

Artificial Life simulations: Consumer behavior modeling for marketing strategy

by **Bruce Grey Tedesco**

Observations of computer simulated agents (Artificial Life) provide insight into the decision process of consumers. This fresh approach to modeling consumer behavior enables researchers to discover innovative solutions to the facets of marketing.

Innovation is fueled by knowledge. Marketers want innovation to enhance brand health. As for knowledge, we will readily accept the now familiar sequence: data → information → knowledge.

Research is responsible for the generation of knowledge. To accomplish this, researchers combine the skills of gathering data and applying analysis. These two skills, which we researchers continue to hone to higher levels, have been the steadfast foundation of market research. Yet even with all this technique in accumulating and interpreting data, CEOs place less faith in research than in most of their other (e.g. financial) sources of information [Lesh, 1999]. New skills combined with a revised orientation of our role will reverse this diminished expectation set of the CEOs.

By focusing on innovation we can present a clear actionable view of the consumer to clients and management. By looking past the mere enumeration and statistical testing of data, we will understand the process of consumer behavior. And, by understanding the process we will formulate how to inject stimuli into the consumer decision system.

Artificial Life (“AL” or “Alife”) presents an ideal discipline in which to conceptualize, examine, develop, and test the very realistic manner in which consumers act as individual agents within a system. To be precise, the *system* (or the domain) is that of the Brand. In this system consumers interact with each other, react to the message they perceive from the Brand, evaluate their needs, and ultimately make a purchase decision.

We will see that through the technique of modeling, the science of complexity, and the study of Alife, researcher can realize the opportunity to bring innovation in method and fact to play on advancement of marketing goals and the growth of brand health.

Modeling

Now we want to take the initiative of facilitating the metamorphoses knowledge into innovation! Modeling is the catalyst for this metamorphoses.

There is a priority for us as researchers, and that is to understand our consumers. Specifically, that priority is to understand how our consumers arrive at their purchase choice decisions, and, further where does our brand stand in the context of every decision the consumer makes. Modeling is the path to this understanding.

Expanding skills beyond the collection and reporting of data has already gathered momentum in recent years. Primarily an emphasis on modeling (and primarily in the package good sector) has begun to provide the kind of insight we researchers want to deliver to our clients/management. As the data and analysis skills have been enhanced, this is the time to enrich the modeling methods that will result in innovation. Observing other disciplines points out a significant shift in the application of modeling in the past few years. This shift is appropriate and necessary for consumer decision making models and the benefits of Alife simulations.

Besides the shift of focus for models is an understanding of how the nature of consumer decision making is enhanced by the principles of complexity science. To apply this knowledge, there are new tools at our disposal. Modeling tools – neural networks and genetic algorithms and now building on these is Artificial Life Simulations.

The innovations possible with Alife simulations become evident with an alteration in two modeling concepts. First, the accepted concepts of modeling as a reduction and prediction machine are replaced by the position that modeling represents the complexity in an observed system (our system of interest is consumer decision making). Second, the concept of a computer as a numerical manipulation machine is substituted with the view that the computer itself can contain and maintain a working experimental environment.

Complexity is not about a single technology or method, it is a way of thinking, a shift in scientific approach.

With Alife, intriguing results materialize from simulating the interactions of a few simple rules. Breathtaking speed characterizes the innovation in these new methods of analysis.

Artificial Life

The world of Artificial Life is our world --- not a new world, but rather a metaphor for our own. Based on the observations that from simple rules emerge complex states, modeling with alife unfolds as reality. Reality which mirrors consumer thinking. Simple rules represent a consumer's needs and desires.

There is fascinating work being done by biologists, economists, physicists, and others that demonstrates fresh ways of understanding behavior. Scientists in a variety of seemingly diverse disciplines now regularly create computer encased environments where "living" systems grow, evolve, and are observed. Market researchers can leverage this commonality of insight by understanding how developments in Artificial Life apply to consumer decision making.

Darwin provided a fundamental understanding of the change in complex systems. Among his insights was the understanding that a species/system is at any time the product of changes over a very long span of time. Bounded by our life span, observing the details and behavior of the evolutionary process in nature is not feasible.

Work in complexity science has reinforced the notion of a similar set of traits shared by all complex systems. From the organization of a single cell into a functioning organism, from the patterns of weather across the globe, and to the operation of economies and markets – these systems exhibit behavior that emerges from the interactions of primary components and a variety of stimulation. And, all these systems seem to share the nature of evolution.

To study and learn the implications of an evolving complex system, an alternative to nature is required. That requirement is satisfied with the advent of Artificial Life. Chris Langton (1995), to many the founder of the field, describes Alife as: "...the name given to a new discipline that studies 'natural' life by attempting to recreate biological phenomena within computers..."

