
Galileo's Instruments of Credit: Telescopes, Images, Secrecy by Mario Biagioli

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More than a decade has passed since Mario Biagioli's *Galileo Courtier: The Practice of Science in the Culture of Absolutism* provided historians of science with a novel and convincing structure for understanding the rise and rise of Galileo Galilei. The Renaissance court, both in ideal and actual forms, was depicted and deployed as the central instrument in enabling Galileo's spectacular career path. Rather than merely providing a limiting social context for science or a consuming market for its products, court life and courtiership were shown to provide powerful models for producing natural philosophical knowledge, especially the virtuoso display and courtly debate, at which Galileo excelled. Patronage, clientism, gift-giving, and etiquette swiftly became central categories for understanding the very practices constituting early modern science.

Biagioli's welcome return to the field, *Galileo's Instruments of Credit: Telescopes, Images, Secrecy*, revisits the period analyzed most successfully in *Galileo Courtier*, 1609 to 1616. In these years, using a modified version of the recently invented spyglass, Galileo made a series of spectacular discoveries: lunar mountains comparable to those on Earth, four moons orbiting Jupiter, and strange spots on the face of the Sun, to name only the most famous. These celestial phenomena were used, *Galileo Courtier* argued, to work two crucial transformations: Galileo himself left his university job as a mathematics professor at Padua to become a court philosopher and mathematician for the Medici in Florence; and he used his astronomical observations to threaten the constitution of the dominant Ptolemaic cosmology. *Galileo Courtier* insisted on a strong relationship between these social and epistemological transformations.

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The very success of Biagioli's model for charting and explaining Galileo's astronomical apotheosis also raised some unresolved historiographical problems. There was a danger that court society might seem as deterministic as other discarded models, a simple wind-up mechanism with which to explain away one of the most important series of discoveries of the Scientific Revolution. And the model itself, while working perhaps too well as a tool to understand Galileo's rise, seemed to strain to near breaking point when applied to the trial of 1633. The idea that Galileo was condemned in part because court favorites have a general tendency to fall after they rise ignored the complexity of actors' categories and motives. Biagioli's own account was finely nuanced, but his readers have sometimes been less subtle.

Galileo's Instruments of Credit both builds on *Galileo Courtier* and replaces it. Biagioli invokes the logic of Derrida's supplement at several points; his own book embodies it. The structures of the older book seem too rigid when read against the more supple methodologies of the new work. Between the two is a historiographical shift from structuralism to post-structuralism. Rather than positing a dialogic dynamic between the social and epistemological, Biagioli here provides us with a series of tactical interventions that well display the flexibility and range of both his, and Galileo's, thought. The certainties of omniscient actors playing clearly defined roles in fixed structures are gone. Now we are witness to bricolage in action: 'Product, producer, and market were shaped simultaneously' [3].

The book is arranged chronologically in four chapters. Several are adapted from previously published versions, and an introduction and epilogue show the relationship between them. Whereas *Galileo Courtier* played variations on a central theme as it moved through Galileo's career, *Galileo's Instruments of Credit* uses the implicit chronological narrative as a series of points of departure into virtuosic analyses both of specific debates and the methodologies developed to understand them. It has been claimed that historians, like dog owners, resemble their subjects. If *Galileo Courtier* were a brilliant manifesto about a brilliant manifesto, *Galileo's Instruments of Credit* not only secures Biagioli's reputation, but displays the admirable adaptability and responsiveness of his work. The *ad hoc* nature of Galileo's strategies is identified and remobilized by Biagioli to spectacular effect.

