

ISAAC, THE MOUNTAIN & THE MOON
BLENDED MATERIALITY: DESIGNING A HYBRID PICTURE-BOOK

by

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ABSTRACT

Innovations in tangible interaction, computer vision and emerging trends in digital reading offer novel opportunities in integrating physical and digital graphic storytelling. Research findings identified design and market opportunities in hybrid publications with blended materiality, that when applied to picture-books, would likely have readers perceiving the hybrid whole as more valuable than the sum of its parts. These findings informed the design of *Isaac, The Mountain and The Moon*, a hybrid physical-digital picture-book that maintains a singular story-world across media, while allowing affordances specific to each. The book's design acts as a model that integrates considerate enhancements and affordances of both physical and digital objects; explores strategies that further engage reader communities in digital craft and social editions; encourages learning, curiosity and new media literacy through storytelling and the interactive experience. Presented are the motivations for the book, an elaboration of its design and future evaluation.

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INTRODUCTION

To satisfy the inner needs of a child.

The growing consumption of traditional print media on digital displays has presented the publishing industry with a significant challenge. Readers continue to seek out both physical and digital properties, each for seemingly exclusive qualities and perceived values. Nevertheless, the increasing demand for digital content creates many novel opportunities for writers, publishers and designers [Goldsteijn, 2012; Madej, 2003; Marcial, 2014; Masataka, 2014; Meyers et al., 2014]. I directed my research and design exploration to better understand and evaluate these opportunities as they would pertain in general, to contemporary reading and graphic narratives, and in particular to the development of a modern picture-book.

Printed books have long been among some of the most cherished physical objects, loaded with sensate qualities and interactive affordances appreciated by children and grown-ups alike. Digital books emerged as digital media adapted from print material, followed by the development of digital hardware and software to better accommodate the format, culminating in apps that evoke active participation from the reader [Madej, 2003]. This forged new behaviours, beliefs, and attitudes toward reading and books [Madej, 2003]. Research on all facets of the evolution from print, to digital to hybrid blended materials should provide crucial insight in evaluating the ongoing synthesis of physical/digital picture-books, and provide the basis for making valid predictions about their future. For example, research suggests that even though

digital reading at large is growing, people still report that they prefer physical books [Booknet Canada, 2014]. This is not surprising, when so often picture-books adapted as digital editions, see many of the cherished qualities of the native medium diminished and affordances for which the new medium is best suited ignored. [Meyers, 2014]

This lead me to explore the opportunities in integrating a physical picture book with a digital picture-book app or e-book, where the two come together to enhance the picture-book reading experience. It has been reported that as the perceived distinction between physical and digital objects in general begins to fade, the attempt to design cherished digital objects will improve through continued research and exploration that transcends discrete formats towards the realm of blended materiality [Golsteijn, 2012]. Research into the real and perceived benefits and shortcomings of the two media helped uncover opportunities and recommendations in developing systems that meaningfully integrate physical and digital books and guided me in the development of such a system for a story driven picture-book.

RESEARCH OBJECTIVES:

- Detail market and consumer trends in digital reading;
- How do physical and digital books differ, in content, technology and perceived values?
- Discover successful (commercial and critical) examples of physical, digital and blended properties and the technologies used;

- Explore technological innovations that could offer further opportunities in blending physical / digital graphic properties. (i.e., computer vision software, guided-view, hyper-modality, motion-books, tangible and embedded interactive.)

DESIGN OBJECTIVES:

- Tackle new problems in the publication and consumption of both physical and digital graphic narratives (in particular picture-books, comic books and graphic novels) with confidence and openness to contemporary artistic and technological directions;
- Design a graphic narrative property as proof-of-concept with affordances best suited to both physical and digital media;
- Develop a strategy for the application of tangible and embedded interactive technologies in the dissemination and consumption of hybrid physical-digital graphic narratives;
- Develop a strategy to apply the data collected and analyzed from readers, allowing contributions for on-going social editions.

The research findings are informing the design of a hybrid picture-book, entitled *Isaac, The Mountain & The Moon* that I am currently writing and illustrating. It aims to provide a rewarding narrative and ongoing experience that engages the reader in abstract, counter-intuitive, yet observable natural phenomena so as to make them more intuitive and familiar when encountered later in life, i.e.: physical motion laws, gravity, mass displacement, etc. The system includes a physical edition that maintains all the cherished characteristics of traditional picture-

books, a digital edition with considerate interactive enhancements, and through the use of tangible technologies that link and expand the two media through physical gestures and computer vision software, a hybrid experience across both media.

The hybrid edition is being designed to leverage advancements in computer vision augmented reality software for hand-held devices. I am currently designing the book to work with a consumer tablet enabled computer vision system that would enable the bridging of the two media, by allowing the pages of the book to act as a tangible user interface that drives specific digital content on the connected device, further contextualizing the story and concepts, and providing feedback during reading.

