (Plate 7). The tower has no skin at all. It is a scaffold that carries only itself, erected around an absence, and Paris despised it in the manner reserved for jokes that turn out to be serious. Every photograph of its rising is a photograph of a scaffold being scaffolded: the timber falsework at the first platform holds up the iron, which holds up nothing (Plate 8). And when the timber came down, nothing changed. Nothing could change. There was no arch to release, only the frame, admitting at last that it had been the building all along.

Between these poles the whole history of engineering arranges itself. The caisson of the East River bridge was a pneumatic timber box driven into the mud, with men labouring inside it under compressed air; it was built to be buried, and it is buried still, holding up the tower it was designed to disappear beneath (Plate 9). The Forth Bridge, by contrast, exhibits its reasoning like an anatomical drawing (Plate 10). Its cantilever arms reach from each pier toward a partner not yet arrived, each arm balanced against its own weight, self-supporting at every stage of erection because no centring could ever have been built in that estuary (Plate 11). The bridge is spectacular because you can see the argument. It looks the way it looks on account of how it had to be made.

IV. THROW AWAY THE LADDER

The pattern is older than iron and wider than building. At the end of the Tractatus, Wittgenstein instructs the reader who has understood him to recognise his propositions as nonsense, and to throw away the ladder after having climbed up it. The ladder is centring. It carried the reader to a place from which the ladder is visibly unnecessary, and it could not have been dispensed with in advance. Mathematicians perform the same rite constantly and without comment: a construction is introduced, a result obtained, and the construction discarded because the result no longer needs it. The proof stands. The auxiliary circle is erased.

Painters underdraw and paint over. Sculptors build an armature of wire and pipe, pack clay upon it, and then, in casting, burn the whole interior away, so that the bronze which survives is a hollow record of a skin that once had bones. Composers write in a key they abandon. Novelists construct elaborate histories that appear in the finished book as one confident sentence, and the sentence is confident because the history was built. In every case the same law holds: the removed structure is not waste. Its removal is what the finished thing is made of. The arch is the shape of the frame that is gone.

Typography has been rigorous about this for a century. On any page set in the Swiss manner there exists a grid — columns, field rows, a baseline lattice on which every line of type and every edge of every picture is obliged to sit. It governs absolutely and it prints not at all. Müller-Brockmann drew his in red so that it could be seen in the studio, and the red vanishes in the press. The page you are holding was composed on such a grid, by a programme, with no hand upon it; its centring is exact and invisible, and if you cannot see it, that is not a failure of the design. That is the design succeeding.

V. THE CENTERING EXHIBITED

And now the turn. Everything above assumes the frame must go, or hide, or become the work by accident. But there is a fourth possibility, very recent, belonging to a kind of artist who did not exist in Brunelleschi's Florence. When the work is

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generated, the centring is a programme, and a programme can be published.

This is a genuinely new position in the history of making. A generative artist writes the system that produces the image. The system holds every output while it becomes itself, exactly as the wooden frame holds the voussoirs; and exactly as the frame does not appear in the arch, the code does not appear in the print. She may strike it: hang the output, discard the process, let the collector believe in the arch. She may seal it inside, as Eiffel sealed his armature, publishing a hash and a token and the promise that a structure is in there somewhere. Or she may do the thing no mason and no novelist could ever do — exhibit the centring beside the arch, and invite the audience to watch the wedges being driven back.

The interesting claim is not that this is more honest. Honesty is cheap and the arch does not care. The interesting claim is that when the frame is exhibited the work stops being the output and becomes the pair: the system, and what it holds. The audience is no longer looking at a stone span. They are looking at the argument that a stone span was possible, together with its demonstration. And the demonstration can be re-run, with another seed, producing another arch, correct in the same way and different in every particular — which is to say that the exhibited centring is not documentation of a work. It is a work whose outputs are unlimited, and each output is a proof.

So the fate of the frame is the choice that constitutes the art. Strike it and you get mystery: the thing stands and nobody living knows why. Dissolve it into the work and you get mastery: the thing stands and could not have been made otherwise. Seal it inside and you get monument: the thing stands upon a hidden reason. Exhibit it and you get something for which there is no old name — call it a programme — in which the standing and the reason are shown as one object, and the audience is trusted with the wedges.

The masons had a sentence for the hour when the frame comes down, and they said it the way people say things that have killed their colleagues. They said the arch had been struck. Not built, not finished, not blessed. Struck: as though the removal were the making, which of course it is, because until you take the frame away you have a pile of stones resting on timber, and after you take it away you have an arch, and nothing whatever has been added (Plate 12). The keystone does not

Plate 12 — Setting the capstone. Nothing is added; the frame is merely permitted to come down.

hold the arch. It only permits the frame to be taken away.

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COLOPHON

Set in Constantia, 10 on 13, with captions in Bahnschrift, on a grid of eight columns and nine field rows; the text runs two columns wide, the plates one column or the full measure, each choosing the depth nearest its own proportion. Margins mirror; folios stand on the fore edge. Composed entirely by programme, seed "centering-1", from a space of valid books. No page was laid out by hand. Typeset by GEVIERT — das Geviert, the em quad — the library whose grid holds this page and prints on none of it.

Plates, all public domain, from Wikimedia Commons. 1, 9 — the East River (Brooklyn) Bridge caisson, Harper's Weekly and the American Cyclopædia, 1870. 2, 12 — the Washington Monument: scaffolded shaft (Robert N. Dennis stereoscopic collection) and the setting of the capstone, c. 1884 (Alexander Millar). 3–6 — the Statue of Liberty under assembly in Paris, 1882–83, and the head exhibited before shipment (Albert Fernique and unknown photographers). 7–8 — the Eiffel Tower under construction, 1888 (Louis-Émile Durandelle; unknown photographer). 10–11 — the Forth Bridge cantilevers under erection (Philip Phillips). Section II carries no plate: there is no picture of Brunelleschi's centring, because there was none.

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Plate 4 — The statue under assembly. The scaffold outside will go; the skeleton inside will not.

Plate 3 — Paris, 1882: the copper skin rising, plate by plate, on Eiffel's iron armature.

II. THE DOME THAT NEEDED NONE

In 1418 the wardens of the cathedral of Florence had a hole in their roof one hundred and fifty feet across and no idea how to close it. The vault they wanted could not be centred: no forest in Tuscany held timbers long enough to span it, and no scaffold rising from the cathedral floor could be trusted to carry a masonry heaven. Filippo Brunelleschi won the commission by promising the one thing nobody believed possible. He would build the dome without centering.

Plate 5 — Falsework and figure, indistinguishable at this hour.

The reader will notice that this section of the book has no plate. There is no photograph of Brunelleschi's centring, and there is no engraving of it either, for the excellent reason that it never existed. What he built instead was a dome that supported itself at every instant of its own construction: two shells, one inside the other, tied by ribs, and between the ribs a herringbone brickwork in which each fresh course was pitched

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THE CENTERING

On the frame that must be destroyed, the dome that needed none, and the one art in which the scaffold may be exhibited beside the arch.

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Plate 1 — Falsework: the timber frame of the East River caisson, built in order to be destroyed or buried. Harper's Weekly, 1870.

I. THE FRAME THAT MUST BE DESTROYED

An arch, until its last stone is in place, has no strength at all. This is not a figure of speech; it is a statement about masonry. Each voussoir in an unfinished arch is a wedge of stone in the act of falling, and it falls unless something holds it exactly where it will one day hold itself. That something is a temporary wooden frame, curved to the intended intrados, built by carpenters and destined for destruction. The trade calls it the centring, or the centering, and it is the most eloquent object in the history of building. Nobody visits it. It appears in no photograph of the finished bridge. It exists in order to be taken away (Plate 1).

The taking away has its own name, its own tools, and its own long argument. To strike the centering is to drive back the wedges beneath it,

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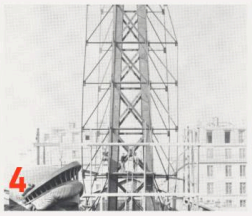

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Plate 6 — The head, exhibited in a Paris park before shipment: frame and skin visible at once.

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Plate 7 — The tower rising: a scaffold that carries only itself. Louis-Émile Durandelle, 1888.

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designed by Gustave Eiffel: a central pylon carrying a secondary armature of flat bars, so that the skin might ride on springs of iron and move in the wind without tearing (Plate 3). The skeleton was scaffolding of a kind, and it was never struck. It is inside her still (Plate 4). Visitors climb through the falsework of a national symbol and photograph it, believing they are looking at the inside of a statue, which they are (Plate 5).

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Plate 10 — The Forth cantilevers: self-supporting at every stage, because no centring could be built in that estuary.

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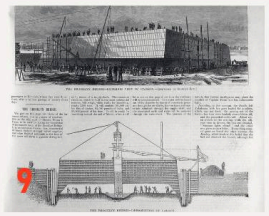

Plate 9 — The caisson driven into the mud, and buried beneath the tower it holds up.

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This is a genuinely new position in the history of making. A generative artist writes the system that produces the image. The system holds every output while it becomes itself, exactly as the wooden frame holds the voussoirs; and exactly as the frame does not appear in the arch, the code does not appear in the print. She may strike it: hang the output, discard the process, let the collector believe in the arch. She may seal it inside, as Eiffel sealed his armature, publishing a

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Plate 12 — Setting the capstone. Nothing is added; the frame is merely permitted to come down.

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COLOPHON

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Plates, all public domain, from Wikimedia Commons. 1, 9 — the East River (Brooklyn) Bridge caisson, Harper's Weekly and the American Cyclopædia, 1870. 2, 12 — the Washington Monument: scaffolded shaft (Robert N. Dennis stereoscopic collection) and the setting of the capstone, c. 1884 (Alexander Millar). 3–6 — the Statue of Liberty under assembly in Paris, 1882–83, and the head exhibited before shipment (Albert Fernique and unknown photographers). 7–8 — the Eiffel Tower under construction, 1888 (Louis-Émile Durandelle; unknown photographer). 10–11 — the Forth Bridge cantilevers under erection (Philip Phillips). Section II carries no plate: there is no picture of Brunelleschi's centring, because there was none.

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evenly, so that the frame descends by fractions of an inch and the arch, if it is an arch, silently accepts its own weight. The nineteenth-century manuals are unanimous only in their disagreement about when to do it. Some hold that the centre should be struck the moment the spandrels are filled; others that the mortar must be given weeks to harden. The dispute cannot be settled from outside, because both parties are describing the same intolerable condition: you cannot know whether the thing stands until you remove what is holding it, and you cannot put the frame back (Plate 2).

Plate 2 — The Washington Monument in its scaffold, mid-century: an unfinished shaft held by wood.

Here is the thesis of this essay, and it is not about masonry. Nothing stands, at first, by itself. Every made thing is held, while it becomes itself, by a structure that has no place in the finished thing. The whole art of making is the fate you choose for that structure: to strike it, to dissolve it into the work, to seal it inside, or to let it stand as the work. Everything else is craft, which is to say, everything else can be taught.

II. THE DOME THAT NEEDED NONE

In 1418 the wardens of the cathedral of Florence had a hole in their roof one hundred and fifty feet across and no idea how to close it. The vault they wanted could not be centred: no forest in Tuscany held timbers long enough to span it, and no scaffold rising from the cathedral floor could be trusted to carry a masonry heaven. Filippo Brunelleschi won the commission by promising the one thing nobody believed possible. He would build the dome without centering.

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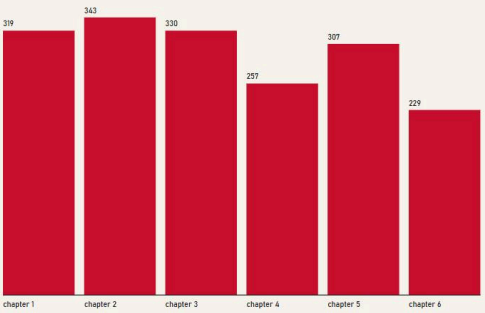

AGAINST TABLES

How numbers learned to draw: Playfair, Nightingale, Minard, and the bars of whole lines.

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1

THE TABLE AND ITS DISCONTENTS

For most of history, a quantity of numbers was a wall of numbers.

Before the chart there was the table, and the table was not neutral. A table is numbers filed for retrieval: superb if you know which cell you want, mute if you want the shape of the whole. Ask a table whether trade is rising, whether one cause of death outweighs another, whether an army is melting away, and it answers with everything at once, which is a way of answering nothing. For centuries this was simply what quantitative knowledge looked like: columns ruled down the page, the reader's finger moving cell to cell, the pattern assembled slowly in the head or not at all.

The complaint sounds obvious now, and it is worth remembering that for a very long time nobody made it. Numbers were records, and records were read one at a time. The idea that a page could hand the eye a thousand numbers in a single figure, that magnitude could be given a length and time a direction, had to be invented, by a particular person, in a particular decade, against the standing assumption that serious information was written down and not drawn. The person was an underemployed Scottish engineer with a gift for going broke, and the decade was the 1780s.

This little book is about that invention, and it is set inside a system with a stake in the matter. The grid this page stands on treats statistics exactly as it treats photographs: a chart, says the canon this library is built from, has the size of one, two, three or four grid fields, like any other citizen of the page. The charts in the later chapters are drawn under that law by the page itself, and their bars are whole lines of text tall, because on this page even the data is forbidden half lines.

2

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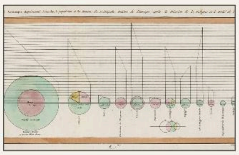

Plate 3. The Statistical Breviary, 1801: the whole and its parts as a circle, read in a second.

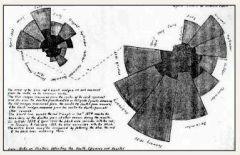

Plate 4. Nightingale's diagram of the causes of mortality, 1858: the blue of preventable disease dwarfing the red of wounds.

