Definition and measurement of lay-flat degree for books

Dr. Csaba Horvath

Professor at Obuda University, Budapest, Hungary

Managing director, Nyomda-Technika Ltd. Debrecen, Hungary

Co-uthors: Dr. Laszló Koltai, Istvan Lorincz and Peter Teleki

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Our senior researcher team

Prof. Dr. Csaba Horvath
Obuda University, Budapest

managing director
Nyomda-Technika Kft.
Debrecen

Istvan Lorincz
bindery plant manager
Alfoldi Printing House Ltd.
Debrecen

Prof. Dr. Laszlo Koltai
Institute director
Obuda University, Budapest

Peter Teleki M.Eng.
senior print engineer
Alfoldi Printing House Ltd.
Debrecen

Introduction

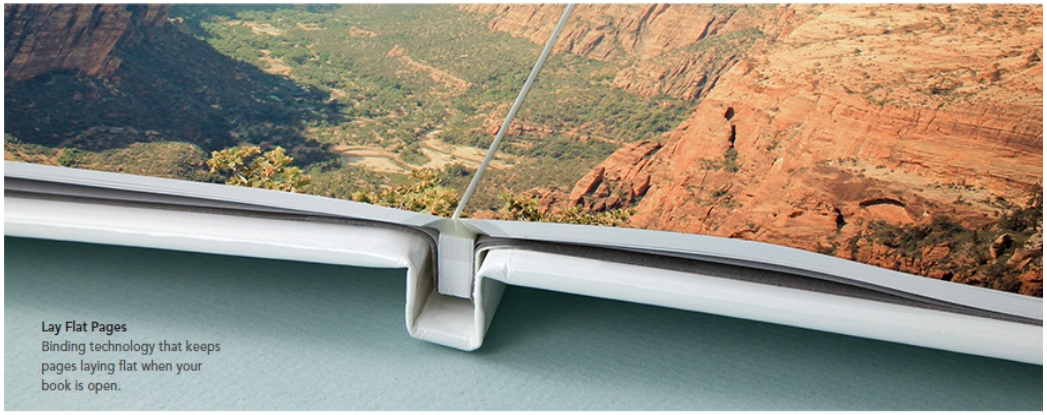
- The evolution of communications technologies exercises substantial influence on graphic communications products, too. In the world of printing, one group of the iconic products, notably books need to adapt to the challenges posed by digital developments of the 21st century.
- Novel solutions surface from time to time to enable readers to associate printed information in books with further information that is available in the digital world. The use of smartphones as a basic device to have access to information seems to be a general trend nowadays, especially among people of younger generations. Such devices are suitable for using certain special symbols, QR codes, passive or active electronic elements that are inserted in the books to become connected to the world of virtual and/or augmented reality.

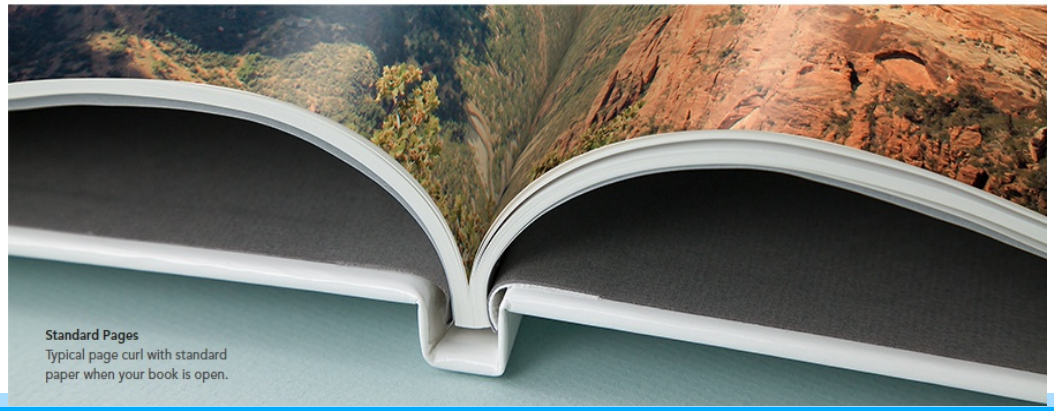
New solutions

- These solutions raise new demands for binding technologies, as well. Photo books call for special binding solutions that allow or at least approximate full lay-flat binding.

