An Interview with Peter Denning

The End of the Future

Interviewed by Brian Branagan

Editor's Introduction

Ubiquity *is dedicated to the future of computing and the people who are creating it. What exactly does this mean for readers, for contributors, and for editors soliciting and reviewing contributions? We decided to ask the editor in chief, Peter Denning, how he approaches the future, and how his philosophy is reflected in the design and execution of the* Ubiquity *mission. He had a surprisingly rich set of answers to our questions. We believe his answers may be helpful for all our readers with their own approaches to their own futures.*

Brian Branagan
Associate Editor

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Ubiquity: Let me get right to the point: What is the future?

Peter Denning: The "future" is events in a time yet to come. Many of us would like to predict the future so that we can take appropriate actions in the present. Most predictions are based on some sort of recurrence—such as a repeating cycle, a calculable time function, or an invariant tenet about human nature.

When I hear a prediction, my willingness to believe it depends on the match between it and my dispositions about the future. Some people are optimists and others pessimists. Some people imagine the future as an already-written series of events that will become known eventually. Others imagine the future as malleable, the product of actions taken by people in the context of declarations made by people.

I rate myself as an optimistic believer in the malleable future, tempered with a good dose of prudence in anticipation of future breakdowns. I tend to be skeptical of predictions that depend on assumptions about what humans will declare and think. It's easier to accept predictions of recurring events, such as sunrises or high tides, than to accept predictions about how people will react when the storm surge comes in. I take delight in watching the future unfold.

Ubiquity: What do you mean by the unfolding of the future?

Denning: Unfolding is a metaphor. When we see a bud, we imagine what the flower will look like when it opens. It opens gradually, eventually revealing its fullness. Unfolding is a process of increasing degrees of opening, of incremental revelations.

As we said a moment ago, a lot of people are interested in predicting the future so that they can orient their present activities accordingly. With a few exceptions we can discuss, I think the future is inherently uncertain and unpredictable. We are way better off if we accept the

enormous uncertainty that pervades the world and approach it with a sense of adventure and mystery. We influence what happens next by our actions. We can experiment to see what consequences our actions produce, and make adjustments when we don't like the consequences. We can help the future unfold even if we can't predict much about how it will unfold.

There are a couple of small but important exceptions to the unpredictability of the unfolding. One is that we can notice a current reality that is hidden or nonobvious. We might notice the reality by looking at data, watching conversations, or observing practices. We then discuss the reality and its consequences in the near term—a year or two is easiest, but sometimes we can go up to five years. Management guru Peter Drucker was a master at this; he said that others who rated him as a good prognosticator were wrong because all he was doing was revealing current truths that most of them had missed.

Ubiquity: What is the other exception?

Denning: The other exception is recurrent events: We notice that a particular event repeats and we extrapolate to its next occurrence. Finding and exploiting recurrences in nature is the objective of science. Engineers build tools and systems whose behaviors can be trusted because they can be predicted accurately by scientific laws.

The two most familiar kinds of recurrences are cycles and functions. A cycle is an event that occurs periodically. After we measure the length of the cycle, we can predict when the event happens again. Predicting sunrise is an obvious example. Even if we don't know the length of the cycle, our conviction that a cycle exists can allow for a fuzzier, but still useful prediction. The stock market, for example, has cycles of up and down, but we don't know exactly when the highs and lows will occur.

When we have a function that characterizes the data seen so far, we can calculate future values using the function. For example, we notice that computer chip speeds double every two years and we predict that the speed will be eight times faster in six years. To make this prediction, we assume that the function itself is recurrent.

Politicians and economists are interested in historical recurrences. These are human conditions that seem to repeat over time, such as economic booms and busts, or cycles between war and peace. Sometimes we can see historical recurrences and use them to give make high probability statements about events over a longer period, such as decades.

But mostly the things we want to know are inherently unpredictable. They depend on too many unknown events and too many decisions and declarations people make in the worldwide network of conversations.

Ubiquity: What can we do in the face of all that uncertainty?

