A Self-copying Manufacturing Process

Adrian Bowyer
http://staff.bath.ac.uk/ensab/replicator

The two most important phenomena in biology are self-assembly and self-replication. Self-replication, in particular, is what allows both an individual and a population to grow at an exponential rate as long as resources are available. Economic wealth can expand exponentially as well, of course—that is what compound interest is. This sometimes allows the manufacture of a successful product to grow exponentially too, because the means of production can be purchased at an exponentially-growing rate (for a short time, at least). But all current manufacturing *processes* produce goods in arithmetic progression. No current engineering manufacturing process is capable of exponentially-expanding production, because none use self-replication. John von Neumann was the first person to propose self-replicating machines back in the 1960s.

Rapid prototyping (RP) is the collection of technologies that allow engineering components to be directly manufactured from descriptions of them held in a computer. The components are usually made from nylon, ABS (the Lego-brick polymer), or a resin. Recent research under my supervision at Bath has developed a new additional technique that allows electrical conductors to be simply and directly incorporated in rapid-prototyped components made on conventional RP machines. This permits complete mechanisms to be created that contain their own control chips, electric motors, and sensors, all without any need for printed circuits.

This prompts the intriguing idea that it should be possible to design an RP machine that is capable of making nearly all its own component parts. Such a machine would have a number of novel characteristics. For example, it does not matter how much the first machine costs - the second and all subsequent machines will only cost as much as their raw materials and their assembly.

Once a company (or an individual) had acquired one self-copying RP machine they could make any further number that they wanted for themselves—or others. This could make RP economic as a production, as opposed to a prototyping, technology.

In addition to having the capacity to create wealth exponentially (within resource limits), a self-replicating RP machine will also be subject to artificial selection. This is because the CAD designs for the machine have to be supplied with it for it to copy itself. Most people will use those designs as they stand; a few people will improve them. Some improvements will be made public on the Internet[1] and will therefore spread, coming to predominate over less-good earlier designs. This is a close analogue of Darwinian evolution selecting better genotypes (the CAD designs) that construct better phenotypes (the machines themselves). Note in particular that a not-so-good machine can make a better machine to a new design if that is available.

It is not the intention of this project to profit by protecting any of the intellectual property generated. To be most useful, a self-replicating rapid prototyping machine has to be made as freely available as possible.

Therefore it is intended to make all the results public, both by publishing a paper on them in the Rapid Prototyping Journal (ISSN 1355-2546) at the end of the project, and by releasing all of them—including all CAD designs—free under the GNU Public Licence on the Internet.

[1] Much of the most robust software is free on the Internet. Linux and the Apache HTTP server are two obvious examples. That robustness stems from continuous incremental evolutionary development by thousands of volunteers.