Replicating 18th Century Magic Lantern Practice

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When the Royal Society celebrated its 350th anniversary in 2010 it launched a wide range of public activities and events to stimulate the public's interest in science and its history. National Museums Scotland were able to secure a RS350 grant to commission an early 18th century magic lantern replica in order to better understand historic projection practices and make them accessible to broad audiences. This chapter aims to explore the design and performance with this replica and tries to situate it in a broader culture of projection technology and public performances during the late 17th and early 18th century. We will also look at different traditions of designing and employing magic lanterns and their changing roles in public spectacle.

Magic lantern projectors as we know them were introduced in the 17th century, when the Jesuit priest Athanasius Kircher projected images with what he called a 'lantern' in Rome during the 1640s. The first reported lecture based on projected images dates from 1653 or 1654 when the Jesuit André Tacquet showed painted transparent pictures of a journey from China to the Netherlands undertaken by a fellow member of his order, Martin Martini. By 1659 the device had been refined to its most definitive features by the Dutch scholar Christiaan Huygens, though he apparently did not perform with it. By 1672 the 'laterna magica' was produced in large numbers in Germany. It was seen as a toy - produced in larger numbers by the Nurenberg toy maker Griendel – but also as an object of scholarly activity. It was reportedly used in an experimental lecture given by professor Johann Christian Sturm in Nuremberg at that time. Magic lantern slides soon became part of the anatomy lectures of the Würzburg scholar Johann Zahn (Fig. 1). By 1705 lantern images were used in lectures on national and biblical themes as well as natural history and mathematics. Around the same time experimenters such as the mathematician Erhard Weigel in Jena embarked on attempts to move these pictures mechanically.[2] By the 18th century the lantern projector had become a common device for both entertainment and study all over Europe. It went through several changes but the technical principle stayed the same: a light source is placed in a container where its illumination is increased by a concave mirror. A transparent picture is placed in front of the light source (later with an added condenser lens) and the light shining through this slide becomes enlarged by means of a focusable object lens and is projected onto a screen.[3]

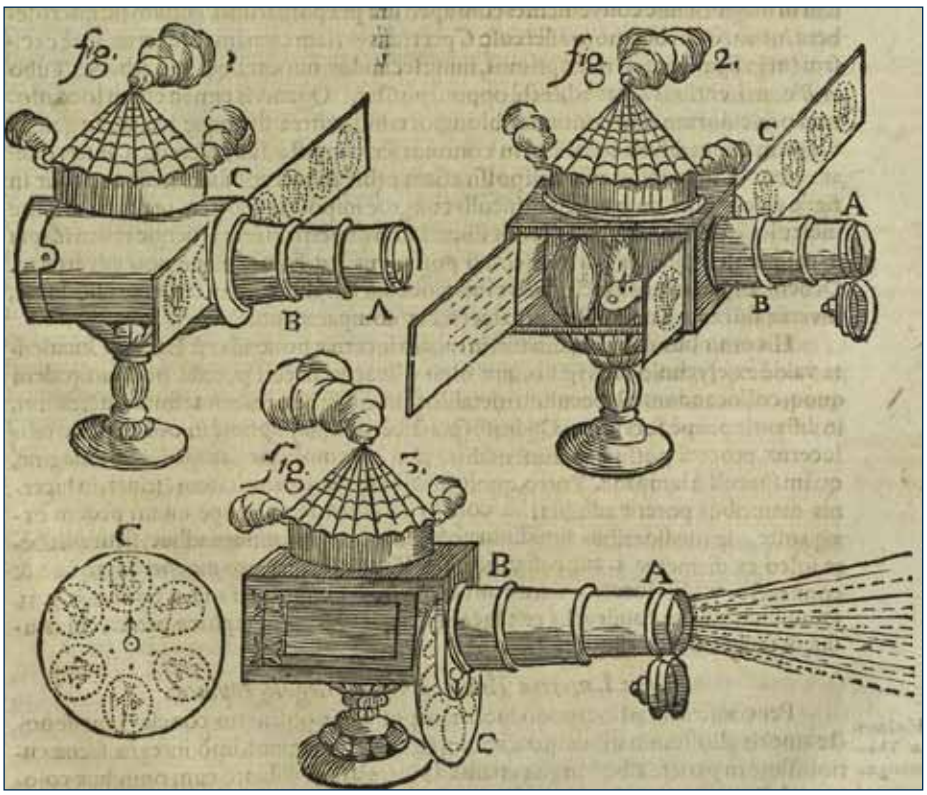

Fig. 1 *Illustrations of three early magic lanterns like those in the Kassel Museum, from Johann Zahn, Oculus artificialis teledioptricus, etc. (c. 1685), p. 253.*