Denning: The worst thing we can do is to become resigned and inactive. There is an old saying that the best way to predict the future is to invent it. In our recent book, Bob Dunham and I discuss eight practices by which people influence the future by bringing about change in their communities (*The Innovator's Way*, MIT Press, 2010). The process of inventing the future is one we can become skilled at. Much of the skill is coping gracefully with the breakdowns and surprises that we will inevitably encounter. I call this "blending with the unfolding."

Ubiquity: Why is prediction a concern for people?

Denning: Uncertainty produces discomfort and disruption. Most of us would rather keep improving our lots in life and not have to put up with disruption. We see technology as progressive, always pulling the world in a better direction. For example, investors would like to predict the stock market. Homeowners would like to know if they are buying in an appreciating neighborhood. College students would like to know which fields will be hot after they graduate. Professionals would like to know what they should learn that will be useful when new technologies become mainstream.

I think that trying to predict the future is a losing proposition. Our track record is absolutely miserable. With few exceptions—notably predicting events with definite recurrences—we get it wrong. That's why science has such an emphasis on reproducibility—people love it that well validated scientific phenomena can give reliable predictions that can reduce risks. But in every domain of politics, economics, business, and even science, numerous macro and micro events defy prediction.

Ubiquity: But we see loads of technology projections. Some of them, like Moore's Law look so spot on that entire industries rely on them, and enable futurists like Ray Kurzweil to predict dramatic changes to humanity within the next generation or two.

Denning: I agree that there are many technology projections. Let's take a look at a few of the more common ones and see how well grounded they are.

In the early 1990s, Internet pundits promoted a pile of predictions that led to the business disasters of 2001-2002, known as the "dot com bust." John Seely Brown and Paul Duguid wrote a book analyzing why the main predictions went wrong (*The Social Life of Information*, Harvard Business School Press, 2002). The main predictions they considered included disappearance of libraries, universities, newspapers, and physical workplaces. Some of these predictions came from prominent people—for example, Peter Drucker was among those predicting the end of the university. None of those predictions came true. What did happen is that those institutions changed and adapted, but they are all still very much with us. All the predictions were based on extrapolations of technology trends discernable around 1990. They failed because technology is only a part of a social system. The prognosticators did not consider how the structure and conceptual understanding of the system might change. A change happens only when technology, structure, and concept all change together. The Internet predictions assumed that the technology drives the other two. In reality, the other two pushed back and changed the technology. In the social system, the technology and its adoption evolved in a different way from the technology extrapolation.

The notion that technology drives (causes) change is very much with us today. We like to say that the Internet technology drove a huge number of changes in the world, including today political and economic changes. This notion is, in my view mistaken. Did the Internet really *cause* the change? Or did it *accompany* the change? Might not the desire of people to communicate more rapidly and do business with more customers have inclined investors to invest in the Internet technology and deploy it widely?

Ubiquity: What about Moore's Law? Isn't that a perfect example of technology driving change in society?

Denning: Moore's law began with Gordon Moore's observation in 1965 that the number of transistors on a chip doubles every two years at the same chip price. Over seven years this produces a 10X (10-fold) speedup. The 10X improvement makes previously expensive computational methods much cheaper and induces people to try new methods that bring them better value. Notice that the changes come from people as they adopt the new technology. The technology is not doing the driving; the people are. This is very important. The changes accompanying Moore's Law are happening in social systems. We can come back to this later if you like.

No law of nature mandates chip doublings every two years. Many leaders in the chip industry have made it their business objective to double the speed of their chips every two years. Might Moore's law be the manifestation of policy decisions made by business leaders?

Ray Kurzweil has argued that a similar doubling rule can be observed in the four information technology generations that preceded silicon chips. He believes that when Moore's Law runs out for silicon—when wires become less than an atom wide—some other technology will step in to continue the process. Today, for example, we see multi-core chips continuing the doubling trend by placing many processors on the same wafer so that they can all proceed in parallel.

Ubiquity: Ray Kurzweil is so certain that Moore's Law will persist through future generations of information technology, that he predicts a "singularity" sometime around 2030. Aren't his predictions founded on a well-established law?

