PHOTOGRAMMETRY AND ARCHITECTURE: THE ANATOMY OF BERNINI'S BALDACHIN (1624-33)

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ABSTRACT

The use of photogrammetry, by Italy's leading centre, to construct the first detailed analytical and graphic renderings of the colossal Roman monument, is discussed. Problems of restitution are indicated, given the extreme three-dimensional nature of the structure; and the initial synthesis of the photogrammetric results is presented in this preliminary report.

TEXT

The Laboratory of Photogrammetry, University of Venice, publishes here for the first time a sampling of the measured drawings of Bernini's Baldachin in St. Peter's, Rome. This occasion provides the forum for a detailed explanation of the various technical devices that were employed during the different stages of the work, but it would have been a tedious report indeed. We preferred instead to submit for consideration more general issues that have arisen during this extraordinarily complicated investigation. And it seemed appropriate for Professor W. Chandler Kirwin, art historian at the University of Guelph, to comment on the significance of this study from his perspective, given that he commissioned the project with financial support from his University and that he has been engaged in the monographic study of the monument for the past six years.

There is a challenge for our Laboratory in every photogrammetric survey of an artistic object, a challenge that affects the planning of the operation and the final results. This is an ongoing process of producing different, successive "models" in direct relation to the unique nature of the architectural object, on the one hand, and the set of requirements that each investigation generates, on the other hand. For this reason, our Laboratory produces "thematic cartography" of the architecture that we analyze, which represents the various phases of the process of the accumulation of the information. The interpretation of the data thus obtained can be manifold, depending on the many possible areas of inquiry such as building techniques, the quality of materials, statical control and design, and stylistic analysis. The analytical approach may be separated into distinct functions that allow for greater precision in the ascertainment of information, and consequently permits cross control of interpretations and successful elaborations. Knowledge of the intricate complexes that are historical monuments of architecture, can be obtained through a seemingly endless process of the acquisition of information, information which comes from the different approaches and disciplines working in coordination.

Gianlorenzo Bernini's Baldachin is one of Italy's most intriguing architectural monuments and is the centrepiece of the decoration inside St. Peter's. It is situated under the enormous cupola of Michelangelo's, which encompasses the largest volume of space in a Christian church, and is built over the traditional site

of the fisherman's grave. It was constructed by Bernini and an army of assistants between 1624 and 1633. The monument is approximately the height of a modern ten-storey building and is made of reinforced bronze and copper. The structure was designed to include four twisted columns that are set on marble-faced pedestals and that support the superstructure of the pelmetted canopy, four standing angels, andthe upsweeping crown with its traditional cross and orb. Although the monument was measured manually twice in the eighteenth and nineteenth centuries, there are large discrepancies between them that have hindered full identification of the individual elements of the monument and their relationships. Consequently, it was determined by Kirwin in consultation with di Thiene that photogrammetry would finally provide the most exact information, which will serve as the basis for future considerations of the intricate nature of Bernini's design and of his architectural practices and principles.

The measured drawings of the Baldachin are the result of three campaigns in Rome that began in 1980:

1) the first one enables us to set up the topographical net, to acquire the general mathematical information, and to establish in concrete terms the problems of restitution that we faced. Once all this was done, then we proceeded with a "simulation" of the technical procedures and practical operations as finalized, in order to obtain efficient results;
2) the second campaign was entirely dedicated to the acquisition of detailed information. The fantastic effects of the complex parts of the monument--such as the supreme quality of the surfaces with the juxtaposition of the dark bronze and the gold leaf, the dynamic growth of the structure from the pedestals through the elaborately designed corkscrew columns with their resplendent capitals, the helical shape of the lower shafts of the cloumns and the rich decoration of the laurel boughs and gamboling infants in hot pursuit of elusive bees that appear on the upper sections of the shafts--all of this posed many specific problems for any surveyor, and they required that we establish certain photogrammetric arrangements (Fig. 1);
3) the third phase completed the survey for those parts that were either previously hidden from view due to the installation of temporary decorations--as, for example, the altar--or were considered as extensions of the area around the Baldachin--specifically, the crypt below--that are essential for the complete integration of the monument in its setting above the tomb with its liturgical functions.

The final phase was only just completed this past winter, and the inordinate amount of time that was needed to bring the survey to a successful conclusion was directly due to a variety of unforseen complications that could not have been anticipated when the investigation was undertaken.