The intention is that the most entertaining and thoughtful experiences will occur when interacting with the hybrid edition of *Isaac, The Mountain & The Moon*. The broader the engagement the more likely the experience will garner deeper media literacy [Antle, 2009; Yokota, J., & Teale, W. H., 2014]. Nevertheless, the research findings are informing the design of a picture-book that is captivating and meaningful as much as a stand-alone physical book as a digital application, regardless of the depth the reader, their family and community engage the various editions.

RELATED WORKS

There are countless examples that engage kids from simply touching the page to pulling tabs, opening flaps and peeping through holes. An ever growing number of ebooks, apps and touch-screen devices have the latest generation of kids tapping, swiping, and singing along as well. Examples of hybrid physical-digital books are not yet as ubiquitous, a few projects of note like Kelaidis' *Blink* [Kelaidis, 2010] Fitzroy's *The Next Ten* [Fitzroy, 2012], Węgrzyn's *Electrobiblioteka* [Węgrzyn, 2012], and Sutur's *Modern Polaxis* [Sutu, 2015] take direction from traditional physical interactions and have enhanced experiences taking the affordances of both print and ebooks beyond Melville House's QR driven *Hybrid Books* [Melville House, 2011].

Projects like Fuji's *FingerLink* [Fujitsu, 2013], and Heibeck, Hope, and Legault's *Sensory Fiction Project* [Heibeck et al., 2013] have attempted to integrate wearables and the coordination of a system that includes cameras, projectors and the real world. Some salient design problems relating to computer vision and storytelling were explored in Samanci, Chen and Mazalek's *Tangible Comics* [Samanci et al., 2007], which used the technology to generate a storytelling environment and graphic narrative generator (2007).

RESEARCH

This report on the research begins with an overview of the current marketplace and survey of recent trends in the sale, production and use of digital books in Canada, and the United States whenever data was sparse for Canada. Context on children's digital book reading and trends in devices being used in digital reading are examined. Research on the differences between digital and print experiences, how each may contribute to traditional and digital media literacy, story comprehension, and entertainment are covered. As is reader preferences and consumers' perceived value in both print and digital books, and a survey of common features and unique affordances of each. Finally, relevant information for authors, producers and marketers of digital books regarding ethical considerations, likely developments and tactics for marketing is examined.

MARKETPLACE & TRENDS

Though hardware and software developments in computer-based reading happened throughout the twentieth century, digital books as we know them become mainstream in the twenty-first century [Madej, 2003]. Digital reading now occurs most frequently on multi-purpose, colour- and touch-screen devices (e.g., iPad, Kindle Fire and Kobo Arc.)

These devices brought about an increase in digital book purchases and number of people having

read a book in a digital format. This growth peaked from 2010 until 2012, when purchases of digital books seems to have leveled off, and currently the population that reads digital books continues to increase but at a slower rate than previously reported [BookNet Canada, 2013c].

In 2012, the total value of the Canadian print book market was \$973.9 million with a volume of 54.7 million books sold [BookNet Canada, 2013c]. BookNet Canada (2013c) reported that 15% of books sold in 2012 were digital books. In 2012, the overall book market including digital books had an approximate volume of \$64.4Million and a value of around \$1Billion [BookNet Canada, 2013c]. This represents a decline of 4.9% in value and 6.6% in volume from the previous year [BookNet Canada, 2013c]. In 2013, this decline continued, with print unit sales at 52.8Million, a 3.41% drop from 2012 [BookNet Canada, 2014, Wischenbart, 2014].

To date, 2009-2012 was the strongest growth period for digital books. During 2012, an average of 15% of books purchased in Canada were in the digital format (9.7Million units), with an average price of \$11.83 (not including free downloads), or an overall value of nearly \$68Million [BookNet Canada, 2013b; 2013c]. Over the course of 2012, the percentage of books purchased in digital format fell from nearly 18% down to 13%, before bouncing back and stabilizing at 17% in 2013 [BookNet Canada, 2014].

The reading of digital books though widespread across North America, is not yet universally adopted. Even though digital books' market-share growth has seemed to plateau, the percentage and frequency of digital book reading continues to steadily grow [Marcial, 2014].

According to BookNet Canada in 2013, 88% of Canadians read a book. Of these, 93% read a print book, 58% read a digital book, and 27% listened to an audiobook [Genner, 2014]. The percentage that read digital books at least several times per week has increased from around 10% to nearly 15% [Genner, 2014b]. A 2013 survey reports more than half of children aged 2-13 in the US read or are read digital books by their parents or caregivers. Eighty-five per cent of children who read digital books do so at least once a week and that pre-schoolers and early elementary school children are the biggest readers [Shuler, 2013].

Small, medium and large publishers and distributors of books in Canada believe they are responding to the demand for digital books. Fifty percent report to have more than half of their available titles available in digital format, and nearly 20% of respondents reported having all titles available in digital format [BookNet Canada, 2014]. Ninety percent of the publishers were already producing digital books, with the remaining 10% planning on publishing digital books soon [BookNet Canada, 2014]. However, fewer backlisted titles (books published more than six months ago) were being transferred to digital format [BookNet Canada, 2014].

