Insights from the Technology System Method for the Development Architecture of e-Textbooks

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Abstract—**Textbook market is considered to be the next wave of digital-reading. However, the textbooks have their own learning purposes, user habits and applications. Whether the development of electronic textbooks (e-Textbook) may continue the current path of development of e-book technology is of concern in this stud. Besides, from the experiences of e-book development, we aim to build the next wave of e-textbook system architecture. This study analyzes key milestones in the e-book history to explore the success of Amazon Kindle and its characteristics. Through the concept of technology systems proposed by Thomas P. Hughes, we elaborate a framework for the development of e-Textbooks.**

Keywords - e-Textbooks; Development Architecture; Technology System

I. INTRODUCTION

In 2007, Amazon launched Kindle e-book reader with its online sales mechanism, digital reading technology and hardware [1,2]. It triggers the development of e-books and digital reading of the trend in global. The market research firm, In-Stat, forecasts, the global e-book device shipments in 2008 was about one million units and will be nearly thirty million units in 2013. The revenue is more than 1.1 billion U.S. dollars [3]. The largest user groups--textbooks, will become the next market of e-book. The research institution, Forrester, estimates that the textbook will be the largest market for e-book reader in five years [4].

However, there are specific attributes of textbooks: learning purposes, user habits and application developments. We concern about how to build the next generation of e-textbooks system based on current technology.

The remainder of this paper is organized as follows. Section II reviews the literature related to key development of e-books. Section III describes analytical framework of e-book development and surveys the characteristics of Amazon Kindle. Section IV introduces the concepts of technology system, then we analysis Amazon kindle's functions and services based on Hughes's view of technology system. In Section V, we propose our framework of e-Textbooks through the technology system. The conclusion and future suggestion are offered in Section VI.

II. LITERATURE REVIEW

The development of e-books has been already 42 years since Alan Kay proposed the concept of Dynabook [5,6,7] e-books in 1968. Because of exertion from different concepts, methods and technology by academia, industry and government, e-books presents rich and diverse definitions and appearance [8,9,10]. E-books can be denoted as digitized books, online databases, CDROM or portable storage media content, browse information on portable hardware device or the digital content. Therefore the orientation of e-books could be digital content (content), integrated device (composer), vehicle (container), access interface (channel), or mechanism (consultant) [7]. Because of different definitions, positioning and technological, e-books have been confined in small minority groups or different areas in the past decades [11].

Because Amazon launched Kindle e-book reader with its online sales mechanism in 2007, e-books and digital reading reached a new situation. The electronics giant Sony restarted its e-book development: promoting new e-book products and following e-PUB specifications [12]. At the same time, Barnes and Noble launched its own brand of e-book reader Nook in 2009. E-reader has successfully established the

concept of digital reading. It is an inevitable trend that the electronic textbook – combined of learning and textbooks will be the next largest market for e-book readers..

III. ANALYTICAL FRAMEWORK OF E-BOOKS DEVELOPMENT

Textbooks are basically paper books. They seem easy to follow the development of e-books flourish. In order to understand whether e-Textbooks can follow the same trend, we review several representative electronic keys to the development process.

In 1945, Bush proposed Memex concept of a working table installed in the microfilm equipment and readers to provide people to unrestrained and easily collect, view and search information [7,13]. In 1968, Allen Kay, working with PARC, proposed the concept of personal portable notebook – Dynabook. Dynabook is like a book, it can carry possessed interaction and run teaching software and reading materials, which is designed by Smalltalk [14]. Smalltalk is an object-oriented programming language. It concretely presents the prototype of today's electronic platform, Dynabook is considered to be the beginning of a portable e-book [5,6,7]. In 1971, Hart noted the concept of digital books have great impact on exchange of knowledge [15]. He began to promote the Gutenberg project. Some books do not advocate copyright, especially classical literature, religious books and references to books. They were scanned as image files by volunteers and then compiled manually enter the nuclear school e-book text file, via the Internet access methods for free [7,16]. In 1976, one project of Oxford University – Oxford Text Archive, planned to provide students to download electronic textbook files to speed up the exchange of knowledge and preservation [7,17]. In 1985, Egan's project SuperBook, developed new software for running in

