



**Costs and Returns of
Conversion to Two-sided Computer Printing at MSU**

by

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Costs and Returns of Conversion to Two-sided Computer Printing at MSU

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Introduction

Shifting from single-sided to two-sided printing has the potential to reduce paper use at MSU. In 2003/04, the University purchased centrally 785 tons (314,000 reams) of white office paper. A sample study suggests that white office paper accounted for 23% of wastebasket contents from faculty and administrative offices (Selke, et al. 2006, pp. 34-35). Since, a substantial share of white office paper on campus is used by computer printers, shifting to two-sided printing can reduce campus paper use. However, two-sided printers typically cost more to purchase and maintain. This study estimates direct financial costs and returns to the University from converting from one-sided to two-sided computer printing. It also discusses non-financial environmental benefits from such a change.

The main financial advantages of converting from one-sided to two-sided computer printing are:

- Paper purchase cost savings
- Landfill disposal cost savings

The financial drawbacks of conversion to double sided printing are:

- Higher initial investment (for some, not all printer types)
- Likely shorter expected useful lifetime (5 years vs. 6-7 for single-sided).

The campus-wide system of E-token printers at shared public computing facilities is centrally managed by the MSU Computer Repair Department, while a larger number of printers in individual offices are managed at the unit level. This study uses net present value methods to evaluate costs and returns to two-sided printing for each of these two cases.

Case Study 1: E-token printers at public computing facilities on campus

The MSU Computer Center is mainly divided into the Computer Store, the Computer Repair Department and Computer Labs. The Computer Repair Department (CRD) services and maintains the 88 E-token printers at MSU's public computer labs, relying on revenue from E-token sales. Normal service and maintenance include repair, replacing toners and refilling papers. The E-token printers use approximately 6 million sheets of paper annually. The current set of printers has been in operation for around 7 to 8 years

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and is mostly due for replacement. The printers consist of HP 8100, HP 8150 and HP 8550 (Color) models that are not equipped for double sided printing.

CRD is planning to phase out the current set of printers in summer 2007, starting with 1/3 of the highest usage printers. CRD proposes to replace current models with the HP 9040n printer, which has a double-sided printing option available for \$400 extra. Assuming that 60% of printing used the two-sided option, this cost would be offset by estimated reduction in paper usage of 20,455 sheets (41 reams) of paper per printer, resulting in annual cost savings of \$150 (for details, see Table 1 in appendix). Hence the added cost of the double-sided printing option for the HP9040n printer can be recovered within 3 years, based on a net present value (NPV) analysis (for details, see Table 2 in appendix). Over a useful life of five years, the NPV of installing the double sided option for a printer comes to \$247 (assuming a 5% discount rate). Replacing all 88 E-token printers with double sided printers will result in a savings of \$21,751 to MSU over the span of 5 years.

Case Study 2: Printer replacement in decentralized campus units

Outside of these public computing facilities, the purchasing and maintenance of computers and printers at MSU is highly decentralized. Departments can purchase printers from the Computer Store, Purchasing Department, General Store or through retail channels. However, the Computer Store and Purchasing Department appear to handle most printer purchases, and most of the printers purchased were from Hewlett Packard (HP)

The 2028 computer printers sold through the Computer Store in 2005 and 2006 can be divided into 4 broad price categories (see Table 3 in appendix). We classify printers costing between \$100 and \$600 as “low-end” printers and these are usually for the personal use of faculty and staff. “High end” printers costing above \$600 are normally used as common network printers in faculty and staff offices.

In order to estimate costs and returns to double-sided printing for the diversity of printer types used in individual units on campus, we examine the difference in price between the most popular one-sided printer and a comparable two-sided printer for each of the four categories identified (Table 4 in appendix). In the low cost (\$100-300) category, an auto duplex unit costs an extra \$80. For the two mid-cost categories (\$300-600 and \$600-1000), there was no additional cost for two-sided printing. For the high cost printer category (over \$1000), the relevant two-sided accessory cost \$275.

The cost savings from two-sided printing hinge mainly on the amount of paper saved. Because we do not have information on the average paper usage by various printer types, we develop a generic analysis illustrated in a Chart 1, which shows the minimum number of annual pages that need to be printed to recover a given difference in purchase price. The analysis assumes a useful printer lifetime of 5 years, similar maintenance costs between duplex and single-sided printers, and a 5% discount rate. The three lines in the chart represent the combination of price difference and number of pages printed that will result in zero NPV at different level of double sided printing rate (details on the zero NPV derivation available in appendix). Any combination of annual pages printed and

price difference above the double sided printing rate line will fail to recover the added cost of two-sided printing. For example, if additional cost of a double sided printer is \$100, then the minimum annual number of pages that need to be printed to recover this additional cost is approximately 15,000 assuming 50% of all the pages printed will be double sided.(refer to dashed line).

