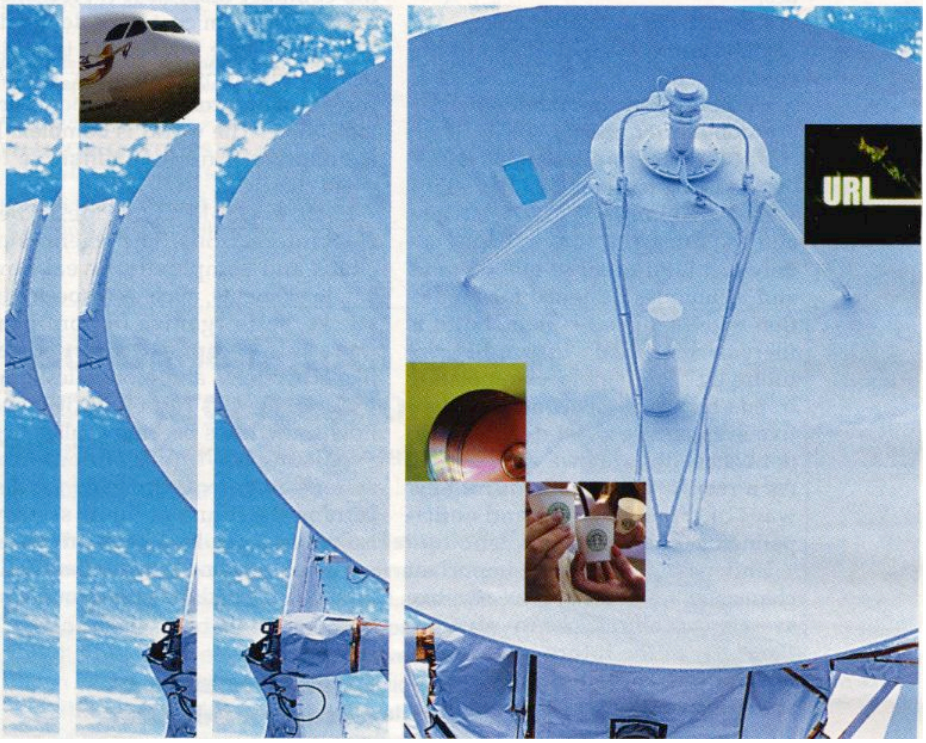
Weak Signals: Detecting the Next Big Thing

Where's the next major innovation coming from? Being alert for weak signals could clue you in.



By S. Dyer Harris and Steven Zeisler

A fundamental tenet of futurists, strategists, and planners everywhere is that the future can be envisioned to a useful degree of accuracy. But even a cursory glance at forecasts and events of the recent past reveals just how poorly prognosticators are performing.

Increasingly, the quest for accurate prediction of even the short term is difficult. And the reason is that, in spite of how we believe them to be, virtually no social, political, or business systems follow straight-line paths of predictability. Rather, they behave in nonlinear ways because they are chaotic, **Complex Adaptive Systems (CAS)**

Much has been written about chaos theory, ranging from scholarly treatises to pop sound bites. Most of these articles encourage us to think metaphorically about the world around us as chaotic. The truth is that the metaphor is not enough. If we are to improve our ability to think about and plan for the future, we must accept the reality that, ultimately, all social systems are complex adaptive systems. These systems have five primary characteristics:

- **sensitivity** to small change,
- **adaptability** to changes in the environment,
- **determinism**, not randomness,
- **complexity**, and
- **short-term forecasting possibilities** and long-term forecasting futility.

As a result of these characteristics and the interplay among them, not only is it imprudent to rely on tools and techniques designed for prediction within a linear system, but it is increasingly futile to predict the future by, for example, extrapolating trends forward. The complex adaptive systems we must deal with do not behave the way we were taught. As a result, we must acquire new ways of thinking about and anticipating the future.

Understanding the five important characteristics of a complex adaptive system can help those involved in the study of the future open up the possibilities, broaden the range of scenarios, and improve the odds for successful anticipation.