In short, the principal categories of the work are as follows:

1) a topographical net of five points has been permanently fixed on the floor, which is related to the corners of the four piers that support Michelangelo's cupola above (Fig. 2);
2) an accurate control of the existing crypt underneath the Baldachin has been installed and the subsequent digitilisation, as a structural reference was required between the two floor levels (Fig. 2);
3) the photogrammetric survey was done of each of the four sides of the Baldachin at various heights. The scale of the photograms is 1:200; and the west front has close range shots up to a scale of 1:100 (Fig. 3);
4) the restitution of the four columns has been done by assembling the different successive profiles with a scale of 1:25. Each column was designed and cast in bronze in five individual sections--the base, three parts of the shaft, and the capital. Logically, for photogrammetric purposes, each column has been so divided. The five sections were then assembled at the end of the survey (Fig. 4). The entire work is the product of an accurate

disaggregation and recomposition of the various sections, following almost anatomical procedures.

The graphic product of this survey--the measured drawing of the whole Baldachin (Fig. 4)--is just one of the many possible representations that the data now make possible, one that is discrete and not continuous and is the result of Professor Kirwin's intentions, which match the capabilities of our Laboratory. It can be said that what we are presenting today is "our model", one of the many possible photogrammetric models of the Baldachin (Fig. 4). A comparative analysis of this graphic model with the optical model, has been the fulcrum on which we have developed the geometrical model and the subsequent mathematical model of each column.

Various elaborations have been done at the plotter in order to find the axes of the sections of the columns (Fig. 5). More importantly, the analysis of the sinuous, corkscrew curve of the profile, has shown that the foliage decorating the upper two sections of the shaft hides an abrupt correction of the vertical axis that was made during the installation. This device was possibly introduced to provide a more axial juxtaposition of the single, interlocking elements, but just as likely is the probability that this was done in order to ensure that the columns would remain standing after their installation in the event of earthquake activity in the area, which occurs regularly. One must remember that the Baldachin covers the high altar of the basilica, which is reserved exclusively for the pope, who surely would have instructed Bernini to make the monument indestructible.

The analytical process has made use of only some of the graphic and descriptive data, as a selection of the information was deemed necessary so that the results would both comprehensively describe graphically the monument in its complexity and serve as the point of reference for future considerations. The process relies entirely on the geometrial data, which are of course significant for the production on our model. What needs to be underlined as a conclusion to the photogrammetric investigation, is that the development of such a project has to take into account on one side the availability of the various complex techniques of analysis and representation at our disposal today, and on the other the desirability of incorporating these procedures in the pertinent and appropriate model of elaboration. This distinction is necessary so that several representations of the same object with different critical finalities can be obtained, if required. Each representation will group data and information in a typologically homogeneous way; each one will unequivocally be related to the other in order to provide full control of the models and of the interpretations that may evolve from them. The user of this thematic cartography will give, through the process of assembling and composing different but complementary data, his own particular synthesis, which in this specific case is the study of a unique and wondrous monument of architecture.

Kirwin's investigation is constructed on two principal objectives: the collection and presentation of comprehensive descriptive data for the Baldachin and its setting that provide accurate information for every component of the structure and its statical properties; and consideration of this evidence in relation to Bernini's apparent architectural practices and principles. My curiosity was initially roused as I read seventeenth-century evaluations of the monument that referred specifically to the "colonne smisurate" (the immesurable or, better said, unproportional columns), and more generally to the centrality of the viewer's eye as the ultimate arbiter of architectural proportion. Such notions evidently represented a rupture in Italian architecture of Renaissance aesthetics and mathematical harmony and the introduction of a new, radical tradition. Could it be, I wondered, that in the centre of Christendom's most venerated shrine and prodigous Renaissance building, Bernini would have been so cavalier as to have broken with the very Renaissance principles of harmonious design and mathematical order that are made visible in the fabric of the building?

First reading of the photogrammetric results reveals that Bernini carefully constructed his monument so that the exact height of the columns is equal to that of earlier pairs of columns, flanking the two tabernacle altars that are cut into the outer faces of the four main piers. The illusion that Bernini's columns are "smisurate" is due to the fact that he raised them on the high pedestals. Actually, Bernini avoided deviating in any way from the architectural decorum of the place and symbolically linked the Baldachin to these tabernacle altars that collectively surround the high altar with the tomb and together reinforce the message of the place.