The introduction and four chapters lead us through four very different disputes. The substantial introduction, ‘From Brass Instruments to Textual Supplements’, depicts the artisanal economy constructed and inhabited by Galileo in Padua. As was normal at the time, the university professor kept his fingers in several pies: he ran a boarding house for students, gave them private lessons, and sold them both mathematical instruments and manuscript instruction booklets. Biagioli reconstructs these overlapping and overlooked economies well, largely in order to contrast them with the very different economy of the Florentine court to which Galileo would soon return. If Galileo’s Paduan economy was based on manual and oral labour, with knowledge produced in close proximity to its consumption, Florence promised a more cerebral existence of leisurely writing books for print that was free from the mess of teaching and students. While the image of two separate Galilean economies—the utilitarian Venetian Republic and the courtly Tuscan Grand Duchy—is certainly appealing, it is unclear to what extent Galileo shifted from one to the other in 1610. His Medici courtiership predated his telescopic discoveries; and his Paduan alumni and friends offered an international network for the rest of his life and functioned, even in the years before his transfer out of the Veneto, as a link to court life. It is unclear whether Galileo was quite as unknown before the telescope brought him fame as is generally assumed: his portrait by Domenico Robusti, now in the National Maritime Museum, Greenwich, seems to portray him around 1607. He was a central figure in both Paduan and Venetian intellectual circles, and certainly planned a series of publications before the *Sidereus Nuncius* happily disturbed him. On the other hand, a 1608 payment authorization from the Medici mistook his given name as ‘Giulio’ implying a lack of familiarity even amongst Florentine bureaucrats.¹

Biagioli regards Galileo’s only noteworthy intervention in the world of print in the pre-telescopic period to be an edition of his instruction manual for the geometric compass, with its modest print run of 60 copies produced out of fear that his neat local monopoly on his version of the instrument might be threatened. This fits Biagi-

¹ Archivio di Stato di Firenze, Mediceo del Principato 300, fol. 136r-v. (Medici Archive Project, <http://www.medici.org/>, entry 13860 in the Documentary Sources database).

oli's analysis well, but there are other texts to consider: Galileo may well have had a hand in the pro-Copernican satirical dialogue in Paduan dialect, published in 1604, which Biagioli relegates to a footnote. Contemporaries thought Galileo was the author; and even if he were not, the example of pseudonymous publication adds a nice twist to Biagioli's story of the construction of 'aura' and the indeterminacy of context. While *Galileo's Instruments of Credit* is not a biography of Galileo, any reconstruction of the economy of his household in these years should surely mention Antonio Poppi's important discovery of 1993 that Galileo's servant and amanuensis Silvestro Pagnoni had testified against him to the Inquisition in 1604. Edward Muir has recently provided a provocative analysis of Paduan intellectual and political life in this fraught decade, and Venetian protection of Cremonini and Galileo would certainly work as a nice backdrop to Biagioli's analysis of the later lack of protection leading to the injunction of 1616 against Galileo (and, indirectly, to the trial of 1633).

Chapter 1, 'Financing the Aura: Distance and the Construction of Scientific Authority', argues that distance, usually seen as a hindrance in the production of scientific knowledge, should be reconsidered as a crucial tool. The episode under consideration, one of the best known in the history of science, is the publication of the *Sidereus Nuncius*. Biagioli's analysis recasts the familiar terms through which it is usually understood, bringing what previously seemed extraneous or disruptive into play as central and formative. By exploiting the distance between himself and his potential patrons, Galileo managed not only to buy himself time but also to construct a self-authenticating process in which all participants acted on partial knowledge and blind trust. This is a far more nuanced and sensitive reading of the way in which the Medicean moons, for example, were negotiated into existence than the usual center/periphery model of discovery. Biagioli steps out of Galileo's world for the second half of the chapter to show the crucial relevance of his model even to the production of matters of fact in the early Royal Society. Shapin's Boyle is his target here, not from the usual direction of anti-constructionists, but from a more radical position that starts to make the entire Society feel real only, or mainly, in so far as it is virtual. Henry Oldenburg's correspondence is often studied as a web spun and sensed by the bloated spider; Biagioli sees it instead as a dense rhizome produced by multiple actors, with its center defined

by its limits. The results of this experiment are striking: partial information and distance no longer seem to prevent facts from being forged but rather enable them. Credit and credibility rely on rhetorical inflation, of course, but this happens only at a distance. An even more extreme version would be Lana Terzi's contemporary Brescian academy, which existed only virtually.