Discerning the Future in Complex Adaptive Systems

We are all intelligent, educated people. We have learned certain truths: That forecasts of the weather are accurate and trustworthy. That species evolve logically to equilibrate with their environment. That the geopolitical division between the East and West is permanent. That markets trend toward the equilibrium of supply and demand. That environmental effects can be modeled by Newton's laws. That customers know what they want in the future. That threats come from well-known enemies.

But: Why does it rain on our picnic? Why do species, stable in the fossil record for millions of years, suddenly disappear? Why did the Berlin Wall crumble overnight? Why does the stock market move hundreds of points on an official's whimsical statement? Why didn't we foresee the effect of DDT on eagles' eggs or chloroflurocarbons on ozone? Why didn't the personal computer, the Internet, ATM machines, overnight mail delivery, the compact disc, Post-it Notes, or CNN arise from customer demand? Why didn't we foresee the tragedy of Rwanda or of September 11? We were taught wrong. Our models are too simple. The world is **complex**. It is **adaptive**. And it is **sensitive** to small change.

Each example above describes CAS interactions. The sciences of chaos and complexity reveal how single elements, such as a species or stocks, self-organize in nonlinear ways into complicated structures like ecosystems and economies; how individual stars form galaxies; and how snowflakes become avalanches. Predicting the future of nonlinear systems with tools designed for discerning the future of linear systems is faulty at best. New tools are necessary for dealing more effectively with complex adaptive systems.

Characteristics of Complex Adaptive Systems

The first important characteristic of a complex adaptive system is that it is extremely **sensitive** both to initial conditions and to small change. These small differences can be amplified disproportionately from their initial state, causing very unexpected outcomes. A minor earth tremor far off the Japanese coast spawns a rogue wave that materializes thousands of miles later as a killer tsunami in New Guinea. In 2001, government leaders in the United States predicted large tax revenue surpluses, assuring Social Security funding for 30 more years with plenty left over for other projects. Then the economy retreated.

It is this sensitivity that chaos pioneer Edward Lorenz said is the critical requirement of CAS. And if small change can make a big difference, then small events, ignored or dismissed by standard future-seeking approaches, must be purposefully sought out. Specifically, we can learn to find what we term **weak signals** and to determine which ones we should pay attention to. Finding the "dots" is more difficult than connecting them.

The second important characteristic of a complex adaptive system is that it is **adaptive**. Within the system is a web of intricate linear and *nonlinear* feedback mechanisms that enable the system to self-adapt to new situations and inform it to evolve, mutate, reenergize, grow, and surprise. A competitor in your marketplace introduces a new product, and you circumvent the normal approval process to accelerate the launch of your newest offering (linear). Fuel prices go up, and you load your trucks up to make more deliveries per run (linear). Raise tariffs on steel, and be surprised at the disproportionate and unexpected responses from other countries, industries, and fellow politicians (nonlinear). Corporations experience consecutive quarters of poor earnings, and a charity's annual fund drive suffers (linear). The stock market sags on Friday, and I decide to forgo eating out this weekend (linear). Two kids form a business in a garage, and the personal-computer industry explodes (nonlinear). Because we have been taught to expect proportionate responses to feedback - for every action there is an equal and opposite reaction - our prognostications ignore unintended consequences and surprise in favor of the familiar and linear.

A third important characteristic of CAS is that they are p**ropelled by deterministic processes, not random events**. CAS are systems in which many interacting factors influence and

Where Is Your Next Big Idea Coming From?

In their book *The Deviant's Advantage*, trend watchers Ryan Mathews and Watts Wacker chart the path of an idea/image/product/persona from freak to chic.

Far from connoting evil or corruption, deviance, as defined by Mathews and Wacker, is simply "a measurable difference from the norm." All good ideas, all successful movements, all innovations begin with deviance existing on the fringe. "Changing your view of deviance can allow you to grow on a personal level; help build the success of both brands and corporations; significantly enhance competitive ability; allow companies to organically renew rather than disruptively reengineer; and, finally, provide a blueprint for internal reorganization that yields a host of benefits, from maximizing intellectual property to true knowledge management."

