A strange monarchy

Another paper included in this volume appropriately calls to mind the work of Francis Bacon. I will adopt a position diametrically opposed to the thoughts expressed therein in order to underline what I consider to be crucial for the historiography of architecture understood as res aedificatoria. I take my cue from an apocryphal letter addressed to Francis Bacon. It bears a date that takes us back almost exactly 400 years: 22 August 1603. The date is clearly not random; on 17 August 1603, just five days previously, the then 18-year-old Federico Cesi and his friends Francesco Stelluti, Anastasio de Filis and Johannes van Heeck had founded the Accademia dei Lincei in the Via della Maecenia d’Oro in Rome. This apocryphal letter, written at the beginning of the 20th century, left an indelible mark on the ensuing decades. It was published in the Berlin newspaper Der Tag (moderne illustrierte Zeitung) on 18 October 1902.

I am referring, of course, to the famous Brief des Lord Chandos an Francis Bacon written by Hugo von Hofmannsthal. I recall it, in spite of the fact that it has lost much of its freshness through repeated quotation, because I should like to attempt to consider it from the point of view of the correspondences with which we are concerned here: a letter published a century ago in Berlin (where the Max Planck Institute for the History of Science has its seat), addressed to Francis Bacon (the focus of our attention), and dated just a few days after the fatal meeting in the Palazzo Cesi in Rome (not far from the Biblioteca Hertziana), exactly four hundred years ago. I will transcribe a passage from Hofmannsthal’s letter without further comment, which will remain the cantus firmus of my considerations: “I felt at this moment with a certainty not wholly untinged with pain that I would write no English and no Latin book in the coming years nor in succeeding years, nor indeed in all the years of my life; […] because the language in which I would perhaps be able not only to write but also to think is neither Latin nor English, nor Italian nor Spanish, but a language […] in which silent things occasionally speak to me, and in which one day I shall perhaps justify myself from my grave before an unknown Judge.”

“Things”, then, are the focus of attention, or (in Hofmannsthal’s words) “a language in which silent things speak.”

Francis Bacon himself is also linked with a scathing judgement that was formulated roughly a century ago by the author of a book which, in its own field, is unsurpassed even today. I am referring to Raffaello Caverni’s Storia del metodo sperimentale in Italia (1891-1900), which castigates the prophecies of Baron Verulam as follows: “Francis Bacon gave the name Instauratio Magna to his new scientific kingdom, and he regarded himself as having been invested as its monarch for having planned the Encyclopaedia of every art and science in his book De augmentis scientiarum, and for having minutely fixed the rules to be followed in experimental method in his Novum Organum. It is easy however to persuade oneself that his monarchy was nothing but an empty name or, if you like, a kingdom that had already passed away. For if there is, in fact, no such thing as science, and never has been, as Bacon maintained, it follows that he divided up the burial niches in his Encyclopaedia without having anything to fill them with.”

Here, too, I shall leave Caverni’s words to resonate in the background without comment. They speak for themselves. I would only add that the empty burial niches (the loculi vuoti) are a warning to us all in this research project, and convey one admonition in particular that is a real literary case.

My considerations will focus on a field of research that has not yet found its rightful place in the order of things and that ekes out a meagre existence on the margins of the official historiography of architecture: mechanics in an architectural context and, more generally, the
history of building construction. By this, I do not mean the history of machines, nor even the history of machines for building sites (on which there is a abundant literature), but the branch of knowledge that is precisely defined in German under the heading of “Geschichte der Baustatik” and which in English is called the “history of structural mechanics”. It is no coincidence that I mention this field of research, of course. The notion of “Epistemic History of Architecture” has its origins in a collaboration between two institutes, each with its own illustrous tradition, and both of which are apparently far removed from one another: the history of architecture and the history of science (with particular regard to the history of mechanics).

