Commenting Arabic technological treatises in illustrated manuscripts

A typology in the case of Banū Mūsā’s Kitāb al-Ḥiyal

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Abstract

Extant manuscripts of Arabic technological treatises often bear the traces of commenting actions and additions undertaken by both copyists and readers. Because of the peculiarities in the perception of technological treatises, commentaries on them deserve special treatment. The main reason is related to the interpretative perspectives of both reader and copyist. Because of lack of authoritative interpretation, the reader or the copyist can feel challenged to intervene on the manuscript. Systematisation and synthetic consideration of apparently independent commenting interventions justify their characterisation as commentaries. As a case study for working out a typology of such commenting interventions several manuscripts of the Kitāb al-Ḥiyal of Banū Mūsā (3rd century H. / 9th century AD) are considered. First we find marginalia concerning dates and persons (owners or readers). Then we find comments referring to previous commenting remarks. Further we find terminological specifications concerning the addenda and other forms of comments. What is particular for technological treatises is the functional control by the copyist and/or the reader – on the basis of both text and illustrations. This control may be accompanied by suggestions and amendments concerning the construction of the devices. Finally we may have manuscripts with additional figures or variations and additions in the figures. The crucial question on the status of the illustrations themselves as a form of commentary will be discussed on the basis of deviations in the iconography of several manuscripts.

1. Peculiarities in the perception of Arabic technological treatises

The focus of this presentation lies upon the peculiarities in the perception and transmission of Arabic technological treatises. With reference to the Kitāb al-Ḥiyal of Banū
Mūsā (3rd century H. / 9th century AD) a typology of such commenting actions will be developed. The final goal is to demonstrate how illustrations of technological treatises can function as a commentary, which, sometimes, may not correspond to (our?) textual understanding.

The term *technological* is used here as a modern analytical instrument for accessing and comparing treatises to parts of treatises which may belong to several types of the Arabic grammatical. Descriptions of devices raise the claim not only to present the outlook of the artefacts, but also to explain how they function, what material they are made of, how they are to be put in action etc. Further they may carry or imply the character of marvel (*ajā'ib*), and they are often evaluated according to these criteria – sometimes in comparison to other devices.

Even if the text itself does not refer to all these topics, comments on these treatises do involve them. This occurs in interpretative ways which recur to logical control, experimental reconstructions, propositions of alleged improvements, as well as to more conventional comment references.

A further peculiarity of the works on technological devices is the form of the illustrations and their multilayer relationship to the artefacts presented in the text. The effects resulting from the copying of such illustrations depend on much more factors and parameters of understanding than the art of copying a text. The rules applied in copying and perceiving the illustrations are often less explicit than in the case of copying and perceiving the text. In this way the new illustration become itself an implicit commentary of both text and original illustration.

After these preliminary remarks, let us focus upon the material of our representative case study. Who were the Banū Mūsā? What is the structure of their *Kitāb al-Ḥiyal* and what is the manuscript information we possess about it?

2. **The Banū (sons of) Mūsā bīn Shākir (3rd/9th century)**

According to the historical sources¹ their father was astronomer and was considered to the companions of the future Caliph al-Maʾmūn when the latter was still living in Khurasan. After their father’s death the three brothers Muḥammad, ʿAḥmad und al-Hassān were entrusted to the care of the Caliph al-Maʾmūn (813-833 AD) and became members of many courtly circles. According to reports going back to Ibn al-Nadīm or Ibn abī ʿUṣaybiʿa, the three brothers undertook major public works as well as patronage role towards eminent scientists and translators (e.g. in the Bayt al-ḥikma). They seem to have undertaken journeys to Byzantium and to have arranged the transfer of Greek and Syriac scientific manuscripts to Baghdad. As for their own scientific interests and activities, they made a name for their scientific works especially on astronomy and mathematics.

There were entries on the Banū Mūsā in all the major Arabic biographical dictionaries, and their political activities (interwoven with intrigues against another prominent scholar, al-Kindī) are mentioned by their contemporary historian al-Ṭabarī. Much later the 14th century historian Ibn Khaldūn wrote²:

“There is a book on mechanics that mentions every astonishing remarkable and nice mechanical contrivance. It is often difficult to understand because the technical proofs occurring in it are difficult. People have copies of it. They ascribe it to the Banū Shākir.”

