1999

Investigation of on-demand digital printing for the needs of Mine Safety Appliances co.

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INVESTIGATION OF ON-DEMAND DIGITAL PRINTING FOR THE NEEDS OF MINE SAFETY APPLIANCES CO.

By

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A Thesis

Submitted to the

Department of Packaging Science

College of Applied Science and Technology

in partial fulfillment of the requirements

for the degree of

MASTER OF SCIENCE

Rochester Institute of Technology

1999

Department of Packaging Science
College of Applied Science and Technology
Rochester Institute of Technology
Rochester, New York

Certificate of Approval

M.S. DEGREE THESIS

The M.S. Degree thesis of Cathy L. McDonald
has been examined and approved
by the thesis committee as satisfactory
for the thesis requirements for the
Master of Science Degree.

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June 1, 1999

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DEDICATION

This thesis is dedicated to my family: Grandma and Grandpa Shultz, Mom and Dad, and my Husband Jan, who have been my main supporters in completing this degree.

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ABSTRACT

The printing needs of Mine Safety Appliances Co. (MSA) along with the definition and functions of on-demand digital printing seemed to be complimentary. Not only can digital presses improve turn around times, but they are also said to be economical for short print runs. Therefore, the focus of this study was to evaluate several on-demand digital printers and determine which press was most appropriate for MSA.

After investigation, it was determined while no one press satisfied all of the areas, the Indigo Omnius met the most needs. The Omnius could save time and money printing bags, labels, and a variety of other packaging items. The Omnius, however, had some drawbacks. These drawbacks included not being able to print on both sides of a substrate and not having in-line finishing options. Also, the finishing options were quite costly to purchase separately.

A cost analysis determined that the implementation of the Omnius at MSA was a project worth considering. However, further investigation beyond this thesis is recommended. This future investigation should focus on determining a better way to print manuals and evaluating whether or not options such as leasing or purchasing from a vendor that owns an Omnius, would be more beneficial to MSA than buying and implementing a press.

TABLE OF CONTENTS

1.0 INTRODUCTION

BUSINESS CLIMATE/ NEED FOR STUDY

In the past four years of working at Mine Safety Appliances Co. (MSA), many issues have arisen due to the immediate need for packaging in small quantities. Within MSA's new product development process, many times the product is created and the text for instruction manuals and packaging is the last to be finalized. Having the items printed then adds to the delay. Every day a product delivery is late, the company loses money (MSA's Marketing Director, John Quinn states that not having packaging ready on an industrial level means the loss of approximately $2000 per day per product). In order to get product to market quicker, shorter lead time packaging such as non printed bags with inserts or cartons with labels are used, rather than the desired long lead time packaging items such as printed bags and cartons. Also making it difficult to order printed packaging is that quite often new product development packaging orders are under 2000 pieces. These small quantities lead to high individual piece costs and difficulty in finding vendors that will do MSA's work with any priority.

MSA's vendors use traditional printing processes such as lithography and flexography which require several set up steps including film separations, proofing, plate exposure, plate development, plate mounting, etc. These steps are the same whether the run is short or long. Therefore, the price for each piece becomes less as the printing run becomes larger because the set up costs are distributed over larger numbers of copies. Traditional printing process lead times for a printed bag or a printed folding carton at MSA is six to eight weeks. Other packaging items such as labels, instruction sheets, have a one to three week lead time.

On-demand digital printing, by definition, is "the ability of a press to accept files digitally and print with short notice and quick turn around time."[1] The cost for each printed item remains the same because unlike traditional methods, the need for many of the aforementioned set up processes is eliminated.

MSA's issues and the general on-demand digital printing claims seemed to make a complimentary problem solving match, thus leading to this investigation.

MARKETING STANDPOINT/ ADDITIONAL NEEDS

At MSA, the Marketing Department's needs are often difficult to meet with traditional printing. In addition to quick turn around times, there is also the need for creating small runs of test market materials and sales samples.

Test marketing is an important factor for MSA as there are many new products that will be introduced to several markets, including retail. Digital printing would be helpful in providing quick, economical samples for focus group studies and for sales kits. It is invaluable for sales personnel to be able to show the product, complete with packaging, to a potential customer.

Also, since digital printing is economical for short runs, many marketing changes can be incorporated and printed quickly. If planning is done correctly, many smaller runs of printed items can be used, thus minimizing scrap charges when a change happens.

Barcodes are another area in which digital printing could be helpful. Different barcode numbers are used for each type of product, different quantities of product in a package, different product colors, etc. Without digital printing, it usually becomes necessary to print barcode labels because the quantity of each package using a specific barcode number is usually too small to have a bag or carton printed. Not only is there a cost associated with the label, but a cost for manufacturing time to place the labels on each package. The variability option found with some digital printing presses allows every item to be printed differently, thus eliminating the additional material and labor costs.

SCOPE

While there is the commonality of short notice and quick turn around times, other features of the many digital presses are far from being identical. This thesis will not attempt to explore all of the different on-demand digital printers, since that would be extremely lengthy. However, it will attempt to generally explore eight of the most talked about presses with a range of features and prices, to determine which

[1] Howard Fenton and Frank J. Romano, *On-Demand Printing: The Revolution in Digital and Customized Printing*, 2nd ed., (Pittsburgh: Graphic Arts Technical Foundation, 1997), 3.

machine is most appropriate for MSA's needs. A cost evaluation of the selected machine will then take place. It is not the purpose of this thesis to become an expert on the inner workings of all of the presses.

PRESSES EVALUATED IN THE STUDY

The eight presses evaluated in this study are the following:

1. INDIGO OMNIUS
2. INDIGO E-PRINT
3. HEIDELBERG QUICKMASTER
4. AGFA CHROMAPRESS
5. XEICON
6. XEROX DOCUTECH
7. XEROX DOCUCOLOR
8. CANNON CLC

STUDY OBJECTIVE AND PROCESS

The objective of this project is to look at the various features of a select group of on-demand digital printing presses and determine which system is "most appropriate" for Mine Safety Appliances Company. Cost factors of the chosen system will then be evaluated to determine if a before tax percent return of eleven percent or greater is achievable using MSA's Investment Analysis (MAPI) system. MSA's accounting department will evaluate the project at a later time to determine if the project should or should not be considered over another capital expenditure for implementation. Also, a chart will be developed as a quick comparison guide of digital printers for those in industry or others wanting to investigate on-demand digital printing.

2.0 LITERATURE REVIEW

On-demand digital printing is a relatively new technology. Only a few books written by third parties exist on the topic. Therefore, most of the information for this thesis depends on the opinions and statements of the manufacturer's representatives and may contain some bias. Other sources for information include articles, and manufacturer's literature.

WORKING DEFINITIONS

Since digital printing is a new area to MSA, many definitions have to be established. These definitions are listed below.

Digital printing- A type of printing that uses digital files output to a digital printer. [2]

Duplex- To print onto both sides of a page.[3]

Electronic Collation- This mode of variability (see definition) allows every page to be 100% different, thus allowing pages of a document to be printed in order. [4]

Electroink- Patented ink used by Indigo which is similar to a liquid toner. [5]

Electrophotography- Technology that utilizes an electrically charged light to create an image, it then attracts toner which is transferred to a substrate. [6]

Finishing- The final steps in completing printed items. Finishing can include cutting, folding, sorting, binding, etc. and can be in-line or off-line depending on whether or not the equipment is attached to the press. [7]

Full bleed- Printing larger than the area needed, so that when the product is cut to size no white space borders the object.[8]

Non-Variable Printing- Printing typical of traditional presses; every sheet printed is the same. Text and

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[2] Fenton and Romano, 2nd ed., 4.
[3] Howard Fenton and Frank J. Romano, *On-Demand Printing: The Revolution in Digital and Customized Printing*, (Pittsburgh: Graphic Arts Technical Foundation, 1995), 83.
[4] Indigo, *Digital Offset Color E-Print 1000* , Promotional Bulletin.
[5] John Fulena, Indigo Direct Sales Manager, Telephone Conversation, June 20, 1997.
[6] Fenton and Romano, 84-86.
[7] Fenton and Romano, 2nd ed., 129.
[8] Jan LeHigh, Sales Representative, Alpine Packaging Inc., Telephone Conversation, June 4, 1997.

graphics do not vary from page to page within one run.[9]

Offset Lithography- A printing process where film is created and is used to make a plate for printing. The plate image areas attract ink, and the non-image areas attract water and repel ink. The ink on the image is then transferred to a blanket and finally to a substrate for the resulting printed piece.[10]

On-Demand- "Short notice, quick turn around of short, economical print runs." [11]

Resolution-The quality of output in printing, usually measured in dots per inch (dpi) and/or lines per inch.

Saddle stitching- A type of binding that stitches stacked, folded booklets in the center fold with wire (like staples) to create the finished book. For thicker books, a trim must be done at the open end of the book to eliminate the longer end in the center that is protruding. [12]

Short run- The amount of impressions printed is small, ranging from one to 6,500. There are several degrees of short runs from "ultimate short run to moderate short run." [13] For the purpose of this thesis we will consider a short run under 2000 impressions.

Substrate- The material which is being printed; can range from traditional paper to plastics, fabric, metal, etc.

Throughput- Industry terminology for the speed of a press; can be measured as number of impressions per hour.

Variable printing- The ability to print different images, text, or even color on different pages in the same run; this allows for personalization and customization of every printed piece.[14]

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[9] Fenton and Romano, 2nd ed., 5.
[10] John Novosel, Triad Litho Printing, Telephone Conversation, June 4, 1997.
[11] Fenton and Romano, 2nd ed. , 3.
[12] Novosel
[13] Fenton and Romano, 2nd ed. , 6.
[14] Fenton and Romano, 4-5.

