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Web-enabled print architectures

Adam Dewitz

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A Research Monograph of the

Printing Industry Center at RIT

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Abstract

New methods for specifying and producing printed products are emerging as print service providers seek to streamline order management, reduce costs, and improve efficiencies in print supply-chain management. These emerging print production models rely on system architectures that use Web applications to interface with highly automated print production workflows. The application of the Internet in print supply-chain management is not a new concept and has been previously investigated (Goldberg and Romano, 2001; Cummings and LeMaire, 2005). However, little scholarly research has been published on Web-to-print or Web-enabled print production system architectures.

The purpose of this research is to analyze the current state of Web-enabled print within the printing industry. The research examined a number of print service providers utilizing Web-enabled print systems. This examination led to the development of an instrument for looking at Web-enabled print service providers. The instrument provides a list of system-independent attribute descriptions for comparing various Web-enabled printing system architectures. The instrument was then used to analyze a number of print service providers. This analysis provides insight into various approaches to developing the Web application processes of a Web-enabled printing system. Lastly, the print production workflows of two Web-enabled print service providers were observed. The observations provided case studies on the strategy behind the development of a Web-enabled printing system and how customer information collected during product specification and order submission can be used to facilitate the production of printed products.

Chapter One: Introduction

Print manufacturing operations today can be divided into two discrete classifications: those that are web-enabled and those that are not. Print service providers with Web-enabled print production systems employ Internet-based processes in the management and production of printed products or in the delivery of print-related services. These Web-enabled services can range from simple file management services such as file transfer protocol (FTP) to completely Web-based document creation and fulfillment management solutions.

Non-Web-enabled Print

While the Internet has radically changed the way business is done, there are still many print communication projects that will never see a fiber-optic transmission line. This is evident at local copy shops or commercial quick printers where print buyers can be seen providing hardcopy originals or digital files on a portable storage medium, such as a CD-ROM or a flash memory drive. While non-Web-enabled print transactions are still common today, most commercial print operations are employing some type of Internet-based process in their workflow.

Web-enabled Print

Web-enabled print is defined as the generation of a printed product where the Internet is employed at any point within the production process. (However, Internet-based communication technologies such as e-mail and Voice-over-Internet Protocol (VoIP) have become commonplace in business. While these Web technologies are used to facilitate business transactions daily, their use in the print production cycle does not qualify a print service provider as Web-enabled.) In this monograph the author distinguishes between two discrete classifications of Web-enabled print: partially Web-enabled and completely Web-enabled. Figure 1 illustrates the taxonomy of print.

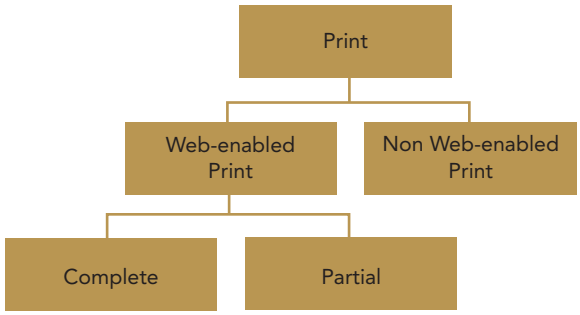

Figure 1. The taxonomy of print

Partially Web-enabled Print

A growing number of print service providers in the U.S. fall under this classification. A print service provider who adopts a partially Web-enabled workflow will strategically integrate the Internet into their workflow where it makes sense based on their market niche, product types, and services offered. A print service provider who adopts a partially Web-enabled print production model may use Internet-based file management tools such as FTP or a more advanced digital asset management system that allows files to be managed via a Web browser. Others may implement an online order fulfillment solution. The level of Internet integration relies heavily on the services being provided. Print service providers adopting a partially Web-enabled print production model have the opportunity to provide value-added services to their customers. These opportunities include design and creative services, project management, and marketing consultation and strategy. According to the National Association for Printing Leadership's (NAPL) *2005 State of the Industry Report* (NAPL, 2004): " By 2010, NAPL State of the Industry participants expect to derive nearly 37.0% of their revenue from something other than lithography." The adoption of a partially Web-enabled print production model allows print service providers to utilize web-enabled services where they fit best, while relying on traditional business functions to increase revenue and add value to their customers.

Completely Web-enabled Print

These emerging print production models rely on Internet-based system architectures and utilize highly automated print production workflows. The goal is to streamline production and enable new opportunities to serve customers by removing the inefficiencies of the traditional print procurement and manufacturing processes. A completely Web-enabled print production system uses a Web-based front end for specifying, ordering, and managing print orders. The print production systems used in these operations employ everything from fully automated digital production presses with inline feeding and finishing to offset lithographic printing with manual binding and finishing operations. This monograph will focus on completely Web-enabled print production models.

Statement of the Problem

Web-to-print has become a printing industry buzzword to describe e-commerce and workflow systems that employ an Internet interface to facilitate transactions that lead to the creation or distribution of a printed product. While research has been conducted to define the scope of e-commerce systems in the printing and graphic communication industry (Goldberg and Romano, 2001; Cummings and LeMaire, 2005), there has been little scholarly research published on Web-to-print or Web-enabled print production workflows.

Web-enabled automated print production workflows are beginning to proliferate in the industry. This is partly due to widespread adoption of the Internet as a commerce facilitator in all realms of business, the adoption of process-integrated manufacturing techniques, and adherence to standard data and metadata exchange formats in the printing industry. Print service providers seeking to adopt a Web-enabled automated print production workflow have to develop their own solution or attempt to integrate a vendor's one-size-fits-all solution into their existing workflow. No matter which route is taken, a clear definition of the various Web-enabled print system architectures does not exist to help guide the decisions of the workflow engineer or technology implementer. A system for classifying the various Web-enabled print system architectures will be provided in this research.

Reasons for this Study

The printing industry is undergoing a fundamental redefinition brought on by cyclical and structural change. This redefinition requires print service providers to adopt new business strategies and to invest in new technology (NAPL, 2005). New technology investments are not limited to the pressroom alone—they also need to occur in information technology infrastructure, workflow, and business informatics. Automation needs to be at the heart of all new technology investments. Automated processes allow the print service provider to reduce labor costs and remove production and clerical processes that provide little or no value to the customer and only serve to raise the cost of the printed product.

One automation method is to integrate the Internet into the print production workflow—to make it web-enabled. Engineering Web-enabled print system architectures requires the adoption of Web-based software applications and process-integrated print production workflows that utilize standardized data and metadata exchange formats.

Some print service providers will take a minimal approach to web integration, such as adopting Web-based digital asset management or content submission systems. Others will custom-engineer their business and print production workflows to completely integrate all processes with an Internet-based front-end. The level of integration and automation depends heavily on a number of factors, including the market being served and print products being produced. To this end, consumer-focused Web-enabled print service providers are on the cutting edge of application development and are building system architectures that enable non-traditional print buyers to create high-quality print products. These service providers are producing low-quantity consumer products at price points at which most commercial printers would scoff. Instead of scoffing, the entire industry would do well to analyze and benchmark these cutting-edge service providers.

The adoption of new Web-enabled production models are one solution to meet the changing needs of the modern printing and graphic communications industry. These new models will have a profound impact on how print is specified and manufactured in the coming years.

Chapter Two: Literature Review

History of E-commerce and Web-enabled Print

In 1999, the Digital Roadmaps Project released a report at Graph Expo '99 entitled *The Circus of E-Printing*. The report, released at the height of the dotcom boom, asked the reader to:

> Step Right Up. Marvel At The Astounding Sights And Sounds Of The All-Digital, E-Future Of Print. Sensational Dotcom Services. Astonishing Anytime/Anywhere Access To Service, Information, And Support. Bullet-Proof Prepress. Acrobatic Production Management. Lightning Fast CSRs. Computer-Integrated Pressrooms. Web-Activated Finishing And Binding. Synchronized Accounting In real-Time.

While the report was full of the dotcom jargon of the time, it portrayed an e-printing framework in which the entire print production workflow was available as networked services (Mills, 1999). It also defined many of the concepts that are today referred to as e-commerce and Web-to-print. Figure 2 illustrates the printing industry eBusiness portrayed in *The Circus of E-Printing*. All of the services illustrated in the eBusiness illustration are now available from a disparate group of printing industry vendors and solution providers. The industry still has not reached true plug-and-play integra-

tion of all the services listed, but the adoption of management information systems and data exchange standards such as the job definition format (JDF) promise to deliver a completely integrated workflow in which intelligent systems can efficiently exchange information and production data.

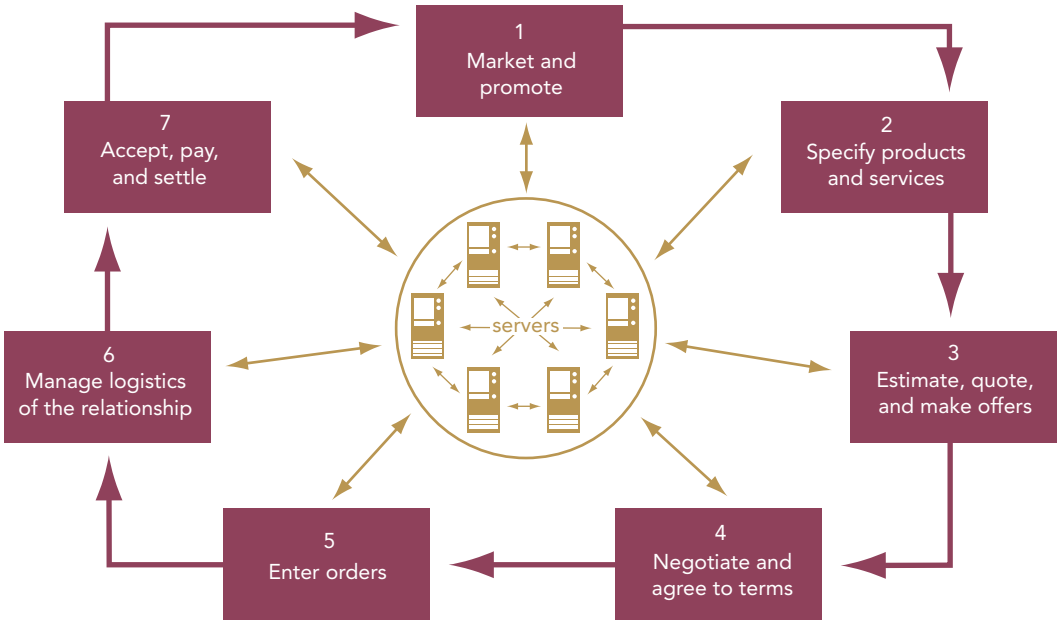

Figure 2. The eBusiness portrayed in *The Circus of E-Printing* (Davis, 1999)

At the Graph Expo 2000 tradeshow, there were more than 100 companies selling e-commerce, digital storefront, e-printing, e-procurement, Web-enabled print, and other online print services and solutions (Shaffer, 2006). The dotcom business model had crept into the U.S. printing industry, promising to deliver more efficient product ordering and higher profits from automated business transactions and reduced turn-around times. A year later the dotcom bubble burst, and many of the e-commerce print vendors merged, folded, or rethought their business model as the print industry side-stepped the e-services it perceived as unnecessary (Shaffer, 2006).

Nickel-Kailing (2002) described the burst by saying, "It turned out that the Internet is NOT a business model, and you couldn't give away applications or content and expect to make a profit on transaction volume." Nickel-Kailing goes on to say, "It [the Internet] has now evolved into the technology backbone that connects data and systems into a sophisticated network of applications, information, and people."

Unlike many of the concepts developed during the dotcom boom, e-commerce evolved due to the cost reductions and improved efficiencies it provides to supply-chain management (Goldberg and Romano, 2001). When the dotcom bubble burst, people did not unplug their Internet connections, but continued to use the Web to collect, distribute, and store information, seek entertainment, and buy products. People became

accustomed to using the Internet as a productivity and business tool. This is evident in the Broadband Adoption studies published by Pew Internet & American Life Project (Rainie and Packel, 2001; Horrigan, 2005 and 2006).

With e-commerce and the Internet in general used to facilitate information and business transactions across all industries, print service providers are again turning their attention to developing Web-aware workflows and information systems to take advantage of the Internet's potential to create efficient business transactions (Shaffer, 2006). Today, e-commerce in the printing industry is seen as a win-win situation for all parties involved. Printers reap the benefits of automated systems that handle everything from design to delivery and accounting. Print buyers are offered efficient, cost saving print procurement services that can be integrated into their supply-chain management systems. End-users of print products benefit from the low costs of print procurement (Cummings and LeMaire, 2005).

Current Definitions of Web-to-Print

At its core, Web-to-print is a form of e-commerce. In a 2005 study, Cummings and LeMaire define e-commerce in the printing industry as:

> An online system that allows customers to perform transactions over the Internet. Transactions include creating and customizing templates, reviewing and soft proofing files, ordering prints, paying for prints, confirming orders, and monitoring delivery all via the Internet. The system interacts with customers, suppliers, and employees.