Further, it is just now becoming clear to me that, as the photogrammetric drawings attest, Bernini paid careful attention to the smallest of details in his colossal design and that he scrupulously continued the Renaissance tradition that enveloped him, as he stood under the cupola and contemplated his project. One of the major objectives of this investigation will be to publish in full detail all the relevant data and to consider the integration of these tiny parts in the larger whole. What can be announced now is that Bernini was just as cautiously maintaining in his design the balance of tradition and innovation as Michelangelo had done before him when he undertook to return the design of the fabric to its original conception as initially articulated by the building's first architect, Bramante.

The data will also make possible the reconstruction of a computer model with the assistance of the Engineering Department at the University of Guelph. With this model, several considerations will be undertaken that will include testing of the statical properties of the monument and the simulation of Bernini's early design for the structure that called for the crowning element to be a larger-than-lifesize bronze figure of the risen Christ. It has been assumed that the structure could not carry this load and that, at the last minute, it was decided to replace the Christ with the smaller and much lighter cross and globe. This assumption, and others, will be tested in the laboratory.

From these quantitative assessments of the Baldachin will emerge a qualitative evaluation of its properties and aesthetics. I should like to state in closing before this august body of photogrammetricians that I am honoured to have become familiar with your methods and your discipline through the investigation. I trust that this fruitful collaboration will further expand the recognition and ultimate value of such an interdisciplinary study within my field and that the cartographic model established by my Venetian colleagues may provoke some of you to reconsider your own participation in similiar ventures. Little did I dream when I made my first youthful expeditions into the Adirondack Mountains with my topographical maps securely in hand that one day I would be reading other photogrammetric landscapes with the same sense of wonder and discovery.

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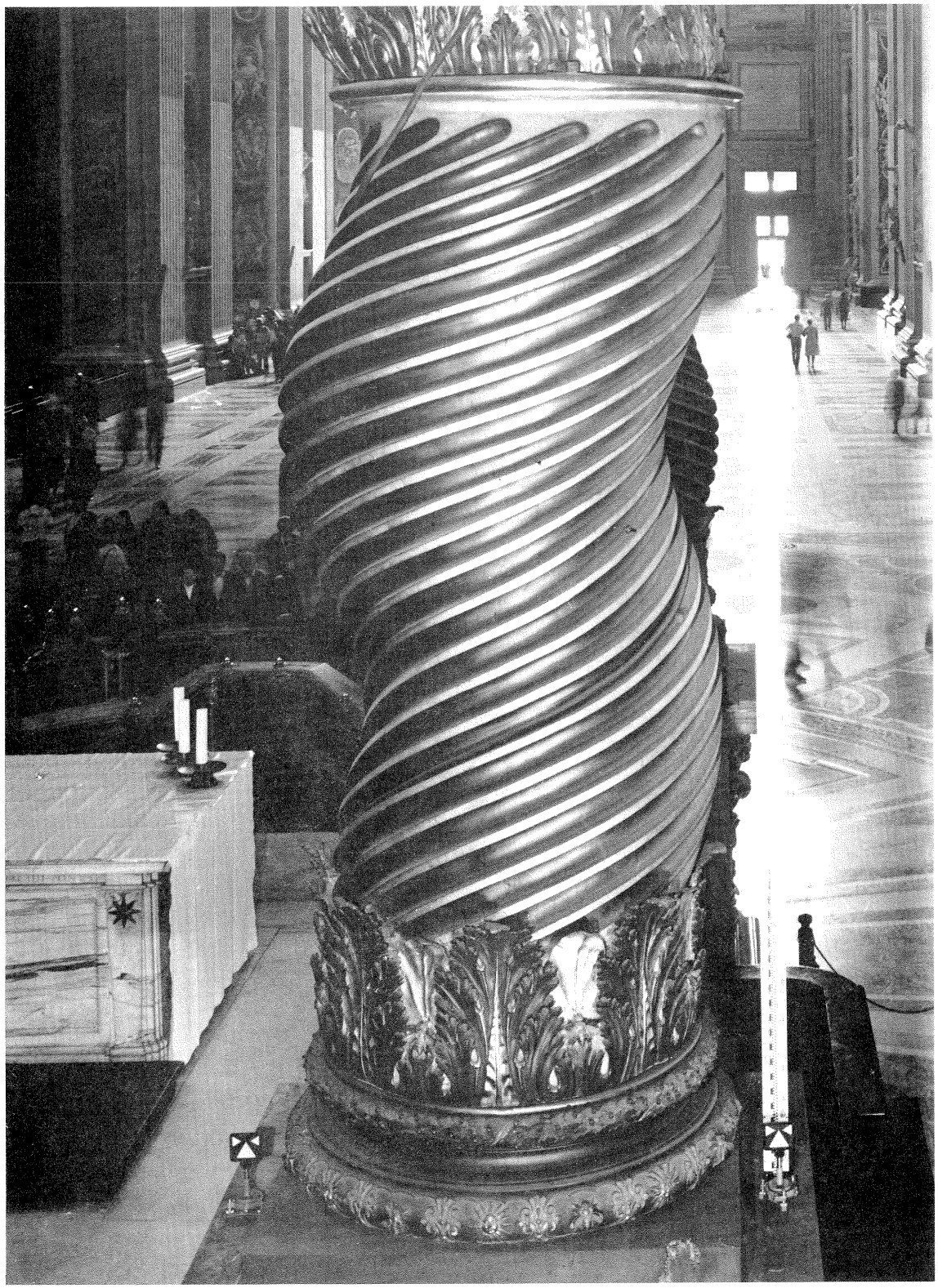

