

Executive Summary

Total Cost of Ownership (TCO) is a method of calculating both the direct and the hidden costs of an equipment purchase. While it can be applied to any type of equipment, this paper will address TCO as it pertains to printers used as computer peripherals and networked print servers in small to mid-sized businesses. The Dell Total Cost Of Printing (TCOP) Calculator version 1.0.0, as reviewed by QualityLogic on 6/29/04, will be referenced as an example of this application of the TCO concept. Both this discussion and the TCOP Calculator cover monochrome and color laser printers.

The perception of TCO by small to mid-sized businesses as a cumbersome and unwieldy tool is unfortunate, because TCO offers the ability to identify hidden costs. It allows its user to look at a technology purchase as an on-going array of expenses rather than a one-time acquisition cost. It factors such elements as training, maintenance, repairs, upgrades, material consumption and the like into the buying decision. In many cases, a product's hidden costs are greater — sometimes by factors — than its actual purchase price.

The Dell TCOP Calculator is a simple, useful tool to facilitate performing objective printer TCO comparisons that address the needs of small to mid-sized businesses. It is not designed to take into account potentially important but difficult-to-analyze TCO criteria, such as print quality and system reliability. While users can accept the model's default values and generate a quick comparison, they should carefully consider each value entered into the Dell TCOP Calculator model to get a result that reflects their specific circumstances.

The Concept

The TCO concept has become a staple of the cost estimation and management processes at most large corporations but has had slower acceptance at small and mid-sized businesses where operational urgency can have a higher priority than rigorous financial planning.

TCO has both benefits and drawbacks. Its best feature is the discovery and assessment of hidden technology acquisition costs. However, the area of hidden cost assessment also contains most of a TCO model's pitfalls. Hidden costs are such precisely because they are not obvious or easy to quantify.

The various cost elements of a TCO model fall into three groups. These data element groups are described in detail in the following tables. The data in this report, in general and in the tables specifically, is based on QualityLogic's research into printer TCO.

Note: This study was sponsored by Dell, Inc.

Data Group 1 – Directly accessible hard data

The first group lists costs that are known, well-defined data that are easily verified. They include the purchase price of the printer, the cost of its optional features and the price of its OEM toner or ink cartridges.

Elements	TCO Area	TCO Impact	Dell TCOP
Printer base and option costs	Acquisition	Direct and simple, typically 10% - 15% of total	Entered as a single value by user with the option to enter an additional acquisition cost as well
Inking system cartridge costs	Consumables	Direct cost data must be modified by page volume use data, typically 60% - 80% of total	Entry points provided for a standard, and a high-yield monochrome cartridge price and yield with additional price and yield entries for color cartridges
Image Transfer System (medium to high-end color printers only)	Consumables	Direct cost data must be modified by page volume use data, typically 10% - 20% of total – may not be used in less expensive devices	The TCOP Calculator offers limited support for high-end color printers that use separate image transfer consumables (a planned update to the TCOP Calculator includes additional entries for multiple image transfer components)
Typical text page yield at manufacturer's specified page coverage (most use 5%; higher density content reduces page yield)	Consumables	Direct cost data; determines number of cartridges used for duration of comparison; high impact; the standard 5% text page is very misleading for color printing	Entry points provided for overall monthly page count parsed by percentage to four typical business page types that represent the majority of business printing activities
Paper costs	Consumables	Direct cost data must be compared to researched use data, typically 5% - 10% of total	Not covered by TCOP model, but not likely to be a cost distinction between similar printers
Maintenance kit costs	Service	Direct cost data; small impact for monochrome, higher impact for color due to more rapid turn over of kits	Entered as a single value by user; some manufacturers provide these kits under extended service plans
Pre-paid service agreements	Service	Direct cost data, impact is based on duration of comparison	Selected from a pre-defined list or entered manually by user

Data Group 2 – Data requires some user research and calculation

The second group is comprised of cost data elements that are, as a group, significant but require internal effort to quantify. This information requires some thoughtful analysis of how the product will be used, how long it will be retained and what will be done to service it. This data modifies and determines much of the impact of the direct cost data.

