Oscillating Between Four Orders of Design: The Case of Digital Magazines

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Introduction

The rapid evolution of digital technologies has significantly affected most industries and their design practices. This is particularly evident in the publishing industry: Historically dominated by a graphic design culture, design decisions mainly concerned page layouts. Increasing digitalization, however, presents publishers with an expanded set of design challenges ranging from device form factors (industrial design), to user experience (interaction design) and business logic (environmental design). In this paper, we examine the characteristics of the new design processes that emerge, asking: As publishing companies move increasingly into digital design, what are the new design challenges, and how can they be dealt with?

Against this backdrop, we conduct an exploratory case study of a leading Swedish media company—Bonnier—and its efforts at designing a digital magazine. The design project was carried out by a global multi-disciplinary team and resulted in a digital publishing platform called *Mag+*. Developed for tablet-based content delivery on the iPad, Mag+ integrates new interaction design principles with a magazine concept to achieve a rich user experience, while introducing a new business model governing the production, distribution, and billing of the content. We apply Buchanan's model of the four orders of design,[1] combined with extant research on digitalization,[2] to analyze the design process.

The study shows that as digitization enables loose couplings between formats and contents and therefore relaxes design constraints within and between orders; designing in digital spaces involves simultaneous challenges in all four orders of design. Further, not only do some design decisions manifest a co-dependency between two orders, they are also likely to cause ripple effects on other orders. We also posit that digital capabilities change the design process—in that digital design processes involve unprecedented dynamism and frequent iterations between the four orders. Overall, we contribute to multi-order design theory by heeding the specific effects of digitalization on design spaces in the publishing industry.

1 Richard Buchanan, "Design Research and the New Learning," *Design Issues* 17, no. 4 (Autumn 2001): 3–23.

2 E.g., David Tilson, Kalle Lyytinen, and Carsten Sørensen, "Digital Infrastructures: The Missing IS Research Agenda," *Information Systems Research* 21, no. 4 (2010): 748–59; Youngjin Yoo, Kalle J. Lyytinen, Richard J. Boland Jr., and Nicholas Berente, "The Next Wave of Digital Innovation: Opportunities and Challenges: A Report on the Research Workshop 'Digital Challenges in Innovation Research' (June 8, 2010), http://ssrn.com/abstract=1622170 (accessed November 28, 2012); Youngjin Yoo, Kalle Lyytinen, Veeresh Thummadi, and Aron Weiss, "Unbounded Innovation with Digitalization: A Case of Digital Camera," (paper presented at the Academy of Management Annual Meeting, Montreal, Canada, August 6–10, 2010).

3   Buchanan, "Design Research and the New Learning": 9.

4   Ibid., 3-23.

5   Robert Harland, "The Dimensions of Graphic Design and Its Spheres of Influence," *Design Issues* 27, no.1 (Winter 2011): 21–34.

6   Buchanan, "Design Research and the New Learning": 3-23.

7   Ibid.

8   Jonas Löwgren, "Interaction Design," in *Encyclopedia of Human-Computer Interaction*, eds. Mads Soegaard and Rikke Friis Dam (Aarhus, Denmark: The Interaction-Design.org Foundation, 2008), www.interaction-design.org/encyclopedia/interaction_design.html (accessed November 28, 2012).

9   Daniel Fällman, "The Interaction Design Research Triangle of Design Practice, Design Studies, and Design Exploration," *Design Issues* 24, no.3 (Summer 2008): 4-18.

10 Buchanan, "Design Research and the New Learning": 12.

11 Ibid.

Figure 1
Four orders of design (Buchanan, 2001).

Four Orders of Design

In 2001, Buchanan introduced the "four orders of design" model (see Figure 1), where design is about "the human power of conceiving, planning, and making products that serve human beings in the accomplishment of their individual and collective purposes."[3] While the "product" is the formal outcome of the design process, it typically connotes a physical object; it is understood as the outcome of an industrial design process. Buchanan argues that this limited meaning is being increasingly challenged as four orders of design have emerged.[4]

The first and second orders emerged in the first half of the twentieth century: While graphic design deals with the nature, shape, and meaning of *symbols* and consists of four distinct but related activities: typography, illustration, photography, and print,[5] industrial design is concerned with tangible, physical artifacts—with *things*.[6]

More recently, however, designers have begun to address problems with a wider scope and thereby expanded design into Buchanan's third and fourth orders. In interaction design, the locus of design is *action*. Here, the focus is on designing experiences rather than physical objects.[7] As of the mid–1990s, the turn towards interaction design became increasingly pronounced.[8] While starting out as a response to the need to design IT systems for and with the users, over time, it increasingly paid specific attention to the user experience.[9] Finally, environmental design is concerned with "[t]he idea or *thought* that organizes a system or environment"[10] Therefore, in the fourth order, the focus is on human systems, "the integration of information, physical artifacts, and interactions in environments of living, working, playing, and learning."[11]

Although Buchanan's paper is widely cited, empirical studies based on the model are scarce. A notable exception is Breslin,[12] who focused on the third and fourth orders of design as she investigated the redesign of FedEx retail centers. While adopting a historical perspective, illuminating how the four orders have emerged, Buchanan argues that, the orders should be thought of as places for rediscovering, rethinking, and reconceiving the nature of design. Although the model (see Figure 1) suggests a range of potential relationships between the orders of design, Buchanan's paper does not explore how interactions between these orders unfold during the design process.

