

Paper presented at the Third International Conference on Complex Systems, Nashua, NH, April, 2000. Please do not quote from without permission.

Agent-based Modeling of Disrupted Market Ecologies: A Strategic Tool to Think With

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For many years, computer modeling and simulations in business have been used for statistical analysis or for visual representations of complex data. Recently, a new modeling approach has been developed--*agent-based modeling*—in which the agents in a complex simulated world interact with each other and the environment based on a set of often simple rules. Agent-based models (ABM) were initially developed for advanced scientific, social science, and military research, (Bar-Yam, 1997; Epstein & Axtell, 1996; Holland, 1995; Langton, 1995; Pagels, 1988), and to date, there have been relatively few applications of ABMs in business and industry (Farrell, 1998). This paper describes our preliminary work on an ABM for business that deals with adaptability and co-evolution involving alternate distribution channels and electronic commerce.

1 Adaptability and Co-Evolution in Business: Alternate Distribution Channels and Electronic Commerce

Many businesses today must respond to disintermediation or the changing landscape in product distribution channels driven by technological innovations associated with electronic commerce. Recently, companies have moved into e-commerce through the

formation of on-line companies such as *Wingspan* or *Amazon.com*, or the conversion of previously “bricks and mortar” companies such as *Schwab* to online only distribution. With lower overall operating expenses and direct Internet access to consumers (as well as businesses), these companies can often provide lower priced products and the convenience of stay-at-home shopping that traditional “bricks and mortar” companies cannot provide. As a result, large and well-established companies face a significant performance challenge as they consider strategic approaches to deal with disruptions in the business ecologies caused by these new e-commerce competitors.

1.1 Setting the Stage

In the past, widely disparate businesses—such as insurance and brokerage firms as well as book and music retailers—have invested heavily in “brick and mortar” infrastructures as points of contact to clients for sales and distribution of products. These companies have a number of strengths compared to their electronic-only rivals, such as: (a) established client base, (b) a combination of prestige locations with wide geographic presence, (c) consumer trust in proven and established “will be there tomorrow” companies, and (d) ability to provide “high touch” products and services to individuals who prefer to deal with a “real person.”

In contrast, new e-commerce companies have several areas of competitive advantage compared to traditional distribution channel companies, such as: (a) lower distribution channel costs leading to potentially lower product prices (i.e., one to many versus one to one), (b) instant country-wide, if not global, distribution, (c) “shop-at-home when you want to” convenience, and (d) ability to leverage increasing public interest in the Internet.

Given the different strengths of traditional versus electronic distribution channels, several questions of strategic importance might be asked: How might the introduction of an electronic distribution-based company influence the business ecology of, say, two traditional distribution companies who each have roughly 50% of their market? How might the marketplace be transformed if one of these traditional companies decided to become a hybrid and promote both traditional and electronic distribution channels? Alternatively, how might either of these two scenarios play out if the consumers are slow to accept electronic commerce or if they are quick to embrace it?

Obviously, now, in spring 2000, we have e-commerce case experiences that shed light on questions such as these. However, what if circumstances the past few years had been different—would similar types of relatively successful e-commerce outcomes such as these occurred? How could the senior leadership of an organization make viable strategic decisions in the face of an uncertain and changing market environment such as this?

1.2 A Tool for Strategic Thinking: The Alternate Distribution Channel Agent-Based Model

We believe that agent-based modeling may provide a tool to inform and enhance strategic thinking about complex business ecologies. The ADC (Alternate Distribution Channel)

agent-based model is a proof-of-concept tool for exploring changes in a simulated business marketplace consisting of three companies, company sales agents, and consumers. Strategic business decisions are made for three provider companies related to the development of their respective distribution channels, and then the actors in the ADC model (i.e., the provider companies, agents working for the companies, and consumers) interact with each other based on their respective internal rules and random factors in the business environment. The ADC model provides a computer visualization of the interactions and generates quantitative graphs showing different aspects of the collective interactions of multiple variables over time. Through multiple runs of the ADC model, the co-evolution of different strategic approaches may be explored, often with the “discovery” of unexpected outcomes that emerge from the interactions of the actors in the model.

