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Flex Picture eBook: A new approach to designing more accessible and inclusive images and text

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Flex Picture eBook: un nuovo approccio alla progettazione di immagini e testi più accessibili e inclusivi

Abstract

The Flex Picture eBook (FPE) project [1] intends to leverage the latest advances in EPUB3 [2] content production and publishing to enhance the creation of accessible and inclusive digital reading materials. FPE allows the authoring of structured, interactive, and adaptable graphical content embedded in EPUB3 [3] publications. By integrating granular structural levels and annotating these parts with semantic information, FPE allows an interactive, step-by-step use of graphics. This approach forms the basis for new accessibility and reading concepts, particularly benefiting people with low vision and/or cognitive disabilities. In general, FPE contributes to the personalization of reading materials by supporting the dynamic tailoring of texts and images to individual children's needs.

Keywords
Accessible illustrations, accessible digital publishing, EPUB3, inclusion, disabilities

Il progetto Flex Picture eBook (FPE) [1] intende sfruttare i più recenti progressi nella produzione e pubblicazione di contenuti EPUB3 [2] per migliorare la creazione di materiali digitali accessibili e inclusivi per la lettura. FPE consente la creazione di contenuti grafici strutturati, interattivi e adattabili incorporati in pubblicazioni EPUB3 [3]. Integrando livelli strutturali granulari e annotando queste parti con informazioni semantiche, FPE consente un uso interattivo della grafica, passo dopo passo. L'approccio costituisce la base per nuovi concetti di accessibilità della lettura, in particolare da parte di persone ipovedenti e/o con disabilità cognitive. In generale, FPE contribuisce alla personalizzazione del materiale di lettura, supportando l'adattamento dinamico di testo e immagini alle esigenze dei singoli bambini.

Parole chiave
Illustrazioni accessibili, editoria digitale accessibile, EPUB3, inclusione, disabilità

1. Introduction

Digital accessibility, due to stronger legal enforcement (e.g. European Accessibility Act [4] and according implementation at national level [5]) gets adopted in more and more domains. Ongoing improvements in implementing technical accessibility guidelines and standards as the Web Content Accessibility Guidelines (WCAG) [6], the European Standard EN 301 549 "Accessibility requirements for ICT products and services" [7], Easy to Read [8], Plain Language [9] support inclusion and contribute to general usability for all. This is applicable also for accessibility of teaching and learning materials and in particular for the production of schoolbooks using the widely adopted EPUP3 [3] standard. EPUB3 is based on and incorporates the Daisy Standard [10] developed and proposed by the community of print disabled people.

While EPUB3's support for rich media holds immense potential for accessible education, widespread adoption is hindered by a steep learning curve for users, educators and designers/developers and the time – and resource – intensive production process for often very small groups of users. [e.g. [11]] This holds in particular true when it comes to graphical content, where only very basic accessibility guidelines, methods and tools are available. Even different types of graphics as

- Illustration
- Photo
- Data and statistical charts
- Graphs (e.g. math, technical)
- Decoration

are most often addressed under one term. In particular for illustrations or illustrative content, there is a trend to see them as "decorative". Even when accessible in accordance in accordance with the existing laws and standards, access to graphics does not provide a good teaching and learning experience in an inclusive setting. Foreseen accessibility measures as e.g. color, contrast, outline and hatching adaptation, support of enlarging/zooming, alternative descriptive text for non-text, or easy/plain language are beneficial but do not support personalization for low vision and cognitive disabled students. Author intent and the underlying didactical concepts of graphical content, in particular for illustrations, are often not transferred by state-of-the-art accessibility measures. This impacts on inclusive education and challenges all stakeholder groups as learners, educators and service providers (e.g. centers/experts for inclusive education or informal support through relatives).

What's more, for young children, this is ill-suited to the notion of 'pleasure' reading. During the first few months of a young child's life, illustrations play an important role in familiarizing the child with the book medium.

The Erasmus+ Flex Picture eBook (FPE) project [1], in partnership with experts in digital accessibility, teachers and a children's book publisher, aims to address this issue. It researches and introduces a new approach to enhance the accessibility and usability of illustrations by:

- adding structural layers through decomposing and aggregating and
- including additional information (e.g. explanatory text, audio, symbols, pictures).

This supports a new personalized accessibility experience by allowing a stepwise approach to illustrations, in particular for students with low vision [12] and those with cognitive/neuro-diverse disabilities. [13] [14] We also stress that FPE contributes to the mainstream discussion on personalizing learning and teaching materials for differential education and individual learning paths. [e.g. [15] [16]]

In this paper, following 1) the introduction, we 2) shortly outline the state of the art in digital media accessibility in which the FPE approach is embedded. This allows for identifying and discussing gaps when adapting and presenting graphical content beyond the existing state of the art. 3) We introduce the FPE approach, its workflow and features for adapting and producing granular interactive illustrations in accessible EPUB3 documents. 4) We discuss possibilities of bringing the FPE concept into practice for a) learners, b) educators, c) content developers and publishers and d) service providers for people with disabilities.

