ANALYSING RARE BOOKS WITH DIGITAL TECHNOLOGIES: THE PROJECT "BLOCKBOOKS IN BAVARIAN COLLECTIONS"

Analiziranje redkih knjig z digitalnimi tehnologijami: projekt »Blockbooks in Bavarian Collections«

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Abstract

Books printed from wooden blocks in the fifteenth century, the so-called xylographa or blockbooks, are exceedingly rare and therefore extremely valuable objects of the European cultural heritage. The paper gives an introduction into the material and the questions examined in current research. Responding to scholars' needs for high-quality reproductions of the blockbooks and their watermarks, a project for the cataloguing and digitisation of the c. 90 blockbooks held at the Bayerische Staatsbibliothek München and other institutions in Bavaria was started in 2009. The aims and methods of the project are described in the paper, and the workflow of the digitisation project carried out at the Bayerische Staatsbibliothek is explained in detail, both with respect to the digitisation procedures for image capture and the detection and documentation of watermarks with an infrared camera. The illustrations exemplify the quality of digital images generated in the project, all of which are accessible on the website of the Munich Digiti-Zation Center (MDZ) at the Bayerische Staatsbibliothek München.

Keywords: blockbooks, watermarks, digitisation, projects, Bayerische Staatsbibliothek München

Izvleček

Blokovne knjige,[*] ki so jih v 15. stoletju tiskali s pomočjo lesoreznih plošč, so izredno redke in so zato zelo dragocen del evropske kulturne dediščine. Tako so v letu 2009 pričeli izvajati projekt katalogizacije in digitalizacije pribl. 90 blokovnih knjig, ki jih hrani Bavarska državna knjižnica v Münchnu ter druge ustanove na Bavarskem (Nemčija), s katerim želijo raziskovalcem in humanistom omogočiti dostop do visoko kvalitetnih reprodukcij blokovnih knjig in vodnih znakov. V prispevku je predstavljeno obravnavano gradivo in podan uvod v projekte digitalizacije, ki so v teku ter vprašanja, povezana s trenutnimi raziskavami. Navedeni so tudi cilji in metode omenjenega projekta. Detaljno je opisana digitalizacija, ki jo v okviru projekta izvajajo v Bavarski državni knjižnici, s posebnim ozirom na digitalizacijske postopke in odkrivanje ter dokumentiranje vodnih znakov z infrardečo kamero. Primeri v prispevku ponazarjajo kvalitetno digitalizirane strani in rezultate, dostopne na spletni strani centra za digitalizacijo - DigitiZation Center (MDZ), ki deluje v okviru Bavarske državne knjižnice.

Ključne besede: *blokovne knjige, vodni znaki, digitalizacija, projekti, Bavarska državna knjižnica v Münchnu*

1   Introduction

Digital imaging technologies do not only allow wide access to rare library materials and the protection of fragile items from intensive use, but they also facilitate new methods of analysis. All the three points are important for an ongoing project of the Bayerische Staatsbibliothek München which is targeted towards a collection of exceedingly rare books produced in the fifteenth century by printing from wooden blocks, the so-called xylographa or blockbooks. Among the rich holdings of mediaeval manuscripts and early printed books of the Bayerische Staatsbibliothek (Griebel [et al.], 2008), blockbooks form a small but outstanding group due to their extreme rarity. While the library holds more than 20,000 copies of books printed with movable type before the year 1501 (incunabula) out of a total estimated at 450,000 incunabula world-wide, only a small quantity of blockbooks has survived: only about 600 such books are known to exist, of which 49 items are held by the Bayerische Staatsbibliothek.