Digitalization

Scholars have recently begun to attend to the process of digitalization of products and services. Central to this research is the distinction between *digitization* and *digitalization:* Here, "digitization (…) involves the encoding of diverse types of analog information into a digital format and the embedding of an ability to process such digital information using a set of pre-programmed instructions";[13] digitalization, meanwhile, is about "the transformation of socio-technical structures that were previously mediated by non-digital artifacts or relationships into ones that are mediated by digitized artifacts and relationships.[14]

In a world of analog artifacts, a tight coupling reigns between content and its format, storage, and distribution. For example, the content on a vinyl record can only be consumed by means of a record player. Digital artifacts, however, enable loose coupling: Sound waves converted to bits (e.g., MP3 format) can be consumed on an array of devices. As bit streams of data can be transferred through digital networks (e.g., the Internet), this also enables new ways of distributing the content. When online peer-to-peer file-sharing services (e.g., Napster) emerged, the full digitalization of open music distribution was made technically feasible. This ignited a grand socio-technical reconfiguration, ultimately resulting in a radical restructuring of the music industry.[15] A similar process is underway in the publishing industry, where the printed magazine served for more than a century as an artifact in which content, storage, and distribution were tightly coupled. Since content today can be consumed on a large range of digital devices, the role of printed media has become increasingly questioned. We argue that because digitalization separates formats and contents, it also generates loose couplings within and between the four orders of design. Therefore, the need arises to study how the interactions between the four orders unfold during the design process. In doing so, we apply Buchanan's model to identify the effects of increasing levels of digitalization across all four orders of design by reviewing how the Mag+ design project evolved.

12 Maggie Breslin, "ZIBA Design and the FedEx Project," *Design Issues* 24, no. 1 (Winter 2008): 41–54.

13 Adapted from Youngjin Yoo, Kalle Lyytinen, Veeresh Thummadi, and Aron Weiss, "Unbounded Innovation with Digitalization: A Case of Digital Camera," (paper presented at the Academy of Management Annual Meeting, Montreal, Canada, August 6–10, 2010): 7.

14 Youngjin Yoo, Kalle J. Lyytinen, Richard J. Boland Jr., and Nicholas Berente, "The Next Wave of Digital Innovation: Opportunities and Challenges: A Report on the Research Workshop 'Digital Challenges in Adapted from Innovation Research'" (June 8, 2010): 6; http://ssrn.com/abstract= 1622170 (accessed November 28, 2012).

15 Gary Graham, Bernard Burnes, Gerard J. Lewis, and Janet Langer, "The Transformation of the Music Industry Supply Chain: A Major Label Perspective," *International Journal of Operations & Production Management* 24, no.11 (2004): 1087–1103.

Table 1 | **Key elements of the four orders in the traditional and fully digital design spaces in the publishing industry**

	PRINT	DIGITAL
GRAPHIC DESIGN	Typography Illustration Photography	Typography Illustration Photography Audio Video
INDUSTRIAL DESIGN	Paper quality (coated/uncoated, bleached/unbleached, weight) Format (page size, number of pages)	Screen size Input & output devices Hardware specifications
INTERACTION DESIGN	Table of contents Pages (flipping/browsing)	Navigation logic Movement Interaction modalities (visual, audio & tactile)
ENVIRONMENTAL DESIGN *Material movement* **Storage** **Distribution**	 Print shop, Newsstand Ground or air to subscriber or newsagent	 Online content management Digital subscription and distribution service
Monetary movement **Exchange**	 Cash, invoice or credit card	 Transaction processing Credit card number

From Print to Digital

Traditionally, creating a magazine involved decisions about how to give a chosen range of editorial content an effective and persuasive graphic form (see Table 1). Design decisions therefore mainly regarded typography, as well as placement and size of photos and illustrations. Indeed, the dominant environmental design in printed media, including the configuration of the business model, emerged over 100 years ago: The content of an issue is assembled by the professional staff of the magazine; the original is then sent off to a print shop, where it is printed and distributed to subscribers or to resellers. Storage and distribution as a material movement is combined with the exchange of value—monetary movement—at specific points of contact in the distribution model: Readers prepay their subscriptions or pay at the time of purchasing a single issue. The business model also specifies the role of advertising and associated revenue streams.