EXTENDED DEFINITION OF ON-DEMAND DIGITAL PRINTING/ THE BENEFITS

On-demand digital printing by definition, is the ability to quickly produce printed items through the use of digital or electronic files. Any press exhibiting both of these characteristics is considered an on-demand digital press. Whereas, a press that is only quick, can be considered on-demand, and a slower press using digital files can be considered digital. [15]

In general, on-demand digital presses skip many of the set up processes and are typically economical for up to 2000 - 8 1/2" x 11" impressions. A traditional press may be more economical for quantities over 2000 impressions.[16]

Most of the literature points out that on-demand digital printing is most beneficial for delivering printed items in a quick time frame. A representative from McDonnell Douglass states that on-demand digital printing is best described with the three W's "what you want, when you want it, and where you want it".[17]

While it appears that many of the applications and time saving benefits are still being discovered, some are well known. These applications include printing small cost effective runs for "mini-marketing" or for salesman samples, producing press proofs in a quick manner, reducing turn around time, reducing inventory, and satisfying the expectations and demands of customers. Basically, it is a "just-in-time tool" [18]

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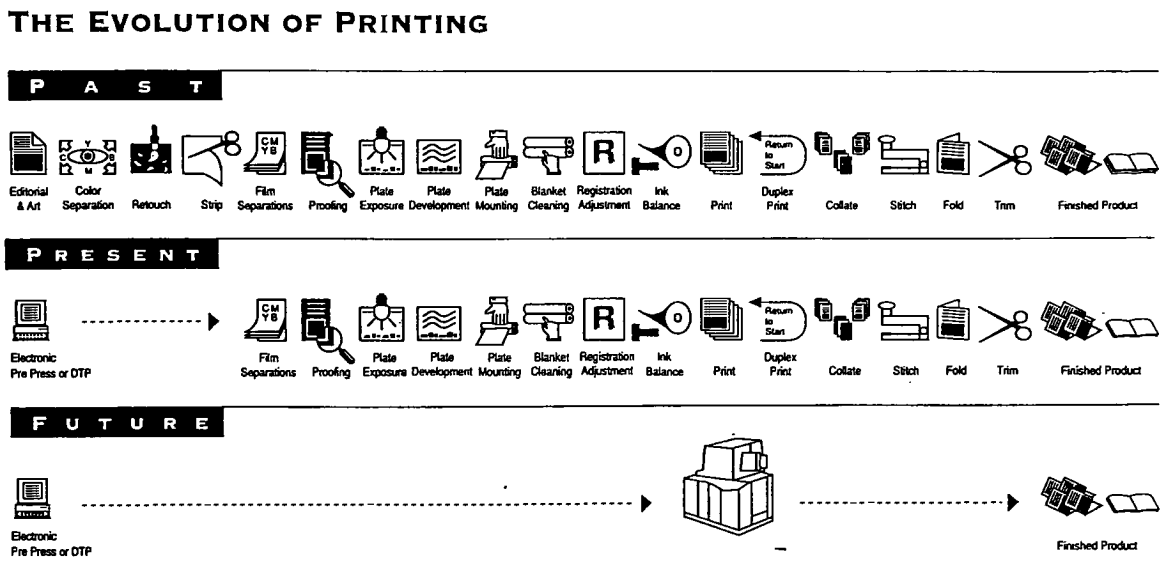
[15] Fenton and Romano, 4.
[16] Fenton and Romano, 2nd ed., 1-5.
[17] "On-Demand Market Status Report Interviews with representatives from GammaGraphX, Indigo America, McDonnell Douglass Aerospace, Scitex America Corp., AM Multigraphics; Xeicon", *In Plant Printer*, Corporate Image, 1997.
[18] Patti Williams, "Quicker Package Development With New Short-Run Printing", *Brand Packaging Magazine*, Spring 1997: 26-28.

EVOLUTION OF DIGITAL PRINTING

The following chart "THE EVOLUTION OF DIGITAL PRINTING" [19](Figure 1) is an illustration of the past, present, and future of printing. The future shows a general overview of the capabilities of some of the digital presses in this study. However, each digital press varies as far as how many steps are required between the digital input and actual output of the final printed item. Note the considerable number of tasks that are eliminated from the past to the future. Having these tasks eliminated can potentially save a company both time and money.

Figure 1



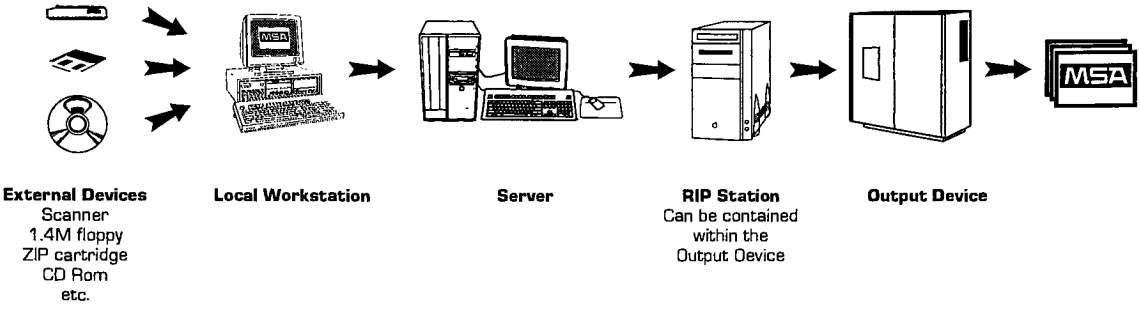
DATA INPUT/ OUTPUT PROCESS

It appears that the process to input data is basically the same for all of the digital presses in this study as shown in the following illustration (Figure 2). Text and graphics can be acquired from external sources such as a scanner, floppy disk, ZIP cartridge, modem, etc. The files are then formatted using local workstations and are then sent to the server (a network device that manages files). The electronic information is then forwarded to the Raster Image Processor (RIP). The RIP is a device that converts a vector image (mathematical formula that defines all of the shapes in an image) into a bitmapped image (a

[19] "Digital Offset Color E-Print 1000", Promotional Bulletin, Indigo.

representation consisting of rows and columns of dots of an image in computer memory). The RIP can be an external device or contained within the output device as in a PostScript laser printer. The press is considered the output device.[20] MSA is fortunate considering that much of the necessary pre-press equipment already exists in the Graphic Design Department.

Figure 2



DIGITAL PRINTING TODAY AND TOMORROW

After interviewing many manufacturers' representatives, it appears that much is still to be learned about on-demand digital printing. Questions still remain on the service lives of the presses and how much maintenance will be required. However, because Industries have an ever increasing need for short print runs in a quick time frame, on-demand digital printing is expected to "catch on" in the future as more become aware of its capabilities. [21]

There is a relatively high capital expenditure for some of the more sophisticated presses (some in excess of $600,000). Unlike other technologies, the price of digital presses has not gone down over time. Actually, the prices increased substantially after the technology became more recognized and after orders were received. [22] Much of the literature, however, did not focus on the high costs, but rather on what the presses could accomplish.

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[20] Keith Bradey, Indigo Specialist, Telephone Conversation, July, 1997.
[21] Frank Romano, IGAEA (International Graphic Artists Education Association) Conference, RIT, July, 1996.
[22] Frank Romano, IGAEA (International Graphic Artists Education Association) Conference, RIT, July 1996.

PRESS CAPABILITIES

The following "Importance to MSA Chart" was formulated from the information provided from various representatives, books, and promotional materials. The chart should be referred to for specific information on each press. Also following is a general overview of each press taken from the information in the chart, which accentuates only the press's highlights. Information beyond what was needed for this thesis was also included on the chart so that it could benefit others who are exploring on-demand digital printing.

IMPORTANCE TO MSA CHART

	Indigo Omnius	Indigo E-Print	Heidelberg	Agfa ChromaPress	Xeikon	Xerox DocuTech Model 135	Xerox DocuColor	Canon CLC 1000
Imaging	n/a Laser	n/a Laser	n/a Laser	n/a Laser	n/a Laser	n/a Laser	n/a Laser	n/a Laser
Carrier	n/a Reusable Plate	n/a Reusable Plate	n/a Dry Offset Plate	n/a Photoconductor Drum	n/a Photoconductor Drum	n/a Belt	n/a Belt	n/a
Technology	n/a Offset/ Electrophotography	n/a Offset/ Electrophotography	n/a Offset	n/a Electrophotography	n/a Electrophotography	n/a Electrophotography	n/a Electrophotography	n/a Electrophotography
Substrates Printed On	4 Paper 4 Label stock 4 Card Stock 2 Board stock (to 18pt) 3 Polyethylene 0 Plastic 0 Aluminum foil 2 Fabrics	4 Paper 0 Transparencies 4 Label Stock 4 Card stock	4 Paper (20 lb. and up to 16 pt. index) 4 Card Stock (110 lb.) 2 Board stock (to 16pt) 0 Foil	4 Paper (40- 90 lb.) 2 Card Stock (90 lb. paper) 2 Polyesters	4 Paper (all 54 lb. to 135 lb. stock) 4 Card Stock (135 lb.)	4 Paper (16 lb. Bond to 74# Cover) 4 Card Stock (110 lb.)	4 Paper (16 lb. Bond to 74# Cover) 4 Card Stock (110 lb.)	4 Paper (20 lb. bond to 110# index) 0 Transparencies 4 Card Stock (110 lb.)
Substrate Supplier	4 Substrate guide provided (many suppliers)	4 3M, Fasson, Warren, Mobile, MacTac, PPG (many suppliers)	4 Any supplier	4 Any supplier	4 Any supplier	4 Any supplier	4 Any supplier	4 Any supplier
Paper Feed	4 Web	3 Sheet	3 Sheet	4 Web	4 Web	3 Sheet	3 Sheet	3 Sheet
Ink Type	3 Electroink technology (liquid toner)	3 Electroink technology (liquid toner)	4 Waterless ink	2 Dry toner	2 Dry toner	2 Dry toner	2 Dry toner	2 Dry toner
Ink/Toner Supplier	3 Ink from Indigo	3 Ink from Indigo	4 Various suppliers	3 Toner from Agfa	3 Toner from Xeikon	4 Toner from Xerox or distributor	4 Toner from Xerox or distributor	4 Canon toner from distributor
Printing Purpose	n/a Packaging concentration	n/a Commercial printing	n/a Commercial printing	n/a Commercial printing	n/a Commercial printing	n/a Commercial printing	n/a Commercial printing	n/a Commercial printing
Paper Size	5 Roll width: 12.6"	4 Max: 11.7" x 17.2"	5 5.5" x 3.5" to 18.125" x 13.375"	5 Roll width: 12.6"	5 Roll width: 12.6"	4 5" x 7" to 11" x 17"	4 4" x 6" to 12" x 18"	4 8.5" x 5.5" to 11" x 17" (full bleed)
Print Area	5 12.6" x 17.2" frame .	4 11" x 17" full bleed	5 17.875" x 13.125"	5 12.1" x 17.7"	5 12.2" x17.7"	0 10.75" x 16.75"	4 3.5" x 5.5" to 11" x 17"	4 8.5" x 5.5" to 11" x 17"
Throughput	2 1000- four color frames/ hour	4 8000- 1 side, 1 color letter size/ hr 2000- 1 side, 4 color letter size/ hr	4 10,000 single side 4 color @ 1270 dpi any size/ hr	2 2100 single or double sided, 4 color letter size/ hr	2 2100 single or double sided, 4 color letter size/ hr	4 8100 single side Black & white letter size/ hr	2 2400 single side 4 color letter size/ hr	2 1860 single side 4 color letter size/ hr
Sides	2 1 sided printing	4 2 sides in one pass Auto duplex printing	4 Standard 2 sided (one side at a time)	4 2 sides in one pass	4 2 sides in one pass	4 Standard 2 sided (one side at a time)	4 Standard 2 sided (one side at a time)	4 Standard 2 sided (one side at a time)
Color	6 4 color (6 color optional)	6 4 color (6 color optional)	4 4 color	5 5 color	5 5 color	3 Black & white	4 4 color	4 4 color
Resolution	3 800 dpi	3 800 dpi	4 1270 dpi or 2540 dpi	2 600 dpi	2 600 dpi	2 600 dpi	1 400 dpi	1 400 dpi
Input Formats	4 Adobe Postscript Scitex hand shake EFI Fiery	4 Interface to DTP Scitex hand shake Interface to CEPS Magnetic tape Optical disk	4 Postscript Level 2 Harlequin	4 Postscript Level 2	4 Postscript Harlequin Level 2 interpreter on 66 MHz Pentium PC EISA bus screen card	4 Adobe Postscript Level 2 PCL 5e TIFF	4 Adobe Postscript Level 2 w/ Eficolor	4 Postscript Level 2