- The expensive technologies used for photo books to produce lay-flat pages are not necessary for the above-mentioned applications designed to link books to the digital world, and it also holds true for photo and art books offering plenty of visual information. Still, the creation of lay-flat pages – as far as it is possible – is certainly required.

Lay-flat binding and standard binding





Lay-flat pages
Special binding technology that keeps pages laying flat when the book is open

Standard Pages
Typical page curl with standard paper and bindery technology when the book is open

Question of lay-flat for books

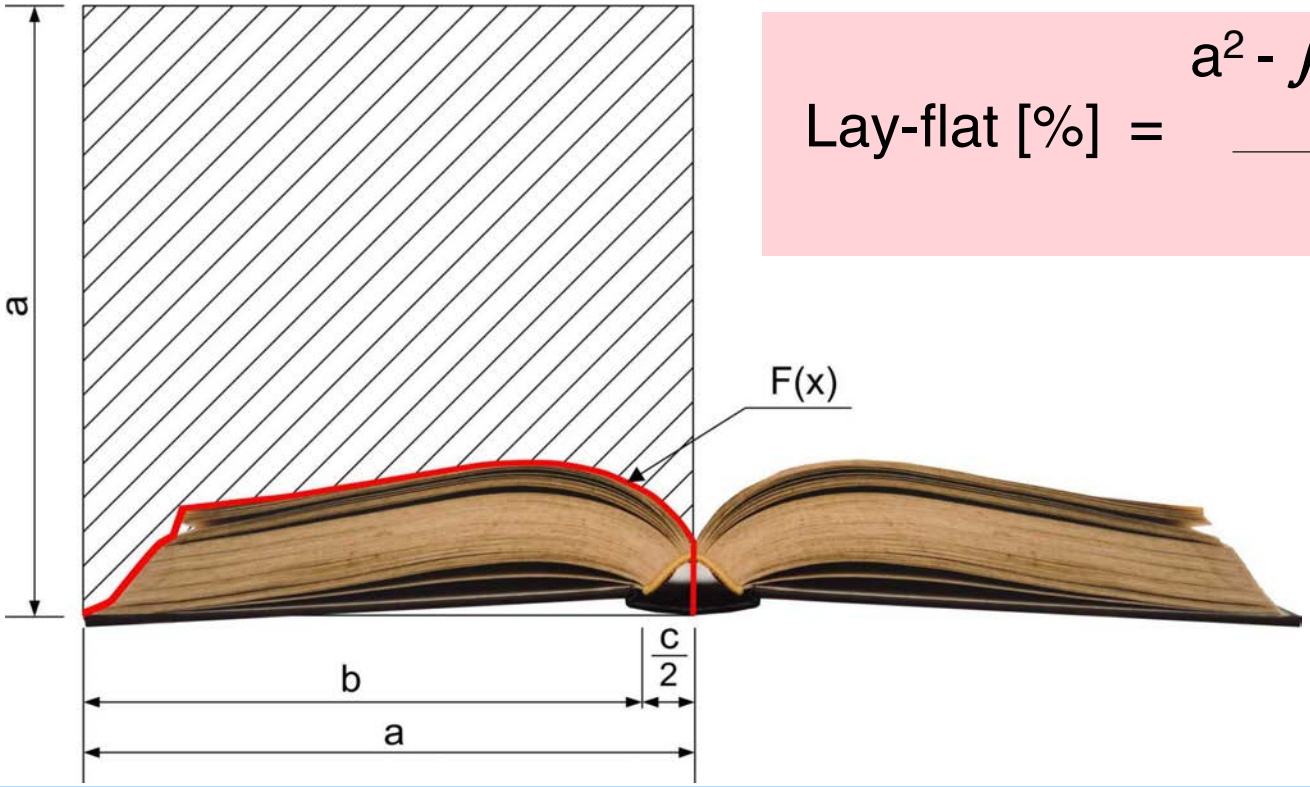
- In addition, the quality of lay-flat binding is also important when smartphones are used to reduce the number of erroneous links (erroneously scanned information), particularly in the case of codes that are incorporated in images to create links.
- In the context of a development effort made to create novel binding technologies, the authors found it necessary to work out a definition for the unit of measurement that describes the degree of the lay-flat character of book pages.