Elements	TCO Area	TCO Impact	Dell TCOP
Page coverage and type mix, includes coverage of monochrome and color pages and monochrome printing mix	Consumables	Requires research of potential printer use; high impact on consumable costs; color printing is much more expensive than monochrome	User can enter a mix percentage for each of 4 different page types
Monthly volume of printed pages	Consumables	Requires research of potential printer use; high impact on consumable costs	Entered as a single value by user; an additional entry for percentage of color versus monochrome pages is present but not enabled in this version
Maintenance kit installation costs	Service	Requires some research; usually a small impact with exception of high-end printers; this cost is incurred more often for color printers	Installation costs are wrapped in as a single value with the maintenance kit cost entry
Printer installation	Acquisition	Requires some research, very small impact	Entered as a part of single "Other Acquisition Costs" value in TCOP
Shipping	Acquisition	Requires some research, very small impact	Entered as a part of single "Other Acquisition Costs" value in TCOP
Financing	Acquisition	Requires some research, small impact	Entered as a part of single "Other Acquisition Costs" value in TCOP

Data Group 3 – Data determined experimentally

The third group covers cost data that is significant and requires test and analysis funding, such as experimental tests and use surveys, to quantify. This data group is typically the province of companies that purchase large numbers of printers and have the funding/resources to perform the research work required to define it.

Elements	TCO Area	TCO Impact	Dell TCOP
Cartridge print quality	Consumables	Impact increases with volume of pages printed over comparison period	Not covered by TCOP model
Cartridge handling costs	Consumables	Impact is usually small but varies with vendors, cartridge brands and page volume; color printing multiplies these costs by a factor of four	Not covered by TCOP model
Cartridge reliability	Reliability	Impact is usually small but varies with cartridge brands and page volume	Not covered by TCOP model
Cartridge impact on printer operation	Reliability	Impact increases for cartridge brands with high failure rates; color printing multiplies these costs by a factor of four	Not covered by TCOP model
Paper impact on printer operation	Reliability	Impact increases with volume of pages printed over comparison period	Not covered by TCOP model
Printer engine design	Reliability	Impact increases with volume of pages printed over comparison period; color printers are much more complex than monochrome	Not covered by TCOP model

TCO Areas

The basic cost component areas of a printer TCO model are acquisition, service, consumables, feature impact, and reliability. Each will be discussed in terms of what cost data is directly available, what is hidden, and what requires active experimental research. The goal of the discussion is to illuminate and weigh the costs and benefits of TCO modeling of printer acquisitions.

Acquisition

The expense of acquiring a printer is among the most easily determined of that first group of directly accessible costs. Typically, a product brochure or web site provides a base purchase price and a list of optional features with the incremental cost of adding each. However, there is more to accurately assessing acquisition costs than is readily apparent.

The printer's base cost may be dependent on the features to be added to it. For example, adding a network interface will require that the printer base model selected have the ability to accept such an interface -- many don't. Another consideration about base models is the addition of high-volume paper handling attachments, such as sheet feeders, output sorters, duplex printing and bins for additional paper sizes. Another major cost difference is that between color and monochrome printers of otherwise comparable capabilities.

Consideration should also be given to additional paper size bins (for letter, legal and special types of paper and sizes) and color printing as a shared resource between several cost centers.

The TCO modeling process generates a significant part of its worth by illuminating such considerations and making their true costs apparent. The Dell TCOP Calculator prompts its user to enter this data as the printer's purchase price.

One data element that deserves particular attention is the "Monthly Print Volume" entry on both the Dell Solution Selection and the Competitive Solution Selection screens. This is not the printer manufacturer's recommended monthly duty cycle for this model. It is Dell's estimate of the likely use level of each installed printer. Thus a printer with a duty cycle of 20,000 pages per month may be listed as printing only 2,000 or 3,000 pages per month in actual use. These values should be carefully checked against the user's actual and planned usage to assure an accurate TCO estimate.