	Indigo Omnius	Indigo E-Print	Heidelberg	Agfa ChromaPress	Xeikon	Xerox DocuTech	Xerox DocuColor	Canon CLC 1000
Finishing Incl.	0 None	5 Variable printing In-line auto booklet collate, stitch, trim, fold	0 None	0 In-Line Auto. Sheeter	0 None	In-Line Stapling In-Line Thermal tape binder	0 None	0 None
Finishing Options (available but not included)	0 None	0 None	0 None	0 Off-line: Trimming Folding Binding Electronic collation Omnigloss	4 In-line finisher (cutter, collator, folder, & job separator)	3 In-line Signature booklet maker with optional covers insertion In-line Perfect Binding-For Hot melt	1 20 bin sorter	1 In-line Stapler/ Sorter
Non-Variable	5 Variable	5 Variable	4 Non-variable	5 Variable up to 16 elements in B/W	5 Variable	5 Variable	4 Non-variable	4 Non-variable
Website	www.indigonet.com	www.indigonet.com	www.heidelberg.com	www.agfa.com	www.am-multi.com	www.xerox.com	www.xerox.com	www.usa.canon.com
Contact	John Fulena 412.656.0207	John Fulena 412.656.0207	Gunther Keithswetter 800.437.7388	Mitch Maller 800.540.2432 X8059	Tim Wildrier 770.979.2512	Whitney Baker 412.937.2464	Whitney Baker 412.937.2464	Jim Cafero 412.921.9950
History/ Development	Recent innovation in pkg. market Announced in 1995	Development in 1987; introduced in 1993	Introduced 1995	Announced in 1993	Began 1988; supported by Agfa and several others	Developed 1988; addt'l. generations developing	Introduced 1996; currently developing	Introduced 1997
Who Uses/ How Many Installed	Examples: Deluxe Corp. Engraph Inc. (labels) 30 ww & 13 in US	50% trade shops & service bureaus 50% commercial 300 units per year	50% trade shops 50% commercial 100 installed plus 70 GTO printers	Mostly trade shops & service bureaus 40-50 in the US 270 worldwide	50% trade shops 50% commercial 750 world wide 150 in the US	12,000 World Wide 60-70 in Pittsburgh	1200 in US since Sept 96'	Corporate & print for pay shops
Maintenance	Response center responds in 4 hr. during business hr Can have parts flown in same day	Response center responds in 4 hr. during business hr Can have parts flown in same day	Help line	Routine daily by unskilled personnel 30 minutes/ day Free training & support network Full maintenance plan	Recommended up to 150,000 A4 sheets or 20 hr. continuous printing Maintenance plan	24 hour service on site within 2 hours	24 hour service on site within 2 hours	On site service warranty
Training	8 day course On site training	8 day course On site training						
Operator	4 Trained personnel	4 Trained personnel	3 Professional press person	4 Trained personnel	4 Trained personnel	4 Trained personnel	4 Trained personnel	4 Trained personnel
Cost	$600,000 approximate $9,700/ mo. lease 60 month lease	$425,000 approximate	$570,000 approximate	$360,000 approximate	$290,000 approximate	$250,000 base price	$130,000 base price	$170,000 approximate
Total Score	69 Omnius	68 E-Print	62 Heidelberg	57 Chromapress	61 Xeicon	54 DocuTech 135	53 DocuColor	53 Cannon CLC

INDIGO OMNIUS OVERVIEW

The Indigo Omnius is a unique printer for many reasons, but mainly for its ability to print onto various packaging materials. The general specifications of the Omnius, such as speed, up time, and simplicity of use are also worth noting. Negative aspects of the press can also be a concern.

With it's packaging concentration, the Omnius prints on substrates such as paperboard stock up to 18 point, polyethylene, plastic, aluminum foil, label stocks, and fabrics. It is a web fed press, with a maximum roll width of 13" and a print area of 12.1" x 17.2" and is also capable of variable printing.[23]

Packaging professionals should take particular note of this press as the final products can be converted into many packaging items such as bags, shrinkable body bands, labels, and folding cartons. Also, the variability option allows for much creativity with the graphics. A sample of variability from Indigo was shown with body bands on a soda can. The body bands had identical graphics, except that the photograph on the front was different. This example showed that every item in one press run can be printed differently, if desired.[24] This is much different than traditional printing methods where every item in a press run is printed exactly the same.

The manufacturer's representative for Indigo, reports that the usual up time is 75-80% with downtime primarily being due to material changeovers and maintenance. However, full support packages can be purchased through Indigo that provide such services as 24 hour a day phone support, on-site service, and an average response time of four hours.[25]

There are many options other than variability available with the Omnius. Among these are: six color printing, an e-rip processor, and a personal online tutor which provides simple instructions for usage, replacement of inks, and proper use and care of the printer.[26] Because of the simplicity and options, the operator need not be a professional press operator. However, several qualifications are necessary which

[23] "Opening An Exciting New World Of Label Printing", Bulletin, Indigo Omnius, 1996.
[24] John Fulena, Indigo Direct Sales Mgr., Rich Gooding, Omnius Sales Mgr., and Bobbi Pierce, Omnius Specialist, meeting at MSA. June 17, 1997.
[25] Omnius Digital Offset Color Web Press Proposal Prepared for Mine Safety Appliances Company, June 23, 1997
[26] "Opening An Exciting New World Of Label Printing", Bulletin, Indigo Omnius, 1996.

includes the knowledge of printing and computers. Indigo also provides purchasers with an Operator Selection Guide which helps identify qualities to look for when hiring.[27]

Although the Omnius does provide quality and various positive capabilities, its negative aspects should definitely be considered before making a purchase. Cost, speed, upkeep, and one-sided printing are major drawbacks for the Omnius. Great care should be taken when considering the positive against the negative.

The unit's high base price of approximately $495,000 is cause for concern for most consumers. Possibly due to the inflated cost, there are only thirteen units installed in the United States at this time.[28] Therefore, there are very few companies to contact for references toward the printer's capabilities, stability, and reliability.

Of all the presses investigated in this study, the Indigo turned out to be the slowest, printing only 1000 four-color frames per hour. Also of note, the Omnius is only capable of printing on one side of the material. [29] This is a major drawback when duplex printing is necessary for items such as manuals and books.

Finishing options are not included with the Omnius; they must be purchased separately and carry a relatively high cost. For example, a slitter cutter can cost about $15,000 and a booklet maker is around $55,000.[30] "Bindery or finishing is the most essential part of digital printing. A document is not a document until it is trimmed, folded, bound and finished in some manner. Users of digital printers are now discovering that they are paying almost as much for finishing machines as they are for the digital printers."[31]

The printable materials can be supplied by many manufacturers. However, the Electroink (unique to Indigo presses), can only be purchased through Indigo. Omnius regulates this price, therefore this is a major determining factor of whether or not a run is economical. However, an Omnius representative contends that the price is being reduced.

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[27] Fulena, et. Al., June , 1997.
[28] Fulena, et. Al., June, 1997.
[29] Fulena, et. Al., June, 1997.
[30] Phil Edwards, SoluTech, Owner, Telephone Conversation, July 10, 1997.

Lastly, another concern is with the Electroink's adherence to materials. Omnius' initial response was that the ink adheres to most substrates run through the press. Samples of polyethylene provided by Omnius demonstrated that the ink did not smear. However, it was noted that if a company had concerns about the Electroink's adherence to particular materials, further testing would be recommended for assurance.

HEIDELBERG QUICKMASTER DI 46-4

Unlike all of the other presses in this study which are electrophotographic or toner based printers, the Heidelberg actually uses a plate to create its documents. This makes the Heidelberg similar to traditional offset printing, but with on-demand features.

With the Heidelberg, the plate is created electronically by sending commands from the computer. The plate is then moved into position with the press of a button, making the press on-demand. This is different from traditional printing where the plate is created offline and is often manually installed. The time to image the plate is six and 12 minutes respectively and time for a plate change is about 30 seconds.

Other on-demand features include an automatic presetting of the ink fountain, automatic blanket cylinder wash device, gripper opening cam which allows "on the fly" accommodation of different stocks.

Some other positive aspects of the Heidelberg include the materials that can be printed and it's high resolution. This sheet fed device can print on stocks from .0024" to .012" in sizes of 5 ½" x 3 ½" to 18 ½" x 13 3/8" and board up to 16 point. The types of stock that can be accommodated include recycled, coated, and uncoated paper, 100 lb. card stock, board stock, and foil. The resolution of 1,270 or 2540 dpi is also the highest in this study.

Some potential drawbacks of the Heidelberg are the need for highly trained press personnel to run the equipment, the machine's lack of ability to print on polyethylene and label stocks, and its non-variability. Also, this four color press, with no additional options, comes with a price tag of approximately $570,000.[32]

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[31] Fenton and Romano, 121.

AGFA CHROMAPRESS AND XEICON

By referencing the Importance to MSA chart, much of the information on the Agfa Chromapress is the same as the Xeicon. This is due to good reason as the Chromapress uses the Xeicon print engine. The major differences between the Agfa and the Xeicon are the front-end systems and the finishing options.[33]

SIMILARITIES

The Chromapress and Xeicon are capable of printing five color, two sided items, in one pass (duplex). Duplexing is accomplished in one pass because of the parallel set up of the print rollers. [34]The overall speed is rather quick printing 4200 single or double sided, four color letter size pages per hour.

Both presses are web fed and can print on paper, polyesters, and cardstock up to 90 lb. These substrates can be purchased from a variety of vendors. Also, both presses have a gloss that can be used to enhance the printing appearance. Agfa's name for its gloss is Omnigloss and Xeicon calls it Gem.[35]

Other features of both presses include the functions that can be performed inline. Among these are electronic collation, variable printing , and automatic sheeting. These options are purchased separately.[36]

DIFFERENCES

Some of the differences between the presses lie in the front-end system. The Chromapress is based entirely on Macintosh software, while the Xeicon is based on the PC with a Microsoft Windows interface. Also, Agfa uses a specially designed server, and raster image processor (RIP).[37]

The Chromapress's software makes the system very user friendly by enabling the user to perform functions including job ticketing, color management, and scheduling. Also, Agfa takes the approach of providing the customer with a "turn-key solution". In addition to its front-end software enhancements,

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[32] "Quickmaster DI 46-4 Market and Technology", Heidelberg, Pamphlet no. 00.996.1102., 1995.
[33] Fenton and Romano, Vol. 2., 238.
[34] Fenton and Romano, Vol. 2, 228.
[35] Fenton and Romano, Vol. 2, 228-246.
[36] Fenton and Romano, 158.
[37] Fenton and Romano, Vol. 2, 238.

training, support, and consumables needed throughout the setup and printing process are items that can be purchased through Agfa. [38]

Another difference between the two presses lies in the finishing process. The Xeicon has an in-line option for stitching, folding, and trimming.[39] The Chromapress has finishing options, but they are not in-line.[40]

[38] Fenton and Romano, Vol. 2 , 238.
[39] Fenton and Romano, Vol. 2, 213.
[40] Fenton and Romano, Vol. 2, 239.