CONTEXT & DEVICES FOR DIGITAL READING

The Apple iPad, Amazon Kindle, Kobo Reader, and multitouch smartphones have radically changed the way people consume text [Chiong, Ree, Takeuchi & Erickson, 2012]. With an ever expanding array of options for people of different ages able to read books in different places, (some where traditional print would be impractical) committing different amounts of time to the task of reading, accessing different applications, devices and displays, not to mention the different types of books—interrelations between all these variable is increasing difficult to determine [Marcial, 2014].

The context of children's reading and early literacy development in particular continues to change dramatically as many kids use these devices to engage with book-apps, enhanced e-books and other emerging textual-graphic applications at home, school, and the library [al-Yaqout, 2011; Bird, 2011; Druin, 2009]. Not surprisingly, Shuler (2013) found that children aged of 2-5 years, 6-9 years, and 10-13 years have a different frequency of digital reading. However, to meaningfully interpret this data, it is crucial to recognize that these groups use different devices (often related to level of digital media literacy) and read in different contexts, such as home, school and library. Therefore, the age-related frequency of reading may be partially a function of the accessibility of certain devices, which is in turn a function of the context in which the reading occurs [Marcial, 2014].

Kids are doing most of their digital reading at home. A US survey reports twice as many kids aged 2-13 read digital books in the home than in school—most likely a reflection of the limited availability of devices for digital reading in schools [Shuler, 2013]. As of 2013, devices used for digital reading in schools are as likely to be purchased by parents as by the school [Shuler, 2013]. This could change dramatically if school boards decide to purchase larger numbers of devices capable of supporting digital reading, or if current restrictive policies on in-school devices shift towards a *bring-your-own-device* (BYOD) approach that has been adopted in some school districts in the United States. [Marcial, 2014]

BookNet Canada (2012) reports that while specialized e-readers have been, and continue to be, the most common devices used for digital reading, this is likely changing. Millar's (2014) study reports that 56% of Canadian readers prefer using a specialized e-reader, as opposed to a tablet, mobile device, desktop, or other device. Nevertheless, that same report suggests an increasing percentage of digital readers are using smartphones and tablets for digital reading, with nearly 30% of Canadian book purchasers using smartphones in 2013. Another report found that less than 30% of consumers plan on purchasing an e-reader in the next 12 months, yet 75% plan on purchasing a smartphone, and 50% plan on purchasing a tablet [Genner, 2014].

With the multi-purpose touch devices offering very similar features as the specialized e-readers, it seems likely that Canadian readers will transition to the use of tablets or smartphones for digital reading. Shuler's (2013) data from the US supports this assumption and reports an increase from 48% to 60% of children's digital reading occurring on tablets. The arrival of the general-purpose Kindle Fire and the Kobo Arc in the marketplace are further indicators of the shift in demand for these devices.

Recent research supports what is clearly obvious—widespread ownership of smartphones and tablets has these devices increasingly in the hands of children. Pachovski (2013) suggests that this is due to parents' desire to develop important future skills in digital literacy for their kids and is connected to their own perceived limitations in technological literacy.

VALUED CONTENT

When designing and marketing books at this time it is important to consider the advantages reading both print and digital media possess. Digital books present a challenge for a consumer segment accustomed to the benefits of print books and the free and ready availability of information on the Internet, as well as to a publishing industry organized around the copyright and sale of print books [Marcial, 2014]. Conversely, the unique affordances of print need not be

completely abandoned. Research has shown that kids can learn from both types of media when comparing literacy and learning outcomes after repeated reading of either print or digital books.

Certain digital books have been seen to produce learning gains significantly below those in comparable print books, while other digital books produce learning gains that match or exceed those from print books.

The most relevant aspect of digital books with regard to learning appears to be the presence and nature of interactive enhancements such as clickable interactive experiences, voice-over text accompaniment or dictionaries [Roslund, 2012]. These interactive enhancements seem to play an integral role in shaping both the educational and entertainment potential of digital books, in positive or negative ways.

A Pew Research initiative (2013) recently published a survey that found that the American teenagers who read e-books had increased from 16 to 23% between 2012 and 2013, but that American adults that read both digital and print, prefer sharing and reading books with children regard printed books as the better option. According to Rideout et al. (2013) people who read only through the use of digital devices, were also three times less likely to report that they enjoy reading very much.

ADVANTAGES OF PRINT BOOKS

Though frequently overlooked by the general public, print books possess many advantages over digital books [Bohn, 2012]. The likes of which are not limited to, spatial layout; no need for power; standardized pagination system; note taking by direct interaction—pen, highlighter; can last thousands of years; and easily sharing. Of course, kids books and picture books in particular, are objects that frequently contain the majority of these affordances.

When choosing or purchasing books, kids are heavily influenced by features that adults generally consider superficial: shape, size, the cover, colour, title, pictures, etc., [Columbo et al., 2012]. These features are immediately available for exploration in print books, whereas on digital platforms they are less accessible or invariable. Digital books tend to have a homogeneous outward appearance, being displayed as icons on a screen and the objects themselves usually adhere to the device and display being used. This is just one example of how the adaptation and translation from the print edition to the digital witnesses a diminishment in native qualities and affordances. The homogeneity in the way these titles are presented in retail spaces like the Apple App Store also limit the original plasticity and tactile qualities that are defining properties of the original medium that blended materiality in picture-books stands to reintroduce.