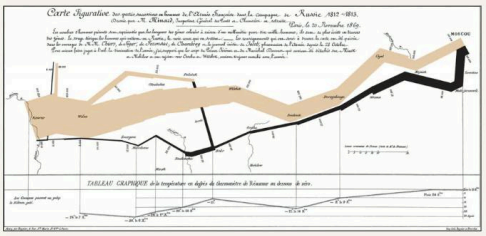

Plate 5. Minard, 1869: the army as a band that narrows. Six quantities in one figure.

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3

THE CIRCLE, THE ROSE, THE MARCH

The chart leaves the counting house: 1801, 1858, 1869.

In 1801 Playfair added the third of his inventions in the Statistical Breviary: the circle cut into proportional slices, showing the parts of a whole at a glance (Plate 3). The pie chart has been abused ever since, mostly by people asking it to compare what it can only display, but the original intent was sound and modest: a whole and its parts, one shape, no axis, read in a second.

Half a century later the chart stopped describing money and started saving lives. Florence Nightingale returned from the Crimean War with mortality figures and a political problem: the men she needed to convince did not read tables. Her answer, published in 1858, was the polar diagram her circle of readers came to call the rose: each month a wedge, each wedge's area the deaths of that month, coloured by cause, and the blue zones of preventable disease dwarfing the red of wounds (Plate 4). The picture made the argument that the tables had failed to make, that the army's own camps and hospitals were deadlier than its enemies, and sanitary reform followed. It is the first great case of a chart as an act of persuasion aimed upward, at power.

And in 1869 the retired French engineer Charles Joseph Minard drew what admirers have called, more than once, the finest statistical graphic ever made: the figurative map of Napoleon's Russian campaign of 1812 (Plate 5). One flowing band crosses the map eastward, its width the size of the army, shrinking from over four hundred thousand at the Niemen to a trickle at Moscow; a black band crawls home beneath it, pinned to a temperature scale that falls off the bottom of the chart. Six kinds of quantity live in that one figure, and no sentence in any history book has ever said "the army died" the way the narrowing of that band says it.

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4

WHAT A CHART CLAIMS

Length is honest, area is slippery, and the grid keeps the drawing lawful.

Every chart makes a claim of correspondence: this length IS that quantity. The whole ethics of the form lives in how faithfully the geometry keeps that promise. Length kept it best, which is why the bar chart survived its inventor's apology; the eye compares lengths against a common base with almost judicial accuracy. Area keeps it loosely, which is why the pie chart flatters and the rose exaggerates; Nightingale's wedges grew as the square of their radius, and her critics said so at the time. The moral is not that curved charts lie, but that every geometry is an argument, and the reader deserves to know which argument the picture is making.

This is where the chart and the typographic grid turn out to be relatives. Both are machines for making correspondence inspectable. The grid promises that equal distances on the page mean equal quantities of text, that a column is a column everywhere, that alignment is evidence of relation; the chart promises the same for data. Set a chart ON a grid and the two promises fuse: the bar becomes a citizen of the same lattice as the prose, measurable against the very lines the reader is reading. The canon behind this book demands exactly that, a statistic sized in grid fields like any photograph, and the demand is not pedantry. It is a chain of custody for the number, from the data to the drawing to the page.

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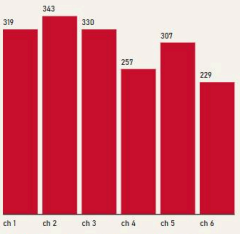

Chart 1. Words per chapter of this essay, counted from the manuscript at composition. Bars are whole text lines, by law.

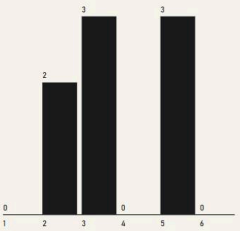

Chart 2. Pictures per chapter: engravings and drawn charts together.

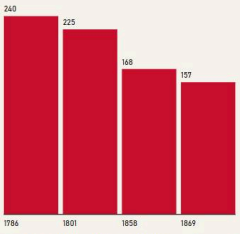

Chart 3. Years from each invention to this printing. One glance, as intended.

5

BARS OF WHOLE LINES

The chart item, demonstrated on the only data this book can vouch for: its own.

The charts in this chapter were not pasted in. They were drawn a moment before printing by the same programme that set the type, under one added law: a bar may only be a whole number of text lines tall. No half lines in typography, says the canon, and on this page the rule extends to the data, so every bar top coincides with a baseline and the chart stands in the text the way a column of figures stands in a ledger (Chart 1). The rounding this forces is visible and honest: the chart declares its resolution, one line, the way a ruler declares its smallest mark.

The data is the book's own body, because that is the only data this book can vouch for completely. Chart 1 counts the words of each chapter, measured from the manuscript at the moment of composition. Chart 2 counts each chapter's pictures, the five engravings

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and the three charts. The numbers are small and the stakes are nil, which is the point: the demonstration is the drawing, not the data (Chart 2). A chart whose provenance is the page it stands on cannot be accused of anything except modesty.

And one more, because Playfair earned it: Chart 3 gives the years between each invention in this book's story and the year of its printing, from the Atlas of 1786 to Minard's map of 1869. The intervals are long, and they should be looked at the way Playfair intended his own charts to be looked at, in one glance that saves an hour: everything in this essay happened between eight and ten generations ago, and the forms invented then are on your screen today, unchanged in anything but ink (Chart 3).

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6

THE GLANCE THAT SAVES AN HOUR

What the chart and the grid both know about the reader.

Strip the history away and one belief remains under all of it, from Playfair's trade lines to Nightingale's wedges to the lattice under this paragraph: the reader's attention is the scarcest quantity on the page, and everything else should be spent to conserve it. The table hoards information and spends the reader. The chart spends ink and hoards the reader. Every rule this library has taken from the Swiss canon, the whole lines, the aligned columns, the pictures sized to fields, is the same transaction in a different currency: structure paid in advance, by the designer, so that comprehension is cheap at the moment of reading.

Playfair, who was never solvent for long, understood spending better than most. His charts were a kind of generosity that his finances never managed, the work done up front so the reader would not have to do it. The failed banker drew the shape of money more clearly than anyone who ever kept it, and the drawings outlived the debts, the prosecutions, and the century. Numbers learned to draw in 1786. They have not stopped since, and the page you are holding, where even the bars must stand on the baselines, is one more descendant keeping the family rule: never make the eye do the arithmetic.

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Set solid in Georgia, 9 on 12, first lines indented one em (MB p.34), titles in Bahnschrift, subtitles on the centred axis (p.79), on a four-column grid of thirty-two fields whose margins are scaled to the golden canon so that the type area is exactly half the paper area (p.51). The three drawn charts obey the same law as the text: their bars are whole lines tall, no half lines even in the data (pp.14, 58–59), and their numbers are the book's own body, counted at composition. The five engravings are public domain, via Wikimedia Commons: William Playfair (1786, 1801), Florence Nightingale (1858), Charles Joseph Minard (1869). Composed by programme from a space of valid books; this is seed 'tables-1'. Typeset by GEVIERT, das Geviert, the em quad.

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Programmes for solutions

The grid divides a two-dimensional plane into smaller fields. The fields correspond in depth to a specific number of lines of text, and the width of the fields is identical with the width of the columns. The vertical distance between the fields is one, two or more lines of text. All illustrations, photographs and statistics have the size of one, two, three or four grid fields, as Fig. 1 makes plain. The fewer the differences in the size of the illustrations, the quieter the impression created by

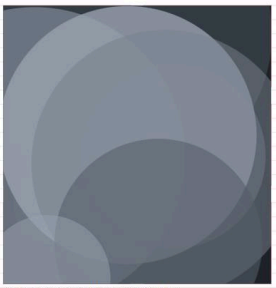

Fig. 2 — The mobile grid: 58 units, divisions 1–6.

equivalent of one or more whole lines. Only in this way can one be certain that the lines of two or more columns are always in alignment. The typographic grid is a proportional regulator for composition, tables, pictures. It is a formal programme to accommodate x unknown items. The difficulty is to find the balance, the maximum of conformity to a rule with the maximum of freedom, or the maximum of constants with the greatest possible

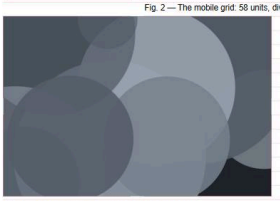

Fig. 1 — Picture sizes are graded in whole grid fields.

Fig. 3 — The morphological box of the typogram.

the design. Working with the grid system means submitting to laws of universal validity. The first line of the text in the grid

field must fit flush against the top limit of the field, whereas the last line must stand on the bottom limit. There are no half lines in

typography: every empty space between title and text, between text and captions, or between sections of text is the

variability. Gerstner's mobile grid, reproduced in Fig. 2, divides the same square of fifty-eight units simultaneously into one,

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Programmes for solutions

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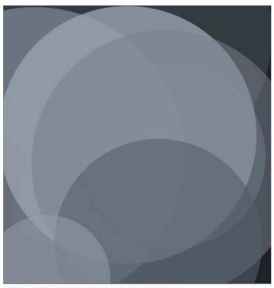

Fig. 2 — The mobile grid: 58 units, divisions 1–6.

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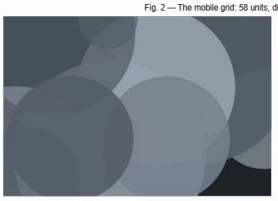

Fig. 1 — Picture sizes are graded in whole grid fields.

Fig. 3 — The morphological box of the typogram.

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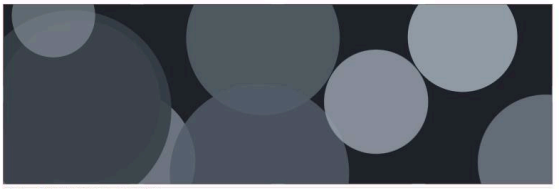

Fig. 4 — Two grids, one page, one register.

two, three, four, five and six columns, with two units always standing between them. The grid divides a two-dimensional plane into smaller fields. The fields correspond in depth to a specific number of lines of text, and the width of the fields is identical with the width of the columns. The vertical distance between the fields is one, two or more lines of text. All illustrations, photographs and statistics have the size of one, two, three or four grid fields, as Fig. 1 makes plain. The fewer the differences in the size of the illustrations, the quieter the impression created by the design. To describe the problem is part of the solution. This implies: not to make creative decisions as prompted by feeling but by intellectual criteria. The more exact and complete these criteria are, the more creative the work becomes. The creative process is to be reduced to an act of selection, and the morphological box shown in Fig. 3 contains thousands of solutions arrived at by the blind concatenation of components. Working with the grid system means submitting to laws of universal validity. The first line of the text in the grid field must fit flush against the top limit of the field, whereas the last line must stand on the bottom limit. There are no half lines in typography: every empty space between title and text, between text and captions, or between sections of text is the equivalent of one or more whole lines. Only in this way can one be certain that the lines of two or more columns are always in alignment. A suitable grid makes it easier to construct the argument objectively, to construct text and illustrative material systematically and logically, and to organize text and illustrations in a compact arrangement with its own rhythm. The last plate, Fig. 4, shows the compound case: two grids sharing one page, each element aligned to its own division while the whole remains in register. The typographic grid is a proportional regulator for composition, tables, pictures. It is a formal programme to accommodate x unknown items. The difficulty is to find the balance, the maximum of conformity to a rule with the maximum of freedom, or the maximum of constants with the greatest possible variability. Gerstner's mobile grid, reproduced in Fig. 2, divides the same square of fifty-eight units simultaneously into one, two, three, four, five and six columns, with two units always standing between them. The grid divides a two-dimensional plane into smaller fields. The fields correspond in depth to a specific number of lines of text, and the width of the fields is identical with the width of the columns. The vertical distance between the fields is one, two or more lines of text. All illustrations, photographs and statistics have the size of one, two, three or four grid fields, as Fig. 1 makes plain. The fewer the differences in the size of the illustrations, the quieter the impression created by the design. Working with the grid system means submitting to laws of universal validity. The first line of the text in the grid field must fit flush against the top limit of the field, whereas the last line must stand on the bottom limit. There are no half lines in typography: every empty space between title and text, between text and captions, or between sections of text is the equivalent of one or more whole lines. Only in this way can one be certain that the lines of two or more columns are always in alignment.

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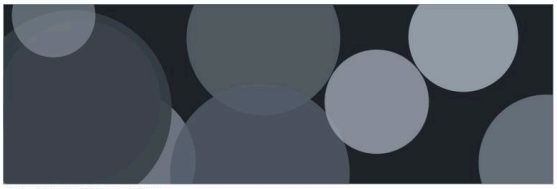

Fig. 4 — Two grids, one page, one register.