There are, however, some problems here. Distance, in itself, explains nothing in these examples; and Biagioli uses it as shorthand for something more difficult to quantify. What is needed is a map of each actor's perception of power, time, and distance rather like mobile versions of Braudel's isochronic maps with two extra dimensions added. Galileo exploited Giuliano de' Medici in Prague, and the distance between the two was part of the story of the production of the Medicean moons; but similar effects could be produced by mis-timing posts or using slow routes. Distance has to be understood historically, as Carlo Ginzburg showed in *Wooden Eyes*, for it to become an actor or a factor in history. One of the great unspoken ironies of this chapter is that the validation of the telescopic instrument that promised to manipulate distance and collapse time took place through such old-fashioned technologies as postal systems and was, at the same time, compared to an ideal, angelic, dematerialized message.

There is another issue at play that also deserves further thought: one of the things distance does produce in the early modern period is archives. The existence of the correspondence that we use is to a large extent the product of distance. One tended not to write letters to neighbors unless a visible paper trail were needed, though some conversations, such as trials, were also written down. So when Biagioli makes an argument about the effect of distance in the production of knowledge, there is a hidden issue about the existence or non-existence of sources. Galileo was no Descartes, withdrawing from the world and engaging with it through writing; he forged his reputation through distance, as Biagioli shows, but also through proximity, though the sources may be harder to locate for these actions. Thus, Biagioli's counterintuitive concluding aphorism, 'local knowledge is an oxymoron' [74], may itself only be true for the locale in question. His analysis certainly provides new and exciting models to understand and exorcise the Derridean specter of the 'metaphysics of presence' [74] that haunts the sociology of scientific knowledge, but the model is more an essential supplement to the sociology of scien-

tific knowledge and Biagioli's own earlier work than a replacement system. Some knowledge is produced through the flux of virtual negotiation, and the discoveries of 1609–1610 are excellent examples. But this does not invalidate other models of knowledge production or render the concept of local knowledge redundant. As the other chapters in Biagioli's book show, many ways of producing knowledge can compete and coexist.

Chapter 2 'Replication of Monopoly? The Medicean Stars between Invention and Discovery', offers a different analysis of the same period, supplementing the account based on distance with one based on the relationship between credit and disclosure. Biagioli identifies a peculiar tactic adopted by Galileo during the crucial period after his initial astronomical observations. Galileo, Biagioli argues, was caught between two competing demands: in order to secure the status of his discoveries, he needed others to replicate them; in order to secure his current and future priority in the field, he needed others not to replicate them. Biagioli asks a fundamental question to chart Galileo's response to this bind: to whom did he send decent telescopes and to whom did he send copies of the *Sidereus Nuncius*? Historians have generally presumed that these objects travelled together or that astronomers immediately got hold of telescopes and the book, while a less expert audience received only the book. Biagioli's findings are surprising: Galileo sent telescopes to patrons who could not use them, and sent his book to astronomers who could not verify its observations without telescopes. Most interestingly, Biagioli makes a strong case for the mutability of the objects themselves as they passed through these different economies:

[Galileo's] tactics (as well as those of his competitors and critics) were not unnecessary obstacles on the path to truth, but constitutive elements of the production of the objects he called 'Medicean stars'. [135]

Biagioli roots Galileo's tactics and the telescope in the local culture of invention and charts their nonlinear transition to a culture of discovery. As William Eamon has shown, secrecy was not just a tactic deployed by inventors but an epistemology of nature itself: one of the jobs of the natural philosopher was to force nature to yield her secrets. The process of translation from one economy to another is still poorly understood.

New readings are also offered for the very ‘objects’ that Galileo discovered: these are usually depicted as stable physical objects, but Biagioli shows how, instead, they both came into being and were presented as processes rather than objects. It was only through the establishment of periodicity that the Jovian moons became discrete objects. There is one bibliographical slip in this analysis, though. The illustrations by which this information is conveyed in the *Sidereus Nuncius* were originally intended to be woodcut strips, with the relative position of the planet and its moons initially cut into a table, then each observation sawn off and surrounded by text. This idea was rejected, probably by the printer, who substituted the woodcuts (which, like all the images of stars in the book, were meant to be printed white on black, not black on white) with typographical characters. This detail does not affect Biagioli’s argument in any way, but offers an interesting example of proto-digital technology, with the relative positions of two signs ‘*’ and ‘0’ conveying all Galileo’s data. This was probably done to save money, not to start the digital age. Biagioli himself occasionally lapses into powerful yet inaccurate anachronism by referring to the sequences as ‘movies’. They seem so now to us, but surely there existed a rich contemporary artistic and rhetorical vocabulary to describe the depiction of stages in a story? Painted narrative cycles were especially strong in 16th-century Venetian *scuole*; going to the movies might be a distraction to understanding this.