The rarity of blockbooks is caused by a variety of factors (Wagner, 2012). First, the technique of cutting a text and images into a wooden block was slow and only suitable for short works like calendars and manuals for schools or religious instruction. In order to

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[*]   Blokóven – nanašajoč se na blok (*Slovar slovenskega knjižnega jezika,* 2008). V rabi je tudi termin blok knjiga (op. ur.).

print a book, the wooden block was inked and paper was placed on top of it so that the ink could be transferred onto the paper by rubbing. Unlike printing from movable type in a press, this procedure only allowed the production of comparatively small print-runs, which considerably lowered the books' chances of survival. Secondly, blockbooks contain texts which were used intensively: calendars for everyday life, grammars for schoolboys, religious tracts for laypeople or novices, many of them in a vernacular language, i.e. German or Dutch. Such books were primarily intended for private use and were often well-thumbed; as a consequence, only few of them were preserved in institutional collections like monastic libraries. Furthermore, most blockbooks are dominated by pictures rather than texts, which meant that the pages could not only be read, but also displayed on walls, pasted onto furniture or into boxes, and that pictures could be cut out and used as illustrations in other books. As a result, many blockbooks have only survived as fragments.

To add to these difficulties, the particular production process of xylographic printing caused a substantial variability of the products – every surviving blockbook differs from all others, even if they were printed from the same wooden blocks. Unlike movable type, which was taken apart after printing, wooden blocks could be stored over many years, but they were often damaged in the course of time. Blocks cracked, parts of them wore off or were deliberately removed. When blocks were reused for printing, a different stock of paper was used. As it was comparatively easy to transport the wooden blocks elsewhere and print from them at a later stage, the producers, perhaps itinerant craftsmen who sold books at fairs or markets, did not normally indicate the place and date of printing. Blockbooks can thus be seen as an early form of "publishing on demand", and, like incunabula, they were also finished individually according to the wishes and financial means of the customers: some copies were painted in colours, others were left in black and white as they were printed; books were normally sold without bindings, but could be bound together with other manuscripts or printed books. In modern times, many such composite volumes were unbound in order to appreciate each item separately, and thus, much evidence for the early use of blockbooks was lost.

2   Background and research methods

For a long time, it was assumed that blockbooks were precursors of books printed with movable types, being produced with a more "archaic" technology. This assumption has been proved wrong, and it is now known that the production of xylographic books extended over the entire second half of the fifteenth century, thus coinciding with the incunable period (e.g. Palmer, 2008). Accordingly, blockbooks were an alternative to

books produced with movable type: the technology was better suited for particular kinds of illustrated texts like the so-called pictorial "Bibles of the Poor" which were in high and continuous demand as well as limited in size. On the basis of their contents, blockbooks may well have been intended for particular audiences: for clerics at the propaedeutic levels of religious instruction or lay readers with limited needs for pragmatic books rather than for theologians or university students and teachers. Thus, until today, blockbooks raise a wide range of research questions, with regard to the origin, date, the organization of the production and distribution, and their readership. These questions, however, can only be examined once a comprehensive survey of the surviving copies has been established.

Picture 1: German blockbook of about 1470: Page 7v of the "Bible of the Poor" with a scene from the New Testament (Christ's baptism) surrounded by scenes from the Old Testament prefiguring it.[1]

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[1]   BSB, Xylogr. 27, http://daten.digitale-sammlungen.de/bsb00038196/image_18

However, the surviving blockbooks – their number is estimated at 600 – are scattered over libraries in the entire world; the largest collections are today housed in Paris, London and New York (see the census in the exhibition catalogue Mainz 1991, pp 355-395). For scholars intending to analyse and compare the books, with a view to reconstructing the circumstances under which blockbooks were produced and used in the fifteenth century, reproductions of books are therefore of essential importance. Such photographs need to be in colour and high resolution in order to allow scholars to detect even minute differences in the printing and hand-colouring. In order to establish the sequence in which the books were produced, every page needs to be examined for damages and alterations in the block in a time-consuming process. As most of the books do not bear a date of printing, only the paper can help to narrow down the time of production. For this purpose, the watermarks need to be documented photographically so that they can be compared with other blockbooks, manuscripts and printed books from the period. If watermarks in the paper used in undated blockbooks match with watermarks in dated manuscripts or printed books, it can be assumed that they were produced at about the same time and possibly also in the same region.