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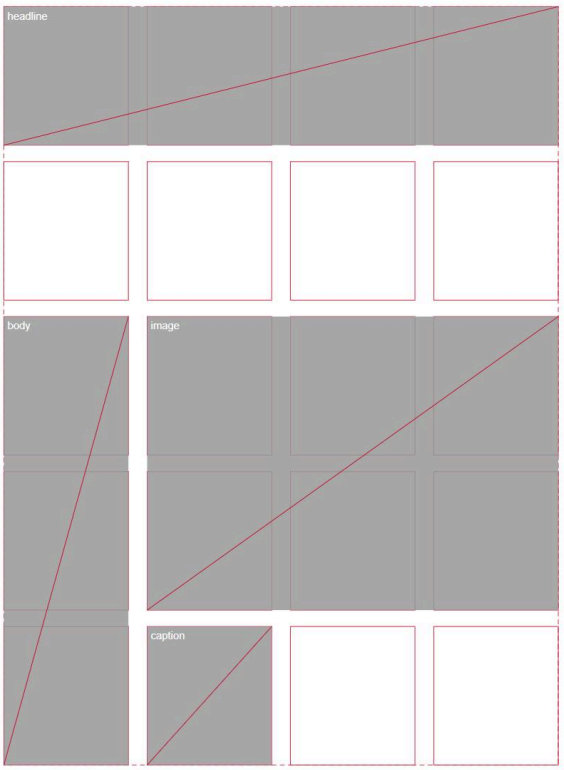

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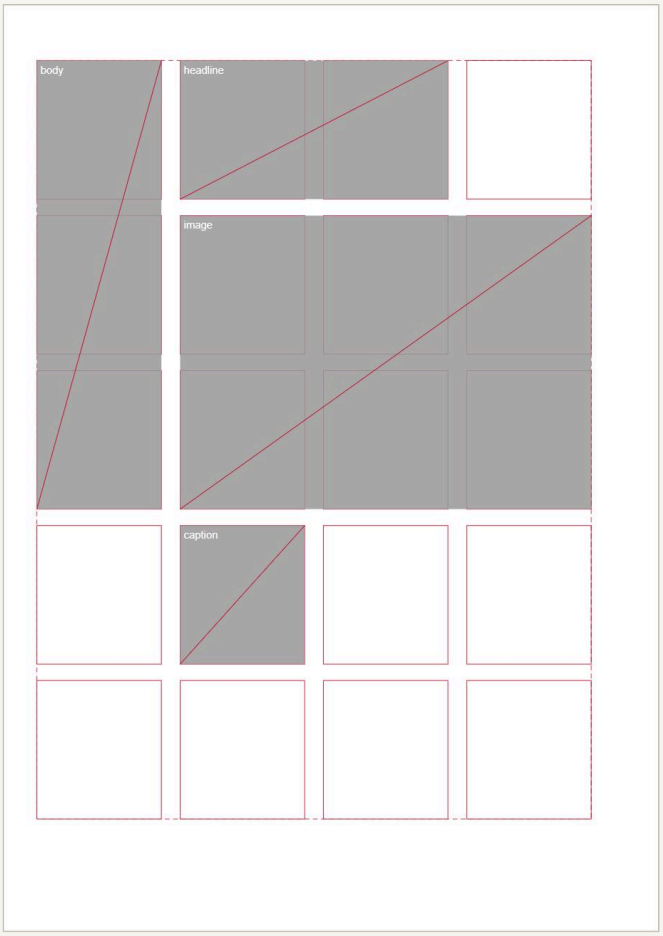

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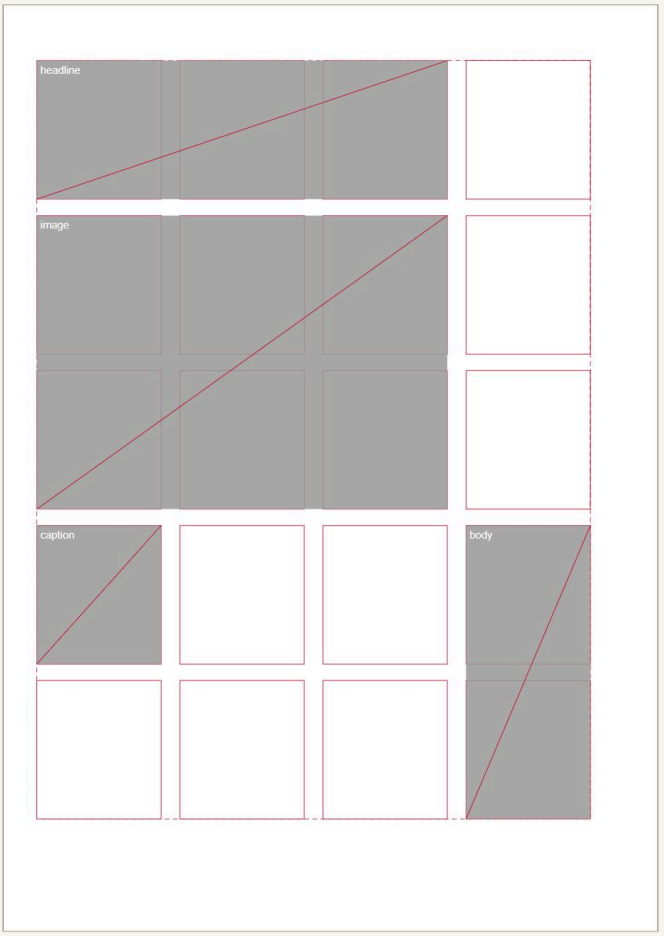

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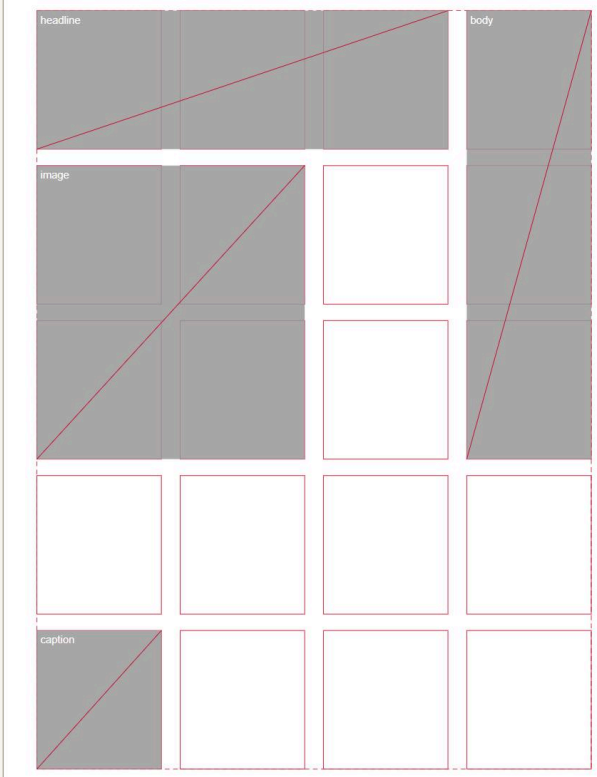

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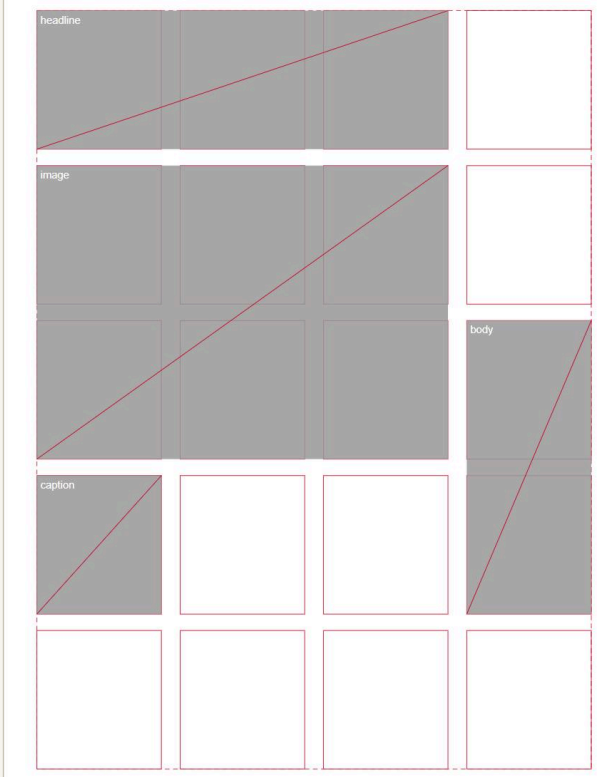

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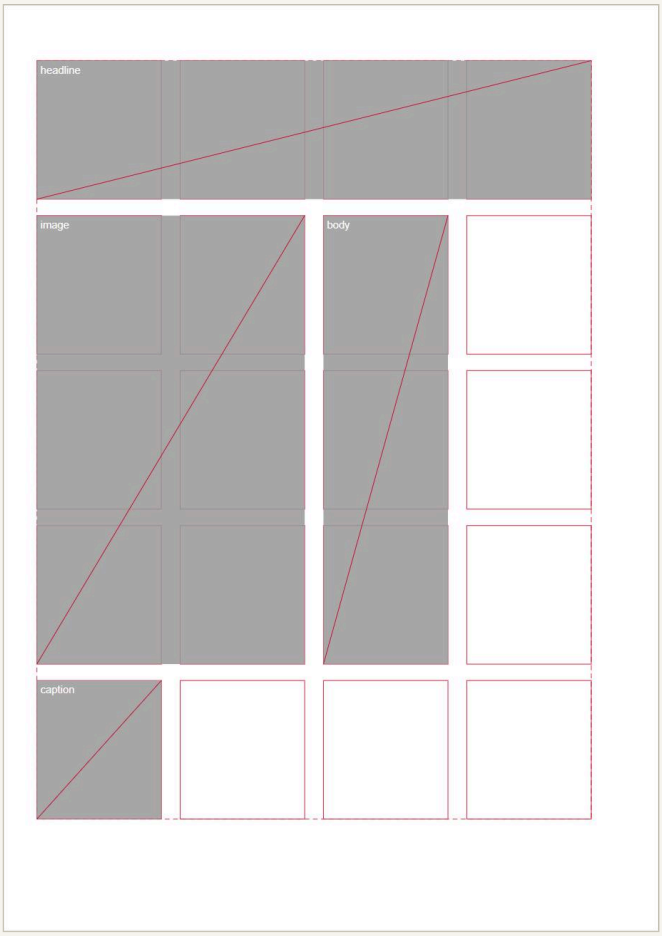

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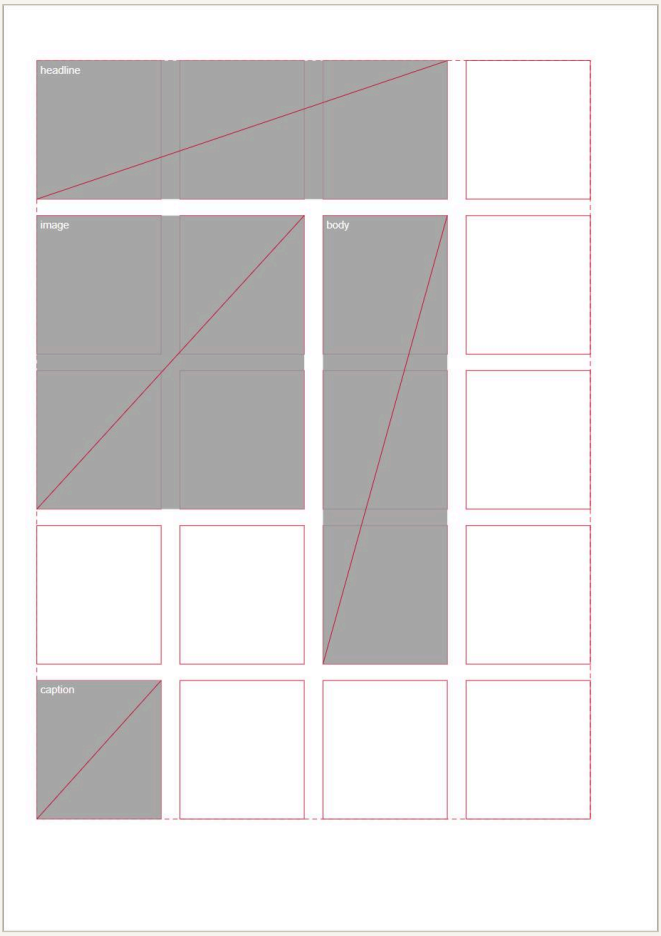

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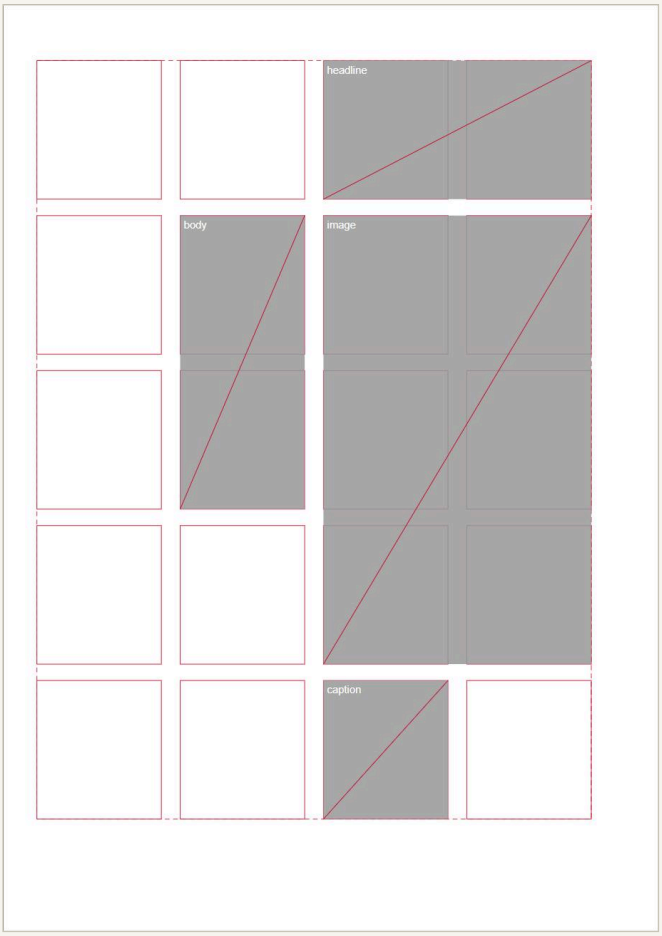