XEROX DOCUTECH MODEL 135

The DocuTech 135 prints only in black and white onto single sided sheets at a quick rate of 8100 impressions per hour (135 per minute). This press may appear quicker than the other presses in this study, but it is only printing one color instead of four. Standard two sided documents can be produced, but at a slower pace.

Unlike most other on-demand printers, the Docutech is unique in that it has many finishing options to create a document from beginning to end. The in-line finishing items included in the price of the press are a stapler and perfect strip binder. An optional finishing feature is an in-line signature booklet maker, which will saddle stitch, fold, trim, and insert a cover. Because of its finishing options and two-sided printing, this technology is the best in this study for producing completed booklets and manuals.

Other features are as follows; The Docutech has the ability to print at 600 dpi and uses dry toner purchased through Xerox or a distributor. Its efficiency is 95% expected up time and is said to be economical for up to 1000 prints per run. With its "24 hour service onsite within two hours maintenance plan", manufacturer's representatives from other companies admit that Xerox probably provides the best service in the digital press industry.[41] Lastly, this press takes basically any type of paper stock up to 74lb. cover or 110 lb. card stock in sizes of 5" x 7" to 11" x 17". However, it is limited to paper stock only.[42]

[41] Fulena, et. Al. , June, 1997.
[42] "The Xerox DocuTech Publishing Series, Model 135 Overview and Specifications", Promotional product brochure, Xerox, 1996.

XEROX DOCUCOLOR 40

Xerox developed the DocuColor 40, capable of four color printing, after the DocuTech . The Docutech and Docucolor's similarities are the dry toner purchased from Xerox and distributors, the substrates purchased from various suppliers, the economical number of prints being under 1000, the input formats of Adobe Postscript and Scitex hand shake, and the paper feed being cut sheets. Also, the maintenance agreements, expected up times, and personnel requirements are basically the same.

Xerox's promotional materials boast it can output 40 one sided or 30 duplex pages per minute (2400 single sided 4 color/ hour). However, its resolution is only 400 dpi.

The DocuColor can print on a large variety of paper stocks only. The maximum size of paper is 12" x 18" and the maximum print area is 11"x 17", which allows for an 11"x17" full bleed, once cut. The machine also takes paper as small as 4" x 6".

Contrary to the DocuTech, the DocuColor has very little in the area of in-line finishing. A 20 bin sorter is the only option.[43] According to a Xerox sales representative, more finishing options are currently in the works and should soon be introduced to DocuColor users. Not having finishing options makes it difficult for those who want to print completed color booklets and manuals. Another difference is that the Docutech is capable of variable printing and the DocuColor is not.[44]

[43] "Xerox Color On Demand: DocuColor 40", Promotional product brochure, Xerox, 1996.
[44] Whitney Baker, Xerox Marketing Executive, and Frank Kanonik, Director of On-Demand Printing GATF, Meeting at MSA, June 2, 1997.

CANON CLC 1000

The Canon color laser copier (CLC) is at minimum a four color copier. Being on-demand and digital the copier can take files electronically and print at a high speed as compared to the typical color copier found in most offices. Canon states that it is economical for print runs under 1000 pieces. This smaller, yet economical print run is lower than most of the other presses in this study.[45]

The machine uses dry toner and prints at a resolution of 400 dpi. Also, compared to the other systems in this analysis, the Canon prints at the second slowest rate (the Indigo Omnius is the slowest) of 1860 single sided, four color pages per hour.

Paper up to 100 lb. card stock and transparencies, ranging from 8.5" x 5.5" to 11" x 17" in size ,are the printable materials for this press, which can be purchased from virtually any supplier. However, the toner must come from either Canon or a distributor of Canon products.

An in-line stapler can be purchased separately as well as several other options. Some of the other options include a film scanner and projector, a re-circulating document feeder, and a preview monitor controller board. [46]

At $170,000, this machine is one of the lower cost digital presses in this study, second only to the lowest cost Xerox DocuColor, which is priced at $130,000.

[45] Jim Cafaro, Canon Sales Representative, Telephone Conversation, May 22, 1997.
[46] "Canon Color Laser Copier 1000", Promotional product brochure, Canon, 1996.

3.0 IMPORTANCE TO MSA EVALUATION

Machines were evaluated by rating the characteristics in which MSA would be interested (See "MSA Ratings" chart for overall ratings). To determine the most appropriate machine for MSA, a rating of zero to four was applied to the individual option or feature. Four was the rating given to the packaging/ printing items currently ordered by MSA. These are the items for which MSA has the "most need". A three was assigned to items that have "more need" than items rated a two, but not as desirable as the items assigned a four. A score of two was given to characteristics that would possibly be useful to MSA in the future with testing. MSA has "less need" for items rated a two than for items rated a three. A score of one was used for items that MSA has "little need" for or for items that went above and beyond the current needs (as an add on to a score of four). A score of zero was given to all items that were of no importance to MSA. This way, machines were not given a higher rating for doing tasks or having many characteristics that were not useful to the company.

After each category was rated, the scores were transferred to the "Importance to MSA chart" to compare.

MSA'S NEEDS

As no one machine in this study meets all the needs of MSA, it would be most desirable to have a combination of attributes from different machines. An ideal machine for MSA would have a high resolution (1200- 2400 dpi), six color capability, be able to print on polyethylene, 24 point board, label stocks with or without backing, and produce finished packaging. Examples of desired finished packaging items would include a heat sealed bag, a die cut carton with scores, a finished booklet, and die cut labels.

SUBSTRATES/ RATING

The ability of the press to print on 60 lb. paper is necessary since this is the stock used for MSA's manuals instruction sheets, and other items. All of the presses print on this type of paper and were therefore awarded a rating of four. Since label stock is currently used at MSA, all machines with the ability to print

on this substrate (the E-Print and the Omnius) were awarded a rating of four. Transparencies, aluminum foil, and plastic were all rated zero since there is no current or foreseeable future need for these substrates. See the "Standard Substrate Listing For MSA Packaging" chart (page 37) for a more detailed listing of the substrates used at MSA.

The Omnius is the only machine in this study with the ability to print on polyethylene. Polyethylene is the substrate that is currently used at MSA to package cartridges and respirators. Three points were added to the Omnius's total points for this added benefit.

SUBSTRATE SUPPLIER/ RATING

It is preferable to have a variety of vendors to order substrates from. This allows for competitive pricing. All presses have more than one supplier and were given a rating of four.

PAPER FEED/ RATING

It is most preferable to have the machine be web fed. This allows for flexible package printing and a better variety of finished product sizes. Roll fed machines were awarded a four, while sheet fed were awarded a three.

INK TYPE/ RATING

The resulting quality of a waterless ink press is usually better than a liquid or dry toner based machine. Liquid toner generally gives a higher quality output than a dry toner machine due to more coverage.[47] Because of this, waterless ink was given a rating of four, Electroink was given a rating of three, and dry toners were given a rating of two.

INK/ TONER SUPPLIER/ RATING

Like paper suppliers, it is preferable to have a variety of vendors to order inks and toners from, since this allows for competitive pricing. Most of the presses require that the inks be purchased from the

[47] John Novosel, Triad Litho Printing.

press manufacturer only and were awarded a rating of three, since this is less preferable to MSA. The Heidelberg was the only press that could have its ink supplied by various suppliers and was awarded a four.

PRINTING PURPOSE/ RATING

Because the printing purpose is determined from the substrates, this category was not rated. It is only to provide information for others who may be investigating these systems.

PAPER SIZE/ RATING

Many of MSA's printed items utilize an 11" X 17" substrate. However, occasionally a larger size sheet is necessary. Because of the added capability, presses that printed larger than 11" x 17" were given a rating of five. Presses capable of 11" x 17" were rated a four.

PRINT AREA/ RATING

An 11" x 17" full bleed is used on several items at MSA and presses capable of this were given a four. Presses capable of printing a larger area were given a score of five. Presses only capable of smaller sizes were given a three since this would greatly limit the items that could be printed on the press.

THROUGHPUT/ RATING

It is very difficult to determine what MSA's throughput will be until the machine is installed. It is expected that many applications in addition to the current need for the machine would take place with company awareness. It is not possible to determine whether several runs will be needed at the same time. Therefore, the quickest machine was given the rating of four while the others were given lower ratings.

SIDES/ RATING

It is preferable for the machine to be able to print on both sides of the substrate. Whether or not this is accomplished in one pass or two isn't relevant unless it affects the speed. This is addressed in the "Throughput" section. Presses with the ability to print onto both sides of a substrate were given a rating of

four. The Indigo Omnius was the only press that could only print on one side and was given a rating of two. Being able to print on only one side of the substrate is a great disadvantage when printing manuals.

COLOR/ RATING

Other than basic office printing, MSA's instruction sheets and manuals were the only items printed in black and white. All other items at MSA are printed in color. Although black and white items are currently being printed, a color press would be most preferable. Therefore, rating of three was given to black and white presses and a rating of four was given to four color presses. Six color printing is used now at MSA and would be a bonus to include on other documents. Presses capable of six color printing were given a four plus one rating. It would also benefit MSA if the press was able to print glosses, varnishes, or aqueous coatings as a substitution for the sixth color.

RESOLUTION/ RATING

MSA's Packaging Engineering and Marketing evaluated samples of different resolutions. It was determined that 400 dpi was only acceptable for NIOSH plates, proofs, and general office printing. NIOSH plates are currently photocopied but a higher resolution would give a higher quality look. A resolution of 600 dpi would be considered in the future for NIOSH plates and instruction manuals. Although 800 dpi would be acceptable, it is not the most preferred resolution. A resolution of 1270 dpi and above is currently used and would be the most preferable.

INPUT FORMATS/ RATING

MSA requires a Postscript input format. Since all machines had this capability, they were all awarded a four.

FINISHING INCLUDED AND FINISHING OPTIONS (COST EXTRA) RATINGS

Each in-line finishing options was given a rating of one. For example; certain in-line finishers are capable of multiple functions such as cutting, collating, folding and separating. These presses would equal

a rating of four for the four functions. Although it is preferable that the finishing options be included in the price of the press, it is still informative and beneficial for MSA if the press had certain in-line options, even at an additional cost. Items that were available for off line production only were awarded a zero, since they could be purchased and used separately with any machine.

VARIABLE OR NON-VARIABLE/ RATING

Since the current need of MSA is to have the machines print non-variable all machines with this qualification were given a rating of four. As MSA enters into the retail environment, the variability option would enable different barcodes to be printed onto packaging without changing the print run. Therefore, the machines capable of variable printing were awarded an additional point (In this study, the Omnius, E-Print, Xeicon, and Chromapress are the presses capable of variable printing).