Denning: It depends on what you mean by well established. It's not a scientific law. It manifests the aggregate effects of many business decisions. Kurzweil may be right about the technology, but people's reactions and adaptations to the technology are harder to gauge. For example, I've heard a lot of people say they see Kurzweil's predictions but don't believe the proposed singularity consequences. Some people believe that with the coming changes of bionic replacement nano-parts, along with brain and other neural implants, we will gradually transform our children and grandchildren into the new beings that Kurzweil says are probable. In other words, we would not *create* new superintelligences, we would *become* them ourselves. No one really knows. AI researchers have a marvelous adventure as they explore these things.

Ubiquity: What about other attempts at long term predictions? Do any of them work?

Denning: In 1892 there was a great exhibition in Chicago celebrating the 400th anniversary of Columbus discovering America. The American Press Association invited 74 leading authors, journalists, industrialists, business leaders, engineers, social critics, lawyers, politicians, religious leaders, and other luminaries of the day to give their forecasts of the world 100 years hence, in 1992. In 1992 Dave Walter (*Today Then*, American World Geographic Publishing, 1992) published a book that reprinted those old essays so that we could all see how accurate they were. All but four were completely wrong. The best Walter could say is that the essays tell us more about the writers and the context of their day than about the future. Many predicted the wars would end, plagues and pestilences would be conquered, social classes would be erased,

unemployment and poverty would disappear. Many believed that pneumatic tubes would replace buses and trains as primary transportation within cities. Others believed that high speed railways would be the primary method of transport across all of North, Central, and South America. Only one thought that air transport would be of any value, and even he thought the value would be primarily military. No one foresaw radio, television, computers, or the Internet. No one foresaw any of the major discoveries of physics during the 20th century. If there is a lesson to be learned from Walter's study, it is that whatever we predict for the long term will almost certainly be wrong.

Ubiquity: You make a good point about changes happening because people adopt them. But before people can adopt anything, someone has to invent it. Isn't important for technology progress to identify and reward inventors and provide incentives for more people to become inventors? Can we do more to identify great inventions early?

Denning: I am very skeptical that many innovations were the consequence of ideas of inventors who created early ideas. In our book, we call that the "Invention Myth"; others call it the "Eureka Myth." It is easy to look backwards and see a chain of connections (e.g., literature citations) from someone's ideas to the present. We try to locate the earliest person to propose the idea and then give that person special recognitions for being the original source of the idea behind today's innovation. But a chain of connections is not a chain of causation. In our research, we discovered that, almost all the time, the inventors of ideas are not the ones who brought the idea into practice and adoption. Fortunately for the inventors, there are numerous innovators. Something seems out of balance to me if we give more recognition to inventors than to innovators. We are not hurting for ideas as much as we are for people skilled in bringing about adoption of ideas.

The fundamental problem is that the judgment whether an invention is great is rendered many years later by those who are immersed in the innovations that followed. It is difficult to tell at the time of an invention whether it will be great.

Ubiquity: What about Andy Grove's idea of the 10X technology and inflection point? Doesn't that give a method of prediction?

Denning: Andy Grove, the former chairman of Intel, wrote a book about how he steered Intel (*Only the Paranoid Survive*, Doubleday, 1996). He observed that if someone had a prototype of

a new technology that looked like it could do a familiar and pervasive job 10X (10-fold) faster or cheaper, it stood a good chance of being a disruptive technology. Grove did not want Intel to be surprised by disruptive technologies of competitors. He therefore invested in research that would see if Intel could realize the 10X improvement in a technology it controlled. Grove did not make technology predictions per se. He created options for the company in case any potentially disruptive technology actually became a threat. Many of his experiments led nowhere, but some paid off handsomely for the company.

Ubiquity: What about chaos theory? Can it predict the future?