Typical handling of smartphone to read the QR code from a book

Definition of lay-flat character of books

- When determining this unit of measurement, the authors relied on the assumption that in the sections that were perpendicular to the spine of the book the lay-flat degree was identical. For this reason, it seems to be sufficient to determine the value only for a single section (top edge/head), as it is characteristic of the entire body of the book.
- When a book is opened in the middle, and laid on a flat surface, the geometry describing the middle pages of the book defines the lay-flat degree based on correlation of next slide's figure.

Explanation for the definition of the lay-flat degree of books

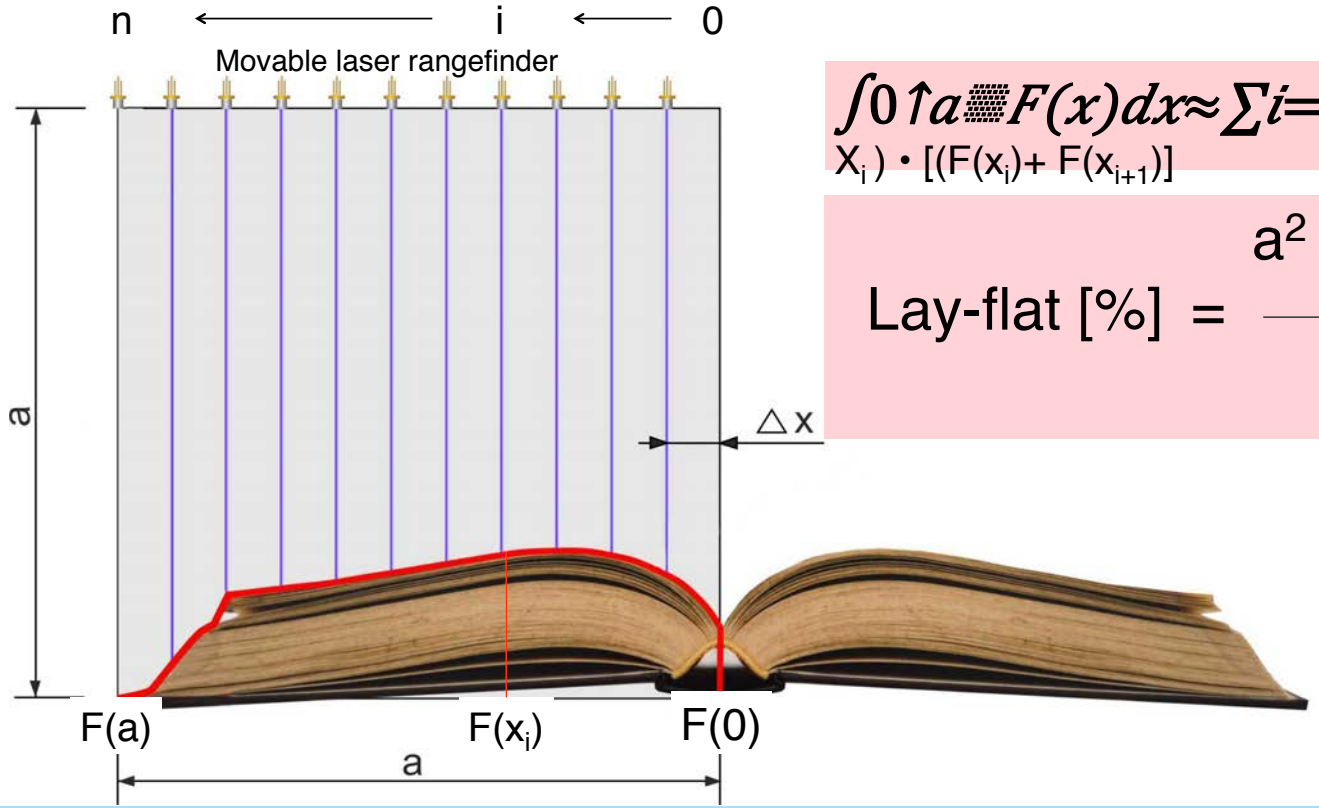


$$\text{Lay-flat [\%]} = \frac{a^2 - \int_0^a F(x)\,dx}{a^2} \times 100$$

Extras for the definitions

- Although the lay-flat positions of the two middle sheets are typically identical, following the precision and unambiguity principle the calculation needs to be made for both sides, and the average should be considered as the lay-flat value of the book.
- As per our definition described herein, the lay-flat value can be interpreted solely for books that remain open after they have been opened in the middle and laid on a horizontal surface.