In a broad sense, the definition provided by Cummings and LeMaire (2005) encompasses the concepts of Web-to-print. Shaffer (2006) defines Web-to-print as "an interaction between those who buy print products and those who sell print products, using the Internet as a medium for exchange." Shaffer then qualifies the exchange by adding, "Web-to-print applications go beyond the mere exchange of files and include value-added services."

Web-enabled Print Implementations

There are many approaches taken by print service providers when implementing Web-to-print system architectures (Roob, 2005). Hu (2004) places web-to-print system architectures into three categories:

1. **Web-to-print Fulfillment.** This is a simple e-commerce implementation designed to facilitate the ordering of pre-preprinted documents or reprints (traditional print-on-demand). The documents are not variable and cannot be edited or customized via a Web interface. This implementation has low barriers to entry.
2. **Web-enabled Customized Documents.** A more advanced e-commerce implementation designed to allow the customization and personalization of templa-

tized documents. This type of system is tailored to print applications that require brand management and for the creation of mass customized marketing collaterals. This is a widespread implementation currently used by print service providers.

3. **Web-enabled Customized Services.** An implementation that integrates the supply-chain of the print buyer into the print service provider's print production processes. In this implementation, the print production processes are integrated in the print buyers' Customer Relationship Management (CRM) or accounting system. This implementation relies on templatized documents.

All three implementation categories provided by Hu are based on an established relationship between the print buyer and the print service provider. Many e-commerce and Web-to-print services provided by print service providers can be placed into one of the three categories provided by Hu.

Documented Automated Printing System Architectures

Web-enabled printing system architectures are described in the literature. While a majority of the systems described were research-and-development concepts, some have been developed into commercial applications.

Freedman (2001) describes an e-commerce system that uses customer-supplied job description information to develop a profile of the print application attributes. The profile is used throughout the print procurement and production processes, and contains all the information required to produce the job. The system streamlines the print procurement process by automating tasks typically processed manually by sales and customer service personnel. Production processes use the profile to preset printing and finishing systems.

A workflow for submitting print-ready variable information jobs using the Internet is presented by Breding, Grunbaum, Kihlberg, and Thor (2003). The workflow streamlines the production of repetitive or template-based printed products (such as business cards) by reusing design templates and document-level digital assets. Using a design, adapt, and print model, the researchers found that, while initial document design time took longer than traditional workflows, subsequent orders were processed more efficiently as the document had to only be adapted to the new template data (Breding et al., 2003). The research concluded that a template system that captures all production data improves production efficiency and provides an order management system that novice users could use with little knowledge of print design or specifications. The workflow has been commercialized under the *Printon PO Workflow* name. Figure 3 illustrates the time savings of using the workflow to produce template-based print products.

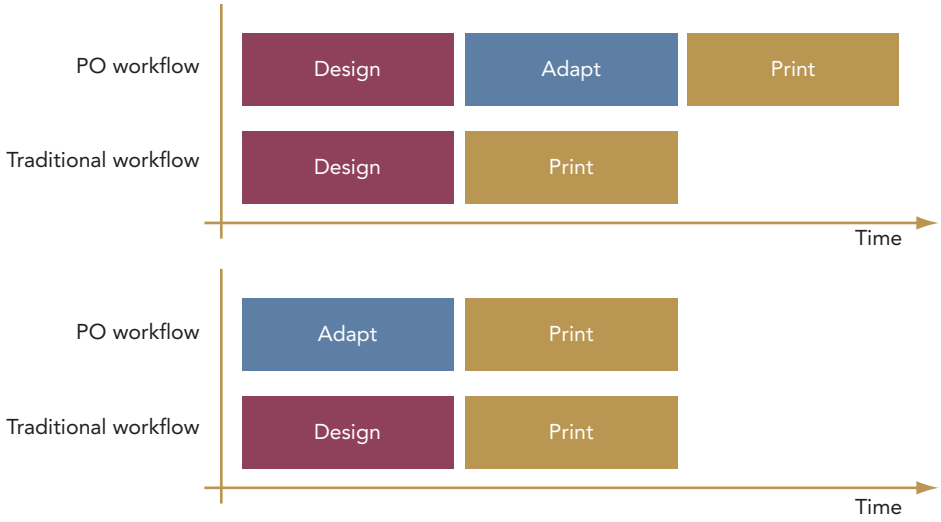

Figure 3. The Printon PO Workflow (Breding et al., 2003)

Moore and Gombert (2005) document a book production system that uses extensible markup language (XML) applications and the portable document format (PDF) to automatically prepare and produce perfect-bound books. This workflow system (illustrated in Figure 4) uses a database to store presentation-neutral DocBook documents that are transformed into a print-ready PDF using extensible stylesheet language formatting objects (XSL-FO). The print-ready PDF is coupled with job metadata stored as a job definition format (JDF) product description and sent to a digital front-end (DFE) of a digital printing press. Production of the print job is managed using the capabilities of JDF.

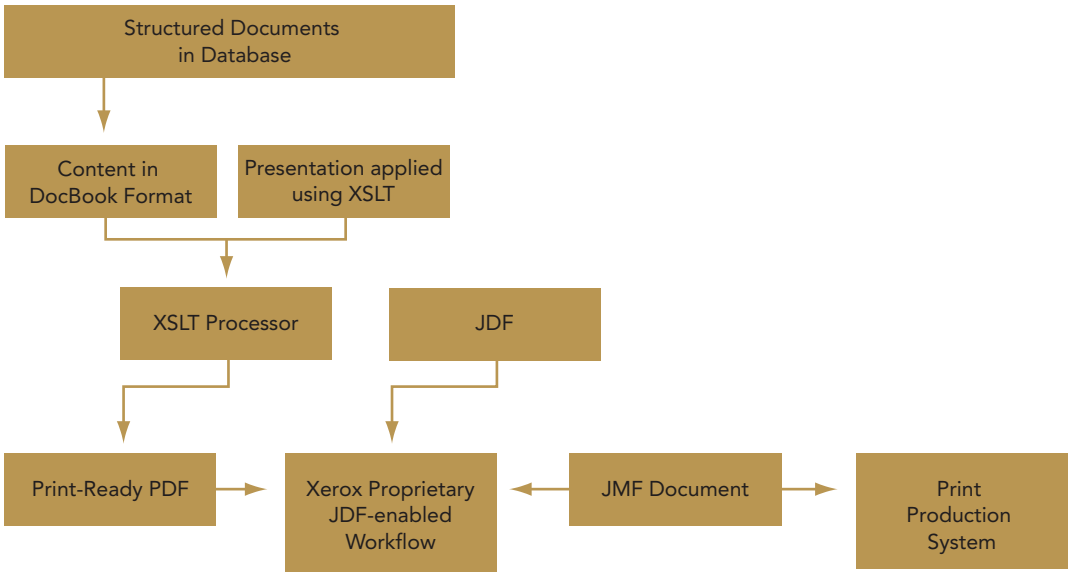

Figure 4. Workflow presented by Moore and Combert (2005)

Deterministic and Non-Deterministic Workflows

The Columbia Electronic Encyclopedia (n.d.) states: "In a deterministic system, every action, or cause, produces a reaction, or effect, and every reaction, in turn, becomes the cause of subsequent reactions. The totality of these cascading events can theoretically show exactly how the system will exist at any moment in time." This philosophical doctrine can be use to describe a process-integrated print production workflow (F. Cost, personal communication, September 2005). Cost describes a deterministic print production workflow as one that has a fixed and predictable production path. Deterministic print production workflows rely on catalogs of predefined attributes and rules or logic to dictate the design and production of a print product. The limits placed on the design parameters such as paper stock, color versus monochrome printing, binding and finishing methods, and product dimensions allow for highly automated print production systems to be engineered. These turnkey print production systems are highly efficient and require little human intervention. In fact, they might be the 'Holy Grail' of computer-integrated manufacturing the print industry is attempting to achieve. While the notion of highly integrated automated print production workflows is a realistic dream for many within the print industry, many print service providers have been slow to adopt the technology and workflow methodologies required to engineer and sustain operations utilizing computer and process-integrated production systems (Lamparter, 2005).

According to Heizer and Render (1999), "Seventy-five percent of all global production is devoted to making low-volume, high-variety products" (p. 229). These shops are typically referred to as "job shops," and have a process-focus manufacturing strategy (Heizer and Render, 1999). Much of the commercial print produced globally is manufactured in job shops using a process-centric manufacturing strategy. The typical commercial printer has engineered the workflow to handle producing low-volume, high-variety products. These print production workflows can be described as non-deterministic (F. Cost, personal communication, September 2005). Cost describes the non-deterministic print production workflow as allowing any product specification to be submitted by the print buyer. The print products coming out of a non-deterministic print production workflow will have a high level of customization and can include specialty paper stocks, specialized printing methods, and unique binding and finishing options. This type of workflow is hard to automate, and is constrained to an 'island-of-automation' approach at best.

Automation within the Printing Industry

Automation in the printing industry is not a new concept. Johannes Gutenberg's invention of moveable type was not only the birth of a new printing technology that would enable the masses to use print as a communication medium, but was also the first step in automating the production of printed products.

Modern day automation strives to integrate the electronic, mechanical, and physical

processes used in the production of printed products (Lamparter, 2005). Lamparter (2005) outlines four methods in which process-integrated automation can be achieved:

1. **Physically Linked Machines Combining Different Functional Elements of Production.** Automating processes using physical connections to create a continuous flow of information and materials. An example of this type of integration is a digital printing press with inline saddlestitching.
2. **Information Integration Only.** Automating the flow of information used to describe, plan, schedule, and track the production of printed products. An example of this type of automation is the use of a management information system to manage jobs as they go through the print production cycle.
3. **Electronic Data Controlled Production Machines.** Automating production equipment to automatically configure to produce the job using job metadata. An example of this type of automation is the use of prepress metadata to preset the ink keys on an offset press.
4. **Information Integration and Machine Control Utilization.** Automating all aspects of a print production workflow. Information flow is integrated between all preproduction and production operations. This information is used to control and monitor machines and processes.

Printing Process Technology

Printing technology has come along way since Gutenberg's moveable type. Modern analog and digital printing processes can quickly take design concepts and transform them to a printed page. The image quality of digital print production systems has evolved to a point that is comparable with and even exceeds the quality of traditional offset lithography (Freedman, 2005). Finishing equipment such as perfect binders and saddle-stitchers have been re-engineered to integrate inline with digital print production systems and deliver the same quality as traditional offline finishing systems (Fetherman, 2005).

Driving the adoption of Web-enabled print system architectures are these highly automated digital print production systems equipped with intelligent digital front-ends (DFEs) and inline finishing that can profitably produce one-off copies of products on-demand. However, some print service providers have been successful with Web-enabled print system architectures as a front-end to traditional offset printing workflows. These systems use intelligent imposition software to combine or "gang" multiple jobs onto an offset plate (Shaffer, 2006).

Business Informatics and Document Engineering

The field of business informatics provides the framework for analyzing business processes using information systems over computer networks and the Internet. Glushko (2005) points to the emerging discipline of document engineering to guide the speci-

fication, design, and implementation of documents used to facilitate business transactions and processes. Document engineering examines legacy business information exchange methods such as Electronic Data Interchange (EDI) and emerging XML-based applications, with the goal of providing specifications or models with rules and logic that allow for the exchange of information between businesses or between internal organizations and processes (Glushko, 2005). These specifications or models provide the means to streamline and automate the exchange of information used in business transactions and print production processes.

Conclusion

The core concepts and technologies exist to build automated Web-enabled printing system architectures that streamline the design and order specifications of printed products. E-commerce is the core concept behind emerging Web-enabled print models. E-commerce has been proven to provide a cost efficient means to manage the procurement of print related products and services (Cummings and LeMaire, 2005). Glushko's (2005) document engineering concepts provide the necessary information technology strategies and implementation insights to build networked services for the exchange of the required information to streamline and automate business processes. Freedman (2001) provides a concept of using customer-supplied job information to manage the procurement and production of printed products. Breding et al. (2003) share a prototype system using a similar concept to Freedman's to provide a Web-based design and order management front-end to a print production system. Moore and Gombert (2005) document a digital print production system that has been automated using job metadata.

Hu has provided one method to classify Web-to-print systems (Hu, 2004). However, his method does not adequately describe the various models being deployed by consumer-focused print service providers. His work will be expanded upon to create a more thorough taxonomy to describe Web-enabled print models.

Chapter Three: Research Objectives

Web-enabled workflows have been employed by a number of print service providers as an effective way to allow customers to manage their print inventory. These solutions are designed to minimize waste and provide faster turn-around times by using the power of the Internet, automated workflows, and digital printing systems.

Little has been published on the system architectures used in Web-enabled print. This research will document a number of system architectures currently in use by print providers for Web-enabled print, and will provide a model for describing Web-enabled print system architectures.