3. **„Kitāb al-Ḥiyal” of Banū Mūsā in the extant manuscripts**

The book is mainly attributed to ʿAḥmad and is obviously the *Kitāb al-Ḥiyal*. It has been intensively copied after its apparition, and several of these copies have been preserved up to our day. The following extant manuscripts are known³:

1. Topkapi Saray (Istanbul); Ahmet III 3474 (here referred by T)
2. Vatican Library; Vatican 317 (here referred by V)
3. A manuscript divided in two parts between
   3a. Gotha Library; Catalogus von Pertsch No. A 1349 (here referred by G) and
   3b. Berlin: Library Ahlwardt No. 5562 (here referred by B).

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There also exist fragments of the treatise in two further manuscripts kept in Leiden and in New York.

The treatise was edited by Aḥmad al-Hassan in Aleppo in 1981. It was translated into English in 1979 by Donald Hill. Both the critical Arabic text edition and the English translation agree in an alleged sequence of 100 models (devices) treated in the several manuscripts with more or less established authenticity. There exists also an earlier German translation by Fr. Hauser since 1922.

The Kitāb al-Ḥiyal contains textual and pictorial descriptions of some 100 mechanical devices. Among them are found beakers (ka‘ṣ), pitchers (ibriq), boilers (milyar), jars (jarra, kūč), fountains (faqwara), lamps (ṣirāj) and other devices. They are based upon pneumatics and hydraulics, with emphasis on automatic control.

The preserved manuscripts contain several forms of comments and additions incorporated during the transmission of the treatise. In the following a categorisation of the commenting forms by means of some characteristic examples will be proposed.

4. Typology of comments in technological manuscripts

A typical folio contains the main text, eventually an illustration and often a commentary – in the margin or incorporated into the main text (see e.g. V folio 6v with the illustration of a pitcher/ibriq of Model No. 9 and the textual description of Model No. 10).

Considering the whole treatise as it is preserved in the manuscripts mentioned above we can distinguish among the following commenting forms:

a) Conventional marginal comments concerning earlier copyists and/or readers.

Typical marginal comments (not specifically on manuscripts with technological subject) concern earlier copyists, readers, owners or commentators of the treatise, as well as on the state of a certain manuscript at certain time of the copying chain. In the Vatican MS there is the following note on the side of the folio treating the Model no. 20: “This Model and its description were not in the copy which was compared with it”. The copy which was compared with it was owned by the daughter of Shaykh Abu Naṣr Yahiya b. Jarir and it had many corrections and amendments in his handwriting. The Model is a fountain (faqwara), which occurs in a sequence of descriptions of trick vessels (!). It is, therefore, considered as a later interpolation. The marginal note should then be an even later comment.

b) Comment references incorporated into the main text.

Another fountain (faqwara) known as Model No. 93 in the Berlin manuscript contains a comment concerning copyists and difficulties with understanding the function of the device. The comment is incorporated into the main text and reads as follows: “Abū-l Hasan ‘Alī b. Aḥmad al- Hāšib said: this is my statement (kalām) in explanation of the ninety-fifth [sic] model from the book of the Banū Mūsā. We have not commented on [just] any copy, but we found it [written] in the handwriting of Fath, the servant of the Banū Mūsā, and in the copy were amendments in the handwriting of Muḥammad b. Mūsā. This model was illustrated but [the illustration] had no letters and no explanation. When I looked at it and put it in order and pondered it, I understood everything they had described about this Model, and it is close [i.e. similar] to the previous one. So I made this commentary. And that is what we wished to explain. And that is all.”

A similar note concerning a chain of addenda is found on a separate page (folio 23r) concerning the flask Model 37 in the Vatican manuscript: “[I found, in the handwriting of Shaykh Abu Naṣr Yahiya b. Jarir the completion of the Model] in a margin in the place, and I have transcribed it fully and this is the picture. An addendum was found in the handwriting of ‘Uṯārid at the end of Model 37. ‘Uṯārid said: this flask requires an additional explanation, namely that the two tanks (xd) [sic] are both double the two tanks (fmj) and between the pipe (ṭh) on the side of the wine, namely the higher one, close to its head (?), so that the wine does not return to it if the flask is increased in [size]. Similarly for pipe (ṭh) in the upper

1 Al-Hassan (1981).
3 Hauser (1922). This translation, however, could not consider the highly appreciated Topkapi manuscript which was made accessible only in the 1970s.
tank (xez) discharges the wine that has entered it from large tank (i) for the wine, and wine will discharge together with half its amount or water. Then it will happen as the writer of the book says after that. However, the pipes for the air should have their open ends close to the floors of tanks (xez), so when the flask is put down then titled, nothing will run through them. End of addendum. Praise be to God.”