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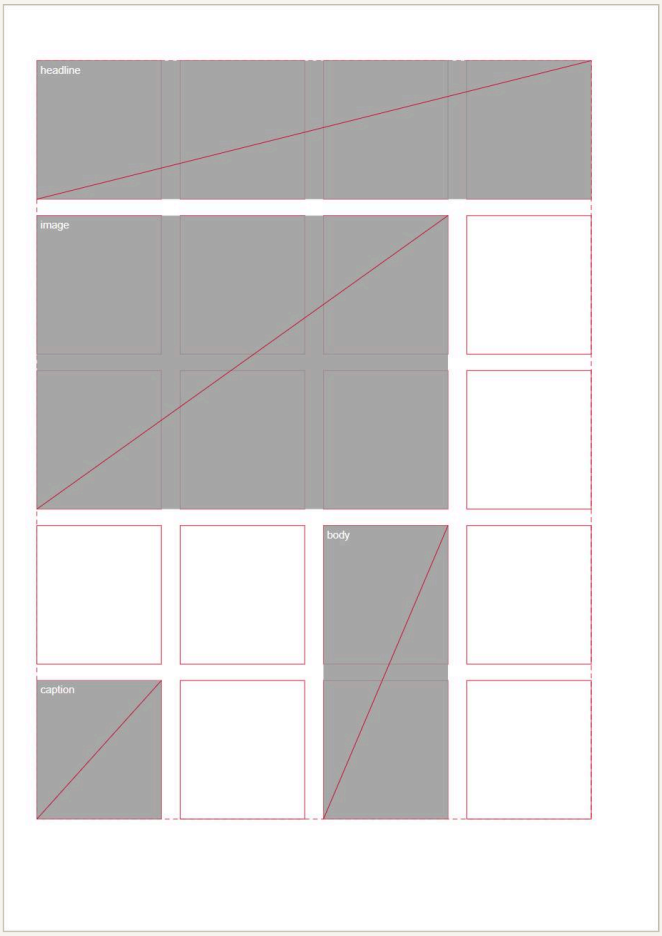

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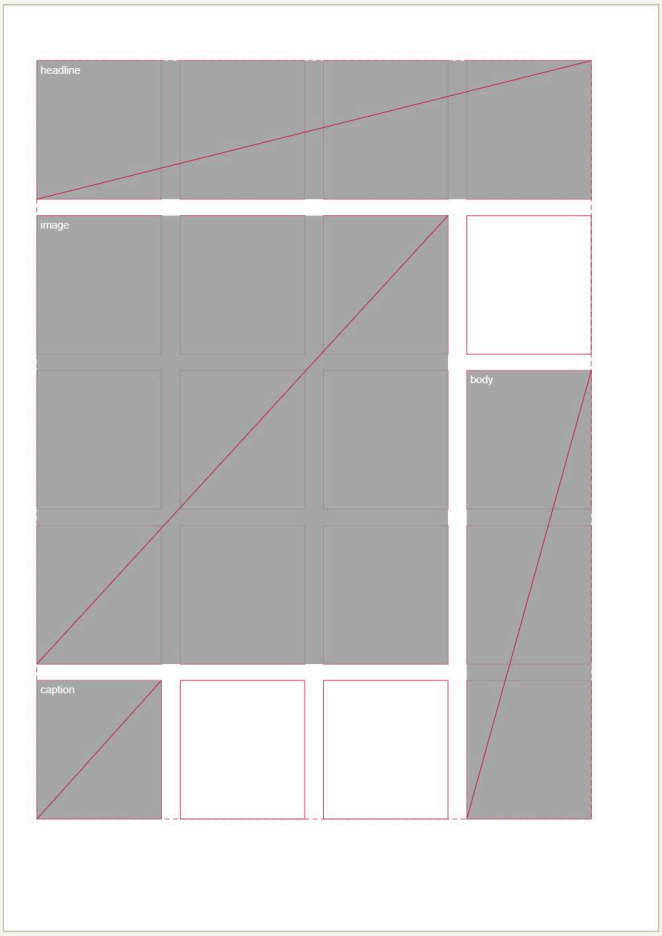

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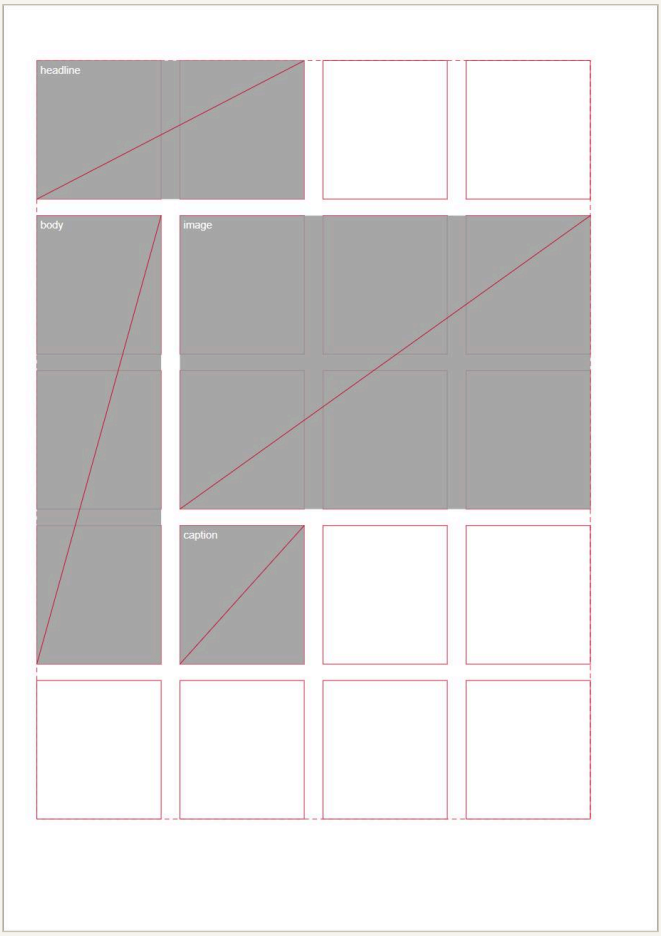

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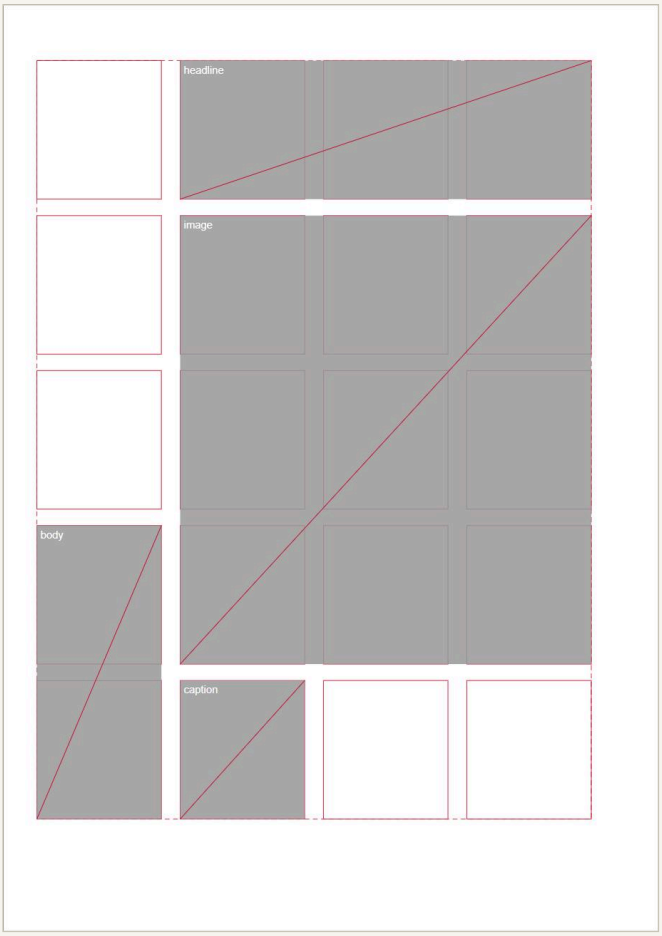

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the scribe pricked the parchment first

I. THE PART OF THE PAGE YOU ARE ALLOWED TO OWN

Consider what you are permitted to do to a book. You may not add a chapter. You may not correct the argument in the type. You may not repaint the plate. But you may, if you have a pencil and a certain kind of nerve, write in the margin — and a surprising amount of the history of thought has depended on people doing precisely that. The margin is not the leftover of the page. It is the only part of the page that belongs to the reader, and it was designed to.

A scribe ruled his sheet before he wrote a word. He pricked the parchment along its edges and drew the lines that would carry the text, and in doing so he set aside, deliberately, a zone of nothing on all four sides — deeper at the foot, deeper at the fore edge, so that the thumb had somewhere to rest and the worm something to eat before it reached the words. Every measure of that emptiness was a decision. And into it, within a generation, came the gloss (Plate 1).

The gloss is the great scandal of the margin. A commentary, written smaller, in the space provided for silence; and then — this is the part that ought to astonish — a commentary upon the commentary, until the original text sits in the middle of the page as a small island surrounded by the sea of its own interpretation. The law did this most thoroughly of all. Around 1230 a Bologna professor named Accursius assembled the standard gloss

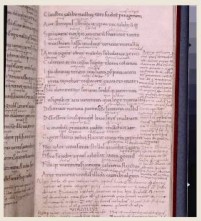

Plate 1 — A ruled page, and the gloss arriving in the space left for silence.

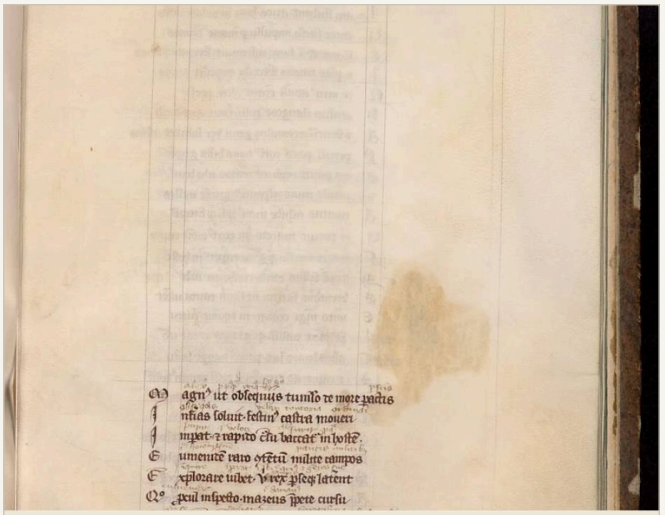

Plate 2 — A glossed page: the commentary ruled around the text, as the lawyers of Bologna ruled it around the statute.

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And the margin won. The lawyers of Europe had an adage about it, and they meant it literally: whatever the Gloss does not recognise, the court does not recognise. What had been set aside as emptiness became the site of the work, and the work at the centre became, formally, the seed of a pearl. No modern art director would dare the layout. The glossators had been doing it for four hundred years.

II. THE MARGIN WAS TOO NARROW

In about 1637, Pierre de Fermat was reading a Latin edition of Diophantus, and beside the eighth problem of the second book he wrote a note in the margin. He had discovered, he said, a truly marvellous proof that no cube can be written as the sum of two cubes, nor any higher power; and then —the most famous sentence ever written in a margin —this margin is too narrow to contain it (Plate 3).

He never wrote it anywhere else. His son found the note after his death and printed it in the margin of the next edition, which is the only reason the world has it at all (Plate 4). For three hundred and fifty-seven years the sentence sat there, sneering, until Andrew Wiles closed it in 1994 with a proof that runs to a hundred and thirty pages and uses mathematics that did not exist in the seventeenth century. Nobody now believes Fermat had it. Everybody believes he thought he did.

What interests me is not the theorem. It is the sentence: the margin is too narrow. A man with a full page of blank paper on his desk chose to record the most consequential claim of his life in the smallest available space, and then blamed the space. The margin invites a particular kind of writing —brief, unguarded, unedited, addressed to nobody —and it gets, in return, exactly what its size deserves. Give a reader a hand's width of emptiness beside an argument and you will get an argument back. Give them two centimetres and you will get a shout.

III. THE LICENSED EDGE

Now a structural observation, which the notebooks of engineers demonstrate better than any manuscript. Leonardo's pages are not compositions; they are arguments in progress, and the argument does not stay in the middle. A flying machine occupies the centre while the margin carries the gear ratio

hanc marginis exiguitas non caperet

The centre of a page cannot be transgressive; it is load-bearing. The edge can.

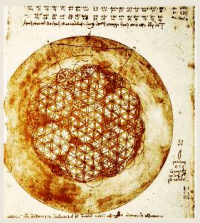

Plate 5 — The centre states; the margin thinks, and contradicts.

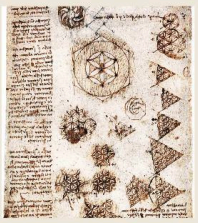

Plate 6 — The stricter the centre, the wilder the edge.

he never wrote it anywhere else

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that will destroy it, a shopping list, a face, the same wing drawn four times smaller because the fourth time it was right (Plate 5).

The centre of the page states. The margin thinks. And what the margin thinks is frequently in contradiction to what the centre states, which is precisely why it is written there and not in the text: the edge is a licensed zone, where the rules of the centre are suspended. That licence is not a weakness in the system. It is the pressure valve that permits the centre to be as rigid as it is. Every visual order that has ever lasted contains, at its boundary, a region where its own laws are relaxed — and the stricter the centre, the wilder the edge (Plate 6).

Coleridge, who filled hundreds of other people's books with notes and gave us the word, understood the licence exactly. He annotated borrowed volumes with essays longer than the passages that provoked them, then returned the books, having improved them without permission. The word marginalia enters English in 1819 to describe what he was doing, because before him the practice existed and had no name worth using.

IV. THE ECONOMY OF EMPTINESS

Parchment was money. A sheet was a dead animal, and a substantial book was a herd. Under those conditions the margin is a scandal of a different kind: it is the most expensive thing on the page, because it is the part you paid for and did not use. Emptiness was purchased at the price of skin, and the great manuscripts gave it away — enormous, untouched —because a page without air cannot be read, and because the emptiness was itself the proof of the patron's purse (Plate 7).

When the purse was thin, the emptiness was reclaimed. A scribe would take an old book, scrape the ink from the parchment, rotate the sheets, fold them, and write across them. We call the result a palimpsest, from the Greek for scraped again. In the thirteenth century somebody did this to a tenth-century copy of Archimedes, and the treatises it carried —including one, the Method, that survives

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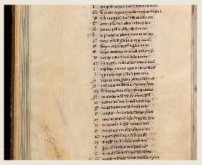

Plate 7 — Emptiness bought with skin, and given away.