Source: *The Deviant's Advantage: How Fringe Ideas Create Mass Markets* by Ryan Mathews and Watts Wacker. Crown Business Publications, www.randomhouse.com/crown/business. 2002. 288 pages. $29.95. (Order online from www.wfs.org/specials.htm.)

	Fringe	Edge	Realm of the Cool	Next Big Thing	Social Convention
Media Coverage	negative, if any	oddity; freak	what you need to know	where you need to be	what you need to own/do
Audience Size	one	limited	identifiable cohort	multiple cohorts	mass market
Who Benefits	originator	originator	media; trend watchers; entrepreneurs	marketers	mass-market makers
Commercial Potential	0%	1% – 5%	10% – 25%	30% – 40%	70% – 100%
Communication Vehicle	originating deviant	word of mouth	events; feature stories	mainstream news coverage	advertising and marketing
Relationship to Conventional Society	antagonistic	hostile	toleration; flirtation	appreciation; cultivation	acceptance
EXAMPLE: STARBUCKS	**1971**: company founded in Seattle	**1982:** five retail stores in Seattle	**1983:** capitalizing on European cafés, Starbucks opens coffee bar in downtown Seattle	**1987:** company expands to Vancouver, Chicago. **1988:** publishes mail-order catalog. **1990s**: expasion continues	**2001:** 1,100 new stores open worldwide; **2002:** more than 5,500 stores in 28 countries

Who could have predicted the Starbucks coffee success story? Shrewd businessmen in the 1970s spun a weak signal, the European café experience, into one of the world's most successful companies—"the most significant transformation in the coffee business since the invention of freeze-drying," say authors Harris and Zeisler. Here, employees celebrate Starbucks' thirtieth anniversary.

impact each other in complex ways. As a result of these complex relationships and nonlinear transactions among elements, the system may appear to many to be random--but, indeed, the system is not. Underneath, CAS are driven by physical laws or purposeful human activity--often a simple set of rules that govern the activities and interactions--as if these systems were obeying a hidden yearning for order.

This insight gives us some hope of influencing, if not predicting, events. The success of a product introduction may not depend on the roll of the dice, but on hard work. A potentially disastrous event can be avoided if proper steps are taken. Shorelines are formed not by random events, but by the interplay among tidal elements and surface structures. Nations evolve because of recurring patterns of the physical, social, and economic needs of people.

Because, for a while at least, these patterns play out in seemingly linear ways--especially when the system is viewed macroscopically--we are deceived into believing that these patterns and the systems are constant, ultimately predictable, relatively stable, and not subject to dramatic change or weak signals. But we are wrong. These systems are incredibly **complex**--the fourth key characteristic of CAS. Those shorelines, although alike from satellite photos and to the uninformed observer wandering on the shore, are dramatically different in detail due to the complex interplay among tides, currents, temperature, geological structures, salinity, flora, and fauna.

While the varying elements of a social system may respond to essentially the same human needs, the number of components that become involved, their makeup, how they interact with one another in feedback loops, the way they adapt--these myriad possibilities create extraordinarily complex variances that form different structures: democracies, republics, monarchies, dictatorships, and rebellions. Because of market patterns, businesses arise to meet needs--alike at a distance, different in detail. Due to broad economic patterns, the dollar rises and falls; suppliers multiply, diversify, and combine; and social support systems expand and contract. The characteristic of complexity, then, creates incredible variety and diversity among systems and, as we are about to discover, makes forecasting frustratingly difficult.

At some point, CAS reach a critical mass of complex elements and interactions, then rapidly transform from linear to nonlinear. Because these systems are intricately adaptive, factors constantly adjust and respond to actions and responses from other elements in the system. Computer software, certainly deterministic and logical in its development, rapidly reaches a point of complexity and intricate feedback that declare it a complex adaptive system. And the responses (freezes, crashes, strange characters) of the software to various combinations of keystrokes and conditions cannot be predicted even by its designers. Prediction of events in a complex, nonlinear system with linear tools and logic becomes ineffective.