Specific Research Objectives

1. To document system architectures used within the industry.
2. To determine how system architectures handle data input and processing, specifically how the data is prepared for production and distribution.
3. To determine how print buyers interact with the Web-enabled system architectures.
4. To develop a taxonomy for describing the variety of different approaches to Web-enabled print.

Chapter Four: Research Methodology

This monograph is based on an analysis of current implementations of Web-enabled printing system architectures. This includes analysis of Web-based front ends and storefronts and observations of current implementations of Web-enabled print production systems. This is low-constraint exploratory research that aims to provide scholarly analysis.

In this monograph, the following methods will be used to achieve the defined research objectives:

1. An in-depth secondary research review was conducted in order to determine the current scholarly view of the topic.
2. Analysis of current implementations of Web-enabled printing system architectures will be conducted by analyzing various Web front ends or storefronts.
3. Direct field observation of Web-enabled print production systems. The companies observed are:
   - Merrill Press in Buffalo, NY.
   - Lighting Source Incorporated in La Vergne, TN.
4. A taxonomy will be created based on the analysis of current implementations of Web-enabled printing system architectures.

Selection of Web-enabled Print Service Providers

This monograph will focus on completely Web-enabled print production models. Service providers had to meet a number of requirements for inclusion in this model. A print buyer must be able to establish a business relationship and complete business transactions through a Web-based front-end without the need for traditional information exchange methods such as phone calls between the print buyer and a salesperson or account manager of the print service provider. This requires the Web-based front-end

to collect all the necessary information required to price, produce, and distribute the final product from the customer at the time of order.

The model was further constrained by only looking at systems that enable a print buyer to purchase print services. Systems that produce printed products as the result of some other adjunct business transaction, such as a person receiving customized marketing collateral after an interaction with a website, are not included in the study. A number of print service providers offer services that meet this definition. In order to create a manageable sample size, a sample matrix was developed to categorize the type of services being offered. The following product customization categories were developed:

1. **Order cataloged products with templatized customization.** Systems in this category provide print buyers with a catalog of templatized products. Customization of these products is constrained to product types and pre-designed layouts and themes. Print buyers submit their own information or digital assets to create the final product. All the customer and job information required to price, produce, and distribute the final printed product is captured at the time the order is placed.
2. **Order cataloged products with design/content customization.** Systems in this category provide print buyers with a set of rules or product definitions to constrain print product development. These systems place limited constraints on visual design or content. It is the responsibility of the print buyer to ensure that visual design and content is presented in the desired manner on the final printed product. All the customer and job information required to price, produce, and distribute the final printed product is captured at the time the order is placed.
3. **Order products with complete customization.** These systems provide complete customization of printed products. No design, content, or product constraints are placed on the print buyer. The product being submitted can be completely unique. All the customer and job information required to price, produce, and distribute the final printed product is captured at the time the order is placed. Systems falling under this category are not included in this research. These systems have been reserved for future study.

Methods of print distribution were categorized to provide another metric for building a sample of print service providers. The following distribution categories were developed:

1. **Direct Distribution.** Systems using direct distribution produce the product order and then ship it directly to the shipping address supplied at the time of the order.
2. **List Distribution (Push).** Systems that utilize list distribution methods produce the product order and then ship the products to a list of recipients specified by the print buyer at the time of the order.

3. **Private Distribution to Order (Pull).** A system using this distribution method permits only authorized buyers to order a print product. The content owner manages the authorization list.

4. **Public Distribution to Order (Pull).** A system using this distribution method permits open access to the printed product. Anyone interested in buying the product is permitted to do so.

The product customization and print distribution categories were used to create a matrix that provides a framework for selecting the print service providers to include the content analysis. The matrix ensures that all the categories of product customization and distribution are adequately represented in the research. Table 1 provides a view of the matrix used to determine the services to include in this research.

Table 1. Matrix of print service providers analyzed in this research

Product Customization Categories	Distribution Categories			
	Direct Distribution	List Distribution (Push)	Distribution to Order (Pull) Private	Distribution to Order (Pull) Public
Order cataloged products with templatized customization	Blurb MagicPrints Moo ShutterFly	Cardstore.com	Blurb	Blurb
Order cataloged products with design/content customization	MagicPrints Lulu VistaPrint	No services found	Lulu	Lulu
Order Products with complete customization	Future study	Future study	Future study	Future study

Limitations of the Study

A number of limitations are placed on this research. The adoption rate of completely Web-enabled print production models by print service providers is happening at an accelerated pace. This monograph selected businesses meeting the completely Web-enabled print definition as outlined in the Methodology as of November 2006. Newer services may provide innovative approaches that diverge from the systems analyzed in this monograph.

This monograph does not look at the growing number of vendor-supplied off-the-shelf solutions coming to market. It was determined during initial analysis that these systems lacked core functionality permitting completely Web-enabled systems to be deployed without the need for custom software development. Vendor-developed systems may have matured since the cutoff date, thus making them able to be described as completely Web-enabled.

This research has a strong focus on non-traditional print service providers. Primary analysis and various discussions with industry professionals revealed that non-traditional print service providers were on the cutting edge of application development for completely specifying and ordering print products via Web interfaces. These print service providers do not completely represent the current population of the printing industry.

Chapter Five: Summary of Results

The results of this research are divided into three sections: Section One presents the System Analysis Instrument, a tool used to describe and analyze Web-enabled printing systems. Section Two presents a content analysis of seven Web-enabled print service providers. The selection process for the Web-enabled print service providers is outlined in the Methodology section. Section Three provides two case studies on print service providers that have engineered Web-enabled print production system architectures.

Section One: System Analysis Instrument

In order to compare the various Web-enabled applications deployed by print service providers, an instrument for analyzing the Web-based front-ends to a print production system was developed. The instrument was developed after preliminary analysis of Web-enabled system architectures used within the printing industry.

Instrument refinement occurred through its use in analyzing the Web-enabled systems of the print service providers identified in the Methodology section.

System Analysis Instrument Description

The instrument provides a list of system-independent attribute descriptions that can be used to describe the Web application of a Web-enabled print production system. The list includes attribute questions such as application type, knowledge and skill requirements, product formats, digital assets input, output intents, proofing, and business transaction complexity. The instrument is described in detail below.

Software Application Type

The software application type questions are used to determine where product specification and order management is taking place. Options included Web-based, desktop-based, and a hybrid Web- and desktop-based approach.

> **Web-based application.** Web-based applications are software applications that run completely within the Web browser. The Web applications do not require any non-browser software applications or computer processes beyond the traditional Web-based client/server system methodology. Web-based applications require a persistent Internet connection during use.

Desktop-based application. Desktop applications are compiled software applications that run natively on a local computer system and are independent of a Web browser. These applications provide all the functionality to specify products and manage product orders. A desktop application may have specific operating system requirements that limit platforms on which it can it can be deployed (i.e. a desktop application that is compatible with the MS Windows or Mac OS platform only). Desktop applications do not require a persistent Internet connection except when transferring data to the print service provider's production system.

Web- and Desktop-based application. A Web- and desktop-based application uses a mixed approach, relying on Web-based and desktop-based software applications to completely specify and order a product. Such as system may use a Web-based application to facilitate account and order management, and a desktop application to handle product design and specification. Depending on the portion of the application being used, a persistent Internet connection may be required.

Real-time WYSIWYG Editor. A real-time *"What You See Is What You Get"* (WYSIWYG) editor provides an accurate representation of the product during the product design and specification stage. The editor updates the product representation as the print buyer makes changes.

Preview-based WYSIWYG Editor. A preview-based *"What You See Is What You Get"* (WYSIWYG) editor provides an accurate representation of the product during the product design and specification stage. The editor updates the product representation when the print buyer requests a product preview.

Knowledge and Skill Requirements

The knowledge and skill requirements questions help determine the complexity of the user interface by analyzing the skill sets that a user may need to have in order to successfully specify and order a printed product.

Knowledge of printing product specifications required. This attribute aims to determine if the print buyer using the system requires any preexisting knowledge of printed product specifications. This includes knowledge of document design and layout principles, product limitations, printing process limitations, understanding of design or printing terminology, and other printing workflow-related skills or knowledge.

Requires special software. This attribute determines if all product specification and order facilitation is handled through the primary Web application or if third-party applications are required to facilitate some part of the process. This includes software applications for handling design and layout such as Adobe InDesign, image and photo editing applications such as Adobe PhotoShop, text editors and word processing applications, and file management applications such as an FTP client. Web browser plug-ins are also included in the special software definition.

End user. The end user attribute provides insight into the intended audience of the Web application and provides insight into the complexity of the system. The end

user can be a business (business-to-business, or B2B, model), a consumer (business-to-consumer, or B2C, model), or a combination of both.

Product Formats

Product formats describe what type of products the system is designed to produce and how the system handles product choice. Products can be catalog-based or completely customizable.

Catalog-based product formats. Product formats are constrained to a catalog of product offerings. The products may or may not be template-based. Systems may or may not have systems logic in place to insure product quality. This may include restricting image or graphical elements from bleeding off a page or being placed in locations that will degrade product quality.

Customized product formats. Product formats are not constrained. Products can be as unique as the job being ordered.

Digital Assets Input and Input Methods

Digital assets input analyzes what types of digital assets are provided and how print buyers supply digital assets to the Web application. This includes the file formats permitted by the system and the methods used to transfer the digital assets to the print service provider.

Portable Document Format (PDF). Does the system allow digital assets to be submitted using the Portable Document Format, including the standardized versions of the format: PDF/X family and PDF/A?

Rich Text Format (RTF). Does the system permit rich text content to be supplied in the Rich Text Format de facto standard word processing exchange format?

Microsoft Word Document (DOC). Can Microsoft Word Document files be supplied?

Comma-separated Values (CSV). Can data be supplied in the CSV format?

Cellular Assets Only (JPG, TIFF, ASCII Text). The system only allows digital assets to be supplied in a cellular form such as images supplied on their own or text elements supplied via ASCII text input via a form field.

HTTP Asset Submission. Digital assets are transferred to the print service provider using the Hypertext Transfer Protocol (HTTP).

FTP Asset Submission. Digital assets are transferred to the print service provider using File Transfer Protocol (FTP).

HTTP and FTP Asset Submission. Digital assets are transferred to the print service provider using the Hypertext Transfer Protocol (HTTP) and/or the File Transfer Protocol (FTP).

Output Intent

The output intent determines what the desired outcome of the printed product will be. The output intent ranges from a print buyer ordering a pre-specified product to a print buyer specifying a completely customized product.

Create a single printed product and purchase it. Systems using this approach allow a print buyer to specify a printed product and purchase it through the Web application. The digital assets supplied by the print buyer may be archived by the system for future orders.

Create a document and merge variable data. System allows the print buyer to specify a printed product with variable data fields. The print buyer supplies a data list to populate the variable data fields. The digital assets supplied by the print buyer may be archived by the system for future orders.

Order managed documents from asset library. This is a traditional print on-demand order management system for static printed products. A content owner uploads digital assets to a Web-based digital asset library. Printed products are produced as they are ordered. The print buyer making an order does not have to be the content owner supplying the original assets. Product customization is limited.

Use templatized documents to create product. The print buyer uses pre-designed layouts and documents templates to specify the printed product. The print buyer has limited options for personal customization.

Select print buyer-submitted digital assets to populate a templatized document. The print buyer submits digital assets and uses pre-designed layouts and documents templates to specify the final printed product. The digital assets supplied by the print buyer may be archived by the system for future orders.

Select print buyer-submitted digital assets to populate a customizable document. The print buyer submits digital assets and uses customized documents to specify the final printed product. The digital assets supplied by the print buyer may be archived by the system for future orders.

Select stock assets to populate a templatized document. The print buyer specifies a print product by selecting stock images or graphical elements from a digital asset library to populate a pre-designed layout or document template. The final product specified by the print buyer may be archived by the system for future orders.

Select stock digital assets to populate a customizable document. The print buyer specifies a print product by selecting stock images or graphical elements from a digital asset library to populate a customized document. The final product specified by the print buyer may be archived by the system for future orders.

Submit print-ready documents and order product. The print buyer submits print-ready documents that were created using print service provider-specified design and product constraints. The product design may use a completely customized

document or a document based on document template provided by the service provider. The final product specified by the print buyer may be archived by the system for future orders.

Proofing

Proofing provides simulation of the final printed product before it produced. Proofing is traditionally achieved by producing the printed product using the same printing process or a process designed to mimic the production process. The proof provides a contractual agreement between the print buyer and the print service provider. Web-enabled workflows are designed to efficiently produce products in quantities of one or greater. Requiring a physical proof can defeat the purpose of using a Web-enabled print production system. Systems using virtual (soft) proofing methods replace the need for traditional physical proofs.

Virtual proofing. The system utilizes virtual or soft proofing methods to simulate the final printed product. Product approvals are done virtually before final product production.

