The Implications of Moore's Law and Exponential Growth

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From the LIC Bullet, May 2016

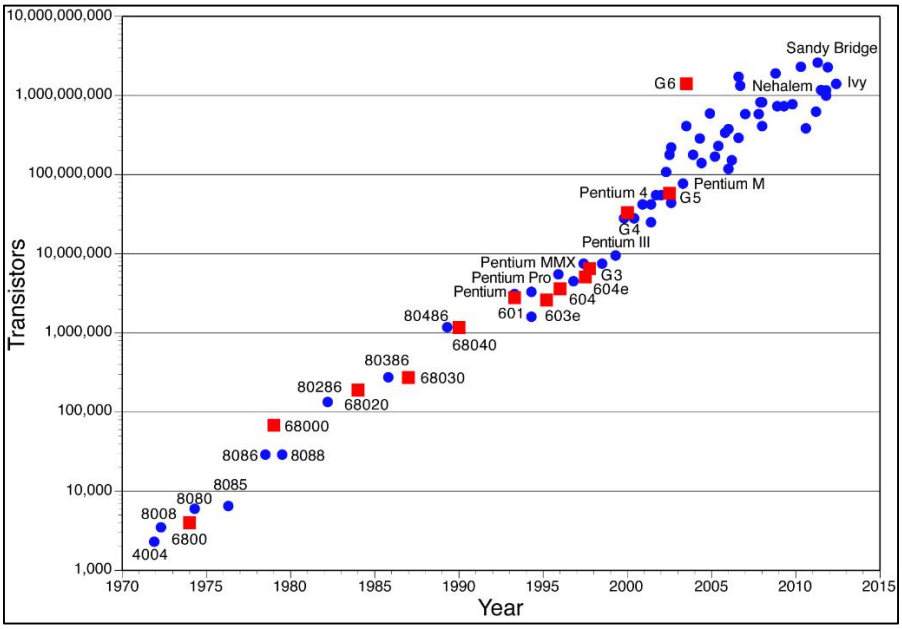
There's a neat parable involving an Indian raja who demanded that his people give him the majority of their rice crop every year so that he could store it and redistribute it in times of famine. When the famine came, he continued to keep it for himself, leaving his people hungry. A quick witted peasant girl, after being caught taking some of the excess rice for herself, tricked the raja into believing that she was returning stolen rice to him. As a reward for her honesty, she asked for a grain of rice every day, doubled every day for thirty days. The raja agreed to the rather modest request, not realizing that by the end of thirty days he would have transferred his entire stockpile of rice to the girl.

A similar story involves doubling a grain of wheat on each square of a chess board. The modern version asks the question, "What would you rather have, a million dollars today or a penny a day doubled every day for thirty days?" At first glance, a million dollars appears to be the better choice—but that lowly penny grows to more than $5,000,000 when doubled thirty times. And when it's doubled sixty times, like in the chess board parable, the number is in the quadrillions!

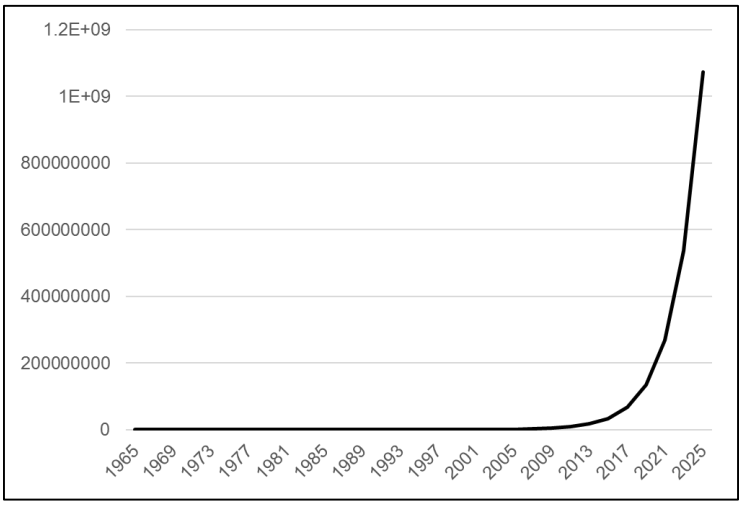
These parables highlight the difficulty that humans have in thinking exponentially. This makes sense since the vast majority of our experience in life consists of linear changes. But it's a potentially dangerous blind spot today when we're trying to anticipate what's coming in the future.

For example, the driving force behind the technological advances we've enjoyed over the past fifty years have been from Moore's Law – which is actually less a law than an observation by Intel cofounder Gordon Moore. Moore observed in 1965 that the number of transistors on an integrated circuit had doubled every two years and would likely continue. And he was right. Intel produced a video commemorating fifty years of Moore's Law and observed that the performance of Intel's microprocessors had improved 3,500 times; their efficiency had improved 90,000 times; and their cost had decreased 60,000 times. If auto technology had improved at a comparable rate, then cars would now travel 300,000 mph, get 2,000,000 miles per gallon, and cost just 4 cents!

