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"Complicated" vs. "Complex" Systems – A Useful Distinction

One of the most useful constructs or distinctions I've run into lately is synthesized in a recent article in the *Harvard Business Review*.[1] Unfortunately, we frequently group together into just one category our conversations around complicated systems and complex systems as we try to contend with them and manipulate them into manageable phenomena. The *HBR* authors make a useful distinction between these types of systems, which helps us to understand the usefulness of our interventions to manage them.

Complicated systems are made up of many different parts. A complicated watch, for example, is a genre of timepieces that does more than tell the hours, minutes, and seconds, and may also be designed as a chronometer (stop-watch), to show astronomical functions (moon phases), to chime at certain times, and even to indicate a power reserve. A normal watch may have 250 moving parts, but a complicated one may easily have over a thousand. However, once designed and built, even complicated instruments perform in very predictable ways. Once understood, they are no longer hard to manage, although they may be expensive to repair or replace. Automobiles, computers, and even robotic systems turn out to be everyday items whose degree of complicatedness we take for granted.

However, complex systems have features that are also complicated and may act in patterned ways, but whose interactions are constantly changing. An air traffic control system is complex because its functioning depends on many variables that keep varying, such as weather, aircraft downtime, peak loading, etc. In general, three elements interact to produce complexity: *multiplicity*, which means the number of potentially interacting elements, such as those which affect continental air travel; *interdependence*, which indicates how connected these elements are; and *diversity*, which means how many different sources they may come from.

With complicated systems, one can usually predict outcomes by knowing the design (or having a detailed engineering manual at hand). In complex systems, the system may produce highly divergent outcomes, depending on the interplay of the elements in the system.

Some of the recent breakdowns in the world financial system are the result of the interaction of elements: for example, the near-collapse of the U.S. banking system in 2009 was in part the result of the lack of information about the risk inherent in the *interdependence* of markets around the world – our models assumed diversification of risk in different industries and countries. When it turned out that markets were much more interrelated than we had thought, our portfolio management strategies collapsed. An example closer to home for me: In graduate school, we economists were taught that any second investment, no matter how risky compared to the first, would lower the risk of a portfolio, as long as the co-variance between the risks was zero. What we discovered, my financial planner and I, was that the co-variance of my portfolio was not zero at all, but closer to a perfectly dependent 1. The investment diversification model

fell apart right before our eyes because of the interdependence of markets around the world!

Even complex systems, such air traffic control, can be managed by careful planning for changing conditions of interdependence, and allowance for adjustment as components change in relation to one another. But when some unusual and powerful interactions take place, such as a hurricane in New Orleans, a tsunami in Japan, or a complete meltdown in security, such as took place on 9/11, the system completely breaks down and is unworkable. Air travel was shut down in large areas during these recent catastrophic events.

However, not only are rare events responsible for breakdowns, but they also due to the other two inherent complexity-producing occurrences and tendencies: again, the financial breakdown also took place because of the *multiplicity* and *diversity* of a number of concentric events that together increased the risk of the system: the relaxation of banking requirements; the invention of instruments of credit which masked their risk and lessened accountability by keeping them off of balance sheets; monetary policies that kept interest rates low, not reacting to increased risk; and the widespread evaporation of reasonable credit standards. Although these may be understood in retrospect, there was a lack of a vantage point where they were viewed as convergent forces producing risks-even by top bankers who were deceived into ignoring warning signs.

Finally, the latter points to another inherent blind-spot, our collective tendency to frequently overestimate our ability to manage complexity because we are faced with the cognitive limits of our own understanding of complex events. Chuck Prince, CEO of Citigroup, told his executives that there was nothing to worry about in the accumulation of sub-prime loans. Although he may be forgiven his lack of understanding as a lawyer not a banker, there was apparently no early warning system in Citi, or any vantage point in the banking community in general, that signaled the impending credit collapse.

So the question becomes, what's a decision-maker to do in order to increase our predictive abilities in complex systems? The authors offer the following suggestions:

1. Reduce reliance on forecasting tools, especially ones that assume that interdependence or co-variance are at low levels. Shift focus to models that provide insight for the ways that various elements interact. Examples include the data-mining tools that predict consumer responses to different kinds of advertising. Watch for trends that really interact differently across our markets, such as local customs or political contexts (For example, Colgate-Palmolive in Canada found, in its marketing for Irish Spring bar soap, that English-speaking Canadians wanted to smell "clean" and Francophiles preferred to smell "good". This information helped mold marketing decisions across these cultures.)
2. Make sure that our forecasting models low-probability but high-impact extremes. Railroads are now aware of heat effects ("sun kinks") on rights-of-way and have people trained to watch out for these occurrences, outside of their normal traffic flow models. A serious accident due to faulty rails can have tremendous consequences for passengers or for communities along the right-of-way.
3. Use different types of predictive information. The authors recommend dividing data into 3 buckets: Lagging data-what has happened in the past (Unfortunately, most performance metrics fall into this bucket); Current data-what is happening at the current edge of operations (Do we know what is happening now? What are our competitors doing in the market place?); and leading data-What ifs?

Although this kind of data may be the most difficult to pin down, without it we may be blinded by unseen change ahead (Sometimes this is called “scenario thinking” in strategic planning contexts).

Another of the techniques advocated addresses diversity-a principle incorporated into by the leadership development programs that we do in TEAM International®. Diversity is more than just a matter of balancing the kinds of people on our teams, as to gender, ethnicity, national origin, etc. To us it also means diversity of ways of thinking and personality styles. As the authors of the HBR article point out:

“Complex systems are organic; you need to make sure your organization contains enough diverse thinkers to deal with the changes and variations that will inevitably occur. Who in your company regularly talks to people you might not interact with yourself, comes up with things that are a little off the beaten path, and is attuned to underlying risks and trends that your other managers might overlook?”

Good leadership and managership recognizes that there is more to business decision-making than understanding how a Swiss timepiece (or other complicated organism) is put together. It also recognizes that in today’s world anything can happen, and that the world is just too complex and stochastic for that not to affect importantly our smaller spheres contained therein.

REFERENCE

[1] Gökçe Sargut & Rita Gunther McGrath, “Learning to Live with Complexity,” *Harvard Business Review, B*oston, MA, September 2011.

 ~T. Noel Osborn, Ph.D.