Fig. 1

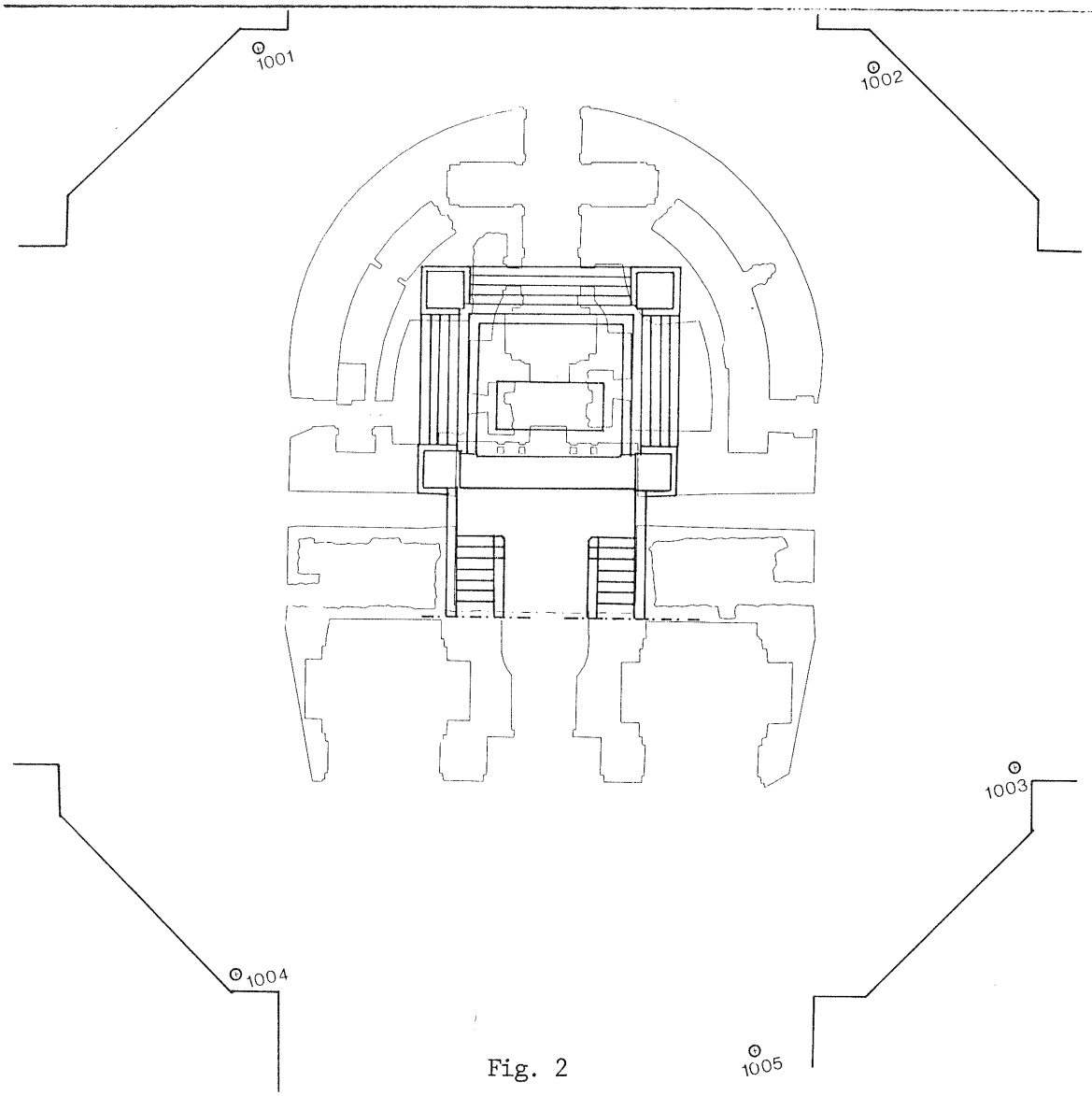

Fig. 2