Here's a graph confirming the evidence of Moore's Law in the history of Intel's microprocessors:



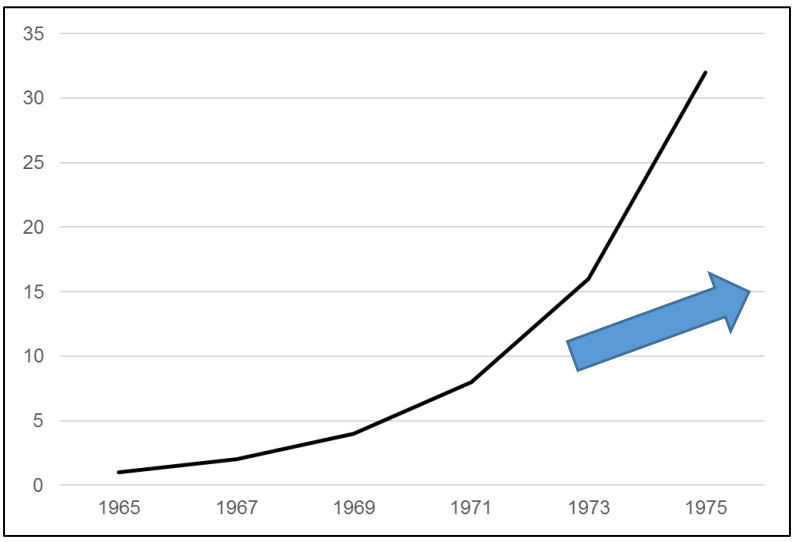
Notice how the scale on the left side of the graph increases by a factor of ten for every grid line? We can illustrate exponential changes in the form of a nice, orderly straight (linear) line by using an exponential scale like this. As the parables demonstrated, in real life exponential changes grow explosively large in a relatively short time. When Moore's Law (or any exponential change) is graphed linearly, the latest growth is so large that it masks everything that occurred previously:



Of course, all good things must come to an end, and Moore's Law is no exception. Much has been written lately about how we're starting to reach the technological limits of cramming more transistors on an integrated circuit. Moore's Law, it seems, is starting to slow down. However, according to inventor, author, futurist, and current head of Google's Engineering Lab Ray Kurzweil , there has been a long history of exponential improvements in technology well before the invention of the integrated circuit. In his book *The Singularity is Near*, he graphs the processing ability of various devices over the past 100 years, including vacuum tubes, relays, and electro-mechanical devices, and it looks very much like the Intel micro-processing graph. If Kurzweil is correct then it's possible we're at the cusp of transitioning to whatever the next new processing mechanism will be that replaces the integrated circuit.

Understanding the implications of Moore's Law and the difficulties of grasping exponential change is important because we all engage in the practice of crystal-ball gazing and predicting the future. This has worked out fairly well for those of us in the life insurance industry because so little has changed. The past twenty years saw an explosion of disruption with the emergence of the internet, Google, Amazon, Apple, and Facebook but with a few exceptions, our industry has resisted both disruption and innovation.

One final graph illustrates why. Below is a depiction of what the first ten years of Moore's Law may have looked like—or more specifically, what five "doublings" look like on a linear scale. The arrow shows why humans are so easily tricked into underestimating exponential changes. A linear projection of the first few numbers would lead to an expectation similar to the path the arrow is pointing in—but the graph shows how far short this would come to the actual result. Although technology has changed exponentially, our industry has evolved at a more linear pace that more closely resembles the path of the arrow than the actual graph.



All that is about to change—it's time to re-calibrate our crystal balls and start recognizing that our predictions going forward will most likely fall far short of what actually happens. What's the reason for this unprecedented optimism? For the first time it's easy to see a number of transformational technologies that will have a dramatic impact directly on our industry.

Let's start with one of the most obvious—self driving cars. Regardless of your level of optimism regarding exactly when the day comes that we can all turn in our driver's licenses, we're already seeing the benefits of computer assisted driving. We've had blind spot indicators, automated parking, and smart cruise control options available for years. It's easy to see a day in the very near future where at the very least cars will limit the ability of their drivers to do anything stupid such as crashing into oncoming traffic or hitting pedestrians or other obstacles we share the roads with. This falls far short of the more utopian vision where we abandon individual car ownership and summon our transportation as needed from an automated fleet—but even this fairly simple and easily achievable (linear?) innovation would have a dramatic impact on our industry.

The reduction in injuries and deaths related to motor vehicle accidents in the very near future will be tremendous, but the benefits for the life insurance industry go well beyond mere improvements in mortality. Cars communicating with each other and with their surroundings open up all of the possibilities of the Internet of Things (IoT) on a much grander scale. We're already seeing the infancy of how the IoT can impact our industry by the growing popularity of fitbits and other activity trackers. In addition to motivating millions of previous couch potatoes to compete with their friends to meet daily step goals, they have inspired a number of companion features such as calorie counters, pulse and heart rate trackers, sleep monitors, and GPS displays. It was a breakthrough for auto insurers to convince safe driving consumers to allow sensors in their cars in return for lower rates. Now life insurance carriers have the same advantage—a means to identify and attract people who are most committed to trying to maintain a healthy lifestyle.

