that robotics is important, maybe even revolutionary. But if a revolution is coming to the consumer market, what will it look like? And why would it happen now?

If you're waiting for an invasion of walking, talking, anthropomorphic robots, the coming changes will surprise you. In fact, robots are already an essential part of modern civilization, but they have mainly performed static, repetitive tasks (dispensing cash as ATMs, for example). Now, thanks to trends including the plunging prices of certain technology components, robots will soon be able to tackle an array of more complex, varied tasks with greater degrees of autonomy and intelligence.

The true barrier in this market has been the cost of buying and prototyping the key hardware components that allow machines to gather data and interact with the world around them. And now, for the first time, these components can be tested and produced at a price consumers can afford. We might see a robot that feeds your pet when you're away from home, or a robot consisting of a punching bag with hands that helps you train at boxing.

The Roomba is one of the few success stories in the market for home robotics, and it's a good example of how a task can be automated with the right combination of technology and cheaper components (such as motors and sensors). The market for vacuum cleaners alone is huge: Transparency Market Research estimated it at $11 billion in 2012 and projected an increase to $14.6 billion by 2018, with robotic vacuum sales rising faster than others.

The smartphone and PC revolutions have given us valuable precedents for studying this market. Once we can make useful devices affordable enough, an entire industry of thinkers, engineers, and inventors will spring up to address the rising demand. In fact, we'll probably see an app store for robot hardware as well. Indeed, trying to predict where the robotics industry is headed feels like holding your first iPhone and imagining how it would become part of your life—it's exciting to ponder what the future holds but impossible to know. With the iPhone, Apple created an extraordinary piece of technology. But more important, it produced an *affordable* product. We can now do the same with robots, and the possibilities are endless.

Dmitry Grishin, an Innovator Under 35 in 2013, founded Grishin Robotics, a consumer robotics venture firm.

SAM KERR

BIOTECHNOLOGY

Proceed with Caution

A promising technique for synthetic biology is fraught with risks.

GENES IN SEXUALLY REPRODUCING ORGANisms typically have a 50 percent chance of being inherited. Some genes have naturally evolved methods of improving these odds; these are called "gene drives." The genomes of almost every sexually reproducing species contain either active gene drives or remnants of drives. Ten years ago, Austin Burt of Imperial College London proposed designing drives to alter genes in natural populations of mosquitoes. But the difficulty of precisely editing genomes to create engineered drives stymied the realization of Burt's vision. This is about to change.

The recent development of a powerful genome editing tool called CRISPR/Cas9 allows scientists to insert, replace, delete, and regulate genes. Since Cas9 can cut essentially any gene and works in most organisms, it could in principle be used to make gene drives in any sexually reproducing organism. CRISPR gene-drive laboratory experiments in yeast and mosquitoes are under way. Development of purpose-built gene drives in the next few years is very likely.

Unlike most applications of biological engineering, gene drives have the potential to propagate changes throughout populations of organisms with short reproduction cycles. And that creates the potential for powerful positive and negative effects. Gene drives could be used to make it harder for mosquitoes to carry malaria and dengue fever, or they could be used to suppress populations of invasive species such as Asian carp. But they could also be misused—for example, to increase the ability of insects to carry diseases, or to suppress populations of economically significant crops and livestock.

I'm less worried about those kinds of deliberate misuses than I am by the unintended environmental consequences. The truth is that we don't fully understand the interactions between gene drives and the environment, or the mutations possible in drive-bearing organisms.

In July, along with other researchers from MIT, Harvard, and other institutions around the world, I published an article in *Science* that recommends 10 steps biological engineers, environmental scientists, and policy analysts need to take before releasing gene drives. These include research to improve our understanding of drives' properties and side effects, measures to address identified risks, and hedges in case the initial assessments are wrong.

Gene drives don't fit into any existing regulatory frames. There are no environmental regulations that would cover the use of gene drives consistently around the world. So the bottom line is that we need to move cautiously. Scientists need time to evaluate the risks and develop safeguards. Legislators need time to evaluate regulatory arrangements. And the public deserves time for an informed debate.

Kenneth Oye is an associate professor of political science and engineering systems at MIT.