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Anthony Gerbino and Stephen Johnston *Compass and Rule: Architecture as Mathematical Practice in England, 1500–1700* Exh. cat. Oxford and New Haven: Museum of the History of Science, Yale University Press, and Yale Center for British Art, 2009. 192 pp.; 120 color ill. Cloth \$65.00 (9780300150933)

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Compass and Rule: Architecture as Mathematical Practice in England, 1500–1750 tells a story of social class played out in math class. In the exhibition and catalogue, Anthony Gerbino and Stephen Johnston chart the rise of the professional architect in the early modern era by presenting the tools of the trade. Subtitle notwithstanding, *Compass and Rule* does not focus on architecture itself but rather on architectural drawing, describing the development of drafting techniques and instruments which led to a division between the design and construction phases of building. Although Gerbino and Johnston are not the first scholars to make this argument about the relationship between drawing and professional organization—it was, for example, a focus of Henry Millon and Vittorio Lampugnani's 1994 exhibition, *The Renaissance from Brunelleschi to Michelangelo*—their show added a new twist with its emphasis on the mathematical principles that British architects applied to their work. This differentiates their project from most of the scholarship on architectural drawings, where the main current rarely flows farther north than medieval France or Germany and tends to pool in the Italian Renaissance.

The scope of *Compass and Rule* might strike some as narrow, since a quarter-century of architectural production cannot be viewed through a single lens without a few distortions. Yet the benefits of this approach are clear, as the authors' willingness to test their thesis with objects brings several obscure issues into sharper focus. Case in point: the first catalogue essay, "Medieval Drawing and the Gothic Tradition," mentions the relative paucity of early English drawings in comparison to the wealth of material from German cathedral lodges, but then fills this void by focusing on a few idiosyncratic objects. Tucked into the binding of a fifteenth-century book listing the names of diners at a college, a plan of the court and kitchen of Winchester College from 1394 might have easily escaped notice given that it consists only of a couple of walls and a short staircase. Nevertheless, Gerbino and Johnston argue for its importance as the sole surviving working plan—i.e., a design drawing to be used for a building project, not a representation of an existing structure—from England prior to 1500. Schematic drawings like a London plot plan and simple building elevation from ca. 1475 are described in terms of their value as survey records. As a document of an official transaction, this particular sheet lacks the glamour of the two early sixteenth-century drawings by William Vertue that follow (one a proposal for a tomb for Henry VI and the other an elevation of a bay from Winchester Cathedral), but Gerbino and Johnston give it equal time, explaining how each line and annotation on the drawing relates to a different aspect of surveying. The attention paid to what drawings do rather than to how they look is the most refreshing aspect of *Compass and Rule*.

The relationship between drawing conventions and real-world practicalities is also the theme of the second catalogue essay, "The Paper Revolution: The Origin of Large-scale Technical Drawing under Henry VIII." It centers on a selection of sixteenth-century survey maps and fortification plans made by the Tudor military engineers Richard Lee and John Rogers. Now in the Cottonian collection of the British Library, these drawings offer some purely visual pleasures, such as the meticulously penned ships in Lee's view of the town and harbor of Calais or the quaintly arranged houses with piping chimneys in Rogers's plan for the fortifications of Hull in Yorkshire. But their real import lies in their practical functions and the ways those ends are achieved through the draftsman's ability to represent elements to scale.

The Hull drawing, for example, contains a plan for the construction of a 2,500-foot defensive wall with bulwarks to be built outside the town. When contrasted with the picturesque rendering of the houses that this wall is meant to protect, the carefully ruled lines of the proposed structures convey the gravity of the town's situation and the thoughtfulness of the engineer's response to it. In the same vein (though less lovely) is a survey plan of Guines that shows only the town's outermost walls and defenses, drawn with minimal detail. Thus the most eye-catching element in the drawing is the scale itself, a measuring tape that wraps around the perimeter of the town like a second moat. In their essay, Gerbino and Johnston argue convincingly that devices like this scale allowed drawings to be used as precision instruments for military planning. The Lee and Rogers survey drawings, they contend, are actually the earliest known scale plans in England. A longer discussion of the continental context would be welcome here, as readers are only briefly reminded of the fact that drawings like this had been in use in Italy since the late fifteenth century. Furthermore the richness of this new material makes it all the more confounding that the catalogue entries for the objects fail to include their dimensions—a curious sin of omission for a study whose central thesis is that size matters.

Fortification drawings constitute an early section of *Compass and Rule*, and once the catalogue moves on to other topics, the military engineers are not heard from again. Their voices are quickly eclipsed by other practitioners who applied mathematical principles to problems of architectural design, first among them Leonard Digges, whose *Tectonicon* of 1556 dealt with methods of measurement. Title pages of books are often included in exhibitions or reproduced as illustrations as a way of making a rhetorical point about a work's historical importance, but to little visual effect; for once this is not the case. *Compass and Rule* features not one but two copies of the *Tectonicon* in the essay "The Mathematical Practitioner and the Elizabethan Architect," and each of them earns its place. In a copy of the first edition from the Bodleian Library, the central woodcut showing two figures measuring the height of a tower with a cross staff has been hand-colored. The pigments draw attention to the way the ground plane doubles as a scale, with the surveyors' distance from the tower divided into units of human paces. A copy of the 1592 edition from the same library is covered in annotations, made by an owner whose relentless effort to add marginal definitions for terms brings new meaning to the idea of close reading.