An outbreak of bovine encephalitis leads to the cancellation of an international sporting event. Linking the Argentine peso to the dollar, in an attempt to curb inflation, creates a monetary inflexibility that leads to export markets lost to foreign competitors. Due to the design of a ballot, an election teeters, and historically reliable forecasts based on exit poll data are suddenly meaningless.

Prediction of a complex adaptive system by extrapolating trends forward and assuming linear feedback loops that attempt to simulate how these elements respond is often specious and all too frequently tragic, as demonstrated by the events of September 11. This, then, is the fifth characteristic of CAS: While **short-term predictability can be possible**, there can be few meaningful and accurate forecasts of the long term.

We recognize that the definition of what is short term or long term is relative to the system being considered, even then it can not be precisely defined. For weather trends, short term is measured in hours and days, long term in weeks or months. For geologic changes, short term may be measured in years, while long term is centuries or even millennia. In business, short term may be this quarter and long-term five or 10 years out.

Despite the difficulty of prediction in CAS, one can dare (as we are all wont to do) to make some prediction of what will happen next. But if we are honest, we will admit that systems and their components become increasingly harder to predict, the time horizons of meaningful prediction becomes shorter, and more and more frequently surprises--unintended consequences and unforeseen second- and third-order effects--occur.

With these five characteristics in mind, we can now consider the importance of weak signals, and, by relating the circumstances in which they are observed to the key characteristics of complex adaptive systems, perhaps increase our insight into the possible consequences of these signals.

Weak Signals

Because CAS are extremely sensitive to small changes and due to the nonlinearity of how their components interact, forecasters must deliberately look for small events that have the potential to make a big difference. We call these **weak signals**. Most planning approaches, however, fail to generate such signals or, having generated them, dismiss them because typical evaluation techniques support only strong trends.

Weak signals are weak because they are easily obfuscated by other factors, including current mind-sets, attitudes, and biases of those involved in the search for the future. In business, weak signals that emerged as the Swatch watch, Amazon.com's "brickless" business model, or the personal

computer did not arise from the incumbent market or technology leaders.

Weak signals are deemed weak not because of lack of importance, but because they are so small as to be obscured by other irrelevant factors or dismissed as inconsequential by quantitative extrapolations. They are actually very important, because recognizing them may make the difference between success and failure of an enterprise. But the traditional way of thinking about business, the future, strategic planning, and many of the tools we use to assist us may, in fact, limit our ability to recognize and take advantage of weak signals.

Classic forecasting, planning tools, and ways of thinking about the future align with a clockwork notion of our world, business, and organizational systems. They are modeled along classical linear theories with their underlying tenet that small changes produce small results. While they may suffice with some effectiveness in periods of high stability or over short time frames, classical strategic planning models and thinking ignore the nonlinear nature of business systems and cycles. Because they call for quantitative measures of strength and probability, they discount or ignore the weak signals. So weak signals such as a 1999 National Intelligence Council report noting "that Al Qaeda suicide bombers could fly an aircraft filled with explosives into the Pentagon, CIA Headquarters, or the White House" (*Nation*, June 10, 2002) or FBI field memos stemming from investigating the enrollment of foreign students in American flight schools are overshadowed or dismissed.

In the **physical sciences**, weak signals are often undetected by instruments not designed to reveal data outside their parameters; weak signals are overlooked because the focus of the observer is in a different direction. Bacteriologist Alexander Fleming was surprised when he finally took note of the substance that was killing organisms in his petri dishes--discovering what had been ignored by himself and others for decades. But that surprise (penicillin) changed the world of antibiotics and altered medicine forever.

