

# Movable Books As Animated Machines

## Creating 3D-Models of Historical Children's Books

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### Abstract

The project BeWeB-3D<sup>1</sup> deals with specific paper-made objects: movable or pop-up books. It aims at designing a computer-made model of 19th century paper-engineered objects, which facilitates interaction. Contrary to ordinary books these objects contain what you could call an interface. Therefore, interaction is a main goal of our 3D realization. BeWeB-3D was launched in February 2017. It is located at Staatsbibliothek zu Berlin (Berlin State Library) and funded by Germany's Federal Ministry of Education and Research (BMBF).<sup>2</sup> Aside from theoretical questions the technological part of the project is a challenging task. This is particularly so for the following (four) reasons. 1) Our average scientific user demands a low-threshold handling which asks for at least a plug-in free solution. 2) The quality of the original invites to reflect on how to live up to this standard best. 3) The implementation as a dynamical 3D model necessitates the use of game-engines like Unity. 4) The research context requires sustainability, long-term preservation and an open international standard.

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1 <http://www.sbb.berlin/beweb3d/>.

2 <https://www.bmbf.de/foerderungen/bekanntmachung-1197.html>.

# 1 Movable books – Frontend

Thinking about the digitization of cultural objects – following the theoretical concept of the material turn<sup>3</sup> and especially the BMBF announcement entitled “eHeritage” from June 15, 2016<sup>4</sup> – one has in mind a wide range of objects from museums, collections and archives etc. rather than books. There is a long tradition of referring to books as two-dimensional objects resp. texts. Putting it differently: Making a book for a long time meant reducing any content – be it speech or any other subject – to the two dimensions of a page, usually made of paper.

The present project deals with paper-objects, too. However, these objects serve a third dimension. Pop-up books or movable books (see fig. 1) contain what you could call an interface. Whereas one can talk of interaction between the reader and the object as early as reading is concerned – reading a multi-paged book makes necessary the turning of pages<sup>5</sup> – the objects of our project are rather machines than books.



Fig. 1: What you see is the different states of the movement of an animated paper lion triggered by the reader, who is pulling a strip of paper. Source: Meggendorfer, Lothar. *Nah und Fern: ein Tierbilderbuch zum Ziehen*. München: Braun & Schneider, 1887.

One the one hand machines are machines as long as they are working, or to put it more generally: Movement is an essential requirement for any machine. On the other hand they are black-boxes:<sup>6</sup> Something goes in, something comes out, what exactly happens in between, how exactly they are *working* remains unknown. As this cybernetical concept leaves behind quite a lot of

3 See e.g. Hicks (2010).

4 Richtlinie zur Förderung von Forschungs- und Entwicklungsvorhaben zur Digitalisierung von Objekten des kulturellen Erbes (Guidelines for the Promotion of Scientific and Development Projects for the Digitization of Objects of Cultural Heritage), available at <https://www.bmbf.de/foerderungen/bekanntmachung-1197.html>.

5 Cf. Schulz (2015). This technique has to be referred to as historical, as the codex obviously has a predecessor without the need of page turning, the scroll.

6 Cf. Ashby (1956), pp. 86-117.

subjects in an unhappy state, the wish to whiten these black boxes or to open them in order to find out what is going on inside, is quite comprehensible.<sup>7</sup> The movable books in our project allow for both of these requests. We are modeling animated 19th century paper-engineered objects. The aim of the project is not a digitized 3D-book but a computer-made model, which enables interaction. A central requirement for reconstructions is the “simulation of their functionality”.<sup>8</sup> The human actor has to be put in a position to trigger the movement of the model. Furthermore we are aiming at giving the visitor the chance of catching a glimpse of the inward parts of the model using computed tomography scanners. So, whereas the trigger point is as trivial as pulling a strip of paper, the impact of this action is rather complex.

## 2 Movable books – Backend

Opening the black-box reveals the mechanism behind (see fig. 2). Whereas the reader just pulls one strip of paper, he activates a fairly complex stage-setting, controlled by ribbons and joints. In the 1880s and 90s the German illustrator Lothar Meggendorfer became one of the most famous actors within this discipline worldwide. Referring to Carola Pohlmann, head of the department of literature for children and young people at Berlin State Library, one of the most striking characteristics of Lothar Meggendorfer is his satirical sight towards the world of adults. During a time of pedagogical papers for courteous children, he is making fun of grown-ups in the presence of kids.<sup>9</sup> His handmade children’s books with sophisticated fold-up, pulling and transforming mechanisms enjoyed great popularity.<sup>10</sup> Some of them were sold in various editions of up to 10.000 copies. Today, due to their purpose of being toys to play with<sup>11</sup> they are a rare find and therefore very costly to acquire.