In both notes we have information on copyists and readers or owners of the manuscripts. Further we get hints concerning the behaviour of copyists when treating earlier comments found in the manuscript they were copying. More significant, however, are the comments on understanding the function or the illustration of a certain device. These comments are characteristic for technological treatises. Sometimes they introduce or justify functional checks (in the form of mental experiments) and additional explanations, eventually also additional construction suggestions.

c) Functional control of the device.

A note by the side of the illustration on folio 58r in the Topkapı manuscript claims that the illustration of Model 46, a vessel (inâ) or jar (jarra), is incorrect and that the device would not work if it were constructed according to this illustration. In his annotated translation D. Hill remarks that the reasoning of this reader’s comment is not evident. For our study the scope of assessing such comments is much wider. What we actually have to compare are not just graphical or textual representations. Moreover, the actual comparison involves the implicit or explicit reasoning of the certain critical reader or copyist, the reasoning and the purposes of the author, the implicit reasoning and the copying ethos of the intermediate copyists – and of course, our technological reasoning and understanding today. Sometimes the functional control requires some additional information that can be provided by modifying or extending the accompanying illustration, as it is the case with the fountain of the already mentioned Model 93.

d) Additional suggestions concerning the construction of the device.

A commentary that resembles but at the same time goes beyond the type of functional cheque is reported on a separate page interpolated between folio 43v and folio 44r in the Topkapı manuscript. It concerns a jar (jarra) described as Model 581. In this interpolation a suggestion concerning the construction is reported to have been previously (i.e. in an earlier copy) proposed by 'Uṯārid. According to 'Uṯārid “two rods ... require retainers, otherwise they will not stay upright.” He then proceeds in describing how these retainers should be attached to the device in order to make outlook and function possible2.

Another case of comment suggesting additional construction details appears in the margin of the description of a beaker (qadaḥ) in the Vatican manuscript under the Model 26 (D. Hill numbering 27)3. In Hill’s translation the commentary reads as follows: “In this construction a plate perforated with small holes like the holes of a pipette should be soldered to the top of the small goblet – it empties and fills through these.” Similar suggestions concern the construction of jars (jarra) in the Vatican manuscript (Models 64 and 65, the latter being at the bottom of the folio 47r)4. Even if the reasoning with respect to the functioning of the device may not look quite evident to the reader of today, as suggest the remarks of D. Hill, such comments imply that the treatise was often read critically by persons possessing technological expertise.

e) Additions or variations in the illustrations

Most of the above commenting interventions refer to the accompanying illustrations and to their relationship to the main text. Some of them suggest changes (“amendments”) in the illustration undertaken by the reader or the copyist with the purpose to correct them according to his understanding of the textual description of the device concerned.

It is not the aim of this presentation to treat the vast and complicated subject concerning the relationship between text and illustration5. Instead, some remarks and suggestions concerning details and variations in the illustrations of one and the same device in several manuscripts will be proposed.

1 Hill (1979), p. 131.
As a case study we shall consider Model 1, a beaker (ka’s) in which a quantity of wine or water is poured with the effect that, after surpassing a certain filling level, the whole content is discharged. In fact the construction involves a concentric siphon pipe installed at the bottom of the beaker (cup) with an outside tube closed on the upper top and an inside tube going through the bottom of the vessel. When liquid is poured into the cup, it rises into the space between the two tubes up to the upper opening of the inside tube. Pouring more liquid into the cup causes the abrupt discharge of it through the inside tube and a subsequent pressure reduction over the opening of the inside tube (under the closed top of the outside tube). This results in a continuous outflow of the liquid until its sinking level in the cup reaches the mouth of the outside tube. If the mouth of the outside tube is very close to the cup’s bottom, we get the impression that almost all the content has been discharged.