Interactivity has been a key feature in many physical children's books, engaging and entertaining kids for centuries [Madej, 2003]. Picture-books are the most abundant examples, evoking interaction in different ways, with different effects, including: pop-up, open-the-flap, and peep-through-the-hole features that give children the opportunity to play and learn and gain the impression of exerting some control over their experience [Lewis, 2001]. At times these actions are incidental and don't affect the story; but in many others, interactivity is integral to moving the story forward [Madej, 2003].

ENHANCEMENT OF DIGITAL BOOKS

As interactivity is a staple in print picture books, it comes as no surprise that interactive developments in electronic picture-books figure prominently [Bird, 2011]. Digital interactive stories made their first appearance as browser based websites with incidental interactive opportunities that rarely pertained to the narrative. At the time, the most advanced application of interactivity in the digital environment for kids was in video games [Madej, 2003].

The emergence of "book apps" and enhanced e-books for kids proved important in the way young children engage with books and narrative. Enhanced e-books are digital books that incorporate additional design affordances that complement in unique ways traditional book features, in the case of picture-books, typography and illustrations, enhanced with audio,

animation, and interactive experiences [Bird, 2011]. These new features engage kids in novel ways with the potential to fundamentally change the role of the reader, the reading process, and psychological approaches to reading [Felvegi & Matthew, 2012; Masataka, 2014], and have been found to attract kids that might not otherwise choose to read. These enhancements offer many opportunities for digital books to distinguish themselves, positively or negatively, as it has been reported that they may also distract young minds and detract from their narrative comprehension of the text [Meyers, 2014].

“CONSIDERATE” & “INCONSIDERATE” ENHANCEMENTS

There is a distinction between “considerate” and “inconsiderate” digital book enhancements [Roslund, 2012]. “Considerate” enhancements are interactive features that deepen the readers’ engagement with the narrative, such as the highlighting of text in time with a voice-over recording, or clickable characters that when tapped offer a perspective about the events of the story. “Inconsiderate” enhancements are interactive features that have little relation to the narrative and tend to distract children. These include clickable screen elements that emit noises unrelated to the story, or jump away to irrelevant or commercial content.

Itzkovich’s (2012) report on enhanced digital books provides excellent examples of enhanced books that successfully integrate interactive features that constructively expand the

reading experience. The report provides several examples salient to my MRP prototype, describing the successful leveraging of the unique affordances of multi-touch screens to provide a context in which young readers can interact with complex scientific concepts. Though these examples may more closely resemble an app than a traditional book—they provide key insight into the potential of hybrid print-digital editions and the opportunity to address counterintuitive concepts.

There have been several studies that indicate that “inconsiderate” enhancements are associated with lower comprehension in children [Chiong, Ree, Takeuchi and Erickson, 2012; Dalla Longa & Mich, 2013; Schugar et al., 2013]. However, it is worth considering that not producing gains in comprehension any better than print is of little consequence in the case of children who would not be reading in the first place, if it weren’t for the greater engagement that e-books promise.

DIGITAL BOOKS, LITERACIES & MULTIMODALITY

The potential for digital books contributing to the development of literacy skills is apparent. Avoiding the distracting potential of ‘inconsiderate’ enhancements through design, there is no reason a digital reading experience shouldn’t provide the comprehension-enhancing benefits of traditional reading [Masataka, 2014]. In addition, e-books can play a greater role than

traditional books in developing textual decoding skills. Mindful design and integration of ‘considerate’ enhancements may augment the traditional reading experience—drawing children to focus on the printed words, supporting decoding of text and further meaning, all the while supporting the development of digital media literacies [Chiong et al., 2012; De Jong et al., 2002].

It is also crucial to consider the qualities of target readers. McNulty et al., (2012) published findings on the effects of certain features may not be valid as a result of certain readers’ lack of expertise, experience, and their orientation towards digital media. Common sense suggest that the features cannot be effective, if the user doesn’t know how to use them. Following this logic, digital and hybrid editions have the opportunity to provide interactive instruction in real-time to readers and should figure more prominently in the design of these publications.

Korat & Shamir (2008) have provided a limited list of common enhancements that exemplify ‘considerate’ enhancements shown to improve literacy, comprehension and engagement:

- optional professional voice-recorded narration programmed so that it plays from the speaker of the digital device, while highlighting the text that corresponds exactly to that being pronounced by the narrator;
- a dictionary option, with optional audio pronunciation reference;
- interactive activations that are congruent with the story;

- appropriate written register (e.g., developmentally appropriate lexicon);
- simple and precise instructions.

Meyers (2014) examined ebooks and apps that possess enhancements that push the limits of the multimodal nature of digital picture books. It is apparent that many of the most popular ebooks and apps though allowing an enriching environment for children to explore many features of digital media with more freedom, these editions distance themselves quite substantially from the concept of a book, hybridizing with other forms of digital media. Meyers (2014) also points out that many of these apps, though quite successful in hybridizing the story with various digital media, often begin to resemble less the textual book experience and more an animated film.