2. State of the Art in Accessibility of Teaching and Learning Materials

The paradigmatic shift towards inclusion [17] has been strongly supported by digitization. Digital technology, through its multimedia (presentation) and multimodality (interaction) potential, provides a much higher level of flexibility and adaptability in accessing, interacting with, and participating in the digital society. The more digitization advances and digital systems enter in all domains, the more they become subject to flexible adaptation and improved accessibility for people with disabilities [18], often using Assistive Technology (AT). [19]

Due to strong legislative accessibility measures particularly in the US [20] [21], the level of digital accessibility on all major digital platforms, standard applications and development environments [e.g. [22][23]] is considerably high. Of course, the uptake in everyday system/content design and development is still lagging behind.

2.1 *Web Accessibility: W3C/WAI*

The Web Accessibility Initiative (WAI) [24] from its beginning in 1994 had a strong focus on accessibility. Tim Berners-Lee, the founder of the World Wide Web Consortium (W3C) made WAI a key domain of W3C in the standardization process. This global cooperation, which uses a vendor and platform independent approach has been supported not only by disabled people and public authorities but also by the industry due to the growing business and socio-economic potential and improved usability for all users. W3C/WAI standards allow industry to develop their products in an accessible manner and therefore they have a strong interest to further support their development. The standards are accompanied with a rich set of practical guidelines, techniques and tools for design, implementation and quality control.

The most important standard is WCAG, the Web Content Accessibility Guidelines [5]. It uses 4 principles (perceivable, operable, understandable, robust), 13 guidelines, a growing set of success criteria and related sufficient/advisory techniques at 3 levels (A, AA, AAA). As technology develops, WCAG is subject to ongoing updates (versions 1.0, 2.0, 2.1, 2.2, 3.0), what is done using the rigorous W3C standardization process [25] which guarantees quality and global agreement. At the moment, version 2.2 is in force and referenced by legislation around the globe.

Besides WCAG, W3C/WAI provides other standards and resources supporting web accessibility as Authoring Tools Accessibility Guidelines (ATAG) [26], User Agent Accessibility Guidelines (UAAG) [27] and Accessible Rich Internet Applications (ARIA) [28]. The COGA working group [29] is working on cognitive accessibility guidelines intended to update WCAG for neuro-diverse users.

FPE contributes to accessibility and provides tools and techniques for content use ("player") and authoring of content (illustration adaptation) in particular in relation to:

Perceivable:
- Guideline 1.1 Text alternatives for any non-text content: All graphics must have a text alternative, inserted and programmatically exposed to AT using e.g. the alt-text, longdesc or figcaption element.
  As discussed, descriptive text for important illustrations might not be sufficient for users with low vision and cognitive disabilities. They might be challenged by more text, even with audio or Braille rendering, easy to read or easy text. Providing more text impacts on the experience and usability of those struggling with text. Users with cognitive disabilities might need symbol support or translation into symbol language. In class this leads to diverse presentations which tends towards divagating didactical concepts and communication gets complex risking segregating tendencies.
  FPE proposes to decompose graphics into more granular parts and supports navigating parts, which is otherwise only possible through visual perception. These parts expose the structure and make it programmatically usable by AT or general software functionalities. With this, not only the whole but also all its parts become accessible and provide supportive measures for personalized accessibility.
- Guideline 1.2 Time-based media: all audio, video, animation or time dependent interaction, be it live

or recorded, provide captions, audio descriptions, sign language and accessible handling (e.g., start, stop, pause, rewind, forward).

FPE starts from static illustrations but transfers them into dynamic, time-based content through animated presentations and self-pathed navigation in the programmatically exposed structure, including accessibility measures as annotation with e.g. descriptive text, captions, audio, symbols/graphics, animation, video, sign language.

FPE uses and promotes the transfer of static graphics into time-based media as an approach for accessibility and better usability by outlining and integrating a meaningful and didactically rich structure, sequencing, presenting and interacting for personalization, which remain an integral part of the original illustration.

- Guideline 1.3 Adaptable: Content can be presented in different ways (e.g. visual, audio, tactile) by standard or assistive tools.
  Adaptability is in particular relevant in FPE by proposing decomposition and aggregation at a granular level to a) outline the relationship between the parts and the whole of the illustration, b) determining and proposing a meaningful sequence of parts, c) supporting that the whole and its parts are not only determined by one sensory characteristic (color, shape, size, location, sound) but also through text and multimedia annotation and d) that the purpose of input and interaction can be identified as a whole or by going through the parts.
  It is one of the strengths of FPE to not only support these accessibility requirements but making them a key asset for new didactical approaches.
- Guideline 1.4 Distinguishable demands that the default presentation is well perceivable.
  Again, even if we start from an accessible illustration, FPE has to guarantee that graphical content as a whole and in parts fulfills the success criteria in terms of visual/audio/tactile contrast, spacing, audio control and quality, resizing and reflow both of the content and all interactive elements (e.g. input elements, hover, focus). Checking tools integrated into the authoring workflow of FPE help in fulfilling this guideline.
  FPE, which allows going into the details of a graphic supports a higher level of distinctness through applying it to parts and not only to the aggregated whole.