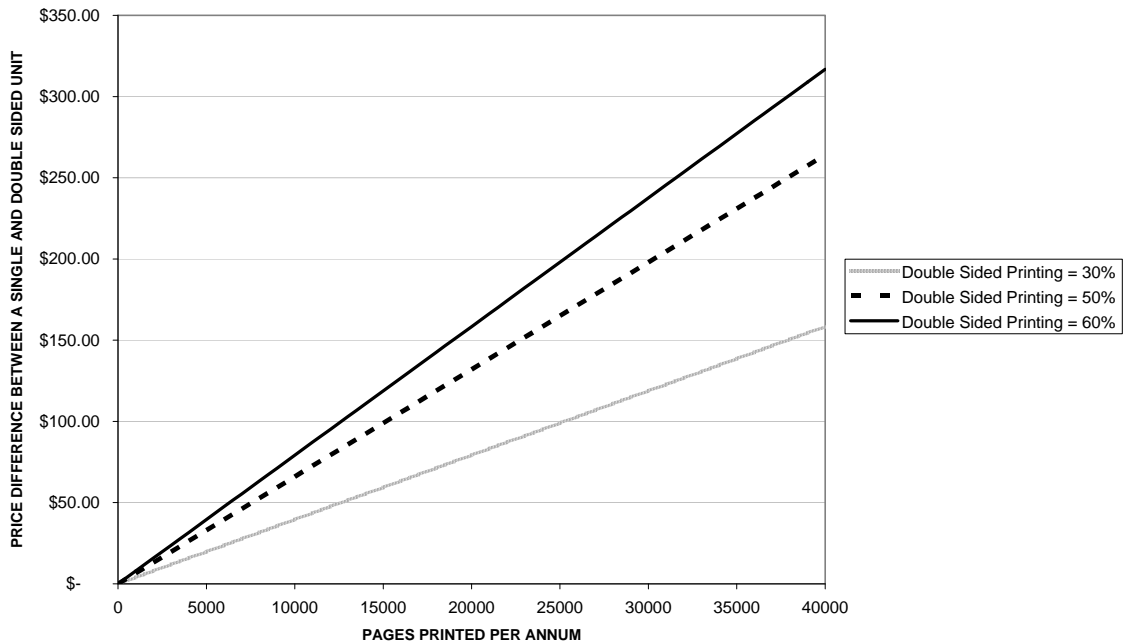
Hence, for printers in the low price category, the user needs to print at least 10,000 pages per annum or on average 40 pages a day (assuming a 240 working days per year and 60% use of the 2-sided option) to justify the additional cost of \$80 to install a duplex unit. For printers in the high price category, the threshold cost of \$275 for the two-sided printing option would require 35,000 pages annually or 146 pages per day. On the other hand, since most printers in the mid and high price range come equipped with double sided printing and there is virtually no price difference between single sided and double sided printers, replacing these with double sided printing appears economic at any rate of usage. Indeed, it is to be expected that the two-sided option will shortly be standard on all high-end models.

Environmental benefits

In addition to the financial benefits, reduced paper consumption due to double sided printing also results in environmental benefits from reduced resource use, energy savings and lower pollutant emissions including greenhouse gas emissions. Considering these societal benefits, the breakeven level of number of pages shown in Chart 1 is further reduced. For example, source reduction of 1 ton of office paper (or 200,000 pages) results in life cycle energy savings of 36.58 Million BTU and 2.18MT carbon equivalent (MTCE) reduction in greenhouse gas emissions (EPA, 2001).

Replacing 88 E-token printers discussed in case study 1, will reduce annual paper consumption by approximately 9 tons, resulting in energy savings of 330 million BTU and GHG reduction of 19.6 MTCE. In case study 2, incorporating the monetary value of carbon reduction at the price of \$4/MTCE will marginally shift our breakeven line to the left. Other likely non-monetary benefits include enhancement of MSU's image as a Green University, signaling its efforts in waste reduction, and space savings in filing.

CHART 1: A BREAKEVEN ANALYSIS OF PAPER USAGE AND PRICE DIFFERENCE ACCORDING TO DOUBLE SIDED PRINTING RATE



Conclusion

Our analysis indicates that replacing the 88 E-token printers at public computing facilities with double sided printers will be financially attractive even without consideration of environmental benefits. Similarly, since most medium to high end printers come equipped with double sided printing capability with little or no price difference, purchasing double sided printers makes easy financial sense and hence is recommended. In the case of low end printers, the decision should be based on the expected level of printing by the users. During the last two years these low end printers accounted for approximately 29% (\$200,000 out of a total \$700,000) of the cost all printers purchased through the computer store. Users who print over 10,000 pages per year (or 40 pages per day) should consider buying double sided printers when replacing their current printers. Because of lack of data either on existing inventory of various types of printers at MSU and their current usage rates, we are unable to make more specific recommendations on replacement policy of low end printers.