OPERATOR/ RATING

Individuals with basic prepress and printing knowledge can run the majority of the presses in this study. However, the Heidelberg, with many qualities of a traditional press requires that the operator be a professional press person.

Because an experienced press person may be more difficult to find, the Heidelberg was awarded a three in this category. All other machines were awarded a four.

REMAINING CATEGORIES

The remaining categories on the chart such as imaging, carrier, and technology, are to aid the reader with his/her project and are not rated for this thesis.

TOTAL SCORES FOR THE PRESSES

Indigo Omnius	69
Indigo E-Print	68
Heidelberg	62
Agfa Chromapress	57
Xeicon	61
Xerox Docutech	54
Xerox Docucolor	53
Canon CLC 1000	53

4.0 COST EVALUATION OF THE INDIGO OMNIUS

MSA INVESTMENT ANALYSIS MANUAL

To justify the purchase of equipment over $25,000, MSA uses an Investment Analysis Manual, otherwise known at MSA as a MAPI (Machinery and Allied Products Institute). By calculating the appropriate information and incorporating it into the analysis, a before tax percentage can be determined, which will eventually be compared against other projects being considered for purchase.

The MAPI is several pages long. Therefore, only the two pages of the evaluation, MSA Equipment Evaluation Summary Form (shown on pages 26 and 27) and a MAPI Chart NO. 1A (shown in appendix)[48], are included in this thesis, along with a detailed description of how each line was calculated.

Because the Indigo Omnius had the highest total score towards meeting MSA's needs, it was the press used in this cost evaluation.

[48] "MSA Investment Analysis Manual", Machinery and Allied Products Institute, 1967, p. 3,10,18.

MSA EQUIPMENT EVALUATION SUMMARY FORM

PROJECT: Indigo Omnius
ALTERNATIVE: Do Nothing

COMPARISON PERIOD (Years) 1 year

ASSUMED OPERATING RATE OF PROJECT (Hours per year) (1900 hours for 1 shift) 1900 hrs.

1. **OPERATING ADVANTAGE**

(Next-year for a 1-year comparison period, *Annual Averages for longer periods)

A. EFFECT OF PROJECT ON REVENUE

		INCREASE	DECREASE
1.	FROM CHANGE IN VLUME OUTPUT	$100,000	$ 0
2.	FROM CHANGE IN QUALITY	0	0
3.	TOTAL	$100,000	$ 0
	B. EFFECT ON OPERATING COSTS		
4.	DIRECT LABOR	$ 91,200	$ 0
5.	INDIRECT LABOR	0	33,360
6.	FRINGE BENEFITS	0	0
7.	MAINTENANCE	30,000	0
8.	TOOLING	0	0
9.	MATERIALS AND SUPPLIES	17,444	0
10.	INSPECTION, SCRAP, REWORK	10,000	0
11.	ASSEMBLY	0	0
12.	DOWNTIME	0	0
13.	UTILITIES	209	0
14.	FLOOR SPACE	5508	0
15.	SUBCONTRACTING	0	56,224
16.	INVENTORY	0	0
17.	SAFETY	0	0
18.	OTHER	0	83,400
19.	TOTAL	$ 154,361	$172,984

COMBINED EFFECT	
20 A NET INCREASE IN REVENUE (3X – 3Y)	$100,000
20 B NET DECREASE IN OPERATING COSTS (19X-19Y)	$ 18,623
21 ANNUAL OPERATING ADVANTAGE (20A + 20B)	$ 118,623

*Next year means the first year of project operation. For projects with a significant break-in period, use performance after break-in.

MSA EQUIPMENT EVALUATION SUMMARY FORM **Sheet 2**

PROJECT NAME: Indigo Omnius

II INVESTMENT AND RETURN

A. INITIAL INVESTMENT

22. Installed Cost of Project	$700,000			
Minus Initial Tax Benefit of	$350,000 (net cost)		$350,000	22
23. Investment in Alternative				
Capital Additions Minus Initial Tax Benefit	$0			
Plus: Disposal Value of Assets Retired By Project	$0		$0	23
24. Initial Net Investment (22-23)			$350,000	24

B. TERMINAL INVESTMENT

25. Retention Value of Project at End of Comparison Period

(Estimate for assets, if any, that cannot be depreciated or expensed. For others, estimate or use MAPI charts.)

Item or Group	Installed Cost, Minus Initial Tax Benefit	Service Life (Years)	Disposal Value, End of Life (Percent of Net Cost)	MAPI Chart Number	Chart Percentage	Retention Value (A X E)
	A	B	C	D	E	F
	350,000	7	0	1A	77%	$269,500

Estimated From Charts (Total of Col. F)	$269,500
26. Disposal Value of Alternative at End of Period	$0
27. Terminal Net Investment (25-26)	$269,500
28. Average Net Capital Consumption $\frac{24-27}{P}$	$11,500
29. Average Net Investment $\frac{24+27}{2}$	$309,750
30. Before-Tax Return $\frac{21-28}{29} \times 100$	35%
31. Increase in Depreciation and Interest Deductions	-------
32. Taxable Operating Advantage (21-31)	-------
33. Increase in Depreciation and Interest Deductions (32 x Tax Rate)	-------
34. After-Tax Operating Advantage (21-33)	-------
35. Available for Return on Investment (34-28)	-------
36. After-Tax Return $\frac{35}{29} \times 100$	TBD

CALCULATIONS FOR INVESTMENT MANUAL LINE ITEMS.

LINE ITEM #1 INCREASED OUTPUT

Time saved using the Indigo Omnius as compared to an outside vendor ranged from seven days to six weeks. The Marketing Department at MSA determined that $2,000 / day in sales is lost because of delayed product. The approximate time savings multiplied by the $2,000/ day figure resulted in the cost savings range of $14,000 to $72,000/ project for the Omnius. A conservative estimate of three projects was used. Two of the projects were from the marketing forecast. For these two projects the low estimation of $14,000 was used as the cost savings. One additional project was determined for new product development. Because this project included bags (which have a longer lead time) in quantities under 2000, the $72,000 amount was used. Total estimated cost savings for the three projects was $100,000.

LINE ITEM #2 CHANGE IN QUALITY

Because there is no actual change in quality of the product, line two was zero.

LINE ITEM #3 TOTAL

This indicates the total of line items one and two.

LINE ITEM #4 DIRECT LABOR

Direct labor is approximately $48/ hour including fringe benefits. This number was multiplied by 1900 for one person on a full time basis. The total cost/ year is $91,200

LINE ITEM # 5 INDIRECT LABOR

The time saved in indirect labor was estimated creating a process flow chart (see page 38). This time was then multiplied by the $48/ hour labor rate for a total yearly savings of $33,360.

LINE ITEM #6 FRINGE BENEFITS

As instructed in the investment manual, no entry was to be made here.

LINE ITEM #7 MAINTENANCE

Maintenance was determined using the figures provided in the Omnius proposal for MSA. $2500/ month or $30,000/ year is the charge for the full service meter plan. Since this is a new technology for MSA, this is the plan that was chosen.

LINE #8 TOOLING

Since the Omnius does not affect a current operating expense, described in the MAPI investment manual as "a cost saved or incurred from changing an existing production method", a figure of zero was entered on line eight.

LINE #9 MATERIALS AND SUPPLIES

Materials and supplies needed for a year were calculated using the marketing forecast for 1998 Consumer Products. Only items with quantities 2000 and under were considered, since all other jobs of higher quantities would be printed by an outside vendor. Using an estimation of 60% coverage and two Omnius charts (See "Operator Maintained Parts" and "Indigo Imaging Products Cost Analysis" charts), the costs for color and black and white printing were .195 and .134 respectively for each impression. These costs were then added to the cost of the packaging material. Packaging material costs and quotes were obtained from vendors in the Pittsburgh area. By using the quantities provided and estimating the packaging items needed for the Consumer Products forecast, the total cost of $17,444 was calculated to be the cost of using the Omnius for year of printing (See the "Omnius" chart for details).

LINE #10 INSPECTION, SCRAP, REWORK

MSA's scrap charges for packaging items in 1997 were approximately $10,000. We would expect the costs to be approximately the same using the Omnius.

LINE #11 ASSEMBLY

Because the project does not improve assembly operations, no entry was made.

LINE #12 DOWN TIME

The Omnius is expected to be 75% efficient. However, no cost is entered, since Omnius is not expected to be fully utilized. Therefore, interrupted service time would be negligible

LINE #13 UTILITIES

Utility costs were calculated at the maximum of 1900 hours. These hours multiplied by an estimate of eleven cents an hour, equaling $209.

LINE #14 FLOOR SPACE

A floor plan including the Omnius and other items necessary to produce final packaging items was created (see "Floor Plan", p. 44). Floor space was calculated at $12/ square foot. This was then multiplied by the estimated room size of 459 square feet (17' X 27') for a total of $5508.

LINE #15 SUBCONTRACTING

Line item # 15 on the MAPI describes a "make" versus "buy" decision. The cost of having all of the items with a quantity of 2000 or less printed by an outside vendor was estimated to be $56,224 (See "Vendor" chart, page 43).

LINE #16 INVENTORY

Because MSA currently uses a "make to order" system, there would be no savings in inventory.

LINE #17 SAFETY

Since the project does not offer increased safety a zero was entered on this line.

LINE #18 OTHER

Film costs, which are incurred by using outside vendors at MSA were estimated to be $200 /each. This cost was multiplied by an estimated 417 orders equaling a cost savings of $83,400/ year.

LINE #19 TOTAL

The totals of the columns were $154,361 for costs that would increase operating costs and $172,984 for costs that would decrease operating expenses.

LINES #20A, 20B AND 21

The increase in revenue added to the decrease in operating costs lead to the annual operating advantage of $118,623.

LINE #22

The installed cost of the Project is $700,000. Part of this cost included the $495,000 Omnius premium configuration, yours truly personalization ($50,000), the additional fifth and sixth colors ($50,000), electronic collation ($15,000). The remaining costs for finishing equipment were estimated by David Morgan, Branch Manager at C.P. Bourg. Finishing equipment included a slitter/ cutter ($15,000), an off -line, 3200 sheet/ hour booklet maker that folds, staples, and trims up to 40 pages ($55,000), and a heat sealer ($20,000). The final cost of $700,000 assumes shipping and installation fees will be waived in the final negotiation.

LINE #23

The initial tax benefit of $350,000 was calculated by multiplying the installed cost of the project by 50 percent.

LINE #24 INITIAL NET INVESTMENT

The initial net investment is $350,000

LINE #25 RETENTION VALUE

The estimated time the press would be used is seven years. At this point in time it is most likely the machine will have been replaced by new technology and will no longer hold any value.

MAPI chart number 1A (p. 46) was used, as instructed, because of the one year comparison period. The corresponding points on the chart for a seven year service life with a zero percent salvage rate we come up with a 77 chart percentage. Multiplying this percentage by the installed cost of the project and subtracting the tax benefit, the retention value is calculated to be $269,500.