In the **arts**, weak signals are what infuse a work with richness. Great art is great at least in part because it is loaded with weak signals. The canvas or score becomes supercharged with information and meaning, because as we develop this ability to see and listen to a wider range of weak signals, we interact at deeper levels with the artist and the art. We go beyond mere observation and become a part of a complex system of feedback and adaptation, and as a result the visual or tonal composition is constantly transformed.

As observers, we bring our own experiences and perspectives; we can also discover weak signals when we increase our knowledge of the greater environment surrounding the object's creation. The viewer or the listener can revisit pieces again and again and make new discoveries, uncover previously hidden weak signals and, along with the piece itself, be changed again.

Identifying Weak Signals

While it may be reasonably easy to find examples of weak signals in hindsight, it is tougher to identify them and their potential importance in foresight. Where do you look? How do you know one when you see it? What are the characteristics? Obviously there cannot be a single simple answer to these questions. But you can begin by applying some general guidelines to proactively search for, rather than trip on, a weak signal. These can augment the more traditional tools already in use in most organizations.

Remember that weak signals only have the potential to be amplified if they are part of a complex adaptive system. Therefore, the starting point is to determine if the environment in which you are looking for weak signals is within the edge of chaos of a CAS. If it is, then an identified weak signal can amplify all out of proportion to its initial size. If it is not, then weak signals have no chance of exploding into game-changing events. Here is a suggested process.

First, view each CAS as a continuum ranging from purely deterministic (drop your coffee mug and it goes down to

the floor) to total randomness (the winning lottery numbers or other events whose course is nearly pure chance). The range between the two extremes is a mixture of order and disorder.

However, the continuum is not quite linear. There appears to be an area, albeit ill-defined, that is popularly called the **edge of chaos** (so called by M. Mitchell Waldrop in *Complexity: The Emerging Science at the Edge of Order and Chaos,* Simon and Schuster, 1992). Weak signals abound in this periphery. Those weak signals that ultimately emerge as breakthroughs in products, businesses, services, processes, solutions, and surprise futures are most frequently found within the edge of chaos.

Too far in one direction and the rigidity of the system will only permit strong signals and quantifiable, paradigm-consistent trends to reach the surface. For example, the over-the-top embrace of bureaucratic procedures and linear, quantifiable processes (such as Total Quality Management and Six Sigma) could ultimately drive out the value of variance and stifle weak signals that herald innovative approaches, products, and solutions. In recent years, those companies that have invested significantly in these more deterministic processes, including DuPont, Motorola, and General Electric, have fallen behind in innovative output even as the quality of their goods and services may have demonstrably improved.

Too far in the other direction and disorder rules because the organizing principles are indistinguishable from the noise; events happen more by pure chance than intent. The dot-com shakeout may be a good illustration of those companies that did not incorporate sufficient structures, processes, and practices that imparted systematic approaches.

But oscillating within the edge of chaos is the rich environment in which weak signals are most likely to be found. As individuals and enterprises become adept at looking within this edge, sometimes closer to order and structure, sometimes nearer to randomness and the undefined, they increase their odds of uncovering weak signals.

The edge of chaos, then, shows you a large map. To zoom into the details you need a variety of tools and techniques. Uncovering weak signals from the marketplace requires you to look beyond current customers. Expanding your vision to include the customer's customer and members not only of the supply chain but the entire value network will increase the likelihood of detecting weak signals that could be the vanguard of the next innovation. What are the vague or fuzzy things contained in your customers' complaints? Plow the information and entertainment sources your next-generation customers are tapping today. Make sure your information sources reach well beyond the traditional, the domestic, and the dominant language of your country.

Looking beyond served markets can also uncover weak signals. Where are technological shifts occurring in any economy or industry outside those in which you operate? What are they? Where are wealth or information distribution shifts appearing? Who are the newly wealthy in economics or information? Where are shifts of power occurring and where are new business designs and models appearing? Listen to what the experts are saying and what the strong trends are--then consider the opposites and look for weak signals that indicate countertrends. Think about new or unusual words or novel uses for words promulgated by fringe or affinity groups ("flipping," "avatars"). The same holds for new or shifting symbols ('swoosh' logos) and myths ("thug heroes", "boys-will-be-boys" attitudes).