Hardcopy proofing. The system requires hardcopy proofs of the product to be examined and approved before final product production.

No proofing services. The system provides no formal proofing services or methods.

Business Transaction Complexity

The complexity of the business transaction can vary from simple payment by credit card to more traditional purchase orders or lines of credit provided by the print service provider.

Credit Card. Payment for the print services can be done via a credit card.

Purchase Order. Payment for the print services can be done via a purchase order.

Net Billing. Payment for the print services can be done via lines of credit established between the print buyer and the print service provider.

Distribution

Distribution plays an important role in the print supply chain. If a printed product does not arrive at its destination, it has failed to provide value or communicate its message. Distribution can also define how a printed product is specified and produced. A system designed to produce products of personal nature may differ from a system designed to make the product available to the open market.

Direct Distribution. The print buyer specifies the product. It is produced and shipped directly to the shipping address supplied at the time of the order.

List Distribution (Push). System utilizes list distribution methods to produce the product order and then ships the products to a list of recipients specified by the print buyer at the time of the order.

Private Distribution to Order (Pull). System uses a distribution method that permits only authorized buyers to order a print product. The content owner manages the authorization list.

Public Distribution to Order (Pull). System uses a distribution method thatpermits open access to the printed product. Anyone interested in buying the product is permitted to do so.

Ancillary Services

The use of a Web-enabled print production system removes many of the activities that provide little or no value to the product specification, production, and fulfillment processes. Use of these highly automated systems does not necessarily prohibit print service providers from providing ancillary services. There are opportunities to provide ancillary services that can be requested, purchased, and fulfilled directly through the main Web application or through a website or Web application integrated within the primary Web-based product specification system.

Storefront Services. Storefront services provide a Web-based marketplace where the content owners can sell their printed products. The print service provider furnishes the storefront and payment processing system.

Electronic Product Ordering. A print service provider furnishes the infrastructure to facilitate electronic distribution in an electronic format, such as an eBook or some other digital file format. Digital Rights Management (DRM) services can also be provided for electronic distribution.

Digital Asset Management Services. Once a print buyer has submitted complete or cellular digital assets, the print service provider manages the digital assets.

Design Services. Graphic design services are available to enhance the print buyer's final product or to provide design concepts for products under development.

Publishing Services. The service provider provides publishing services, such as editing, proofreading, International Standard Book Number (ISBN) distribution, and product marketing.

Distribution Services. The print service provider provides professional distribution services. This includes making the product available through wholesale channels and distributors.

A graphical representation of the system analysis instrument is shown in Figure 5.

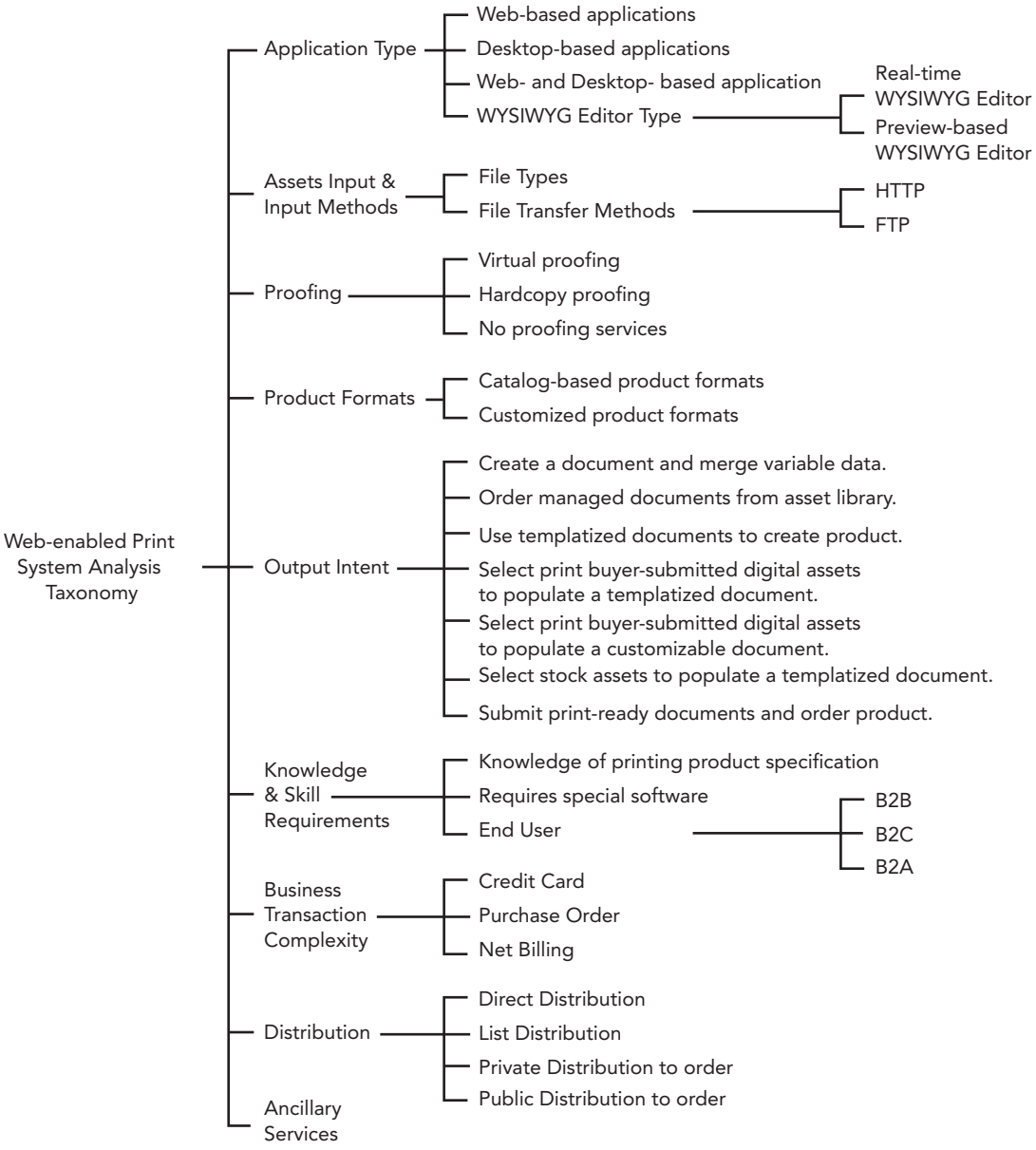

Figure 5. Graphical representation of system analysis instrument

Conclusion

The system-independent attribute descriptions outlined above provide a framework to evaluate current Web applications of a Web-enabled print production system. They also provide a set of questions to be asked during the initial planning stages when developing a Web application for a Web-enabled print production system. The questions provide a checklist of features a systems developer may wish to include in a Web application.

Section Two: Analysis of Service Providers

Section Two provides a content analysis of seven Web-enabled print service providers. The selection process for the Web-enabled print service providers is outlined in the Methodology section. The content analysis is based on the System Analysis Instrument presented in Section One. The findings are organized based on the product specification and distribution methods as listed below.

Order cataloged products with templatized customization using Direct Distribution

- MagicPrints
- Blurb
- ShutterFly
- Moo

Order cataloged products with design/content customization using Direct Distribution

- Lulu
- VistaPrint

Order cataloged products with templatized customization using List Distribution (Push)

- Cardstore.com

Site Analysis: MagicPrints (MagicPrints.com)

MagicPrints is a print service that enables print buyers to purchase business cards using templatized layouts or via the submission of completely customized documents conforming to business card product limitations and print production processes. The system uses a completely Web-based application to manage product specification and order fulfillment. MagicPrints is available to anyone wishing to use the service.

Results of Analysis

Application Type

The MagicPrint service utilizes a completely Web-based application to facilitate the transaction between the print buyer and itself. The Web application is comprised of Web page views and HyperText Markup Language (HTML) forms. The views provide service information, product status reports, digital asset management inventory, and order review. The HTML forms provide the input mechanism the print buyer uses to supply digital assets. The Web application uses the PHP: Hypertext Preprocessor programming language to handle data processing and dynamic Web page generation.

A preview-based WYSIWYG editor is employed to simulate product representation. This requires the print buyer to request a preview by submitting an HTML form button that instructs the server to generate a preview using the print buyer's supplied digital assets.

Knowledge and Skill Requirements

The MagicPrint service provides two product specification workflow paths. The first path is completely constrained by input templates that are mapped to locations on a templatized document. This path requires no knowledge of document design and layout principles, product limitations, or printing process limitations. Instead, the intelligence has been engineered into the templatized document. This workflow path also does not require any special software. A Web browser is all that is needed to completely specify and order business cards.

The second workflow path allows the print buyer to submit custom digital assets for the business card background or a completely customized print-ready business card. This path requires knowledge of document design and layout principles. Product limitations are addressed through a proofing process required directly after the print buyer uploads the customized digital asset. This workflow path requires special software to specify portions of the product or the complete print-ready document. The system is designed to be a business-to-business (B2B) and business-to-consumer (B2C) application allowing small business owners, the self-employed, or hobbyists to create professional-looking business cards.

Product Formats

MagicPrints uses a catalog-based product formats approach, and has constrained its product offering to two products: business cards and address labels. Both are only available in standard sizes (3.5 x 2 inches or 89 × 51 mm), with the print orientation either vertical (portrait) or horizontal (landscape).

Digital Assets Input and Input Methods

The MagicPrints Web application only allows digital assets to be supplied in a cellular form. The application supports submission of files in the JPG, PCX, BMP, PNG, TIFF, or PDF formats. Text elements are supplied via HTML form input fields that are mapped to a location on a templatized document. The application does not support the importing of text from a file. Digital assets are submitted to MagicPrints using the Hypertext Transfer Protocol (HTTP).

Output Intent

MagicPrints has built a system that enables the print buyer to create a single printed product and purchase it. Creation of the printed product uses an approach in which the print buyer submits digital assets to populate a templatized document. Advanced users of the MagicPrints system could use the system to submit print-ready documents by

submitting business card backgrounds containing all required type and design elements. Documents submitted in this fashion would have to be designed to take into account the limitations of the product and production processes.

Proofing

The MagicPrints Web application utilizes virtual (soft) proofing methods to simulate the final printed product. Before a business card order can be submitted to the production system, MagicPrints requires the card to be previewed and digitally approved using a "terms and agreement" checkbox that limits MagicPrint's liability for typographical errors, misspellings and omissions. Hardcopy proofing services are not provided.

Business Transaction Complexity

MagicPrints does not require the establishment of a formal business relationship for print buyers to use its printing services. Payment for print services is handled using a credit card. The creation of an account is optional and does not need to be established to begin specification of a business card or to complete a business transaction. Optional account creation can occur at the time of checkout. Creating an account with MagicPrints provides the ability to order reprints without having to re-specify a business card and provides functionality to track orders.

Distribution

MagicPrints uses direct distribution to ship a print buyer's finished product directly to the shipping address supplied at the time of the order. No other distribution methods are employed.

Ancillary Services

Digital asset management is provided for the print-ready business cards. The final print-ready file cannot be altered. Business cards needing customer alterations must be entirely re-specified. MagicPrint does not provide download access to the file used for production.

Site Analysis: Blurb (Blurb.com)

Blurb provides high-quality photo book publishing to the consumer and prosumer market. Utilizing a mix of Web- and desktop-based software applications, they have built a system that makes it easy to specify, order, and sell printed book products.

Results of Analysis

Application Type

Blurb uses the Web- and desktop-based application approach. A Web-based application is used to facilitate account and order management. The Web application is comprised

of Web page views and HyperText Markup Language (HTML) forms. A print buyer specifies products using Blurb's proprietary BookSmart desktop application. The proprietary application is Java-based, providing cross-platform support (both MS Windows and Mac OS). The application utilizes the Java Advanced Imaging API, the iText PDF document generation library, and the Swing graphical user interface (GUI) toolkit. Swing's "Pluggable" architecture is implemented to allow the application to inherit the native GUI look and feel of the operating system on which it is runs. The application uses a Real-time WYSIWYG Editor that allows the print buyer to use drag-and-drop actions to manipulate the images, graphical, and textual elements. The BookSmart application does not require a persistent Internet connection except when transferring data to Blurb's production system.

Knowledge and Skill Requirements

Through the use of pre-designed themes and document layouts, the BookSmart software application removes many of the skills required to design and layout a professional photo book. The application uses a wizard-based guide at the beginning of a project to assist the print buyer in determining the physical dimensions of the book, the basic layout, and the location of the photos to be imported. The application provides an "autoflow" function that can be used to place photos based on date or a file name. The photos can be rearranged using intuitive drag-and-drop actions.

To manage an account or book already in Blurb's digital asset library, the only application required is a Web browser. Blurb requires the BookSmart application for the specification of products and provides this free of charge.