That noted, we take a quick look at just why biological phenomena is of importance to the study of consumer behavior.

Complexity Science

At the Santa Fe Institute the study and configuration of complexity coalesces from the ongoing studies of scientists in physics, biology, cosmology, computer systems, economics and mathematics. These workers guide the way in providing a new set of understanding on how systems work.

A set of traits for complex systems holds across the majority of research done in the field. Whether a biological system or the behavior of a flock of birds, common system wide descriptive characteristics are shared. From the blending such vastly different problems at Santa Fe we can safely conclude that complex behaviors exhibit the following:

- sensitivity to initial conditions
- a propensity toward self-organization (Kauffman, 1993)
- interaction among the system components
- reaction to feedback from previous behavior

The usefulness of this knowledge is to have a firm science from which we can draw rules and properties for understanding the system of most interest to marketers --- the complexity of consumer decision making.

Complexity research uses metaphors from nature that have direct application to business situations in general and consumer decision marketing in particular. Farrell (1998) has implemented the aspects of complexity to predicting consumer acceptance in the realms of fashion, movies, publishing, and toy manufacturing.

Lessons learned at Santa Fe and other institutions where complexity study is advanced have direct application for researchers. In order to bring innovation to the top of the objectives we provide, it is necessary for our thinking to be aligned with these findings.

For the modeling of marketing strategy, even terminology of the process can obscure the notion of the response we are measuring and the object of our quest. Often we speak of

“the impact of price change on *sales*, seasonal effect on *sales*, and advertising influence on *sales*”. But, what we are truly looking for is “how do all of the elements in the marketplace interact in the complex, self-organizing, adaptive system that is each individual consumer’s mind?”.

Simulations

Operation of Alife simulations leads to innovation developing brand strategy. Once a problem is defined within the context of a complex dynamic system environment, simulations with competing traits are observed and compared. Economist Brian Arthur (1995) describes the process “As feedback from the repeated plays [simulations] comes in, we strengthen or weaken our beliefs in our current hypotheses, disregarding some when they cease to perform, and replacing them as needed with new ones.”. In other words, we have a system to guide us in the formation of a complete strategy for any level of brand marketing.

The levels of brand marketing referred to include: aggregate marketing mix models, individual consumer responses and choices, acceptance and reaction to dimensions of brand image, etc. And the strategy formation encompasses all elements of the brand’s environment: competition, seasonal effects, product life cycles, and of course, the consumer’s ultimate buying behavior.

The following Alife simulation is a model of a 100 agents (consumers) buying and selling (purchase decisions) a financial commodity on the basis of their predictions (evaluation of marketing influences) of what direction the stock will go.

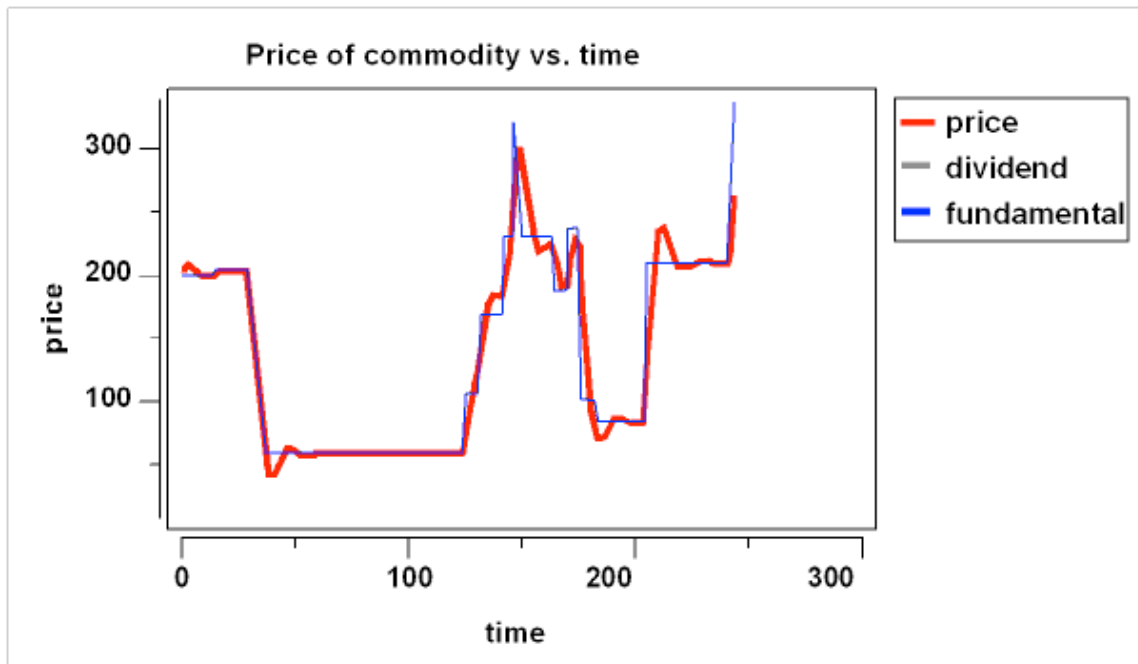
Two tiers of assumptions are present in the model. On one level each of the 100 hundred individuals is programmed to make decisions based on their personal needs. Included in their action is (a set of predictors) information pertaining to their relationship to the brand/product, timeliness of next purchase, and all factors relating to their experience with the brand. In addition, the model provides for adjustment of marketing strategy elements and relevant external factors.

