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TECHNICAL DISCUSSION

Editor's Note: The following debate had its origin in the article "A Possible Declining Trend for Worldwide Innovation" by Jonathan Huebner in this Journal, vol. 72, no. 8, Oct. 2005, pp. 980–986. It prompted a discussion by Theodore Modis and John Smart, with a response by Huebner, in the same issue.

Joseph Coates also wrote a rejoinder to the Huebner piece, "Looking Ahead: A Visible End to Innovation? I Think Not" in Research Technology Management (Nov.–Dec. 2005). This and their subsequent exchange are presented here for our many interested readers.

Harold A. Linstone
Editor-in-chief

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

Joseph F. Coates

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 7198 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% estimated economic limit of technology, which he projects will reach 90% by 2018 and 95% 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 not 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, SubSahara 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