Blurb's approach to product specification lends it to being a business-to-consumer (B2C) service. However, the streamlined approach to product specification could make the service worthwhile to some professional photo publishers.

Product Formats

Blurb has constrained its product offerings to a catalog of book types and sizes. It offers four different book formats: 10x8 inches, 8x10 inches, 13x11 inches, and 7x7 inches. The size available depends on the book format. For example, the cookbook product line is only available in 2 formats: 8x10 inches and 7x7 inches. Pricing depends on book format, but is independent of product type.

Digital Assets Input and Input Methods

The BookSmart application only allows digital assets to be supplied in a cellular form. Images are added to a book project through an import mechanism. The application only supports JPEG and PNG file formats in an RGB color space. Text elements are supplied via template input fields embedded in the design template. The application does not support the importing of text from a file. Finished projects are submitted to Blurb as a print-ready PDF using the Hypertext Transfer Protocol (HTTP).

Output Intent

The output intent is dependent on the print buyer using the system. Blurb's primary focus is to allow a print buyer to create a single printed product and purchase it. However, they allow print buyers to order managed documents from their storefront.

For print buyers using the system to create a single printed product and purchase it, the system constrains the buyer to using pre-designed layouts and document templates to specify the printed product. The print buyer has limited options for customizing the layout or product theme. Blurb retains the copyrights to the product templates and themes used within a book. Once a book has been published, the print buyer has the opportunity to enroll in Blurb's Set Your Price Program, allowing the book to be sold through Blurb's bookstore.

Proofing

The BookSmart application utilizes virtual (soft) proofing methods to simulate the final printed product. BookSmart refers to this as a preview, and requires the book to be previewed before being submitted to the production system. The application also allows the print buyer to print all or part of a book on a local printer for physical inspection.

Business Transaction Complexity

Blurb allows the print buyer to establish a business relationship using its Web site. Blurb does not restrict anyone from creating an account or accessing and using its BookSmart application. To order print services from Blurb, the print buyer is required to use a credit card for payment.

Distribution

Blurb uses direct distribution to ship a print buyer's finished product directly to the shipping address supplied at the time of the order. They also provide public and private distribution to fulfill orders purchased through its Web storefront. Books can be made public, making them available for purchase to anyone browsing the bookstore, or they can be made private, requiring an invitation from the content owner to purchase the book. Distribution fees based on the level of distribution service are charged to the print buyer.

Ancillary Services

Blurb's primary focus is to allow a print buyer to create a single printed product and purchase it. They also provide a Web storefront, the Blurb Bookstore, to enable customers to sell their books to interested third parties. Blurb furnishes the storefront and payment processing system used to facilitate transactions.

Blurb provides digital asset management for the print-ready files of books submitted to its system. However, if the print buyer does not order an initial print of the book, Blurb

deletes it from its system after thirty days. Blurb does not provide download access to the uploaded print-ready PDF file, and the file cannot be used to restore a book project within the BookSmart application.

Site Analysis: Shutterfly (shutterfly.com)

Shutterfly provides digital photo printing and personalized photo books, calendars, greeting cards and other photo products to the consumer market. The system uses a completely Web-based application to manage product specification and order fulfillment.

Results of Analysis

Application Type

Shutterfly utilizes a completely Web-based application to facilitate the specification of products and to handle the transaction between the print buyer and itself. The Web application comprises static Web page views and HyperText Markup Language (HTML) forms and a Java-based Rich Internet Application (RIA) interface. The RIA provides desktop-like application functionality to the Shutterfly Web application. The application uses a Real-time WYSIWYG Editor that allows the print buyer to use drag-and-drop actions to place images. A preview-based WYSIWYG editor is employed to preview the result of image manipulation tasks such as rotating or scaling. Preview-based WYSIWYG editing is also used during the specification of text elements. The completely Web-based nature of the Shutterfly application requires a persistent connection for application tasks.

Knowledge and Skill Requirements

Through the use of pre-designed themes and document layouts, the Shutterfly Web application removes many of the skills required to design and layout a professional photo book. The Web application uses templatized documents to minimize knowledge of document design and layout principles, product limitations or printing process limitations. Instead, this intelligence has been engineered into the templatized document. For some of the print applications offered by Shutterfly, such as greeting or note cards, all knowledge of printing product specification has been removed. The workflow for these print applications uses a simple HTML form to map the placement of a digital asset to a location on a templatized document. Customization beyond selection of the image is not permitted.

Shutterfly's services seem to be aimed at the consumer and prosumer photo markets. Many of the print applications are consumer products, such as cards, calendars, photo books, and other photo accessories. Finished products also contain Shutterfly brand elements.

Product Formats

Shutterfly has constrained its offerings to a catalog of products. They offer four different book types that are in a fixed format, but these can range in page count depending on the number of photos the print buyer wishes to publish. Shutterfly has set a minimum and maximum page range. They also offer three different fixed-size card products and a single photo calendar product. Shutterfly also provides traditional photofinishing services.

Digital Assets Input and Input Methods

The Shutterfly Web application only allows digital assets to be supplied in a cellular form. Shutterfly only accepts files in the JPEG format. Text elements are supplied via HTML form input fields that are mapped to a location on a templatized document. The application does not support the importing of text from files. Digital assets are submitted to Shutterfly using the Hypertext Transfer Protocol (HTTP).

Output Intent

Shutterfly has built a system that enables the print buyer to create a single printed product and purchase it. The print buyer submits digital assets to a digital assets library. Digital assets can then be used to populate a templatized document.

Proofing

The Shutterfly Web application utilizes virtual (soft) proofing methods to simulate the final printed product. For its card products, Shutterfly also includes a simulation of the product in the context of a real-life setting. For example, a greeting card with the print buyer's specified digital asset is simulated sitting on a desk next to a pen. Hardcopy proofing services are not provided.

Business Transaction Complexity

Shutterfly allows the print buyer to establish a business relationship using its Web site and does not restrict anyone from creating an account. Shutterfly requires the print buyer to use a credit card to pay for print services.

Distribution

Shutterfly uses direct distribution to ship a print buyer's finished products directly to the shipping address supplied at the time of the order. No other distribution methods are employed.

Ancillary Services

Digital asset management services are provided to users of Shutterfly free of charge and without storage or file size limits. The system allows the print buyer to share photos via a personalized online gallery. Photos shared online can be kept private by requir-

ing an invitation and pass-phrase to view, or they can be made public. Shutterfly offers a Shutterfly Pro Galleries service that allows photographers to set up storefronts to sell their work.

Site Analysis: Moo (Moo.com)

Moo is a United Kingdom-based print service provider that offers a single novelty printed product called Moo MiniCards. Moo has formed strategic partnerships with Web 2.0 companies to offer streamlined specification and order fulfillment of its 1.1" X 2.75" MiniCard product. This analysis examines the Web application Moo has developed to integrate with the Flickr online photo community. The system uses a completely Web-based application to manage product specification and order fulfillment. Moo is available to anyone wishing to use the service.

Results of Analysis

Application Type

Moo utilizes a completely Web-based application to facilitate order specification. The Web application is comprised of Web page views and HyperText Markup Language (HTML) forms and a JavaScript-based Rich Internet Application (RIA) interface. The RIA provides drag-and-drop functionality used to select digital assets. The views provide service information, product status reports, and order review. The Web application uses a Real-time WYSIWYG Editor that allows the print buyer to determine how images will be cropped and how text will appear on the finished product. A preview-based WYSIWYG editor is employed to simulate product representation after the image is cropped. The completely Web-based nature of the Moo application requires a persistent connection for all application tasks.

Knowledge and Skill Requirements

The Moo MiniCard order process takes four simple steps: Choose, Crop, Personalize, and Purchase. The order workflow requires no knowledge of document design and layout principles, product limitations or printing process limitations. This intelligence has been engineered into the templatized MiniCard document. The Web application does not require any special software; a Web browser is all that is needed to completely specify and order MiniCards cards.

Product Formats

Moo uses a catalog-based product format approach and has constrained its product offering to one product: the MiniCard. The MiniCard card is 1.1" X 2.75" and is printed in four colors on both sides. The front of the card is a photo or graphic and the card back is a mix of text and icons. Moo MiniCards are ordered in quantities of 100.

Digital Assets Input and Input Methods

The Moo Web application only allows digital assets to be supplied in a cellular form and only accepts files in the JPEG format. The Web application uses the Flickr online photo gallery service to provide digital asset input. Text elements are supplied via HTML form input fields that are mapped to a location on a templatized document. The application does not support the importing of text from a file. Digital assets are submitted to Moo using the Hypertext Transfer Protocol (HTTP).

Output Intent

Moo has built a system that enables the print buyer to create a single printed product and purchase it. The print buyer specifies the print order by selecting stock images or graphical elements from their Flickr digital asset library to populate a pre-designed document template.

Proofing

Moo utilizes virtual (soft) proofing methods to simulate the final printed product. Product approvals are done virtually before the final production order is submitted. Hardcopy proofing services are not provided.

Business Transaction Complexity

Moo requires the print buyer to have an account with the Flickr online photo gallery services. Moo allows the print buyer to establish a business relationship using its Web site and does not restrict anyone from creating an account. The print buyer is required to use a credit card or PayPal to pay for print services.

Distribution

Moo uses direct distribution to ship a print buyer's finished product directly to the shipping address supplied at the time of the order. No other distribution methods are employed. The final product is manufactured in the United Kingdom.

Ancillary Services

Moo does not provide any ancillary services.

Site Analysis: Lulu (Lulu.com)

Lulu is the premier service provider for self-publishers. It offers a variety of print and digital media products. Printed products include traditional paperback and hardcover books, calendars, and brochures. Digital media products include eBooks, CD- and DVD-ROMs, images, video, and software. Lulu provides the composition services and customer care for its product offerings, but outsources the production and distribution of the finished product. This analysis includes only Lulu's printed product offerings.

Results of Analysis

Application Type

The Lulu print specification system utilizes a completely Web-based application to facilitate the transaction between the print buyer and itself. The Web application is comprised of static Web page views and HyperText Markup Language (HTML) forms. The static Web page views provide service information, product status reports, digital asset management inventory, and order review. The HTML forms provide the input mechanism the print buyer uses to supply digital assets. The Web application uses the PHP: Hypertext Preprocessor reflective programming language to handle data processing and dynamic Web page generation.

A preview-based WYSIWYG editor is employed to simulate product representation. This requires the print buyer to request a preview by submitting an HTML form button that instructs the server to generate a preview using the print buyers' supplied digital assets.

Knowledge and Skill Requirements

Lulu has engineered its system so that anyone can successfully use it to submit project files and order printed products. However, the level of graphic art and print production knowledge required to successfully do this varies depending on the printed product being ordered. Lulu's book products require more knowledge than the calendar products. The following provides further analysis of knowledge requirements for Lulu's book and calendar products.

Book products. The specification of book products is constrained by product format and file formats the print buyer is permitted to submit. Content submitted in a permitted file format does not undergo any analysis or validation to determine if it meets the requirements of the production processes. The Web application will automatically scale any assets to meet the product format. Lulu's book publishing services require special software. The content of a book submitted to the system must be specified in a third-party application. The software application used to specify the product design can range from Microsoft Word to Adobe InDesign or any software application that can be used to create a PDF file. This requirement adds a level of complexity to the system that may deter use of the print service. However, it provides a streamlined service for print buyers with knowledge of graphic art applications.

Calendar products. The specification of calendar products is constrained using an HTML form that maps the print buyer's photos to the photo pages of the calendar. This requires no knowledge of document design or layout principles, product limitations, or the limitations of printing process. This intelligence has been engineered into the templatized document. The only specialized software required in this workflow is photo editing software to make any desired image alterations.

Lulu's Web-enabled application provides services geared towards both business-to-business (B2B) and business-to-consumer (B2C) audiences. While its book product specification workflow may require special skills and knowledge of the graphic arts, Lulu has built a support system that provides peer-to-peer and Lulu-to-buyer support to print buyers using the system.

Product Formats

Lulu uses a catalog-based product approach and has constrained its product offerings to four different print applications: paperback books, hardcover books, calendars, and brochures. Product offerings are further constrained by a catalog of product sizes, colors, and finishing options. While product formats are constrained, Lulu's system allows almost complete customization of the content.

Digital Assets Input and Input Methods

Digital asset submission depends on the product being specified. The Web application only allows digital assets to be supplied in a cellular form for calendar products. Supported file formats for calendars are JPG, GIF, and PNG. Text elements such as photo captions and events are submitted using HTML form input fields that are mapped to a location on a templatized document. Book products require the complete specification of the book body using a third-party software application. File formats permitted by the system are Microsoft Word, Rich Text Format, Microsoft Excel, Microsoft Works, WordPerfect, OpenOffice (.rtf or .doc) or a print-ready PDF. The book cover can be specified using a third-party application or created using a Lulu-supplied cover template. The PDF file format is the only file type permitted for print buyer-submitted covers.