References

Selke, S. E., S. Joshi, S. Sidique, and G. Dabholkar. 2006. "Michigan State University White Paper on Campus Solid Waste." Unpublished report to Office of the Vice President for Finance and Operations. Michigan State University, March 14, 2006.

EPA 2001: Waste Rduction Model(WARM) documentation

http://www.epa.gov/climatechange/wycd/waste/calculators/Warm_UsersGuide.html

Appendix

Table 1: Cost Information on Double Sided Printing Adoption

Cost of installing a double sided option	\$ 400.00
Paper savings per annum from double sided printing (60% rate ²)	20455 pages
Paper cost savings per annum	\$ 122
Labor cost savings per annum for paper re-filling	\$ 25
Landfill cost savings per annum	\$ 2
Total cost savings per annum	\$ 150

Table 2: NPV Analysis of Double Sided Printing Adoption

Year	Cash Flow	Discounted Cash Flow	Cumulative Discounted Cash Flow
0	(\$400)	(\$400)	(\$400)
1	\$150	\$142	(\$258)
2	\$150	\$136	(\$122)
3	\$150	\$129	\$7
4	\$150	\$123	\$130
5	\$150	\$117	\$247

Table 3: Computer Store Printer Sales in 2005 and 2006³

Price Category	Quantity	Total Cost
\$100 < \$300	1289	\$199,004
\$300 < \$600	464	\$181,546
\$600 < \$1,000	153	\$121,262
> \$1,000	122	\$198,731
Total	2028	\$700,542

Table 4: Purchasing Department Printer Sales in 2005 and 2006 - Popular Printers in Different Price Categories

Printer Type	Quantity	Avg. Price	Double Sided Printing	Replacement Printer/ Duplexing Unit Type	Cost of Double Sided Replacement	Incremental Cost
<i>(\$100-\$300)</i>						
HP LaserJet 1022 (B&W)	72	\$172	No			
HP Deskjet 6540 Color Inkjet	45	\$120	Optional	HP Auto-Duplex Unit	\$200	\$80
<i>(\$300-\$600)</i>						
HP LaserJet 1320 (B/W)	243	\$413	Yes	N/A	\$0	\$0
HP Color LaserJet 2600n	35	\$359	No	HP Business Inkjet 1200dtwn (Color)	\$349	(\$10)
<i>(\$600-\$1000)</i>						
HP LaserJet 2420dn (B/W)	29	\$739	Yes	N/A	\$0	\$0
HP Color LaserJet 3500n	16	\$674	No	HP Color LaserJet 2605dtn	\$629	(\$45)
<i>(over \$1000)</i>						
HP LaserJet 4250n (B/W)	27	\$1,087	Optional	HP LaserJet Two-sided Accessory	\$1,362	\$275
HP Color LaserJet 3800	17	\$1,236	Yes	N/A	\$0	\$0
HP LaserJet 4250dtn (B/W)	13	\$1,514	Yes	N/A	\$0	\$0

² The figure is obtained from the average duplex rate printing of 3 printers in the Agricultural Economics Department graduate computer lab from 2004 to 2007.

³ The Purchasing Department printer sales for 2005 and 2006 are \$933,582.

Zero NPV Derivation

Chart 1 is based on breakeven net present values (NPV) of savings from choosing a two-sided over a one-sided printer. These breakeven values represent the threshold where the NPV of the switch to two-sided just equals zero, that is when the averted paper costs just equal the added purchase cost. The following notes explain how this zero NPV calculation was derived.

$$C_p = I_s \cdot \frac{d}{2} \cdot p \quad (1)$$

C_p is paper cost savings, I_s is pages printed, d is double sided printing rate and p is price of paper per page.

$$C_l = I_s \cdot \frac{d}{2} \cdot \alpha \cdot l \quad (2)$$

C_l is landfill cost savings, α is the paper weight conversion factor into cubic yard and l is the landfill fee (\$ per cubic yard)

Therefore, the total cost savings C_s is

$$C_s = I_s \cdot \frac{d}{2} (p + \alpha \cdot l) \quad (3)$$

$$NPV = -C_d + \sum_1^n \frac{C_s}{(1+r)^n} \quad (4)$$

where C_d is the price difference between a single sided and a double sided printer, r is the discount rate and n is the cash flow period.

Since C_d is constant throughout the life of the printer we can rewrite equation (4)

$$NPV = -C_d + I_s \cdot \frac{d}{2} (p + \alpha \cdot l) \cdot A \quad (5)$$

where A is the present value annuity factor.

Let $NPV = 0$, we rewrite equation (5)

$$C_d = I_s \cdot \frac{d}{2} (p + \alpha \cdot l) \cdot A \quad (6)$$