Fig. 3

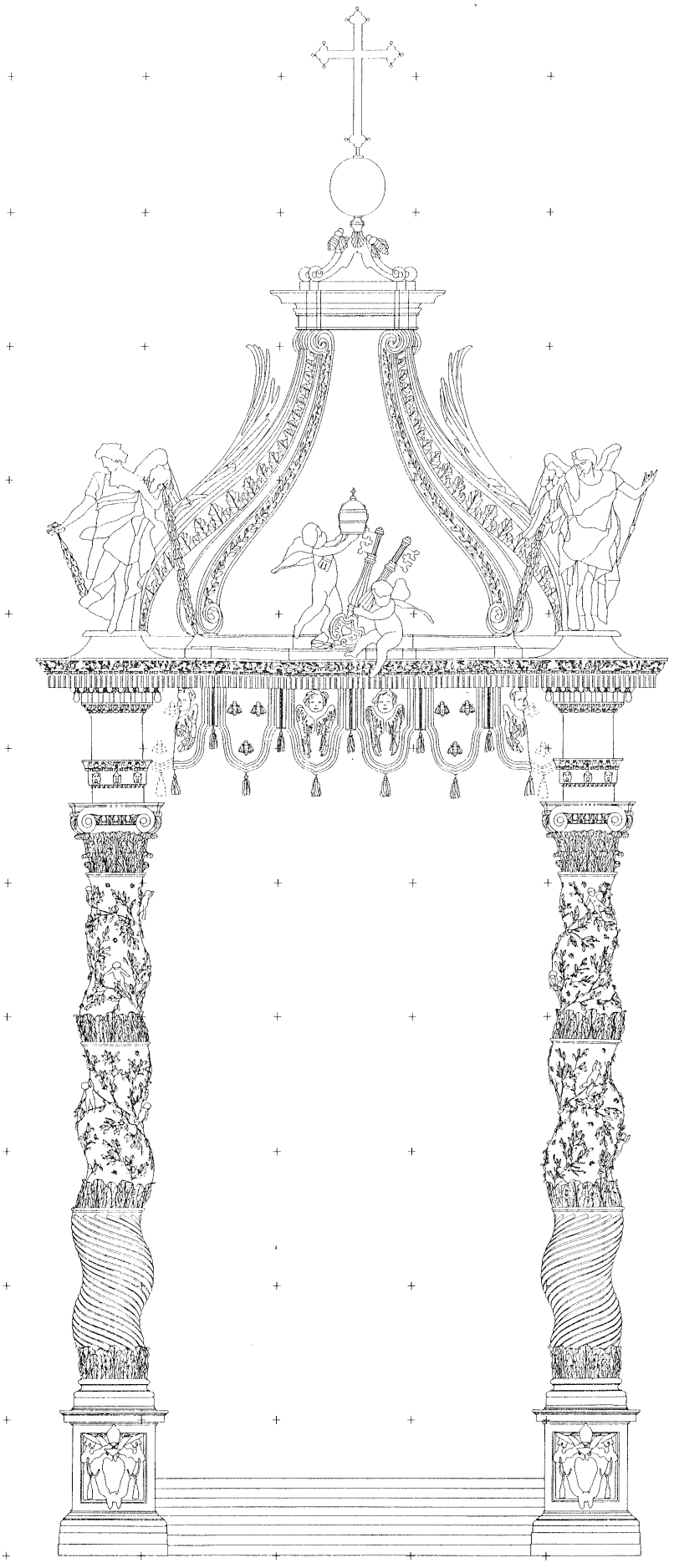

