



# EMERGENT TECHNOLOGIES TO ENRICH READING OUTCOMES THROUGH AUGMENTED REALITY

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**Our paper presents a series of modern ways used for augmenting reading and increasing people's interest in books. In today's society, reading has been replaced with other activities related to technology and the evolution of science. However, the advantages brought in by technology can also be applied to books in order to increase their attractiveness. Virtual and augmented reality, internet of things or movement detection are just a few examples of technologies which can be integrated into classical books and bring with them a great series of advantages: increase interest of young people, raise attractiveness and entertainment. Social collaboration is also an aspect which can help people share their interests, encouraging others to read, write, collaborate, share, thus getting closer to creating a better future of reading. We will also present our current project, Lib2life, which has the purpose of augmenting reading and libraries through interactive 3D reconstructions and social-collaborative means.**

## 1. INTRODUCTION

In a society where young people spend most of their time on social media or on their smartphones, books are starting to lose their focus and relevance. People use online resources as means of communication and knowledge, so new ways are needed in order to modernize and revitalize books [1, 2]. Unfortunately, older people are usually skeptical regarding the introduction of e-books, so other alternatives are needed, combining the advantages of both worlds: physical books and technological features [3].

The statistics related to the interest in reading are worrying. A report published by Time Magazine in 2014 shows that American adolescents show little interest in reading as a leisure activity, as 45 % of 17 year-olds read for pleasure only once or twice per year [1]. The situation is even worse in Romania, where only 51 % of the population declared they read at least one book per year as a hobby, not imposed by education, work or law [4].

However, in the last years, the generation gap in using the technology tools has been decreasing. More and more adults and elderly people are discovering the benefits of using the Internet, the social-media sites and the electronic devices to read, to be informed, to share information, to work together in projects. They understood that the technology is merely a mean, a way to find and use information for their work, health and free time. More adults and elderly people are now taking part in the academic life, as students, teachers or researchers, and the use of augmented books can help them understand faster and easier the benefits of technology in education and learning, both for them, their students and their co-workers.

Our current paper presents some technical aspects and experiments made by different universities and researchers in order to improve reading and augment books. In the following chapters, we are going to see some modern ways

of augmenting books and reading in general by using technology means, we are going to analyze some statistics related to the interest of academia and researchers regarding e-books and collaborative reading, then we are going to see how we can add social-collaborative aspects to reading and present our own project called Lib2Life.

## 2. AUGMENTING READING USING TECHNOLOGY

Living in a highly technologized era, it becomes natural to start thinking about introducing technology in various domains. Young people are used to being surrounded by technology, they spend most of their time online and cannot imagine their life without their smartphone, Facebook, Instagram or Snapchat accounts. Statistics from 2017 show that adolescents and young adults spend an average daily time of 180 minutes (in Europe) and 230 minutes (in Latin America) on social media [2]. This is probably one of the main reasons why they do not enjoy reading, as books often seem outdated for their tastes. Sociologists classify the main reasons why young people do not read into three categories: lack of immediate satisfaction, context and education [5]. The truth is that the act of reading lacks dynamism and immediate entertainment: young people can feel like they are reading tens of pages without getting anywhere, without getting to action, without an immediate outcome. The satisfaction of finishing a good book is sometimes not enough in order to change the perspective people have over the act of reading itself. The second reason is related to today's context: nowadays, there are more popular alternatives to reading: television or internet are just some broad examples which are viewed as better alternatives than reading by the young generations. Finally, the third reason is related to the rather outdated practices used in literature classes from middle school or high school. Students are imposed to read classical novels written by prestigious authors, even if they are not fond of those

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specific genres. The text might be too difficult for them to understand, the language may be archaic and the subject not actual anymore. Furthermore, they should gain the pleasure of reading by being encouraged to read the genre that they like, as they can discover the pleasure of reading also through contemporary literature.

In addition to its entertaining nature, it is proven that reading has a series of scientific benefits, as opposed to other media: the information is absorbed more rapidly and more accurately from paper reading than from e-books, from a medical point of view - paper books do not cause eye fatigue and do not lead to blurred vision, they cause fewer distractions and allow the reader to focus more on the content of the book [6]. These are just a few examples why books should not be replaced by technological alternatives and new solutions should be found.