CONSUMER PREFERENCES

Amongst all consumers in Canada and the United States no strong consensus in preference has been revealed between print and digital books. However, there may be some new trends developing in certain segments of readers. BookNet Canada (2013) published a report showing that of the 27% of teens who read digital books, 37% prefer print, 29% prefer digital, and 34% show no preference. This suggests teens are nearly evenly split in their interest of digital offerings [Booknet Canada, 2013b]. From fall 2012 to spring 2013, the percentage of

teens reporting a strong preference for print has dropped dramatically [Nowell & Henry, 2014]. This sentiment is not present with the caregiver segment, who would be choosing reading material for their children. Most iPad owners who read digital books still report a preference in reading print books to their children [Vaala & Takeuchi, 2012].

In the US, Shuler (2013) reports that among parents who read digital books to their kids, 85% believe print books are important. The digital book may be exciting and more enjoyable for young readers, but caregiver consumers may still resist due to the fact that certain digital books, specifically those with “inconsiderate” features, are associated with lower degrees of narrative comprehension than print books, which may prevent readers from enjoying the book outright [Chiong, Ree, Takeuchi & Erickson, 2012; Jones & Brown, 2011].

As with most digital media, online reviews and recommendations prove critical in informing consumer choices [Bird, 2011]. Reviewer specific values and the variety of needs between parents, teachers and librarians, make for vastly different impressions on what makes a good ebook or app. An evaluation of review sources confirms that the variability in reviews can lead to confusion: many sources focus on the digital features, others strictly on literary quality—an e-book with excellent reviews for its literary merits in a professional review can be panned by parents if the app does not keep their kids engaged [Meyer. 2014].

Links to unrestricted social networks, like Facebook and Twitter, and links that may lead to websites inappropriate for children to access leave parents and teachers with lingering concerns over safety and privacy [Aram & Aviram, 2009, Vaala & Takeuchi, 2012]. Meyers et al., (2014) reports that some developers limit this risk by creating barriers for children to access by presenting paratext like credits, and links to social media or to other apps in sections labelled “For Grown-ups,” which can only be accessed after following guidelines presented in written text, virtually blocking it from young children not yet able to read.

BLENDING MATERIAL

Several studies have shown that people have more difficulty identifying cherish-able digital objects, than similarly cherished physical objects—which may contribute to people attributing greater value to printed books than digital books [Golsteijn et al., 2012]. However, Jung et al., (2011) describe how the physical and digital are becoming less discreet as more technological objects consist of “blended materiality.” Golsteijn et al., (2012) recognize growing and lucrative design opportunities for cherish-able digital objects that successfully integrate both media. They also suggest important issues for designers and developers of future products and systems to consider:

“extrapolation of the advantages of the physical to the digital, such as supporting digital uniqueness and gift-giving; the exploitation of reasons for cherishing digital objects, such as supporting digital craft; and the development of meaningful integrations of physical

and digital, such as employing physical interaction, uniqueness or craft as a means to make the physical more than merely a carrier for digital objects, and supporting the visibility of digital objects in the everyday landscape of the home; support meaningful use of digital objects, e.g. for reminiscence and storytelling; and encourage engagement in active selection of meaningful media to keep and use.” (p. 8)

FUTURE DIGITAL BOOK DESIGN

The use of digital books has increased dramatically over the last five years, in terms of both raw numbers, and as a per cent share of the overall book market [Booknet Canada, 2013c]. During this same period, as the print market as a whole has contracted and since 2013, the growth in market share of digital book has slowed down [BookNet Canada, 2013c; BookNet Canada, 2014]. It seems likely the market place is ready for a third category of the reading experience is emerging that successfully integrates the best characteristics of both physical and digital media [Marcial, 2014].

Attributed with coining the term “affordance,” Gibson (1977) states that the use of everyday objects is transmitted through their aesthetic appearance, function and potential action [Gibson, 1977]. Affordances require relationship with the user and object, and are not implemented in a strictly formal way—providing an affordance does not always guarantee

desired outcomes or application by the user [Hutchby 2001; Gaver, 1991]. This is of particular interest to the picture-book experience, where children will likely interact and use the available affordances in unique and novel ways, based on their capabilities and level of literacy.

There is evidence that interactive affordances are becoming increasingly common. Regardless if they are “considerate” or “inconsiderate,” it remains unclear whether they will prove profitable for publishers. BookNet Canada (2014) reports that although only 19% of surveyed publishers are currently producing enhanced digital books, 13% are planning to produce them in the near future, and 32% are investigating the possibility of beginning production. The most popular ways of enhancing digital books included audio (87%), video (73%), scripted animation (33%), interactive images (27%), slideshows (20%) and other/non-specified (13%). Seven percent of publishers responded that enhancements had produced a positive impact on sales. Most reported only a slight impact (33%), no impact (40%), or that they were unsure (20%) (BookNet Canada, 2014).