Digges's *Tectonicon* included illustrations of instruments for measuring and drawing, as well as instructions on how to use them, and this third chapter of *Compass and Rule* aims to do the same. A short history of the carpenter's rule from the ubiquitous simple wooden stick to the elaborate brass models turned out by instrument makers like Humfrey Cole encapsulates Gerbino and Johnston's argument that the application of practical mathematics helped transform architecture from a craft tradition into a more rarified profession. This essay might have been better paired with the seventh chapter, "Gentlemen, Practitioners, and Instrumental Architecture," which presents sets of drawing tools stored in carrying cases of gilt brass or sharkskin and lined with velvet. Contrast these instruments with the hefty wooden builder's level and iron compass illustrated at the beginning of the catalogue and one must concede the authors' point—although the level and compass in question actually date to the eighteenth and nineteenth centuries, respectively.

Two other objects illustrated in *Compass and Rule* reiterate this shift from craft to profession. A stone from the late thirteenth-century hospital chapel of St. John the Evangelist bears the incised lines of a design for a window, carved into the floor of the building site with a metal compass. Made entirely of arc segments, the arrangement seems particularly simple when compared to Robert Smythson's design for a rose window, a delicate spiral of interlocked petals drawn with pen and ink on paper. Dating to 1599, the drawing shows the window in both plan and elevation, aligned along an axis with a scale at its center. The *Compass and Rule* exhibition included video demonstrations of how drafting tools were used to generate forms like these—the videos are now posted on the exhibition website—but these demonstrations are, to a certain degree, extraneous. Smythson's drawing displays a degree of complexity so beyond that of the stone carving that the technical advantages of these tools are immediately obvious.

Compass and Rule follows this narrative thread of progressive specialization within the architectural profession along two trajectories. On the one hand the essay "Raised High, Brought Low: Architecture and Mathematics around George III" traces the idea of drawing as an intellectual exercise, one that culminates in the monarch's lackluster studies of the orders from the late 1750s. It is exactly this kind of fussy obsession with details, divorced from the realities

of building, that William Hogarth satirized in his print *The Five Orders of Perriwigs* (1761), which presented and dissected hairstyles like so many varieties of column capitals. But the real evisceration is performed by Gerbino and Johnston, who present the inimitable Christopher Wren as the other pole in the development of architectural drawing in Britain.

A founder and president of the Royal Society—a group whose activities are, unfortunately, barely discussed in *Compass and Rule*—Wren from an early age was interested in astronomy, anatomy, and other scientific pursuits; architecture came later. In three essays that feel like a book-within-a-book, Gerbino and Johnston devote themselves to reconciling these different aspects of Wren’s biography. First, the essay “Vision, Modelling, Drawing: Christopher Wren’s Early Career” demonstrates both the range of the architect’s graphic technique and the limitless curiosity of his mind by including his pencil sketches for a weather clock, watercolor of a small intestine, plan for the Sheldonian Theater at Oxford, and most spectacularly, diagram of the path of the comet of 1664. The following essay, “Structure and Scale: The Office of Works at St. Paul’s,” rapidly switches gears to explore the project drawings for the cathedral, most of which cannot be assigned to Wren. A third essay is necessary to connect these dimensions of Wren’s career together, and it is a shame that a piece by Gordon Higgott that largely accomplishes this task is found at the end of the catalogue, separate from the first two essays.

In “Geometry and Structure in the Dome of St. Paul’s Cathedral,” Higgott, acknowledged dean of studies of St. Paul’s, explores how the problem of covering the vast expanse over the crossing was investigated in a series of drawing experiments. Higgott untangles the graphic evidence for the development of the resulting triple-shell solution, presenting each sheet as a response to a particular structural concern. The catalogue includes several examples of these drawings for St. Paul’s made by draftsmen from the Office of the Works—Nicholas Hawksmoor and William Dickinson among them—and two by Wren himself: one project from before the Great Fire of 1666 and one for the dome from around 1690 that shows how Wren used the cubic parabola as the basis for the curvature. In this last drawing, Wren proves himself to be the epitome of the professional architect driven by an interest in and knowledge of practical mathematics. In *Compass and Rule* it is he, not George III, who deserves the royal treatment.

Compass and Rule sets out to explore a single aspect of architectural practice (the role of mathematics) in one country (Britain) during a relatively short time frame (1500–1750). The subtitle’s narrow brief works well for the catalogue, which weaves a coherent narrative out of esoteric material, much of it new. And at a time when most museums are suffering budget cuts, the exhibition—the Yale venue in particular, where items from the Center for British Art’s Paul Mellon collection were substituted for the British Library drawings that could not travel to the United States—demonstrated how smaller-scale shows culled primarily from local collections can in fact be a boon for specialists.