

# Cicero and the ‘EnCyropedia’: mathematical optics and Roman builders

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Science and technology underpinned much of life in ancient Rome, but are rarely obvious in ancient sources other than technical treatises. Thomas Kelly examines a letter from Cicero which offers a rare glimpse of a discussion about geometrical optics: the study of how vision works.

## Cicero’s home improvements

In a letter sent by Cicero to his friend Atticus in 60 B.C., he relates a conversation he had with an architect working on a project for him. The project is likely to be the construction of part of a house, though this is not mentioned directly. The context of the letter is Atticus’ impending arrival in Rome, where Cicero supposes he will be surprised by the narrowness of the windows on a newly constructed portion of the building. It is something Cicero has already raised with his architect.

*If you make any criticism of the narrowness of the windows, be aware that you’ll be criticising the ‘EnCyropedia’. I mentioned it, and Cyrus launched into a speech about the view of the gardens not being as sweet with broad windows. ‘Let the eye be A, the object seen BC, the rays D and E...’. You see how the conversation went. For if we saw **impacts from images**, the images would have to work very hard in the narrow windows. But as it is, the **pouring out of rays** works charmingly. And if you criticize anything else, you won’t hear the end of it, unless it is something that can be put right cost-free. (Letters to Atticus 2.3).*

[The letter is written in Latin; the phrases in bold are translations of Greek terms].

Cicero’s letters often reflect his (admittedly unusual) experience of day-to-day life in ancient Rome, and this passage is an excellent case study of the light a non-technical source can shed on ancient science and its social and cultural associations. The architect, Cyrus, defends his construction of the house with narrow windows by means of a detailed exposition of the theory underpinning

his design. According to Cyrus, wide windows would counterintuitively afford a less good view through to the gardens, and he refers to several different strands of theoretical optics in support of this. As it happens, Cyrus’ statements as reported here do not actually justify his claim, but before returning to this point it will be useful to consider briefly the history of the subject.



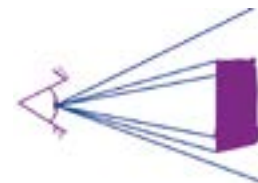
Early sixteenth-century marble head of a man (imitation of a portrait of Cicero). ©J. Paul Getty Trust.

## Studying vision

The study of vision had been of interest to Greek philosophers since at least the fifth century B.C., and by Cicero’s day there existed several competing theories about how seeing took place. They can be divided loosely into two groups: those which supposed some kind of emanation from an object into an eye and those which posited some kind of ‘fire’ emanating from the eye to the object

seen. Optics had also been a mathematical discipline since the third century B.C. From this period there survives a book on the subject attributed to Euclid, the author of the foundational Greek geometrical text the *Elements*.

Euclid’s *Optics* dispensed with philosophical theorizing about the nature and mechanics of seeing and instead treated the subject entirely geometrically. Euclid described visual rays emanating from



Thomas Kelly’s sketch of the type of geometrical diagram of optical illustration discussed.

the eye in the shape of a cone, such that any part of an object touched by the rays could be seen, and any not touched by the rays was invisible.

With a few basic definitions in place, any situation involving seeing could be described with the language and structures of mathematical geometry. Points in a two- or three-dimensional space could be denoted by letters of the alphabet, straight lines by the letters of the points at either end, angles by the intersection of two straight lines, and so on.

This geometrical model of optical illustration had become widely known by the first century B.C, although the number of people who took an active academic interest in this and other geometrical endeavours, sometimes called *Mathematicians* (although this group had wider interests than what we would recognize as simply mathematics) remained surprisingly small throughout all of antiquity. The geometrical apparatus with which they constructed their proofs, through the drawing of diagrams labelled with alphabetic letters, was a highly distinctive feature of this group.

In his conversation with Cicero, Cyrus has described a geometrical diagram in the style characteristic of the *Mathematicians* and used it to model the act of someone looking out of the windows. Cicero does not go on to elucidate

the whole proof that Cyrus used (if indeed he did give such a proof). Instead, we hear that Cyrus has gone on to refer to a theory of vision involving emanations from objects to the eye, which the architect says would indeed – if it were true – cause problems for someone wanting to look out of the window. But since the rays, according to Cyrus, actually emanate from the eye of the viewer, they can ‘pour out’ from the narrow window and give a beautiful view.