However, Madej (2003) warns of the susceptibility of advanced digital media publishing and communication to become market-driven to a fault, which could undermine the cultural value of the stories [Madej, 2003]. Incorporating enhancements that solely drive sales or even choosing a topic from one of a series of lessons to be learned will make an initially profitable or educational story, but it won’t likely generate a story that satisfies the spiritual and inner needs of a child or help them understand their place in the world [Madej 2003].

Digital books may also begin to satisfy some learning needs and aspirations of parents. Pachovski (2013) reports that Canadian parents believe tablet and smartphone use is important for their children's development in digital literacy skills, and are crucial for the future. They also see tablets and smartphones as a more enjoyable context for the development of educational and entrepreneurial skills for their kids.

There are already well-established findings regarding the role of print books in recreational and educational practices and the benefits of their use [Chiong et al., 2012, Jones & Brown, 2011; McGee & Morrow, 2005; Moody et al., 2010]. While more research needs to be done to extend these findings to digital books, one thing is clear: the educational benefits, user experience and entertainment value of digital books depends on the design and contents of the digital books in question and how they relate to the broader context of reading.

Children can learn from digital books, but what they learn, the way that they learn, and how much they learn depends on the design of the books they read. With further attention to design, interactive features in digital books might contribute to learning outcomes, story comprehension, engagement and enjoyable entertainment.

DESIGN EXPLORATION

The kids are alright!

Picture-books are often the very first storytelling media one encounters, they are instrumental in helping us comprehend the world around us. They are an invaluable tool that conveys thoughts, ideas, history, lore, practical advice, cautionary tales and vital life lessons — all of which shape our perception and calibrate our sense of ethics and aesthetics.

It is interesting to consider that picture-books are one of the only media purchased most frequently not by their immediate target audience but by their caregivers, who seize the opportunity to impart some of their own preferences and world view [Salisbury & Styles, 2012]. Though appreciated by all, picture-books are more often found in the hands of children. The widespread ownership of smartphones and tablets has these devices also increasingly in the hands of children. Pachovsky (2013) suggests that this is due to parents' desire to develop important future skills in digital literacy for their kids and is connected to their own perceived limitations in technological knowledge and proficiency. One doesn't have to look far to find children engrossed by these devices, due in part to their capability to supporting a variety of different activities—both caregivers and children stand to benefit if these activities foster further development meaning making and both textual and media literacy.

Hardcovers, Tablets & TUIs.

Digital reading is increasingly occurring on general-purpose tablets and smartphones with colour touch screens, creating new opportunities and constraints on how and when reading occurs [Genner, 2014]. Multi-purpose tablets are designed to accommodate an ever growing number of activities—as these devices increasingly become the domain of digital reading, reading will increasingly be influenced by the affordances and characteristics of these devices and naturally lend themselves to interactive, hyper-modal reading experiences [Marcial, 2014].

The iPad is a natural and obvious choice to facilitate blended materiality in picture-books, not only due to its popularity, product support and marketplace, but more importantly its support of computer vision systems like Tangible Play’s Reflective AI system which could be used to bridge the physical and digital editions of *Isaac, The Mountain & The Moon*. The research indicates that children love and learn from both print and digital books and a blended system can maintain the learning and enhance the experience of both media, especially if designed to replace “inconsiderate” and non-essential interactive features with “considerate” features that enhance context and comprehension.

ISAAC, THE MOUNTAIN & THE MOON.

“Doesn’t the Moon also fall?” - Sir Isaac Newton



Image 1: character development and art direction

Kids and their caregivers universally enjoy experiencing picture-books, reading and listening to their narration [Aram & Aviram, 2009]. Through this process children bond with whom they share this experience, experience a variety of emotions, build literacies and communications skills; and advance intellectual capabilities and build lasting appreciation for

text and graphic meaning making [Masataka, 2014; Arnold & Colburn, 2007; McGee & Marrow, 2005]. *Isaac, The Mountain & The Moon* recounts the adventures of a loosely interpreted Sir Isaac Newton as a curious, albeit somewhat lonely child, as he makes insightful discoveries about the physical world, illuminating the relationships between objects, motion and the forces that act upon them. The story aims to encourage learning, curiosity and new media literacy through the content and the interactive experience.

It is my intention to apply first-hand the findings and design recommendations synthesized from the research and review of literature. I have written a first draft of the story that portrays Sir Isaac Newton as a lonely little boy growing up on his grandparents farm. He finds solace and satisfies his curiosity by undertaking several projects that include kite-making, raising small windmills, separating sunlight through a prism and launching a cannonball into orbit. I have also begun developing the artistic direction of the book and have generated a great deal of the layout and artwork that will feature throughout the printed and digital display, which includes a physical edition that supports all the cherished characteristics of traditional picture-books, a digital edition as iOS app with considerate interactive enhancements, and an expanded hybrid experience that uses the printed book as a tangible user interface linking to the digital book through computer vision software. In addition to the design complexity of a picture book as controller/TUI, it is crucial that story comprehension and continuity remain intact across the multiple media.

