

Z[®] CORP. IN EDUCATION

Many schools, colleges and universities are increasingly enjoying the benefits of having easily accessible 3D printers in their schools.

3D printing gives students the ability to realistically experience the design process that actual engineers and designers use. Students get the opportunity to experience an entire product design cycle, from concept to prototype, without leaving the classroom.



Having a 3D printer in the classroom engages students and increases enthusiasm by providing them a tangible goal for their learning. Knowing that their virtual design will become a real object has a powerful impact on their motivation and learning. Furthermore, having a portfolio of their physical models gives students an advantage outside of the classroom, when competing for advanced education or jobs.

This document contrasts the Z Corporation[®] ZPrinter[®] 310 Plus vs. the Stratasys[®] Dimension[™]. The comparison highlights the differences with respect to Productivity, Operating Cost, Color and Process and addresses why Z Corporation is the only choice for educators when purchasing a 3D printer.

“Students get an idea, sketch it out, develop it in Rhino, animate it, print it, and then hold it in their hands.

When they hold it in their hands, they’re closing the loop, which really brings the value of the exercise home. Until then, it’s all conceptual, virtual and 2D. Completing the circle is important. It turns kids on.”

— Bruce Weirich
Drafting Instructor
Ontario High School



STUDENTS REMOVE THEIR
NEWLY PRINTED PROTOTYPE



THE IDEAL SOLUTION FOR SCHOOLS
AND UNIVERSITIES:
Z CORPORATION ZPRINTER 310 PLUS

Productivity

In a classroom of students, one of the main challenges is ensuring each student has exposure and access to resources. When looking at this challenge from a 3D printer standpoint, the most important result is to put 3D printed parts in the hand of every student, for learning, for engagement and for progression. Would you teach a classroom of students with only one book? Of course not. When evaluating 3D printers the key attribute to consider is productivity. Can the machine support an entire classroom (or classrooms) of students?

How do Z Corp. and Dimension compare? The Z Corporation ZPrinter 310 Plus prints 5–10 times as many parts as a Dimension machine. How? Z Corporation 3D printers print a layer at a time, while in contrast, Dimension extrudes liquid from a nozzle about the size of a pen tip. Think of it as similar to painting a wall with a roller versus coloring a wall in with a pen.

Below are some examples of parts and their print times on both Z Corp. and Dimension. In many cases, printing 2 or 3 copies of the part on a Z Corporation 3D printer would only add a small amount of time, whereas it would double or triple the time required on a Dimension machine.

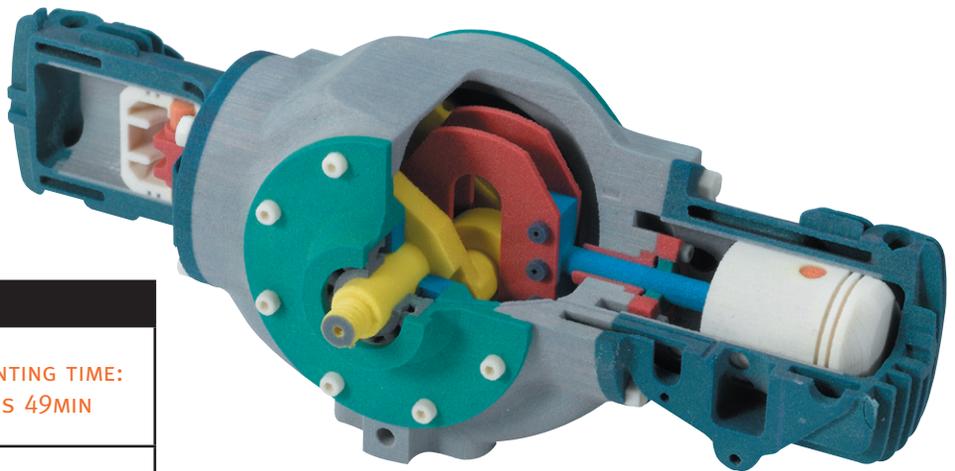
| MOTOR HOUSING – 5.6" x 8.4" x 7.3" | | |
|---|-----------------------------------|-------------------------------|
|  | ZCORPORATION ZPRINTER 310 PLUS | PRINTING TIME: 7HRS 49MIN |
| | STRATASYS DIMENSION | PRINTING TIME: 87HRS 43MIN |

| CORDLESS DRILL – 8.107" x 7.75" x 2.56" | | |
|---|-----------------------------------|-------------------------------|
|  | ZCORPORATION ZPRINTER 310 PLUS | PRINTING TIME: 3HRS 46MIN |
| | STRATASYS DIMENSION | PRINTING TIME: 38HRS 53MIN |

| DRILL BEZEL – 7.16" x 9.413" x 1.93" | | |
|---|-----------------------------------|------------------------------|
|  | ZCORPORATION ZPRINTER 310 PLUS | PRINTING TIME: 3HRS 19MIN |
| | STRATASYS DIMENSION | PRINTING TIME: 25HRS 8MIN |

In addition, Z Corporation 3D printers can print multiple parts at once, which a Dimension machine cannot. That is a huge advantage when trying to serve a whole classroom of students. Each student in a class of 20 can print a unique model in a single build, while in comparison; it would take weeks for a Dimension machine to achieve this.