Specifically, in this example, agents buy or sell the commodity on the basis of which of their predictors (see figure 3 & figure 4) look most accurate at each stage of this simulation’s evolution. Assumptions and structure of the model are:

- value of the dividend changes randomly
- price fluctuates as agents revalue the stock
- predictors compete for influence on agents

As already noted, one of the significant attributes of a complex system is the sensitivity to initial conditions. For this example two separate simulations are examined. The only difference in the assumptions for the two simulations is the initial value of the dividend.

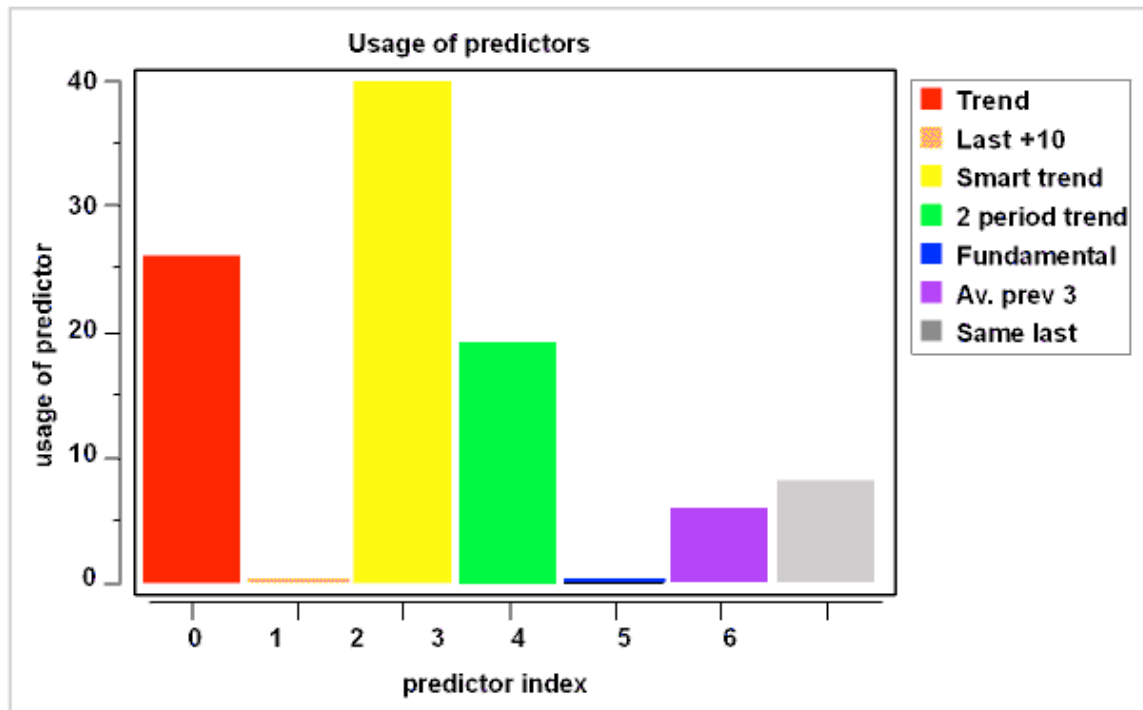
In Figure 1 we see the price, dividend and fundamental of 300 simulated cycles for the 100 consumers.



Consumers evaluating the seven available predictors have collectively driven the price to closely follow the fundamental value of the commodity.