Denning: Many things are chaotic and unpredictable. We'd like to know when the next earthquake will happen. Or whether a nuclear power plant can withstand a 9.0 shock. Or who will prevail in the Middle East. Or how to get the national economy to grow. Or whether a social networking company will succeed or go bust. Or who will be our competitors when our product is ready for market. Or whether 2012 be a disaster year for the planet? On and on.

Santa Fe Institute was formed to explore chaotic phenomena mathematically and see if there are any exploitable recurrences. They discovered some interesting things including power laws, sudden phase transitions, and scale-free systems. But these have not helped much with making predictions. The mean and standard deviation of a power law distribution are infinite or undefined, meaning you cannot set confidence intervals on predictions. The mathematical model says Internet is scale free but in reality engineers design in redundancy and that falsifies the model's predictions on failure probabilities. An earthquake is an example of a cascade phase change, but all that tells us is that we can't know at that moment it starts how long it will last or how much energy it will release; we'll know a few minutes or hours later.

So I don't think chaos theory is very helpful for most of the human systems whose future we would love to know.

Ubiquity: We're not done exploring prediction methods yet. Futurists use trend extrapolations and scenarios. How good are these methods?

Denning: Trend extrapolation means to find some variable in the data that can be described as a time function, then use that function to predict a future value. I noted earlier that these become increasingly unreliable with distance into the future; they are at best good for a year or

two before the environment changes too much. And of course they are no good at all if the environment undergoes a disruptive change, so that the function no longer applies.

Scenarios are short stories that depict a future situation and explore the consequences. Scenarios have been very helpful to help people understand their own reactions to various possibilities. If futurists discover scenarios they do not like, they inquire into policies that could be implemented in the present to make that future less likely. And of course they favor present policies that make good futures more likely. Since there are no guarantees that any of the policies leads to the desired outcomes, scenarios are not really a method of prediction. They are a method of evaluating reactions to possible worlds.

Ubiquity: Finally, let me ask about "learning from failures," about which there has been much discussion of late.

Denning: Yes, Google has publicized its company practice of encouraging people to fail early and often, and learn from the failures what might work. Years before Google existed, Peter Drucker pointed out that failures can be sources of innovations.

The key idea is not failure, but learning. The process of embracing uncertainty and adventuring in the mysteries of the world is a learning process. We cannot learn if we do not try. When something we try fails, we seek to understand what made it fail and modify our future behavior when we try again.

I don't see learning from failures to be a prediction method, but a practice for blending with the unfolding world.

Ubiquity: Let's bring all this back to Ubiquity. What does it say about the kinds of things *Ubiquity* publishes? What can readers take away from what you have said?

Denning: In *Ubiquity*, about half our articles are commentaries and the other half interviews. The commentaries give authors the opportunity to expose truths about the world today and explore the near term consequences. All the commentaries are on file in the ACM Digital Library, we hope that future authors will review some of them to see how well those authors did with their extrapolations.

The interviews give us firsthand accounts from people who are engaging with the future as an unfolding adventure in the mysteries of the world. We are particularly interested in how they cope with the breakdowns and surprises they encounter. The how may be useful to other readers.

In the past year, we instituted a new feature, the *Ubiquity* symposium, to allow a group of participants to explore a proposition. We intensely dislike the "point-counterpoint debate" formulation popular in many magazines and talk shows. That formula makes it seem that every proposition has only two sides and one must be right. It is a bad way to grapple with the mysteries of life. Our symposia, instead, encourage inquiry and exploration. We hope our symposia are learning experiences for readers, and that they will gain a greater understanding of a difficult topic by seeing how others are grappling with it.

Our intention is to help readers face the uncertainties of the future and see that they can develop effective practices for coping with them. This is what I mean when I say the end (goal) of Ubiquity is the future.

Ubiquity: Thank you.

Denning: You're welcome.

About the Author

Brian Branagan has worked in the field of software test management and quality engineering for more than 20 years in Fortune 500 companies such as Adobe Systems, Getty Images, and RealNetworks. He is currently the Director of Test Engineering at F5 Networks. Brian's focus areas include risk management for complex systems and software project management methodologies.

DOI: 10.1145/1979462.1979464