Other rich sources for weak-signal detection reside on the fringes. Who and what are comedians lampooning in comedy clubs? Remember that Lenny Bruce anticipated civil rights shifts and Andy Kaufman predated the mass popularity of wrestling and "chaos" television. What are the trends in the arts? Plato believed that changes in the arts predicted major political and social change.

The deliberate search for weak signals, especially in the edge of chaos, will ultimately yield a bountiful crop of them. That is the first step. The next step is evaluation--but the danger is to subject weak signals to the standard, quantifiable screens and sorting filters through which trends and other strong signals are evaluated. Doing this will eliminate them. A different filter is required.

Amplifying Weak Signals

By their very nature, weak signals cannot be quantified as the way we quantify trends, surveys, hard data, and other strong indicators. Weak signals are more qualitative and need to be amplified if they are to bubble up to the surface for key decision makers.

We have derived a process that uses a **weak-signal amplifier** for qualitatively filtering weak signals from the noise and other weak signals by comparing their potential for causing change in a complex adaptive system. The result of the filtration does not rank or prioritize according to a quantifiable scale, nor does it weigh or handicap them in some grid or matrix format. It would be counterproductive to surrender to the pull of determinism by adding up a score.

This filter is not precise. Since we are applying it to weak signals in a complex adaptive system, such things cannot be precise. But it is better than guessing or, worse yet, dismissing the weak signal out of hand. The weak-signal amplifier is also a dialogue and learning tool. When used in teams and groups, it sparks a conversation that will identify blind spots, surface hidden and potentially restrictive paradigms, and open up perspectives and thinking.

In order to use the weak-signal amplifier effectively, you must identify the perspective you wish to take to examine the weak signal. It may be your organization's viewpoint or

Virgin Group chairman Richard Branson endows his business ventures with a "sense of fun," detecting many weak signals ignored by more staid and conventional entrepreneurs, according to authors Harris and Zeisler.

another's--perhaps a competitor's. Once you have identified the viewpoint, vigorously maintain that perspective through the next steps. You can always change perspective and run the process from the new vantage point at a later time.

With your perspective firmly in mind, your first step is to determine if the weak signal has **game-changing potential**. This is absolutely a qualitative determination, a pure "if-then" hypothesis. If the consensus is that it would not have the potential to dramatically change the "rules of the game," regardless of the probability of it occurring, then do not pursue it further.

If the answer is Yes, then you must confirm that the system or environment in which the weak signal will play is a complex adaptive system and that it ideally is in the area deemed the edge of chaos. Drawing a simple continuum bar and locating the system on it can be helpful. Review the five characteristics of a CAS that we have discussed: sensitivity, complexity, adaptability, short- but not long-term predictability, and underlying drivers that are deterministic, not random. The weak signal will not have the potential to rock your world unless it is embedded in a complex adaptive system.

Now, let us assume that an identified weak signal is in fact a game-changing factor in a complex adaptive system. Our weak-signal amplifier directs us to two other considerations that are perhaps more practical.

The second step involves asking, "will it **catch fire**?" Since we have previously determined the weak signal's game-changing status, we now must assess honestly any restraints that would prevent its energy from being released. Are there considerations that might limit, maximize, or protect the game-changing potential of the weak signal? These might include competitive response as a limit. Is the weak signal easy to copy or counter? Could there be prohibitive financial requirements or cultural barriers? Protection could include patentability or technical difficulty. Maximization potential could include familiar factors such as significantly lower cost to users or significantly higher value (the interpretation of "significant" can vary, but if it implies a factor of 10 instead of two or less, you have something). Maximization could include infectious attributes, such as fads typify: "I gotta have one."

Step three follows a positive response to the first two. If you are confident that it is a game-changer and that the weak signal has potential to catch fire, then are you--or someone else (depending on your perspective)--able to **light the fire**? Will the weak signal yield to internal know-how? Does the expertise exist to fulfill the potential of the weak signal? Is there an infrastructure capable of dealing with this complexity level? What can one accurately predict in the short term about resources, investments, and costs needed for this weak signal to occur? Are these resources available?