In a classroom of students, it is important that each student gets the opportunity to print their part in a timely manner, to maintain the progression of the lesson and ensure that everyone is learning at the same rate. If a classroom has a 3D printer that can only print one part at a time, at a very slow rate, this will negatively impact learning and equity in the classroom.



ONLY ZPRINTERS CAN PRINT PARTS OF THIS QUALITY FOR A WHOLE CLASSROOM OF STUDENTS

“Given its accuracy, strength, surface finish, build speed and cost, we calculate a very good price/performance ratio for the Z Corp. ZPrinter 310. It is paying off handsomely in teaching, learning and business.”

– Professor Dimitri Dimitrov
Laboratory for Rapid Product Dev.
Stellenbosch University

Cost

Acquiring funding to secure and improve technology in schools can be challenging, which is why cost is an important factor when choosing a rapid prototyping technology in which to invest. Not only is the actual equipment cost important, but more important is the material cost. These are the materials from which students will create their models. What may initially seem to be the cheaper option in systems, ends up surprisingly more expensive from a material standpoint. Many educators have stated that after purchasing a Dimension machine, they found that they could not actually afford to make parts for students because the material costs were so high.

On a Z Corp. machine, unused powder can be recycled, wasting no material, and therefore no money. Z Corp.'s materials range from \$2.00-\$3.00/cubic inch, which includes all material costs to get a final part (powder, binder, infiltrant and printhead amortization), while Dimension's run at \$6.50/cubic inch, including infiltrant and/or waste. Z Corp. does not use support structures in their parts, so students will not waste their time removing them and schools will not waste money in extra material costs.

In addition, Z Corporation offers an education discount to help schools secure funding. Please ask your local dealer for more information. Productivity and affordability equal student accessibility when it pertains to 3D printers. The system that is the fastest and has the lowest operating cost is the system that will help students succeed. That system is clearly a Z Corp. 3D printer.

**Z Corp. material cost:
\$2.00-\$3.00/in³**

**Dimension material cost:
\$6.50/in³**

| | Dimension | ZPrinter 310 Plus |
|--------------------------------------|-------------|--------------------|
| Build Size (in.) | 8 x 8 x 12 | 8 x 10 x 8 |
| Layers (in.) | .010 – .013 | .004 – .007 |
| Material Cost (\$/in ³) | 5.25 | .82 |
| Material Cost (\$/in ³)* | 6.50 | 2.00 – 3.00 |

* COST WITH INFILTRANT AND/OR WASTE

Source: T. A. Grimm & Associates, May, 2005, Rapid Prototyping & Manufacturing Conference



“There are three major reasons why a Z Corporation 3D printer was purchased: it is extremely cost effective since the excess powder can be recycled so that there is nearly no waste, the materials are benign with no toxic fumes, and the third is its ease of use.”

– William Murray
Technology professor
South Kitsap High School

Safety and Process

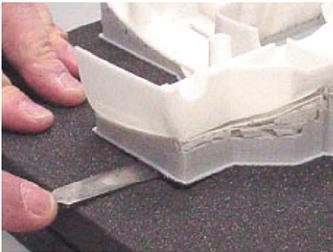
Safety is the first priority of every teacher. Z Corp.'s 3D printers reflect a commitment to safety. Z Corp.'s technology uses no lasers, corrosive chemicals or cutting instruments. In addition, no hazardous waste is created by Z Corp. systems. Dimension systems, on the other hand, use high temperature liquid polymer as their material. To remove support structures, they require sharp cutting and scraping instruments

or a liquid phosphate bath that's as corrosive as lye or ammonia and requires special disposal. In addition to safety, there is the issue of post-processing. Currently all rapid prototyping technologies have some sort of post-processing steps. Below is a brief description of the Z Corporation and Dimension processes. For more detail, consult your local reseller for further explanation and a live demo.

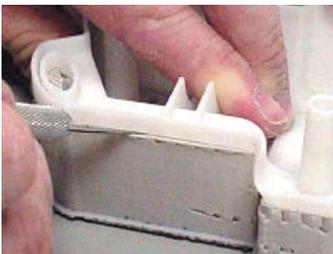
Dimension Process

In the Dimension process, there are two nozzles, one to extrude the build material and one to extrude the support material. The picture depicts a part with "breakaway" support structures. The grey material, as seen below, is support structure and must be painstakingly removed with several sharp tools such as razor blades.