In addition to full colour reproductions of the surviving copies, detailed descriptions of the blockbooks which include information on the individual features of each item (e.g. states of the blocks and provenances) are also required. Yet only a few of the major collections of blockbooks have been catalogued so far. Among them, the collections of the Bibliothèque de France in Paris (54 items, see CIBN 1992), the British Library in London (40 items, see BMC 1908) and the Bodleian Library of the University of Oxford (8 items, Palmer, 2005) stand out, whose holdings of blockbooks were described in the course of long-term enterprises to catalogue incunabula. However, the catalogue of the largest collection of incunabula world-wide, that of the Bayerische Staatsbibliothek in Munich (BSB-Ink), does not contain descriptions of the 49 blockbooks preserved in the library. Therefore, a separate project to catalogue the blockbooks was initiated after completion of the catalogue of incunabula, and the availability of state-of-the-art digitisation technology at the library opened up perspectives to answer diverse needs: to make the blockbooks accessible to researchers worldwide, and to gain new bibliographic insights on the basis of high-quality reproductions and watermarks. In order to broaden the range of the material subject to this detailed analysis, all fourteen institutions in Bavaria in which blockbooks are preserved were invited to join the project, as many of the surviving blockbooks had never been reproduced in print and thus could not be analysed and compared with each other in detail. For the first time, the technology of digitisation and infrared imaging allows a comprehensive documentation of both the textual and pictorial content as well as the watermarks in the paper on which blockbooks were printed.

3   Research design

The project for digitisation and cataloguing of blockbocks in Bavarian collections has been funded by the Deutsche Forschungsgemeinschaft (DFG) since 2009 and is carried out at the Bayerische Staatsbibliothek München (Wagner and Bacher, 2011). Its three main targets were:

- the production of digital reproductions of all c. 90 blockbooks preserved in 14 Bavarian institutions (libraries as well as museums)[2] and their watermarks,
- the online presentation of all digital images on the websites of the holding institutions or the Bayerische Staatsbibliothek[3] and the Bayerische Landesbibliothek Online,[4]
- the compilation of detailed descriptions of all blockbooks, including information on the state of the woodcuts, occurences of watermarks in other books, the colouring and bindings of the books, as well as their provenances and history of ownership.

This paper first gives some general information about the digitisation project. Then, the scanning workflow is described in detail. A short introduction into the infrared technique for watermark detection follows. Finally, the paper concludes with a presentation of some sample images and results.

3.1   Workflow for the digitisation of blockbooks

The digitisation of the blockbooks was carried out at the BSB in the Scanning Center of the Munich DigitiZation Center (MDZ). The process of scanning watermarks is a sub-process within the entire digitisation workflow,[5] which consists of the following major steps:

- Preparation of the books and setups.
- Scanning
    - of the images and texts with colour cameras,
    - of the watermarks using an infrared camera.
- Indexing or production of metadata (enrichment), including administrative, bibliographical, technical and structural (incl. full-text) metadata.

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[2]   See the list of holding institutions on http://www.bayerische-landesbibliothek-online.de/xylographa-sammlungen

[3]   http://www.digitale-sammlungen.de/index.html?c=kurzauswahl&l=de&adr=daten.digitale-sammlungen.de/~db/ausgaben/uni_ausgabe.html?projekt=1236933450&recherche=ja&ordnung=sig

[4]   http://www.bayerische-landesbibliothek-online.de/xylographa

[5]   See also: http://www.digitale-sammlungen.de/index.html?c=digitalisierung-zend&l=de

- Storage and long-term preservation.
- Access, to support the material-specific presentation on the internet; nowadays ready for multi-devices, like smartphones, tablets and desktops.

The individual processes always depend on the structure and composition of the original object and the intended presentation mode on the internet (e.g. browsing, search, 3D animation) (Brantl and Schäfer, 2011). The empirical formula is: the older an object is or the more metadata it needs - for example, information for search and retrieval - the more complex and costly the entire production process will be. To standardise the production processes and ensure a consistent production of digital data, the Central Digital Asset Management System (ZEND), a software tool with different document and workflow management components, was developed by the MDZ in 2003. ZEND controls the entire production process from the preparation up to the automated transfer of the digital master files to archival storage.

