



# Ubiquitous clicks and complements

SHANE GREENSTEIN

greenstein@kellogg.northwestern.edu

.....One of the most well-known anachronisms in Western literature occurs in the first scene of the second act of Shakespeare's *Julius Caesar*. A public clock strikes three. But the European mechanical clock was invented more than a dozen centuries after Caesar uttered "*Et tu, Brute?*"

I never appreciated this anachronism until I had children. One day I found myself talking with my kids about the Internet in that effusive way in which my grandparents talked about electricity. My kids just shrugged their shoulders at their father's histrionics. They didn't care that people in old television programs never went online or played video games, as they do.

Shakespeare anticipated that his contemporary audience would happily accept the appearance of a clock in ancient Rome. Clocks were familiar. Similarly, my children can't imagine a world without the pervasive technologies they use every day. Clicks are familiar. In both cases, a once-exotic technology became pervasive and, as a result, unremarkable to contemporaries.

Part of this observation is not news to anyone today. Modern economies frequently change frontier technologies into widely used ones.

Yet, although most adults recognize that such a transformation—from exotic to unremarkable—makes each generation better off, most could not say why or how that transformation occurs. Something so important seems worth an explanation.

## Pervasiveness and complements

Radio and television were once frontier technologies, but are unremarkable today. A similar observation holds for VCRs and DVDs, air conditioning, microwave ovens, and (among higher-income households) personal computers, cell phones, and household Internet access. Soon we will say the same for digital cameras, portable music players (such as iPods), and wireless e-mail devices, to name a few others.

This type of transformation can be viewed from two different angles. One is cognitive and the other is economic.

The cognitive angle involves changes that pervade our daily routines. For example, nowadays not having e-mail has become unthinkable among middle-class parents. Room parents at the grade school and coaches at weekend soccer ask every parent for their e-mail addresses and expect a 100 percent response.

More to the point, changing perceptions about an increasingly pervasive technology shape the availability of what economists call *complementary services*. This process is the economic aspect of a technology becoming pervasive.

Some of this is straightforward. Anybody who owns an automobile understands that repair services are cheaper for the most popular models. Similarly, if computers become more widely used, repair services grow cheaper. More users support more regular businesses.

More generally, widespread use of a technology generates customers for small but essential after-sale activities. Costs for

complements decline when the technology becomes widely used. In most cases, these costs reach their minimum long before every potential adopter employs the technology.

Widespread use also has a way of encouraging the invention of complementary services that had not previously existed. More widely used technologies help inventors overcome the limits of human imagination. No matter how many times humans see a diagram of the future, there is something more informative about observing its operation concretely.

In addition, widespread use also encourages the specialization of inventive energy. Demonstrating pervasiveness alleviates inventors' concerns that they must invent all the pieces of a system.

The invention of complements for telephony provides many examples. A pervasive mobile communications infrastructure had been a standard element of technology visions long before Star Trek communicators popularized the phrase "Beam me up, Scotty." Yet, actually building the cellular network—and especially bringing its price down in the 1990s—spurred new ideas about how to use it.

Some ideas were mundane: Delivery services changed. Communications improved for physicians on call, sales representatives on the road, and real estate agents traveling from one showing to another. User groups spread such inventiveness around. Over time, professional activity improved in efficiency.

Other improvements required technical

invention. For example, as cell phone use increased, handset makers (and their carrier partners) had large incentives to invent better phones. This is particularly obvious in hindsight. If you lay out a decade's phones one next to another, you see how remarkably quickly the improvements occurred. (That said, I was amused some years ago when, in deference to both Scotty and copyright, Motorola named a newly designed handset StarTak.)

Inventions can also come from parties outside an existing industry. For example, Research in Motion was one of several inventors who figured out how to use the existing cellular infrastructure with a new kind of receiver—creating, in that case, the Blackberry. Simultaneously, the company invented great software to let their device work at business enterprises. In that case, the owners of the pervasive infrastructure (AT&T Wireless) negotiated behind the scenes and came to a deal. However, sometimes an owner prefers not to strike a deal but is forced by regulators to do so. This is not the ideal setting for inventive complements, but it can be sufficient.