The publishing industry has utilized digital capabilities for about 30 years. In doing so, it has optimized internal production processes, such as content creation and editing. These digitization efforts, however, have neither significantly changed the overall way of doing business nor loosened the tight coupling between the content and the printed medium. Still, the rise of the Internet and the emergence of social media have prompted publishers to heed the potential of full digitalization: as the number of subscriptions

and the advertising revenue have both stalled and more recently decreased,[16] the viability of the dominant business model has indeed been questioned, and publishers have been pushed into engaging with all four orders of design by digitalizing their whole business model.

In contrast to paper-based printed media, digital magazines present designers with second-order design challenges that concern the very material characteristics and form factors of the devices on which the content will be rendered. Screen size, hardware specifications, which input and output devices to utilize and where they are located provide new design opportunities and constraints. While readers have traditionally interacted with printed magazines through a table of contents, or by flipping or browsing pages to reach the desired content, digitized content enables alternative interaction designs: How does the user find the content she wants to consume? How does she interact with rich content, such as audio and video? The digital interaction modalities enabled by touch screens (i.e., haptic gestures) also spawn design challenges in which the second and third orders become entangled. Finally, publishers need to ask themselves: How do we organize the monetary flow and source content in this digital environment?

Table 1 summarizes and compares some key elements and their associated interactions across the four orders in the traditional and fully digital design spaces. Design in this new space covers multiple orders *at the same time.* While at least two orders were always fixed in the design of a printed magazine, a fully digital magazine not only involves graphic design—challenges arise in all orders. Moreover, digital devices evolve rapidly, and we see an absence of a dominant design that governs interaction rules and business models for digital magazines.

Research Design

We studied designing for digital spaces by conducting a case study of Swedish media company Bonnier. The study aimed at gaining an understanding of how the design process unfolded in the Mag+ project: when and how key design decisions were made in each of the four orders and around which design elements. We chose the case study approach because of its strengths in analyzing contemporary and unique phenomena with little theory.[17] Case studies help focus on the transitions between theory and practice.[18] The challenge in design case studies is to carry out a two-pronged job of both establishing theory and creating a bridge back to the practical by illuminating principles that designers can use.[19] The data were collected from October 2010 to May 2012: We conducted a total of 14 interviews with nine project members. All interviews were audio recorded and transcribed. In addition, we had access to design materials and archives.

16 "Annual Combined Paid and Verified Average Circulation per Issue of All ABC Magazines, 1970–2010," www.magazine.org/insights-resources/research-publications/trends-data/magazine-industry-facts-data/2011-1970-annual (accessed November 28, 2012); and "Magazines: By the Numbers," *The State of the News Media 2011,* http://stateofthemedia.org/2011/magazines-essay/data-page-4/ (accessed November 28, 2012).

17 Robert K. Yin, *Case Study Research: Design and Methods,* 3rd ed. (Thousand Oaks, CA: Sage Publications, 2003).

18 Maggie Breslin and Richard Buchanan, "On the Case Study Method of Research and Teaching in Design," *Design Issues* 24, no. 1 (Winter 2008): 36–40.
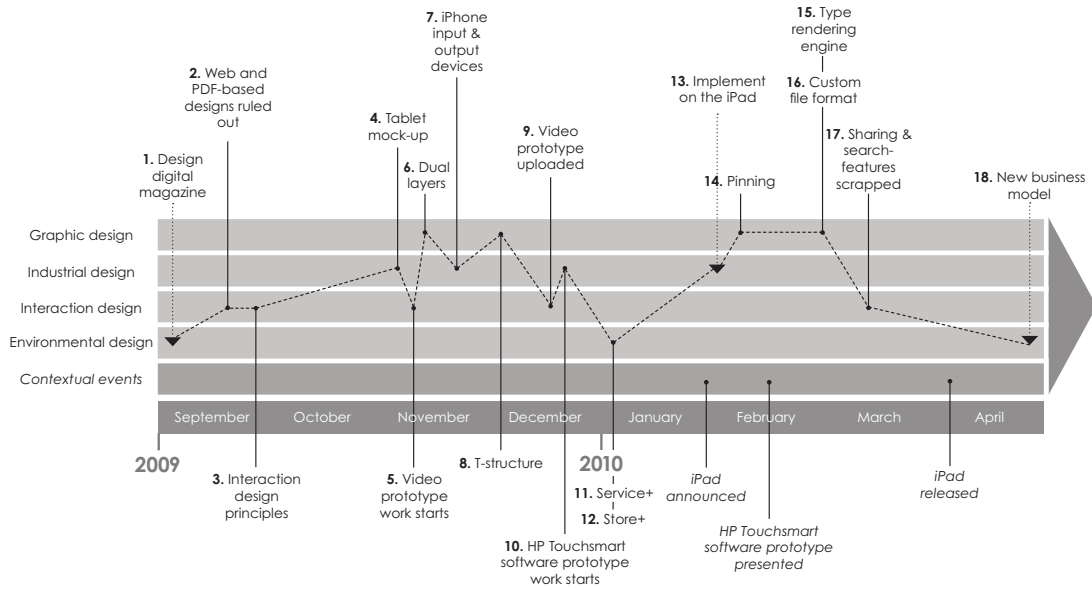
19 Ibid.