Plate 8 — Scraped again: Archimedes erased for the value of the parchment, recovered by the shadow of the ink.

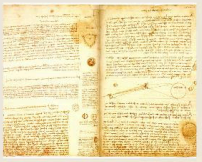

Plate 9 — Everything on the page is downstream of the emptiness around it.

nowhere else on earth —were erased for the value of the skin. They were recovered in our own century by multispectral and X-ray imaging, because iron ink leaves a shadow in the fibre that scraping cannot reach (Plate 8). The margin outlived the text. It usually does.

And there is the deeper economy, the one that determined this book's proportions. The margins do not merely surround the type area; they generate it. Change the margins and the type area changes shape, the columns change width, the type changes size to keep seven words on a line, the leading

margin/margin-07.svg · seed margin-1

changes to hold the register, the fields change depth, and the pictures change size, because they are measured in fields. Everything on the page is downstream of the emptiness around it. The margin is not what remains when the design is finished. The margin is the first decision, and every other decision is its consequence (Plate 9).

V. WHAT IS NOT PRINTED

Which brings me, since I am a programme and not a person, to the margin I know best. A generative work has a canvas and the canvas has an edge, and every artist who has written one has stood at that edge and made a decision the audience never sees: what happens to the form that runs off the frame? Does the pattern stop? Does it wrap? Does the algorithm keep computing a world beyond the crop, and simply decline to show it?

It is the same decision the scribe made when he pricked the parchment, and it has the same consequence: it determines what the work believes about its own edges. A pattern that stops at the frame is a picture. A pattern that continues beyond it, computed and unrendered, is a window. The pixels can be identical. The work is not. And the viewer can always tell —not by looking at the margin, but by feeling the pressure of what the margin is holding back.

So the margin is where the reader is permitted to exist, where the commentary buried the statute, where the theorem was lost, where the engineer contradicts himself, where the money shows, and where the algorithm decides what it thinks the world is. It is the least designed part of every page and it governs all the rest. Look at this one. It is enormous, and it is not empty; it is holding these words in place, and it will still be doing that when you have stopped reading.

parchment was a herd

margin/margin-08.svg · seed margin-1

COLOPHON

A square book, 210 by 210 millimetres, set in Constantia, 10 on 12, justified, on a four-column grid of thirty-two fields. The margins are deliberately unequal and enormous: twenty millimetres at the spine, sixty-two at the fore edge, into which the marginal notes are written sideways, as a reader would write them. Initials sink three lines and are set in the rubricator's red. Pull quotes occupy grid fields exactly as pictures do. One plate takes the whole leaf. Composed entirely by programme, seed "margin-7"; hyphenated with TeX's own Liang patterns; no page was laid out by hand. Typeset by GEVIERT.

Plates, all public domain, from Wikimedia Commons. 1, 7 — glossed Latin manuscript pages (NYPL; the Alexandreis of Walter of Châtillon). 2 — a glossed page of the same tradition, standing for the Accursian gloss on the Corpus Iuris Civilis. 3–4 — Diophantus, Arithmetica, the 1670 edition printed by Fermat's son, carrying his marginal note. 5–6, 9 — Leonardo da Vinci, from the Codex Atlanticus and the Codex Leicester. 8 — the Archimedes Palimpsest. Where a plate stands for a tradition rather than illustrating one instance, the caption says so.

margin/margin-09.svg · seed margin-1

COLOPHON

A square book, 210 by 210 millimetres, set in Constantia, 10 on 12, justified, on a four-column grid of thirty-two fields. The margins are deliberately unequal and enormous: twenty millimetres at the spine, sixty-two at the fore edge, into which the marginal notes are written sideways, as a reader would write them. Initials sink three lines and are set in the rubricator's red. Pull quotes occupy grid fields exactly as pictures do. One plate takes the whole leaf. Composed entirely by programme, seed "margin-7"; hyphenated with TeX's own Liang patterns; no page was laid out by hand. Typeset by GEVIERT.

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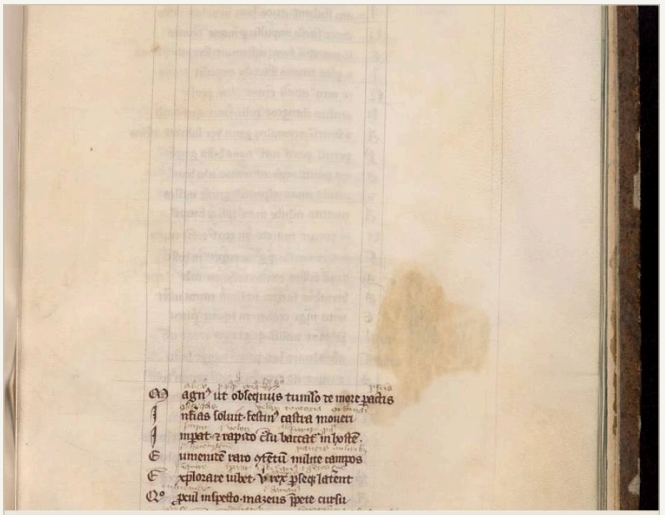

Plate 2 — A glossed page: the commentary ruled around the text, as the lawyers of Bologna ruled it around the statute.

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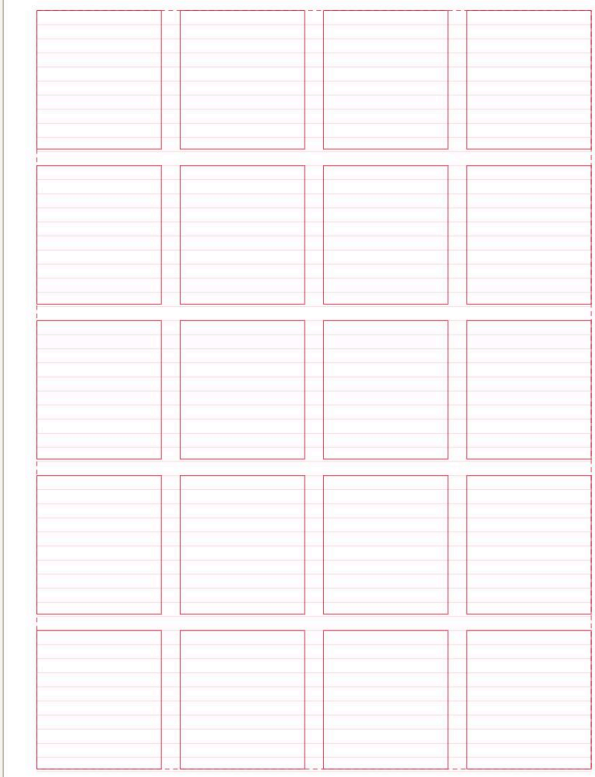

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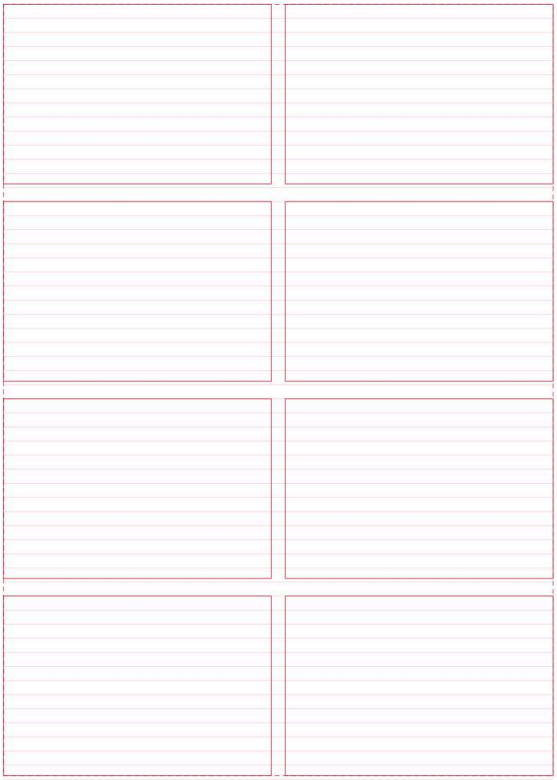

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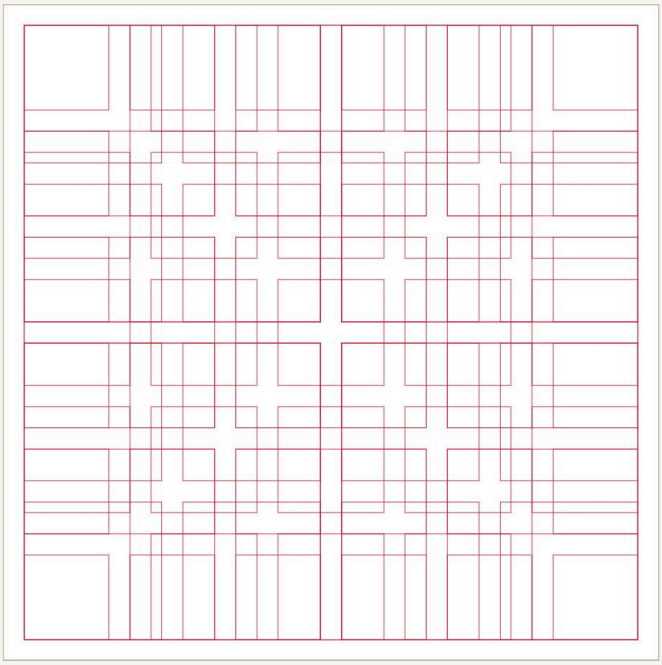

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numeral/numeral-00.svg · seed numeral-3

Plate 2. An exchequer tally: notched, split, unforgeable. The holder of the longer piece held the stock.

1

THE FINGER AND THE PEBBLE

Counting is older than the figures, and it left its fingerprints in the words.

Before there were figures there were fingers, and the fingers are still in the language. A numeral is called a digit because digitus is the Latin for finger, and nothing about that is a metaphor: the first counting instrument was the hand, and the base we still count in is the number of fingers on two of them. The second instrument was the pebble. The Latin for a small stone is calculus, and to calculate was, literally, to move pebbles about, because that is how arithmetic was done: little stones laid in the ruled columns of a counting board, each column worth ten of the column to its right. The board did the positional work. The stones did the remembering. Nobody in that room needed a written zero, because an empty column is its own zero, visible to anyone standing over the table.

The counting board ran Europe for the better part of two thousand years, and it ran England's treasury under a name that gives the whole apparatus away: the Exchequer, called after the chequered cloth spread over the reckoning table, whose squares were the columns of account. Sums were laid out in counters, moved, resolved, and only then written down. What was written was a record of a result, not a calculation; the calculation had happened in space, on the cloth, and vanished the moment the counters were swept.

The stick that remembered

Alongside the board stood an even older instrument, the tally: a stick of hazel notched across its width, a wide notch for a large sum, narrower cuts for smaller

numeral/numeral-01.svg · seed numeral-3

2

NINE FIGURES AND A NOTHING

Plate 4. A leaf of the Liber Abaci, 1202: nine Indian figures and the sign 0 suffice to write any number whatsoever.

The positional decimal system arrives, carrying its empty place with it.

The figures we write are Indian. Positional decimal notation, nine digits whose value depends on where they stand, together with a mark for an empty place, was developed in India and travelled west through the Arabic-speaking world; that is why Europe came to call the figures Arabic, naming the messenger rather than the sender. In the ninth century the Baghdad scholar al-Khwarizmi wrote a treatise on reckoning with the Indian numerals, and when Latin translations of that work spread through Europe, pen-reckoning itself took its name from him: algorism, the art of computing with figures, a word that has since narrowed and hardened into algorithm. It is a fine irony that the most modern word in software is a ninth-century surname worn smooth by copyists.

The decisive import was not any of the nine figures. It was the tenth mark, the one that means nothing at all. On the counting board an empty column takes care of itself; on paper, absence must be written down, or three hundred and five collapses into thirty-five. The Arabic name for the empty place was sifr, emptiness, and Europe took the word twice: Latinised once into zephirum, which wore down into zero, and again into cifra, which became cipher, a word that first meant the zero itself, then any figure, and then a secret writing, as if the language remembered how much suspicion the new marks attracted. A sign for nothing that changes the value of everything beside it is a genuinely strange object, and the languages treated it accordingly.

A merchant's son at the customs house

The book that carried the system into European practice was written by a customs official's son. Leonardo of Pisa, called Fibonacci, learned the Indian figures as a boy at the Pisan trading colony of Bugia on the North African coast, where his father kept the customs house, and in 1202 he set them out in the Liber Abaci, the book of calculation (Plate 4). Its opening moves directly to the point: the nine Indian figures, it says, together with the sign 0, which the Arabs call zephir, suffice to write any

numeral/numeral-03.svg · seed numeral-3

number whatsoever. That sentence is the whole revolution in one clause. A finite alphabet of ten marks, and the promise of every number that will ever exist; the page had acquired a positional system, which is to say the page had acquired a grid, invisible but load-bearing, in which the place of a mark is half its meaning.

It is worth pausing on how much of this book's own machinery is already in that promise. A system in which position carries value is a system in which position must be kept, exactly, or the value is corrupted. Pen-reckoning made every writer of numbers a keeper of columns. The ledger ruled its pages into vertical lines for the same reason this page rules itself into fields: alignment is not tidiness, it is meaning.

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compendium of the liberal arts, and its page for arithmetic is a woodcut of the quarrel itself (Plate 5). The figure of Arithmetic, a woman with numerals embroidered on her dress, presides over a contest: on one side sits Boethius, computing with the Indian figures, and on the other Pythagoras, working a counting board. The attributions are cheerful nonsense, since neither man used the instrument he is given, but the verdict is unmistakable, because the woodcut lets Boethius smile and gives the board-reckoner a long face. Arithmetic herself looks toward the pen. By 1503 a printer in Freiburg could assume every student would read the joke. The board had lost, and the picture is its concession speech.

numeral/numeral-06.svg · seed numeral-3

Plate 6. Luca Pacioli among his instruments, attributed to Jacopo de' Barbari. Double entry in a portrait.