### 2.1. THE BEGINNING OF TECHNOLOGY USE FOR REVITALIZING READING

A possible solution to the previously mentioned problems involves the inclusion of technology for augmenting books and reading in general. Probably the first project which had the intention of modernizing books was Enciclopedia Mecanica, which appeared in 1949 and is considered the precursor of the e-book. Created by a Spanish schoolteacher, it combined mechanical, electrical and air pressure components, adding functionalities such as illuminating the pages, zooming in, writing and drawing notes. Text fragments and graphics were placed on cylindrical devices so that the reader could move them easily and stop to whichever topic they liked. Many books could be read and integrated in the same device, thus solving the problem of students who had to carry around heavy books for each particular school subject [5].

One of the most spectacular technologies, which becomes more and more popular nowadays, is virtual reality (VR). It is defined as a technology which creates “complete, 3D virtual representations of the actual world or of objects within it” [7, 8]. Nowadays, we can take virtual tours of museums or other cultural buildings, we can train skills in the virtual world, we can even treat psychical conditions or doctors can perform surgical procedures by using virtual means. In order to increase the authenticity of the experience, various additional devices can be used, such as head mounted displays, gloves, vests etc. Another technology, this time related to both virtual and real worlds, is the augmented reality (AR). If we think about a scale connecting the real world and the virtual reality, the augmented reality would be situated somewhere in between, as it refers to the introduction of virtual elements or objects in a real environment [9]. The introduction of virtual data adds some new information to people which can be really valuable, if processed and used at its full capacity [10]. Combining augmented reality with physical books can produce an interactive, modern component, which can help the revitalization process of reading. The idea is not new, as it goes back to 1991, when Pierre Wellner from the University of Cambridge and Xerox EuroPARC presented the concept of DigitalDesk, a device which allows the tactile manipulation of electronic elements placed on top of physical documents [11]. His main arguments for the usefulness of this invention involved the advantages brought by both electronic documents and paper

ones, which should be combined through various ways. According to Wellner, the best solution is to add electronic properties to a physical desk, by using a projector and a camera connected to a computer. The camera is used in order to identify the user’s movements with the help of gesture recognition techniques, thus seeing which parts of documents are touched by the user. Based on this identification process, the projector is used to display feedback or other digital components on the physical document placed on the desk. At the time, few hardware limitations brought a series of implementation issues, such as slow response time of image processing in real time, low resolution cameras or slow system architectures. Today, all these could be overcome by the evolution of technology.

### 2.2. RESEARCHES USING AUGMENTED REALITY FOR REVITALIZING READING

Modern projects which use augmented reality are now running on more powerful hardware devices, overcoming the previous limitations. Such an example is represented by a project called WikiTUI, from 2008, which creates a system based on gesture recognition where users can utilize both physical books and digital content (images, videos, links or comments) in order to read their favorite material [12]. Similar technologies evolved even further, with the project FingerLink created by Fujitsu [13]. Their goal was to create a bridge between physical paper and digital technologies and use a camera and a projector in order to identify the finger touches or swipes over any type of printed material. Its evolved technology manages to follow finger movements as high as 30 cm / second, thus easily capturing the natural reading movements. Another nice example, but at a smaller scale, is “Novais Teixeira”, a Portuguese biography of a famous cinema critic [14]. Red boxes are present on the books’ pages in order to represent interactive content which can be identified with the help of multimedia devices (smart phones or tablets); other details related to the technology behind the creation of the project were not revealed.

Another innovative concept, prototyped firstly in 2006, is Blink, which was created by a designer at the Royal College of Art in London [15]. The name comes as an acronym from the words “book” and “link” and it refers to printed books which contain digital content through electronical components. These components, usually buttons contained in the cover of the books and linked with conductive ink, communicate with other digital devices through a wireless connection.

