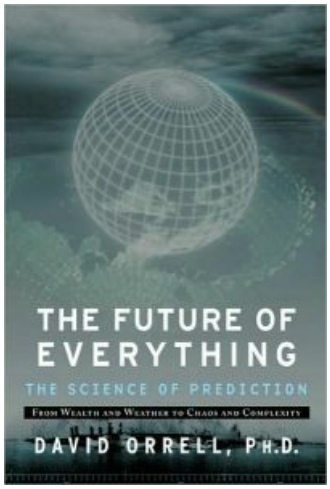

Book The Future of Everything

The Science of Prediction

David Orrell
Basic Books, 2008
First Edition:2007
Listen now

- play
- pause

00:00
00:00

Recommendation

This book is a fascinating, very readable look at the accuracy of modern forecasting. David Orrell begins with an overview of the history of telling the future, including humanity's inherent need to try to decipher what tomorrow holds. He covers the current state of forecasting in fascinating detail, dwelling on weather and climate, economics and medicine. He points out the shortcomings in experts' current ability – or lack thereof – to predict the future accurately in any of these realms. Finally, he discusses the future of forecasting, and makes a case for using the limited models available to become better prepared for future events, particularly climate-related ones, even those that are impossible to forecast with precision. The fiscal and commercial relevance of his advice is startlingly clear in light of recent natural disasters. *BooksInShort* highly recommends this well-structured overview of forecasting and the author's cautionary message that the planet's health will govern much of what lies ahead.

Take-Aways

- The modern quest to predict the future is crucial in weather, medicine and economics.
- Forecasting's evolved since soothsayers and prophets – but not as much as you think.
- Ancient Greeks viewed the Oracle at Delphi as having mystical prophetic powers.
- Plato and Socrates' premise that people can use simple principles to understand complex systems is the basis of the modern scientific method.
- Scientists from Galileo to Isaac Newton saw the universe as an ordered, structured place.
- Today, most people believe meteorologists, doctors, scientists and economists know more about the future than they actually know.
- "Past performance is no guarantee of future results" always applies. Forecasting, particularly in the long term, is complex and subject to many contingencies.
- More information has not necessarily meant more accurate long-range predictions.
- Models can help explain systems, but multiple models mean multiple uncertainties.
- Models can reflect trends and provide some insight, showing, for instance, that humanity has changed the planet, and should minimize its harmful impact.

Summary

Is Forecasting an Exact Science?

In many ways, people in today's media-focused societies take modern forecasting for granted. When it comes to weather, for instance, the public assumes modern forecasting has made vast improvements, and that meteorologists have complex mathematical models that will only improve with time until the day when science can

accurately forecast weather far into the future. People make similar assumptions about medicine, assuming that the mapping of the human genome will result in scientists' ability to forecast and stop the development of various diseases. The economy, in particular the stock market, is another area where observers assume that forecasting is accurate, and that economists really can provide valid, correct insights into the future. But is forecasting the exact science many people believe it to be? Can experts really predict the future? To answer these questions, and to understand the problems inherent in predicting the future, you first need to go back in time and examine the history of forecasting.

The History of Forecasting: From the Oracle to Galileo

Since the beginning of human history, humankind has wanted to know what will happen tomorrow. Ancient societies used various methods to foretell the future. The most notable practitioners were the ancient Greeks, who turned with great faith to the Oracle at Delphi. For centuries, people viewed Delphi as the mystical center of the ancient world. Kings and philosophers based many of their decisions on what the Oracle's priestess, known as the Pythia, told them. Her prophecies were sometimes vague and could be interpreted, though with some difficulty, to support almost any decision, yet the Oracle remained a powerful force for centuries. The Oracle lost sway in the third century, when its influence gradually faded as Christianity gained strength.

> "Social forecasting, scientific and otherwise, is about as accurate as random guessing."

In the ancient world, numbers also played an important role in foretelling the future. Pythagoras believed that numbers were the key to understanding the universe. His students studied philosophy and divination through numbers, elevating numerical prediction to new levels. Pythagoras said scholars should use reason and analysis to predict the future, instead of relying on subjective predictions from mystical sources – a view that has survived to the present day. Plato, Socrates and those who followed them refined Pythagoras' methods, but the basic premise that people can use simple, easily defined principles to understand more complex systems is the basis of the modern scientific method.

