3D PRINTER BUYER'S GUIDE

It's survival of the fittest in this tough economic climate, and making the right purchase choice in 3D printers is more important than ever.

3D printed color model.

Selecting the Right 3D Printer Can Dramatically Streamline Iterative Design.

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THINKING IT THROUGH

Tight economic times make a powerful argument for investing in 3D printing capabilities. Not only does money spent on 3D printing yield long-term strategic value — enhancing design capabilities and speeding time to market, it can also save money right now by raising productivity. A trend in 3D CAD design is to use ever more prototypes far earlier in the development cycle, thus improving design collaboration and reducing errors before tooling and production begin. Low cost models are essential for high volume iterative designs, as are the 3D printers capable of producing them affordably.

Where they have been adopted 3D printers have had an impact that is nothing short of revolutionary. Now, designers can have realistic, full-color conceptual models. Sales and Marketing can bring products alive even before official manufacturing has begun; and in some instances, actual low-volume production of some items has been entrusted to this new higher technology. But to make successful 3D printer purchases, decision makers also need to fully understand not only up-front acquisition costs of a 3D printer but all the costs, which can "make or break" some applications. What's more, it's important to understand how 3D printer products differ and what terminology is being used to ensure that a vendor-to-vendor comparison is really producing "apples to apples" data.

Initial Costs

Among the factors you may want to consider are the initial machine purchase cost, first year service, the cost of required post processing equipment and desirable optional equipment, the initial consumables kit, installation and training costs, and maintenance for the second year and beyond.

These costs are not always immediately apparent. Beware of "systems" packages. What are you really getting in a "system" package? Some vendors only include a basic machine but in order to achieve full functionality (or in some cases, any functionality) you need to invest in additional pre- or post-processing equipment.

Likewise, some vendors have more demanding electrical power and user environment requirements (for example, the need to deal with toxic odors and chemical waste). And while all 3D printers require some kind of post processing activity, the way this is accomplished varies tremendously. This can be as simple as using compressed air to blow off powder and dipping in water or as complex as dissolving away polymer support structures in a special machine and manually cutting away the physical supports with razor knives later. Depending on the vendor and the specific machine, you may need to budget for additional ventilation equipment or special stands just for the 3D printer to sit at an ergonomically-friendly height.

On-going Consumables Cost

Another factor is the cost of materials or "consumables." This can vary with the specific type of 3D process being used, the specific geometries of the parts and the application. For example, applications like concept modeling require numerous parts to be created for short periods throughout the iterative design cycle. Because some materials are inherently more costly than others, the use of expensive prototype materials becomes wasteful. In addition to the materials actually used to build the models there can be other costs related to the process that are not apparent initially. Some machines use simple, off-the-shelf inkjet print heads as a consumable. Others have requirements for modeling bases supplied by the manufacturer. Moreover, there are additional materials used for support structures for overhangs and solvent bath solutions. Often, a "starter" kit of supplies is included with the initial purchase and the size and composition of this starter kit will have an obvious impact on first-year costs.

When thinking about on-going consumables costs, be sure to recognize the multiple dimensions of these costs. The surest comparison point is the cost per unit volume in the parts produced rather than the weight of product produced. Be realistic. The consumables requirement for creating mobile phone components will probably be different from those needed to print exhaust manifolds or water pump housings.

What's more, all types of 3D printers process material in excess of what is required for the finished part. Some systems permit reuse of some or all of this material and others do not permit any reuse at all. These process differences can yield sharp contrasts in consumable costs over time.

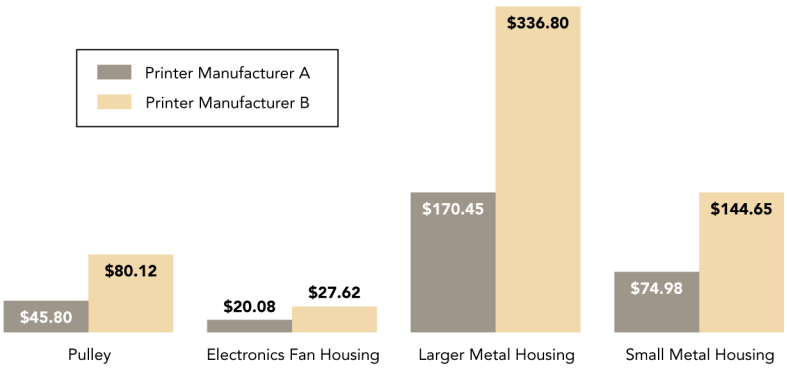
Finally, of course, some consumables may be hard to dispose of or recycle — and some may even be hazardous, incurring additional costs.