PHYSICAL AFFORDANCES — THE PRINTED PROTOTYPE



Image 2: The physical printed edition

Most iPad owners who read digital books still report a preference in reading print books to their children [Vaala & Takeuchi, 2012]. Print books possess many advantages over digital books, not limited to, spatial layout; no need for power; standardized pagination system; direct interaction—notes, drawing, tracing; can last thousands of years; and are easily sharable. Of course, picture books in particular, are objects that frequently contain the majority of these affordances and young readers are heavily influenced by physical features like shape, size, colour, title, the cover, etc., [Columbo et al., 2012]. *Isaac, The Mountain & The Moon* is no exception, engaging young readers with these features which are immediately available for exploration in the printed prototype picture-book. Conversely, on digital platforms these features are less accessible or invariable and digital books tend to have a homogeneous outward appearance, being displayed as icons on a screen and the objects themselves usually adhere to the

device and display being used. However, having the physical book act as a tangible user interface might bring about opportunities to minimize these shortcomings. This will be further explored when discussing the hybrid affordances.

Interactivity has been a key feature in children's books, engaging and entertaining kids for centuries—picture-books the most abundant example. The print edition evokes interaction in different ways, for different purposes, including: page-turning, flap-folding, and project-instruction features that give children the opportunity to play and learn as they affect objects in the real-world.

DIGITAL AFFORDANCES — THE DIGITAL PROTOTYPE

The most relevant aspect of digital books with regard to recreational and educational potential appears to be the presence and nature of the interactive enhancements. “Considerate” enhancements [Roslund, 2012] are interactive features that deepen the readers' engagement with the narrative, such as highlighting of text in time with voice-over recording, or clickable characters that offer context about specifics to the story.

The digital edition transmits the same story and graphic elements as the print, but mindful design and integration of “considerate” enhancements augment the traditional reading experience—

drawing kids to focus on the printed words, supporting decoding of text, graphic and conceptual meaning making, all the while supporting the development of digital media literacies.



Image 3. The digital app edition.

In addition, the digital book can play a greater role in developing textual and pictorial decoding skills. Mindful design and integration of “considerate” enhancements may augment the traditional reading experience—drawing children to focus on the printed words, supporting decoding of text, graphic and further meaning. Playable and customizable interactive tasks will provide context and elaboration on more complex concepts all the while supporting the

development of digital media literacies. Superficial interactive features that take the reader away from the narrative or activity are frequently viewed as detrimental to a child's learning experience will be avoided.

Applied Considerate Enhancements:

- optional narration;
- animated read-along text;
- gestural page-turning;
- dictionary option, with audio pronunciation reference;
- interactive content that deepens engagement with story;
- customization;
- hyper-text and links

Platform Features:

- in-app purchases;
- version & edition history and updates;
- access to reader communities;
- personalized recommendations;
- access anywhere

The digital platform will also allow for the culling of user data that will be indexed, analysed and used to inform subsequent digital editions, inform personalized recommendations and growing online reader communities.

HYBRID AFFORDANCES — BLENDED MATERIAL

Research suggests that there are many critical and commercial opportunities for designers and producers of digital objects that can be applied to the systems and thinking of hybrid books in particular [De Jong, 2002; Goldsteijn, 2012; Marcial, 2014]. Successful applications would likely employ physical interaction; enhancing the physical to be more than just a carrier for digital objects—not just a storage container; allowing customization and uniqueness to both physical and digital objects [Goldsteijn, 2012]. Salient examples that have worked towards this in the past and deal with graphic narratives and picture-books are briefly outlined in the Related Works Section of this paper. With this in mind several, several affordances were considered integral to the hybrid component of *Isaac, The Mountain & The Moon*.



Image 4.1: Printed book as TUI.

Applied Blended Enhancements of the Hybrid Experience:

- AR/Machine vision application that *bridges* the digital and physical.
- Expanded content that unlocks when the two editions are synched.
- Networked Spaces that engage readers in physical and online communities.



Image 4.2: The hybrid edition.

Reviewing the contemporary research listed and the examination of current products available in the marketplace lead me to consider several Augmented Reality applications for bridging the two media. In the past, digital books, epubS and picture-book apps have offered objects that substitute their physical counterpart, however AR offers ways to supplement and

integrate the physical with the digital and vice-versa. In the case of *Isaac, The Mountain & The Moon*, the physical picture-book acts as the foundation to which the digital device adds contextual information helping the reader to a deeper understanding and richer experience with Isaac and his adventures. Advancements in machine and computer vision technology has seen a wide range of tangible objects being used to interface with digital media, which has us moving away from the increasingly familiar AR experience that uses the digital display as a window through which we can see virtual objects superimposed onto the physical [Sonka et al., 2014].