PC. The software can be stored on disk, tape and CD [7,18]. From 1998 to 2003, NuvoMedia release commercial products -- Rock eBook based on the concept of Dynabook [7,19]. Users could import digital data (special format) into Rock eBook for reading. In the mean time, there were products provided by other companies whose size is similar to books. Those products could download authorized files provided by company's web site through built-in modem or via adapter on PC. Because many readers reflected that it is tired for readers to read on the LCD display for a long time [20], a new technology – to display a screen similar to the paper was developed in the 1970s. It made e-book employed by e-ink being popular [20]. On March 2004, Sony released the first e-ink reader, Sony LIBRIé. At the end of 2007, Amazon launched Kindle [20].

The main e-book technology milestones of e-books are: Content (information), Composer (software necessary to create an e-book), Container (the distribution medium and / or file format), Storage, and Access (the technology and software used to provide access to the content).

We can generalize them into four parts: Digital content, Carrier, Storage, and Access, as depicted in Figure 1. We analysis the milestones of the development of eBook on Figure 2.
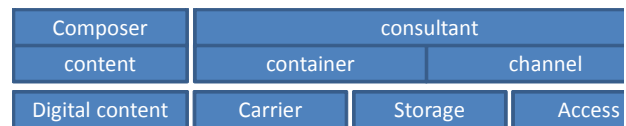
Composer	consultant	
content	container	channel
Digital content	Carrier	Storage	Access

Figure 1. Inducted dimensions of e-books technology development

	Digital content		Carrier	Storage	Access
Bush(1945) -Memex	Scan Books, Record	Microfilm Tech.		microfilm	
Kay(1968) -Dynabook	Teaching Materials	SmallTalk	Programming instruction	Portable Computer	
Hart(1971) - Gutenberg	Free books	Scan; Keyin		Network Site / Deposits	Web
1976 Oxford Text Archive	Textbooks	Text Encoding Initiative		Network Site / Deposits	Web
Egan(1985) -Superbook	Books; Document; Hypertext	Automate Document Processing		PC Software / CD-ROM,tape, disk	Browser
1998 Rocket eBook	Books; Multimedia	Private Software		Hand Hold Device - Rocket eBook / Memory	Download, USB Connected
2004 Sony LIBRIé	Books; Multimedia; Music	Private Software		e-Ink: Hand Hold Device / Memory	Download, USB Connected
2007 Kindle	Books; Multimedia; Music	Private/ public Software		e-Ink: Hand Hold Device / Network Deposits / Memory	Download, USB Connected

Figure 2. Development of e-Books

From the above analysis in the two figures, we can not find out the reasons why Amazon Kindle was sold more than Sony LIBRIé [21]. There should be other dimensions not having been yet evaluated.

IV. CONCEPTS OF TECHNOLOGY SYSTEM

The definitions of e-books vary in academic researches. As stated above, e-books can be digitized books, online databases, CDROM or portable storage media content, browse information on portable hardware device, or just digital content. Different definitions of the e-books and different cognition on Kindle's e-books product, much like Edison invented the light. The invention of the light acted as a representative of electricity in the era. Because impact of bring light to human, we took it as a key innovation-- effects in civilization. Because of the success of Amazon Kindle's digital reader, we took e-books as an ideal framework. We usually inference framework of e-Textbooks based on e-book. In this viewpoint, there is expected to be a single technological achievements and will made many R & D (research and development) staffs worked tirelessly to find a breakthrough innovation.

However, in 1989, Thomas P. Hughes [22] changed the view of invention for the light is the key to the development of civilization of view of electricity. Hughes studied the history of electrification in U.S. and proposed the concept of System Theory of Technology.

Based on Hughes's study, Edison not only invented the high-impedance filament technology but built up a concept-- holistic conceptualization theory to consider large electrical equipment, transmission and distribution lines which did not exist at that time. Edison thought about technology of electric light bulb, systems cost of planning and installation. It made overall social atmosphere, with the government system to implement this innovative technology ideas. The team of Edison deliberately calculated the cost of scientific knowledge and experimental point of view the overall planning considerations, combined with inventors, engineers, management, finance, public relations professionals in different roles, completed with electric lighting system is one big target. Therefore the social, economic and technical can create a comprehensive system to replace gas lighting lamp lighting system, and thus contributed to the electrification of the United States. The concept of systems for innovation and technological development are of great inspiration, innovation and technology development can come from broader perspective thinking and planning thus better ensure the success of technological innovation.