Once the base model and feature costs are determined, there are other expenses associated with the initial acquisition that need study. The printer has to be uncrated, connected to a computer or network, driver software installed and its user community trained. In most cases, training will be a matter of putting the printer's user manual in a pocket attached to the

printer for the perusal of any user who decides that they want to do so. This makes training a small impact on small businesses and only somewhat larger on mid-size businesses.

The rest of the installation costs must either be researched and that value entered into the model under other acquisition cost or may be handled as a service performed by some vendors. These vendors will, for a fee, perform the bulk of the installation process at the time the printer is delivered, and their fee cost can be used in the model instead. The Dell TCOP Calculator requires its user to calculate this data into a single cost entry but does not go into detail about its constituents. Much of the impact of installation costs will revolve around the number of printers to be installed and their complexity.

Shipping costs are usually considered for a new purchase, especially if the product is large enough to give this cost element significant value. Receiving costs can also be variable depending on whether a product can be delivered directly to its point of use or has to go through a receiving facility with its attendant labor expenses. A last consideration is the cost of money. What are the financing implications of the purchase? Would leasing be a better plan? Both of these cost elements would be entered under other acquisition costs and, again, their impact varies directly with the size and cost of the printer and quantity purchased.

Of the list of acquisition costs, only the installation and training variables require more research and consideration than some users will consider worth while. Whether or not the research is performed will also revolve around the base cost of the printer(s) being purchased and the expected page volume to be printed.

It is a good idea when installing a color printer in an area for the first time to provide an explanation to the user community of the cost differences between monochrome and color printing. In the case where the color printer serves a group that does not have a monochrome printer available, a key concept to introduce would be the ability to turn off color printing via the driver interface.

Service

Another set of initial costs that the Dell TCOP Calculator queries are those related to preventive service and support of the printer. The calculator prompts for this data as a selection among three possibilities with the cost entered directly for each printer model. The first two selections are for on-site repair agreements that are purchased for a given period with an annual fee, either two or three years. The third possibility is a three-year advanced exchange agreement wherein the vendor will ship out a replacement for a malfunctioning printer within a guaranteed time frame, and the customer sends the defective unit back in the same packaging. These three service program selections point to three different service cost values recorded in the

printer model information stored in the calculator. The labels themselves may or may not correspond to the maintenance programs offered by Dell and its competitors, thus the user should carefully compare service program details and costs. Fortunately, all of these costs are easily researched, as is the OEM warranty coverage, which bears directly on them. The greater complexity and higher cost of repairs for color printers make them good candidates for extended service agreements.

Warranty service is much like a parachute in that it is a comforting thing to have but, if you have to use it, it means that something has not gone according to plan. By the same token, a printer that actually needs to be serviced under the terms of the commonly provided manufacturer's warranties is not going to have a satisfied owner. The strong intent of both the manufacturer and buyer is that the printer easily survives its warranty period with no significant problems. For this reason, the Dell TCOP Calculator offers limited support for warranty service, offering a selection of three common warranty plans.

Another service cost that is indirectly tracked by the Dell TCOP Calculator is also one of the defining characteristics that can separate "consumer" printers from devices intended for business environments -- the maintenance kit. This kit contains replacements for the paper handling parts that suffer the greatest wear in daily use and those that directly bear on image quality but are not replaced as normal consumables. In a laser printer, the fuser is an example of this last category.

The manufacturer prescribes installation of a maintenance kit at regular intervals in a printer's life, typically every several hundred thousand pages. Maintenance kits are more complex and expensive and have a much higher turnover rate for color printers. The Dell TCOP Calculator model addresses maintenance kits directly as a periodic cost across the printer's operational lifetime. Entry points are provided for maintenance kit cost and page yield per unit.