Look to the Heavens

In the following centuries, prediction and forecasting were tied closely to astrology, which was viewed as akin to the science of astronomy. That began to change when 16th-century scientist Tycho Brahe and his followers began to show that the planets did not revolve around the Earth, but around the sun. When the Inquisition forced Galileo to refute such findings, his beliefs almost cost him his life. During this period, the concept of the universe as an ordered, structured place came into prominence – yet another view that still has a profound influence on how modern thinkers view forecasting. By the time Sir Isaac Newton published his work in the 18th century, the scientific method was firmly established, and the concept that the universe is ordered and structured became gospel. On this basis, it appeared that it would only be a matter of time until science could explain all the details behind how the Earth and the celestial universe worked.

Underlying Systems

After centuries more of scientific experimentation and evaluation, a total understanding of the planet – and certainly of the universe – is still out of reach. Each new discovery reveals the fact that humankind needs still more knowledge. In relation to forecasting and predicting how complex systems will work, the practical question is: Will mankind ever be able to accurately predict what will happen based upon its knowledge of how smaller parts of the whole work? When you examine the state of forecasting in the real world, the science of prediction has turned out to be conditional, varied and extremely complicated.

> "It's time for action, not calculation. I feel a storm is coming, but I don't know if it is atmospheric, medical, economic or all three."

Just consider the following facts about the methods and models used in the complex art of predicting the future:

- "Predictive models are based on sets of equations."
- "However, the underlying systems cannot be reduced to equations."
- "Models of these systems tend to be sensitive to changes in parameters."
- "More data and bigger computers do not necessarily help."
- "Statistical methods can sometimes be of use." And sometimes, they cannot.

Modern Forecasting: Weather, Health and the Economy

Weather forecasting, medical research – in particular, genetic research and prediction – and economic forecasting are closely related. In all three cases, knowledge about smaller parts of the whole and about the scientific basics in the relevant fields has not led to a higher degree of accuracy in forecasting future events. If the basic premise of the scientific method holds true, then experts should be able to use the facts they already have about these systems to predict how they will behave in the future. Unfortunately, that isn't the case.

> "Prediction has always been not just about foretelling the future but about controlling it."

For instance, science knows a great deal about what causes different kinds of weather, but meteorologists are still unable to forecast with great accuracy beyond a few days. Their advanced scientific ability to predict major weather disasters is not much better than it was in the past. Weather depends on so many factors that calculations and predictions about when it will rain, or when a blizzard or hurricane will hit – and how fast, big, wet or powerful it will be – can be expressed only in percentage probabilities. Major weather catastrophes with staggering economic impact still remain elusive to predict with any accuracy.

> "Science has changed a great deal since...Pythagoras, but the emphasis on using reason and analysis to provide hard, fixed solutions for particular, specialized problems has remained."

The issues making weather forecasting more difficult, even with smart models, include:

- Weather is complex and based on local variables.
- Individual features, such as clouds, can't be gauged from their initial states.
- The use of forecasting models is subject to model error that limits forecasts' accuracy.
- Simple models allow scientists to issue general warnings and predictions, but having more complex models doesn't necessarily lead to more accurate forecasting.

> "A key difference between a living thing and an object is predictability: kick a stone, and you know what will happen; swat at a bee, and things get more complicated."

Just try predicting earthquakes. While experts can predict where they are likely, given where tectonic plates strain against each other, they cannot determine when they will happen because the release of tension between plates is not gradual, but abrupt. The circumstances are comparable to economic plunges that happen because of "a sudden shift in balance between buyers and sellers. Like financial crashes, earthquakes occur at unpredictable intervals, and their magnitude tends to follow a power-law distribution: there are many smaller ones, and fewer large ones."

> "Life is not a predictable machine. Life is a surprise."

On the health front, scientists have mapped the human genome and medical researchers have discovered what triggers certain conditions. Yet, science is not appreciably closer to predicting whether a particular set of conditions will cause certain diseases to occur, and whether specific treatments will work. As breaking news often indicates, "The emergence of new diseases is inherently random and unpredictable." Despite such uncertainty, research has made great strides in many areas of medicine. Countless lives have been saved (and fortunes made) as a result.

> "The fact that [the Greek solar-system model] worked quite well as a model of the universe is a poignant reminder that a model that can be made to fit the data isn't necessarily an accurate representation of reality."