The relations between mechanics and architecture will inevitably converge, therefore, in future investigations: a point of intersection in the history of thought that at present plays a modest role in architectural historiography. This is indeed an empty or abandoned burial niche, sometimes temporarily occupied by some vagabond, who comes upon it by chance, driven there by curiosity or by necessity. One might object that the literature on this subject has grown in recent years, with new authors and new research programmes entering the limelight. Although I understand the reasons for this obsession, I still think that the reality is very different – apart from the effects of a Fata Morgana that may deceive the unwary.

The first example dates from January 2003, when an article signed by Sigurd Fleckner was published in the authoritative journal *Bouwsingelsi
cier* under the title “Gotische Kathedralen – Statische Berechnungen”. The subject of the paper is stimulating, and the article is worthy of closer reading, judging at least by what is promised in the editorial note: “This specialist paper has been scientifically assessed and recommended in the editorial note: “This specialist paper has been scientifically assessed and recommended in the editorial note: “This specialist paper has been scientifically assessed and recommended in the editorial note: “This specialist paper has been scientifically assessed and recommended in the editorial note: “This specialist paper has been scientifically assessed and recommended in the editorial note: “This specialist paper has been scientifically assessed and recommended in the editorial note: “This specialist paper has been scientifically assessed and recommended in the editorial note: “This specialist paper has been scientifically assessed and recommended in the editorial note: “This specialist paper has been scientifically assessed and recommended in the editorial note: 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“This specialist paper has been scientifically assessed and recommended in the editorial note: “This specialist paper has been scientifically assessed and recommended in the editorial note: “This specialist paper has been scientifically assessed and recommended in the editorial note: “This scholar has dedicated a large part of his life to advancing and developing the “history of the sciences and techniques of construction” and their teaching, a scholar who has turned the doctus curiosus into a lifestyle. The misunderstanding, of which Del Piero became the mouthpiece, stems from the suspicion that historical analysis is a soft option, a short cut to relieve “conceptual fatigue” and to trans- form the hard core of the discipline into a frag- ile popularisation of hagiographic character. There are even those who believe that the his- tory of scientific concepts can be no more than “anecdotal”. One is aware that this misunder- standing has had many advocates over the past century – some distinguished, others who, whose hand was admittedly strengthened by some rather unedifying examples of the histori- ography of science. It is hard to believe, though, that this dismissal of the methods of historical analysis could be reaffirmed with such assurance as something obvious, especial- ly by those who ought really to represent the dignity of their opus curiosum. Historiography, then, is regarded as something spurious (at least by some distracted and mis- informed representatives of academic culture), instead of being a wonderful opportunity to in-
vestigate the genesis of the concepts and structure of the formal apparatus commonly used by the calculatores. Del Piero cannot yet have found time to investigate the problem with very much attention and to read the texts that could have opened up new perspectives of thought. Yet little effort would have been needed to enrich his stock of knowledge. It would be enough, for example, to consider the judgement of Gottfried Wilhelm Leibniz that Clifford Truesdell wanted to adopt as an emblem of the history of architecture: “Utilissimum est cognoscere veras inveniendi, cognita methodo illustribus exscripsere laudes invitentur, sed etiam ut augeatur notuere. Id enim non eo tantum prodest, ut ars inveniendi, cognita methodo illustribus exscripsere laudes invitentur, sed etiam ut augeatur notuere. Id enim non eo tantum prodest, ut