Users who want to perform their own service still need to add up the hidden labor costs of changing out the maintenance kit and enter the sum of these and the cost of the kit as a total value per unit into the model as the maintenance kit cost. Maintenance kit costs have a greater impact on TCO as print volumes rise and especially for color versus monochrome printers.

Consumables

Dell's TCOP Calculator model goes into considerable detail to prompt user consideration of this very important element of a printer's TCO. Consumable costs are a direct product of the cost of the consumables themselves and the rate at which they are used. The model points up the fact that they can heavily outweigh the cost of the printer itself.

The most recognized consumable for a printer is the replaceable inking system. This can take the form of toner cartridges for laser printers, ink cartridges for inkjet printers, and ink ribbons for impact and thermal transfer printers. The Dell TCOP Calculator assumes that the same manufacturer of cartridge will be used throughout the printer's useful life. This brings up the question of OEM versus third-party manufactured or re-manufactured cartridges.

These third party cartridges can significantly reduce the TCO of a printer by providing a lower cost alternative for its most expensive element. The main argument against them is that some manufacturers' product quality is not as good as that of their OEM equivalent, causing page yield per cartridge to drop. A basic consideration to a printer's TCO calculation is whether or not good third-party cartridges are available to reduce consumable costs.

Color laser printers carry significant consumables cost penalties in the form of having four colors of toner to deposit rather than one, and they commonly have additional consumable image transfer equipment as well. The image transfer consumables are actually unique to the high-end of the color printer model array and, as such, are not covered by the calculator. The lower cost color printers do not have transfer kits, while the more expensive ones do. These lower cost printers typically use four different toner cartridge/image drum units to print color output in order to avoid the use of a transfer kit. There are, currently, very few remanufactured color cartridges and virtually no remanufactured transfer components to reduce the costs of these consumables.

The good news is that as demand has risen for color printing, manufacturing economies of scale have reduced the overall costs of both printers and consumables. Just a few years ago the entry point for color laser printing was around \$5,000. It has now fallen by a factor of 10 into the \$500 range. Another helpful development is the high capacity toner cartridge that provides a lower Cost Per Page (CPP) than the standard cartridge by providing more toner in each cartridge at a price that, in the long run, is less expensive than buying an equivalent number of the standard units.

The most common cost rating for these devices is Cost Per Page or CPP. This is simply the cost of the consumable divided by the number of pages that the printer can print before it has to be replaced. That concept is not quite as simple as it sounds.

Most ink system consumables are specified by their manufacturers to print some minimum number of pages at a particular density of ink coverage. A value that is used in most printer manufacturer's specifications is the rating of laser printer toner cartridges by the number of pages with 5% ink coverage that they will print. A 5% coverage page is one on which an ink dot has been printed on 5% of the printable dot spaces available on that page.

This becomes somewhat more complex when the four colors of toner used by a color printer are taken into account. A 5% coverage page for calculating the life of a color toner cartridge implies printing each of the four colors on 5% of the page, or a total toner coverage of 20%.

Printing 5% pages is not what typically happens in real world use. Different types of pages are printed that have different coverage levels. A business letter might actually be a 5% page but the product brochure might have a 35% coverage factor. Color printers are more likely to print the higher density pages, as they are used to print high impact color graphics and photographs.

Much industry press ink has been spilled over what constitutes a true 5% page and whether one such page can be held as a standard from one printer engine to another. Few small and mid-sized businesses have the time and resources to perform detailed page coverage analysis. For this reason, the Dell TCOP Calculator model suggests the use of a set of default page coverage values for four different kinds of pages and provides the option for the user to supply a mix percentage for each.

In the "Page Types and Coverage" section of the TCOP Analysis, the calculator displays the assumed page coverage percentages for printing both monochrome and color versions of the model pages. These coverage values can be modified in this data view to more closely reflect the expected usage of the printers. If a printer has only monochrome consumables specified, only the monochrome coverage is used in TCO calculations. If color cartridges are specified, the calculator bases TCO costs on printing color pages. A point to note is that the "percentage of color pages printed" entry in the Usage Profile of the calculator is not enabled in this version and has no effect on the TCO calculation.