Measurement model for the calculation of the lay-flat degree



$$\int_0^a F(x)dx \approx \sum_{i=0}^{n-1} 1/2 \quad (x_{(i+1)} - X_i) \cdot [(F(x_i) + F(x_{i+1})]$$

$$\text{Lay-flat [\%]} = \frac{a^2 - \int_0^a F(x)dx}{a^2} \cdot 100$$

$$\Delta x = a/n-1$$

Measurement with one sensor (cheaper solution)

Bosch GLM 50 C Professional Laser Rangefinder 0.05-50m

The smart solution for measuring and documenting. Direct digital transfer of measuring results. Simple exchange and smart documentation of measured values thanks to GLM measure and document app (available from popular app stores), supported Android devices.

Measurement range: 0,05 - 50 m

Measurement time, typical: < 0.5 s

Memory capacity (values): 30

Tripod thread: 1/4„

Measurement accuracy: < 1.0 %

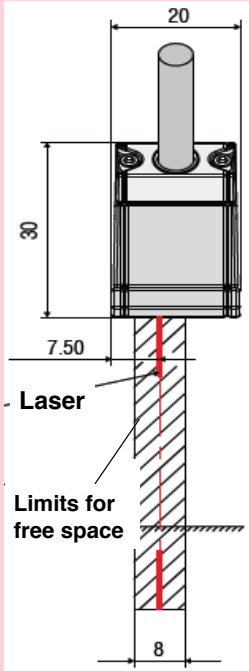
Smart laser triangulation displacement sensor

The optoNCDT 1420 offers a unique combination of speed, size, performance and application versatility in the range of compact triangulation sensors. Analog and digital output signals.

