# Approaching the New Millennium

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As the new millennium approaches, more and more of what we see published has to do with either extrapolation of trends into the future, or warnings against such extrapolations. My thoughts below conform to this norm, but hopefully cover ground that has not received limelight recently.

There is no question that trend extrapolations carry a risk. There is an abundance of examples in which forecasts made years ago appear ludicrous today. And there is worse. It is practically hopeless to try to assess the long-term consequences of technological changes. Lynn White has demonstrated this is in a superlative way with an article in an early issue of this Journal arguing that democracy spread across Europe in the Middle Ages thanks to the Chinese invention of the spinning wheel [1].

The advent of the science of Chaos in the late 1980s raised hopes for breaking through the difficulties associated with the most unpredictable of situations, random fluctuations. The extensive studies of Chaos and fractals that ensued impressed the world in many ways, but Mandelbrot still admits today that having succeeded in modeling the chaotic patterns seen in stock-market indices did not bring him any closer to becoming rich.

Given the difficulties and the risks involved in trend extrapolation, what are the lessons we draw form our 20th century experience? Should we be more humble about forecasting or give it up all together, at least when the stakes are high, for example war prediction?

There are some trends one can not argue against. The increase of leisure time is one of them. At the beginning of this century—our parents told us—the concept of leisure was unfamiliar. In some countries, for example Greece, the translation of the word leisure is still awkward today. Because there was no need, the Greek language has no equivalent word. But leisure plays an increasingly important role in western society, and the percentage of time devoted to leisure activities increased steadily throughout this century, largely because the numbers of people in retirement increased. There is little risk in extrapolating this trend into the new millenium. The risks are rather associated with the consequences of this trend, and much has already been said about that, namely the problems stemming from an enormous "dead weight" on society,

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the old people. But as entrepreneurs like to say, problems may be opportunities in disguise.

The ergodic theorem in physics says in simple words that anything that *can* happen eventually *will* happen, given enough time. Applied to the problem of too many old people, this theorem promises surprises. Large numbers of retirees over prolonged periods of time could give rise to yet unknown activities, products, and market opportunities, with beneficial fallout for society. The industries of entertainment, book publishing, voice-controlled information technology, Internet, virtual reality, and education could be particularly affected.

Besides trends whose extrapolation involves little risk there are the trends whose extrapolation involves maximum risk. Two such trends are the "phasing out" of nuclear energy, and the "booming" of the American economy. The former represents ecologists' utopia, the latter Americans' wishful thinking.

The green movement managed to slow down the diffusion of nuclear energy as a primary-energy source, but fell short of stopping it. It is much easier to talk against nuclear energy than give it up. Sweden "renounced" nuclear energy 20 years ago, but still has nuclear plants in operation today. No matter what politicians say, in the absence of a viable alternative energy source, the use of nuclear energy will grow to complete a cycle of service to the world not unlike the one we have seen from oil. (This argument was first made by Marchetti [2] and later by Modis [3].)

The good performance of the American economy may be similarly deceptive. The persistent worldwide economic crisis that began in the early 1990s continues in many parts of the globe. This crisis echoes Kondratieff's economic cycle, which stipulates that the rock bottom of the rate of growth was in the mid 1990s and *progressive* recovery should bring us to another boom with an apogee only in year 2024. This end of the century still falls within the generally low-growth, winter-type season, and therefore, it is too soon to talk about prosperity. The fact that spending exceeds earning in America speaks for a "bubble" economy. Growth in the United States needs to slow down—if not decline—before picking up again. But the end of the century also is late for the economic collapses of the kind we have seen in the Far East. In my mind, American and Indonesian economic performances depict fluctuations in opposite directions from one and the same trend.

A special kind of trend, following a rather unusual trajectory, could be found in space exploration. When I read Bruce Cordell's prediction about the next major thrust into space culminating around year 2025, I was reminded of a picture depicting the early stages in the mathematical production of chaos [4]. Figure 1 shows a logistic curve in the process of being populated by chaotic fluctuations, before and after the rapid-growth phase [5]. For once I want to exploit this graph in a semi-quantitative way.

Space exploration in the United States was triggered by Sputnik, the first Russian satellite, launched in 1957. Activities intensified and culminated with the Moon-landing missions between 1969–1972, which have been often criticized as an expensive luxury, if not a mistake. Space launches dropped to an all time low during the years 1985–1989. However, mapping this evolution on the pattern of Figure 1 tells us that interest in space is coming back and will reach a peak in the 2020s, as Cordell predicts. In retrospect—and in all fairness—the Moon Apollo project must be seen as a precursor to space colonization.