Digital assets are primarily submitted to the Lulu production system using the Hypertext Transfer Protocol (HTTP). For larger files or batch submission, Lulu allows the print buyer to use the File Transfer Protocol (FTP). Files submitted using FTP are available for use via the Web application once they have been successfully uploaded.

Output Intent

The output intent is dependent on the print buyer using the system. Lulu's primary focus is to allow a print buyer to create a single printed product and purchase it. However, a major part of the Lulu service offering is allowing print buyers to sell their print products through Lulu's storefront. In this role, Lulu provides traditional print on-demand order management services. The print buyer in this scenario is ordering managed documents from an asset library and has no opportunity to specify or request product customization.

Proofing

Lulu's Web application utilizes virtual (soft) proofing methods to simulate the final printed product. A print-ready PDF is used as the medium for displaying the proof.

Lulu also recommends that print buyers purchase a hardcopy for proofing purposes before selling a product in the Lulu Marketplace. By providing access to the PDF files that will be used in production, the print buyer may also utilize local printing resources to produce a hardcopy proof.

Business Transaction Complexity

Lulu allows the print buyer to establish a business relationship using its Web site. This applies to print buyers using the system to specify and order products and to print buyers by products in the Lulu Marketplace. All activities beyond casual browsing of the Web site require the print buyer to create an account. To order print services from Lulu, the print buyer is required to use a credit card for payment.

Distribution

Lulu uses direct distribution to ship a print buyer's finished product directly to the shipping address supplied at the time of the order. They also provide public distribution to fulfill orders purchased through its Web storefront. Books can be made public, which makes them available for purchase to anyone browsing the Lulu Marketplace. Distribution fees based on the quality of distribution service are charged to the print buyer.

Ancillary Services

The primary services provided by Lulu are the production of printed and digital media products and the Web storefront to facilitate the sale of its customers' products. Lulu also facilitates a number of ancillary services through its Services Marketplace in which Lulu-approved third-party service providers can advertise their services. Third-party services include: copy-editing, proofreading, formatting, graphic design, marketing, and other publishing services. Lulu furnishes the business transaction platform and individual service providers set prices for these services.

Site Analysis: VistaPrint (VistaPrint.com)

VistaPrint is a provider of print and graphic design services to small businesses and consumers. They offer products based on templatized documents or custom designs provided by the print buyer. The system uses a completely Web-based application to manage product specification and order fulfillment. VistaPrint's services are available to anyone.

Results of Analysis

Application Type

The VistaPrint service utilizes a completely Web-based application to enable the order specification and business transaction. The Web application includes Web page views, HyperText Markup Language (HTML) forms, and a JavaScript-based Rich Internet

Application (RIA) interface. The RIA provides drag-and-drop functionality used to select digital assets. The views provide service information, product status reports, and order review. The HTML forms provide the input mechanism the print buyer uses to supply digital assets. A preview-based WYSIWYG editor is employed to simulate product representation. This requires the print buyer to request a preview by submitting an HTML form button that instructs the server to generate a preview using the print buyer's supplied digital assets.

Knowledge and Skill Requirements

The VistaPrint service provides two product specification workflows. The first workflow is completely constrained by input templates that are mapped to locations on a templatized document. The workflow requires no knowledge of document design and layout principles, product limitations or printing process limitations. This intelligence has been engineered into the templatized document. No special software is required to use this workflow; all product specification can be accomplished via the Web application. The second workflow allows the print buyer to submit custom digital assets that completely specify the design of the product. This workflow requires knowledge of printing product specification and special software to facilitate product design. In order to assist print buyers using their own designs, VistaPrint provides a number of templates in popular native application formats.

The system is designed to be a business-to-business (B2B) and business-to-consumer (B2C) application allowing small business owners, the self-employed, or hobbyists to create professional-looking printed products.

Product Formats

VistaPrint has constrained its offerings to a catalog of 48 different products which are limited to select sizes and formats. They allow quantities from 10 to 20,000 to be ordered, depending on the product. VistaPrint's products consist of business identity pieces such as business cards, letterheads, and envelopes, and marketing materials including postcards, brochures, and flyers.

Digital Assets Input and Input Methods

Using VistaPrint's design template workflow requires text elements to be submitted via HTML form input fields that are mapped to a location on a templatized document. The application does not support the importing of text from a file. The custom design workflow allows print buyers to submit digital assets in a number of file formats. Permitted formats include PDF, Adobe Illustrator, Adobe Photoshop, BMP, CorelDRAW, GIF, JPEG, PCX, PICT, PNG, PostScript, Scalable Vector Graphics, TARGA , and Windows Enhanced Metafile. While VistaPrint offers flexibility in the number of supported formats, it recommends that digital assets be submitted in either the PDF, Adobe Illustrator, or Adobe Photoshop formats. The maximum upload file size is 5 megabytes. Digital assets for both the design template and custom design workflows are submitted to VistaPrint using the Hypertext Transfer Protocol (HTTP).

Output Intent

VistaPrint has built a system that enables the print buyer to create a single printed product and purchase it. The print buyer can use templatized documents to create the product or submit print-ready documents meeting VistaPrint's product specifications. VistaPrint does not allow a print buyer to submit a completely customized product format.

Proofing

The VistaPrint Web application utilizes virtual (soft) proofing methods to simulate the final printed product. Before a product order can be submitted to the production system, VistaPrint requires the product to be previewed and digitally approved. Hardcopy proofing services are not provided.

Business Transaction Complexity

VistaPrint allows the print buyer to establish a business relationship using its Web site and does not restrict anyone from creating an account. VistaPrint requires the print buyer to use a credit card or electronic check/bank transfer to pay for print services.

Distribution

VistaPrint uses direct distribution to ship a print buyer's finished products directly to the shipping address supplied at the time of the order. No other distribution methods are employed.

Ancillary Services

VistaPrint provides digital asset management services free of charge to its customers. Digital assets include products that were specified using VistaPrint's design template workflow or any assets submitted using the custom design workflow. VistaPrint does not provide access to print-ready files.

Site Analysis: CardStore.com

CardStore.com provides personalized greeting card design, production, and distribution services. The system uses a completely Web-based application to manage product specification and order fulfillment. The service is available to everyone.

Results of Analysis

Application Type

The CardStore.com service utilizes a completely Web-based application to facilitate the order specification and business transaction between the print buyer and itself. The Web application comprises static Web page views and HyperText Markup Language (HTML) forms. The static views provide service information, product status reports,

and order review. The HTML forms provide the input mechanism the print buyer uses to supply digital assets. A preview-based WYSIWYG editor is employed to simulate product representation. This requires the print buyer to request a preview by submitting an HTML form button that instructs the server to generate a preview using the print buyer's supplied digital assets. The completely Web-based nature of the CardStore.com application requires a persistent connection for application tasks.

Knowledge and Skill Requirements

The CardStore.com order process takes three simple steps: Card Selection, Message Personalization, and Purchase. The order workflow requires no knowledge of document design and layout principles, product limitations or printing process limitations. This intelligence has been engineered into the templatized card document. The Web application does not require any special software; a Web browser is all that is needed to completely specify and order products from CardStore.com.

Product Formats

CardStore.com uses a catalog-based product formats approach and has constrained its product offering to three different greeting card sizes. These three sizes are used to create a catalog of greeting cards for a number of different occasions including holiday themes, birthday, graduation announcements, wedding announcements, and invitation cards, among others.

Digital Assets Input and Input Methods

The CardStore.com Web application only allows digital assets to be supplied in a cellular form and only accepts files in the JPEG format. Text elements are supplied via HTML form input fields that are mapped to a location on a templatized document. The application does not support the importing of text from a file. The address book functionality uses HTML form input fields or file upload to populate a print buyer's contact list used during distribution specification. Digital assets are submitted to Cardstore.com using the Hypertext Transfer Protocol (HTTP).

Output Intent

The CardStore.com system enables the print buyer to create a single printed product and purchase it. The print buyer has the option to use stock imagery or submit custom digital assets. The system uses pre-designed layouts and document templates to specify the final printed product.

Proofing

The CardStore.com Web application utilizes virtual (soft) proofing methods to simulate the final printed product. Hardcopy proofing services are not provided.

Business Transaction Complexity

CardStore.com allows the print buyer to establish a business relationship using its Web site and does not restrict anyone from creating an account. The print buyer is required to use a credit card to pay for print services. No other payment methods are accepted.

Distribution

CardStore.com utilizes list distribution methods to produce the product order and then ships the products to a list of recipients specified by the print buyer at the time of the order. The list can be specified at the time of order or uploaded to the print buyer's CardStore.com Address Book.

Ancillary Services

CardStore.com does not provide any ancillary services.

Site Analysis Key Findings

The goal of the site analysis was to determine if the Site Analysis Instrument presented in Section One provides the vocabulary to accurately describe the Web application used in a Web-enabled print workflow. Additionally, the site analysis provides an overview of seven different approaches to Web-enabled print. Although each Web-enabled print service provider analyzed took a unique approach to build its service offerings, there are some similarities between each system.

Table 2. Tabulated results from site analysis

Software Application Type	Count	Proofing	Count
Web-based application	6	Virtual proofing	7
Desktop-based application	0	Hardcopy proofing	0
Web- and Desktop-based application	1	No proofing services	0
Real-time WYSIWYG Editor	2		
Preview-based WYSIWYG Editor	5	Business	
		Credit Card	7
Knowledge and Skill Requirements		Purchase Order	0
Requires special software	1	Net Billing	0
Product Formats		Distribution	
Catalog-based product formats	7	Direct Distribution	7
Customized product formats	0	List Distribution (Push)	1
		Private Distribution to order (Pull)	1
Digital Assets Input and Input Methods		Public Distribution to order (Pull)	1
File Formats	6		
Cellular Assets Only (JPG, TIFF, ASCII Text)	1	Ancillary Services	
		Storefront Services	2
HTTP Asset Submission	6	Electronic Product Ordering	1
FTP Asset Submission	0	Digital Asset Management Services	7
HTTP and FTP Asset Submission	1	Design Services	1
		Publishing Services	1
		Distribution Services	

Application Type

A majority of the print service providers utilize completely Web-based applications to handle the product specification and order management tasks. Blurb uses a desktop-application to handle product specification, but relies on a Web-based application to manage account and order management tasks. Rich Internet Application (RIA) technol-

ogy has reached a point that many features and functionality traditionally associated with desktop applications such as drag-and-drop can now be deployed within the Web browser. Many of the features found in Blurb's BookSmart application can be implemented within the Web browser using standard Web technologies such as HTML, CSS, JavaScript, and XML. Embedded Web browser plug-ins can be utilized to address any shortcomings of the standard Web technologies. Completely Web-based applications provide a number of benefits over desktop applications. Bug fixes and new features can be silently released without having to update software on the user's computer.

Knowledge and Skill Requirements

All of the print service providers analyzed have built workflows that minimize the knowledge of printing product specification required to successfully order some or all of their print services. Lulu provides both print services that can be used without any special skills and print services that are designed to meet the requirements of users with design and printing product specification knowledge. The analysis of all the systems shows that requiring no special software and using a completely Web-based approach almost eliminates all special knowledge and skill requirements needed to successfully use the system.

Product Formats

All of the print service providers analyzed constrain product offerings to a limited number of products and product formats. This approach is essential not only in building low-barrier-to-entry Web applications, but also in designing process-integrated production systems that can efficiently produce products.

Digital Assets Input and Input Methods

Digital asset formats are constrained to a select number of formats. PDF, JPEG, GIF, and PNG formats are utilized by a number of the systems. These are popular business and consumer formats, and a number of propriety and open source software libraries exist to manipulate these file types. While Hypertext Transfer Protocol (HTTP) can be a slower protocol for data transmission, it is being successfully used by all the service providers analyzed. Lulu provides an additional File Transfer Protocol (FTP) submission for large files.

Output Intent

All the systems allow the print buyer to specify a printed product and purchase it through the Web. Using templatized documents to create product is the common approach. This enables the service provider to use a more streamlined order specification workflow. Highly constrained template-driven workflow enables complete specification of the printed product in three or four steps. None of the service providers allow completely customized products to be specified. Building automated systems for these types of products is not commercially possible at this time.

Proofing

All of the print service providers use virtual (soft) proofing methods to replace the need for traditional physical proofs. None of the services offer hardcopy proofs. If the print buyer requires hardcopy proofs, a single copy of the product must be ordered.

Business Transaction Complexity

A business relationship can be established with all of the service providers over the Internet. This process is as simple as creating an account by filling out an HTML form. All the service providers require payment for the print services to be done via a credit card.

Distribution

The most common distribution method is to produce the product and ship it directly to the shipping address supplied at the time of the order. The book publishing services (Lulu and Blurb) also provide storefronts for the content owner to sell their products. These two services use both private distribution-to-order methods that permit only authorized buyers to order a print product and public distribution-to-order methods that allow anyone interested in buying the product to do so.