Figure 2
Timeline illustrating key design decisions in the four orders.

Case Study: Bonnier and the Mag+ Project

Bonnier was founded in 1804 and is the oldest publishing house in Scandinavia. The company, describing itself as a "multi-channel media company," owns some of Sweden's largest morning and evening newspapers, one of the largest television channels, and the dominant movie theater chain in Sweden. In the past decade, Bonnier has also become a global player through a series of international acquisitions. Overall, it consists of 175 firms operating in 16 countries, with the headquarters located in Stockholm. The Mag+ project was started in September 2009, when the CEO handed the Research and Development (R&D) department the task of designing a digital magazine. This decision was based on the CEO's understanding that Bonnier's digital business was not working. The R&D Department assembled a global design team including members who had strong editorial experience, web design skills, software designers in Silicon Valley, and people with marketing competence, as well as a British design agency—Berg. Figure 2 illustrates the key design decisions in the four orders and the movements between orders over the course of the project. We also highlight three key *fixating decisions:* to design a digital magazine (1),[20] to implement on the iPad (13), and to implement a new business model (18). Each of these decisions reduced the search space in this otherwise enormous design space.

Table 2 illustrates the key design challenges and the decision sequence made to address them in the four orders, as shown by event numbers.

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20   Numbers in parenthesis correspond to event numbers in Figure 2.

Table 2 | Design challenges and decisions in the four orders

	CHALLENGE	DECISION
GRAPHIC DESIGN	Screen size smaller than print page	Dual layers (6) & T-structure (8)
	Horizontal & vertical orientation	Pinning (14)
	Font alignment	Type rendering engine (15) & Custom file format (16)
INDUSTRIAL DESIGN	Device unknown	Tablet mock-up (4)
	Input & output devices unknown	Assume iPhone standard (7)
	Present interactive prototype on device	HP Touchsmart software prototype (10)
INTERACTION DESIGN	Discouraging research & evaluation results	Web and PDF-based designs ruled out (2)
	Define user experience for unkown device	Interaction design principles (3)
	Illustrate interactions & user experience	Video prototype (5) (9)
ENVIRONMENTAL DESIGN	Digital business not working	Design digital magazine (1) & Implement new business model (18)
	Back-end architecture	Service+ (11)
	Distribution & monetary transactions	Store+ (12)

Graphic Design (First Order)

From the start, the design team perceived *surface* as a central property of the printed magazine. Therefore, content should always be in the front layer, filling up the screen. However, a challenge was the tablet's smaller screen size in relation to a printed magazine page. To address this reduced size, the team decided to present content in dual layers (6), where the text is in the top layer and the photos are in the bottom layer. They also settled on a *T-structure* (8), where articles are organized horizontally and the content of each article is laid out vertically.[21] Another difference is that tablets can display content in both horizontal and vertical orientation, depending on how the user positions the device. To address this challenge, the team came up with the pinning feature (14), which allows magazine art directors to define how the graphical elements should move dynamically according to certain rules. Another challenge revolved around the limitations of the typographic assets available in the chosen tablet—the iPad's iOS—vis-à-vis the options for a printed magazine. Therefore, a decision was made to bypass this rendering and develop a type rendering engine (15) for typographic assets and a custom file format (16). The design lead (lead designer) at Berg explains the reasoning:

> We realized that in order to get the kind of typographic control that magazine editors are used to, we weren't going to be able to use the core text API, which is the framework for rendering text in iOS. In typography, you always specify the baseline that the type sits on, whereas, in iPad-land

21 The T-structure and dual layers – features are illustrated in this video: http://vimeo.com/10630568 (accessed November 28, 2012).

and HTML-land, you specify the top of the tallest letter. Therefore, the type "floats up" like a bubble, and that's why HTML looks so awful.[22]

Industrial Design (Second Order)
Although the Mag+ project did not result in a tangible artifact, it involved several second-order design decisions dealing with the question: On what sort of material device should the magazine be rendered? The device landscape in September 2009 looked radically different from its current state. Amazon's Kindle 2 had been released in the United States, but it had a black and white screen and was intended for reading books. Some photos of a dual-screen tablet called Microsoft Courier had been released.[23] At this point, there were only rumors about Apple releasing a tablet in the future. The design team described the initial situation as gazing into darkness.

