Short Abstract

Interpretations of Marks from Draughting Tools in
Some Italian Renaissance Drawings

Evidence for the Use of Geometrical and Numerical Design Systems

Trinity Term 2002

Submitted in partial fulfilment of the requirements for the degree of
Doctor of Philosophy at the University of Oxford
by Edward Ford, Trinity College

The focus of this thesis is the examination of evidence left by draughting tools in Italian Renaissance drawings. Because of the archaeological evidence of tool marks it is possible to investigate artists' use of design systems in a scientific manner, with almost forensic certainty. When evidence is sufficient and interpreted in the context of design traditions, the sequence of steps that the designer employed can be recreated, shedding light on the artists' methods and the decisions that informed the design process.

The historical survey in Part I describes the origins and subsequent manifestations of two primary design systems that, I argue, were traditional among designers up to the Renaissance. These are the numerical and geometrical systems of designs. Numerical systems involve simple ratios that derive from relationships found in nature, e.g. musical harmonies. Geometrical systems involve using a compass and straightedge to locate points and intersections that aid in building compositions. Part II contains analyses of physical evidence in drawings by Leonardo, Antonio da Sangallo, Palladio, Uccello, Michelangelo and Peruzzi.

My conclusion is that evidence from draughting tools can be brought to bear on the question of artists' design procedures; that information on artists' design procedures, thus obtained, cannot usually be found anywhere else; and that revealing the information requires the implementation of an investigative methodology. This methodology involves examining and recording the tool marks and determining the sequence of their creation by reference to the design traditions. The results of the drawing analyses provide examples of artists design procedures revealed by this methodology.

As a draughtsman and designer myself, I have a special appreciation for drawings, compositions and the process of making them. It is my hope that others who share this appreciation and desire to investigate further, can benefit from the methodology and investigatory results of this thesis.

Long Abstract

Interpretations of
Marks from Draughting Tools
in Some Italian Renaissance Drawings
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Many have examined the celebrated masterpieces of the Italian Renaissance looking for the "secrets" behind their designs. The desire to discover hidden proportional or geometric systems has lead to insufficiently grounded, speculative analyses with questionable methodologies. The results of these analyses, instead of providing an accurate picture of how artists designed their works, have made all investigations into the proportional and geometrical underpinnings of design less reputable. But this does not have to be so. It is possible to investigate such design systems in a scientific manner, considering the archaeological evidence within the works themselves, and historical contexts.

The focus of this thesis is the examination of the kinds of evidence left by draughting tools in selected Italian Renaissance drawings, especially those for designed structures for which a geometrical foundation is obviously required. This evidence can be interpreted, in the context of design traditions, to provide us with a clearer picture of some artists' methods of design. The method of investigating design processes in the following analyses eschews the overlaying of

imagined geometrical grids and speculation involving harmonic numbers, in favor of interpreting indentations from dividers and grooves caused by a stylus drawn against a straightedge. Because these marks form a physical record of the designers' steps in the design process, they can sometimes be analyzed with almost forensic certainty. In those cases where evidence is sufficient, the sequence of steps that the designer employed can be recreated so as to shed light on the decisions that informed the design process.

The draughting operations that are here described and analyzed have been brought to light by the examination of countless infinitesimal marks. My method of research was to examine the original drawings with a small light held at a low angle to the paper to cast a raking light over the surface. This is because much of the visible evidence consists of construction marks impressed into the paper by a compass and stylus. Designers who use these tools often rely on the almost invisible incised marks as reference for their compositions. Interpreting these marks requires an awareness of what kinds of operations these are and how they came to be performed. It is also helpful to be aware of this background when following these analyses. To this end, Part I provides this historical context for the analyses in Part II.

The historical survey in Part I describes the origins and subsequent manifestations of two primary design systems that, I argue, became traditional among designers up to the Renaissance. These are the numerical and geometrical systems of designs. Numerical systems involve simple ratios that derive from relationships found in nature, e.g. musical harmonies. Designers, since Antiquity, used numerical systems to make compositions or organize parts of compositions by means of enumerated modules. Modules are standardized units of length that can be multiplied or divided but their numerical relationships are governed by the system and are the expression of the system. Numerical systems are conceptual; the design is in the idea and its philosophical or theological rationalizations, rather than in the actual visual phenomena. The origins of numerical systems in design contexts are in the writings of Greek philosophers who understood numbers to be essential elements in their cosmologies. In the Middle Ages, Christian theologians combined Greek cosmology with the metaphor of God as an architect, who designed with numbers and geometry. Because certain

numbers or number combinations have special religious and metaphysical properties, designing with numerical systems that take part in those properties can produce designs that are supposedly consonant with cosmic order.

The other system is know as the geometrical system of design or "constructive geometry" and is much more visual and "hands on." It involves the use of a compass, or dividers, a stylus and a straightedge. Designing with geometry means using the tools to locate points by means of intersecting lines and arcs. The points are connected with lines to make shapes. The structure of a composition can be laid out with these tools, following geometric procedures, resulting in a design that is visually stable. From its ancient origins to the Renaissance designers used geometric systems to give their designs structural unity. Because the process of designing with geometry involves steps, where each step depends on the preceding steps, it is sometimes possible to recreate, with a high degree of certainty, the sequence of steps in an analysis. Geometrical systems can either be used along with numbers or without them. There are cases, however, where geometrical operations result in measures that are incommensurable and consequently designers sometimes found it necessary to find ways to resolve the conflict.