Operable

- Guideline 2.1 Keyboard accessible and 2.2 enough time demand that all functions are operable by the keyboard and the interaction provides enough time.
  Even if FPE does not address requirements of users who depend on the keyboard interface, e.g. users with motor disabilities or blind users, keyboard accessibility as well as adjusting timing and limits is key to allow diverse users to use the FPE potential. All functions, in particular navigation has to be possible via keyboard and animations have to support start, pause, stop, rewind, etc.
  By implementing keyboard accessibility at a granular level, FPE supports the user experience in particular also for those with complex disabilities also including co-morbidities (vision, motor, cognition).
- Guideline 2.4 Navigable: Users find the content they want/need and know where they are.
  FPE challenges the navigability of digital content by introducing granular levels into illustrations. Efficient navigation is an important criterion. Providing e.g. titles/headings/lists, defining focus order and making it visible, defining a reasonable order and jumping over aggregated parts at different levels, providing information where you are, etc. has to be implemented. A granular navigation is seen as an interesting possibility to establish a motivating experience to users who are not able to use the standard representation of the whole.
  FPE supports diverse and personalized navigation experiences as add-ons to visually encoded and innovative (gamifying) accessibility features. This is proposed as a technical foundation to establish new approaches for developing a mental map, understand, navigate and use graphical content for all.

Understandable

All guidelines under this principle of WCAG are applicable for FPE. So far, these guidelines very much have focused on issues already discussed under perceivability, in particular on consistency and provision

of help, error prevention/recovery and input assistance. In addition, it demands for easy-to-read language. This is to be supported by FPE. So far, access to graphical content is only treated at the level of the whole through providing descriptive texts. By proposing decomposing and aggregating, by transferring static graphics into dynamic time-based media, FPE provides new approaches for low vision and neuro-diverse users. This also shows potential for e.g. blind users to better understand and cope with graphical content through establishing a mental model through the navigation experience in addition to textual descriptions. In general FPE could provoke new didactical approaches based on personalization.

Understandable has been in the background for a long time [30] but gains more attention. The COGA working group [29] proposes a set of guidelines to better meet with the requirements of neuro-diverse users:

- Providing clear and understandable content
- Supporting memory limitations
- Offering alternatives to complex text
- Reducing cognitive load
- Helping users maintain focus
- Supporting users in decision-making and understanding choices
- Supporting error prevention and recovery
- Ensuring usability for diverse needs through adaptability for different cognitive abilities

Again, this discussion very much focuses on text authoring, explanatory text and providing/including graphics/symbols. What is not yet addressed is supporting personalization through:

- Decomposing graphical content for providing a navigable structure and applying the accessibility requests at a granular level and
- Supporting understandability at a granular level.
FPE is therefore seen and proposed as a new and innovative approach to cognitive accessibility.

2.2 ePub3 and Daisy

The Daisy initiative, starting in 1988, [31] led to the creation of the Daisy standard and format [9], enabling accessible content consumption in visual, audio, and Braille formats. This standard aligns with W3C/WAI, offering synchronized multimedia access for better usability. While tools like Google Docs support ePub exports [2], they only handle static files, making them unsuitable for creating Flex Picture eBooks, which require manual XHTML, CSS, and JavaScript coding. This complexity poses challenges for publishers without programming skills, as the ePub format demands strict folder structures and technical precision.

Specialized tools like ePub Checker [32] help validate ePub files, still require technical knowledge. Software like Sigil [33] aids in generating directory structures, yet the process remains inaccessible for non-technical users. The developed Flex eBook software, as discussed in our previous paper [34], automates the creation of compliant ePubs, significantly reducing the need for manual coding while offering full functionality, thus lowering the barrier to creating accessible eBooks.
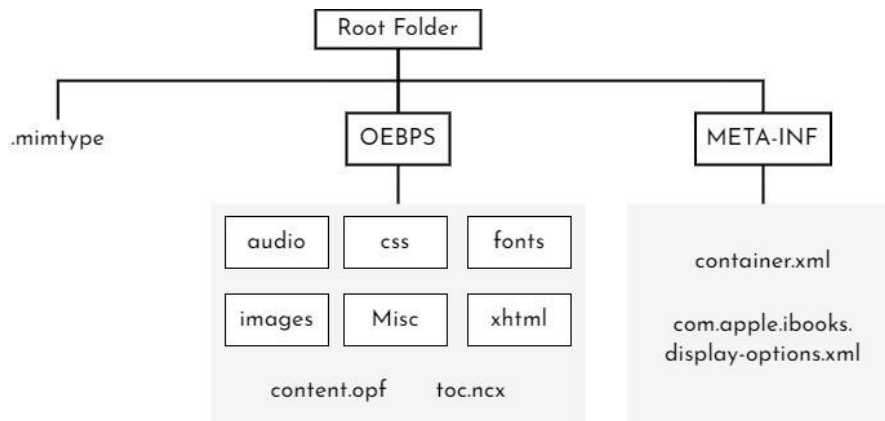
Fig. 1. The ePub file structure includes the mime type, which identifies it as a digital publication, META INF for pointing to root documents, and the OEBPS directory for storing all book files in organized subfolders. [36]

2.3 *Plain Language [9] and Easy to Read [8]*

For a long time, these techniques intend to provide better accessibility and usability of text the broadest audience possible in terms of readability (perceiving the content) and understandability (comprehension of the content). In the same way as already discussed with WCAG, these guidelines primarily focus on text and do only superficially address access to graphics. Again, annotating pictures and symbols or translating into symbol languages is mentioned. But access to graphics as part of the content and their inner complexity is not addressed beyond descriptive text and its readability.

Plain Language has been introduced for political, administrative and business reasons. With inclusion it also came into focus for neuro-diverse people. Easy to Read got started to facilitate participation for neuro-diverse users. While Plain Language is seen more as a task for mainstream content authors, Easy to Read primarily is defined as a specialized service by disability experts including quality assurance by users themselves.