Visual evidence is also central to chapter 3, ‘Between Risk and Credit: Picturing Objects in the Making’, where the analysis of satellite periodicity is extended to Galileo’s debate with Christoph Scheiner over marks on the face of the Sun. Here the depiction of sequence is contextualized, though the reader remains unclear about how innovative Galileo’s image-making agenda was and to what extent it was strictly his and not that of the printer or patron. The sunspot debate was complex and is hard to reconstruct—an edition by Albert Van Helden and Eileen Reeves, to which Biagioli was a one-time contributor, is due soon from Chicago—and Biagioli does a good job of both conveying what happened and granting access to the actors’ viewpoints. He crucially recasts the two protagonists’ differing modes of depicting sunspots not as a competition of realism, but as appealing to, and constructing, different audiences. Galileo’s images, committed to representing a process unfurling in order to posit the

existence of a troublesome object, ended up, Biagioli argues, by doing much more: they convinced him to adopt a dangerous ‘ontology of change’ [217].

The final chapter, ‘The Supplemental Economy of Galileo’s Book of Nature’, addresses the series of manuscript letters and tracts that culminated in the famous ‘Letter to the Grand Duchess Christina’ in 1615. This text is generally considered to offer a separation of natural philosophy from theology, a kind of disciplinary truce. Biagioli elegantly shows how Galileo’s transformation of the trope of the Book of Nature forced him to base the model and authority of natural philosophical knowledge on the theological model. Far from declaring the discipline autonomous, this move rendered it even more reliant on its authenticating source. Biagioli’s argument posits a logocentrism at the basis of Galileo’s bibliocentrism; but, given the power convincingly attributed to diagrams and illustrations in the preceding chapters, I do not see why this should necessarily be the case. When Galileo uses words like ‘language’ to describe the content of the Book of Nature, he may well be redeploying his central argument within the ‘Letter to the Grand Duchess Christina’ that even in Scripture not all words are literal. That he should use a metaphor to make himself understood does not detract from the truth behind the metaphor. In this sense, the printed sunspots, with their suggestive technological effacement of human intervention in their process of production, come close to providing a glimpse of Galileo’s actual Book of Nature. The mathematical language in which it is expressed is not another form of representation for Galileo, but a laying bare of the only true qualities humans may know of objects. It is not so much that ‘Galileo’s book of nature stretched the metaphor of the book so far that it started to fall apart at its many seams’ [242], but that the book was itself an extraordinary act of mental experimentation, a single sheet coexistent with the universe imprinted, one assumes, with animate diagrams containing the past, present, and future of the universe. In the same period, several attempts were made to rethink the prison of language—Campanella’s pedagogical icons in *The City of the Sun* are only the best known semiotic experiments in an extraordinary century. But this is an aside. The main point of the chapter is to make strange some of the self-evident tools of analysis: terms such as ‘obstacle’ and ‘resource’ are given the same kind of shakeup that Galileo himself proposes to overburdened Aristotelian language in

Sunspots. Biagioli suggests that our language itself is metaphysically loaded, and that we should rethink these terms as ‘the conditions of possibility for the articulation of Galileo’s discourse’ [259] rather than as simple explanations of causes.

This is a brave, timely, and welcome historiographical experiment; and it remains consciously open-ended, though far from inconclusive. The debates over comets leading to *The Assayer* in 1623 and the trial documents of 1633 especially, now demand fresh readings. Latent positivism lurks in even the most groundbreaking histories of science, with their tendency to chart the closure of debates by recourse to fully informed actors in control of their resources. Biagioli, by contrast, presents a more disturbing and liberating vision, a nomadic and hybridizing historiography that takes its aporias and differences as it finds them, reconfigures its field as it moves, producing and embracing a Galilean ontology of change.