Some Renaissance texts contain references to the process that I term trial, judgment and modification. This is simply the process of repeatedly changing the initial attempt at design, with the designer responding to prior attempts, in a sequence that delays commitment and increases the number of possibilities, until the designer is satisfied. Where this process is recorded in drawings, there is a trend throughout the Renaissance, possibly initiated by Leonardo, to lengthen the process, so that more trials are attempted, often within a single drawing. The process of trial, judgment and modification can occur when designing in either a systematic or unsystematic manner. In those cases where this process is employed in an unsystematic or intuitive manner there can be no successful reconstruction of the steps. When multiple trials are made while designing systematically, however, the steps can sometimes be reconstructed, revealing the restrictive effects that the system causes in the design process.

One of the procedures of the geometrical design process that I have singled out as especially significant is the crossed arcs method of drawing a

perpendicular lines. One reason for the significance is the frequency with which it is mentioned in Renaissance treatises. Tool marks, showing that the procedure was used, are also found on many drawings by a wide range of artists and architects. I theorize that there is a ritual aspect to the use of the crossed arcs method that provides a reassuring indication to the designer that the drawing is well started.

Part II of the thesis consists of observations and analyses of specific drawings, arranged according to the chronology of the artists. Chapter 4 addresses Leonardo's design process for the drawings *Perspective Study for the Adoration* and *The Madonna and Child with St. Anne and the Infant John the Baptist*. The analysis of *The Adoration* shows the steps that Leonardo undertook to construct the perspective grid. Analysis reveals that Leonardo began the construction with the greatest care and attention to geometric accuracy and, over time, gradually transformed into a procedure that was loose and gestural. In the *Madonna* drawing, Leonardo employed his typically loose manner until the figures were drawn, but afterward used dividers and straightedge to precisely locate and calibrate the proportions of the bounding rectangle. In each case, Leonardo's priorities changed during the design process.

An analysis of the sequence of drawings that Leonardo made for the *Adoration* shows that Leonardo's concern for illustrating the illusion of space changed according to the design process he was using. In the intuitive mode he rendered the architectural scene so that the illusion of space was emphasized. In the more cerebral mode of working out the perspective framework and in the final painting, he chose a more flattened, representational point of view.

Chapter 5 is a detailed analysis of an exemplary construction of some complexity, a full scale drawing for an architectural pilaster base, destined for St. Peter's, by Antonio da Sangallo the Younger. The purpose of the drawing was to make a template from which the pilaster base could be cut. Since the forms of a pilaster base are traditional and there were any number of available sources, including Vitruvius' prescription and the bases in the Pantheon, a profile could have been easily copied. Sangallo was, to some degree, obligated to follow tradition, however, he left behind evidence that he did introduced his own inventiveness into the design. The analysis reveals that the designer performed all of the

design procedures discussed in this thesis. There are examples of constructive geometry, numerical ratios, crossed arc axes, and trials and modifications. A large number of construction marks resulted from the design process and were clearly visible in the paper. The amount of evidence in the original drawing allows for an exceptionally complete analysis of the whole design process from beginning to end.

Chapter 6 is a complementary analysis of another architectural drawing from Sangallo's extensive and important oeuvre. It is a design for a Corinthian capital. The analysis reveals Sangallo's use of constructive geometry to modify, and perhaps improve upon, a design for a Corinthian capital prescribed by Vitruvius. Sangallo's solution involves combining the plan and elevation into one unified geometrical construction.

Chapter 7 looks at Andrea Palladio's design process with reference to Palladio's treatise, *I quattro libri* and contains observations of his design drawings in the collection at the Royal Institute of British Architects. My analysis infers from the treatise an emphasis by Palladio on geometry as his major system of design. The observations of Palladio's drawings also reveal some evidence of thinking along geometric lines. This is in contrast to Wittkower's thesis, currently the orthodox view, that numerical proportion, (specifically harmonic numbers), was at the center of Palladio's design process.

Chapter 8 contains more limited analyses of a selection of drawings that were not candidates for full chapters. These drawings, however, contain information that supports the conclusions of this thesis. Leonardo's *Vitruvian Man* drawing reveals the dichotomy and interaction between the two design systems under discussion. Uccello's *Chalice* drawing illustrates the use of perspective as constructive geometry in its most complex application. An anonymous Italian architectural drawing from the 16th or 17th Centuries demonstrates the continued application of the kind of constructive geometry for architecture advocated by Francesco di Giorgio in the 15th Century. Finally, two drawings for the church San Giovanni dei Fiorentini, one by Michelangelo, the other by Baldassarre Peruzzi, are compared to show the differences between the intuitive and systematic approaches.

My conclusion is that evidence from draughting tools can be brought to bear on the question of artists' design procedures. The information on artists' design procedures, thus obtained, cannot usually be found anywhere else and revealing the information requires the implementation of a certain investigative methodology. This methodology involves examining and recording the tool marks and determining the sequence of their creation by reference to the design traditions. The design traditions that I analyzed are the geometrical and numerical design systems. The results of the drawing analyses provide examples of artists design procedures revealed by this methodology. Although a relatively small number of drawings have been subjected to detailed analysis – for practical reasons – it is envisaged that the kind of analysis I am undertaking can be applied to a large, if currently undefinable, number of drawings in the Renaissance.

The opportunity to examine closely so many great drawings and to attempt to unlock some of their secrets has been a fascinating experience. As a draughtsman and designer myself, I have a special appreciation for drawings, compositions and the process of making them. It is my hope that others who share this appreciation and desire to investigate further, can benefit from the methodology employed and the investigatory results of this thesis.