1.3 General Features of the ADC Agent-Based Model

The ADC model is not intended to be a “full” systems level simulation in which every conceivable detail of “real world” companies, affiliated sales agents, and consumers is incorporated. Rather, the purpose of the ADC model is to provide a simulation based on a set of selected or *distilled* factors derived from a detailed probing of the thinking of experts with a rich business experience backgrounds related to how businesses and consumers act. There are several advantages of this distillation approach, such as forcing model developers and business people to make explicit their own thinking about the system that often exposes assumptions, points of view, and/or biases; facilitating the use of model for “thought experiments;” and helping to identify a selected set of variable factors that may be the “drivers” of the overall behavior of the system of interest.

To determine the variables and agent rules for the model, three content experts who were highly experienced in the areas of financial, insurance, and brokerage service were interviewed. The critical variables we distilled for the model related to four main factors: (a) agents affiliated with companies, (b) company strategies related to distribution channel approaches, (c) consumer buying preferences related to products and company trust, and (d) types of distribution channels and environmental factors.

1.4 An ADC Model Scenario

As an illustration of how the ADC model may be used, consider this scenario. For many years, two large insurance companies, Blue and Green, have each controlled about 50% of the market share in their region. Recently, a new e-commerce company distributing only via the Internet, Red, began selling insurance products at a lower price than either of the two established companies. One of the companies, Green—which a provider company with affiliated agents who sell its products—feels seriously threatened by the e-commerce competitor and is considering its options. The senior executives of Green are evaluating three main strategic courses of action:

Option 1: Stay the Course

- *Rationale:* Things are going well, and the e-commerce competitor has yet to prove itself a threat. Hope any loss in market share would come at the expense of Blue.
- *Assumption:* Minimal short-term risk, wait and see before doing anything.
- *Dangers:* If customer acceptance of electronic distribution of products and services increases rapidly, then Green (and Blue) could both be threatened with significant losses in market share.

Option 2: Gradual Bricks & Clicks

- *Rationale:* Recognizing that Green's customers have a high level of trust in its products and assuming it will take some time for the new e-commerce company to establish a similar level of trust, Green decides to add e-commerce as a second distribution channel, and to equally support both traditional and electronic distribution.
- *Assumptions:* Existing insurance agents will realize the company needs to add an e-commerce option in order to compete with Red. Gradual is safer and less risky.
- *Dangers:* The Option 2 assumptions may be wrong, and existing agents might fear the company is planning to go "all-electronic." If the better agents, who would have more customers, left the company, they would probably take many of their existing customers with them, and thus cause a significant loss in revenue before the electronic distribution channel is developed.

Option 3: Rapid Bricks & Clicks

- *Rationale:* Recognizing that Green's customers have a high level of trust in its products and that it will take some time for the new e-commerce company to establish a similar level of trust, Green decides to preemptively move into electronic distribution and directly compete with Red before it is solidly established. Green plans to devote the major portion of its channel development resources to e-commerce, and to invest in less support of the traditional distribution channel.
- *Assumptions:* While realizing that the existing insurance agents may feel threatened by Green's high channel investment in the electronic distribution and leave to join Blue (and thereby taking away some customers), the risk of this short term loss is viewed as acceptable given the opportunity to be initially established in the potential growth market represented by the electronic distribution channel. High gain.
- *Dangers:* While this options tries to address the dangers identified in Option 2, if the customer acceptance of electronic distribution is slower than expected, the loss of agents and traditional customers could be seriously threatened the company. High risk.

There are compelling arguments for each of these three options, and the dangers associated with each are serious as well. At this point in their deliberations, the executives of Green are leaning towards Option 3 as it seems to offer the potential of both directly countering the “intrusion” of Red into their region and gaining market share away from Blue by being innovators. If that means losing some of the affiliated agents, then that was a price they would be willing to pay.

However, the only way to know “for sure” which is would be the “correct” option would be to try each and see. This is, of course, impossible in the “real world,” as once a company commits to a particular strategic direction, the competitor companies will see this, and possibly change their strategic directions as well (i.e., they would adapt and co-evolve). In addition, there are random factors beyond the control of any of the companies, and so it is possible that any of the options will work (or not work) in certain circumstances that most likely could not be predicted very far in advance. Rather than just flip a coin, the senior leadership of Green worked with the ADC agent-based model that allowed them to “experiment” in a “virtual world” with these (and other) options in a variety of different environmental circumstances (e.g., rapid customer acceptance of e-commerce, slow acceptance of e-commerce). Here are two of the many scenarios they ran.