Compared to the large numbers in which these lanterns were produced at the time only very few still exist. There are many explanations for the absence of early lanterns but a key role might have played that these devices often were not considered 'scientific' instruments but commodities and toys. One museum that still has a small number of early magic lanterns in its collections is the Cabinet for Astronomy and Physics in Kassel. It was one of the Kassel lanterns (Fig. 2) we decided to replicate (see Fig. 3).[4] This lantern forms part of a set of three, which show striking similarities but also intriguing differences. All lanterns show similarly shaped containers, lens mountings, chimneys, decoration, and colour schemes (white with blue highlights). Interestingly, whereas two lanterns have low stands, one has a tall one. And whereas two lanterns carry relatively plain decoration, one is decorated in a highly elaborate way. One lantern features a circular slide revolver (see Fig. 1), and only one lantern still contains an object lens. There had been some speculation that these lanterns had been bought by the Duke of Hesse in Nuremberg, on his way back from Italy in 1699 but Karsten Gaulke and Bjoern Schirmeier at the Kassel Cabinet have convincingly argued that the lanterns were almost certainly produced by a local maker in Kassel.[5]

For conservation reasons most original historical instruments are not allowed to be operated again and so it is almost impossible to learn anything about their practical performance, required skills and operational knowledge of those delicate historical devices. The magic lantern at Landgrave Karl's court exhibited at the *Orangerie* in Kassel is such a piece of science and handcraft. This is why we decided to revitalise the lantern through its replication. Our replica of the original instrument is in full working order and closely follows the original design. We carried out various practical experiments in order to learn about the optical performance and how to operate the oil-lamp, the mirror and the lens. The findings during the research for the re-enactment of the lantern's demonstrative performance generated significant information about its characteristics and triggered in addition new questions. Therefore, our project has to be understood as a work in progress.[6]

When we visited the instrument for the first time, we were very much surprised by its appearance. Situated in a cabinet of scientific instruments, we expected to find a noble splendid instrument, perhaps with some damages obtained during the centuries, but this magic lantern seemed not to fit into the category of glass-brass-mahogany devices so well esteemed by the public then and now. It was not in a poor condition at all and seemed a completely different piece of collection: on first sight the lantern looks poorly done i.e. not manufactured by an artist but rather a plumber or a tinsmith. The body of the lantern is not made of brass or another valuable or shiny looking material but out of tin-coated sheet metal. Also, the lantern had been painted and coated very 'amateurishly' or roughly. In this respect the most interesting question for us was: Is this magic lantern in the collection of Landgrave Karl indeed part of his collection or did it end up there by some accident, and how did it get into the collection then? Remarkable in this respect is that other lanterns of the collection are manufactured in the same way and awkward style even though we find different sizes and varying versions of the slides mechanisms (revolving-type, etc.).

The rough surface coating of the lanterns was one of their more unusual features. While coating techniques existed to a very high standard at the time the lanterns were produced, the surfaces are painted very roughly. Also, the paint is lead white paint which even in the late seventeenth and early eighteenth century was only used for surface coating rather than refined paintwork.[7] More interestingly, the paint shows few signs of heating, as one would expect after use with a lantern. Only a brighter shade of white on one of the lanterns' funnels indicates a possible re-painting. The white with blue colour scheme are the colours of the district of Kassel (Landkreis Kassel), and it can be imagined that the lanterns served a representative role rather than a functional one during their later career. This representative role is supported by a slide found with one of the lanterns, showing an image of a noblewoman. We will return to the uses of these lanterns later.

Aside from the mirror made from brass the lantern is completely manufactured out of tinned sheet metal, which is joined together either by soldering or crimping. Certainly a special crimping machine must have been in use in order to perform the needed joints. This means that the use of this tool which is restricted to special applications, is pointing to professionals and not to some kind of tinkering. The ornamentation has been made in a similar way which has been executed by a beading-machine and in addition by punching the sheet. Inside a cardboard-tube, which serves as a lens-tube, a second tube made from sheet metal is inserted. Along with an iron spring it fixes the lens in its position. There is no indication that a second lens was being used. The focal length is 135mm. The lens itself is greenish and obviously original; certainly an old one. The appearance of the lens-tube generates an impression of a prototype shape.