The Haak case
To illustrate one of the many possible forms of collaboration “between mechanics and architecture”, I should like to dwell briefly on what I call the “Haak case”. The name of Henrik Haak is mentioned in an article I consider of great importance. It was published in the “Preprints of the Max Planck Institute for the History of Science” (Preprint 97, 1998) and, two years later, in the periodical Science in Context. The paper reproduces a manuscript page by Guidobaldo del Monte, to which the authors devote a magisterial analysis. The subject is the law that describes the trajectory of projectiles and the interpretation proposed by Guidobaldo del Monte, who compares the trajectory to the catenella suspended by the traditional disciplines, which have for
turn to 1841, the year in which Guglielmo Libri published a partial transcription of the manuscript in question and the respective drawings (fig. 4). Neither the roof truss nor the text at the top left of the page is mentioned in the transcription. The two spheres of interest are divided by an invisible line that nevertheless seems quite concrete and apparently unbridgeable, brutally cutting the manuscript in two. Over the years, other scholars have commented on this passage, and more recently it has been subjected to a new and original interpretation, in which the roof becomes a metaphor for an inclined plane. Here, the conjunction of a chain (catenella) suspended between two points. The comment referred to the manuscript as follows: “At the end of one of Guidobaldo’s notebooks there are two drawings which possibly depict an inclined plane used for such an experiment, together with a protocol which perfectly resembles the description of Galileo’s second method mentioned in the Discorsi (see figures 4 and 5) (in the present publication figs. 2 and 3). A closer inspection of Guidobaldo’s drawings shows that they actual
ty represent a roof which may well have offered a convenient setting already at hand for experimentally verifying a method similar to that described by Galileo on a scale comparable to that of ballistics, the usual context in which projectile motion was considered at that time”. Note 11 (p. 311) explains the genesis of this inter
terpretation: “Henrik Haak, who constructed the apparatus for our reproduction of the historical experiment, has directed our attention to the fact that the inclined planes depicted by Guidobaldo immediately before and almost im
directly after the protocol represent a roof construction”. Haak is therefore the mediator between me
cchanical and architectural historiography, but the problem remains unresolved, rather like something of secondary importance that is worth only a marginal note. For a better under