Similar to this concept, over the last years, augmented reality books have slowly started to gain ground. They consist of physical books where digital content has been added in order to increase interaction and immersion, while still keeping the advantages of paper documents [16]. People prefer physical paper, as they feel like they own that specific document, they like the tangible feeling of turning pages or they simply feel more comfortable than reading from a screen [17]. Augmented reality books assure the introduction of digital elements (3D animations, sounds, tactile interactions with the user) when the printed document is viewed through special devices, such as smartphone or web cameras, smart glasses or head mounted displays [18]. A thorough review related to the interest shown in research studies about AR books has been

conducted at Anadolu University, Turkey. By taking into consideration the biggest and most well-known scientific databases, they discovered only 46 studies published until 2016 related to augmented reality books, augmented desks or approaches used for paper augmentation. Their review shows that the concept of using a digital desk has lost popularity over the years and the focus is lately on the creation of AR books for children (called “interactive 3D pop-up books”). Regarding the devices used, more accessible ones are preferred over the years, such as smartphones and laptop cameras [16].

### 2.3. THE EVOLUTION OF AUGMENTED REALITY FOR REVITALIZING READING

AR books did not stay at a research stage – they are already commercialized and sold by some companies. Carlton Books had a great success with its platform AR Digital Magic and sold over 3 million AR books worldwide, written in 28 different languages, since its launch in 2010 [19]. Melville House uses the concept of Hybrid Books: physical books which have a QR Code that can be scanned using a smartphone in order to access the AR content. Most augmented reality books are written for children or adolescents, as they can combine both worlds: books and games. Popular series from J.K. Rowling or classic novels published by Penguin Classics (“Moby Dick” or “Great Expectations”) were also released in special editions, where virtual elements were added, being visible only by using a smartphone application. The technology has a huge potential and new, smaller companies have emerged, such an example being ImagineMe, which creates AR books personalized with unique characteristics for each children, as every person is unique and enjoys reading from a different point of view. Augmented reality is extremely suitable for comic books also, an interesting example being Modern Polaxis, a project which was funded on Kickstarter. The comic book (available both in a physical and digital format) represents the journal of a mad time traveler, whose secret and conspiracies can be found out by using an additional iOS application. By using the camera of the electronical device, additional content is attached over the book’s pages, bringing them to life. All the augmented reality characteristics are amazingly well integrated in the story and the atmosphere of the comic book, being presented as a “holographic projection from another universe” [20]. Augmented reality is not used just for belletristic books or pleasure reading; it is suitable also for scientific writings, such as anatomy books, encyclopedias or atlases. Such an example is called “Visible Body”, which includes an anatomy atlas textbook that can be used together with a smartphone application. By using the device’s camera, key anatomy systems or body parts can be seen in 3D and interacted with, bringing realism, engagement and improving learning experience for both students and practitioners [21].

Furthermore, the technology becomes more and more accessible and anyone can become a developer of AR books, using a free platform called Metaverse. The platform allows the creation of interactive stories with AR elements through an easy to use, drag-and-drop editor called Metaverse Studio. Users can instantly add the AR stories to paper books or even e-books and they can be easily accessed on smartphones [22]. Recent studies show that the

benefits of introducing augmented reality in the world of books are immense: they increase the reader’s engagement, as they feel the need to participate more, they become curious and interested in giving their own interpretation of the text. The focus is on the context and the content of the book, underlying the relevant parts of the text and illustrations, providing thus a “learning tool that relates to the reader” [23]. Other advantages include the augmentation of creativity, imagination, engagement, competitive spirit and bonding between different generations [24]. This technology has a huge potential and it could be included easily in libraries or at any level of education, from kindergarten to college.

This was also the intention of a Japanese Mobile Applications developer, which launched almost a decade ago a project called PhoneBook. The advantages brought by an electronical device are used as easily as possible, by creating a hybrid book – the device is inserted in the pages of the traditional book, allowing thus the addition of dynamic elements, playing videos, sounds, without losing the atmosphere and the attractiveness of traditional books [20]. This idea can be extremely attractive for children starting from very young ages, such an example being SmartBound, a book which includes an integrated electronic module in order to add high-quality audio elements to the book (music, lullabies, animal or city sounds) [25].

The inclusion of digital elements into books is brought to an even higher level by a startup company named Campfire, which uses the advantages of the internet of things (IoT) in order to revitalize books. By using a speech-to-text service from IBM and a smartphone application, smart devices can be triggered in order to add music, sound effects or lights if several keywords are detected when a parent reads a story to their children [26]. The advantages of smart devices are not used to improve reading just in the case of children, as they can bring benefits and revitalize reading for each person. Such an example is represented by an application named Booke, a so-called “reading companion” for mobile devices. By using voice commands and smart devices (with the help of voice services such as Siri, Google Assistant or Amazon Alexa), readers can enjoy the benefits of e-books without having to give up on the printed version of the book. The application is able to link physical books with their digital counterparts, adding thus many functionalities, such as selecting favorite quotes, bookmarking pages or sharing content on social media [20].