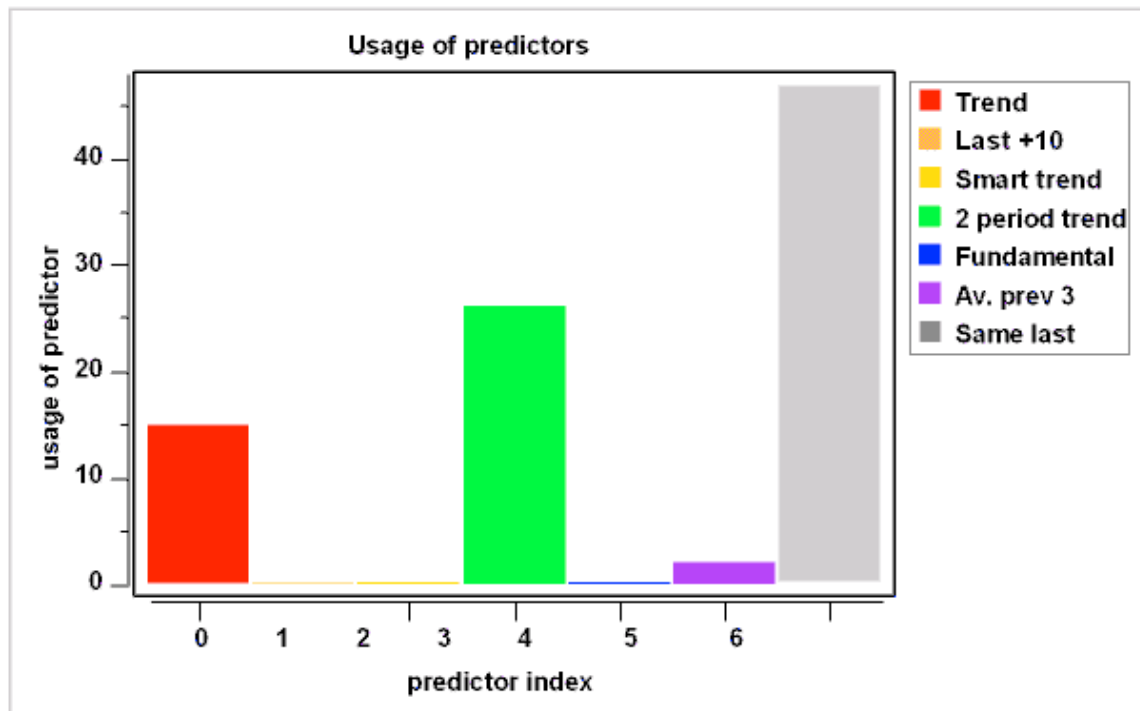
In a second simulation the initial value of the dividend was set 60% lower than its value in the first simulation. While the dividend value still changed at random at each cycle, an entirely different price structure developed (see figure 2). Agents adapted to a buy/sell strategy that strayed very little from the dividend.

The outcome of each simulation provides the insight needed to view the ultimate impact of marketplace behavior. That is -- how have all factors affected sales. And, there is no other goal than profitable sales. Also, Alife simulations present a guide to how a market evolves. In the current example, we can view the relative importance of each predictor which the individual agents evaluate at every purchase cycle.



In the first simulation (see figure 3) a variety of trend measurements were the key decision drivers. Trend, smart trend, and 2 period trend were most frequently used by the consumers to reach a decision.

The second simulation tells a different story.



When the initial conditions surrounding the dividend are reduced, the influence of the last price has a critical impact on decision making (see figure 4). Clearly trend and 2 period trend are still a factor. But, the shift to reliance on the last price will direct a very different marketing approach.

It does not take much to imagine how similar Alife models can be constructed to address all of our consumer marketing issues. Merely substituting marketing mix elements for the predictors; and replacing the commodity with, say the choice of an airline for a family holiday, Alife can replicate the environment in which marketers design innovative strategies for success.

Conclusion

Inventive applications for Artificial Life are being proposed from a variety of sources.

Bruce Klemz, whose work definitively establishes the advantages of neural network models as a preferable choice to regression based marketing mix modeling, uses evolving/growing strategies for pricing decisions. With aggregate sales data Klemz (1998) estimates timing rules for the coffee market. A set of assumptions for price changes among brands leads to a best set of rules for lowering, holding, or increasing prices to maximize share. Simulations evolve in a world where each generation of changes are grown from those that best increase market share.

A novel model is used by Marks et al (1998) to create a synthetic set of brand managers and monitor their decisions. Results of their modeling “provide much insight into the

historic patterns...in a market, as well as revealing how brand managers might learn to improve their profitability and competitiveness by consideration of the patterns and strategies learnt by the artificial brand managers ...”

What Alife creates is the vehicle for innovation. Researchers are no longer restrained by techniques that do not naturally symbolize the behavior of the marketplace. Artificial Life simulations directly characterize the environment in which we dwell. Results in this line of study will demonstratively increase our ability to provide innovation.

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