Fig. 4

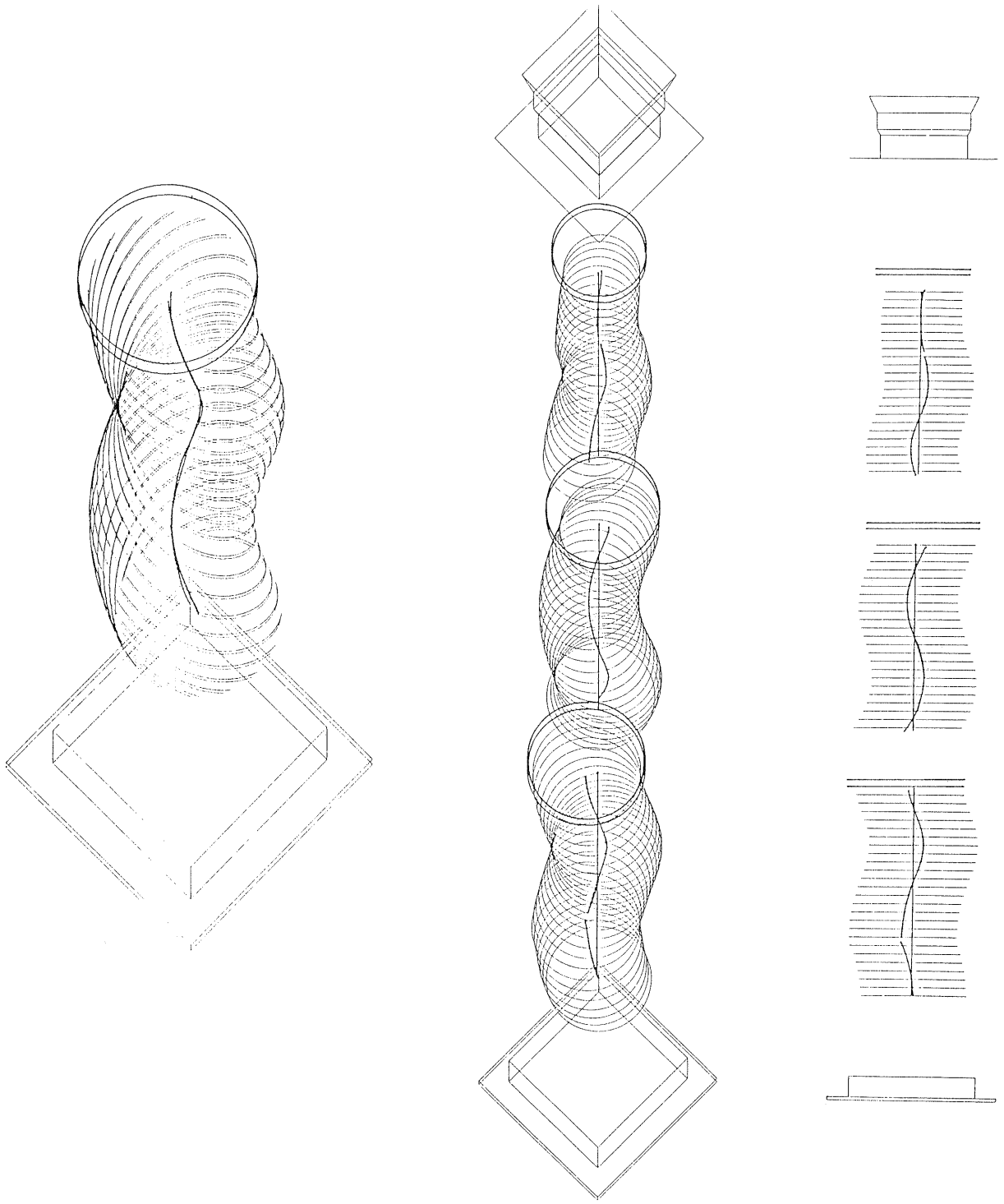

Fig. 5