### Showy geometry

We have already noted that the architect’s justification of his work, at least as reported, is somewhat defective. But whether wider or narrower windows are in fact better is not a question Cicero is very interested in here. Changing the size of the windows would cost time and money, and Cicero really sees Cyrus’ elaborate geometrical explanation as a way of shutting down any suggestion of extra work. He reports the conversation in his letter less to start a scientific discussion with his friend Atticus than to sneer at his architect’s oh-so-clever displays of erudition.

Cicero skips over the details of whatever proof of his point Cyrus offered: he either does not have or is unwilling to betray any serious academic interest in it or either of the theories of vision mentioned. In fact, his quotation of the geometrical explanation Cyrus gives – the setting out of a diagram labelled A, B, C, etc. – reflects a slight misunderstanding of the way these diagrams usually worked. Individual letters like ‘C’ and ‘D’ would normally be used to refer to points on physical objects, not to the visual rays themselves. These would be described as ‘AC’ or ‘AD’, where A and C or A and D are points in the line of the ray.

As reported by Cicero, the geometrical model of the windows situation also fails to interact with the competing theories of vision that Cyrus mentions. It is not actually clear that the imagined diagram explains the point that Cyrus is trying to make. Cicero merely alludes to the lettered diagram as a way of gesturing at the kind of long-winded explanation he was about to get. The arcane idiom of geometrical optics is sufficient to stereotype the pretentious technician.



Portrait of Lucius Junius Moderatus Columella from Jean de Tournes *Insignium aliquot virorum icones*, Lyon, 1559. Photo: Public Domain.

### Expert knowledge

This is not to say that Cicero is entirely ignorant of the subject on which Cyrus is expounding. By his elliptical use of the diagram letters as a way of signalling the type of explanation Cyrus launched into, Cicero signals to Atticus a type of knowledge in which they both share on a superficial level, but whose details it is not their business to understand. This notion that certain categories of knowledge, particularly scientific knowledge, belong to specific groups of people, is not unusual. Columella, the author of a book *On Agriculture*, prefaces a series of geometrical problems about the size of fields as follows:

*Have no doubt that this more the business of geometers rather than of country people, so please forgive me if I make any errors. I do not claim any expertise in this topic.* (On Agriculture, 5.4).

It is also significant that where Cicero quotes Cyrus’ use of the technical language of theoretical optics, he does so in Greek. Cicero’s use of Greek in his letters is hardly an unusual phenomenon but it is nonetheless indicative of a more general principle that theoretical scientific knowledge was by and large a Greek phenomenon, even in the obviously Roman context.

This passage has implications for the history of science in Rome more gen-

erally and demonstrates the importance placed on the theoretical knowledge which underpinned practical disciplines like architecture. The architect Cyrus is a recurring character in Cicero’s letters (we hear about him building a house for Cicero’s brother in a letter from 56 B.C., for example). Cicero’s mocking of his tendency to expound on technical topics implies that elaborate displays of knowledge of the kind reported in the passage above were not uncharacteristic. Although it is difficult to say whether the planning of a building actually relied on the theoretical methods Cyrus waffles about, it is apparent that knowledge of theoretical disciplines adjacent to the practical profession of designing and building was a marker of professional status for Roman architects, even those who worked on relatively small-scale projects. The

evidence from the letter discussed above appears to confirm the prescription for the education of architects given by Vitruvius, the author of a long treatise *On Architecture* from the first century B.C.:

*An architect should be highly literate, skilled at drawing, accomplished in geometry. He must know his history, have paid serious attention to the philosophers, know music; he cannot be ignorant of law or medicine, and he must understand the study of the heavens and the motions of the sky.* (On Architecture, 1.3).

Vitruvius’ description may be idealized, but Cyrus’ pretensions at the very least demonstrate an aspiration to this ideal.

In one sense, this passage from a letter between friends simply describes one man’s minor annoyance at his overly pretentious and work-shy employee. But viewed through the right lens, it shows us evidence of technical knowledge in practical professions in ancient Rome, and refracts scientific debates current in the first century B.C. about the relatively opaque topic of the production of vision.

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