Numerous models predict how the economy will react to various trends. Each one has a sound mathematical basis, but still economists' predictions about the future behavior of markets and the economy are limited to very short time frames. The fact that market trends can be tallied to show the direction things are heading at present does not mean that the trends will continue that way. Any market watcher can describe sudden, unexpected shifts in various economic sectors, but people have fooled themselves into thinking they can envisage trends well enough ahead to invest for future gain based on the past performance of various financial instruments. Yet, "economic predictions that extend more than a few months ahead are more futurology than science."

> "The models often get better at fitting what has happened in the past, but they don't get much better at making predictions."

Given the complexity of these overall systems, can people expect that science will be able to derive better forecasts in the future? Will human beings amass enough knowledge to predict even how well they will be able to tell the future – in the future?

Can Experts Predict Anything Accurately?

Each new discovery seems to raise the bar, to increase the amount of information experts need to make more accurate predictions. The most valid statement about these systems is that the past is not an accurate predictor of the future. Just because something happened in one of these complicated areas does not mean that anyone can figure out when (or if) it might recur.

> "Trying to model a cloud is about as easy as trying to hold one in your hands."

The scientific premise that people can make assumptions about larger systems based upon knowledge of their individual parts seems false because the various systems always interact in different ways. They don't exist in a bubble in a laboratory. The economy is closely tied to weather, and how it affects crops and other factors tied to fiscal growth (or lack of growth). The health of the populace is likewise dependent on economic and environmental factors, from whether people have clean water or whether they are starving – due to poverty, bad crops or both. The weather itself can be influenced by humanity's reaction to economic concerns, as evidenced by the impact of global warming.

> "Our impact on the planet can be visualized only with scientific technology that extends our senses to a global level."

When examining forecasting in weather, health and economics, many things become clear:

- "Simple predictions are still possible," but science cannot yet "accurately state the uncertainty in predictions."
- "Models can help us understand system fragilities," but "small changes to existing models often result in a wide spread of different predictions."
- "When different models are combined, the uncertainties multiply."
- "Uncertainty means that discussions become polarized between opposing camps of optimists and pessimists."
- "Prediction is a holistic business."

> "To prophets of different persuasions, anything from tea leaves to animal entrails to segments of the Bible can form a...text that can be probed for glimpses of the future."

People know the world is a complex system, but they tend to believe that humanity will come to understand and possibly control it. The reality is that while models can explain how a certain process works, no one can predict how a specific instance of that process will turn out. For example, science might know a plant's biochemical makeup, but it can't foretell how a single transplanted specimen will do – too many variables are at work to allow specific predictions.

> "The realization that the earth system is inherently unpredictable – coupled with a deeper understanding of...complex systems – may turn out to be highly liberating."

The experts who use models to forecast the ecological future of the planet derive greatly different results based on variations in their input, so how can concerned

nonexperts begin to know what will happen? Can humans "predict the climate if [they] can't predict next week's weather?" The best they can do is to realize that humanity has an impact on the planet and should minimize that impact whenever possible. No one can forecast the future accurately, but experts in weather, health and economics have models they can use to examine trends and provide insight into how things are working now. This insight gives humankind a clue about its impact on the natural world, now and in the future.

> "What unites our future weather, health and wealth is that they all rely on the state of the planet."

Given all these caveats, the events that are likely to occur by the year 2100 include a continuing increase in global temperature (unless, for instance, technology evolves to remove carbon from the air). Sea levels will probably continue to rise as ice sheets melt, creating coastal flooding, erosion and loss of habitat that could displace millions of people – but no one knows how soon or if some other change can prevent such a cataclysm. Will the rain forests collapse, the droughts spread, the heavy storms increase – and will people go to war over water? It seems plausible that these things can happen, yet as Johannes Kepler's tutor Michael Mästlin told him, "predict disaster, since that was bound to come true sooner or later." Without knowing the future, mankind can still sense its hazards. It makes sense to head them off by trying to "pollute less, tread more lightly" and treat the planet with care, whether the best minds can foretell the exact future or not.

About the Author

David Orrell, Ph.D., received his doctorate in mathematics from the University of Oxford. His work on the prediction of complex systems has been featured in numerous publications and on radio in the U.S. and the United Kingdom.