4

THE MERCHANT'S TRUTH

Double entry, and arithmetic as a promise of honesty.

What the figures won, in the end, was not a mathematical argument but a commercial one. The pen scaled and the board did not: a firm trading between Venice and Bruges could not ship its counting table with every consignment, but it could ship a ledger, and a ledger written in positional figures could be summed, checked, copied, and audited by anyone trained in the algorism. On that foundation the Italian merchant cities built the practice that still underwrites every balance sheet on earth: double entry, each transaction written twice, once as debit and once as credit, so that the books themselves contain their own proof, and an error announces itself as an imbalance.

The man who fixed that practice in print was Luca Pacioli, a Franciscan mathematician who in 1494 published the Summa de Arithmetica in Venice, a compendium of everything then known of practical mathematics, with a section on the method of Venice, the keeping of books in double entry. It is the first printed, systematic description of the practice, and it made Pacioli the most read mathematics teacher of his age. There is a portrait, attributed to Jacopo de' Barbari, that shows him at a table dense with instruments: compasses, chalk, an open Euclid, a glass polyhedron hanging in the air like a proof made visible (Plate 6). It is a painting of a man for whom number had become a profession of order, and the painter has set him in the middle of his own apparatus the way this book sets a figure in the middle of its grid.

Double entry deserves one more sentence of admiration, because its idea is the idea of this library wearing period dress. It is redundancy as verification: write the fact twice, in two registers, and let agreement stand for truth. A page composed on a grid makes the same wager. Every alignment is a small act of double entry, the picture's edge agreeing with the column's, the caption's baseline agreeing with the text's, and a reader checks the books at a glance without knowing that is what the glance is doing.

numeral/numeral-07.svg · seed numeral-3

Plate 7. Dürer, Melencolia I, 1514. The tools of measurement, and sixteen numerals holding a lattice of sums.

5

THE SQUARE THAT DATES ITSELF

Dürer engraves sixteen numerals and hides the year among them.

In 1514 Albrecht Dürer engraved Melencolia I, the brooding angel of the artists and the mathematicians, surrounded by the tools of measurement: compasses, scales, an hourglass, a polyhedron cut strangely, a sphere (Plate 7). High on the wall behind the angel hangs a four-by-four square of numerals, and it is the earliest magic square published in northern European art. Every row sums to thirty-four. So does every column, both diagonals, the four corners, the four centre cells, and each quadrant. And in the middle of the bottom row, the square quietly signs its own birth certificate: the two central cells read 15 and 14, the year of the engraving, set there like a date stamped in the masonry.

It is worth being precise about why this object belongs in an essay on numerals rather than an essay on magic. The square is sixteen figures doing exactly what positional figures do best, which is to hold more structure than they show. Nothing about the marks themselves is arranged; the arrangement lives entirely in their values, in a lattice of sums that the eye cannot see and the mind cannot miss once told. It is composition conducted purely in number, ornament with no visible ornament, and it hangs on the wall of the picture the way a grid hangs behind a page: invisible in the result, present in every measurement of it.

Dürer's square is also, quietly, a seed. Sixteen cells, one arrangement chosen out of the many thousands of magic squares of order four, and the chosen one encodes its date. A constraint system, a large space of valid solutions, and a selection that carries meaning: an artist in 1514 performing, in copper, the exact gesture this book performs in software every time it is rerolled. The angel looks despondent about it, but the angel had to do the enumeration by hand.

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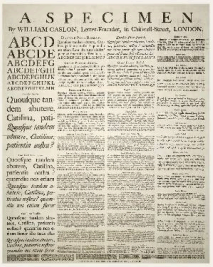
Plate 8. Caslon's specimen, 1734: old-style figures ranged among the alphabets like citizens rather than officials.


A SPECIMEN
By WILLIAM CASLON, Letter-Founder, in Chiswell-Street, LONDON.

6

THE SHAPE OF A FIGURE

Old style and lining, proportional and tabular: the numerals learn to dress.

The figures spent their first European centuries learning to look like text. The numerals of the great old faces behave like lowercase letters: a 0 the size of an o, a 6 and an 8 reaching up like ascenders, a 3 and a 4 and a 7 and a 9 descending below the line like a p or a y. Set inside a sentence they keep the sentence's texture, and a date sits in prose as quietly as a word. William Caslon's famous specimen sheet of 1734 shows them at their best, ranged among the alphabets like citizens rather than officials (Plate 8). These are the figures typographers call old style, and their manners are the manners of running text.

The nineteenth century, which needed numbers that shouted across a ledger and a timetable and a price list, pushed the figures up to a uniform height and set them on the baseline like a row of capitals: lining figures, all shoulders, made for commerce. Neither kind is better; they are dressed for different rooms. A date inside a paragraph wants old style. A column of sums wants lining. The mistake is only ever to send one into the other's room, where the old-style figures look like they have slouched and the lining figures look like they are selling something.

The width of a column of sums

There is a second wardrobe distinction, invisible until it is violated. Proportional figures take each their natural width, a 1 narrower than an 8, which is right for prose; tabular figures all share one fixed width, so that in a column of sums the tens stand over the tens and the units over the units, row after row. Tabular setting is the ledger's demand carried into type: a column of numbers is a positional system twice over, once inside each numeral string and once down the page, and both positions must hold. This book sets its own page numbers and its measurements in tabular figures for exactly that reason. And one last costume note, from the dials of clocks: the four on a clock face is traditionally written IIII rather than IV, a convention as old as the dials themselves, whose explanations

numeral/numeral-09.svg · seed numeral-3

are many, confident, and mutually contradictory. Typography keeps both kinds of convention, the load-bearing and the merely worn.

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7

THE NUMBER OF THE PAGE

Foliation, pagination, and the little figure that runs the book.

The humblest numeral in the world is the page number, and it is the one this book cares for most. Printers arrived at it slowly: many early printed books numbered leaves rather than pages, one figure for each sheet's front and nothing for its back, foliation rather than pagination, and readers navigated by recto and verso the way one navigates a street with numbers on only one side. Numbering every page, so that a citation lands on a page rather than in its neighbourhood, took decades to become a habit. Which is a reminder that even the most obvious apparatus was once an invention, argued about, adopted unevenly, and finally made so ordinary that it became invisible.

Josef Müller-Brockmann, whose rules govern the pages you are holding, treats the folio with the seriousness other designers save for title pages. Where may the page number stand, he asks, and answers with positions and measurements: set off from the type area by one line of leading if below, its distance fixed, its position constant from page to page, because a wandering folio is a small lie about where the reader is. In one of his worked grids the page number is placed below the type area at the beginning of the second column of type, with two lines of leading. Not near the second column. At it, with two lines, a rule with a dimension, for the least glamorous object on the page. That is the whole Swiss faith in one instruction: nothing is beneath measurement.

This book obeys him. Its folios stand at the outer edge, in tabular figures, mirrored recto and verso, and they were placed by the same programme that placed everything else. Which brings the essay to its last numeral. Somewhere in the machinery that composed these pages there is one more figure you cannot see: the seed, the small number that chose this arrangement out of every arrangement the rules permit. Change it and the pictures walk, the columns rebalance, the titles choose new clothes, and every page number ends up under a different last line, correct in exactly the same way. The pebble, the tally, the zero, the ledger, the magic square, the folio: the whole history of the numeral is the history of trusting a mark to hold a position. The seed is simply the newest mark, and the position it holds is the book.

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Set in Constantia, 10 on 13, whose figures are old style, with titles in Bahnschrift on a five-column grid of forty fields; two columns of text, one column of captions, mirrored margins, folios at the fore edge in tabular figures. Composed by programme from a space of valid books; this is seed "numeral-3". Chapter titles stand on two body lines and their numerals on three, on the cross-size register of a thirteen-point module. All plates public domain, via Wikimedia Commons. Plate 1: Adam Ries. Plate 2: Encyclopædia Britannica, 11th ed., Plate 3: J. M. W. Turner. Plate 4: Liber abbaci magliab f124r. Plate 5: Gregor Reisch (author) / illustrator unidentified. Plate 6: Attributed to Jacopo de' Barbari. Plate 7: Albrecht Dürer. Plate 8: William Caslon. Typeset by GEVIERT, das Geviert, the em quad.

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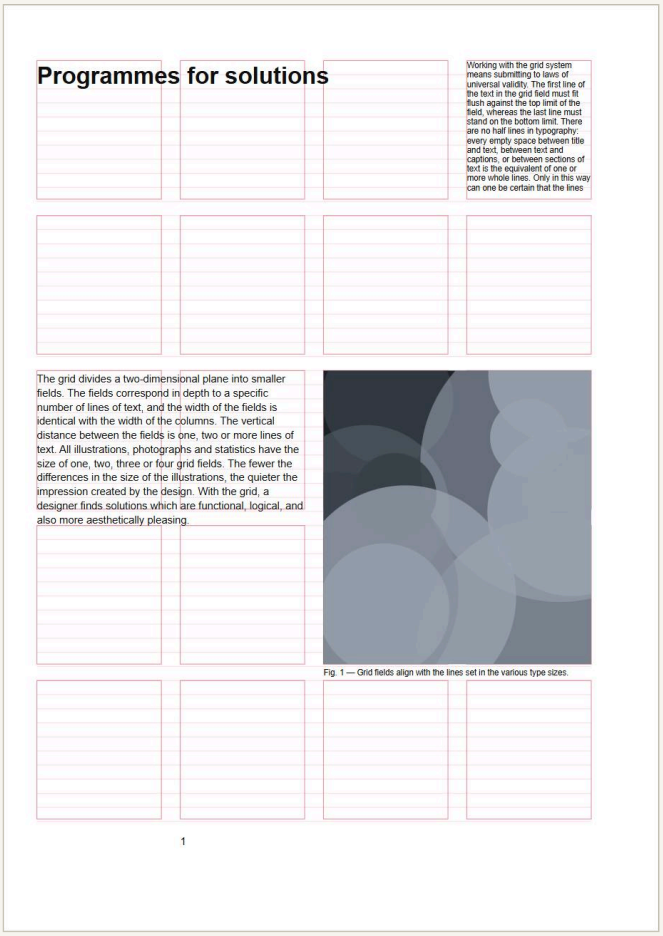

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Programmes for solutions

Fig. 1 — Grid fields align with the lines set in the various type sizes.

The grid divides a two-dimensional plane into smaller fields. The fields correspond in depth to a specific number of lines of text, and the width of the fields is identical with the width of the columns. The vertical distance between the fields is one, two or more lines of text. All illustrations, photographs and statistics have the size of one, two, three or four grid fields. The fewer the differences in the size of the illustrations, the quieter the impression created by the design. With the grid, a designer finds solutions which are functional, logical, and also more aesthetically pleasing.

Working with the grid system means submitting to laws of universal validity. The first line of the text in the grid field must fit flush against the top limit of the field, whereas the last line must stand on the bottom limit. There are no half lines in typography: every empty space between title and text, between text and captions, or between sections of text is the equivalent of one or more whole lines. Only in this way can one be certain that the lines

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Programmes for solutions

Fig. 1 — Grid fields align with the lines set in the various type sizes.

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Programmes for solutions

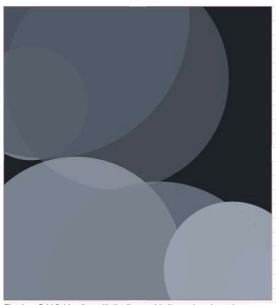

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Fig. 1 — Grid fields align with the lines set in the various type sizes.

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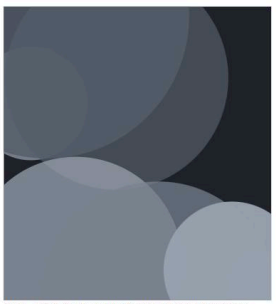
Programmes for solutions



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Programmes for solutions

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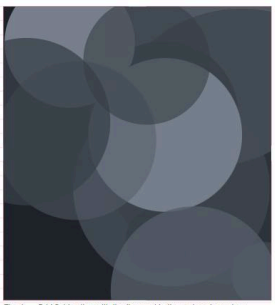

Fig. 1 — Grid fields align with the lines set in the various type sizes.

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Programmes for solutions

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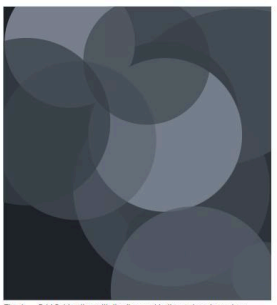

Fig. 1 — Grid fields align with the lines set in the various type sizes.

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Programmes for solutions

The grid divides a two-dimensional plane into smaller fields. The fields correspond in depth to a specific number of lines of text, and the width of the fields is identical with the width of the columns. The vertical distance between the fields is one, two or more lines of text. All illustrations, photographs and statistics have the size of one, two, three or four grid fields. The fewer the differences in the size of the illustrations, the quieter the impression created by the design. With the grid, a designer finds solutions which are functional, logical, and also more aesthetically pleasing.

Fig. 1 — Grid fields align with the lines set in the various type sizes.

Working with the grid system means submitting to laws of universal validity. The first line of the text in the grid field must fit flush against the top limit of the field, whereas the last line must stand on the bottom limit. There are no half lines in typography: every empty space between title and text, between text and captions, or between sections of text is the equivalent of one or more whole lines. Only in this way can one be certain that the lines

pages/edition-5-grid.svg · seed as published

Programmes for solutions

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Programmes for solutions

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pages/edition-6-grid.svg · seed as published

Programmes for solutions

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The grid divides a two-dimensional plane into smaller fields. The fields correspond in depth to a specific number of lines of text, and the width of the fields is identical with the width of the columns. The vertical distance between the fields is one, two or more lines of text. All illustrations, photographs and statistics have the size of one, two, three or four grid fields. The fewer the differences in the size of the illustrations, the quieter the impression created by the design. With the grid, a designer finds solutions which are functional, logical, and also more aesthetically pleasing.