The Scanning Center of the MDZ is today equipped with 22 different scanning devices, including book scanners and special equipment scanners (including four automatic book scanners, a thermography scanner for watermarks, and a 3D scanner for book covers), which are able to scan format sizes up to DIN A0 standard (e.g., historical maps) with high optical resolution and different book cradles in order to avoid any damages by mechanical handling of the books.[6]

Images of the blockbooks were produced with the following parameters:
- Optical resolution of 400 ppi, relative to the original size of the object (1:1; due to the different sizes of the book scanners)
- Digital master storage format for all images, even watermarks: Tagged Image File Format (TIFF) (version 6.0) uncompressed. This results in colour scanning file sizes of 20 to 800 megabytes per image, depending on the format, the size of the book, and the image resolution
- Colour depth of 24-bit or 8-bit for watermarks
- Colour management and media neutral image production: the entire production is based on the use of a colour management system (in RGB and LAB as transformations colour space), i.e. scanners and monitors are colour calibrated.
- Targets for visual control of colour, grayscale, depth of sharpness and scale are scanned once per object and stored with the digital master of the object. For watermarks there was built up a special copper target.

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[6] For the scanning technology currently used at the Bayerische Staatsbibliothek München, see http://www.digitale-sammlungen.de/index.html?c=digitalisierung-scanner&l=de

Picture 2: *The scanning campaign at the Bayerische Staatsbibliothek.*

The process of the scanning set-up was doubled:
1. for the colour production of the pages and
2. for the thermographic watermark reproduction.

Depending on the value, size, and condition of a document, the set-up on the selected scanner can take from a few minutes up to an hour. In the case of the blockbooks it was a time-consuming process, which was monitored by a conservator. It consists of the following steps:

- Position the book on the book cradle of the scanner
- Scan targets
- Constantly re-adjust the depth of focus, due to the varying thickness of the book as the pages are turned. This is inevitable when working without a glass plate. Only the constant readjustment of the book cradle height will compensate for the changing focus.
- Separately scan recto and verso pages that are linked afterwards by the software (this is a critical, error-prone process due to the fact that the books often lack a pagination), if required due to the scanning device and opening angle of the book.
- Scan the book covers (out- and inside)
- Perform "what you see is what you get" (WYSIWYG) - quality control throughout the scan using the monitor
- Remove the book from the cradle after finishing the work.

3.2 Methodology of watermark digitisation

The digital photographs of watermarks were taken with equipment invented and developed by the Fraunhofer-Institute for Wood Research (WKI) and the Technische Universität Braunschweig, Institute for Communications Technology (IFN), and tailored to the specific needs of blockbooks, by using a book cradle to ensure that the books are opened at an angle hardly wider than 90°, and by controlling the exposure to infrared radiation during the imaging process (Meinlschmidt and Märgner, 2011; Wagner and Bacher, 2011). The system consists of a metal plate heated to 30-50° Celsius and a digital infrared camera which transmits images directly to a computer; the leaves are placed between those two devices. For every leaf, a series of images are taken within milliseconds, and successively, the image with the best contrast is selected for analysis, manual enhancement and storage. Even for leaves which have been glued together with a thickness up to 0.35 mm, the process has generated impressive results. For the first time, the watermarks of the blockbooks in Bavarian collections have been documented comprehensively, which greatly facilitates the comparison and identification of the watermarks and is an important preliminary step towards the cataloguing of the blockbooks.

### 3.2.1 Watermark detection with infrared transmission

When a sheet of paper is placed between a light source and an observer, the inherent watermark can be seen instantly in transmitted light. For digitisation, the observer's eye simply needs to be replaced by a digital camera. This technique works satisfactorily as long as the paper is sufficiently transparent for light and the variations in density are rather small to allow recognition of the watermark contours. But the limitations of the technique are revealed once the surface of the paper is covered with different types of inks or drawings, particularly if the writing or drawing appears on both sides of the paper.

In order to overcome this interfering problem, a solution is to use a certain part of the spectrum in which the writings and drawings are transparent. Tests in the near-infrared (NIR - 700nm to 3μm) and in the mid-infrared spectrum (MWIR - 3μm to 7μm) have shown much better watermark detection in MWIR than in NIR.