Based on Hughes's technical system concept, the development of science and technology is not just technology, but also considers the management level and financial level of planning, which is very similar to the idea of John Law: 'The argument is that those who build artifacts do not concern themselves with artifacts alone, but must also consider the way in which the artifacts relate to social, economic, political, and scientific factors. All of these factors are interrelated, and all are potentially malleable [22; p112].

There are three dimensions in Thomas P. Hughes's technology system concept: 1. Inventor Entrepreneur, 2. Manager Entrepreneur, and 3. Financier Entrepreneur. But Hughes's study was based on the division of people. This paper considers John Law's claim and tries to add the fourth dimension of e-books technology development on Hughes's three concepts: technical, managerial and financial areas. In this way, we analyze the design, planning and systems architecture of Amazon Kindle. In order we can find out the reasons of its critical role in e-books.

We got following data from Amazon Kindle's web site as well as classified technology functions and services. We analysis them based on Hughes's view of technology system. The result is shown in Figure 3. Except the analysis of technology, we add two levels of management and financial, we can see clearly Amazon Kindle also provided a lot of functions and services in management and finance. Thus when we talk about development of e-books, in addition to focusing on technology for handheld devices, we should not neglect the technology-related management systems and financial supporting planning. Since a single light bulb could not be effective without a reasonable price, electricity transmission and distribution lines. Thus the following policies made by Amazon Kindle in leading position: to U.S. 9.9 dollars for digital-book, provide network management stacks, file conversion service, convenience and access to services of books, etc. The introduction of technical systems makes us gain more insights, thus we can have a clearer understanding on the Amazon Kindle's success.

V. BUSINESS SYSTEM ARCHITECTURE OF E-TEXTBOOKS UNDER TECHNOLOGY SYSTEM

Technology system provides a clear framework for understanding of technical functions. Therefore, we try to view through the technology system when thinking about e-Textbooks [19].

First of all, we believe that the development of electronic textbooks should start from digital publishing and then technology of teaching and learning activities, such as notes, priorities, study records, etc. For functions of the rapid response learning [23] and Internet, we consider the Mobile Internet Device (MID). We emphasize functions of management and financial from the view points of technical systems. For teaching, we suggest function of main control, synchronization and group functions. It enables the teacher's group students in MID devices to display teaching materials through the master control and synchronization.
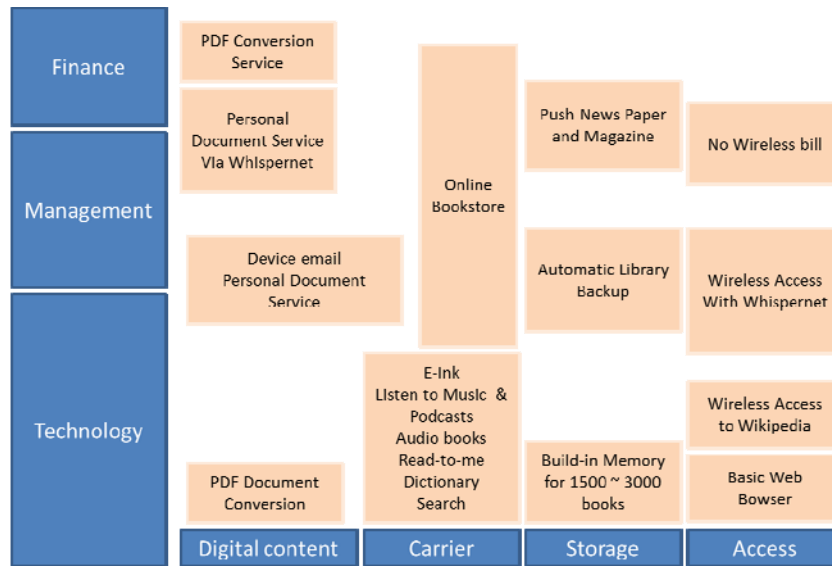
Figure 3. Technology System analysis of Amazon Kindle System function