Augmented reality refers to the stimulation of the five senses, so it becomes natural to include them all in the process of enhancing physical books. An ambitious project called Sensory Fiction brings together a digitally augmented book and a wearable, similar to a vest. Based on the character’s mood changes and emotions, the device tries to transmit the same sensations to the reader and influence their physiological reactions, through lights, sounds, vibrations, heating or air compression [27].

The modernization of books through digital means does not include only the addition of digital elements directly on the book pages. Electrolibrary represents a custom book which can be connected to a computer via USB and thus create an original computer interface. The project was inspired by a Russian artist who predicted in the 1920s that books will eventually become objects enhanced by

electrical components. The book is connected to a special website which can be accessed by performing actions on the physical book: flipping pages, zooming in or out, interacting with images – all will produce the resulting actions on the website pages. Both components, the book and the website, can be used independently, but they become better when put together. By integrating sensors and conductive ink in the book's pages, the website reacts and brings additional information to the book's content (such as external links, quotations, animations, or YouTube videos) [28].

### 3. RESEARCHERS' INTEREST IN AUGMENTED READING

In order to see if researches are conducted regarding the ways of augmenting reading, we need to evaluate the statistics obtained from scientific databases.

The first criteria was the interest of conducting researches about the importance and the evolution of electronic books. By searching keywords such as e-book, electronic book or kindle, we can discover over 250 000 scientific articles in the last 18 years, with the interest growing from one year to another (Fig. 1).

This comes in contradiction with the statistics regarding the sales of e-books taken from the Association of American Publishers [3], which show that e-book sales are decreasing over the last years, as they represent only a quarter of the sales of paperback, hardback and audio books combined. The statistics from the scientific databases can be however explained by the fact that over the last years, the interest in discovering why the e-book decline took place and what methods we can find to revitalize books has increased.

If we look at the statistics regarding the countries which show the most interest in digital books and methods for improving and augmenting reading (Fig. 2), things are not encouraging for the countries situated in Central and South Europe. Results in terms of articles on ScienceDirect show 11 515 articles in Romania, 9 296 in Bulgaria and 5 173 in Serbia, ten or even twenty times less when compared to Western European countries (France – 190 195, Germany – 209 298, UK – 276 251), Asian countries (China – 130 709 and Japan – 164 160), the USA (375 665).

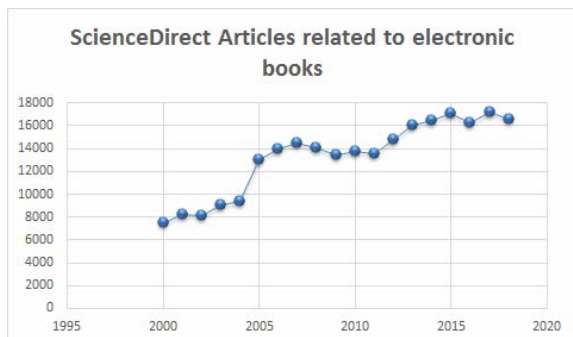


Fig. 1 – Number of scientific articles containing electronic book related keywords

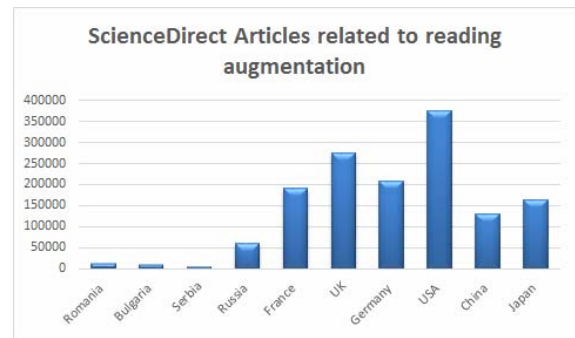


Fig. 2 – Statistics regarding the interest in digital books and the methods of augmenting reading in terms of number of scientific articles

A change in the mentality of people, as well as new methods of encouraging and augmenting reading are needed in order to help people rediscover the pleasure of books.