With these advancements in mind, I have begun developing story elements and interactive enhancements that blend the physical and digital through the use of computer vision applications that run and display digital content on consumer tablets, and that interface with the printed book through the tablet's built-in camera. Tangible Play's Reflective AI system that is used by the educational game platform OSMO is a great example that implements a sophisticated computer vision software that processes physical human interaction with nearly any object, integrating these actions into the digital enhancements in real-time. It uses reflector that aims the device's camera down onto the surface before it, acting as the playing space for the user. This system or a similar application of this technology would allow the physical book to act as a tangible user interface while the tablet display serves to both contextualize the concepts and provide feedback during reading. The physical book in essence is the controller for the digital display, allowing at times an expanded book space, an interactive gaming experience, or assistance in reading or comprehension. The potential to fabricate a stand that holds the digital

device integrated into the hard-cover edition of the book is still being explored. At the moment the book is intended to lay flat on the floor or table and a separate stand holds the device at a complimentary angle to the book, allowing the reflector to obtain a view of the large surface before it and collect digital images while the book is being engaged. The computer vision algorithms recognize items and objects, integrating them into the digital experience. Turning the page, touching the artwork, even rotating the book gives a physical dimension to the digital information being displayed and manipulated on the device.



*Image 5.1: Reflective AI system reflector.
TUI.*



Image 5.2: Reflective AI system

The intention was always that the book remains meaningful and fun as much as a stand-alone physical book as a digital application. The blending of these materials through a hybrid application like the one described above is not intended to be distracting or used as a gimmick to drive sales, but rather further contextualize the concepts, take advantage of the benefits of

embodied interaction and potentially engage young readers that might not otherwise show an interest. However, research supports my intuitive feeling that the broader the engagement the more likely the experience will garner deeper media literacy [Antle, 2009].

READER COMMUNITY — THE SOCIAL EDITION

A key aspect to the project is fostering reader communities. Since our target users are children, the community has to be accessed, built up and maintained by caregivers (parents, family members, teachers, etc.) It is within these communities that the digital edition provides the channels for integrating feedback from all readers to inform subsequent Social Editions. These Social Editions will be subsequent digital updates that offer content catered specifically to the reader, or broader updates based on analysis of interactions and contact with the book from the reader-community at large. A working prototype will inform the specific opportunities that could be explored within the story world, but some example could include guided crafting projects on topics from the book that readers seem most interested, like building a windmill, or separating sunlight with a prism in order to observe the spectrum.

By creating an interactive design project which connects the digital with the tangible and supplying the user community with a platform to comment and provide continuous feedback, we are able to encourage a social collective for informing future editions.

- Allowing the users to provide comments and collectively share their digital crafts in an online book-club allows a platform for social input that will inform subsequent editions.
- Comments and direct reports from users through blog and comment posts will generate insights that guide future editions.
- Recording, tracking, and analyzing user data from digital and hybrid interactions provide metrics on the following:
 - stand-alone edition or bundled edition.
 - user activity: time spent on page; engagement with narrative or graphic element;
 - accessing expanded content;
 - unique physical book interactions.

Communal spaces such as living-rooms, classrooms and libraries provide for another interactive space and new interactions when multiple copies of the book are present. Digital book authors/publishers may also set themselves apart by facilitating connections to living authors for schools, libraries and readers at large.

- Foster Kids-Lit community on existing popular forums.
- User profiles within the app
 - kids are encouraged to draw their own avatar for their profile
 - feedback and reviews would be provided through a blog style book club
 - users can share their experiences

- Rewards & Encouragement
 - earn badges and rewards as they read.
 - expanded interactive content that engages the reader with others present and online.
 - personalized recommendations from creators and fellow readers.
- Social media to engage users
 - @isaac_tmtm
 - constant updates on new editions and hidden features

CONCLUSION AND FUTURE WORK

Though far from universal, digital books are becoming more and more integrated into the daily lives of children and their families with digital reading occurring on a variety of devices. Of course, digital reading does not occur in a vacuum; it is affected by the environment and context in which it occurs, including the digital devices at hand, the availability of those devices, the availability and quality of content for the devices, not to mention the attitudes and behaviours of the user, and the broader social situations in which readers read.

There are many well-established findings regarding the role of print books in recreational and educational practices and the benefits of their use. Research has extended these findings to digital books [Schreurs, 2013]. Now further research is necessary as hybrid projects are on the

rise—but one thing is clear: the learning benefits, user experience and entertainment value of hybrid books depends on the design, contents and technological effectiveness of the system employed by the books in question and how they relate to the broader context of reading and play.

The Canadian marketplace is prepared for the emergence of a third category of reading experience that successfully integrates the best characteristics of physical and digital media [Marcial, 2014]. Nevertheless, I remain weary of strictly market-driven advancements in digital media and communication as it often diminishes the cultural value of narrative work, leading to a market laden with digital games and apps that serve more as distractions and advertising opportunities than genuinely satisfying the spiritual or inner needs of a child trying to understand their place in the world.

Rather than treating digital books or their features as having specific effects on learning outcomes, they are better understood as a medium capable of supporting a variety of different activities. The research findings also suggest that there are many critical and commercial opportunities for designers and producers of digital objects and systems with blended materiality. These opportunities and recommendations are put into action in the prototype in the hopes of developing a system that meaningfully integrates media through storytelling and technology. Linking physical and digital books through the use of consumer digital devices and a computer vision AR system, a complete blended material (print, digital, hybrid) first edition can be studied

to collect validated learning about user impressions on the content and experience. Analysis of the myriad ways real readers of pictures-books interact with the various editions of *Isaac, The Mountain & The Moon* will then be used to generate social editions based on the data and will be the subject of further study.

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