This process can be very time intensive depending upon the part geometry. The tools provided do not always allow for clean support removal causing



rough or uneven surfaces. The foam platform shown in this picture is designed to be reusable. However, it is very difficult to remove the part from the foam board without tearing or damaging the board. At first this may seem like a trivial cost, but at \$15 a platform, the cost can add up quickly.



Dimension offers the option of "soluble support structures" with the purchase of its SST platform. This option requires an additional cost for the printer and the purchase of an ultrasonic tank (shown below). To utilize this feature, the part must be submerged in a phosphate bath with a pH of 12 (equal to lye or ammonia). Once in the bath, the supports will dissolve in 2 to 8 hours depending on the size of the part and the volume of supports. The phosphate bath must be replaced for every 30 in³ of material dissolved. The system is not office friendly, and requires gloves and special facilities to drain the tank and dispose of related chemicals. At the end of the soak, some manual removal is typically still required.



DIMENSION CHEMICAL BATH:
HIGH-MAINTENANCE AND
TIME-CONSUMING



Z Corporation Process

Post-processing is only necessary with certain Z Corp. materials. With the introduction of zp[®]140, finished parts can actually be dipped in water as the infiltration step, rather than using an epoxy. This is a huge advantage for schools using Z Corp. technology, eliminating an extra step as well as further cutting down on cost. The water hardens the part to a degree that it is more than suitable for evaluation and handling. Comparable to quality and resolution of other powders, zp140 is the perfect solution for education, combining convenience, safety and ease of use into one material.

In addition to the convenience of zp140, Z Corp. offers a wide variety of materials and infiltrants to give parts various properties. The properties range from durable parts that can be used for functional testing, to flexible parts with a consistency similar to rubber.



Z Corp. recently launched the ZPrinter[®] 450, the next generation of 3D printers. Most operations are automated making it even easier for students to print models fast and easily. The Z450 is ideal to use in a classroom environment with its closed-loop powder loading, removal and recycling, zero liquid waste, noise-suppression technologies and eco-friendly, non-hazardous build material.



In addition, the depowdering unit on the Z450 is actually attached to the machine, which simplifies the depowdering process, making the part easily transferable.



THE NEW Z CORP. ZPRINTER 450
HAS A DEPOWDERING UNIT BUILT
INTO THE MACHINE

Color

The previous comparisons in this study are between the ZPrinter 310 Plus and the Dimension. However, Z Corporation also offers two full color versions of its 3D printing technology. Both systems use standard Hewlett Packard HP®11 printheads and generate brilliant color and realism without painting. Parts can be labeled, described and colored. Pictures and finite element analysis can be printed directly onto parts.



SNEAKER PROTOTYPE PRINTED ON A ZCORP. PRINTER, ALONG WITH A FINAL PRODUCTION VERSION

The Spectrum Z®510 prints at 600x540 dpi, and has the largest build volume in the Z Corp. line at 10"x14"x8".

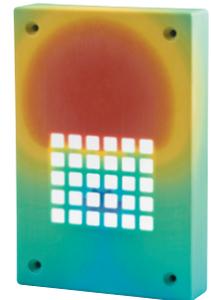
The ZPrinter 450 has a smaller build volume, but introduces a variety of features that make it the most automated and easy to use color printer in the world.

In conjunction with Z Corp.'s proprietary ZPrint® Software, the ZEdit® interface provides additional options for editing and manipulating parts prior to printing. You can add labeling and annotation, apply texture maps, add images and logos, as well as apply color to monochrome parts.

The resolution and definition on Dimension equipment is poor, at best. The images to the right illustrate this. The blue part, printed on a Dimension machine, ceases to be legible past the size of 10 point font. The white part, printed on a Z Corp. machine, prints legibly up to 4 point font.



COMPARE COLOR AND RESOLUTION OF ON-MODEL TEXT BETWEEN DIMENSION AND Z CORP. MACHINES



USING A Z CORP. PRINTER FOR FULL-COLOR FEA ANALYSIS

“Color had a much bigger impact on our design process than we ever imagined. We knew it would save time and enhance communication, but it’s really been a giant leap forward for us. It won’t make monochrome prototyping obsolete, but it has dramatically accelerated our progress from simple sketches to success on the market”

**– Paul Bates
Reebok International**

Summary

3D printers enrich the learning environment and students’ experiences in numerous ways. As a complement to any design class, Z Corp. 3D printers allow students to print out prototypes of their designs, to hold in their hands to evaluate and learn from. This advantage to a student is priceless. Z Corp. manufactures the only 3D printers that can print multiple parts at once, ensuring that every student gets their part, in hand, in a timely manner, at the lowest cost possible. Our 3D printers breach the gap between simply learning in a classroom to actually experiencing the process designers go through in real life, giving students a great advantage to secure jobs or higher levels of education once graduating from their programs.

“...when a student shows up at interviews with colorful models to pass around the table, that makes a big impact on whether they’re admitted or hired.”

**– Bruce Weirich
Drafting Instructor
Ontario High School**