While there was no appropriate device on the market, the team still needed to explore the design options associated with a touch screen tablet. Therefore, Berg built a tablet mock-up (4) out of modeling board. An area was painted with green screen paint, enabling video to be projected onto it. The mock-up assumed the input and output devices of an iPhone-standard (7), and the screen size was set to 9.7 inches. While the mock-up enabled the team to visualize user interactions effectively, they also wanted to create a prototype to help them further explore the tangible aspects of the design. To this end, a software prototype was implemented on a HP Touchsmart laptop (10) to generate a more specific appreciation of the material design challenges. Although this prototype was later presented at a conference, the scene changed abruptly as Steve Jobs announced the iPad concept (see Figure 2). Bonnier quickly decided to implement the magazine on the iPad (13) by creating a digital version of the *Popular Science* magazine, called *PopSci+*, in time for the iPad's official release date.

Interaction Design (Third Order)
At the start of the project, Japan and South Korea were considered leaders in mobile technologies. Therefore, market research and user experience evaluations from these countries were reviewed, and the review showed that offering premium editorial content in a browser was bound to fail. Consequently, the team ruled out web and PDF-based designs (2). The team also reviewed internal customer surveys that verified some of the team member's initial understanding: Magazine readers considered themselves paying for the experience rather than the tangible product. Since the target device was as yet unknown, the team focused on exploring how that experience could be recreated in a digital form. This was done

22   Design lead, Berg.
23   The Microsoft Courier project was terminated in 2010.

Table 3 | Mag+ Interaction Design Principles

QUIET MODE	Keep it immersive and relaxing. Lean back, away from the browser. Allow few distractions than the blinking, frantic web.
A BEGINNING AND AN END	Retain that linear pacing and story flow that we do in print. Give people a sense of completion.
ISSUE FORMAT	Reward that sense of anticipation people feel around a new issue. Take advantage of convenient and inexpensive distribution. Save the secon-by-second updates for the Web.
FLUID MOTION	The digital magazine should feel like it's made for this device—not print ported to a screen, complete with page-flip animations, but rather like a camera panning over the content. Flow is the new flip.

through formulating a number of interaction design principles (3), articulating what the user experience of a digital magazine implemented on a tablet should be (see Table 3).

To get a sense of how to shape user interactions based on these rules, the design team consulted several editorial teams and asked them to generate prototypes of a digital magazine that followed the interaction design principles (3). Simultaneously, Berg explored a number of alternative *interaction paradigms*—fundamental behaviors of how magazine content might be rendered on a touch-screen tablet. The design team decided to use video as a prototyping tool (5) to visualize the third-order design, following the interaction design principles (3) so as to understand the details of the user experience. The team settled on haptics as the main interaction modality, where the user taps to handle the dual layers (6) and swipes to achieve movements in the T-structure (8), as previously described. The video showing the interaction patterns on Mag+ was uploaded on video service *Vimeo* (9).[24] The clip received more than 200,000 views during the first week, and illustrations of the Mag+ concept were on the front pages of *Wired, Engadget,* and *Gizmodo.* The team was overwhelmed with the level of response: A large number of people offered both critical and constructive feedback.

Because the digital version of Popular Science is designed for the iPad, the team had to come up with a design for the "app" functionality of the magazine. According to the magazine's executive editor, this design was created as follows:

24 "Mag+," http://vimeo.com/8217311 (accessed November 28, 2012). Berg's design lead described the benefits of using video as a prototyping tool: "It's much quicker to try and get a sense and feel and smell, which are some of the types of qualities that you end up dealing with in interaction design. Although you don't gain the benefits of actual interactivity, you gain benefits of rhythm and flow, and because magazines are so esthetic, that's so important to how they look and feel." (Design Lead, Berg).

Figure 3
Magazine architecture exercise.
Rights-holder credit: Bonnier.

We cut out every page of the magazine and taped it onto a whiteboard, and then we sketched below it in marker what the architecture of the translated Mag+ version would be for that page. The exercise of going through that, looking at all these different types—from the cover to the editor's letter to complicate it, gadget pages to long features—the process of really trying to go through that translation and having both the guys from Berg, our art director, and myself, all debating these things, really helped to inform the rest of the process.[25]

See Figure 3, which is a photo from the exercise described.