Ancillary Services

A number of the service providers provide digital asset management services to assist the print buyer in re-ordering products. However, the capabilities of the digital asset management services are limited. Most of the systems do not provide download access to the digital assets once submitted to the system. A popular service is providing Web storefronts that enable customers to sell their products. The print service providers furnishing storefront services have further opportunities to generate revenue by placing a service fee on each product a customer sells.

Section Three: Case Studies

The two companies studied are positioned on opposite ends of the system development spectrum. Merrill Press started as a small local commercial printer and built its Web-enabled print production system architecture without heavily investing in machinery or human capital. On the other end of the spectrum is Lighting Source Incorporated (LSI), a heavily funded venture of Ingram Industries. Ingram is a large private company with business subsidiaries that include Ingram Book Group, Ingram Barge Company, and Ingram Insurance Group. A large team of business analysts, printing specialists, and system and software engineers built the Lightning Source system architecture from the ground up to support its Books on Demand and eBook distribution services. The cost of building the company was enormous. It took seven years of operation before the company became profitable.

Each company applied a different development strategy to building its system architecture, but both companies' efforts resulted in a turnkey production system that uses the

Web to efficiently manage print procurement and production processes. These systems have been engineered to minimize the non-value-added activities associated with customer service and order specification by capturing all business and product description data required to produce and fulfill the print product order.

Case Study One: Merrill Press

Merrill Press was founded in 1986 in Buffalo, New York. It is a general commercial printer specializing in the production of printed marketing communication solutions. Products include catalogs, business communications, sell sheets, and point-of-purchase materials. The company utilizes both traditional offset lithographic and digital printing presses to manufacture its customers' products.

In 1999, company owner Michael Gotthelf saw an opportunity to use the Internet to streamline order specification and business card production. This led the company to develop its Quickbizcards.com system, an order specification system that applies a web-enabled customized document approach to create template-based print-ready documents. The system is customized for each client and includes brand and identity management functionality. In some situations, Merrill includes the custom development of the order specification system as an incentive to attract new business.

In a 2006 interview, Gotthelf said Merrill Press had used the system to print five million business cards for one of their Fortune 500 clients. Based on the success of its corporate offerings, the company developed a second web-based system to make web-based business card specification and order fulfillment available to everyone.

System Development Methodology

After determining that off-the-shelf software applications would not meet its application requirements, Merrill Press decided to develop a custom web application in-house. Leveraging open-source software such as GNU/Linux, Apache web server, PHP: Hypertext Preprocessor, and the MySQL database engine, Merrill developed a web application framework that enables it to efficiently build custom web-based order specification systems for their corporate Quickbizcards.com system.

The same open-source technology used for the Quickbizcards.com system was used to develop a new service called MagicPrints.com. MagicPrints is a web-based service for producing business cards. To decrease the time to market, Merrill hired local university students to work part-time on the development of the MagicPrints.com web application.

Workflow

The Merrill Press Quickbizcards and MagicPrints services are both web-based order specification applications that streamline the production of business cards. Both systems rely on slightly different business and production workflows to produce the same end product. Figure 6 illustrates the Quickbizcards.com workflow.

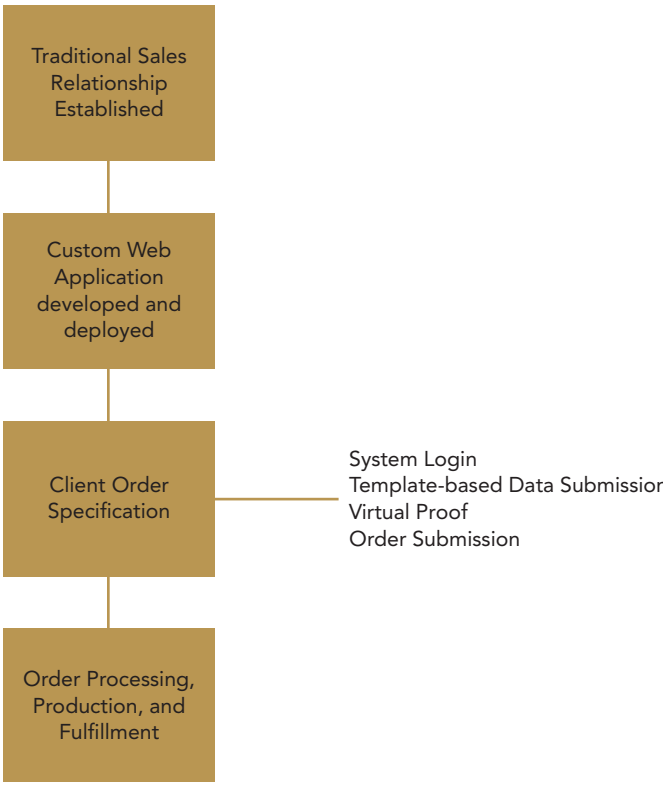

Figure 6. Quickbizcards.com workflow at Merrill Press

The customized nature of Merrill's Quickbizcards service requires a traditional sales relationship to be established between Merrill and a company wishing to use the system. The sales relationship is used to collect the print application requirements and business logic that specify the parameters that guide the development and deployment of the customized order specification system. Once the order specification system has been deployed, the customer service interaction between Merrill Press and a client is mainly through the web application. An established customer using the Quickbizcards.com service does not need to interact with a Merrill representative to order business cards. All order specification and customer service is handled through the web application. Invoicing is setup through the sales relationship.

Merrill's MagicPrints service uses a different approach to customer service and relationship management. Unlike the Quickbizcards service, Merrill's MagicPrints.com service does not require an established business relationship with Merrill Press. Anyone can visit the Web site and order business cards using the Web-based templated document creation workflow. The MagicPrints.com web application handles all the details required to produce and fulfill a business card order. Figure 7 illustrates the MagicPrints.com workflow.

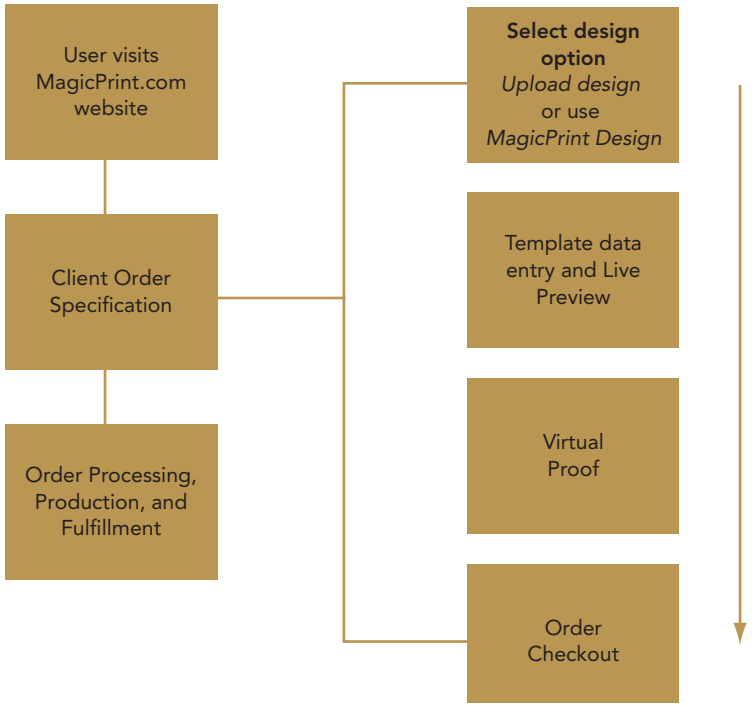

Figure 7. MagicPrints.com workflow at Merrill Press

The MagicPrints.com workflow has been engineered to enable customers to create business cards with little effort or knowledge of print application design or specification. Using the MagicPrint design templates, a customer can specify and order business cards in minutes. For customers seeking more design freedom, the system provides an upload mechanism for custom background. In a 2006 interview, Merrill's IT Manager, David Setzer, said the day-to-day challenges with the MagicPrints service are not technological, but providing post-sale customer care that includes addressing perceived product expectations such as on-screen versus printed color matching. To address some of these issues, Merrill has specified terms and conditions for the MagicPrints service that limit its responsibility for typographical errors, misspellings and omissions that are the result of customer negligence.

Web-Enabled Strategy

Merrill Press does not offer Web-enabled print production as an ancillary or value-added service. Instead, it is a core part of the company's business strategy. Merrill Press has developed a workflow that has been engineered to efficiently specify and produce a single product: business cards. Using this methodology, Merrill has constrained the number of variables its workflow system needs to handle. This allows Merrill to use a high level of automation in the order specification and entry stage—a stage that is typically full of manual and redundant non-value-added tasks. The automated system provides all the required information to fulfill an order and minimizes the turnaround time for print orders.

Case Study Two: Lightning Source Incorporated

Launched in 1997 as a subsidiary of Ingram Industries Incorporated, Lightning Source Incorporated is a market leader in on-demand book production and supply chain management services to the publishing industry. Lightning Source's headquarters and principle production facility are located in La Vergne, Tennessee. It has operated a production facility in the United Kingdom since 2001. In early 2007, Lightning Source announced plans to open a second production facility in the United States in Lehigh County, Pennsylvania.

As of 2006, Lightning Source has partnered with 3,500 publishers and amassed a digital library containing 350,000 book titles, of which 250,000 are print titles and 100,000 are eBook titles. Its large eBook library makes Lightning Source the largest eBook distributor in the world. Lightning Source uses a highly automated order and production management system, a combination of monochrome and color digital production presses from IBM and HP Indigo, and near-line binding and finishing systems to manufacture between 850,000 and 1 million books per month. Lightning Source guarantees books will enter the distribution channel 24 hours after an order has been submitted. Since its inception, more than 25 million books have been manufactured on-demand.

In a 2006 interview, Senior Vice President and General Manager Charles Marshall said that Lightning Source's Book on Demand solutions help publishers reduce inventory, minimize re-print decision risks, free up capital, and decrease production and distribution turnaround time. The company is able to do this by leveraging print-on-demand technology and inventory management strategies.

System Development Methodology

Lightning Source has a dedicated system and software engineering team that is responsible for developing and maintaining its information systems. All information systems used by Lighting Source have been custom-engineered in-house to meet its print application and production requirements. This includes its web-based accounting, content submission, and e-commerce systems, its production planning and management system, and its prepress systems. The digital front-end systems used to control the digital printing presses have also been developed in-house.

Workflow

Lightning Source relies on the Internet to facilitate most of its business relationship management and customer communications. Publishers wishing to use Lighting Source's on-demand production and distribution services establish a business relationship by opening an account on its website. Once an account has been opened, publishers can use the Web-based account management system to view customer communications, submit titles, accept proofs, manage digital library inventory, view financial reports, and submit production orders. Figure 8 illustrates the Lighting Source content and order submission workflow.

