NEW IMAGES FOR OLD

Should we reassess our metaphors for biotechnology? Metaphor, simile, analogy, synecdoche, metonymy: the arsenal of rhetoric overflows with tricks for saying one thing by talking about something else entirely. We seek out parallels, the likeness that makes the unfamiliar seem familiar, that lets us see the future by light of the past. Even our science is made of metaphor: the physicists' equations give events names, logic, and a predictable order. They have turned the conjectures of natural philosophers into worldly power. Just as surely, simple homilies condense entire ideologies—fixing them sometimes so firmly in people's minds that decades of chafing cannot wear them away. Today, one man's search for a system of moral metaphors has thrown rubble in biotechnology's road to commercialization (as Marvin Rogul pointed out in last month's "Last Word").

So we have been casting about for new parallels—both analytical and moral—for biotechnology. But we must be cautious in our selection; a metaphor can limit understanding as well as expand it.

Bye, Bye, Big Blue

Analysts often compare biotechnology with electronics. The U.S. Office of Technology Assessment spent eleven pages of its mammoth *Commercial Biotechnology: an International Assessment* searching for parallels between biotech and the early semiconductor industry. There are, the report found, more differences than similarities.

There may be more parallels between biotechnology and the computer business. Both have enjoyed favorable, even adulatory, press. Both have sparked boomlets in the capital markets. Both are, at bottom, information technologies that turn abstract strings of code into salable products. General purpose computers organize bits into bytes, bytes into machine language, machine language into subroutines, subroutines into programs, and programs into systems. General purpose organisms organize nucleotides into codons and codons into genes, translate genes into proteins, and order proteins into entire metabolisms.

Cetus Corporation's president, Robert Fildes, warns against the computer trap. The metaphor creates unrealistic expectations: biotech's R&D lead times are greater; products must often pass many more levels of much more stringent testing; and we can expect biotechnological products to have correspondingly longer sales lives before the next generation products replace them.

Anyway, computers have become consumer products; engineered bugs have not. Well, yes, some engineered organisms—plants, most likely—will undoubtedly become consumer items. But consumers will not buy them as they buy computers; consumers will buy computers because computers can be reprogrammed to do many tasks; they will buy bioengineered products because the new organisms will do one task surpassingly well.

Today's biotechnology may better resemble the mainframe computer rush of the '60s, when big computers went to big companies and the capital markets thrilled to new incorporations by renegade wizards from IBM and the Seven Dwarves. But fundamental differences remain. Computers are "staff"; microbes are "line." Computers are white-collar; bugs are blue-collar. Computers are assembled one-by-one; piles of parts and hours of labor go into each. In this issue Merck's B. C. Buckland describes a high-tech plant that runs up to twelve 150,000-liter fermentations simultaneously. Two people can run that plant while the microbes turn out not only more product, but more labor as well.

Hello, Rossum

Robots, on the other hand, are "line." They're general-purpose, blue-collar, information-driven machines. They have been hailed as the saviors of aging industry and have been the victims of an unpitying circumstance that didn't seem to be reading the papers. For roboticization (an awful word) demands a lot from the would-be user. Robots are expensive; all that flexibility means that the buyer inevitably pays for a machine that could do a lot of things the owner will never ask of it. And robots are stupid; they can act only within the limits of some comparatively simple algorithms. A manufacturer must understand the manufacturing process perfectly before trying to restate that understanding in the constrained and formal language of robotics.

The robot's star has not ascended the way boosters predicted in the late '70s, nor has it fallen. Roboticization proceeds at a steady pace, increasing when capital is plentiful, falling off when funds are tight. Scientists continue to expand the robot's "intelligence." Engineers keep trying to bring the price down. And the machines are moving into countless jobs that are finicky, boring, or threatening—what the industry calls "3-D" jobs, dull, dirty or dangerous (repetitive welding in a reducing atmosphere, spray painting, even bomb disposal).

These categories may not apply precisely to the challenges facing biotechnology, but we do need to start laying ground-rules for those situations in which the biotech approach makes more sense than other production strategies. We could add two more biotech D's right off the bat: difficult and dear. Biotechnology is probably the only way to create some compounds and modify some organisms without enormous trouble and expense.

The parallels between robotics and biotechnology are not absolute. On closer inspection we may find that the roboticists have nothing to teach us and no insights to offer. At the very least, though, when investors and writers are at the door, howling for results like Apple's or IBM's, biotechnologists can point to a successful, growing industry that is not taking the silicon path.

Meanwhile, we should remember that roboticists have been in business longer than biotechnologists, some of them as long as twenty years. If we can eke the least profit from their experience, we are that much ahead of the game.

—Douglas McCormick