LINE #26 DISPOSAL VALUE OF ALTERNATIVE

Since the alternative to this project is to do nothing, a zero was entered on line #26.

LINE #27 TERMINAL NET INVESTMENT

The terminal net investment is $269,500.

LINE #28 AVERAGE NET CAPITAL CONSUMPTION

The average net capital consumption was figured by subtracting the terminal net investment from initial net investment and then dividing by the service life of seven. The result was $11,500.

LINE #29 AVERAGE NET INVESTMENT

By adding the initial net investment with the terminal net investment and dividing by 2, the average net investment of $309,750 was calculated.

LINE #30 BEFORE TAX RETURN

By subtracting the average net capital consumption from the annual operating advantage and dividing by the average net investment, then multiplying by 100, the before tax percentage of 35 was calculated.

INVESTMENT ANALYSIS RESULTS

Results using the MAPI analysis showed that a before tax return of 35 percent is achievable. The remainder of the items on the analysis will be evaluated by MSA's treasury department and were not filled in at this time.

5.0 CONCLUSION

The contribution of this thesis is mainly to those at Mine Safety Appliances, who now have a better understanding of the features needed and costs associated with on-demand digital printing along with the press that most matches its needs. In addition to providing information to MSA, this thesis can be used for those in Industry who want a quick reference chart that outlines details of several on-demand digital printers in a easily accessible chart format.

By investigating on-demand digital printing it was apparent that there were various on-demand digital printers available from low to high cost, with a variety of options and amenities. Some of the differences between the presses included the number of substrates in which the press could print, different paper feed mechanisms, speeds, resolutions, and number of colors. Other differences included options such as variability and in-line finishing. General base prices of the presses ranged from approximately $120,000 to $495,000.

To narrow the broad range of on-demand digital printers, a representative sample of eight presses with varying prices and capabilities was investigated. Gathering and organizing detailed information about the presses was quite lengthy, as there were many sources with limited information. However, a rather thorough chart with detailed information on the presses' amenities was created.

Using a point scale, the features of the eight presses were rated according to MSA's needs. Presses with additional functions were not given higher ratings unless those functions were needed at MSA. The press with the highest total points indicated the press that met the most needs.

The press that had the highest score was the Indigo Omnius. The Omnius was able to print onto a variety of packaging materials including paper stock, label stock, card stock, board stock, foil, and polyethlylene. The other presses in the study were much more limited as to which materials could be printed. The fact that the Omnius could print onto polyethylene was a great benefit for MSA. MSA's need for bag materials printed in a timely fashion is great. The current lead-time for a printed bag is six to eight weeks. The Omnius could make it possible to have bags printed in a day, if necessary.

Other capabilities matching the needs of MSA included six color printing, the variability option, and the fact that the press is web fed. By being able to print six colors, MSA can create many of its new Consumer line of packaging on the press. The variability option would allow for an ideal way to print MSA's barcode labels, which have small quantities and slightly varying print. Also, having a web fed press allows for options in document size.

Even with the many positive features, the Omnius had some major drawbacks. One of the drawbacks was that the press only printed onto one side of the substrate. Two sided items would need to be printed on another press such as the E-Print, DocuColor, Docutech, or by traditional methods such as lithography. Another drawback was that the Omnius had no in-line finishing features. Finishing options must be purchased separately and are quite costly, or the item would need to be sent to an outside vendor. Along with the other presses, the Omnius was also not capable of printing onto thicker card stocks used to create folding cartons. Folding cartons, like bags, are long lead-time packaging items at MSA.

With many positive aspects and a few major drawbacks, a cost analysis was conducted to see if the press would be worth implementing at an MSA site. MSA's "MAPI" or "Equipment Evaluation Form", used for items over $25,000, indicated the areas that needed to be investigated for cost purposes. These areas included a time study to indicate increased output, a "make versus buy" analysis, and a determination of costs associated with the equipment, installation, maintenance, and labor.

The evaluation resulted in a 35% before tax return. This is rather large percentage compared to the MSA requirement of an 11% return to consider the project for a capital expenditure. This additional information from the cost analysis was beneficial because it indicated that even a very expensive press, such as the Omnius would be a worthwhile capital consideration for MSA.

The "needs" assessment indicated that the press in this study that meets MSA's needs the most was the Indigo Omnius. The entire investigation shows us that there are a few very important amenities that the Omnius is not capable of doing. Finally, the cost analysis shows us that a very expensive digital press with the Omnius's capabilities could be strong capital consideration for MSA.

6.0 RECOMMENDATION

This thesis shows MSA that out of several presses with varying capabilities and price ranges, the Indigo Omnius meets the most needs. The Omnius was the most expensive press in the study and in most areas had more capabilities than the other presses. However, because the capital expense was significant for implementing the Omnius, along with the fact that it did not meet some of the major needs at MSA, the recommendation is to further the investigation.

Options for satisfying the needs of finishing items, two sided printing, and printing onto thicker board stocks are areas that need more research. Also, on-demand digital printing is a technology in which MSA has little experience. Therefore, investigating companies which have already installed an Omnius, along with options such as leasing the equipment, partnering, or purchasing printed items from another company with an Omnius would be next steps. By investigating the rate at which on-demand digital printing is developing and by doing additional interviews, we may also find that the digital printing technology is planned to evolve enough to meet all of MSA's needs in a few short years.

7.0 CHARTS AND APPENDICIES

MSA RATINGS

4= Most Need
3= More Need
2= Less need than items rated a three
1= Little Need or used as an add-on to 4 for those items which have added capability.
0= No Need

Substrates	**Rating**
Paper (uncoated , coated, and recycled) Including 60#	4
Card Stock (paper) including 110#	4
Polyethylene	4
Foil	0
Board stock under 18 pt.	2
Transparencies	0
Polyesters	0
Fabric (possibly for tags in clothing)	2
Labels	4
Substrate Supplier	
Various suppliers	4
Manufacturer Only	3
Paper Feed	
Web	4
Sheet	3
Ink Type	
Uses water based ink	4
Uses liquid toner (electroink)	3
Uses dry toner	2
Ink /Toner Supplier	
Can buy from a variety of sources	4
Buy from Press manufacturer only	3
Economical Number of Prints	
Over 200 and Under 5000	4
Under 2000	3
Under 1000	2
Paper Size-Size of Out put	
Larger than 11 x 17	4 +1= 5
11 x 17 and Smaller	4
Print Area	
Larger than 11 x 17 full bleed	4+1= 5
11 x 17 full bleed	4
Smaller than 11 x 17	4

Throughput

4000 and over 4 color/hr	4
2000 to 4000 4 color/hr.	3
2000 and under 4 color/hr.	2

Sides printed

2 sides	4
1 side	2

# of Colors

6 Color (how to rate this/ the system does the min. 4 color + more	4+1+1=6
5 Color	4 +1= 5
4 Color	4
Black and White only	2

Resolution

2400 dpi or 1200 dpi	4
800 dpi	3
600 dpi	2
400 dpi	1

Input formats

Adobe postscript: All take adobe postscript which complies with MSA.

Options

Omnigloss	1

Finishing Options.

Only in-line items are rated. Those that are off line can be purchased from different manufacturers.

In-line Finisher (includes cutter, collator, folder, and job separator)	4
Auto Booklet Maker (includes saddle stitcher, trimmer, and folder)	3
Stapler/ Collator	1
Sorter/Separator	1
None	0

Variable or Non-Variable

Variable Printing	5
Non-Variable Printing	4

Expected Up-Time

95-100%	4
85-94%	3
75-84%	2

Operator Needs

Trained personnel with printing and prepress knowledge	4
Professional press person	3

STANDARD SUBSTRATE LISTING FOR MSA PACKAGING

PRODUCTS	SUBSTRATE/ DESCRIPTIONS
LABELS	Tape: Rolls; No Liner; •3M #256 white paper tape Flat Sheets with backing; White High Gloss Paper, Litho Matte Paper, Uncoated Paper, White Vinyl, Polyester, Mylar, Lexan, Teslin •2 mil white or clear polyester; •Fasson satin litho or vinyl; •3M silver or white polyester; •MacTac clear mylar with over coating; •Fasson mirage or primatherm •High contrast materials (primatherm is themal transfer) •R400 reflective vinyl; •.002 white mylar with .001 mylar overlaminate; •.010 suede/matte Lexan w/ 468 transfer tape; •Datacal PC600 yellow match V-26 with 90# liner; •.002 white polyester with .001 matte polyester overlam; •60# litho- R195 removable adhesive; •R100 commercial grade reflex vinyl flatsheets; •MacTac Starliner teslin labels (varnished)
MANUALS/ INSTR. SHEETS	Paper •60# white offset & 65# cover; Hammermill & Cougar •50# or 60# text Wierhouser or Huskie offset
BAGS	Polyethylene •1 mil to 4 mil
CARTONS	Board Stock •24 pt (-2/+4 rule) clay coated new, craft back, with gray or natural colored liner
INSERTS	Card Stock •110#

Process Flow Chart For Specific Task Times

	Current Task Time		Omnius Task Time
Purchasing Requisition written	10 min.	Purch. Req. is sub electronically	10 min.
Purchasing Logs in Request	10 min.		
Purchasing Calls Vendors for Quotes	30 min.		
Purchasing Evaluates Quotes	10 min.		
Purchasing Calls Packaging (Send Art)	5 min.		
Packaging Pulls copy of Drawing	15 min.	Packaging Pulls Copy of Drawing	15 min
Packaging Compares elect. file to dwg.	30 min.	Packaging compares electronic File to dwg.	30 min.
Packaging Makes Print out of elect. File	5 min.	Packaging sends file to Omnius	5 min
Packaging Calls Film Vendor	5 min.		
Packaging Fills out Fed Ex Form and Packages item to be sent to vendor	5 min.		
Packaging receives film and reviews for appropriate registration points and text flow	30 min.		
Packaging fills out fed ex form to send film to appropriate vendor.	5 min		
Packaging reviews blue line from vendor before printing takes place.	30 min.	Packaging reviews proof from Omnius	30 min.
Total	190 min.		90 min.