Operational Costs/Savings

Another great contributor to cost differentials is the factor of time. The time required to fabricate parts can differ by a factor of as much as five. Similarly, some require more operator steps, including setup, than others

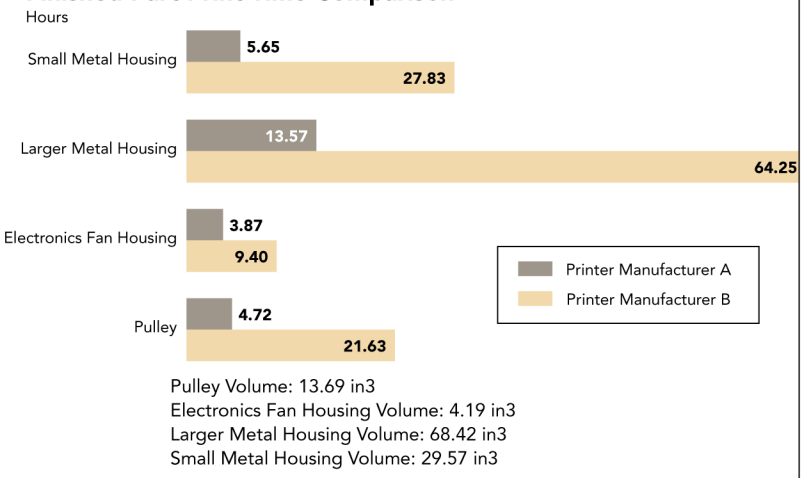
Graph 1

Per Part Cost Comparison



Graph 2

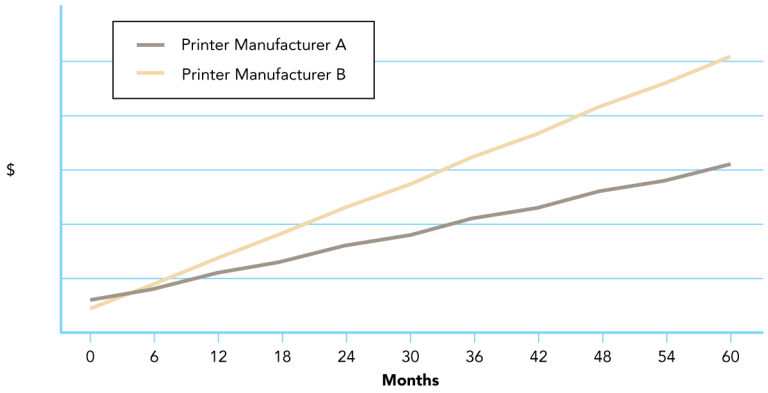
Finished Part Print Time Comparison



Pulley Volume: 13.69 in3
Electronics Fan Housing Volume: 4.19 in3
Larger Metal Housing Volume: 68.42 in3
Small Metal Housing Volume: 29.57 in3

Graph 3

Total System Cost over Time with Annual Maintenance



** Approximation based on the assumption of 5 models of 30 cubic inches in volume printed per week with the first two years of maintenance included.*

— which can affect the schedule and availability of valuable employees.

Similar printers from two leading manufacturers yield comparable output but with different speeds and much different costs. To make the sample 6-inch diameter pulley, illustrated below, Printer Manufacturer A had an average cost per cubic inch of output of $3.41 as a multi-color printed part while Printer Manufacturer B had an average cost per cubic inch almost twice as high — $5.56 per cubic inch as a monochrome printed part. In manufacturing this specific part, Printer Manufacturer A achieved the task (even when set up time is included) in 5.17 hours, using just under $47 in consumables. Printer Manufacturer B achieved the same task in 21.63 hours at a consumables cost that exceeded $80.00. In this scenario, an engineer using Printer Manufacturer B would have had to wait four times as long for a print job to finish and at a cost of almost twice that of Printer Manufacturer A, and then paint the model to add color.

