

The Coming Tech-led Boom

Three breakthroughs are poised to transform this century as much as telephony and electricity did the last.

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In January 1912, the United States emerged from a two-year recession. Nineteen more followed—along with a century of phenomenal economic growth. Americans in real terms are 700% wealthier today.

In hindsight it seems obvious that emerging technologies circa 1912—electrification, telephony, the dawn of the automobile age, the invention of stainless steel and the radio amplifier—would foster such growth. Yet even knowledgeable contemporary observers failed to grasp their transformational power.

In January 2012, we sit again on the cusp of three grand technological transformations with the potential to rival that of the past century. All find their epicenters in America: big data, smart manufacturing and the wireless revolution.

Information technology has entered a big-data era.

Processing power and data storage are virtually free. A hand-held device, the iPhone, has computing power that shames the 1970s-era IBM mainframe. The Internet is evolving into the "cloud"—a network of thousands of data centers any one of which makes a 1990 supercomputer look antediluvian. From social media to medical revolutions anchored in metadata analyses, wherein astronomical feats of data crunching enable heretofore unimaginable services and businesses, we are on the cusp of unimaginable new markets.

The second transformation? Smart manufacturing.

This is the first structural shift since Henry Ford launched the economic power of "mass production." While we see evidence already in automation and information systems applied to supply-chain management, we are just entering an era where the very fabrication of physical things is revolutionized by emerging materials science. Engineers will soon design and build from the molecular level, optimizing features and even creating new materials, radically improving quality and reducing waste.

Devices and products are already appearing based on computationally engineered materials that literally did not exist a few years ago: novel metal alloys, graphene instead of silicon transistors (graphene and carbon enable a radically new class of

electronic and structural materials), and meta-materials that possess properties not possible in nature; e.g., rendering an object invisible—speculation about which received understandable recent publicity.

This era of new materials will be economically explosive when combined with 3-D printing, also known as direct-digital manufacturing—literally "printing" parts and devices using computational power, lasers and basic powdered metals and plastics. Already emerging are printed parts for high-value applications like patient-specific implants for hip joints or teeth, or lighter and stronger aircraft parts. Then one day, the Holy Grail: "desktop" printing of entire final products from wheels to even washing machines.

The era of near-perfect computational design and production will unleash as big a change in how we make things as the agricultural revolution did in how we grew things. And it will be defined by high talent not cheap labor.

Finally, there is the unfolding communications revolution where soon most humans on the planet will be connected wirelessly.

Never before have a billion people—soon billions more—been able to communicate, socialize and trade in real time.

The implications of the radical collapse in the cost of wireless connectivity are as big as those following the dawn of telegraphy/telephony. Coupled with the cloud, the wireless world provides cheap connectivity, information and processing power to nearly everyone, everywhere. This introduces both rapid change—e.g., the Arab Spring—and great opportunity. Again, both the launch and epicenter of this technology reside in America.

Few deny that technology fuels economic growth as well as both social and lifestyle progress, the latter largely seen in health and environmental metrics. But consider three features that most define America, and that are essential for unleashing the promises of technological change: our youthful demographics, dynamic culture and diverse educational system.

First, demographics. By 2020, **America will be younger than both China and the euro zone**, if the latter still exists. Youth brings more than a base of workers and taxpayers; it brings the ineluctable energy that propels everything. Amplified and leavened by the experience of their elders, youth and economic scale (the U.S. is still the world's largest economy) are not to be underestimated, especially in the context of the other two great forces: our culture and educational system.

The American culture is particularly suited to times of tumult and challenge. Culture cannot be changed or copied overnight; it is a feature of a people that has, to use a physics term, high inertia. Ours is distinguished by incontrovertibly powerful features, namely open-mindedness, risk-taking, hard work, playfulness, and, critical for nascent

new ideas, a healthy dose of anti-establishment thinking. Where else could an Apple or a Steve Jobs have emerged?

Then there's our educational system, often criticized as inadequate to global challenges. But American higher education eludes simple statistical measures since its most salient features are flexibility and diversity of educational philosophies, curricula and the professoriate. There is a dizzying range of approaches in American universities and colleges. Good. One size definitely does not fit all for students or the future.

We should also remember that more than half of the world's top 100 universities remain in America, a fact underscored by soaring foreign enrollments. Yes, other nations have fine universities, and many more will emerge over time. But again the epicenter remains here.

What should our politicians do to help usher in this new era of entrepreneurial growth? Liquid financial markets, sensible tax and immigration policy, and balanced regulations will allow the next boom to flourish. But the essential fuel is innovation. The promise resides in the tectonic technological shifts under way.

America's success isn't preordained. But the technological innovations circa 2012 are profound. They will engender sweeping changes to our society and our economy. All the forces are in place. It's just a matter of when.

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