All three of these steps must be positive, and clearly so. It is easy to get positive answers to these questions if you have a bias ("the idea was mine!"). The process works best when considered openly, with many viewpoints expressed.

The weak-signal amplifier isn't infallible, but it is an indicator of which signals you should pay attention to and which ones you should disregard. Because reasonable people may disagree on whether an element is or isn't positive, the final conclusion is not exactly either, but the dialogue that takes place as a result of the disagreement can help you decide whether or not to take action. Once you decide a weak signal is actionable, then the more traditional tools--scenario planning, research, market tests, trend analysis--can kick in.

Acting on Weak Signals

The world abounds with examples of weak signals dismissed and discovered. Consumable coffee's market leader of the early 1980s applied linear models

Applying the Weak Signal Amplifier: An Example

The veterinary industry, which provides health products and services for domestic animals, has a history of accepting new technologies that are perceived to benefit and attract patients.

A small company in the veterinary industry is exploring the opportunity to capitalize on a weak signal: digital radiology. Currently, X-rays taken in the field must be transported to a facility for chemical processing, which can delay diagnosis by hours. Digital radiology provides instant display of images, thereby facilitating immediate diagnosis.

• **Step One:** Does Digital Radiology have Game-Changing Potential in this market? Yes. Digital radiology offers a radical departure from current film/chemical use. It meets significant and unfulfilled needs for instant imaging and quick diagnosis both in the field and the clinic.

• **Step Two:** Digital radiology have the potential to catch fire in this market? Yes. The demand for speed - in this case instant imaging/rapid diagnosis - is clear. Once veterinarians experience instant imaging, the belief is they will want that capability. Although current digital radiology equipment is expensive, there are a significant number of veterinary practices that have sufficient resources. In addition, prices can be expected to drop as the cost of computing goes down. Currently, there are no substantial digital radiology offerings in the veterinary market.

• **Step Two:** Does this company have the capability to ignite the weak signal in this market? Does the environment exist to make the weak signal thrive? Yes. This company has the internal know-how and technical expertise to fully integrate an excellent digital radiology solution. In addition, prediction of short-term resources needed is accurate and meaningful, and it does have those resources. The chief issue in determining if this company has the capability to fulfill the potential of the weak signal is the company's ability to deal with the complexity of supply chain infrastructure nationally.

- S. Dyer Harris and Steven Zeisler

and frameworks to forecast a declining market for coffee consumption and embarked on a "cash cow" strategy. Meanwhile, a couple of small-business entrepreneurs in Seattle were sensitive to frequencies not on the dial of any incumbent and they detected a weak signal--the "café experience"--that resulted in the most significant transformation in the coffee business since the invention of freeze-drying. Starbucks was born and ultimately achieved profit and growth margins unimagined by the former market leaders.

Entrepreneur Richard Branson's forays to find and develop the diverse businesses that make up the Virgin Group, detecting in many cases a weak signal ignored by incumbents with a "sense of fun," distinguish his business ventures in what many consider staid or impenetrable markets. Robert E. Lee's failure on day three at Gettysburg is due--at least in part--to his failure to consider weak signals that surrounded him in that edge of chaos.

While there are many more cases easily identifiable in hindsight, weak signals are only valuable if we can identify and leverage their potential in foresight. Without this ability, we will find that surprises are increasingly frequent and, that unexpected opportunities will be accompanied by unanticipated problems and unwanted costs. We have presented a tool and a way of thinking, based on the growing understanding of complex adaptive systems that will assist you determine, from the myriad possibilities presented every day, the ones more likely to yield to application of resources and produce disproportionate returns or dangers.

It is time for futurists and those engaged in thinking about, planning for, and moving into the future to develop and embrace a range of tools, methods, and approaches that recognize and work within the real nature of our world--that of complex adaptive systems. □

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