As an example of the effect of page mix, text pages at 5% coverage may constitute 30% of all the pages printed on this system while presentation slides may have 30% coverage and make up 15% of its use. The user of Dell's model should survey the new printer's potential user community to gather the data necessary to modify these values to more closely represent the printer's expected usage. If the printer under consideration is a high-end color printer that uses a transfer kit, allowance should be made for the replacement of this kit at anywhere from one-half to one-tenth the rate of the color toner cartridges. The page yield and cost of transfer kits should be a prime element of TCO calculation for color printers.

Another aspect of cartridge yield is the "print quality" setting of the printer that actually controls toner/ink deposition rates. Most printers are shipped with this control set to the middle of its range as the best compromise of print quality versus toner/ink consumption. Manufacturer's page yield specifications assume this mid-range setting. If the user intends to adjust this control, that decision should be factored into the expected consumable page yield entered into the Dell TCOP Calculator model.

One interesting element of using color laser printers is the commonly provided driver switch to cause the printer to print 'monochrome only'. This aspect of the prospective printer's operation should be carefully investigated. If it can truly be used to turn off the operation of the color cartridges, this feature can provide large savings in reduced color toner usage. Most color printers will print a monochrome page of simple text using multiple colors in addition to black to create process black text and background page shading. Careful examination of the printed page will determine whether or not black toner only was used to print the page after color usage has been tuned off in the driver.

Dell's TCOP Calculator model covers the first two groups of data mentioned at the beginning of this document, which are accessible to most small and mid-sized businesses, but does not cover data in the third group, which is difficult for such businesses to acquire and analyze. For comparisons of data limited to what is directly accessible or easily researched, the calculator works well.

A model that does not account for every cost aspect that impacts a printer's TCO can be used to compare printers to ascertain which will provide the best return on investment in a given usage situation. This is the purpose and function of the Dell TCOP Calculator. The third data group becomes much more important and should be taken into account when high device cost, high page volumes and/or large quantities of printers are evaluated. Examples of this group are yield of usable pages, cartridge reliability and cartridge impact on printer operation. For the purposes of Dell's model, usable page yield is assumed to be equal to raw page yield, cartridge reliability is assumed to be 100% and cartridge impact on printer operation is assumed to be zero.

This holds true for color printing with some additional considerations. Color consumables are an even bigger percentage of a printer's TCO than are those for monochrome printers. Image drums and maintenance kits typically cost more for color printers and have shorter life times. High-end systems have the additional cost of replacing transfer assemblies.

As mentioned above, Dell's TCOP Calculator model allows the user to enter four document types by their percent of total usage. After defining the page mix, the user enters the expected number of pages of monthly print volume and the number of years for which the TCO is to be calculated. The model assumes a 5% coverage value for the published cartridge specifications. This is the value used by most manufacturers for monochrome laser printers but would not be correct for a cartridge specified at a different coverage.

The "number of years" value is important as it sways the weight of the calculated result between the acquisition costs and the consumable costs. A printer's useful life tends to be somewhat longer than that of a computer because its functionality does not impact the user's subjective sense of value as directly. Thus, it is not uncommon for a printer to stay in service until it

fails rather than being replaced because of obsolescence. Since this time to failure data is not readily available, Dell's TCOP Calculator model simply queries the user for a number of years across which it will calculate the printer's TCO.

This data is compared to another set of entries that cover the published specifications for the consumable cartridges used by the printer under consideration. The values entered are the page yield rating for the cartridge and its unit cost. Two sets of entries are available for this data, as many printers have available both standard and high capacity cartridges. The user sets the mix of these cartridges to be used in the calculation. The Dell TCOP Calculator model even prompts the user to enter the expected page yield of the cartridge that comes in the shipping carton with the printer.