As clearly defined our project is referring to its materiality, the conceptual outcome is to remain as open as possible. Therefore, the project aims at deve-

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7 See e.g. Kassung/Kümmel-Schnur (2008).

8 Kümmel-Schnur (2010), p. 364.

9 Pohlmann (2000), p. 9.

10 Bachmann (2016), p. 11.

11 Peter Goßens points to the interconnection between play and the dissemination of knowledge within the hybrid-medium movable book. See Goßens (2016), p. 61.

loping a *generic concept*,<sup>12</sup> which shall be the foundation for other ventures, likewise dealing with movable parts made out of paper.<sup>13</sup>

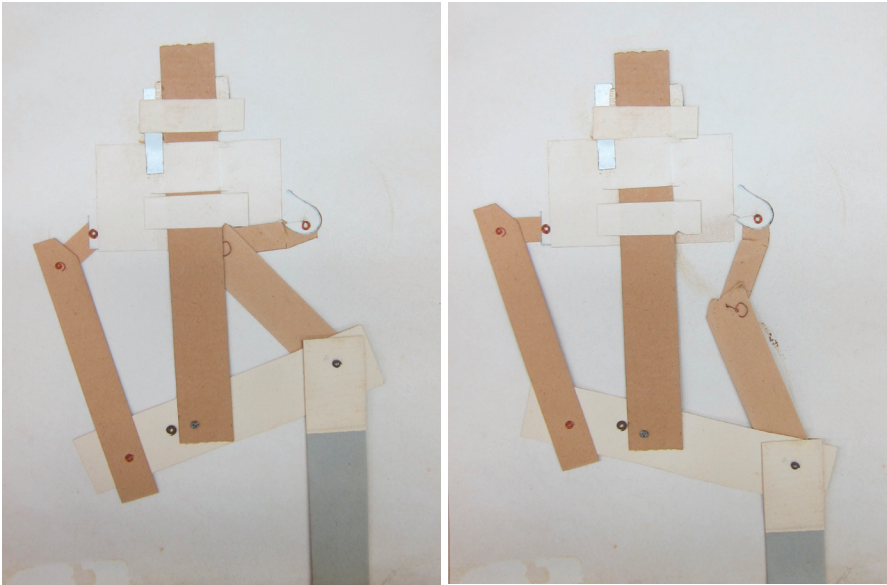


Fig. 2: Two stages of the mechanism of a movable book. Source: Meggendorfer, Lothar. *Lustiges Automaten-Theater: ein Ziehbilderbuch*. Eßlingen: Schreiber, 1890.

At any point one has to keep focusing on the research which is to be affiliated to the gained realization. Therefore, what is an adequate implementation of the human-machine interaction as far as virtual movable books are concerned? What role do they play in the context of animated objects of the 19th century in general?<sup>14</sup> To what extent one has to regard malfunctioning as something to be implemented in a digitized version of such objects? What are implications of the binary functioning of toy books – e.g. to the question of what is movement – referring to the fact that they often do have two privileged states in which the model remains? What impact, if any, does the industrialization have on the making of animated toy books considering that all movable books up to the present contain handmade parts? Or the other way

<sup>12</sup> <http://blog.sbb.berlin/beweb-3d/>.

<sup>13</sup> Surprisingly the history of making books is full of examples. The earliest proven book, the *Chronica Majora*, dates back to the first half of the 13th century and was a teaching tool for adults by the monk Matthew Paris ([http://www.bl.uk/manuscripts/Viewer.aspx?ref=royal\\_ms\\_14\\_c\\_vii\\_f157r](http://www.bl.uk/manuscripts/Viewer.aspx?ref=royal_ms_14_c_vii_f157r)).

<sup>14</sup> The phenakistiscope, zoetrope, thaumatrope, praxinoscope, mutoscope all are instruments of animated motion of the 19th century.

round: What impact does this handmade character have on the digitization of the objects? Finally, what are the conditions of possibility of making movable books a component of – 19th as well as 20th and 21st century – playrooms?

### 3 The technology behind BeWeB-3D

The project aims at modeling a representative quantity of what one could call animated paper-engineered toy books.<sup>15</sup> The technological side of the project is realized by the Berlin-based Center for Digital Cultural Heritage in Museums (ZEDIKUM).<sup>16</sup> Here we are challenged in different respects:

1. Our average scientific user demands a low-threshold handling which asks for at least a plug-in free solution, e.g. browser technologies based on WebGL.
2. The outstanding haptic quality of the analogue original invites to reflect on how to live up to this standard best.<sup>17</sup>
3. The implementation as dynamical 3D model may necessitate the usage of game-engines like Unity or Blender.<sup>18</sup>
4. The research context requires sustainability, long-term preservation and an open international standard, e.g. CIDOC-CRM<sup>19</sup>, which guarantees interoperability as well.<sup>20</sup>

Due to the complexity of our objects – they are books made of pages including text and illustrations and as such quite ordinary elements of library catalogues, but they are animated objects as well, which as far as a digitized presentation is concerned call for an advanced 3D-solution – a systematic proceeding is stringently required. Therefore, one of the first working steps was to categorize the different types of movable books according to the level of interaction: Some of them contain, as mentioned above, strips of paper to

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15 The English but mainly the German language has some difficulties in finding a precise denomination, particularly as there are about 25 different types, gradually incremented concerning the degree of interactivity.