Measurement range: 60 – 260 mm

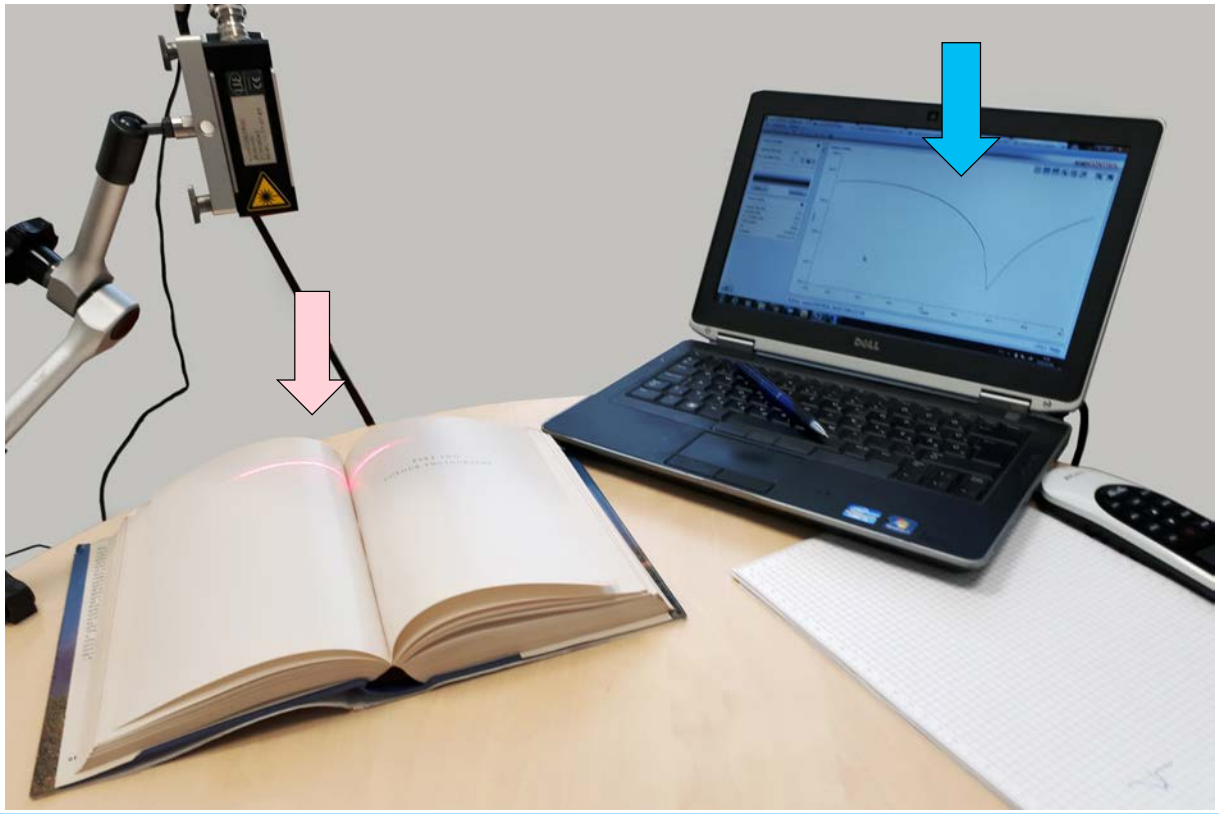
Output: digital RS422 / 16 bit

Spot diameter: 750 x 1100 µm



Measurement accuracy: < 0.01 %

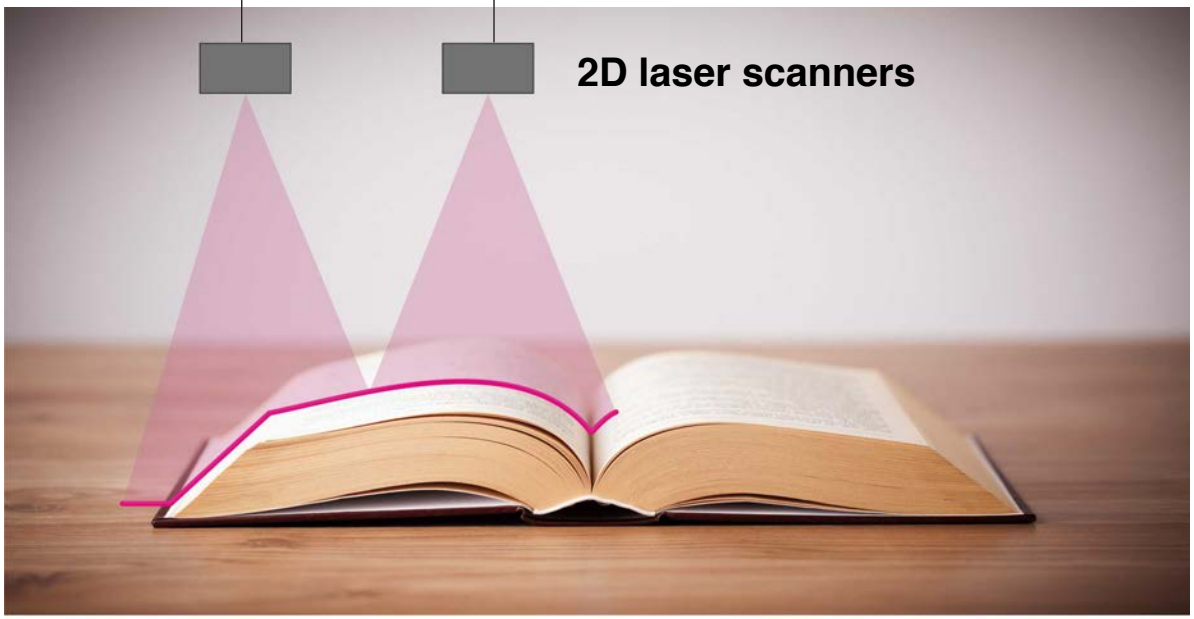
Simple measurement model with 2D laser scanner



Curve shows the curl of the pages on display

The distance range of the laser scanner (142 mm)

Principle of measurement using two 2D laser scanners to cover the range to be measured



The calculation by an app developed for measure of the lay-flat of books

Conclusion

The definition of lay-flat values related to books offers assistance and guidance to the evaluation of new binding methods and research results, and at the same time it can also be considered as a new quality assessment factor.

Thank you for your kind attention!

Csaba Horvath
horvath.csaba@rkk.uni-obuda.hu
csaba.horvath@nyt.hu