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In his commentary on the treatise of Guglielmo Libri, who reads Guidobaldo's text and recognizes its impor-
tance for his own purposes (the history of mathematics), through the appreciation of in-
numerable other scholars, down to modern scholars who broaden their investigation to in-
clude the roof truss and interpret it more gen-
erally as an inclined plane. The question we
must now ask is whether it is not time to read
this manuscript, too, as a detail – perhaps sig-
nificant, perhaps not – in the history of con-
struction. Should we not also read it as source
material for the history of mechanics and for
the history of architecture, and (in a quite spe-
cial way) the history of architectural mechan-
ics. In the context of some vaulted struc-
tures, whether rightly or wrongly. From the
historiography of the 20th century, Architects
and archaeologists alike have amused them-
selves by seeing hanging chains in all sorts of
problems that architects ought to read
and chains have been transformed by expert
smith’s eye”, so to speak, in what is perhaps an
improvised but not insignificant descriptive
treatment of the structural behaviour of the roof
truss. This is immediately recognizable if one
compares it with those structures reproduced
in the manuscripts of Taccola, Orsino Vannocci
Biringuccio, Pellegrino Pellegrini and, to stick
to Guidobaldo’s lifetime, Giorgio Vasari.
Guidobaldo designs not just an inclined plane,
not even a generic roof truss with its compo-
ents quoted above. In this way, the archi-
tect would discover that Guidobaldo is here
dealing with the gradient of a channel designed
to bring water to a mill and, by analogy with the
gradient of roofs: in other words, the ques-
tion of roof slopes, which was to be a recurrent
theme in architectural thought of the period.
If the architect in question were a little more
curious, he or she would go even further and
note that the structure designed by Guidobaldo
is far from schematic. Indeed, it is a precise
description of the structural details of a roof
truss. This is a small example through which one
can follow the history of the “discovery of sci-
entific methods” (of whatever kind) is located, a lab-
oratory of ideas between theory and practice, a
space for the verification of mechanics rather
hastily defined as “rational”. This no-man’s-land, this free zone, which is, in
principle, exempt from disciplinary idiosyn-
crasies, remains terra incognita. Neither me-
chanical nor architectural historians have ven-
tured into it: the former because they do not find it “mechanical” enough; the latter because
they do not find it “architectural” enough. The
fact remains that the separation between them
is academic and exists only on paper, not in fact:
the jugglers’ chains
I will now move on to the second part of my re-
fections, the part that more directly concerns the
eggs, turnips and chains of my title. Here,
too, I should have liked to preface my argu-
ments with some remarks about the remote past,
with certain premises that affect the pres-
ent. But since the space at my disposal is limit-
ed, I shall make only very cursory mention of
this latter aspect.
It is interesting to note that the question of the
chain has also become a rhetorical topos in the
historiography of the 20th century. Architects
and archaeologists alike have amused them-
selves by seeing hanging chains in all sorts of
places, whether rightly or wrongly. From the
pergola, King post, tie beam, struts). He goes into detail. For example, he notes the
bisection in the joint between rafter and strut,
and accurately marks the absence of the struc-
hated question whether the curvature in ancient buildings is to be regarded as an arc of a circle or a parabola has thus found a new solution. It is neither. It is in essence a catenary, which in a curve as slight as this would be indistinguishable from a parabola. Our discussion of this problem could, of course, continue at some length, recalling the important and more convincing works of Dieter Mertens40 or Lothar Haselberger41. I cannot dwell on the question, but it should be borne in mind that fashions condition our interpretation and even lead us to draw erroneous and exhilarating conclusions. With regard to Brunner’s hypothesis, for example, one should ask whether sufficient account has been taken of what Pietro Cataneo wrote in I quattro principi libri di architettura (1567), where he explained that the entasis of the column could be obtained with a long, thin and very flexible wooden batten42. This solution may have its roots in remotest antiquity; and it is so much simpler and more convincing (even if less brilliant and symbolic) than the catenary that it was revived by Andrea Palladio43, who claimed to have invented it himself, maintaining that he had illustrated it years before Cataneo. No trace of this solution is to be found in Haselberger’s study Old Issues, New Research, Latest Discoveries: Curve and Other Classical Refinements44, though the author does consider some Renaissance texts. Gerhard B Steven45, on the other hand, confirmed its widespread diffusion many years earlier, connected with the theory of vaulting, this principle is excluded in principle. In order to guarantee the mechanical equilibrium of an arch designed according to the catenary principle, one has to ensure the absorption of lateral loading on the impost46. If one goes further back in time to Galileo, in the Discorsi e Dimostrazioni Matematiche47, one finds a celebrated passage relating to solids of equal resistance and the “problem of the beam”, in which Galileo explains how to design a parabo-
This well-known passage reads as follows: “I use an exquisitely round bronze ball, no larger than a nut; this is rolled [tirata] on a metal mirror held not vertically but somewhat tilted, so that the ball in motion runs over it and presses it lightly. In moving, it leaves a parabolic line, very thin, and smoothly traced. This [parabola] will be wider or narrower, according to whether the ball is rolled higher or lower. From this, we have a clear and sensible experience that the motion of projectiles is made along parabolic lines, an effect first observed by our friend, who also gives a demonstration of it. We shall all see this in his book on motion at the first meeting. To describe parabolae in this way, the ball must be somewhat warmed and moistened by manipulating it in the hand, so that the traces it will leave shall be more apparent on the mirror. The other way to draw on the prisms the line we seek is to fix two nails in a wall in a horizontal line, separated by double the width of the rectangle in which we wish to draw the semi-parabola. From these two nails hangs a fine chain, of such length that its curve [comma] will extend over the length of the prism. This chain curves in a parabolic shape, so that if we mark points on the wall along the path of the chain, we shall have drawn a full parabola. By means of a perpendicular hung from the centre between the two nails, this will be divided into equal parts. In these few lines, the seduction of the Gedankenmodell of the catenary reaches its climax and creates a close link between the chain and architecture. The passage could be interpreted as a significant shift in the definition of the falling trajectory of projectiles, as was brilliantly proposed in the above-mentioned study. But one can also perceive a formidable connection between two problems that were to be related only much later and in rather a rush way in the case of Ghiberti and the Ponte Santa Trinita in Florence. Galileo states that the “best shape” (in terms of solids of equal resistance) of a cantilever loaded on its free end is a parabola (this is the source of the quotation above), with an axis parallel to the longitudinal axis of the beam. This is a correct if only partial indication. Galileo adds that a homogeneous suspended chain subject to its own weight assumes a parabolic form. In this, however, he is mistaken; the form it assumes is not that of a parabola, but of a hyperbolic curve. The application of the catenary to structural optimization, however, could not be more valid. Galileo does not proceed beyond this point, but he does come close to the solution of another problem related to structural optimization: namely, the transition from the catenary to the “best form” – not of the beam, but of the arch. Precisely this distinction between the two types of structural behaviour – that of a beam and that of an arch – leads to the last example I wish to describe. If one goes back a little in time, to the year 1584 to be more precise, one is faced by yet another variation on the problem of the use of chains in architecture. I refer to an invention contained in Erhard’s Premier livre des instruments mathematiques mechani ques, a mathematical book that places the architecutural machine in the classic repertoire of machinery that were widespread in the Renaissance. Here, Erhard raises the question of the distinction I have just drawn: between the beam and the arch. A beam may resemble an arch if it has a curved profile; but it does not ipso facto become an arch in the true sense of the term. At most, it is a beam in the form of an arch. This fine distinction consists not in the form, which remains identical, but in the mechanical behaviour. Resting horizontally on two columns, a rigid beam forms part of a trilithic system that does not create lateral im- purities. Moreover, like the arch, the beam may consist of a number of small elements combined together, just as an arch is composed of coussins. To form a beam, however, these elements have to be firmly wedged together, otherwise the whole structure could collapse. Erhard’s in-
sense of similar kind) may happen in buildings.  