Environmental Design (Fourth Order)
Since the team found no examples of fully digital magazines that were successful, it had to engage in fourth-order design and create a viable business model. Indeed, in designing a digital magazine (1), one of the few design constraints initially given by the CEO of Bonnier was that the outcome of the project had to illustrate a premium product. While the Mag+ reading experience was becoming increasingly defined through the prototypes, the team also had to address issues concerning monetary transactions, user-IDs, the editorial interface, and the whole back-end architecture of the digital magazine. The user experience director articulated some of the necessary considerations:

> The product had to address these issues: What happens when the reader who has five years of magazines decides to switch devices? What happens if the user logs on to PopSci+, but she's bought another magazine as well? Does she have to create multiple accounts?[26]

To address these issues, the team started working on two separate modules: *Service+* (11) and *Store+* (12). While Service+ (11) was designed to handle back-end architecture including content

25   Executive Editor, Popular Science.
26   User Experience Director, Bonnier R&D.

management and therefore became an integral part of the platform, the decision to implement the magazine on the iPad (13) ultimately rendered Store+ (12) obsolete: Mag+ and its monetary transactions had to comply with Apple's content management standards and business rules. Indeed, the decision to deliver content through an iPad app served as a way to increase the likelihood of a user's willingness to pay.

Oscillating Between the Four Orders

From the start, the team faced complex challenges across multiple orders simultaneously. How to handle those challenges and in which order was not clear at the beginning, however. Berg's design lead described the project as an *agoraphobic* design situation:

> It's kind of like "One day a company might make a tablet, it might be this big. It might have a touch screen, it might have a web connection, it might not. There might be a billing model, there might be an app store. What's the best thing to do?" It's kind of like swimming in this huge universe… also, it's important to remember that Bonnier is a business and that we're not trying to make things that are just nice.[27]

The sequencing of decisions as illustrated in Figure 2 results in wave-type oscillations across orders as the design process moves forward. Two distinct cycles emerge, separated by critical events: the *conceptual cycle,* where the concept of a digital magazine is generated, culminating in a video, and the *material cycle,* where the dependencies and behaviors across the orders are fixed on the chosen iPad platform.

The conceptual cycle begins with the first key fixating decision, the decision to design a digital magazine (1). While the magazine as a historical artifact can be classified as a physical and tangible *thing* that can be placed in the second order of design, it also carries meaning, since long integrated in a human system. Therefore, through this decision, several fourth-order design constraints are introduced: In addition to the explicit constraint to create a premium product, these concern the established relationships between editorial staff, advertisers, and readers, as well as the structures that govern content production. In terms of the readers, insights about the usage and meaning attached to printed magazines are revealed in the internal customer surveys. These constraints helped the team to start discussing the potential properties and user experience of a digital magazine, navigating down the design path towards formulating interaction design principles (3). In the rest of the conceptual cycle, every decision made results in a movement either up or down to another order. At the end of the cycle, the major downward movement through the four orders
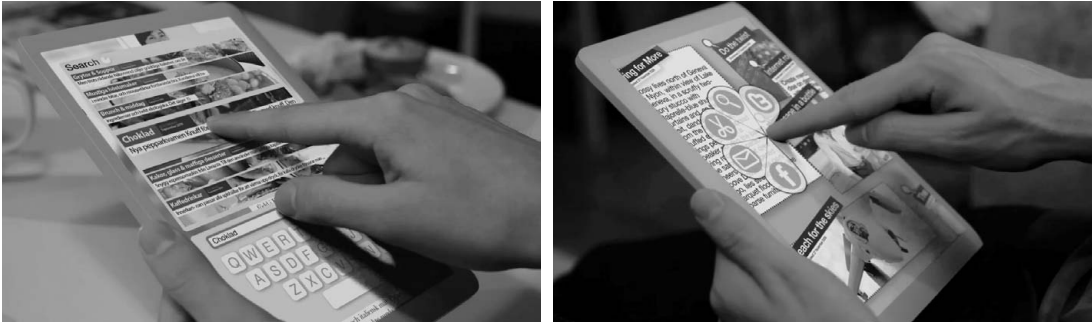
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27   Design lead, Berg.

Figure 4
Video prototype: Search-feature (left);
Share-feature (right). ©Bonnier.

is ignited by the decision to lay out the content in a T-structure (8). It enables the design process to move to the third order and finalize the user experience that is then conveyed through a video prototype (9), briefly turning back to the second order where material aspects are explored in the HP Touchsmart software prototype (10). Monetary transactions and back-end architecture are not illustrated in the prototypes, so as the last step of the conceptual cycle, the design search continues down to the fourth order, and the team decides to start designing Service+ (11) and Store+ (12).

The material cycle is initiated by the second key fixating decision (see Figure 2)—a decision to implement the final product on the iPad (13). This decision not only fixates the second-order design but also imposes design constraints on all other orders and channels the design search that follows. The pinning feature (14) serves as a bridge by preserving the visual identity of a printed magazine page (first order) while utilizing the potential of new interactions on tablets (third order). These constraints also lead to the decision to build a type-rendering engine (15) and custom file format (16), which generate ripple effects on the third order, as the search feature (17) illustrated in the video prototype (9) cannot be implemented (see Figure 4, left). Because image files are used to represent the letters, they cannot be made searchable.