2.4 *EAA and EN301549*

As mentioned in the introduction, following the US [20] [21] and the UN Convention on the Rights of People with Disabilities (UNCRPD) [35], the EU enforced the European Accessibility Act (EAA) [4], which must be implemented implemented in all member countries [e.g. [5]]. For the implementation, the standard EN301549 [7] has been provided and is now updated, providing more and better measurable criteria for accessibility. It references and uses the state-of-the-art digital accessibility standards, in particular WCAG, but goes beyond by including a first range of products and services, including digital interfaces. As it stands, again, it does not change the above analysis of access to graphics.

Other standards as PDFUA [36] or graphic formats as SVG [37], which are candidates for implementing the FPE approach also do not change the above discussion in terms of accessibility.

3. The FPE Approach: Introducing Multi-Layered Access to Illustrations

We present a comprehensive software suite specifically designed to simplify the creation of accessible digital content. This suite offers advanced tools that focus on two core aspects:

• Flex Picture eBook Builder: The software provides a seamless approach to embedding these layered, accessible illustrations into ePub3 publications. It ensures full compliance with ePub3 standards, guaranteeing compatibility across a broad range of consumer electronic devices and assistive technologies.

The automated process manages the complex file structures and formatting requirements, including XHTML, CSS, and JavaScript, minimizing the technical burden for authors.

- Creation of Accessible Illustrations: The software simplifies the process of generating illustrations that are adaptable to various comprehension levels. Authors can design visuals with built-in accessibility features, allowing users with diverse needs (e.g., visual or cognitive disabilities) to interact with and understand the content more easily. The software facilitates the breakdown of complex images into simpler, more digestible components, enhancing usability for all learners.

3.2 Flex Picture eBook Builder Workflow and Updates

As outlined in our previous publication [34], the Flex Picture eBook software automates the creation of compliant ePubs by generating structured, accessible multimedia content. Since the initial release, several key updates have been introduced to enhance functionality and improve user experience.

New Features and Enhancements:

– Improved User Interface: The UI has been redesigned for greater accessibility, offering clearer navigation and more customization options during the EPUB creation process. (see Fig. 2)
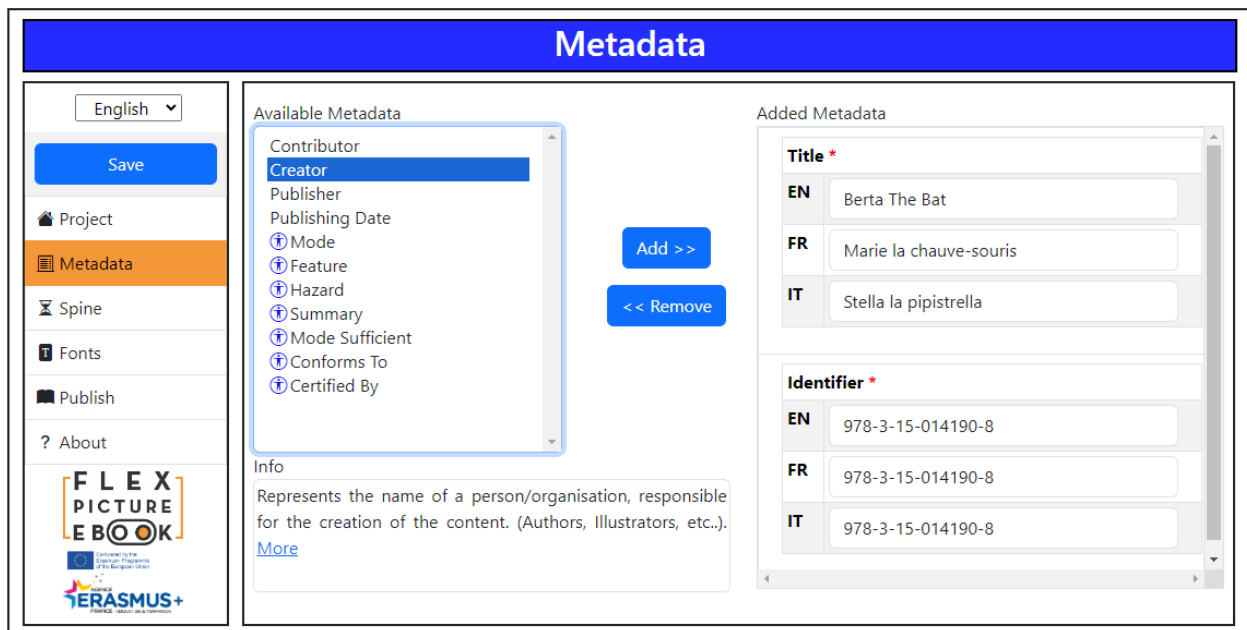