Not Including:
*Disk cost
*Fed ex costs
*Form costs

Difference 190 min- 90 min. = 100 minutes 115 min. = 1.66 hours
1.66 hours x $48/hour = ~ $80 / job
346 1996 jobs + 71 Marketing Forecast jobs = 417 Total Jobs under 2000 impressions

$80 X 417 = $33,360

indigo

Imaging Products Cost Analysis (at % Coverage)

% Total Coverage	Photo. Imaging Plate	Imaging Transfer Blanket	Cyan Electro-Ink	Magenta Electro-Ink	Yellow Electro-Ink	Black Electro-Ink	Imaging Oil	Total Cost Per 12"x18"	Total Cost Per Sq. Inch
10.00%	$0.0475	$0.0458	$0.0034	$0.0034	$0.0034	$0.0034	$0.0027	$0.1095	$0.0005
20.00%	$0.0475	$0.0458	$0.0068	$0.0068	$0.0068	$0.0068	$0.0053	$0.1257	$0.0006
30.00%	$0.0475	$0.0458	$0.0101	$0.0101	$0.0101	$0.0101	$0.0080	$0.1419	$0.0007
40.00%	$0.0475	$0.0458	$0.0135	$0.0135	$0.0135	$0.0135	$0.0107	$0.1581	$0.0008
50.00%	$0.0475	$0.0458	$0.0169	$0.0169	$0.0169	$0.0169	$0.0133	$0.1743	$0.0008
60.00%	$0.0475	$0.0458	$0.0203	$0.0203	$0.0203	$0.0203	$0.0160	$0.1905	$0.0009
70.00%	$0.0475	$0.0458	$0.0237	$0.0237	$0.0237	$0.0237	$0.0187	$0.2067	$0.0010
80.00%	$0.0475	$0.0458	$0.0271	$0.0271	$0.0271	$0.0271	$0.0213	$0.2229	$0.0011
90.00%	$0.0475	$0.0458	$0.0304	$0.0304	$0.0304	$0.0304	$0.0240	$0.2391	$0.0011
100.00%	$0.0475	$0.0458	$0.0338	$0.0338	$0.0338	$0.0338	$0.0267	$0.2553	$0.0012
110.00%	$0.0475	$0.0458	$0.0372	$0.0372	$0.0372	$0.0372	$0.0293	$0.2715	$0.0013
120.00%	$0.0475	$0.0458	$0.0406	$0.0406	$0.0406	$0.0406	$0.0320	$0.2877	$0.0014
130.00%	$0.0475	$0.0458	$0.0440	$0.0440	$0.0440	$0.0440	$0.0347	$0.3039	$0.0015
140.00%	$0.0475	$0.0458	$0.0474	$0.0474	$0.0474	$0.0474	$0.0373	$0.3201	$0.0015
150.00%	$0.0475	$0.0458	$0.0507	$0.0507	$0.0507	$0.0507	$0.0400	$0.3363	$0.0016
160.00%	$0.0475	$0.0458	$0.0541	$0.0541	$0.0541	$0.0541	$0.0427	$0.3525	$0.0017
170.00%	$0.0475	$0.0458	$0.0575	$0.0575	$0.0575	$0.0575	$0.0453	$0.3687	$0.0018
180.00%	$0.0475	$0.0458	$0.0609	$0.0609	$0.0609	$0.0609	$0.0480	$0.3849	$0.0018
190.00%	$0.0475	$0.0458	$0.0643	$0.0643	$0.0643	$0.0643	$0.0507	$0.4011	$0.0019
200.00%	$0.0475	$0.0458	$0.0677	$0.0677	$0.0677	$0.0677	$0.0533	$0.4173	$0.0020
210.00%	$0.0475	$0.0458	$0.0710	$0.0710	$0.0710	$0.0710	$0.0560	$0.4335	$0.0021
220.00%	$0.0475	$0.0458	$0.0744	$0.0744	$0.0744	$0.0744	$0.0587	$0.4497	$0.0022
230.00%	$0.0475	$0.0458	$0.0778	$0.0778	$0.0778	$0.0778	$0.0613	$0.4659	$0.0022
240.00%	$0.0475	$0.0458	$0.0812	$0.0812	$0.0812	$0.0812	$0.0640	$0.4821	$0.0023
250.00%	$0.0475	$0.0458	$0.0846	$0.0846	$0.0846	$0.0846	$0.0667	$0.4983	$0.0024
260.00%	$0.0475	$0.0458	$0.0880	$0.0880	$0.0880	$0.0880	$0.0693	$0.5145	$0.0025
270.00%	$0.0475	$0.0458	$0.0913	$0.0913	$0.0913	$0.0913	$0.0720	$0.5307	$0.0026
280.00%	$0.0475	$0.0458	$0.0947	$0.0947	$0.0947	$0.0947	$0.0747	$0.5469	$0.0026
290.00%	$0.0475	$0.0458	$0.0981	$0.0981	$0.0981	$0.0981	$0.0773	$0.5631	$0.0027
300.00%	$0.0475	$0.0458	$0.1015	$0.1015	$0.1015	$0.1015	$0.0800	$0.5793	$0.0028

Operator Maintained Parts (OMP)

Operator Maintained Part	Price/Unit	Yield/Imp	Price/Impression
Bobbin Wire, Set	$200.00	270,000	$0.000741
Squugee Roller Assembly	$200.00	150,000	$0.001333
Grid	$41.75	180,000	$0.000232
Doctor Blade Colors	$11.45	100,000	$0.000115
Doctor Blade Cleaning	$11.45	250,000	$0.000046
Doctor Blade Wetting	$12.20	500,000	$0.000024
Wiper Cleaning-Short	$33.00	20,000	$0.001650
Flourescent Lamp F16.5	$46.00	750,000	$0.000061
Slit Cleaning	$4.00	600,000	$0.000007
Density Senor Cleaner	$4.00	800,000	$0.000005
Imaging Agent	$23.00	170,000	$0.000135
Sensor Insulate	$1.70	120,000	$0.000014
Grease	$11.00	968,000	$0.000011
Average Cost Per Impression for OMP			$0.004375

Yield / Usage is dependent upon customer's monthly impression volume, the type of jobs being printed, the experience of the operator and the quality of the daily maintenance routines that they perform.

APPROXIMATE IMPRESSION COSTS-UNDER 2000 IMPRESSIONS

OMNIUS

60% Coverage- 4 Color	0.01905
Operator Maintained Parts (OMP)	.0.004374
Total	0.195

60% Coverage Black and White	0.1296
OMP	0.004375
Total	0.134

APPROXIMATE OMNIUS COSTS INCLUDING SUBSTRATE

B1	.204
L2	.3673
P1	.1489
P2	.2348
C1	.2099

APPROXIMATE AVERAGE VENDOR COSTS

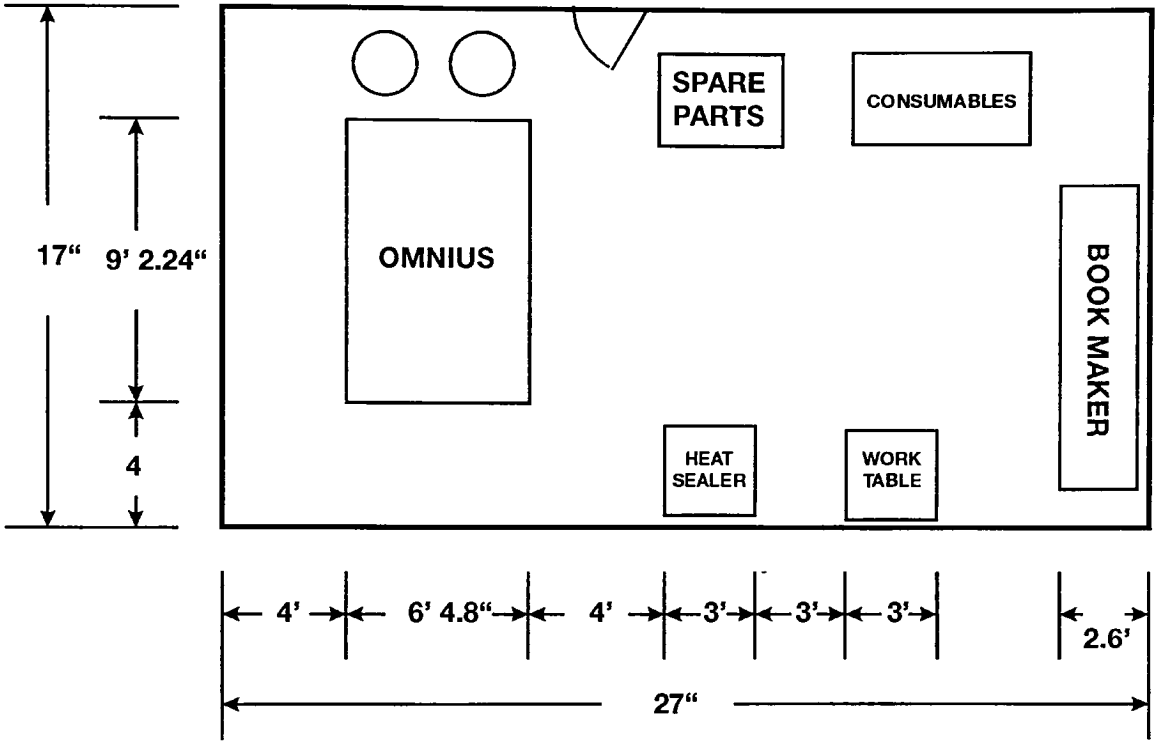
B1	.49338
L2	.24925
P1	.20699
P2	.40565
C1	1.39

B1= Bag
L2= Labels
P1= Paper stock (typical 60 lb.)
P2= Paper stock (tags)
C2= Card stock

	0.19	OMNIUS											
	0.13	BAG	BOARD	BOARD	INSERT	INSERT	INSERT	INSERT	LABEL	LABEL	PAPER	INDIVIDUAL	LAUNCH
		PRINTED	HEADER	SLEEVE	APPROVAL	CARD	CLAMSHELL	MANUAL	BARCODE	CARTON	TAG	TOTALS	TOTALS
		0.0092	0.015	0.015	0.015	0.04	0.015	0.015	0.1725	0.1725	0.04		
		0.204075	0.209875	0.209875	0.148975	0.234875	0.209875	0.148975	0.308475	0.387375	0.234875		
Replacement 1/4 Mask Filters	499		1		1							0.38	179.14
Adv 200 w/ P100 (Asbestos) Respirator	824		1		1							0.38	223.92
Comfo w/ P100 (Asbestos) Respirator	824		1		1							0.38	223.92
Adv 200 w/ GME-P100	824		1		1							0.38	223.92
Comfo Classic w/ GME-R95	824		1		1							0.38	223.92
Adv 200 P100 Replacement Cartridge	824		1		1							0.38	223.92
Comfo P100 Replacement Cartridge	824		1		1							0.38	223.92
Adv 200 GME-P100 Replacement Cartridge	824		1		1							0.38	223.92
Comfo GME-P100 Replacement Cartridge	824				1		1	1				0.51	318.88
Adv 200 N95 Replacement Cartridge	824				1		1	1				0.51	318.88
Comfo R95 Replacement Cartridge	824				1		1	1				0.51	318.88
Adv 200 GME Replacement Cartridge	824				1		1	1				0.51	318.88
Comfo GME Replacement Cartridge	824				1		1	1				0.51	318.88
Goggles - Welder's	824				1		1	1				0.51	318.88
Faceshield Assembly	824				1							0.15	92.98
White V-Gard w/ Ratchet Suspension	749				1							0.15	111.58
Nuisance 1/4 Masks	832				1							0.15	123.95
Nuisance 1/4 Masks	832				1							0.15	123.95
Hearing Protection - Ear Muffs	832				1							0.15	123.95
Hearing Protection - Ear bands	832				1							0.15	123.95
Disposable Nuisance/Dust Comfort Mask- 25 pack	998				1							0.15	148.74
Disposable Nuisance/Dust Comfort Mask- 50 pack	998				1							0.15	148.74
First Aid (10 unit kit)	998		1		1							0.36	358.28
First Aid (large, plastic)	998		1		1							0.36	358.28
First Aid (large, metal)	998		1		1							0.36	358.28
First Aid (box of band-aids)	998		1		1							0.36	358.28
Comfo w/ GME-P100	1248		1		1							0.36	447.84
Adv 200 w/ GME-N95	1248									1		0.37	458.48
Affinity Plus (N95)	1248									1		0.37	458.48
Affinity Pro w/ Nuisance OV	1248									1		0.37	458.48
Affinity Pro w/ Adj. Strap & Ex Vavle	1248									1		0.37	458.48
Goggles - Perforated - low end	1248									1		0.37	458.48
Goggles - Fashion/Splash	1248			1					1		1	0.75	937.53
Spectacles - Visitor's Style	1248			1					1		1	0.75	937.53
Spectacles - General Purpose	1248			1					1		1	0.75	937.53
Hearing Protection - Ear Plugs, rubber w/ cord	1248			1					1		1	0.75	937.53
Goggles - Perforated - low end	1498			1					1		1	0.75	1125.03
White V-Gard	1498			1					1		1	0.75	1125.03
Yellow V-Gard	1498			1					1		1	0.75	1125.03
First Aid (mini-pouch)	1997			1					1		1	0.75	1500.05
Affinity Pro w/ Nuisance OV	2498												
Spectacles - General Purpose	2498												
Spectacles - General Purpose	2498												
Spectacles - Fashion/High End	2498												
Goggles - Perforated - low end	2995												
Disposable Nuisance/ Dust Comfort Mask	3328												
Disposable Nuisance/ Dust Comfort Mask	3328												
Affinity Plus (N95)	3744												
Hearing Protection - Ear Plugs, foam	3744												
Disposable Nuisance Dudst Comfort Mask	6656												
									GRAND TOTALS			18.75	17444.33