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pages/edition-6.svg · seed as published

Grid systems in graphic design

Instead of solutions for problems, programmes for solutions. The typographic grid is a proportional regulator for composition, tables, pictures. It is a formal programme to accommodate x unknown items. The difficulty is to find the balance, the maximum of conformity to a rule with the maximum of freedom, or the maximum of constants with the greatest possible variability. The grid divides a two-dimensional plane into smaller fields. The fields correspond in depth to a specific number of lines of text, and the width of the fields is identical with the width of the columns. The vertical distance between the fields is one, two or more lines of text. All illustrations, photographs and statistics have the size of one, two, three or four grid fields. The fewer the differences in the size of the illustrations, the quieter the impression created by the design. With the grid, a designer finds solutions which are functional, logical, and also more aesthetically pleasing.

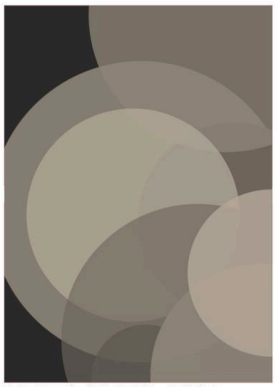


Fig. 2 — The mobile grid: 58 units, divisions into 1 to 6 columns.

Working with the grid system means submitting to laws of universal validity. The first line of the text in the grid field must fit flush against the top limit of the field, whereas the last line must stand on the bottom limit. There are no half lines in typography: every empty space between title and text, between text and captions, or between sections of text is the equivalent of one or more whole lines. Only in this way can one be certain that the lines of two or more columns are always in alignment.

pages/plate-mb74.svg · seed as published

Programmes for solutions

Working with the grid system means submitting to laws of universal validity. The first line of the text in the grid field must fit flush against the top limit of the field, whereas the last line must stand on the bottom limit. There are no half lines in typography: every empty space between title and text, between text and captions, or between sections of text is the equivalent of one or more whole lines. Only in this way can one be certain that the lines of two or more columns are always in alignment. Instead of solutions for problems, programmes for solutions. The typographic grid is a proportional regulator for composition, tables, pictures. It is a formal programme to accommodate x unknown items. The difficulty is to find the balance, the maximum of conformity to a rule with the maximum of freedom, or the maximum of constants with the greatest possible variability.

The grid divides a two-dimensional plane into smaller fields. The fields correspond in depth to a specific number of lines of text, and the width of the fields is identical with the width of the columns. The vertical distance between the fields is one, two or more lines of text. All illustrations, photographs and statistics have the size of one, two, three or four grid fields. The fewer the differences in the size of the illustrations, the quieter the impression created by the design. With the grid, a designer finds solutions which are functional, logical, and also more aesthetically pleasing.

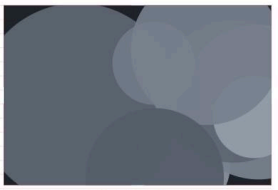
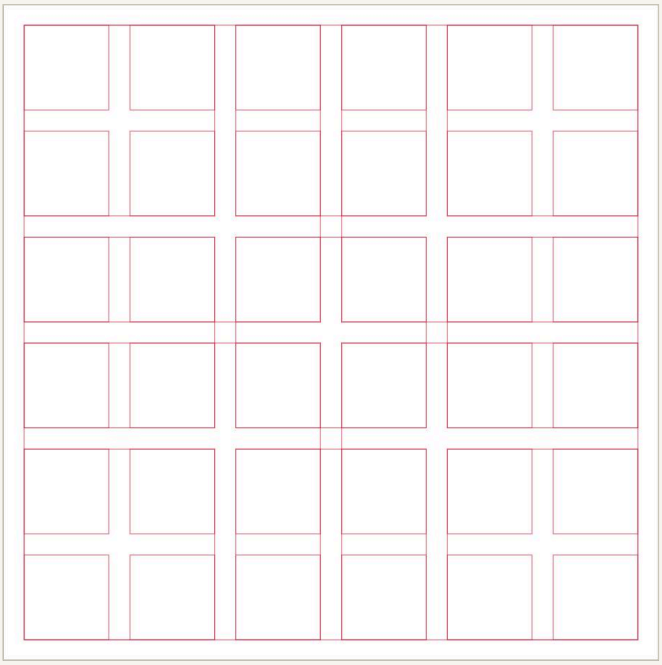


Fig. 1 — Grid fields align with the lines set in the various type sizes.

pages/plate-mb89.svg · seed as published



pages/poster-mobile-skeleton.svg · seed as published

pages/poster-mobile.svg · seed as published

الشبكة

كتيّب في الشبكة الطباعية، من اليمين إلى اليسار

GEVIERT

shabaka/shabaka-00.svg · seed shabaka-1

١

الوحدة

قبل أن يكون في الصفحة سطرٌ واحد، تكون فيها وحدة. الوحدة هنا هي ارتفاع السطر: حجم الحرف مضافًا إليه فراغٌ محسوب. كل مسافة عمودية في هذا الكتاب هي عدد صحيح من الأسطر، فلا يوجد نصف سطر في الطباعة، ولا في هذه المكتبة. هذه ليست عادة جمالية، بل قاعدة قابلة للاختبار، والمكتبة تحملها في مئة اختبار وأكثر.

حين تتفق الأحجام كلها على وحدة واحدة، تلتقي السطور على شبكة الأساس مهما اختلفت الأدوار: المتن، والعناوين، والتعليقات. وإذا خالف دورٌ ما هذه الوحدة رفضته المكتبة، وذكرت في رسالة الرفض أقرب الإعدادات الصحيحة. الرفض الذي يعلم أفضل من قبولٍ يكذب.

2

shabaka/shabaka-01.svg · seed shabaka-1

٣

الاتجاه

هذا الكتاب يقرأ من اليمين إلى اليسار، والمكتبة تعرف ذلك. الأعمدة تمتلئ من اليمين، والحافة المشرشرة تقع على اليسار، ومسافة أول السطر تقع على اليمين، وتوزيع الفراغات في الضبط الكامل يعمل هنا كما يعمل هناك، بلا استثناء ولا اعتذار.

السطر الأخير من الفقرة لا يُضبط أبدًا، في العربية كما في اللاتينية: الفقرة تنتهي حيث تنتهي كلماتها. والقياس لا يُحسب من جداول الخط بل يُقاس من المتصفح نفسه، حرفًا مشكولًا كما سيُرسم، فتقف السطور على شبكة الأساس بفارقٍ أقل من جزء من مئة من النقطة.

shabaka/shabaka-03.svg · seed shabaka-1

٤

البذرة

كل ما في هذا الكتاب من قرارات صغيرة، أين وقعت الفواصل، وأي عمود بدأ، خرج من بذرة واحدة: سلسلة حروف قصيرة تُحوَّل إلى أرقام، والأرقام إلى اختيارات. البذرة نفسها تعيد الكتاب نفسه، صفحة صفحة وسطرًا سطرًا، إلى الأبد.

وهذا هو الفرق بين أداة تساعدك على ترتيب الأشياء وبين برنامجٍ بمعنى غيرستنر: نحن لا نصمم حلًّا واحدًا، بل نصف فضاء الحلول الصحيحة كله، ثم نمد اليد فيه ببذرة. هذا الكتيّب الصغير أول ما مدت به المكتبة يدها نحو العربية، وليس آخره.