Fig. 2. Metadata Screen

– Enhanced Customization Options: A new Fonts Screen (see Fig. 3) feature has been added, allowing users to specify the fonts to be used in their published eBook. Additionally, a Menu Illustration Page has been integrated into the eBook spine (see Fig. 4), enabling a higher level of customization and personalization for the final product.
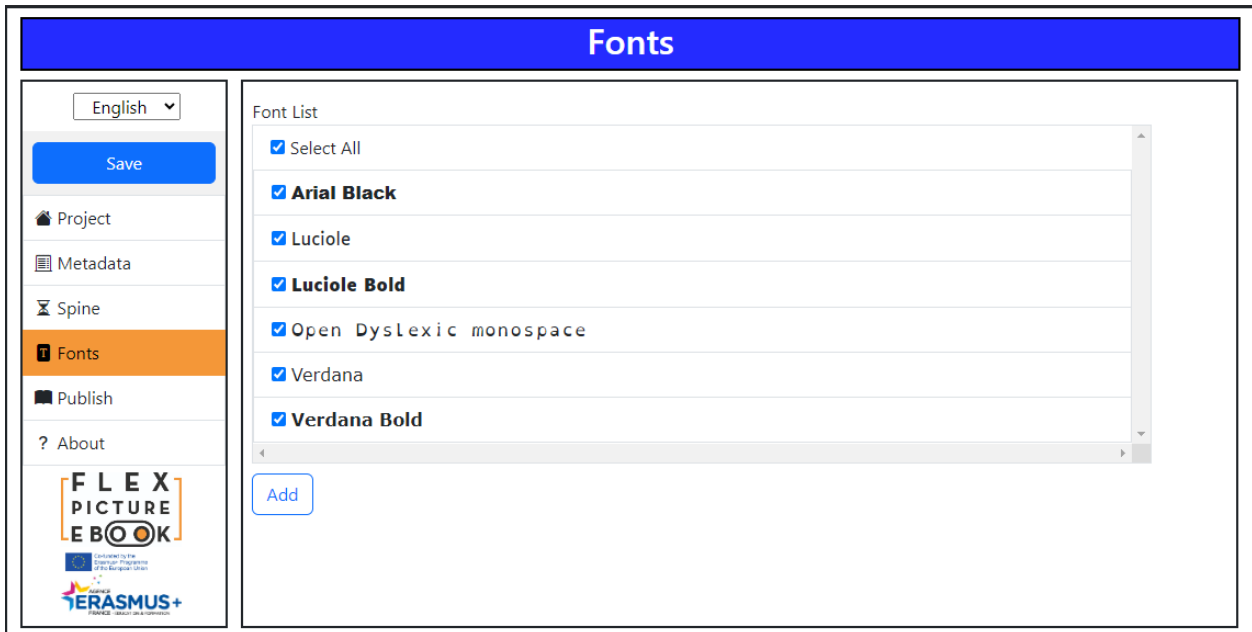
Fig. 3. Fonts Screen

– Automated Validation: A built-in validation feature has been introduced to automatically check for EPUB compliance and accessibility issues during the creation process, significantly reducing the need for manual checks. For example, if audio narration settings are enabled on the project screen, the software will require narrations to be added for the cover page and all other book pages in every selected publication language. (see Fig. 4)
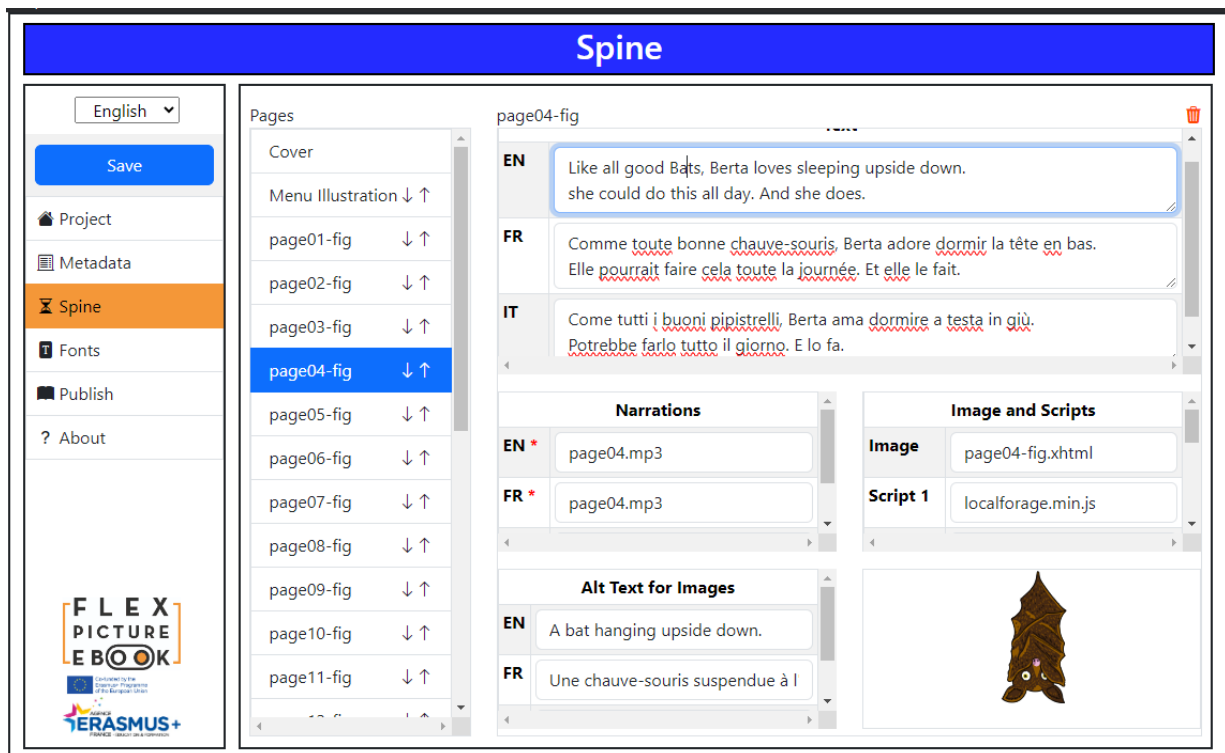