Related to cost and time savings, throughput is another important point to note. Throughput is a measure of the total cubic volume that can be produced in a given period of time. For example, using the sample benchmark parts with various geometries in the graphs on to the left, Printer Manufacturer A has a throughput range of 120-220 cubic inches per 24 hours while Printer Manufacturer B has a throughput range of 15-25 cubic inches per 24 hours, which translates to approximately 10 times the total throughput.

Some printers can make multiple copies of a single item or several different items in a single pass — allowing one machine to easily support many users. So throughput can also be calculated based on the number of reference parts that can be created in a given timeframe. Throughput is a critical factor when an entire department of engineers or a classroom of students is sharing just one 3D printer. Much time and productivity is lost if the 10th engineer in the queue is waiting a week or longer just to get his or her part printed.

When considering all of the factors involved, including purchase, maintenance and supplies along with the efficiency with which given printers can produce 3D output, it is clear that sharp differences emerge in per-part prices and time. Some further illustrative comparisons are shown in the graphs to the left, for two leading printer companies.

Service and Maintenance Costs

Finally, when assessing service and maintenance costs be sure to find out if the warranty is included and how long that warranty will last. How about service? Some things may be covered within the warranty but others may not — and once the warranty has expired, service and support costs could mount.

CONCLUSION

In short, just as with the purchase of an automobile, it is important to look beyond the sticker prices to include factors like fuel economy, reliability, customer satisfaction and so on. 3D printers should be assessed just as thoroughly. Above all, investing wisely in a 3D printer now can help you save R&D costs and bring your products to market faster at a time when competition for markets is particularly intense.

Running Ahead of the Pack at Converse

Bryan Cioffi, manager for digital product creation at Converse, a leading maker of athletic shoes, used to run an engineering team in a biomedical design firm where he had started working with rapid prototyping technology.

Then, when Cioffi came to Converse a few years ago he found the company had no rapid prototyping capability, "and I really wanted to move the organization in that direction." Cioffi says before he brought 3D printing into Converse, footwear was made the same way it had been made for the past century. Design and development would sketch components, which they would send to Asia. There, it would go to a pattern maker who would hand cut the parts and then build what's called a pull-over. Photographs of that would be sent back to the US for tweaking. Frequently, designers would need to fly to Asia to make revisions in the shoe as it evolved. And every revision meant the shoe had to be taken apart and then stitched back together. The whole process would take 3-4 weeks.

The entire process from design to actual production could take months more of "back and forth" before all the details were finalized. "It was ridiculous," he adds.

At Cioffi's urging, Converse ended up buying both an ABS-type 3D printer and an inkjet 3D printer, "which I really liked because of the color inkjet capability," he says.

Indeed, within a few months, the inkjet printer had made the ABS-type machine obsolete. "Sometimes I tried to make the same parts in both machines but the ABS machine was ridiculously slow. You would come in after leaving it running overnight and only a small fraction of the part would be done," says Cioffi. Cioffi began making a few individual components but now he "builds the entire shoe, from the inside out." Once the designer in the US gives an OK, the same 3D items are printed in Asia and used to make patterns and molds — resulting in substantial savings in direct costs and time to market.

The design of Converse products has been revolutionized by 3D printing.

"Now we can make five complete shoes in 10 hours instead of one shoe in 55 hours, which was what was required in the ABS printer." With those results, Cioffi traded in the ABS machine for another more advanced color 3D printer. Because of this repeated success, Converse has recently added the ZPrinter® 650 for its headquarters in Massachusetts, and other 3D printers for their Costa Mesa, California and Asia offices.

Cioffi says the company has been able to sharply reduce the number of employee trips to Asia each year, each of which cost $10-12,000. "Last year our printer consumables budget was only about $30,000, but it probably saved us the cost of eight trips to Asia, easily justifying itself," says Cioffi.

Furthermore, he notes, "We have seen an unbelievable reduction in tooling costs from $350,000 a year in 2006 to just $150,000 in 2008."

Cioffi also hails the cleanliness and ease of use his 3D printer provides. "It is practically zero cleanup and zero effort," he says.

"With the Z Corporation 3D printers we have insanely great color — we are working on one shoe that has a zebra design — so these machines have really changed how we do business — we can even take the output on sales calls," he says.