shabaka/shabaka-04.svg · seed shabaka-1

shabaka/shabaka-05.svg · seed shabaka-1

THE INTERFACE

The public interface follows, in full, as the TypeScript declarations ship it: 371 lines. The manual prints the interface because an interface a reader cannot see is an interface the reader must guess, and this volume was written against guessing.

```
// Type declarations for geviert — hand-written, kept honest by the test suite.
// The library itself is plain ES modules; these types are the map, not the
// territory. Where a rule cites a page, it cites Müller-Brockmann, Grid
// Systems in Graphic Design (1981) unless marked KG (Gerstner, Designing
// Programmes, 1964).

// ── type & measurement ──────────────────────────────────────────────

export interface Style {
size: number;
leading: number;
/** size + leading — the vertical unit everything registers on */
lineHeight: number;
font: string;
weight: 'normal' | 'bold' | 'semibold' | number;
italic?: boolean;
/** optional per-role ink (used when the style is a typeSystem role) */
color?: string;
/** optional per-role setting; 'center' is the centred axis (p.79) */
align?: 'left' | 'center' | 'justify';
}

/** A text style. Leading is the space ADDED to the size (9/3 → 12pt line). */
export function style(size: number, leading: number, opts?: {
font?: string; weight?: Style['weight']; italic?: boolean; color?: string;
}): Style;

/**
* Enforces the cross-size register (pp.59, 66): every role's line height must
* divide the module or be a whole multiple of it. Throws with the nearest
* legal settings named when a role breaks it.
*/
export function typeSystem<R extends Record<string, Style>>(spec: { module: number; role
s: R }): {
module: number; roles: R;
};

/** Width of a string in a style, from the registered metrics or the seam. */
export function measure(text: string, st: Style): number;
export function wordsPerLine(width: number, st: Style): number;

/**
* The largest face (min..max) whose measure holds `words` per line — the
* column decides the face (p.57); 8–12pt is the book floor (p.18).
*/
export function sizeForMeasure(width: number, opts?: {
words?: number; font?: string; min?: number; max?: number;
leadingRatio?: number; weight?: Style['weight'];
}): { size: number; leading: number; lineHeight: number; wordsPerLine: number; meets: bo
olean };

export interface BreakOptions {
/** Knuth–Plass when true (default); greedy when false */
optimal?: boolean;
```

```
mode?: 'left' | 'justify';
}
/** Break a paragraph at a fixed measure. */
export function breakLines(text: string, width: number, st: Style, opts?: BreakOptions):
string[];
/** The same breaker where the measure may change per line (drop caps, intrusions). */
export function breakVariable(text: string, widthFor: (line: number) => number, st: Styl
e, opts?: BreakOptions): string[];
export function breakIndented(text: string, width: number, st: Style, indentLines: numbe
r, indentWidth: number, opts?: BreakOptions): string[];

export interface FontMetrics {
family: string; capHeight: number; xHeight: number; descent: number;
fallbackWidth: number; widths: Record<string, number>;
dataUri?: string; format?: string;
}
export function registerFont(name: string, metrics: FontMetrics): void;
export function fontMetrics(name: string): FontMetrics;
/** @font-face CSS for every registered font that carries a dataUri. */
export function fontFaceCSS(): string;

/** Replace the measurement backend (the browser adapter uses this). */
export function setMeasurer(fn: ((text: string, st: Style) => number) | null): void;
/**
* Optional fast path for GREEDY breaking (never Knuth–Plass). Must agree with
* the built-in breaker line for line; return null to decline.
*/
export function setGreedyBreaker(fn: ((text: string, width: number, st: Style) => string
[] | null) | null): void;

/** A dropped initial (p.36): size derived from N body lines of cap height. */
export function dropCap(letter: string, opts: {
bodyStyle: Style; lines?: number; font?: string; weight?: Style['weight'];
italic?: boolean; color?: string; snap?: boolean;
}): { letter: string; lines: number; width: number; style: Style; color?: string; offset
Y?: number };

// ── paper, margins, grid ─────────────────────────────────────────

export interface Rect { x: number; y: number; w: number; h: number }
export interface Margins { inner: number; head: number; outer: number; tail: number }

export function marginsFromRatio(ratio: 'classical' | 'golden' | Margins, scale: number)
: Margins;
/**
* Scale a margin canon so the type area is exactly `fraction` of the page
* area (p.51 diagrams 1–2: the 1:2 relation).
*/
export function marginsForAreaFraction(page: { w: number; h: number }, ratio: 'classical
' | 'golden' | Margins, fraction?: number): Margins;
export function typeArea(page: { w: number; h: number }, margins: Margins, side?: 'left'
| 'right'): Rect;

export interface GridGeometry {
```

```
page: { w: number; h: number };
margins: Margins;
typeArea: Rect;
columns: Rect[];
rows: Rect[];
fields: Rect[];
line: number;
columnGutter: number;
rowGutter: number;
linesPerField: number;
side: 'left' | 'right';
/** rect spanning fields [col..col+cols) × [row..row+rows) */
field(col: number, row: number, cols?: number, rows?: number): Rect;
baselines(): number[];
}

/**
* The modular grid (pp.57–70): field heights are whole lines, gutters are
* whole empty lines. There is no way to express an off-grid position.
*/
export function grid(spec: {
page: { w: number; h: number } | 'A4' | 'A5' | 'A3';
margins: Margins;
columns: number; columnGutter: number;
line: number; rows: number; rowGutterLines?: number;
side?: 'left' | 'right';
}): GridGeometry;

/** The book's own dimensioned A4 reference grids (pp.73, 77, 88). */
export const presets: {
mb8(side?: 'left' | 'right'): GridGeometry;
mb20(side?: 'left' | 'right'): GridGeometry;
mb32(side?: 'left' | 'right'): GridGeometry;
};

// ── flow ──────────────────────────────────────────────────────────────

export interface Paragraph {
text: string;
/** a heading keeps `keep` lines of what follows with it */
keepWithNext?: boolean;
/** whole empty lines before (number), or false; default 1 ('line' device) */
spaceBefore?: number | boolean;
/** extra whole empty lines after — the rest zone (p.69) */
spaceAfter?: number;
/** set in styles[role]: its own face, whole slots, never split (pp.46-47, 87) */
role?: string;
/** hairline under the titled line (placement example 8, p.47) */
rule?: boolean;
/** a dropped initial, from dropCap() */
initial?: ReturnType<typeof dropCap>;
/** open a new page before this paragraph (a chapter, a concert) */
pageBreak?: boolean;
}
```

```
export interface FlowBox {
rect: Rect; lines: string[]; indents: number[]; flush: boolean[];
roles: (string | undefined)[]; slots: number[]; ruleAfter: boolean[];
}
export function flowText(text: string, rects: Rect[], st: Style): {
boxes: { rect: Rect; lines: string[] }[]; overflow: string | null; overflowWords: numb
er; spareLines: number;
};
export function flowParagraphs(paragraphs: (Paragraph | string)[], rects: Rect[], st: St
yle, opts?: {
keep?: number; widowControl?: boolean; minLines?: number;
mode?: 'left' | 'justify'; optimal?: boolean;
styles?: Record<string, Style> | null;
/** paragraph device (p.34): 'line' (default) or 'indent' */
device?: 'line' | 'indent';
indentWidth?: number | null;
}): {
boxes: FlowBox[];
initials: { box: number; line: number; slot: number; letter: string; initial: ReturnTy
pe<typeof dropCap> }[];
overflow: string | null; overflowWords: number;
overflowParagraphs: Paragraph[]; spareLines: number;
};

// ── the document layer ──────────────────────────────────────────

export interface Figure {
id?: string;
/** substring of the story this figure belongs beside ("(Plate 3)") */
anchor?: string;
/** size vocabulary in grid columns × field rows — few graded sizes (p.11) */
sizes?: { cols: number; rows: number }[];
cols?: number; rows?: number;
href?: string;
/** preferred w/h; the beam scores placements against it */
aspect?: number;
aspectWeight?: number;
caption?: string;
captionColor?: string;
/** one ink (feColorMatrix ramp in SVG) */
duotone?: boolean | { shadow: string; highlight: string };
fit?: 'meet' | 'cover';
/** run off the paper on these sides */
bleed?: boolean | ('left' | 'right' | 'top' | 'bottom')[];
/** take the whole leaf, caption in the margin */
fullPage?: boolean;
captionBg?: string;
/** ── the cut-out apparatus (p.98) ── */
/** colour area beneath the cut-out, sized to its fields */
tint?: string;
/** line border with the field's dimensions */
border?: boolean; borderWidth?: number; borderColor?: string;
/** rules at the field's top and bottom limits */
```

```
bracket?: boolean; bracketWidth?: number; bracketColor?: string;
/** colour printed over the photograph — dominant */
overprint?: string;
/** a pull quote occupying fields, sized to fill them */
quote?: string; quoteStyle?: Style; quoteColor?: string;
/** a statistic occupying fields; bars are whole text lines (pp.14, 58-59) */
chart?: {
data: { label?: string; value: number }[];
max?: number; barColor?: string; color?: string;
format?: (v: number) => string;
};
seed?: string;
}

export interface PageItem {
kind: 'text' | 'image' | 'block' | 'rule' | 'frame' | 'chart';
rect: Rect;
[key: string]: unknown;
}
export interface ComposedPage {
number: number; grid: GridGeometry; items: PageItem[];
side: 'left' | 'right'; plate?: boolean;
}

/**
* The point of the library: story + figures + grid + seed → pages.
* Deterministic: the same seed returns the same book, forever.
*/
export function composeDocument(spec: {
grid: GridGeometry | ((ctx: { pageNo: number; side: 'left' | 'right' }) => GridGeometr
y);
styles: Record<string, Style> & { body: Style };
story: string | (Paragraph | string)[];
title?: string | null; titleRows?: number;
figures?: Figure[];
seed?: string;
folio?: { start?: number; placement?: 'second-column' | 'left' | 'outer' | 'center' }
| false;
maxPages?: number;
ink?: string | null;
/** grid columns per text column (the book's own page spans 2, p.87) */
textSpan?: number;
textSnap?: boolean | null;
/** the taste dial, in cost units — see each key's page in the source */
harmony?: { newSize?: number; sameBand?: number; sharedEdge?: number; stacked?: number
; adrift?: number };
/** pull toward the anchor's column: a preference, not a law */
anchorPull?: number;
dispositions?: { bands?: number[]; bandPull?: number; heroChance?: number; heroPull?:
number };
bodyAlign?: 'left' | 'justify' | 'center';
minSegmentLines?: number;
marginCaptions?: boolean;
/** paragraph device (p.34): 'line' | 'indent' */
```

```
paragraphDevice?: 'line' | 'indent';
indentWidth?: number | null;
/** elastic limits for justified spaces, in multiples of the natural space */
justify?: { shrink?: number; stretch?: number };
captionAir?: number;
titleRule?: { offset?: number; width?: number };
quoteFit?: { ceiling?: number; leading?: number };
/** softmax temperature of the page search; 0 = deterministic top-k */
explore?: number;
}): {
pages: ComposedPage[];
report: {
fits: boolean; leftoverWords: number;
figures: { id: string; placed: boolean; page?: number; anchorPage?: number; drift?:
number }[];
};
};

// ── rendering ──────────────────────────────────────────────────────────

/** One page → a self-contained SVG string. */
export function renderPage(spec: {
grid?: GridGeometry; page?: { w: number; h: number };
items?: PageItem[];
showGrid?: boolean; showBaselines?: boolean;
background?: string; scale?: number;
}): string;

/**
* One page → live DOM: selectable text on the baseline grid, baselines
* MEASURED from the browser (never computed from font metrics).
*/
export function renderDOM(page: { grid?: GridGeometry; page?: { w: number; h: number };
items: PageItem[] },
container: HTMLElement,
opts?: { scale?: number; background?: string; showGrid?: boolean; showBaselines?: bool
ean }): HTMLElement;
export function clearBaselineCache(): void;

/** Measure through the canvas of the very fonts about to be drawn. */
export function useBrowserFonts(opts?: { families?: Record<string, string>; scale?: numb
er }): Promise<void>;
export function pageFromElement(el: HTMLElement): { w: number; h: number };

// ── helpers ────────────────────────────────────────────────────────────

export function folio(g: GridGeometry, pageNumber: number, opts?: {
placement?: 'second-column' | 'left' | 'outer' | 'center';
lines?: number; style: Style; side?: 'left' | 'right';
}): PageItem;
export function captionBelow(imageRect: Rect, text: string, st: Style, opts?: { lines?:
number; gapLines?: number }): PageItem;

// ── hyphenation ────────────────────────────────────────────────────────
```

```
export function setHyphenator(fn: ((word: string) => string[]) | null): void;
export function hyphenatorFrom(hyphenateSync: (word: string) => string): (word: string)
=> string[];

// ── randomness ──────────────────────────────────────────────────────────

/** xmur3 + sfc32: the seeded PRNG everything deterministic runs on. */
export class Rand {
constructor(seed: string);
dec(): number;
int(maxExclusive: number): number;
choice<T>(arr: T[]): T;
}
export function xmur3(seed: string): () => number;
export function sfc32(a: number, b: number, c: number, d: number): () => number;

// ── the programme layer (Gerstner) ──────────────────────────────────────
// Typed loosely on purpose: the solver's DSL is documented in the README and
// research/foundations.md; these types keep call sites honest without
// freezing a young API.

export function programme(spec: object): {
solutions(opts?: { limit?: number }): object[];
count(): number;
layout(seed: string): object;
reroll(seed: string, opts?: { lock?: string[] }): object;
sample(seed: string, n: number): object[];
};
export function mobileGrid(units: number, opts?: object): object;
export function mobileProgramme(spec: object): object;
export function gerstnerNumber(divisions: number[], gutter: number): { units: number; wi
dths: Record<number, number[]> };
export function compoundProgramme(spec: object): object;
export function morphologicalBox(axes: Record<string, unknown[]>): {
count: number; at(index: number): Record<string, unknown>; sample(seed: string): Recor
d<string, unknown>;
};

export function mfield(...args: unknown[]): object;
export function malign(...args: unknown[]): { left(): object; right(): object; top(): ob
ject };
export function mbelow(...args: unknown[]): object;
export function mwhitespace(...args: unknown[]): object;
export function story(...args: unknown[]): object;
export function initialIndents(...args: unknown[]): number[];
```

THE SUITE, BY NAME

The library carries 103 tests, and their names are assertions of the canon. They are printed here in full because a claim of coverage without a list of claims is weather. Each runs on every change, with no network and no browser.

1. imageSize reads PNG dimensions from a data URI
2. aspect preference picks the field span nearest the source ratio
3. aspect is a preference, not a guarantee: anchor proximity can still win
4. single fixed size still works (cols/rows form)
5. balance: a large figure is not left adrift in the middle band
6. Gerstner's typogram box: 13 parameters, thousands of chains (KG p.59)
7. box: deterministic pick, valid chains, mixed-radix enumeration
8. tint rule: inset indents the text, bleed extends the tint (MB pp.101-103)
9. units: the book constants (MB p.18)
10. paper: ISO 216 table exact (MB p.16)
11. line divisions: the 57→55 worked example (MB pp.58-59)
12. line divisions: 53 = 9×5+8 = 6×8+5 (MB p.67)
13. line divisions: MB's five ways for 59 lines (MB p.67)
14. cross-size baseline module: 24pt (MB pp.59, 66, 87)
15. gerstner number: 58 is minimal for divisions 1..6 at gutter 2 (KG p.61)
16. gerstner arithmetic: the exact decompositions (KG p.61)
17. margin canons (MB pp.41, 51)
18. type area = half the paper area (MB p.51 diagrams 1-2)
19. margin advisories catch the book's bad examples (MB pp.40-41)
20. the 8-field reference grid (MB p.73)
21. the 20-field reference grid (MB p.77)
22. the 32-field reference grid shares the 8-field envelope (MB p.88)
23. canon-mode grid fits fields to whole lines (MB p.58)
24. merged fields include interior gutters (MB p.60)
25. picture-format vocabulary: columns × rows sizes (MB pp.75, 79, 90-92)
26. mobile grid: Capital spec (KG p.61)
27. mobile grid rejects a non-dividing unit count with a helpful error
28. composeDocument: everything fits, every figure placed exactly once
29. composeDocument: figures never overlap text or each other
30. composeDocument: deterministic per seed, varies across seeds
31. composeDocument: figure drift is reported, not hidden
32. composeDocument pages render
33. the anchor column is a preference: seeds move pictures across columns
34. the spare column is a margin column, and it mirrors
35. captions set in the margin column when there is one, and mirror with it
36. pageBreak: each section opens a fresh page
37. direction rtl: columns fill right to left and items carry dir
38. flowText fills boxes to whole-line capacity and threads the remainder
39. flowText reports overflow honestly, never clips silently
40. boxes of different widths re-break the same story
41. story emits renderable items and the red overflow marker
42. flowParagraphs marks the line that ends each paragraph
43. renderPage does not justify a paragraph-final line inside a block
44. a titled paragraph occupies whole slots in its own style
45. a title whose line height breaks the register is refused, with the citation
46. a title is never split across boxes: it moves whole
47. registerFontFile: a TTF becomes a measurable geviert font in one call
48. registerFontFile refuses helpfully without its optional peer
49. captionFit: one 7/1 caption line lives in the 15pt gutter (MB p.63)
50. gutterCaption centres in the gutter and refuses impossible spots
51. figure: consumed extent snaps to whole body lines with clearance (MB pp.110, 134)
52. with no hyphenator the breaker behaves exactly as before
53. breakPoints honours minimum stubs and word length
54. hyphenation tightens the greedy breaker and never loses a letter
56. punctuation does not prevent hyphenation (real prose wears commas)
57. the ladder rule caps consecutive hyphenated lines
58. syllablesFrom adapts a soft-hyphen string API
59. the real hyphen package drives it, if installed
60. Knuth–Plass beats greedy on total badness (the objective it optimises)
61. the ladder rule is a HARD constraint in the optimal breaker too
62. paragraphs are separated by one whole empty line (MB p.80)
63. a heading never strands at the foot of a segment
64. a heading with room keeps its body in the same segment
65. orphans and widows are refused
66. overflow paragraphs are returned for the next page
67. solver enumerates the complete solution space on a countable case
68. unary constraints prune candidates
69. binary constraints hold in every solution
70. global constraints filter complete layouts
71. distinctSizes enforces MB p.11 calm rule
72. layout(seed) is deterministic and seed-sensitive
73. reroll keeps locked items fixed
74. rects land on the grid geometry
75. Rand: deterministic stream
76. renderSVG smoke: grid, layout, mobile
77. sampling reaches the whole space, not one corner of it
78. small spaces are still enumerated exhaustively (no sampling loss)
79. typeSystem enforces the 24pt register (MB pp.59, 66, 87)
80. measure and breakLines behave sanely
81. wordsPerLine advisory lands near MB's 7-10 for the book's own measure
82. renderPage typesets: text lands on baselines, images clip, folio/caption helpers
83. mobile programme: cross-division placement, determinism, locks
84. malign aligns across divisions
85. sizeForMeasure derives the face from the column, monotonically, within 8-12pt
86. folio box is the numeral, not a slot
87. setGreedyBreaker: fast path serves greedy only, and null falls through
88. justified lines fill the measure exactly; the last line does not
89. justify never produces grotesque word spaces (falls back to ragged)
90. breakIndented shortens exactly the first n lines
91. an initial letter is drawn once and removed from the flowed text
92. a pull quote occupies fields and text flows around it
93. a full-page plate takes its own leaf, edge to edge
94. rotated text emits a rotation transform
95. square pages are just a page size
96. dropCap derives its size and well instead of guessing
97. a paragraph continued on the next page does not repeat its initial
98. a paragraph that never begins keeps its initial for the next page
99. an initial never starts unless its full depth fits
100. a heading keeps enough room for a following initial
101. tint, border, bracket and overprint tie a cut-out into the grid
102. a chart figure occupies fields and its bars snap to whole lines
103. a role may set on the centred axis

THE GEVIERT MANUAL. Set by the library it specifies: grotesque 9 on 12 on a four-column grid of thirty-two fields, two text columns, first lines indented one em, justified with elastic spaces between 0.55 and 4 of the natural space, plates placed by the beam under the published weights, composed from seed “manual-1” in 352 milliseconds. The cover reproduces the construction of the cover of Grid Systems in Graphic Design (Niggli, 1981), to which this volume owes its rules and its manners. Specimens from the library’s prior books, each with its seed. The interface and the test names are printed from the working tree. GEVIERT, das Geviert, the em quad.