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EBF3—A 'Star Trek'-Worthy Replicator

To replicate basically means to duplicate or copy something. You use tools and processes to replicate physical objects. You use math and scientific procedures to solve math problems and replicate scientific experiments. In all cases, successful replication basically means that when you apply the same procedures over and over again you will always have the same outcomes.

Gene Roddenberry, creator of the *Star Trek* franchise, envisioned a future where replication would take place in a physical machine that he called a Replicator. Within this device tools, weapons, machine parts, food, and other nonliving physical objects could be created out of the subatomic particles that the machine manipulated.

EBF3 (electron beam free-form fabrication) is a new manufacturing technology recently invented by NASA scientists. This technology has already been tested in zero gravity. Here on earth, EBF3 must be performed in a vacuum chamber. (See Photo 1.) On the International Space Station, moon, and other future space missions, it could be used to recycle broken or no longer needed metal parts into new ones. Without a doubt, what it can actually create parallels the function of the Replicator from Star Trek.

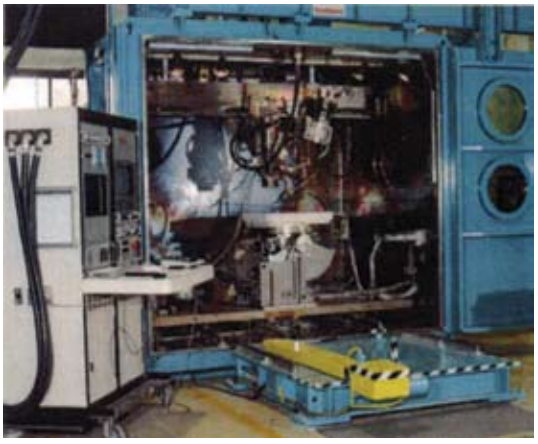

Photo 1— Electron beam free-form fabrication must be performed in a vacuum chamber.

EBF3 is not a prototyping process. EBF3 creates metal products that astronauts in space and people here on earth might use right out of the machine. (See Photo 2.)

Photo 2—Sample EBF3-created part

The EBF3 replication process starts with a CAD drawing of the object that you want to fabricate. The fabricator uses the information supplied in a drawing to build the object one layer at a time.

Inside the machine, an electron beam liquefies aluminum, titanium, or a metal alloy and then directs the metal flow to the proper location on the object under construction. (See Photo 3.) The metal object is formed one layer at a time on a spinning table. To lay down the molten metal in the correct location, the computer directs the movement of the electron beam and the tilt and speed of the table's rotation.

This level of robotic movement is often referred to as the "six axes of motion" or "six degrees of freedom." The movement of the electron beam in combination with the movement of the rotating table performs every type of motion that must be performed to get the beam to every possible location of the object in three-dimensional space. With two separate material feedstocks and two electron beams, it is actually possible for the EBF3 machine to lay down two separate materials into different areas of the same object as each layer is formed.

NASA scientists indicate that EBF3 will also be able to embed glass fiber optic cables directly into the structure of a metal part. The sensors connected to these cables would then be able to report on how the part functions once it goes into service.

Today, many precision parts are created by machining the part out of a solid block of material. At times as much as 95% of the original block must be removed to create the precise part needed. In contrast, EBF3 will soon be used to create an almost finished product that might require the removal of 5% of its material to create the final critical dimensions. The process can also be used to add structural elements to parts produced using other manufacturing processes. You can watch a video on this new and emerging technology at www.youtube.com/watch?v=WrWHwHuWrzk.

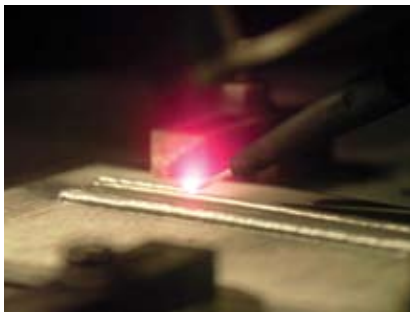

Photo 3—EBF3 in process

Recalling the Facts

1. In what way is EBF3 similar to the Replicator seen in Star Trek? In what way is it different?
2. How could EBF3 speed up the machining of precision metal parts?

Alan Pierce, Ed.D., CSIT, is a technology education consultant. Visit www.technologytoday.us for past columns and teacher resources.