Poleni no doubt arrived at the analogy of the skull from two previous discussions with his friend Giovanni Battista Morgagni, a famous anatomist and pathologist with whom he had conducted experiments on the cardiovascular system. The anatomical analogy forms part of an illustrious tradition, to which Alberti had given a decisive impulse in his De re aedificatoria. In this case, though, it acquired a novel technical emphasis.

The skull is per se a good model for a dome, i.e. for any construction that could, if possible, be thin. (The example of the Pantheon was much admired, but would not be reproposed in the same technical and structural terms) but that is also resistant, thanks to its form. The problem is always the same, namely to deduce from the nature of things (whether one is talking about a skull, subject to the natural law of gravity; or a skull as a resistant structure) guidelines for their artificial reconstruction; i.e. for construction contro natura (stones suspended over a calicioni” had learnt it from nature it’s)

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Is the shell able to support very great weights, where of the same thickness; so how does it, according to him, withstand such large weights placed on the convex and maintain its constan-

If we follow his comments, he adds that a half-barrel vault […] and, as we will be able to see in the continuous investigation of the dome of S. Maria del Fiore: “There are many stones and cossedale [stones] in the angles which are not evident to anyone, while others can be seen. Those that can partially be seen are long circumference. When he [Brunelleschi] discussed those with the stonemasons, they could not understand him at all. [He made some models for them] in soft clay and then in wax and wood. Actually those large turns, called “cingleoli” (large goblin), which come on the market in winter, were used less its parts are overdrawn [subjected to too much tension]; and if a glass that resists tension breaks when one wants to pull it, it is because of this inflexion: namely, more effort is needed for making the small models and for ex-

Among other edible analogies, one recalls Leonardo’s “oranges”, in other words, domes that, in collapsing or cracking, behave like squashed oranges; or the “pomegranates” of the three mathematicians Jacquier, Le Seur and Boscoevich, who used the analogy of this fruit in their analysis of the dome of the Vatican Basilica. Boscoevich was to return to the same image in the 1727 edition dedicated to the librum of Milan Cathedral. It was Vincenzo Scamozzi, however, who took the decisive leap in the direction of mechanical analysis. His Idea dell’architettura universale contains the following description after a reference to the dome of S. Maria del Fiore: “The same author, who had used clay, wax, wood and even winter turnips to explain to his workmen the constructional idea he had in mind? As An-

7 I. Giovanni Battista Morgagni, La statique ou la science des forces mortuaires, Paris 1813, p. 151.

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la statique ou la science des forces mortuaires, Paris 1813, p. 151.