Thus, it should provide function of cloud bookshelf; data was kept in the network and synchronized to the programmed group terminals. By the way, function of courses management is needed. For financial level, in addition to Amazon's online sales management, Push Service, the discount of purchase of electronic textbooks and teaching materials on electronic textbooks is also very important. Reading milestone certification, the cloud stacks of authorizing, printing on Demand (POD) and the authorization certificate-- students can legally print chapters, photocopying manufacturers and textbook publishers can share the profits. Therefore, the need for sales on the chapter, POD printing the profit sharing mechanism and bonus points for the readers of financial functions. Figure 4 shows the viewpoints of technology system of textbook business structure.

VI.   CONCLUSIONS AND FUTURE SUGGESTIONS

This study is a government e-learning development plan application under the e-books reader technology and the electronic learning plan of the bookcase. Through the concept of technology system, we can have better insights for the holistic perspective. Not only the original e-books reader attached to a particular technology R&D team, but thinking beyond the technology development and broader way of regarding as a single point. Therefore, we can complete construction of those concepts in a holistic way.

Under the holistic conceptualization point of view, we think the future operations of the mechanisms of electronic textbook. From the technology needed to start learning technology, and gradually incorporated into management capabilities and financial technology capabilities, we develop Figure 4, the electronic textbook of rich business framework. After successfully complete the project. We try to propose a framework of electronic textbooks from technology system concept and rendering systems and applications of bookcase.

The impacts of this framework are two-fold. One is that there is always a first-mover advantage for this framework. We mean the first players involved in this framework will benefit as well as establish a firm basis. The other is the negative impacts of e-Textbook will be the issues worth further studies. From the preliminary experiences we met, there are quite different roles and functions in the classroom owing to the engagement of e-Textbooks.

Thus the original innovation-- brainstorming, while in the agitation, has been thinking of positioning the direction of rich/ innovative content and speed up the process of innovation. The concept of systems analysis, help us to understand the proposition Law-- a successful R&D is not simply a matter of developing technology, but uses a broader and comprehensive perspective of thinking and planning, to ensure the success of technological innovation.
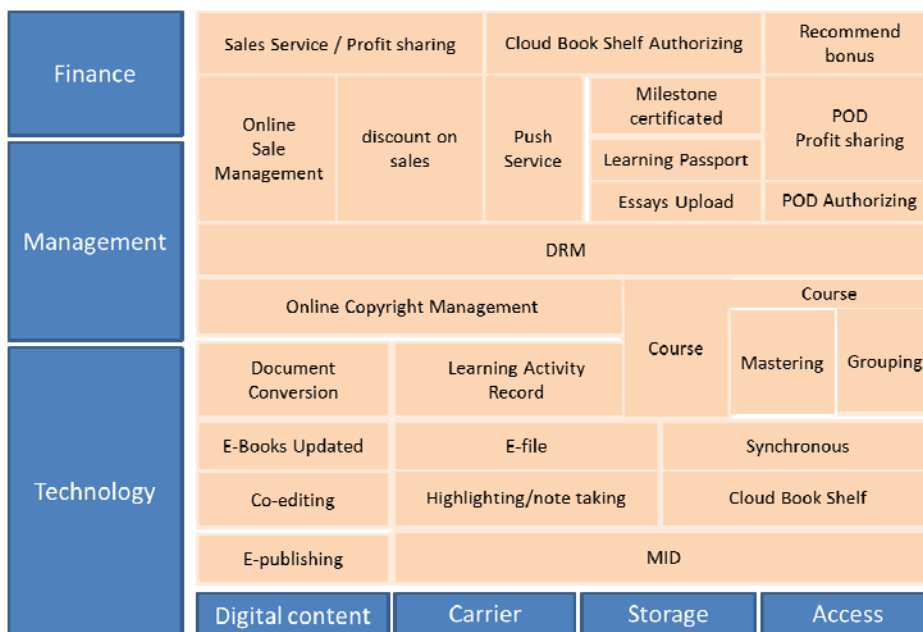
Figure 4. The framework of electronic books from technology system perspective

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