Chaos Theory: Limits of Analysis and Predictions

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In my Last Word article on stakeholder analysis, I ended the discussion by teasing readers with a reference to Chaos Theory. It deserves more than a casual mention because it is one of the more profound discoveries of the 20th century, with applications to a wide range of phenomena. Chaos Theory, as one part of Complexity Theory, analyzes the properties of *unpredictable* systems. The radio industry is an example of an unpredictable system embedded within an even larger complex system. These theories help explain the limits of what we can understand about our industry. No amount of thinking will make sense out of the random attributes of a system.

The story of how chaos was discovered illustrates its implications. In 1961, Edward Lorentz was doing weather simulation with computers. When he restarted a simulation with data that was only insignificantly modified by numeric truncation, the simulation then produced completely different results. Storms appeared where previously there had been sunshine, and vice versa.

The phenomenon of chaos, which would later be called the butterfly effect, also applies to social and technology trajectories. Consider that a butterfly could change history if it distracts a hunter who then accidentally kills the scientist who would have developed a new type of modulation that would have changed how audio was distributed. A butterfly can dramatically influence the future of radio. Several examples illustrate how minor events came to be seen as the birth of a revolution.

After developing the PC computer in 1980, IBM attempted to license the CP/M operating system from Digital Research, but negotiations failed because the owner's wife, Dorothy McEwen, would not sign the non-disclosure agreement. As IBM's second choice, Bill Gates licensed QDOS (quick and dirty operating system) to IBM after having just acquired rights to it from Tim Paterson at Seattle Computer Products. The way in which computers changed broadcasting in the 21st century was clearly the result of a sequence of unpredictable events by these (at the time) insignificant individuals. Any of the parties involved in starting the personal computer industry could easily have selected a slightly different path, like truncating data in a weather simulation.

Similarly, Linus Torvalds was indulging his software hobby when he created a primitive—but free—operating system, called MINIX, which would later become LINUX. And his contribution was itself a response to the earlier work of Brian Kernighan and Dennis Ritchie at Bell Laboratories, who developed UNIX and the C programming language because executive management was phasing out Multics. These individuals wanted a new computer playground to replace their mainframe time-sharing system. They had not set out to change the world, but they did.

The Internet is also a perfect example of Chaos Theory in action. The current Internet is the result of millions of minor choices made by thousands of contributors. In contrast to the failure of numerous dot.com companies, Jeff Bezos's Amazon and Larry Page's Google are unique. Not only did they survive and thrive, but they also created a new business model: low overhead selling and advertising. These individuals did not set out to change the relationship of advertisers and listeners to radio broadcasting. But they did, through a long series of seemingly unrelated event trajectories.

A personal story about the origins of digital audio illustrates the degree to which trivial events changed the world. While sitting in an MIT laboratory at 3 AM playing a video game in 1970, I noticed a colleague, Francis Lee, who specialized in computer memory. We discussed how the combination of audio and computers might produce a commercial product. Our conversation eventually led to the founding of Lexicon with the first commercial digital delay line, and that event induced EMT to invest in the first digital reverberator. Observing the success of these two small-scale endeavors, Sony and Philips began the development of the digital audio CD, which provided a market for high quality, low cost digital to analog converters.

Had I not just lost that video game, and had I not stopped to chat with Francis, the history of digital audio would have taken a different trajectory. Our unplanned interaction was just one of many possibilities. Digital audio would certainly have come about had I gone to bed earlier, but its properties would have evolved differently because different people would have reacted to different contexts at different times. A decade later, the Audicy workstation for radio production resulted from a friend breaking his leg while jogging over an ice patch.

If these events had not happened, my career would have certainly taken a different path, and there never would have been any Last Word columns. And without these articles, some reader would have made a different decision managing radio technology. Like the butterfly, losing that video game changed the radio industry.

There is, however, an asymmetry between trivial events and the profound changes that they cause. While all changes arise from the minor actions of a few individuals, only a very tiny fraction of such actions actually have consequences. Only by looking backward, can we identify those events that would ***later*** prove to be significant. But at the time events are happening, we cannot identify those that will have "revolutionary" consequences.

Chaos Theory, a mainstream intellectual discipline that explores the properties of unpredictable systems, considers the implications of minor perturbations. How is it relevant to the radio industry? Like all large systems, our industry has a chaotic (random) component. No amount of analysis by the most brilliant minds can accurately predict the consequence of minor choices made by thousands of individuals. In other words, stakeholder analysis, like predicting the weather, works best in the short term but fails miserably in the long term. When a seemingly random event eventually changes the

paradigm of a stakeholder group, its relationship to other stakeholder groups also changes, and so on.

Now, in 2006, there are also thousands of trivial events occurring, and a few of them will have a profound effect on the broadcast industry of 2016. But nobody can determine which events will have what effect; analysis can predict the equivalent of the weather for the broadcasting industry over a year or two, but not a decade.

What are the implications for individuals living in a chaotic system without any means of predicting how that system will evolve? The initial step is to accept the premise that there are limits to analysis and knowledge; there is a random component. We are then left with several important conclusions.

First, because events follow the law of unintended consequences, we should always be on the lookout for the sudden appearance of an unexpected opportunity. It has often been said that success arises from the ability to notice luck when it presents itself, and the wisdom to take advantage of it when it appears. This principle applies equally to managing a radio network or a professional career. Focusing only on the problem and its proposed solution ignores unintended consequences, which may be good or bad. Unintended consequences are always opportunities: “the tail wags the dog.”

Second, because we cannot know the properties of an unexpected event, having broad skills and knowledge raises the likelihood that we can take advantage of an opportunity when it appears. This immediately couples back to an earlier Last Word article on the importance of having an efficient mechanism for learning, especially tangential topics. The more you know, the higher the likelihood of detecting, and then taking advantage of an opportunity.

Third, every long-term problem should have a plan A, plan B, and plan C. Not only do multiple plans provide flexibility, but also they reinforce the awareness of unexpected opportunities. An ideal plan will always need to be modified because it will have chaotic components. Having contingencies is not a reflection of pessimism or inadequate analysis. Rather it is the explicit acceptance of randomness.

With these three conclusions, we have unified earlier Last World themes into a holistic viewpoint: analysis, planning, learning, and randomness. This is my version of wisdom: a way of living, not an academic subject.