Fig. 4. Spine Screen

– Multi-language Support: The software now allows users to easily create eBooks in multiple languages, simplifying the workflow for international publications. (see Fig. 5).
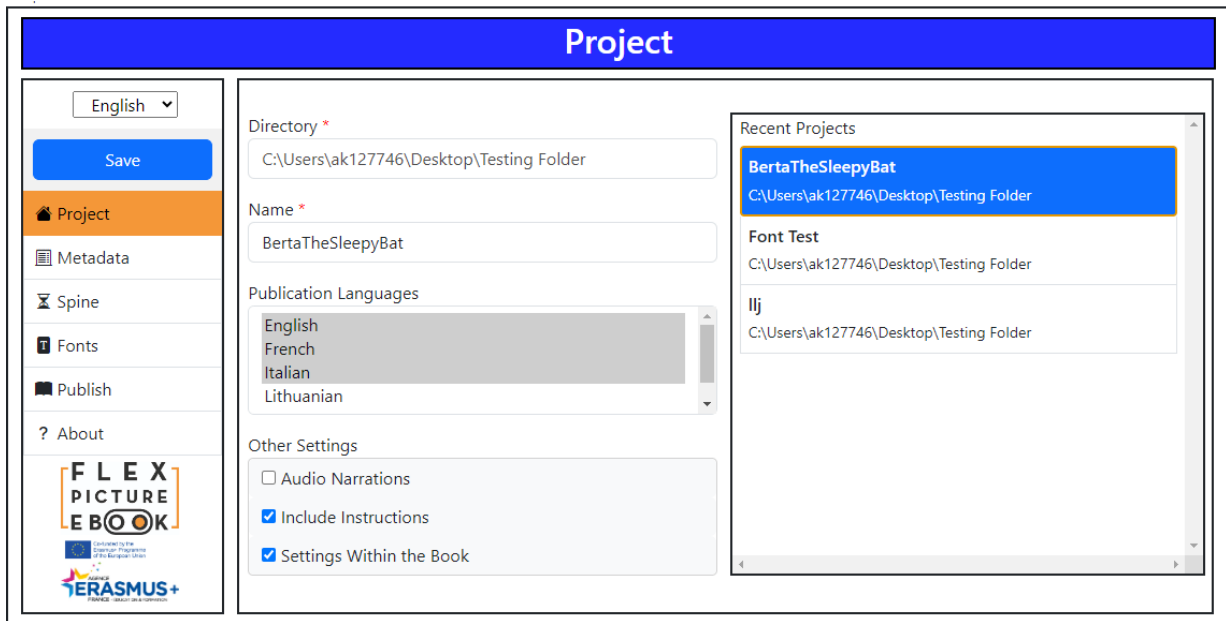
Fig. 5. Project Screen containing the dropdown for selecting the UI language.

These updates have been implemented in response to early user feedback, enhancing the software's flexibility and making it even more accessible for educators and publishers to create high-quality, inclusive educational materials. These improvements further lower the barriers to producing accessible digital content, ensuring that diverse user needs are met with ease.

3.3 *Accessible Illustrator plugin*

We developed a plugin for Adobe Illustrator that streamlines the image creation process for Flex Picture eBooks. It solves a couple of issues that normally arise during their production.

The main problem is that the EPUB format does not support .png or .ai files as input: the images have to be .xhtml files, which cannot be created using regular digital-arts software.

Flex Picture eBooks also require the capability to switch the level of complexity for the images, but this cannot be done with static files. Previously, to create these dynamic images technical knowledge about programming was required, as the functionality had to be manually added, thus making the barrier to entry unnecessary high for potential creators.
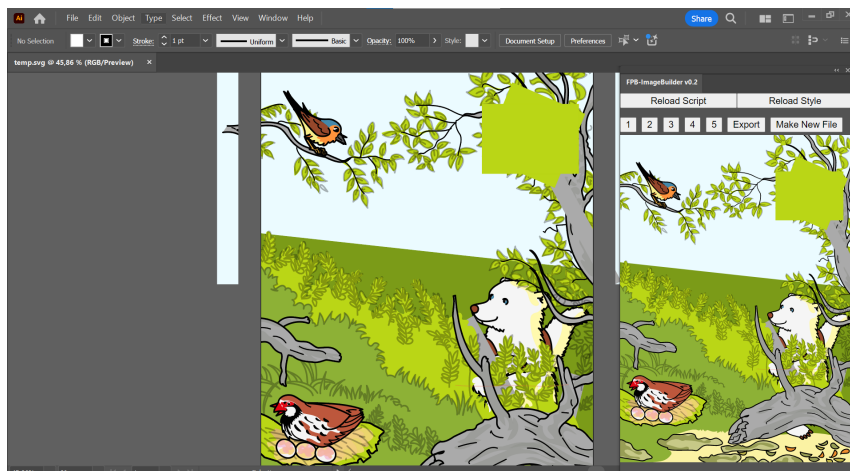

Fig. 6. The plugin for Adobe Illustrator

The plugin allows users to directly export a file that is dynamic by default. Artists can select which objects are shown at which level, without having to leave Adobe Illustrator. This is done through a visual interface, which also allows to hide or isolate layers associated with a specific level.

