that your inventions have their day in the sun.

May 2004

Illustration by Istvan Banyai

I am often asked my advice on how to succeed as an inventor. More than 30 years of experience have given me a few insights. To wit: invention is a lot like surfing; you have to catch the wave at the right time. This is why I have become an ardent student of technology trends. I now have a research staff that gathers data on a broad variety of technologies, and I develop mathematical models of how technology in different areas evolves. These models show that the pace of innovation itself is doubling every decade.

As we approach the steep part of technology's exponential growth, timing becomes ever more crucial in successfully developing and introducing an invention. You need to aim your invention at the world of the future, not the world that exists when your research project is launched. Inevitably, the world will be a different place when you seek to introduce your innovation. Everything changes—market needs, competition, channels of distribution, development tools, and enabling technologies.

To time an invention properly, you need to consider its entire life cycle. We can identify seven stages in the evolution of a technology: precursor, invention, development, maturity, false pretenders, obsolescence, and antiquity. An invention will thrive, becoming a successful product, only if the crucial phases—precursor, invention, development, and maturity—are attended to.

The Life Cycle of an Invention

In the precursor stage, the enabling factors for the new technology are in place; visionaries may even describe its operation or its goals. But the invention has yet to become a reality. Leonardo da Vinci, for example, described flying machines, but we don't consider him to be the inventor of the airplane.

Our society especially celebrates invention, but this stage exists only in the context of those before and after. Inventors need to bridge science and practical problem-solving skills. They clearly need determination; Edison, for instance, went through thousands of materials before settling on a satisfactory light bulb filament. As I mentioned, they need a sense of timing. They also need a measure of salesmanship to attract the necessary resources, including investment and coworkers—not to mention customers.

The third stage is development. Often an invention enters the world as an ungainly and impractical device. It would be hard to develop an effective business model around the Wright brothers' airplane. Further refinements had to take place before we really entered the age of aviation.

Development is followed by maturity, which constitutes the bulk of a technology's life span. The technology has now become an integral part of everyday life, and it appears that it will never be replaced. Invariably, there are assaults on the now established technology, which form the fifth stage, that of false pretenders. Here a new, potentially disruptive technology claims to be in a position to replace the mature technology. Although better in certain ways, the new technology is invariably found to be missing salient and critical features of the established invention. The failure of the upstart only strengthens the conviction of technology conservatives that the old order will indeed hold indefinitely.

Over time, however, new inventors master the absent qualities of the upstart, pushing the older technology into obsolescence, which constitutes about 5 to 10 percent of its life cycle. The final resting ground for a technology is antiquity. Consider today the horse and buggy, the manual typewriter, and soon, the music CD.

I have personally been involved in inventing an upstart technology to replace a venerable mature one: the piano. The precursor of the piano was the harpsichord. Musicians were dissatisfied, however, that the harpsichord couldn't vary the intensity of its sound; so Bartolomeo Cristofori invented one that could. He called it "gravicembalo col piano e forte" (harpsichord with soft and loud), or "piano" for short. It was not initially popular, but refinements ultimately made the piano the keyboard instrument of choice throughout the 19th and 20th centuries.

The false pretender was the electric piano of the early 1980s. It had many advantages: no need for tuning, a panoply of sounds, and automated accompaniment, among others. But it was missing one crucial feature: a convincing piano sound.

With advanced signal processing and insights from pattern recognition, this deficit was overcome. Today, the sound quality of electronic pianos surpasses that of the upright piano, which used to constitute the bulk of the market for acoustic pianos. Electronic instruments now come close to dominating the market for pianos, and the sale of acoustic pianos continues to decline.

Three Steps to Successful Invention

Trying to predict the life cycle of your invention, as well as those of the technologies you may be displacing, is the first step to success. But fostering the key stages in the development of a new technology requires attention to detail. My experiences have led me to a number of observations on ways to facilitate the process.

One insight I've gained is that most modern technologies are interdisciplinary. For example, speech recognition, another area I've worked in, involves speech science, acoustics, psychoacoustics, signal processing, linguistics, and pattern recognition. A major challenge to interdisciplinary technology development is that different disciplines use different terms for the same concept. Norbert Wiener commented on this in his seminal book *Cybernetics*, written in 1948: "There are fields of scientific work…which have been explored from the different sides of pure mathematics, statistics, electrical engineering, and neurophysiology…in which every single notion receives a separate and different name from each group, and in which important work has been triplicated or quadruplicated, while still other important work is delayed by the unavailability in one field of results that may have already become classical in the next field."

At my companies we've solved this problem by creating our own terminology and thus, in essence, new interdisciplinary fields. The goal is to try to eliminate the tendency for everyone to describe the same thing differently and find one term to agree on. (This also has advantages in keeping our work secret: anyone overhearing our discussions has no idea what we are talking about!) We teach all the requisite disciplines to every member of the team. And to foster cross-fertilization and new ways of approaching problems, we'll assign, for example, an acoustics problem to the pattern recognition experts, and vice versa.

This brings up another critical consideration: the importance of creating devoted and passionate teams. One way to accomplish this is to adopt a goal that has the potential to inspire. I've tried to do this in my own career by selecting projects that contribute to my own social and cultural goals. And in assembling a team, I consider each member's personality and team-building skills as important as his or her technical skills. Most importantly, I try to include the intended users of a technology as key members of the team. For example, when I was developing a reading machine for the blind in the 1970s, I recruited blind scientists and engineers from the National Federation of the Blind, and when working on music synthesis in the 1980s, I required that all of the engineers be musicians. Invariably, the users of a technology are sensitive to subtle issues that nonusers fail to appreciate.

Based on these insights, I offer a three-step program for beginning the invention process, good for innovators from the lone inventor to the large corporate team. Step one is to write the advertising brochure. This can be a real challenge. It compels you to list the features, the benefits, and the beneficiaries. You will find this impossible to accomplish if your ideas are not well formed.

Step two: use this brochure to recruit the intended users. If these beneficiaries don't immediately get excited about your concept, then you are probably headed down the primrose path. Invite them to participate in creating the invention. After all, if they want it so badly, let them help you invent it.

Finally, engage in some fantasy. Sit down, close your eyes, and imagine that you're giving a speech some years from now explaining how you solved the challenging

problems underlying your new invention. What would you be saying? What would you have to be saying? Then work backwards from there.

Ray Kurzweil has founded nine businesses based on his inventions and is a member of the National Inventors Hall of Fame.