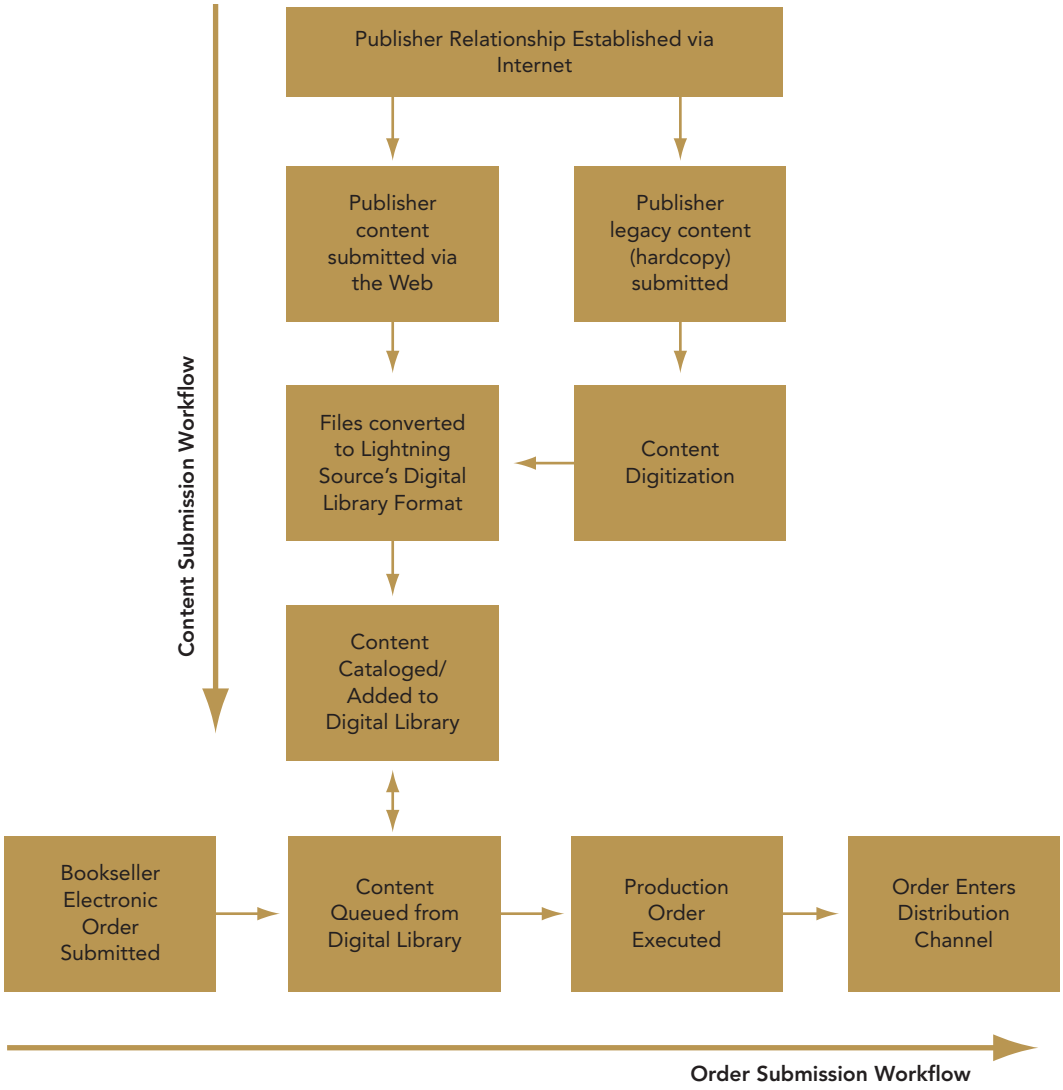

Figure 8. Content and order submission workflow at Lightning Source

Lighting Source's content submission workflow has been engineered to allow publishers to efficiently submit book titles in digital format. The digital submission system accepts the Adobe Portable Document Format (PDF) and Adobe PostScript page description formats, as well as Adobe InDesign and QuarkXPress native application files. Lighting Source provides book digitization services for legacy titles not in a digital format. Lighting Source also provides traditional design and digital prepress services during the file submission process.

The process of adding content to Lighting Source's digital library is still handled manually: a prepress associate at Lighting Source inspects and preflights all files before they are added the digital library. This process reduces file submission errors that may cause production problems. For large quantity submissions, Lighting Source has a process in

place that streamlines the content submission process by allowing publishers to submit certified digital files. First-time users of the service are required to sign off on a proof before this process is completed.

Once a file has been successfully preflighted, proofed, and cataloged in the digital library, it is available for order. Titles can be ordered directly by the publisher or by booksellers with an established relationship using the standard Electronic Data Interchange (EDI) order submission process. Lighting Source has established relationships with a number of booksellers, including retailers Amazon.com and Barnes & Noble Books, as well as book distributors, including Ingram Book Group, Baker & Taylor, Bertram Group, and others. Lighting Source does not sell directly to consumers.

To execute the production of book orders, Lighting Source has built a highly automated computer integrated manufacturing facility. It employs a deterministic production workflow in which all manufacturing processes are scheduled, tracked, and guided by a custom management information system (MIS). The MIS monitors production data sent directly from production equipment, manually input from production personnel, or captured from barcodes on products being produced or on bins and carts used to transport products within the plant. The Lightning Source manufacturing system process is illustrated in Figure 9.

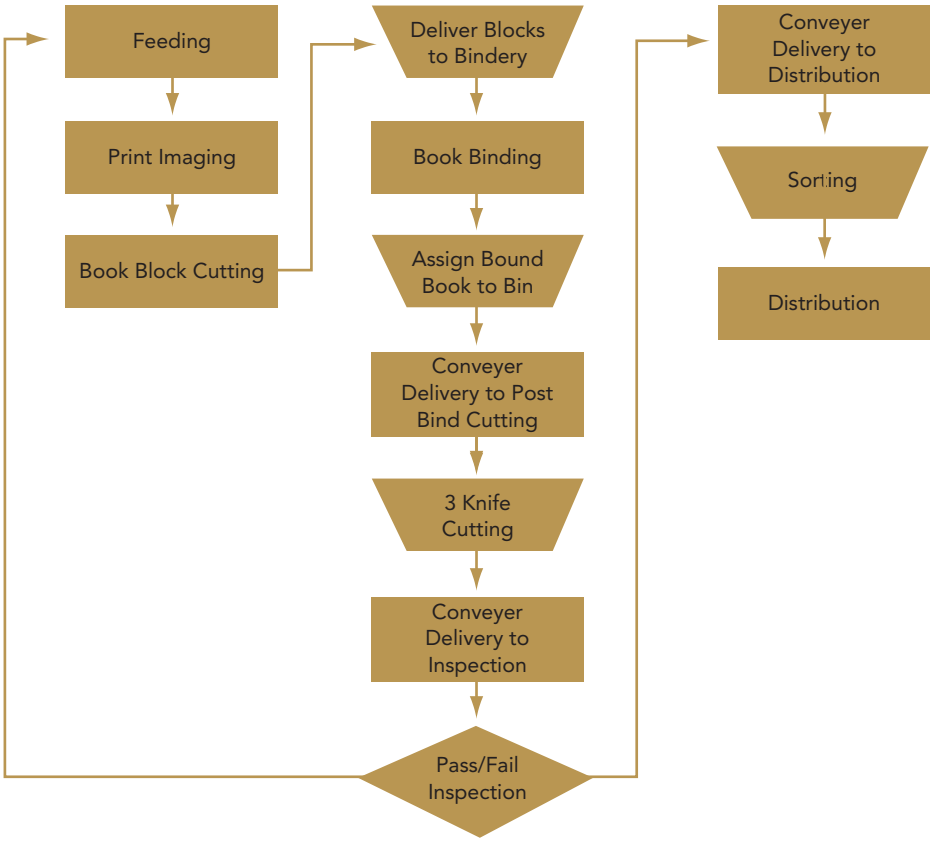

Figure 9. Lightning Source production workflow

Lightning Source has built automation into its workflow where it financially makes sense and relies on manual operations where automation would be too costly or does not provide any additional benefits. To this end, its production systems are linked together using a combination of inline and near-line feeding and finishing systems. Near-line systems are connected using manual carts and computer-aided conveyer belt delivery systems. Each manual process in the workflow includes product defect inspection by production personnel. This culminates with a final manual inspection of the book. Books that pass inspection are allowed to enter the distribution process. Those that fail are sent to quality stations, where attempts are made to fix production defects. Once fixed, the books are allowed to enter the distribution process. If defects cannot be fixed, the job is queued to re-enter the production system. Lightning Source's 100 percent inspection policy minimizes the chance of defective books entering the distribution channel, where any revenue from the book production process would be lost if the book had to be returned.

Lightning Source provides a variety of distribution and fulfillment services to its customers. Publishers can opt to have book titles distributed through the wholesale channel, fulfilled using Ingram Book Group's Print To Order service, shipped to the publishers for self-distribution, or drop shipped directly to the publishers' customer. The Print To Order service offered by Ingram Book Group combines its distribution services with Lightning Source's Book on Demand service. The service works by having Ingram's inventory management system show an on-hand inventory of 100 copies of a book available for next-day shipping. Booksellers can then order these books as if the book were physically in its warehouse. Orders placed through the Print To Order service are queued and transmitted to Lightning Source throughout the day. The orders are then produced and shipped to the bookseller or drop shipped directly to the customer.

Web-Enabled Strategy

Lightning Source's business strategy relies on the Web and electronic information exchange services to manage its relationships with customers and handle order transactions with publishers and booksellers. Its Web-based account management system provides the mechanisms to completely manage the business relationship through the Web, but the company also assigns each customer a customer service representative to help customers get acclimated to the Web-based workflow and to provide customer care for issues to that cannot be addressed through the Web. The order submission workflow is completely based on Web and EDI transactions. This requires all order submissions to be placed using an electronic transaction methods.

Requiring electronic order submission and standardizing the transaction data interchange provides Lightning Source with all the information necessary to produce and fulfill production orders. Electronic order information can easily be pulled into its management information system, allowing each order to be automatically scheduled, queued for production, tracked, and prepared for distribution.

Chapter Six: Summary and Conclusions

Key Findings

Development of the System Analysis Instrument

A taxonomy for discussing Web-enabled printing systems has not been published before this research examined the issue. The lack of a taxonomy led to ambiguities when analyzing or discussing Web-enabled printing systems. A list of system-independent attribute definitions and descriptions provide the necessary frame of reference to analyze and discuss these systems. The System Analysis Instrument proved to be a useful tool in the analysis of Web-enabled print service providers.

System Analysis of Web-enabled Print Service Providers

Web-enabled print service providers are taking different approaches in deploying Web applications that permit a print buyer to purchase print services over the Internet. These systems allow the print buyer to establish a business relationship, completely specify a product, and purchase the final print product without having to engage a printing sales or customer service representative. In this research study, all of the print service providers utilized catalog-based product offerings. This constrains the number of features and functions the applications need to support and allows the Web application to provide a streamlined workflow that removes a number of printed product specification skills needed to use the system. Lower knowledge and skill requirements provide new opportunities to sell print services to non-traditional print buyers. Professional print buyers and businesses can also take advantage of the streamlined workflows to make print supply-chain management more efficient. The site analysis showed that, while print service providers limit the number of products they offer, Web-enabled print services are being deployed to meet diverse business and print application requirements.

Observation of Web-enabled Print Production Systems

Companies use different development strategies when building their system architectures. The strategies are dependent on the company business model, industry niche, print applications, and production processes employed to manufacture the printed product. While strategies can be varied, commonalities exist in their implementation. The goal of both observed companies was to engineer a system that combined information systems for collecting all the customer information required to completely specify a printed product and then use this information to drive highly automated process-integrated production systems. The systems have been engineered to remove any non-value-added activities from the order specification and production processes. To achieve these efficiencies, both companies had to adopt catalog-based product offerings based on their industry niche. This allowed them to utilize a deterministic workflow methodology that provides highly streamlined production and decreased turnaround times for customers.

Implications of the Study

This research study has implications that could impact consumers, professional print buyers, print service providers, equipment vendors, and academia. Consumers can benefit from the deployment of Web-enabled printing systems by print service providers. These systems are designed to allow efficient product specification and order submission of printed products. This gives consumers access to systems that are engineered to produce high-quality printed products. Professional print buyers benefit for the same reasons. They have access to systems that streamline their print supply-chain.

Print service providers benefit by having the technology in place to embrace new business opportunities and expand into new markets. Print has become a commodity service, but a number of the print applications produced using new Web-enabled workflows are evocative and provide value that is not seen with mass-produced printed products. Small and regional print service providers can use Web-enabled printing systems to reach new audiences and compete with larger companies.

When printers succeed, so do the companies that supply the technology, equipment, and raw materials required to do business. Many equipment providers see the opportunity in Web-enabled printing systems and are helping print service providers readjust business models, adopt new technology, and deploy new workflows that enable the use of Web-enabled systems in product manufacturing.

As the industry continues to embrace these new Web-enabled workflow methodologies, they will look to academia to provide graduates knowledgeable in selling, building, and maintaining the information systems and production processes required to support Web-enabled print.

Recommendations for Further Research

Many within the printing industry see Web-enabled print as technology that will provide new business opportunities. As such, investment in the development and deployment of Web-enabled print production systems is occurring at an accelerated pace. This research has provided a method for analyzing Web-enabled print at the systems-level and insight into how a Web-enabled system could be deployed. However, there is much more to be studied on the topic of Web-enabled print. The following topics have been identified as areas of further study and potential research:

1. This monograph only looked at a select number of completely Web-enabled print service providers. A number of service providers are deploying tools that provide partial Web-enablement. A project exploring what the various tools and software applications used in partially Web-enabled print may be useful to the industry.
2. Equipment and software vendors are bringing a plethora of hardware and software applications to market that provide a print production workflow with

Web-enabled functionality. These off-the-shelf systems are developed to provide the general functionality required to use the Web to facilitate product specification or order management. A key disadvantage to these systems is that they are not specifically developed for a single workflow. A study examining how print service providers are deploying off-the-shelf systems would be helpful to print service providers looking and at vendor-supplied solutions. Specifically, the study of how print service providers are handling any custom software development or workflow process re-engineering required to get systems to meet specific application requirements would be helpful to print service providers looking at vendor-supplied solutions.

3. Ancillary services are seen by print service providers as an opportunity to add value to print services and provide additional sources of income. A study of how ancillary services can be integrated into Web-enabled print production system architectures may be useful to print service providers that have invested in the development of ancillary services and are now investing in Web-enabled print.

4. The advent of Web 2.0 has resulted in a number of Web sites that aggregate user-generated content, or that aggregate the content from a mash-up of data from other Web sites. A commonality between Web 2.0 sites is the support of rich application programming interfaces (APIs) for interacting with aggregate data. Opportunities to use this data to create printed products exist. An investigation into business opportunities, print application requirements, or computing and system requirements may be useful to the industry.

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