The new infrared technique for visualizing watermarks was invented in close collaboration between the Fraunhofer Institute for Wood Research (WKI) and the Institute for Communications Technology (IfN) of the Technical University of Braunschweig (Meinlschmidt and Märgner, 2001). This method is based on the one hand on the fact that most of the different types of ink are invisible in the infrared wavelengths and on

the other hand on the certainty that the transmitted infrared radiation is scattered or absorbed differently by the paper and the watermark. The process is as follows. Infrared images are taken using a stirling cooled sensor with 384 x 288 pixels and a temperature resolution of better than 20 mK. To obtain a homogeneous infrared radiation from the rear, a 3 mm thick black painted copper plate is heated from behind by means of a rubber heating mat glued to the back of the metal sheet (Picture 3, a). A piece of passe-partout about 10 mm thick is placed on the metal (Picture 3, b) to secure a specific distance between the paper under investigation (Picture 3, c) and the heat source. With the camera in front of the system and focused on the paper, high qualitative watermark images can be obtained within a few seconds.
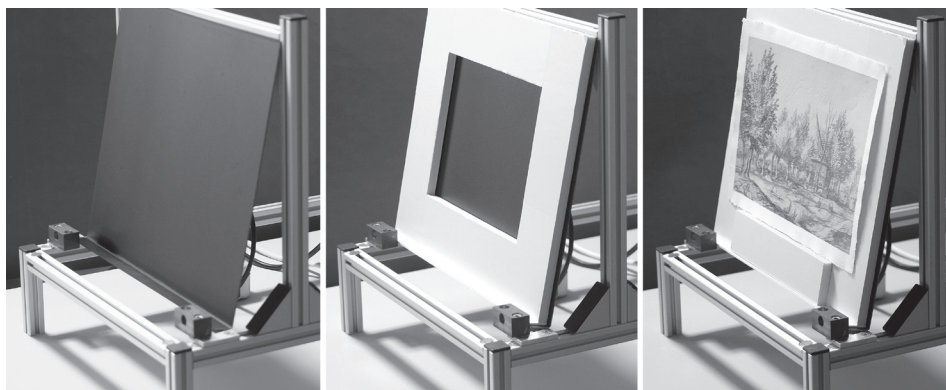
Picture 3 a, b, c: *A copper plate painted black and at a temperature of about 40°C serves as an infrared emitter (Picture 3a), while a piece of passe-partout (Picture 3b) secures a certain distance from the valuable drawing (Picture 3c).*

Picture 4 shows a photograph of a drawing in brownish ink made around 1665 by Jan Lievens (Döring, 2006). At the time the watermark was taken it was not quite clear whether the drawing really belonged to the original school of Rembrandt or it was a later reproduction of the eighteenth century (Laurentius, 1996). Recognition of the emblem proved that the paper and therefore the drawing was an original.
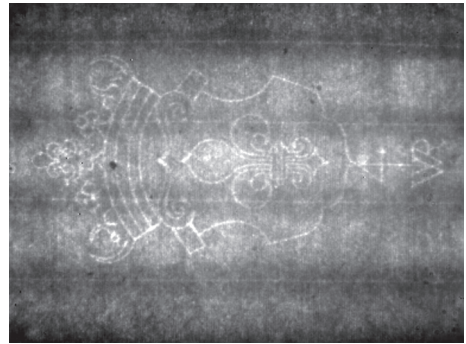
Picture 4 a, b: The photograph on the left (Picture 4a) shows the drawing "Farm and trees by the water", pen and brown ink, made around 1665 by Jan Lievens, Braunschweig, Herzog Anton Ulrich-Museum, Inv. No. Z 103.7 On the right (Picture 4b) the watermark emblem can be seen in the infrared image without interference from the drawing.

3.2.2 The new device for watermark detection

For the reproduction and digitisation of watermarks within the blockbook project, a special setup was developed consisting mainly of a book cradle, an infrared camera and a warm blackened copper plate (Picture 5). The book holder or cradle can be adapted to almost every size and angle of books while the heated copper plate has to be brought in a save position during turning of the book pages.