The old approach involved creating all levels of an image in one single file, exporting it as an SVG, and manually tagging the paths with the corresponding level-tags. This was a very time-consuming task, which was also very technically demanding due to its complexity. Through our proposed solution using the Illustrator Plugin, this workload and difficulty should be significantly reduced.
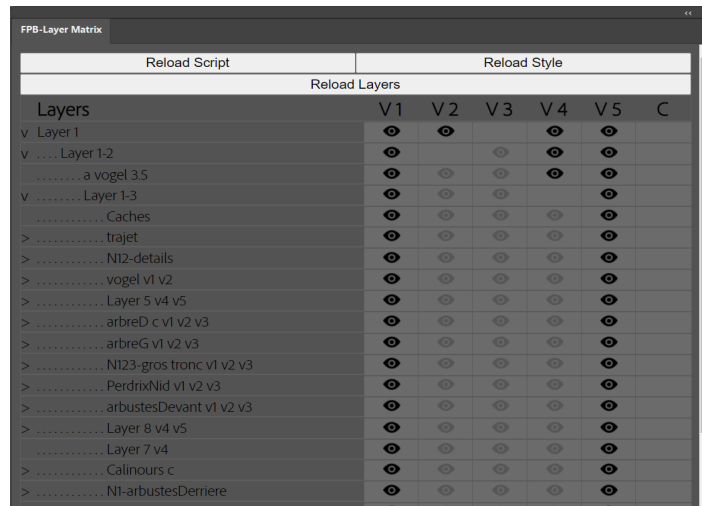
FPB-Layer Matrix						
Reload Script		Reload Style				
Reload Layers						
Layers	**V 1**	**V 2**	**V 3**	**V 4**	**V 5**	**C**
⌄ Layer 1	👁	👁		👁	👁	
⌄ …. Layer 1-2	👁		👁	👁	👁	
……… a vogel 3.5	👁	👁	👁	👁	👁	
⌄ ……… Layer 1-3	👁	👁	👁			
………… Caches	👁	👁	👁	👁	👁	
> ………… trajet	👁	👁	👁	👁	👁	
> ………… N12-details	👁	👁	👁	👁	👁	
> ………… vogel v1 v2	👁	👁	👁	👁	👁	
> ………… Layer 5 v4 v5	👁	👁	👁	👁	👁	
> ………… arbreD c v1 v2 v3	👁	👁	👁	👁	👁	
> ………… arbreG v1 v2 v3	👁	👁	👁	👁	👁	
> ………… N123-gros tronc v1 v2 v3	👁	👁	👁	👁	👁	
> ………… PerdrixNid v1 v2 v3	👁	👁	👁	👁	👁	
> ………… arbustesDevant v1 v2 v3	👁	👁	👁	👁	👁	
> ………… Layer 8 v4 v5	👁	👁	👁	👁	👁	
………… Layer 7 v4	👁	👁	👁	👁	👁	
> ………… Calinours c	👁	👁	👁	👁	👁	
> ………… N1-arbustesDerriere	👁	👁	👁	👁	👁	

Fig. 7. In this window the users can assign objects directly to the corresponding layers

4. Challenging Educational, Publishing and Service Provision Practice

The first part of the project aims to design and test in the classroom an illustrated digital book that adapts dynamically to the individual needs of children, particularly children with disabilities, with several levels of simplified illustrations, visual and audio animations and an audio narration, as well as innovative teaching scenarios for teachers made possible by this book concept.

To understand the potential and challenges of using the FPE approach two surveys were carried out in France, Italy and Lithuania, the first in spring 2023 and the second in spring 2024. In total, 351 children and 71 teachers and parents were accompanied in their discovery of the book 'Emile veut une chauve-souris' (Emile wants a bat) [2] by the project partners. On each occasion, the aim was to gather information on the uses and needs of the children and accompanying adults, and to use this feedback to improve the EPUB3 Flex Picture eBook. In addition to improving the ePub between these 2 series of tests, the difference also lies in the fact that during the 2nd series of tests, the carers were given a teaching guide to help them make the most of the many possibilities offered by this digital book.

At the end of the reading session, the children and their carers answered a questionnaire containing 59 and 42 questions respectively. The summary of responses below concerns the 2nd series (226 children and 42 adults) with the most advanced version of EPUB.

• Children's responses: In terms of their profile, 18% had a visual impairment and 8% an autism spectrum disorder or other neurodevelopmental disorder. 85% of the children said they liked the story and the illustrations. In terms of their use of the book's functions:
  – 92% triggered the sound animations
  – 84% used the buttons on their own (reading by the actor, image adaptation levels, animations).
  – 67% changed the font (for better visibility in particular),
  – 63% changed the background colour of the text,
  – 60% used the different levels of illustration, giving the following reasons: because it's fun, out of curiosity, to see and understand better.