### 4. SOCIAL-COLLABORATIVE READING

People are, first and foremost, social human beings. They evaluate their success based on the ability to cooperate, find solutions to everyday problems, and integrate themselves in the society. The term social collaboration defines any type of work which is achieved by a group of two or more persons. The introduction of social-collaborative techniques can help improve people's interest in reading, as classical reading becomes interactive, interesting and pleasurable. Such examples include the creation of classroom reading communities [29], where participants are encouraged to share their interests in reading with their peers, interpret book passages, write and share reviews.

Another new technique involves the use of collaborative strategic reading (CSR), which includes various group activities, such as role playing, thinking out loud, and forming cooperative learning groups where students have different roles and purposes [30]. Reading can thus be perceived as a pleasant activity, because it includes the social component. Current studies from the University of Bergen, Norway, show that young people especially prefer reading texts socially, add annotations, discuss their findings with their friends or colleagues. This can improve both reading and writing for courses, and can be extended to reading poetry or any other genre suitable to people's taste [31].

### 5. LIB2LIFE PROJECT

Facing the challenges of the digital era, the wonders of technology and the multitude of information that can be found on the Internet, the libraries must redefine their role and purpose. For the new generation of users, it is much easier to read on the Internet than to go to the library and read printed books. So, what can the librarian do to encourage them to read more? The answer is simple: use the advantages of technology, convert the books in electronic products, augment their properties, and make them free and easily accessible for everyone. Nowadays, libraries must have an electronic component, they must provide access to e-books and augmented books, to digital and collaborative information in order to attract new users. Our project, Lib2Life, has the intention of revitalizing both

libraries and reading by adding a social-collaborative component to them. The project focuses on two main components:

- interactive 3D reconstructions of important library buildings;
- adding social-collaborative elements on physical books.

By using specialized techniques for 3D reconstructions (such as photogrammetry, laser scanning, analyzing depth and RGB images) [32, 33], the project will build a bridge between reality and virtual worlds. People will be able to participate in events taking place in the libraries and being streamed online (symposiums, conferences, book launches), interact with them, and explore the libraries halls, rooms and physical archives. Gamification elements are introduced in order to raise awareness about the importance and immense potential of reading. People using the system will be able to engage themselves in adventure games taking place in a mixed environment (combining both virtual elements from the virtual library with real elements from physical books). Elements such as quests, clues, rewards and competition with other users will engage the participants in entertaining actions, which can help them rediscover the pleasure of reading and going to the library.

Furthermore, creating reading groups, sharing opinions with friends, posting on social media about their book reviews – all these aspects can create a new type of reading, focused on socialization and collaboration. A new type of books will be available: interactive books, which can bring new opportunities to classical books: videos, animations, even opening virtual scenes which recreate the atmosphere and the environment presented in the book. All these aspects can help people discover the advantages of introducing digital means and social-collaboration into the world of reading, thus facilitating the revitalization process of books and libraries.

## 6. CONCLUSIONS

The libraries must remain the custodians of culture and scientific information, because the information and facts found in the printed books and periodicals are scientific and trustworthy, we know who wrote them and their authorities. The information on the Internet may be easily reachable, but it is not always reliable. So, by using technology, we can bring a plus to a book, we can make it accessible online, so the user, the student, the teacher, the researcher can use it, annotate it, cite it, read it and associate it to their needs. Augmenting reading brings the books closer to the reader using the 3rd millennium technology in addition to the classical reading, using software based on books.

We live in a world where both technology and society are evolving rapidly. Education, reading habits and attitude towards library have changed and new ways are needed in order to augment and revitalize all aspects related to reading. Modern technologies, such as virtual or augmented reality, 3D reconstructions and electronical devices can be combined with social-collaborative principles in order to have a positive influence among people. Augmenting reading through technological means, and through AR in particular, cannot be classified as being closer to classical reading or closer to using software based on books: it represents the perfect mix, the perfect balance, situated at the middle of

these two techniques, and keeping the strong points from each one of them.

Our project, Lib2Life, adds innovative components to classical books and libraries by bringing together multi-user virtual environments, social interaction, collaboration, gamification elements and mixed reality – a mix which can revolutionize the future of reading.

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