Fig. 2 *The original lantern in the Kassel Cabinet, painted in white and blue which are the heraldic colours of the district of Kassel.*

The oil-lamp inside is mounted to the lantern by an arrangement that allows adjusting the flame horizontally into a suitable position in front of the mirror. It is not possible to move or adjust the lamp in vertical direction. In the middle of the rear cap we find a hole in axial alignment with a second one drilled through the middle of the mirror. The mirror of the lantern is fixed to the rear cap by soldering. This construction renders the mirror impossible to be adjusted which in turn causes occasionally poor illumination of the slides especially because of the need of making full use of the very poor light of the oil-lamp. The need for adjustment is possibly the reason for the hole through the rear cap, which to us appears not to carry any other function. It can be speculated that the lantern maker has drilled this hole in order to manipulate the direction of the light beam to the slide. This conclusion leads us to 'modify' the replica by using holes that were drilled at the same position into cap and mirror together with a simple manipulator made from a screw, a small sphere, a spring and some nuts. This simple mechanism enabled that despite the orientation of the rear cap, which couldn't be fixed every time exactly in the same manner, the best possible illumination could be contrived without any problem.

The mirror itself consists of polished brass sheet metal and we could not find any visible traces of silvering. This at first was supposed to be due to repeated polishing of the mirror during the centuries, but experiments with silvered mirrors told another story. From the present point of view silvered mirrors would be needed but this depends on modern white light sources. Of course the newly silvered mirror made from watch glass was more reflective but not much more than the new polished brass-type. The difference is due to the colour of the oil-lamp, which is very different from modern sources and so the illumination of the slide in both cases seems reddish. It is hardly possible to distinguish the colour and the brightness on the screen between the two types. It is therefore possible that the mirror itself is in original condition, and with the illuminating power of the replica we were able to show the image quality was completely satisfactory; the benefit of silvering the mirror seems negligible.

Fig. 3 a) and b) *The replicated lantern and wooden slide holder and the replicated oil-lamp assembly.*

The replicated lantern (Fig. 3), which we manufactured in identical dimension and shape, shows a satisfying performance mainly because the geometrical design and the optical components are perfectly co-ordinated. This shows that the lantern had been made to serve as a lantern and not as a mere lamp. This insight is not entirely new. It is the instrument-maker and historian of optics, Paul Liesegang, who points us towards understanding the historic development from lamps to lanterns such as the one found in Kassel. Liesegang in his work on the development of the early magic lantern distinguishes magic lanterns such as described by Athanasius Kircher and others and an earlier tradition he traces back to the so-called bull-eye lantern ('Blendlaterne'). Using such lanterns in conjunction with projected images, Liesegang argues, predates the magic lantern by some centuries. Both types of lanterns included features such as a concave mirror, an oil light and a projection lens and by the middle of the seventeenth century both lantern designs merged to what we perceive as magic lanterns today. Makers in the German countries such as Sturm, Walgenstein or Zach based their magic lantern designs on the bull's eye lantern. Liesegang reminds us that bull's eye lanterns were not uncontroversial. Because of their not always legal employment such as illegal hunting or fishing, their uses were controlled by local authorities and governments and in some countries banned completely.[8] Simple in their design these lanterns could become troubled objects when it came to their uses.

Was the Kassel lantern indeed different from other types of magic lanterns at the time? In order to answer this question it is worthwhile to contrast the Kassel lantern and our replication of it with another magic lantern of the same period, the one made by the Leiden instrument maker Jan van Musschenbroek for the scholar Willem Jacob 's Gravesande, and now kept at the Museum Boerhaave in Leiden.[9] This lantern made by van Musschenbroek is quite different in design as it is built as a wooden 'camera' rather than an actual metal lantern (Fig. 4).[10] It has several features that indicate a rather scientific way of using it: almost all parts can be moved or adjusted, from the height of the stand to all side openings, to the arrangement of the burner. This design is quite different from that of the Kassel lantern, which hardly allows for active experimenting with the apparatus. It certainly indicates that these two lanterns originate from very different contexts, both in their making and in their use. 's Gravesande had intended his lantern as an experimental device, an expression of the visual culture of seventeenth and eighteenth century Netherlands. The Kassel lantern was different in this respect. It was sturdier, more solidly built and easier to use. These features became especially apparent when we employed our lantern replica as part of our museum activities, events and outreach. Children could operate the lantern which occasionally led to some rough handling and on one occasion to a child literally banging the lantern on the table. However, the lantern took this without any damage or parts being broken. The Kassel lantern was almost certainly designed for continued practical use. This is reflected in features such as the strong metal work and thick surface coating.