Sharing (17) was another feature in the video prototype (9) (see Figure 4, right), but given the iPad's application programming interface, figuring out how and if the app could be integrated with social media was difficult. While the video prototype illustrates how the user can rub the screen to enter a "heated mode" where sharing, search, and save options are displayed, this feature did not make it into the app. Finally, the fourth-order design is fixated as most issues regarding the new business model (18) are dictated by Apple's terms and conditions (Ts & Cs).[28]

In a sense, the sequence illustrates what designers typically do: They come up with concepts, and then they materialize them. However, publishers historically have rarely become involved in challenges other than those of the first order. In fact, one or multiple orders are fixed not only in publishing, but in many historical design processes. In this case, however, due to digitalization, the orders are highly fluid and the design space at the start

28   The rules and content management
     standards that app designers have
     to comply with in order to get their
     app approved.

is enormous. Therefore, the team has to constantly move between all orders in a piecemeal fashion to constrain the search in the design space and create a sort of "fixed" alignment between all orders. By oscillating through constant iterations between the orders, the team carries out a search process, exploring what can be a suitable form for a digital magazine given the original design intent. While traversing through these oscillations, the team must employ a number of alternative strategies to fixate the design in every order.

To summarize, the conceptual cycle involves a search process, given the initial task to design a digital magazine, where different ways of combining and synthesizing digital capabilities into a digital magazine are explored. Indeed, the notion of fluid high-level conceptual design is central in this cycle; it arrives at prototypes that articulate a user experience on which the team can agree. During this cycle, the first and third-order design decisions strike a balance between the traditional magazine format and a new digital user experience. In the material cycle, decisions are concerned with fitting the high-level concept into a chosen computer platform. Here, new tensions between these two orders are revealed and resolved through compromises.

As illustrated in Figure 2, all the key fixating decisions identified in the study are made either in the second or fourth order. These decisions trigger subsequent design search. Making fixating decisions in these two orders reduces the overall size of the search space by setting up constraints, while at the same time revealing new co-dependencies. Yet, a decision in one order does not dictate what order to move to next and what decisions have to be made therein; sometimes the move is "up" and sometimes "down," as illustrated by the resulting waveform.

Discussion

This paper makes three contributions to the design discourse. Empirically, we show how Bonnier relied on improvised and generative design strategies across Buchanan's four orders to create a digital magazine. Conceptually, the paper demonstrates the plausibility of analyzing design in digital spaces by mapping movements and relationships between the four orders. Theoretically, the paper recognizes the unlimited design potential in digital design created by loose coupling between format and content and reviews how design searches in such spaces can be effectively conducted.

The design space of the printed magazine has remained relatively fixed for more than one hundred years. Product categories were dictated by the underlying material, which forced a tight coupling between format and content; a dominant model for doing business and organizing work had cemented the relationships between the four orders of design. However, in the digital design

space, the malleability of digital materiality,[29] makes product categories fragile and negotiable. Indeed, the material that is given form in digital design processes displays fundamentally different properties. A printed magazine is expensive to produce and distribute: Tangible pieces are produced in a print shop and physically distributed by ground or air to newsstands and subscribers. Each unit can only contain a limited amount of content. In the digital space, production and distribution are cheaper; how much content can be included in a digital magazine is without limits. Loose coupling not only relaxes the design constraints in each order, but also blurs their boundaries, opening up new design spaces.

In one sense, a digital magazine published through Mag+ can be viewed just as a *digitized* product—information previously represented with atoms in a printed magazine is now represented by bits—stored, processed, and displayed on a digital device.[30] But this simplified analog can be misleading. PopSci+ is also an outcome of designing a truly *digitalized* way of producing and consuming a magazine. Producing PopSci+ and other Mag+ titles changes the structures and processes of production for editorial teams and business divisions. Further, it assumes a new delivery process and introduces a new business model, organized through an app store. However, in terms of the ways in which the digital magazine is consumed, the extent of the changes is not yet clear. Indeed, traditional magazine elements are combined with audio and video and presented in a novel way, and the experience of interacting with the iPad is different. Readers have to depend on a battery-operated device, but they can carry a huge number of issues with them with ease. At the end of the day, however, PopSci+ is still a magazine—only rendered on a tablet.

This paper illustrates how digitalization expands design spaces by showcasing their potentially enormous size: When Bonnier first sought to produce a digital magazine, many issues were already settled. Other issues, however, were continuously opened up: The nature of the digital essentially implies that despite having created a final product (i.e., a digital magazine), questions remain about its meaning (i.e., what a digital magazine is and which features it should have). The components of an analog product can now be separated, digitized, and re-configured into other sorts of artifacts that are radically different from the original product. The definition of a magazine as a product category is basically up for grabs.[31] Since the digital design space is less confined and constrained by the tangible, slicing the content into smaller units and, for instance, charging for articles instead of an entire issue also becomes possible. Consequently, publishers are faced with the decision: Which features of a magazine should they keep when entering the digital world?