The forecasts previously discussed all rely on natural laws and therefore enjoy enhanced confidence. Survival of the fittest, homeostasis, rheostasis (stability due to motion), feedback, chaos, and harmonic motion, are all laws whose validity has been

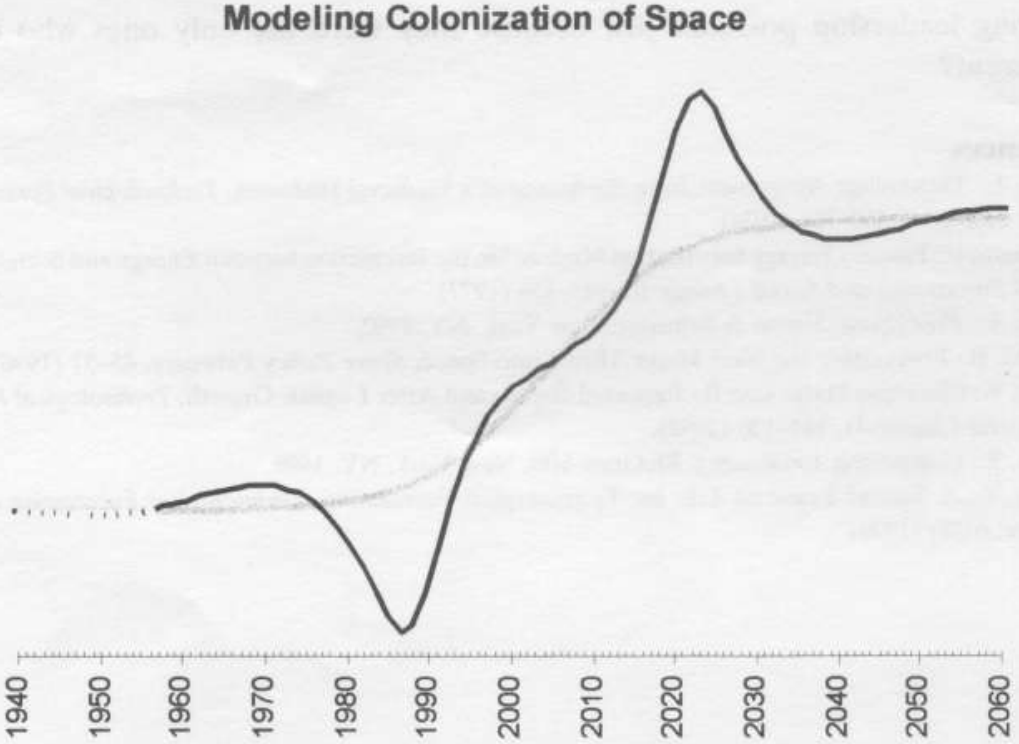


**Fig. 1. The black line is mathematically produced from the gray line by varying the parameters in the discrete expression of the logistic function. The height attempts a relative indication of interest. The time scaled has been adapted to describe the early history of space exploration in the United States.**

established in a scientific way. Having been trained as a physicist, I have always been partial to laws because they lead to objective conclusions.

Prompted by opinions such as "The future is no longer what it used to be," I have gone to some length in my recent book *Conquering Uncertainty* [6] to demonstrate that the future is *always* what it used to be. The argument involves a metaphor: the four seasons mapped to the four stages of a growth cycle (see Figure 1 in my earlier piece in this issue) [7]. In anticipating the future, you should try to put yourself in the shoes of someone in the same season of the previous growth cycle. The psycho-emotional state of the person of year 2000 should be compared to that of the person of 1946. Playing down the effects directly related to WWII, we might find much similarity in the way these two people feel about the future.

Finally I want to call upon another law of physics—equally subtle and sophisticated as the ergodic theorem—which in a free translation says the following: if two "things" fit well together, there will be a force pulling them together.[1]

Controversy and emotions are increasingly raised regarding genetic engineering. Fully aware of the difficulty in making long-term assessments of technological breakthroughs, I want to put forth a disturbing, if extreme, scenario for genetic-engineering fallout on society. Suppose that sometime in the future advances in genetic engineering enable all newborns to enjoy enhanced and equal intelligence, ability, and health. In a society with lack of differentiation there would be a problem filling those posts that by definition require exceptional individuals, such as the posts of leaders. Is it conceivable that lesser candidates—products of the rare unsuccessful genetic intervention—end up

[1] The physics principle in question associates stability with low-energy systems.

occupying leadership positions just because they were the only ones who qualified as different?

## References


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