- 17% changed the font size.
- To the question 'What helped you understand the story better?
  - YES to the sounds and animations (72%)
  - YES to the story read by the actor (68%)
  - YES to the different levels of image adaptation (39%)
  - YES to zooming in on images (28%)
  - YES to highlighting a detail in the image (23%)
- As for the responses of the accompanying persons, they responded positively to the following statements
  - I would like to see more digital books with interactive illustrations and customisable text": 100%.
  - This book allowed me to interact with the children": 98%.
  - The children were enthusiastic when they discovered the book' at 88%.
  - This book helped me to better understand what a complex illustration is (legibility, comprehension) and how to make it more accessible', 88%.
  - They found it particularly useful (several answers possible)
    - Interactive illustrations: 43
    - Text read by the actor (31%)
    - Customisable written text (21%)
    - Described illustrations (if you used Thorium): 6%.
- Lastly, 98% of those accompanying the actor 'found the book easy to use'.

This survey showed a great interest in the FPE approach, both from the side of the kids, as well as from the parents. Giving disabled users access to the books and illustrations through means beyond alt- and descriptive text, allows them to interact with the medium in a whole new dimension, which was hailed by a large number of testers.

The different levels of complexity give them the option to perceive the images in a way that is specifically tailored to each person's needs and the feature was used by a majority of participants. The sound and animation features were also very well received, with 92% triggering them and 72% claiming that it helped them understand the story better. The addition of narrations by a voice actor also contributed massively to the comprehension of the contents.

Enhancing the set of tools for modelling and adapting interactive illustrated books, providing accessible ePub versions and thereby improving the quality and usability of products for all. b) Enabling and supporting service providers and supporters ("such as") of students with disabilities with a new approach in providing multi-media access to content. c) Allowing educators to personalize and/or prepare accessible and better usable multi-media content for inclusive and general education.

The software suite that was developed should lessen the workload and required technical knowledge to create Flex eBooks and lower the barrier of entry to such a degree that the format becomes more widespread. One of the ways this process could be further simplified, is through the creation of a tool that allows illustrators to export directly to the required format and simplify the process of manually abstracting images. In the next steps, this tool will be implemented as a plugin for Adobe Illustrator, which hopefully makes the task of image-creation easier and more accessible.

In summary, FPE shows potential as a novel approach enhancing the set of tools for modelling and adapting interactive illustrated books, providing accessible ePub versions and thereby improving the quality and usability of products for all.

a) It is seen as a new and promising service for students with disabilities with potential to make the adaptation work of inclusive education experts more efficient and cost-effective
b) It could become a concept and approach striving to revolutionize the educational material production in the publishing sector through provision and adaptation for diversification in education.

4.2 FPE as a Tool for People with Disabilities (Assistive Technology)

As underlined by the evaluation above, FPE books provide a new and innovative approach to overcome the often frustrating and tiring experience of low vision and cognitive disabled learners. Being dependent on verbal description and support and restricted to text instead of a motivating illustration leads first to disadvantages. FPE, by retaining the same original content, provides an independent, self-driven and personalized approach for navigating and exploring the structure and parts of graphical content. This allows the development of a mental map for understanding and working with content based on very granular accessibility support where and only where needed. Even if students use diverse personalized approaches to the content, they stay with the same original in the learning process what supports staying in the same discourse and inclusive didactical concepts.

4.3 FPE as a Tool for Publishers and Content Authors

FPE is seen as an innovative next step in the transition from traditional school/teaching/learning books and materials towards enriched and flexible multimedia and multimodal tools. FPE shows potential to enhance the set of tools for modelling and adapting interactive illustrated books, providing accessible EPUB versions and thereby improving the quality and usability of products for all. Besides supporting accessibility, FPE is a strong contribution and model for improved personalization answering the increasing needs for more flexible and rich teaching and learning materials.

4.4 FPE as a Tool for Service Providers, Supporters (Transcribers)

Support and services for students with disabilities have long developed in parallel to mainstream education. One of the key reasons for this has been the use of traditional media as schoolbooks which build up barriers. With this, services and support in providing alternative learning and teaching materials has been segregated from mainstream. Digitization and digital accessibility make this sector part of mainstream and a strong resource for supporting inclusion. FPE is seen as a resource for this sector to include its know-how into an inclusive digital material production contributing to better usability for many students beyond the traditional target groups. Safeguarding this know-how and these resources is seen as a key potential for the transformation towards and inclusive teaching and learning material production. FPE is seen as a framework and a tool for their contribution and for the cooperation with mainstream.

4.5 FPE as a Tool for Educators

As already discussed, FPE is a rich resource to answer the demand for answering the need for more diverse approaches to learning in inclusive settings. FPE allows educators to adapt and/or prepare accessible and more usable multi-media content for inclusive and general education. It is a tool to support personalization by managing an inclusive setting of working on the same content.

4.6 FPE as a contribution to WCAG, Daisy, SVG accessibility and others

As discussed in paragraph 2, FPE goes beyond the actual state of the art in digital accessibility and provides new concepts and tools to address issues of perceivability, operability and understandability at a much more granular level. In particular, FPE contributes to the work on cognitive accessibility performed in the COGA working group. FPE is seen as an example of content personalization, which could also be applied to other technical frameworks besides EPUB3 as e.g. for designing rich SVG graphics.

5. Conclusions

With the Flex Picture eBook tools, we propose solutions for building inclusive educational resources. We have not only marked out but also automated many of the stages in the design of these resources in order to reduce the amount of time editors have to devote to them and thus facilitate the emergence of a business model.

Although our solution offers a level of accessibility that exceeds the requirements in EN301549, field tests have demonstrated its relevance in offering fun, comprehensible resources to children with a wide range of specific needs. This is not a niche audience.

Acknowledgement

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