Contemporary paintings of historic lanterns point at historic practices at the court of Hesse-Kassel and indicate that both performing shows as well as handling the lanterns by various people were part of the original entertainment. From replicating historic performance, we know that the sturdy nature of the lantern would have been essential for theses demonstrations. Satirical and humorous images were likely part of the home entertainment, whereas representational images, including arms, were used on more official occasions. It would not be surprising if because of the sturdy nature of the lantern these were used for outdoor presentations such as city illuminations as well.[11]

Performing in outdoor spaces situates lanterns in a context less explored by historians of magic lanterns so far, their employment in stage technology and Baroque public spectacle. During the seventeenth and eighteenth centuries Kassel was one of the European centres of culture and spectacle. Under Landgraf Karl of Hesse-Kassel (1654-1730) the architecture and environment of the city of Kassel became completely transformed. A harbour and channel, a landscape park, impressive water plays, an orangery, a marble bath and many more landmarks were erected under Landgraf Karl, many inspired by Italian baroque art. Kassel was also given a new museum for its 'treasures of art and curiosities', and moreover, a new theatre. Sources of income to fund such

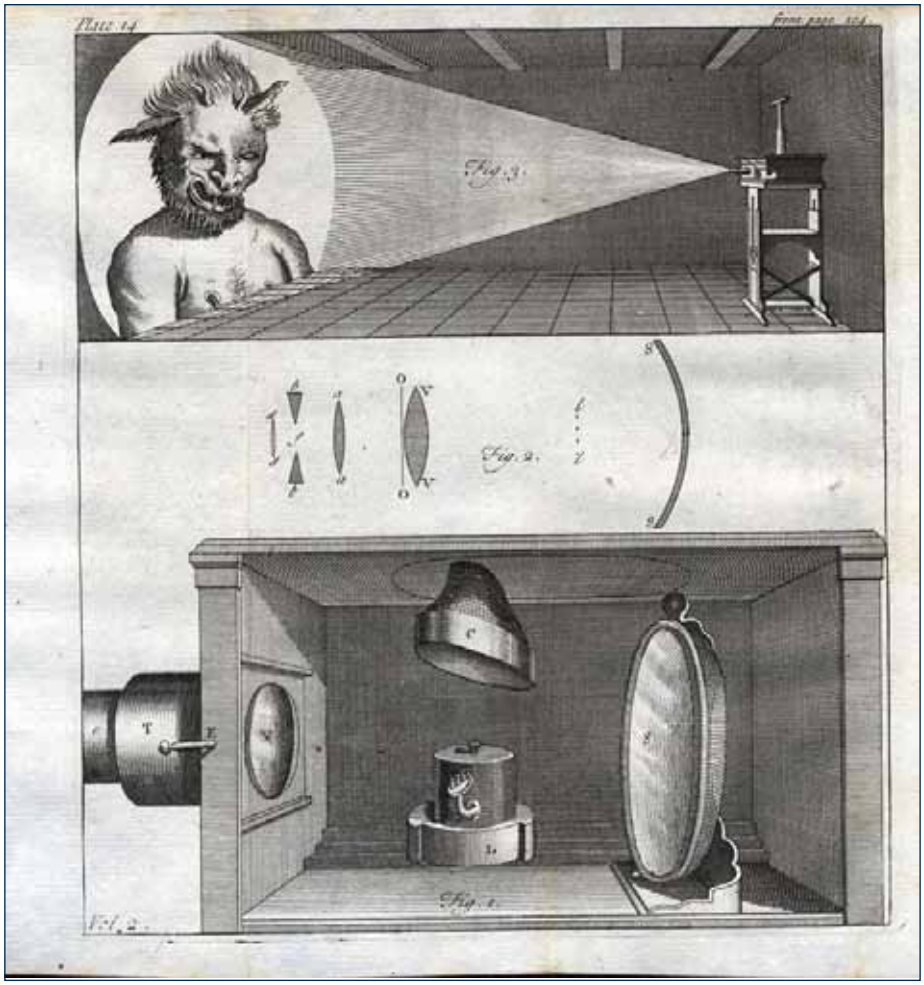

Fig. 4 *The lantern in Willem Jacob 's Gravesande,* Mathematical Elements of Natural Philosophy Confirm'd by Experiments*, 1731, Vol. 2, Pl. 14. The lower engraving is of the interior of the magic lantern: a wooden box containing a concave mirror, a lamp, and a round hole fitted with a convex lens.*

prestigious projects largely originated from state funds as well as from early industrialisation, including textile manufacturing.

