

# CONCLUSION

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“If there is a distinctive path that modern technological change has followed, it is that technology goes where it has never been,” Langdon Winner, a political scientist, wrote in 1980. The development of drones, surely enough, has followed this progression. As this book chronicles, within a few short years of coalescing as technological artifacts, drones have been deployed to the corners of the world, from the Arctic to the Antarctic, in mountains and in desert valleys below sea level, in cities and above isolated villages.

It is a truism that drone technology is rapidly changing. But this is not the whole truth. Some aspects are changing rapidly; others, such as propellers, are changing slowly, if at all. As a rule, those parts of a drone that have to do with information collection and processing are likely to continue to develop at a brisk pace; the parts that have to do with the physical movement of a drone through the air are also changing, but not as dramatically. Crucial inflection points in the development of drones have come when innovations in microelectronics have enabled innovations in physical movement. This is true of the accelerometer and gyroscope data that make it possible for quadcopters to maintain stability, and of GPS devices that allow drones to navigate from one point in space to another. Another such inflection point may come when the efficiency of photovoltaic cells in converting light to electricity becomes such that even small drones, if light enough in weight, will be able to loiter indefinitely. The intelligence of drones in sensing and avoiding obstacles is, along with that of their cousin, driverless cars, improving rapidly.

All of this means that the amount of information drones can gather has the capacity to grow more quickly than the human ability to take it all in. There is little to be gained by flying drones around willy-nilly. As Mathew Lippincott and Shannon Dosemagen wrote in chapter 2, drones, like any other device, are part of a social system. Because they are new, norms are only now emerging for their use. There is a story in the news almost weekly about an irate neighbor taking potshots at a drone that wandered over his property.

As airplanes did before them, drones are forcing us to reconsider the question of who owns the air above our heads. It is unclear at present how profound their impact on daily life will be.

This question hinges in part on whether delivery of physical goods via drone will become commonplace. A number of new initiatives, like Red Line at the Swiss Federal Institute of Technology in Lausanne, propose to deliver payloads in rural Africa using drones. If they succeed, they may reshape the lives of hundreds of millions of people who live hours from basic health services, schools, and markets, cut off from the world by muddy, rutted, often impassable roads.

Large companies like Amazon and Google propose to reshape the rich world’s infrastructure with drones delivering packages that are now sent by truck. Many of these cargo initiatives plan on aircraft that will take off vertically and fly horizontally. This is a technically tricky problem to solve. It likely is a necessary hump to be overcome if delivery drones are to prove economically viable. Pure quadcopters lack the needed range and endurance; fixed-wing aircraft that can carry a substantial payload need too much space to take off and land. But if delivery drones succeed, they will likely far outnumber all the other uses of drones put together.

Drones as observers in the sky will remain important for the indefinite future. They will grow easier to operate. The ease of flying and taking pictures can mask the fact that questions concerning how to use those pictures will not get any easier with higher sensor resolutions, better lenses, or cheaper memory.

In an essay on the effect of new technologies, Winner came to the conclusion that the crucial questions are: “How are we to live together? How can we live gracefully and with justice?” These may seem rather generic questions to pose in closing a book on drones. However, the hope expressed in this book is that the information that drones gather can, in some small way, help answer them. §