Why? Consider this example: Regulatory enforcement shaped the early vintages of the Internet. Most telephone companies were not keen on carrying Internet dial-up calls because their calling features—distribution over the day and length—differed from those of voice calls. Yet, countries where regulation compelled phone companies to cooperate with ISPs, such as the US, experienced an earlier boom in Internet use.

### **When pervasive means everyone**

Widespread use can bring down prices, but it doesn't always. As markets grow, the incentives for imitators increase. If imitators succeed, their entry stimulates price competition or inspires differentiated provision for special niche uses, altogether reducing the market value of a technology's common facets.

Smart business strategists anticipate this process and take actions to make the price declines fall on someone else. For example, reflecting on the early travails of Microsoft, Bill Gates once observed in an

interview that his company signed its deal with IBM and then hoped for (and eventually encouraged) clones for the IBM PC, which brought hardware prices down, raising demand for software.

Indeed, one of Gates' biggest innovations was making a business out of managing complements in a mass-market setting—that is, supporting a broad array of developers around a software platform. This activity was not controversial through most of the 1980s and early '90s. It became so only when (alert: space-saving euphemism coming) Microsoft became very testy because another firm (Netscape) aspired to take the same role in Internet software.

I will end this discussion of pervasive complements with a special but important case. It involves a market setting in which complements are best sold everywhere to every last person. When that is the case, it is possible for the last set of buyers to hold everyone else hostage.

We can see an example of this scenario in HDTV markets today. It is no secret that broadcasters don't want to operate expensive transmission equipment supporting both the analog and digital signals. That, however, will be necessary if a large fraction—more than a quarter of TV viewers, by some estimates—don't buy HDTV receivers when high-definition programming becomes available on all channels. In other words, reluctant switchers could impose costs on broadcasters by prolonging the period requiring dual operation of analog and digital.

Another factor matters much more: Policy makers foresee a big prize for society in the freeing up of the spectrum now used for analog transmission. They will be able to reallocate that spectrum to much higher-value uses, most probably a range of wireless services.

That is where it gets interesting. Most governments, especially in countries that elect their politicians, don't have the guts to turn off broadcast television to the large population watching analog signals. Technology laggards vote too, after all. So governments are considering schemes for subsidizing the adoption of HDTV.

Last year, for example, the US Congress

authorized allocating money a couple years from now to help tens of millions of households buy equipment that converts receivers from analog to HDTV. Think about that policy for a minute. It is an explicit, politically authorized bribe to laggards, with the goal of reaching the technical frontier sooner. Now that is remarkable.

### **Economic growth**

In the 1870s and '80s, US railroad firms began moving to the use of rails made of steel instead of iron. Steel was more durable, yielding savings on maintenance costs. However, as steel became more widespread, clever engineers discovered how to use the steel to support larger and heavier rail cars. This encouraged railroads to convert their entire networks to steel, even the rarely used lines.

The next events were incredible. The widespread conversion to steel, in turn, motivated other entrepreneurs to employ the rail lines in new ways, figuring out how to achieve greater efficiencies in expanding nationwide operations. Those initiatives brought about, over the next decades, the success and ascendancy of the newly born national corporations. Most economic historians regard these few decades as a second industrial revolution.

Are we observing a change of similar importance today? Widely used dial-up inspired someone to invent mobile e-mail, better portals, and search engines; these advances inspired others to accelerate broadband deployment and invent better Web services. These days, we are testing a variety of Web 2.0 applications, while youngsters increasingly watch the Internet instead of television. It is not a linear process of unerring progress, to be sure, as the telecom meltdown and the dot-com crash demonstrate. The pattern continues in fits and starts as one pervasive complement generates another.

As the complements accumulate, I wonder what technical feats and commercial services will emerge over the next several decades. If I am ever so lucky, these technologies will perplex my children, but be utterly familiar to their offspring.