State spectacle ranged from the impressive Herkules water plays to street festivals and fireworks.[12] Festivals would often last long into the night and projecting images in honour of the rulers during the city's festive illumination was part of the public spectacle. Trials with the replica showed that images could be projected well over a distance of five metres or more. In this context it is not surprising to see the Kassel lantern painted in the state colours. We can speculate that it was used as part of the extensive city illumination on the occasion of the Hesse government anniversary in1727.[13] Magic lanterns at that time were already established part of baroque theatre technology and representative lantern images would have been displayed together with water plays, fireworks, etc. Understanding baroque art in turn is impossible without understanding the technology that enabled it.[14] The Kassel magic lantern needs to be seen in this context of enlightened seven- and eighteenth century technology of wonder and spectacle. It was this very culture of both unmasking and creating illusions by using both technology and skill that marked the success of the magic lantern, both in private and in public.

Notes and References

1. Carl-von-Ossietzky Universität, Oldenburg, and National Museums Scotland, Edinburgh.

2. Paul Liesegang, *Zahlen und Quellen zur Geschichte der Projektionskunst und Kinematographie* (Berlin, 1926), p. 7.

3. *Ibid*.

4. We would like to sincerely thank Karsten Gaulke for providing us with access to the Kassel lanterns, supporting us in our research and answering our numerous inquiries. Preliminary aspects of our research were presented at the International Scientific Instrument Symposium in Kassel in 2011 and a more comprehensive analysis at the annual conference of the German Society for the History of Medicine, Science and Technology in Berlin in 2015.

5. Communication with Karsten Gaulke, Kassel, 8 July 2010. See also Karsten Gaulke and Bjoern Schirmeier, *Optica – Optische Instrumente am Hof der Landgrafen von Hessen* (Petersberg: Michael Imhof Verlag, 2011)

6. We are especially interested in tools and materials here and the related professions and trade guilds, something which we hope to turn into an article for this *Bulletin* in the not so distant future.

7. The paint analysis with kindly carried out by Dr Volker Koesling at the Deutsches Technikmuseum Berlin in October 2010.

8. Paul Liesegang, *Laterna magika und Blendlaterne: Eine geschichtliche Studie, in Rundschau für die Installations-, Beleuchtungs- u. Blechindustrie*, Vol. 1, p. 42, Sonderdruck, undated, probably 1918/1919. For a more recent discussion of bull eye lanterns see e.g. Deac Rossell, ‚Some Thoughts on the Bull's Eye Magic Lantern', *New Magic Lantern Journal,* **9**-5 (2003), pp. 71-75 revised 1/2012 on www.academia.edu/1200403/Nuremberg_and_the_Bulls-Eye_Magic_Lantern, *and Erkki Huhtamo,* 'The Early Magic Lanterns: Where Are They?', *The Magic Lantern Gazette*, **19**-3 (2007), pp. 11-12.

9. We would like to thank Hans Hooijmaijers and Tiemen Cocquyt for their assistance with examining the Boerhaave lantern.

10. For 's Gravesande's description of his magic lantern see William-James 's Gravesande' *Mathematical Elements of Natural Philosophy confirmed by Experiments*, translation, second edition (London, Senex, Innys, Osborn & Longman, 1726), for comments on vision and perception in 17th century projection optics: Klaus Staubermann, 'Comments on 17th Century Lenses and Projection', in Wolfgang Lefèvre, ed., *Inside the Camera Obscura – Optics and Art under the Spell of the Projected Image*, Max-Planck-Institut für Wissenschaftsgeschichte, Preprint 333 (Berlin, 2007), pp. 141-145.

11. Bjoern Schirmeier (note 5), pp. 103-121.

12. For fireworks and the broader relationship of arts and science in the eighteenth century see for example Simon Werrett, *Fireworks* (University of Chicago Press, Illinois 2010).

13. Bjoern Schirmeier (note 11).

14. Jan Lazardzig, *Theatermaschine und Festungsbau* (Akademie Verlag, Berlin, 2007), p. 236.

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