At first glance, it's easy to dismiss the significance of this trend but the implications are tremendous when you consider the 3-4-50 Model. Three lifestyle behaviors (physical inactivity, poor nutrition, and smoking) lead to the incidence of four chronic diseases (diabetes, heart disease, lung disease, and cancer) that together cause more than 50% of all deaths. Are we going to convert the entire population into annoying health fanatics? Of course not. But because lifestyle is such a significant driver of mortality, even incremental improvements across large swatches of the population have the potential to have a major impact.

A counterpart to the IoT is Big Data—the refinement of complex algorithms that make sense out of the vast amount of seemingly unrelated data. Although Big Data has long been a valuable tool in the P&C industry, life carriers have been largely stuck on the sidelines—until recently. TransUnion and RGA have developed a mortality predictor that uses credit history. Tools are now available that can predict persistency on an individual policy basis. There are a number of automated underwriting engines that instantly interpret complex prescription and medical data to assist underwriters in a process that used to take hours. And one of the most surprising is a resource called Chronos from Lapetus Solutions, a facial recognition software company that has incorporated a selfie into the underwriting process that uses their technology to combine facial analytics, bio-demographic information, and life event data to calculate mortality in minutes.

All of these eyebrow-raising products are available today, although many have been met with a healthy degree of skepticism. But even looking linearly into the future leads us to an eager anticipation of improved risk selection on an instantaneous basis that will make simplified issue the norm rather than a niche.

And finally, fans of the TV show *Jeopardy* will recall the 2011 show where IBM's computer Watson defeated two of the most prodigious winners of all time. IBM had already proven their gaming skills when they defeated chess champion Garry Kasparov with Deep Blue in 1996. But *Jeopardy* posed a whole new set of challenges, most notably understanding spoken questions that included as much cultural nuance, satire, and wit as they did facts. In addition, with Deep Blue IBM had the benefit of thousands of actual chess matches they could use for programming. Poor Watson had to play (and lose) thousands of games of *Jeopardy* to gain incremental insights from its mistakes.

But the effort paid off. IBM now offers Watson as "a technology platform that uses natural language processing and machine learning to reveal insights from large amounts of unstructured data." The success of Watson's machine learning process has inspired companies like Apple (Siri), Amazon Echo (Alexa), Google (OK Google), and SoundHound (Hound) to push beta versions of personal assistants into the hands of users in order to begin "teaching" and improving their software through trial and error. The day is coming when we will converse just as easily with our computers as we do with our friends—no more cursing autocorrect or those tiny screens!

As exciting as it is to imagine the day when our phones will respond to our beck and call (rather than the other way around), these personal assistants still fall far short of the transformational platform of something like Watson. Rather than offering personal assistance, Watson offers "cognitive assistance" —or as IBM puts it, "Now any professional can be as good as the best professional in their field by partnering with the cognitive assistance of Watson."

We've seen a recent proliferation of robo-advisors and have rightfully scoffed at their attempts to replace the value added by a real financial advisor. And life insurance, a product desired by no one but the uninsurable, is on even firmer ground since it needs to be sold rather than bought. But that kind of thinking isn't even linear—it's entrenched firmly in the past. What trainer hasn't lamented the challenges of getting agents to use time tested responses to objections and key words that have been proven to be more effective? How many hours have trainers spent sitting in joint appointments trying to improve the techniques of their new hires? As people become more comfortable interacting with their personal assistant devices, they will also be more receptive to incorporating computers in their everyday interactions.

To put it another way, who have would turned down the opportunity to do joint work with industry icons like Ben Feldman and John Savage? As a cognitive assistant, Watson offers the potential to combine the wisdom and talent of our top sales people with the means to simplify the insights from big

data and complex financial models and make it available in real time while our representatives are sitting in their prospect's living rooms.

For a perfect example of how technology is changing on an exponential basis one only has to look at Google's Alpha-Go program, a winner of a March 2016 tournament between Lee Sedol, the world's top *Go* champion for the past decade. *Go* is an ancient game with an exponentially greater number of possible moves than chess. In fact, there are more possible moves in *Go* than there are atoms in the universe. Winning the game also involves a fair amount of intuition—something seemingly impossible to program into software. This victory was a huge breakthrough in the area of artificial intelligence and vividly highlights how far we've come in just the five years since Watson.

Since the foundational premise for this article has been the difficulty of thinking exponentially, the examples discussed have intentionally been more linear and have involved innovations that are already here. Yet it's still difficult to process the potential impact that these exciting new tools are going to have in a very short amount of time. And this is just the beginning. If there's one thing we've learned from Moore's Law, it's that even our wildest and most optimistic predictions over the past fifty years would have fallen far short of the reality.

Ray Kurzweil succinctly described in English the mathematical implications of exponential growth resulting from consistent doubling. He observed that if the technological improvements we experienced for the last 100 years continue, then we should experience the equivalence of an entire 20th century worth of progress from 2000 to 2014. And another 20th century worth of progress between 2015 to 2021. By 2050 we will be measuring this rate of improvement in weeks or months.

If this sounds completely unbelievable, then I'd like to make a bet with you involving a chess board and a lowly grain of wheat.