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7   Copyright: HAUM, Claus Cordes.
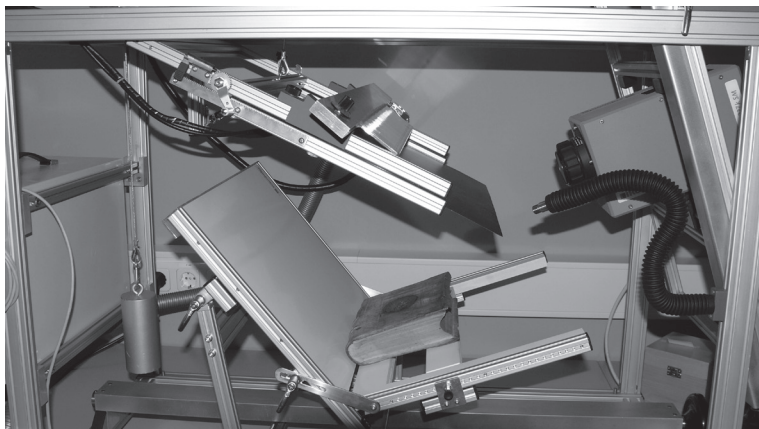
Picture 5: *Set-up for IR-watermark detection with a book cradle that can be adapted to sensitive books and with the heated copper plate in its highest position for choosing the page under investigation. The camera (right) is focused on the plane were finally the paper under investigation will be.*

Special attention has to be taken that good images of watermarks can be captured even if the opening angle of the book is sometimes only 60°. For security reasons, the black pyroelectric detector shown in Picture 5 in front of the camera controls the maximum paper temperature. If the book is in position and a leaf under investigation is chosen, a vacuum will be applied to a perforated flat rod to hold the paper in a straight position in relation to the camera. Infrared images or videos can now be taken always at the same distance and therefore with the same scale.

Picture 6: *Detail of the setup showing that every single leaf of the book will be held flat in a certain position by a vacuum bar.*

3.3   Storage and presentation

During the digitisation process it is essential to save the generated digital master files and their derivatives, like images, metadata and if available full text, within an appropriate storage solution as the primary storage capability. After the completion of the digitisation process, the files will be organised and managed in two copies and in two separate archive systems, with the secondary and tertiary data storage serving as long-term preservation. This was covered by ZEND workflow.

An automated process is used to register the files, and a semi-automated process to generate the metadata for the digital objects:
1. The digital master files (e.g. watermarks) are separated accordingly to their ZEND-ID and all images of an object are stored in their own directory.
2. The master TIFF files are then converted for standard Web presentation into a JPEG format with two different resolution versions.
3. Next the simple structural metadata of the object is generated in TEI-XML (P5) to describe the logical and physical structure of the object. With this description, the book can be browsed later and edited online with the ZEND Table-of-Contents Editor.[8]

As a last step in digital preservation, the digital master files for images and other metadata are transferred in their long-term stable file formats (TIFF and XML) to long-term archival systems in two setups: to a Network Attached Storage System (NAS), which currently has 220 terabytes of net capacity and to the Tape Library of the Leibniz Supercomputing Center in Munich-Garching, which is running under IBM Tivoli Storage Manager software. The files are also stored in another copy in another location.

As soon as the final quality assurance in the ZEND-system has been carried out, the object will be published on the internet immediately. An automatic message is generated with the information that the object is ready on the Web and available under a persistent internet address, which is sent to the local library online public access catalogue (OPAC) as well as to other reference systems (union catalogue, Europeana, etc.). As a result, the digital object on the internet can be accessed in various and multiple ways, for example via the Digital Collections of BSB/MDZ, the Bayerische Landesbibliothek Online (regional portal for Bavarian history), catalogue systems, search engines etc. In addition, a free and full pdf download is possible for every object, which enables the data transfer to a user-PC and facilitates offline work. Furthermore, the bibliographical metadata can be exported for re-use in other information environments, for example via an OAI interface to the European or the World Digital Library.