It is interesting to compare the illustrations of this device in the several extent manuscripts. Generally both D. Hill and A. al-Hassan praise the quality of the Topkapi manuscript, especially concerning illustrations: “The illustrations are clear, and serve as valuable complements to the text; they are by no means perfect but the faults are usually trivial and do not hinder understanding.” Illustrations in the Topkapi manuscript are also characterised by plenty decorative elements – also by the fact that they include figures of animals, birds and humans, whereas such elements do not appear in the other extent manuscripts. In the case of Model 1 the illustrations given in the manuscripts V, B and G, though varying in the outline, are consistent with the text which claims that “... if a quantity is poured into beaker (ab) up to point (j), then increases even by a small quantity, everything in it will be discharged to the outside from pipe (jd).” Precisely in the Topkapi manuscript, where only the last line of the text describing the device is extent on folio 1r, the illustration on the same folio depicts a beaker with such outline details that render the explicit functional claim unrealisable! The mouth (lower edge) of the outside tube is so high, that the stem of the beaker would always remain full of liquid! It is symptomatic that this illustration in the Topkapi manuscript is the only one of the four manuscripts which depicts the beaker with a (decorative?) stem! It is also the only beaker illustration in the Topkapi manuscript at all depicting a beaker with a stem!

Should we take the illustration in the Topkapi manuscript isolated, this illustration would restrict the validity claim of the text. In the perspective of our comparative iconographical approach, however, it seems more probable, that the illustration on T 1r includes decorative addenda which belong to (or inaugurate?) a distinctive tradition parallel to that of the textual copies. The criteria for the iconographical validity (e.g. exact iconographical copy of the unknown precedent figure; correspondence between the object “beaker” and the culturally connoted beaker typology or at least one variety of this formal typology) would precisely refer to those details which contradict the textual claim.

5. Illustrations as commentary in technological manuscripts

The above considerations on the several aspects of the relationship between text and illustration introduce an iconographical perspective with several claims.

First, we have the leading motif of interpretation and functional understanding as a link between text and illustration. The text explains the illustration, and the illustration makes the text understandable by commenting it on the level of functional reasoning.

Then there is the dimension of referentially inside the iconographic tradition. In a similar way in which the (Arabic) text implicitly or explicitly comments previous treatises on automata (namely Greek treatises of the late antiquity, e.g. by Ksesbios or Heron of Alexandria) illustrations of the Arabic treatise can also correspond to illustrations of such reference manuscripts, whether in Greek, in Syriac or in Arabic. Further, the iconographic tradition of such treatises, even poorly known to us, is not merely a complement, an appendix to the textual tradition. The relative independence of iconographical codes,
especially when the represented objects are taken from the contemporary everyday life (beakers, jars, pitchers, fountains), introduce a distance to the purely technical-functional status. This distance enables an interaction between the distinct code systems, i.e. the textual and the iconographical. This relationship is much more complicated than the one alluded in the formulation of D. Hill “…to make them [the illustrations] match the text”1, or in the conventional assertion of subordinated illustrations which merely accompany the text. Moreover this “accompanying” action creates a mutual commenting between text and illustration, an indication that neither code, neither system of signifiers encloses the other. Precisely this commenting potential can resolve the apparent discrepancies mentioned above in the case of the illustrations of Model 1 in the extent manuscripts.

Finally we have to mention the systematic omission of figures of living beings in all the manuscripts except that of Topkapi. As mentioned in the previous section several illustrations in the Topkapi manuscript include figures of animals, birds and humans, whereas such elements do not appear in the other manuscripts. The systematic omission of figures of living beings may be due to religious reasons. Who decided the omission? Was it a common or rather an exceptional practice when copying manuscripts of that type at a certain period? We should certainly compare this copying practice e.g. with that of al-Jazari’s treatise on automata (ingenious devices) which also involves figures of animals and humans. We could imagine e.g. that the manuscripts B, G and V (or their precedents) were ordered by spiritual Muslim leaders or pious Muslims. Whether we accept this explanation or not, this omission increases the significance of the functional-technological iconographical elements transmitted in all manuscripts.

6. Conclusion

The present study suggested a typology of commenting interventions encountered in Arabic manuscripts with technological treatises. Some of these commentaries are not specific for the technological subject. However, the peculiarities in the perception of technological treatises are associated with specific categories of comments. These categories involve the functional control through the reader or the抄写员, additional suggestions concerning the device construction, as well as the several types of illustrations. This categorisation organises the different types of comments in commentaries. Especially the relation between text and illustration, a form which we could call iconographical commentary, remains a rather unexplored field that requires more comparative work on the basis of several illustrated technological treatises.

References


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1 Hill (1979), p. 15.
2 The manuscripts B and G date back to 1210 A.D. / 607 a.H.