To cover color toner cartridges, the Dell TCOP Calculator has an entry screen labeled "Consumables – Additional". This screen supports entry of a cost for color toner cartridges and the image drum (if used on the subject print), along with their page yields. A point to note is that the price entered should be the cost of all three color cartridges (cyan, magenta, yellow) combined, as the calculated TCO uses this cost directly as a function of color coverage without a multiplier for the use of three cartridges.

The goal of entering all this coverage and page yield data is to calculate the number of cartridges, maintenance kits and image drums that will be used over the projected time frame for which the Dell TCOP Calculator is calculating the printer's TCO. On casual examination, this may seem like a lot of work to measure out the usage of a relatively inexpensive resource. However, ink consumables usage typically accounts for anywhere from 60% to 80% of a printer's TCO. As mentioned above, a primary determinant of this percentage is the length of the printer's service life. The longer it is in use, the more important the consumables cost is to the TCO calculation.

Considerations

The alert reader will have noticed that no mention has been made of paper as a consumable. The average page of the "plain paper" used in computer printers costs about \$0.005 per page, which comes out to \$500 per 100,000 pages. Considering that a laser printer's operational life could easily cover half a million pages this becomes a noticeable cost. The distinction is that it is a cost that is independent of the printer brand and model selected for TCO comparison. In a comparison of one printer against another with the goal being to determine which unit will print the same quantity of pages for the least cost, paper cost is a moot point as it is expected that the same paper will be used across any comparable group of printers.

A point to note about the "Competitive Versus Existing Installed Printers" selection on the Analysis Options page is that the associated Average age of the installed printer base is not used in the TCO calculations. This is provided mainly as a reference entry and may be enabled in a later version. Additionally, the yield and

cost data for some competitive printer models will need to be entered by the user as it does not exist in the calculator's database.

Another consideration about Cost Per Page, CPP, is how many usable pages the system produces. This is largely determined by the design and manufacturing quality of the toner or ink cartridge used in the printer. This is an important factor in choosing a cartridge supplier. For high volume printing applications or large quantities of printers, it is an important aspect of printer TCO. The problem with basing CPP on usable page yield is that it is not a published specification (raw page yield is the number specified by cartridge manufacturers) and requires considerable experimental effort and expense to determine. This is an even larger problem for color printers as proper color rendition is another print quality variable to be considered. Usable page yield is one of those items of hidden data that costs more than the average business can afford to spend on research to acquire it.

Quality of the ink or toner cartridge is also a consideration for lost printing time due to an outright failure. While rare, such failures can happen at the least opportune of times taking a printer down when its services are most needed. Though most manufacturers will replace a failed cartridge with an overnight shipment of a replacement, there is still the labor cost to process and replace the failed cartridge.

For the reasons listed above, the Dell TCOP Calculator does not have entries for paper costs or cartridge failures and calculates cartridge costs rather than CPP. This reduces the time and cost to the user of gathering the data to be evaluated by the model at the expense of reducing the accuracy of the outcome. These cost elements become more important and worthwhile to research as page volume increases.

Summation

Comparing printer TCO calculations is not just for the Fortune 500. It is a useful exercise for small and mid-sized companies. It will prompt awareness of cost elements and influences that are not usually considered and it makes a strong case for a careful analysis of consumables costs, as they are typically the bulk of the bill for ownership of a printer.

The Dell TCOP Calculator is a useful tool that facilitates performing even-handed comparisons. It does not take into account some potentially important but difficult-to-analyze TCO criteria, such as print quality and system reliability. The tool's default values should be used only as a starting point. Users of the Dell TCOP Calculator should carefully consider each value entered into the tool against their specific circumstances. Provided with well-considered input, the TCOP Calculator is a reliable, objective method of comparing the cost of ownership between printer models. For further information about the TCOP Calculator and reporting please contact the Dell sales team.