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[8]   See also *TEI: P5 Guidelines* on: http://www.tei-c.org/Guidelines/P5/ and further on http://www.digitale-sammlungen.de/~mdz/mdz/content/service/docs/2011-10-19_Brantl_Digitization_Lifecycle.pdf.
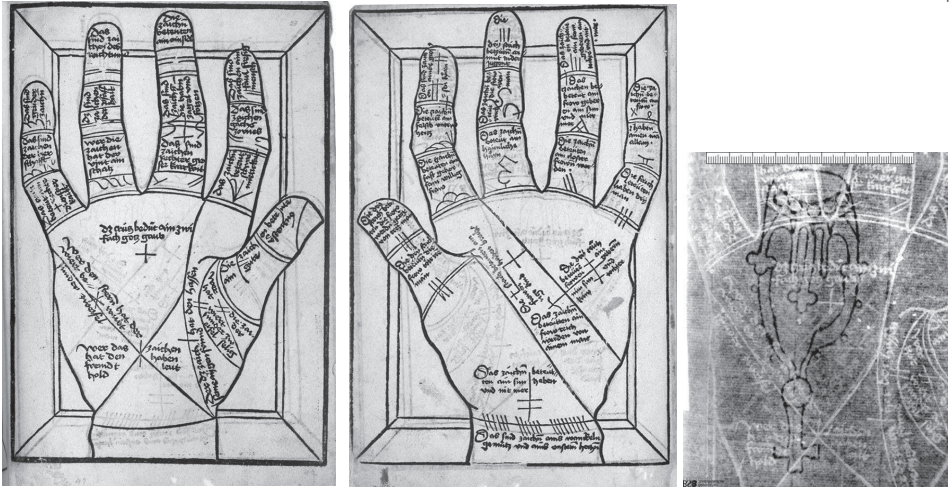
3.4   Sample images

Picture 7 shows the photo of the front/recto (a) and the empty back/verso (b) side of leaf 4 of the German 'Biblia pauperum' blockbook which was produced in Nördlingen in 1470. As printing was done by placing a relatively thin paper on the block and rubbing the water-based ink only on one side of the sheet, the watermark is clearly visible on the infrared photograph.
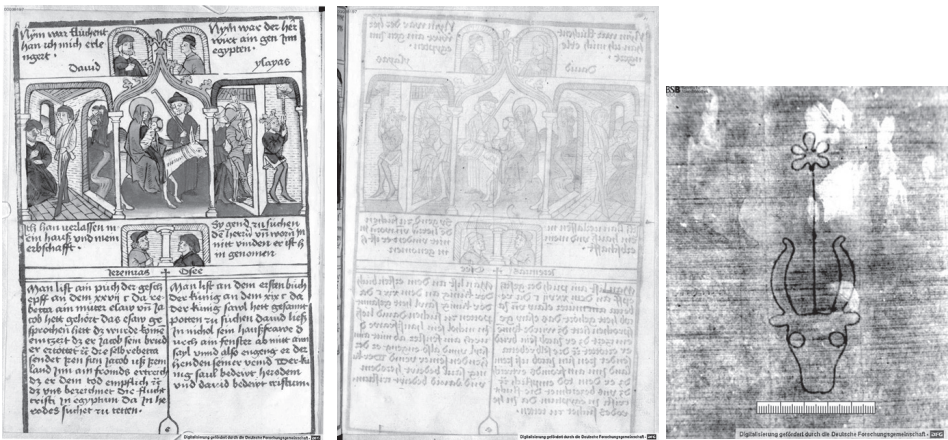
Picture 7a, b, c: *Leaf 4 of the blockbook "Biblia pauperum - Nördlingen, 1470" (recto – a; and verso – b) and its watermark – c.[9]*

Picture 8 shows the photo of the front/recto (a) and the back/verso (b) side of leaf 23 of the blockbook 'Chiromantie' which is ascribed to Johann Hartlieb and was presumably produced in Augsburg around 1485/95. As both sides of the paper were printed with black and white oil-based ink in a press, the watermark is overlaid on the infrared photograph by traces of black printing.