16 <http://www.zedikum.de/>.

17 At beginning of the project one conceivable solution aims at a mixed reality implementation.

18 <https://unity3d.com/de> resp. <https://www.blender.org/>.

19 Conceptual Reference Model (CIDOC-CRM, ISO 21127), <http://www.cidoc-crm.org/>.

20 The new DFG guidelines give some suggestions as far as 3D objects are concerned, cf. [http://www.dfg.de/formulare/12\\_151/12\\_151\\_de.pdf](http://www.dfg.de/formulare/12_151/12_151_de.pdf), p. 26ff.

pull at, others contain volvelles, which one can turn, another type includes flaps which can be folded out and so on.

ZEDIKUM is specialized on 3D-digitization of cultural heritage, for instance using the Structure from Motion technology (SfM). But as this treatment is rather costly and time-consuming and not all of our movable books contain a spatial third dimension it is necessary to reassess which of the objects require this procedure.

Whether advanced 3D-digitization technologies or rather ordinary flatware-scanning will be deployed, the crucial point is the presentation of the data, as a requirement for the desired interactive animation. In this respect the approach of Technische Universität Braunschweig (Technical University of Brunswick) is insufficient.<sup>21</sup> Aiming at digitized versions of their movable children's books, they merely produced short videos in which the movement can be seen. Interactivity then is limited to starting and stopping the video. From a technical point of view Ellen Rubin presents an only slightly advanced solution:<sup>22</sup> By a simple javascript-based mouse-over effect, the reader is actually capable of interactively controlling the movement with his mouse. This is very basic but takes the right direction. One could obviously think of an extension for the mouse, which takes the reader closer to the original pull-movement.

The present project aims at figuring out a technical solution working on multiple stages. We will have to serve the reader, for whom browser-based consumption is kind of cutting edge technology. But obviously we are aware of Augmented Reality solutions and see in it a huge potential for making our objects accessible, be it a tablet-based implementation as provided by tiger-books<sup>23</sup> or a realization working with head-worn displays. The decisions as to which is the proper execution will have to be made on a case-by-case basis. There are movable books which make a 3D-digitization absolutely necessary and which are begging for a virtual reality environment to approach them, for instance the so called peep-shows, which have been a very popular amusement device in the first half of the 19th century.

Last but not least and coming back to movable books as objects for research: One species of the so called movable books is literally realized as playable picture books. The book itself serves as a kind of stage and added to this one

21 See [https://publikationsserver.tu-braunschweig.de/content/collections/videos\\_picture\\_books.xml](https://publikationsserver.tu-braunschweig.de/content/collections/videos_picture_books.xml).

22 See <http://popuplady.com/mm-main.shtml>.

23 <https://www.tigerbooks.de/>.

gets a couple of little paper-made figures. This toy asks for ever new settings. On the one hand one can literally imagine types of movable book within a VR-environment. On the other hand the project aims at implementing a decent annotation solution in order to make these changing stills citable, too.

## 4 Conclusion

Movable (children's) books are – 130 years after they flourished for the first time at the end of the 19th century – still very captivating objects. On the one hand they quite obviously have not lost their fascination being a well-established item of many nowadays children's rooms. On the other hand they help to raise questions about best-practices for digitizing specific media. At this their call for interactivity is mostly inherited:

Now Children, dear, pray come with me  
And see some comic sights,  
You all will laugh with mirth and glee,  
Or should do so by rights.

When you to them your hand apply  
These figures dance and caper  
"Tis really" hard I hear you cry  
"To think them only paper."

The men and creatures here you find  
Are lively and amusing,  
Your fingers must be slow and kind  
And treat them well while using.

But more of them we must not tell,  
The pictures would be jealous,  
So turn the leaves and use them well  
And don't be over zealous.<sup>24</sup>

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24 Cf. Meggendorfer, Lothar. *Comic Actors: A New Movable Toybook*. London: H. Grevel & Co., 1895, which is the English translation of the German 1st edition: Meggendorfer, Lothar. *Lustiges Automaten-Theater: ein Ziehbilderbuch*. Eßlingen: Schreiber, 1890.

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