Looking Ahead: **A Visible End to Innovation? I Think Not**

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Henny Penny's message that the sky is falling is one of the recurrent themes in American science policy research. The latest example of this passion for bad news is a *New Scientist* article[1] previewing a forthcoming article in *Technological Forecasting and Social Change* by Jonathan Huebner, an independent scholar[2].

The *New Scientist* article is headlined "Are We on Our Way Back to the Dark Ages?" It's catchy but hardly the central point of Huebner's article. Huebner's primary conclusion is the article's title: "A Possible Declining Trend in Worldwide Innovation."

Huebner arrives at his conclusion by using as his database *The History of Science and Technology,* published in 2004[3]. This is an inventory of 7,198 technological developments since the nominal end of the Dark Ages, 1455. He plots the technological developments in 10-year averages divided by world population, against time and concludes that the rate of innovation peaked in 1873, and that we are at the 85 percent estimated economic limit of technology, which he projects will reach 90 percent by 2018 and 95 percent by 2038.

Huebner is not interested in physical limitations on innovation, like the impossibility of perpetual motion machines; economic limits are his concern. Huebner plotted the number of technological developments divided by world population against time. It should be immediately clear what his first core difficulty is, and less clear what the second one is.

What the Data Miss

The less clear difficulty is his selection of data. While *The History of Science and Technology* is a well-regarded compilation that draws upon many sources, it includes scientific as well as technological developments. Huebner makes no distinction there, calling everything an innovation. A sorting out of some types would raise the reader confidence in the data. Criteria independent of *The History's* for selecting and grading the importance of each datum could create subsets likely to follow different patterns.

Other people have attempted to sort and grade discoveries and inventions in many works by questioning experts or distinguished scientists, and by reviewing the historical literature. Any sampling set is open to question since it must involve subjective judgment. Aggregating collective subjective judgments may improve the situation, but this was not done by Huebner and is, therefore, a built-in weakness.

Some developments, such as the railroad, spawned thousands of inventions. But is the railroad an invention or a development or a cluster of inventions or just serial process improvement? In other cases, a scientific discovery, like penicillin, leads to the discovery and development of scores, if no hundreds, of antibiotics, many of which are themselves patented as independent inventions. With penicillin, at what point and in whose hands did science become invention?

There also are technologies, unlike the railroad, that do not primarily stimulate developments for their own enhancement, but stimulate boundless numbers of developments in their application. Central electrical power is probably the best example.

The absence of information to understand the importance of various kinds of technological developments that Huebner drew upon undercuts the relevance of his work to the kinds of inventions and developments that are occurring today and in the future. More on this below in the discussion of U.S. patents.

As I hinted at earlier, the more striking deficiency in Huebner's work is his plotting the innovation data using world population. His vertical axis is number of innovations divided by world population. The horizontal axis is time intervals. Most of what we now think of as technological developments came out of the West in the period following the Dark Ages, and then in the areas largely settled by the West, notably North America.

Up to the period of explosive growth in the then-called Third World, plotting innovations divided by world population, against time, might make sense. But with the explosive growth of populations in India, China, Sub-Sahara Africa, Latin America and Southeast Asia, which had little or no modern history of extensive creativity in science or technology, the denominator in his valuations is simply inappropriate. It makes any decline in innovation far more dramatic and masks real increases in invention. If he had concentrated on the geographic areas of emerging innovation over time and added in new areas as they fell in line for inventiveness (e.g., Japan after 1945, Korea after 1955) his results could be strikingly different.

Patents as a Measure of Invention?

A second frayed string in Huebner's bow is the U.S. patent situation. He finds invention in the U.S. as measured by patents starting out low in 1795, peaking around 1915, then going into a decline, and then rising up slightly in 1995 to roughly match the level of 1955. The peak in the patents, 1916, is some 43 years later than the peak in the rate of innovation

on a worldwide basis. However, he gives no attention to what underlies the use of patents, that is, their business and industrial functions.

For example, trade secrets have always been an alternative to patenting. And intellectual property has boomed in scope and affected patenting. More and more items are now patentable as opposed to copyrightable than ever before. There is a fair chance, for example, that the system a U.S. stockbroker uses to manage your stock portfolio is patented and not just copyrighted.

We are moving through the expansion of the term intellectual property toward patenting social technologies. But the term "social technology" is apparently foreign to Huebner. If one looks at social technology as invention, one would have had to include in his plot such things as the invention of high school, of taxation, of variations on taxes, of the corporation, the hospital, free education, and on and on and on.

Questioning the "New Dark Age"

As for a new Dark Age, Huebner makes only one incidental note of that as a possibility, not even as a plausible conjecture but on a list of "...questions...for the interested reader to ponder."

Even if we assumed that the end of invention is at hand and it stopped tomorrow, what would be the consequences? Since the Dark Ages, we have seen an enormous accumulation of inventions, innovations, technologies, and institutional mechanisms for using them nationally and globally, especially those developed in the last 150 years.

If all invention stopped, the already established ones would not disappear. They could still be propagated around the world, they could be maintained, they could be replaced, and so on. We have a vast repository of inventions already in use that form the basis of our current existence, and that could spread through the rest of the world, to improve people's well-being.

In summary, Huebner's conclusions are at best a flash in the pan and, at worst, something of a science policy annoyance as his conclusions get propagated without any fair understanding and critique of their unstable base.

On the other hand, the questions raised here, and by two critics of his paper, as well as Huebner's response, in the same issue of *TFSC*[4], could become the nucleus of a fresh look at the long-term issues of discovery, research, invention, and innovation: what they are, how they come about, how inventions link to other inventions, and what will be new categories of inventions and discoveries that will yield thousands of other inventions. For instance, the five bottomless cornucopias of genetics, brain science, materials, nano-products and processes, and energy opportunities have barely begun to deliver new technologies.

A Lesson Learned

The New Scientist, unlike the daily press and weekly news magazines, is not hawking automobiles or women's underwear. For its fact-oriented readership, hyperbole is out of order.

In any case:

1. Don't believe headlines.

2. Be wary of news reports.

3. If the subject is important to you, go to the original source.

References

1. Adler, Robert. "Are We on Our Way Back to the Dark Ages?" *New Scientist,* 2 July 200S, pp. 26-27.

2. Huebner, Jonathan. "A Possible Declining Trend for Worldwide Innovation." *Technological Forecasting and Social Change,* Vol. 72, no. 8, Oct. 200S, pp. 980-987.

3. Bunch, A. and A. Hellemans. *The History of Science and Technology,* Houghton Mifflin, Co., New York, 2004.

4. Modis, Theodore. "Comments on the Huebner Article," pp. 987-988; Smart, John. "Comments on the Huebner Article," pp. 988-994. Huebner, Jonathan. "Response to Modis and Smart," pp. 995-1000; *TFSC,* Oct. 200S.