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[9]   BSB, Xylogr. 23; http://daten.digitale-sammlungen.de/bsb00038197/image_1

Picture 8 a, b, c: *Page 23 of the blockbook 'Chiromantie' ascribed to Johann Hartlieb, produced in Augsburg, about 1485/95? (recto – a; and verso - b) and its watermark – c.*[10]

Picture 9 shows the photo of the front/recto (a) and the back/verso (b) side of leaf 19 of the Latin 'Biblia pauperum' blockbook which was produced in Germany around 1469/1470. As ink was transferred by rubbing on one side of the paper and the blank pages were afterwards pasted together, two overlapping watermarks are indistinctly visible on the infrared photograph.
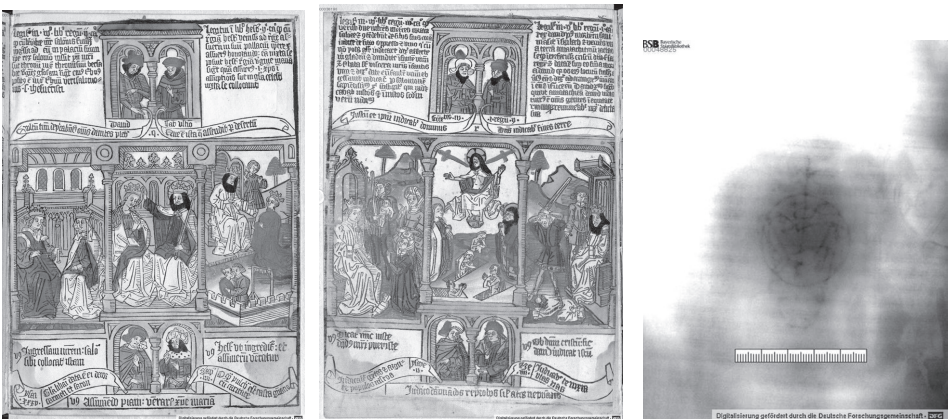
Picture 9 a, b, c: *Leaf 19 of the Latin 'Biblia pauperum' blockbook which was produced in Germany in 1469/70 (recto – a; and verso – b) and its watermark – c.*[11]

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[10]   BSB, Xylogr. 36; See http://daten.digitale-sammlungen.de/bsb00048849/image_13
[11]   BSB, Xylogr. 27, http://daten.digitale-sammlungen.de/bsb00038196/image_1

4   Results

As a result of the project, over 90 blockbooks from 14 different institutions, extending from university and state libraries to church and private collections as well as museums, are now accessible online. All parts of the blockbooks are reproduced and archived, including the bindings (covers, pastedowns, flyleaves) and verso pages, even if they are blank – a feature typical for blockbooks (Picture 7, b). The digital images are displayed in a standard viewer developed with the support of the DFG which allows easy navigation and offers important additional functions, like an electronic table of contents, access to catalogue records and the option to download images as PDF documents. The infrared images of watermarks are accessible on the same site. An integrated and structured presentation of the digitised blockbooks together with their watermarks is available under http://www.bayerische-landesbibliothek-online.de/xylographa.

In order to present the project and its results to a scholarly audience and to a wider public, an academic conference was held in February 2012 in the Bayerische Staatsbibliothek München which was accompanied by an exhibition. The proceedings of the conference, at which 18 papers were given, will be published in 2013 as a thematic volume of the German journal 'Bibliothek und Wissenschaft' (ISSN 0067-8236). The catalogue of the exhibition (Wagner, 2012), in which 45 items (including 16 blockbooks) were on display, places the blockbocks in the context of fifteenth-century book production both in manuscript and print and gives an introduction into fifteen different works which were distributed in the form of xylographic books.

After completion of the project in early 2013, detailed descriptions of all 90 blockbocks in Bavarian collections will be made accessible on the project website. The descriptions will also be published in print as a scholarly catalogue. It is hoped that the project will stimulate similar enterprises in other institutions holding blockbocks. Several large research libraries have already undertaken to make their collections of blockbocks accessible in digital reproductions on the internet, ideally accompanied by detailed descriptions. If the holding institutions agree, any digitised blockbook can be integrated into the website developed for the project 'Blockbocks in Bavarian collections', expanding it into a comprehensive and truly international resource for research concerning fifteenth-century printing.

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