		VENDOR											
		BAG	BOARD	BOARD	INSERT	INSERT	INSERT	INSERT	LABEL	LABEL	PAPER	INDIVIDUAL	LAUNCH
		PRINTED	HEADER	SLEEVE	APPROVAL	CARD	CLAMSHELL	MANUAL	BARCODE	CARTON	TAG	TOTALS	TOTALS
		$0.49338	$1.39000	$1.39000	$0.20699	$0.40565	$0.20699	$0.20699	$0.24925	$0.24925	$0.40565		
Replacement 1/4 Mask Filters	499		1		1				1			1.85	921.64
Adv 200 w/ P100 (Asbestos) Respirator	624		1		1				1			1.85	1152.05
Comfo w/ P100 (Asbestos) Respirator	624		1		1				1			1.85	1152.05
Adv 200 w/ GME-P100	624		1		1				1			1.85	1152.05
Comfo Classic w/ GME-R95	624		1		1				1			1.85	1152.05
Adv 200 P100 Replacement Cartridge	624		1		1				1			1.85	1152.05
Comfo P100 Replacement Cartridge	624		1		1				1			1.85	1152.05
Adv 200 GME-P100 Replacement Cartridge	624		1		1				1			1.85	1152.05
Comfo GME-P100 Replacement Cartridge	624				1		1	1	1			0.87	543.02
Adv 200 N95 Replacement Cartridge	624				1		1	1	1			0.87	543.02
Comfo R95 Replacement Cartridge	624				1		1	1	1			0.87	543.02
Adv 200 GME Replacement Cartridge	624				1		1	1	1			0.87	543.02
Comfo GME Replacement Cartridge	624				1		1	1	1			0.87	543.02
Goggles - Welder's	624				1		1	1	1			0.87	543.02
Faceshield Assembly	624				1				1			0.46	284.69
White V-Gard w/ Ratchet Suspension	749				1				1			0.46	341.72
Nuisance 1/4 Masks	832				1				1			0.46	379.59
Nuisance 1/4 Masks	832				1				1			0.46	379.59
Hearing Protection - Ear Muffs	832				1				1			0.46	379.59
Hearing Protection - Ear bands	832				1				1			0.46	379.59
Disposable Nuisance/Dust Comfort Mask- 25 pack	998				1				1			0.46	455.51
Disposable Nuisance/Dust Comfort Mask- 50 pack	998				1				1			0.46	455.51
First Aid (10 unit kit)	998		1		1				1			1.85	1843.29
First Aid (large, plastic)	998		1		1				1			1.85	1843.29
First Aid (large, metal)	998		1		1				1			1.85	1843.29
First Aid (box of band-aids)	998		1		1				1			1.85	1843.29
Comfo w/ GME-P100	1246		1		1				1			1.85	2304.11
Adv 200 w/ GME-N95	1248								1	1		0.50	622.13
Affinity Plus (N95)	1248								1	1		0.50	622.13
Affinity Pro w/ Nuisance OV	1248								1	1		0.50	622.13
Affinity Pro w/ Adj. Strap & Ex Valve	1248								1	1		0.50	622.13
Goggles - Perforated - low end	1248								1	1		0.50	622.13
Goggles - Fashion/Splash	1248			1		1			1		1	2.45	3058.29
Spectacles - Visitor's Style	1248			1		1			1		1	2.45	3058.29
Spectacles - General Purpose	1248			1		1			1		1	2.45	3058.29
Hearing Protection - Ear Plugs, rubber w/ cord	1248			1		1			1		1	2.45	3058.29
Goggles - Perforated - low end	1498			1		1			1		1	2.45	3669.94
White V-Gard	1498			1		1			1		1	2.45	3669.94
Yellow V-Gard	1498			1		1			1		1	2.45	3669.94
First Aid (mini-pouch)	1997			1		1			1		1	2.45	4893.26
Affinity Pro w/ Nuisance OV	2496												
Spectacles - General Purpose	2496												
Spectacles - General Purpose	2496												
Spectacles - Fashion/High End	2496												
Goggles - Perforated - low end	2995												
Disposable Nuisance/ Dust Comfort Mask	3328												
Disposable Nuisance/ Dust Comfort Mask	3328												
Affinity Plus (N95)	3744												
Hearing Protection - Ear Plugs, foam	3744												
Disposable Nuisance/ Dust Comfort Mask	6656												
										GRAND TOTALS		54.97	56224.05

FLOOR PLAN

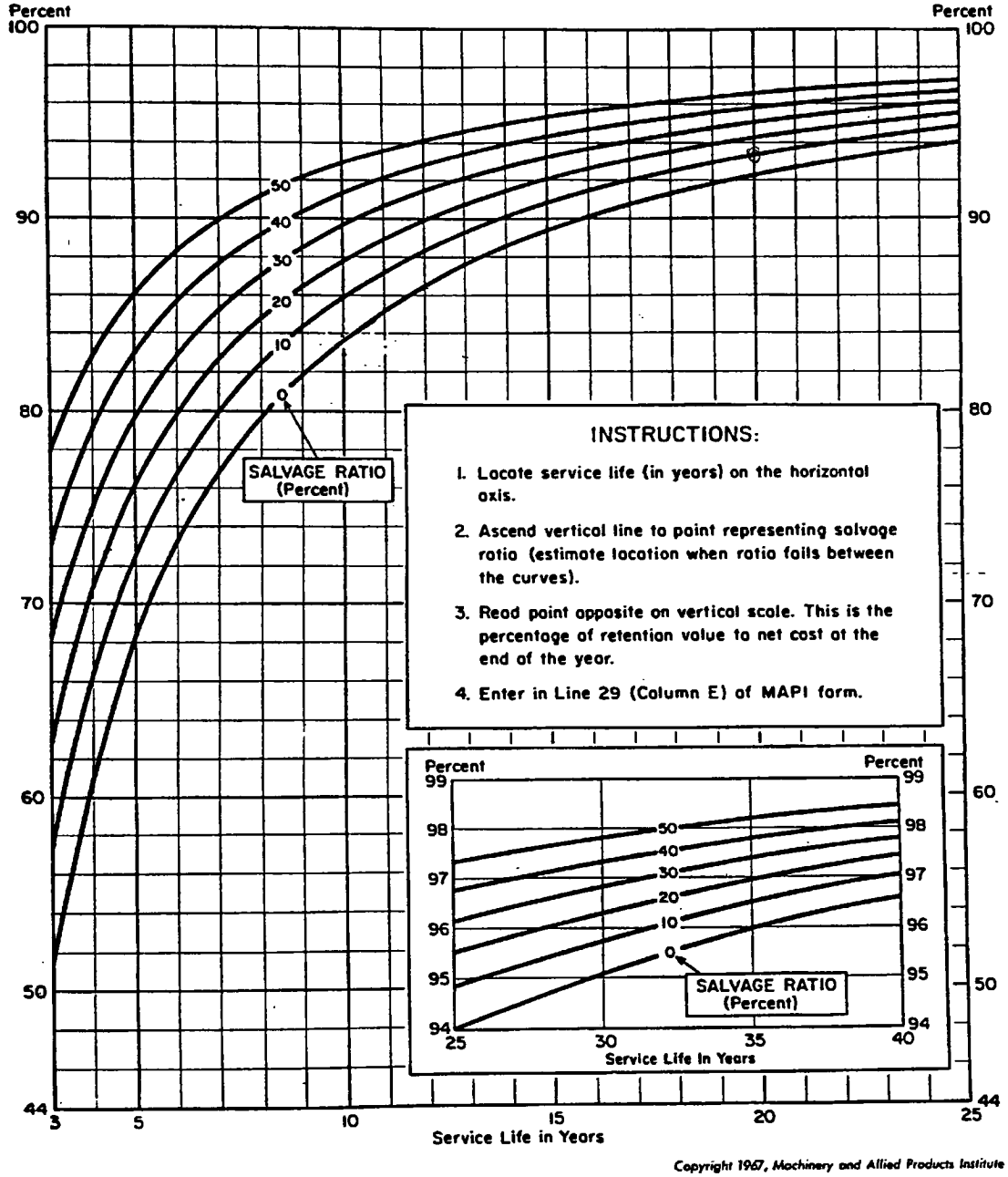

17"
9' 2.24"
4
OMNIUS
SPARE PARTS
CONSUMABLES
BOOK MAKER
HEAT SEALER
WORK TABLE
4'
6' 4.8"
4'
3'
3'
3'
2.6'
27"

INSTALLED COST OF PROJECT

OMNIUS BASE COST	$495,000
YOUR'S TRULY PERSONALIZATION	$50,000
COLORS 5 & 6	$50,000
ELECTRONIC COLLATION	$15,000
*SLITTER/ CUTTER	$15,000
*BOOKLET MAKER	$55,000
*HEAT SEALER	$20,000
TOTAL COST	$700,000

MAPI CHART No. 1A

(ONE-YEAR COMPARISON PERIOD AND SUM-OF-DIGITS TAX DEPRECIATION)



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