Mechatronics Fuels Revolution in 3D Printing

Z Corp. leverages automation advances in its newest color printer for desktop prototypes

BY LAWRENCE D. MALONEY, CONTRIBUTING EDITOR

For design engineers who want something more to demonstrate their ideas than a solids model on a computer screen, 3D printers have become the latest rage. A new report by industry analyst Terry Wohlers shows 3D printer sales grew from just 157 units in 1993 to 4,165 in 2006.

What's behind the growth of 3D printing, which turns CAD, GIS or CT scan files into physical models? As Wohlers sees it, today's printers are more office friendly, easier to use and less expensive.

FROM MACHINE SHOP TO OFFICE

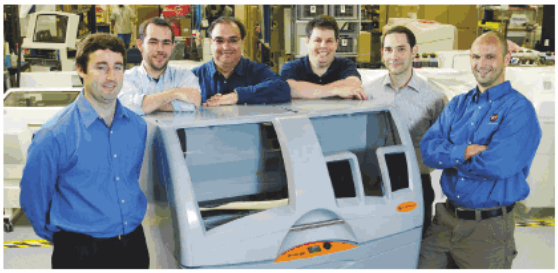
Case in point is Z Corp.'s recently launched ZPrinter® 450, which the company claims is the first color 3D printer to break the $40,000 price point. "The ZPrinter 450 delivers on our '3D Printing Bill of Rights,' which holds that 3D printing should be fast, easy, affordable and office-friendly, like printing on paper," says Z Corp. CEO Tom Clay.

The ZPrinter 450 aims to spare users the materials handling chores that traditionally come with operating a 3D printer. This typically has included manual handling and vacuuming of the composite powder that is the raw material for producing 3D printed objects. Some machines also have required knife work or chemical baths in post-processing.

Prior to the ZPrinter 450, customers needed to handle powder at several stages. They scooped it into the feeder and tamped it down with a trowel. After printing, they pulled the part from the build chamber and shook it clean. Users then vacuumed the extra powder, manually placing that and overflow powder back into the feeder.

In contrast, the ZPrinter 450 virtually eliminates manual powder handling and automates most setup and printing processes. Any powder that doesn't become the part is piped back to the feeder, automatically, for the next build. Users now simply tote a sealed powder cartridge to the machine, connect it and let the machine take over. A vacuum draws powder from the cartridge into the build chamber. Once the part is printed, the same vacuum transports powder from the overflow container back to the feeder.

In addition, the machine automatically removes powder from the printed object, carrying that powder back to the feeder, as well. Finally, the user reaches through a port into an enclosed chamber and uses a tiny air nozzle to blow off any remnants of fine powder. The vacuum is operating the entire time, so these particles are also drawn back into the machine and end up in the feeder.



Z Corp. designed in-house many of the ZPrinter 450's automation features, including the control system. Engineering team members from left: Josh Kinsley, Ben Sweet-block, Dmitriy Katalichenko, Diego Torres, Andrew Berlin and Leo Kiefer.

MECHATRONICS IN ACTION

The internal powder routing within the ZPrinter 450 requires a hidden network of hoses and a six-way vacuum valve the Z Corp. engineering team designed, built and programmed. The valve uses an off-the-shelf stepper motor that indexes the rotary valve to six different positions depending on the processing stage.

The new printer also simplifies the actual 3D printing process. Rather than using a piston to push powder up to the build area, powder floats down to the build platform in a uniform layer. To ensure the proper amount of powder is spread every time, a load cell sensor measures the weight of the feeder, interacting with a proportional integral derivative (PID) control system driven by a proprietary Z Corp. algorithm written in C++. This sensor/control system constantly adjusts to changing conditions to dispense the correct layer of powder approximately every 30 seconds.

Z Corp. engineers also developed the printer's simple firmware control. Users manipulate the printer's control knob to select functions ranging from checking powder levels to aligning print heads to actual printing. In one mode, a push of the knob rotates through menus. In another, it controls the flow of compressed air.

"Since 3D printing's most common use is making engineering prototypes, you're probably wondering if we used any 3D printed parts in developing the ZPrinter 450," says Z Corp. Engineering Program Manager Josh Kinsley. "We created hundreds of prototypes of 65 different parts, saving hundreds of thousands of dollars in development costs by printing versus molding prototypes for injection-molded parts."

Z Corp.'s six-person integrated mechanical, electrical and firmware engineering team used SolidWorks 3D CAD software for mechanical design, OrCAD® for printed circuit boards and Microsoft Visual Studio® for the firmware. "Our number one success factor in the two-year development cycle was keeping our eye on customer needs, thinking big and never surrendering to obstacles," says Walter Zengerle, Z Corp.'s director of engineering.