29   Yoo, Lyytinen, Boland, and Berente, "The Next Wave of Digital Innovation: Opportunities and Challenges: A Report on the Research Workshop 'Digital Challenges in Innovation Research.'"

30   Youngjin Yoo et al., "Unbounded Innovation with Digitalization: A Case of Digital Camera" (paper presented at the Academy of Management Annual Meeting, Montreal, Canada, August 6–10, 2010).

31   José Antonio Rosa and Joseph F. Porac, "Categorization Bases and Their Influence on Product Category Knowledge Structures," *Psychology & Marketing* 19, no.6 (2002): 503–32.

Our findings also indicate that the four orders become increasingly co-dependent in the digital design process. Some design decisions manifest co-dependency between two orders; every decision made is likely to cause ripple effects on the other orders, creating a cascading movement, as illustrated in Figure 2. Our case study shows how the project task was initially described and conceived as the design of a digital magazine. While the design team related this to a *thing*—the established industrial form that is the printed magazine—most of the team members also knew immediately what this product *means,*[32] and how it is embedded in a human system. While the printed magazine was an effective cognitive anchoring point, the first key fixating decision especially concerned *thought,* as to what role the digital magazine was expected to play in people's lives and how they could identify with it,[33] ultimately fixating the environmental design at the start of the conceptual cycle. As illustrated in the case study, the subsequent wave-like movements took place across all four orders of design (see Figure 2). Going back to Buchanan's model (see Figure 1), these wave-like movements can be seen as taking place across the diagonal. While the model suggests a matrix of complex combinations of *symbols, things, actions,* and *thoughts,* Buchanan does not discuss each combination in detail. Given the concurrency of the design challenges illustrated in the case study, the co-dependencies between the four orders, as well as the initial combination of *thing* and *thought,* we argue that it is also possible to view the movements as taking place either in the second row, or in the second or fourth column in Buchanan's model (see Figure 1). Indeed, had the team chosen another anchoring point (e.g., a content service), the design process would most likely have taken another route. The Mag+ case study illustrates how, as new constraints were introduced, they increased creativity—exemplified by the team's choice of a tablet as the rendering device and eventually by specifically choosing the iPad.

Currently, only a few digital product categories have been established in the publishing realm (e.g., podcasts and e-books). To wit, publishers are still debating as to whether to store and distribute content through existing platforms (e.g., Apple's app store and Facebook), or whether to design alternative platforms and distribution channels. Major concerns for publishers are payments, subscription models, and the commissions paid to external platform owners. However, in the future, dominant designs may emerge as diverse actors continue to venture into the design of new digital products and services.

The current environmental design in which the printed magazine is embedded serves as a dominant organizing logic for the publishing industry.[34] It also serves as a sense-making mechanism for the readers, making clear what the product *is*. As a

32 Ibid.
33 Buchanan, "Design Research and the New Learning," 3-23.
34 Youngjin Yoo, Ola Henfridsson, and Kalle Lyytinen, "The New Organizing Logic of Digital Innovation: An Agenda for Information Systems Research," *Information Systems Research* 21, no. 4 (2010): 724–35.

redesign in the second and fourth orders seems inevitable, the question of whether the user will perceive the final product as a *magazine* remains unanswered. With the enormous number of design options available in the third order, the case study illustrates how the team had to carefully balance which established product features they would keep. For example, the sharing and search features were not implemented in Mag+ as the team prioritized preserving the brand identity of Popular Science and thus did not integrate the user experience with that of, for example, Facebook.

The heterogeneous landscape of digital devices also presents a constant challenge as to how a digital magazine will be consumed. Due to the rapid evolution of digital technologies, the lead-time for designing a digital product is extremely short. This is illustrated in the case study: The Mag+ project ran on a tight schedule of eight months, which meant that compromises had to be made. Likewise, balancing a dynamic set of competencies becomes a central challenge when managing such a project. The more radical products a design team seeks to create, the more specialized and varied are the competencies needed.

To summarize, our findings illustrate how the digital presents designers with a new world: Multiple choices arise in every order; distinctions between graphic, industrial, interaction, and environmental design activities disappear; and no clear, "singular" evolutionary path exists in moving from one order to the others. The design future is basically wide open. The case study exemplifies just one type of movement in such a digital space, but vast numbers of other routes have yet to be explored. Scholars undoubtedly will discover such design processes in the future, and we thus encourage further inquiry into this exciting domain. In doing so, scholars might also discover the extent to which design constraints across the four orders grow increasingly fixed, as new dominant models for digital publishing emerge. The digital world ultimately might not be as fluid and open after all.