8 I. Giovanni Battista Morgagni, La statique ou la science des forces mortuaires, Paris 1813, p. 129.

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Once again, then, the question of entasis, among architects, architectural historians and historians of science, in the context of a rigorous, systematic and far-sighted "Episteme History of Architecture". To achieve this, however, one would need to overcome, once and for all and in a resolute and incisive manner the growing pains that have left their mark on our research and on that of others into the "ars oeconomica". This research, as I have suggested, suffers from three main failings. Firstly, it is threatened by those who deny or ignore the value of history for the development of scientific knowledge. Secondly, it is impeded by a toothless historiography that is incapable of coming to grips with the problems that is accustomed to cooking an epiphenomenal wing in which doctrinal substances are of uncertain origin float. Thirdly, it is rendered sterile by a sort of ping-pong between academic disciplines and by a perverse pigeon-holing of studies in which so-called experts dilate the exploration of a network of themes among themselves: to you the holes, to me the crumbs. By carving up disciplines in this way, one plays with the mesh and the openings in the net, but the essential elements are allowed to fall through the gaps and slip away as if they were something irrelevant. As a result, architecture is divorced from its history in the shortighted view that one does not understand the premises of an "ars oeconomica".

I remember that a few years later Leonhard Euler was to clarify the "buckyball" problem (buckling of a compressed beam) by analyzing the concept of Euler's remarks, and that soon afterwards, the great mathematician Louis Lagrange was to be inspired by this to construct a framework that is coincident with the structure of the viruses.

If we consider that a few years later Leonhard Euler was to be inspired by the notion of Euler's remarks, and that soon afterwards, the great mathematician Louis Lagrange was to be inspired by this to construct a framework that is coincident with the structure of the viruses.

Through the exploration of a network of themes among themselves: to you the holes, to me the crumbs. By carving up disciplines in this way, one plays with the mesh and the openings in the net, but the essential elements are allowed to fall through the gaps and slip away as if they were something irrelevant. As a result, architecture is divorced from its history in the shortighted view that one does not understand the premises of an "ars oeconomica". In analysing the great mathematician Louis Lagrange was to be inspired by this to construct a framework that is coincident with the structure of the viruses.

To achieve this, however, one would need to overcome, once and for all and in a resolute and incisive manner the growing pains that have left their mark on our research and on that of others into the "ars oeconomica". This research, as I have suggested, suffers from three main failings. Firstly, it is threatened by those who deny or ignore the value of history for the development of scientific knowledge. Secondly, it is impeded by a toothless historiography that is incapable of coming to grips with the problems that is accustomed to cooking an epiphenomenal wing in which doctrinal substances are of uncertain origin float. Thirdly, it is rendered sterile by a sort of ping-pong between academic disciplines and by a perverse pigeon-holing of studies in which so-called experts dilate the exploration of a network of themes among themselves: to you the holes, to me the crumbs. By carving up disciplines in this way, one plays with the mesh and the openings in the net, but the essential elements are allowed to fall through the gaps and slip away as if they were something irrelevant. As a result, architecture is divorced from its history in the shortighted view that one does not understand the premises of an "ars oeconomica". In analysing the great mathematician Louis Lagrange was to be inspired by this to construct a framework that is coincident with the structure of the viruses.

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1748, col. "E sono vi molte pietre, e delle nascono..."


"Questa forza, & egualità della Volta a mezza botte..."

Gianlorenzo Bartoli, Firenze 1692, Firenze 1550.

"Il qual caso, chiamato da Bartolomeo Vanni, figlio di Filippo Brunelleschi, precedentemente la scolla del prossimo, entral test edition..."

Contrafisura, Firenze 1862.

Cecchino di Filippo Brunelleschi, precedente della la scolla del prossimo, entral test edition..."

Gianlorenzo Bartoli, Firenze 1692, Firenze 1550.

"Questa del prossimo, con legnami, e in vero lo serviva molto..."

Contrafisura, Firenze 1862.