The strategic direction of Option 2 was implemented in the ADC model with the following main parameters (see Figure 1):

- Blue (top left) and Green (top right) start with the same market share, and Red (bottom center) has very few initial customers.
- Blue and Green are each putting out a moderately high level of channel development resources (e.g., advertising) to attract customers (70% each), with Blue completely focusing on the traditional channel while Green splits its resources 50% to the electronic channel and 50% to the traditional channel.
- Red puts in a high level of channel development resources to attract customers (99%).

In the run of Option 2 shown in Figure 1, at Time = .1, both Green and Blue start out the same size, but the first electronic channel development sign of Red is also seen with the curved red lines in the lower and middle portions of the figure (curved red lines indicate electronic channel investment, gray curved lines indicate traditional channel investment). By Time = .4, Red is clearly increasing in size, but so is Green. Also, note how the Blue agents have moved from being around the Blue square to be closer to Green. Agents follow relatively simple cognitive rules whereby they are attracted to traditional channel investment and to a company with more customers, while they are not attracted to a provider doing electronic channel investment. However, since Green is doing so well, it is keeping both its existing agents and causing Blue agents to defect. This continues in screens Time = .6 and 1.0, until finally there are no agents left with Blue. Green is clearly the largest of the providers.

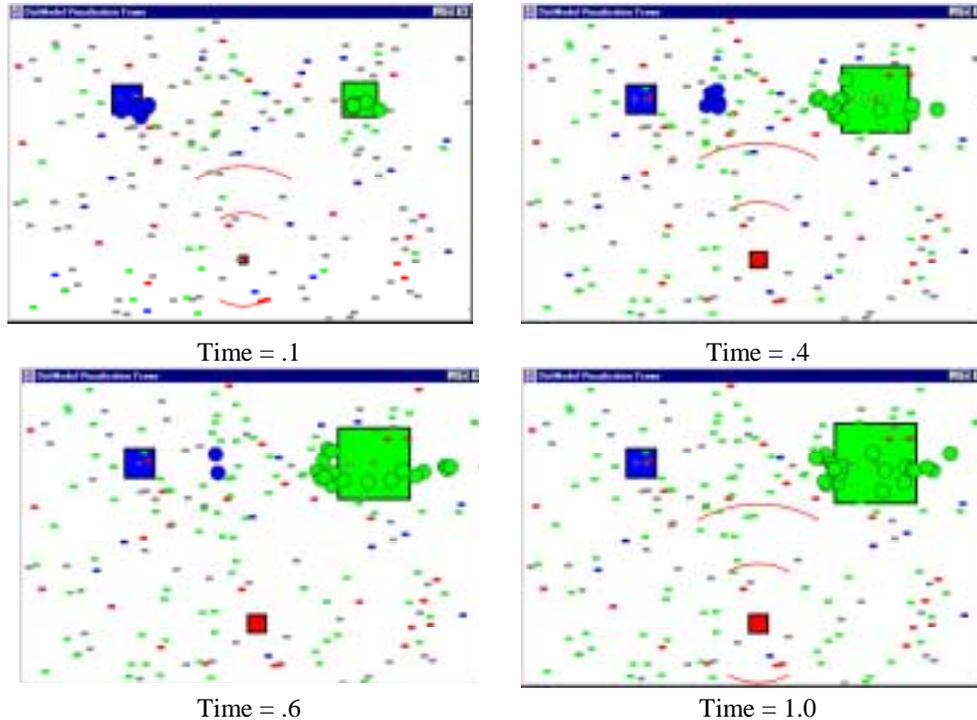


Figure 1. Option 2 ADC model run.

Option 3 represents the most aggressive strategic option that Green is considering. The model parameters for simulating Option 3 are the same as Option 2, except that now 99% of Green's resources are allocated to the electronic channel and only 1% of the resources are devoted to the traditional channel. At the earliest point (Time = .05), both Blue and Green are the same size, and Red is starting its investment in the electronic channel development. At Time = .2, Red has gained a noticeable number of customers, while Blue is about the same and Green is slightly larger. By Time = .5, however, Green is still about the same, but nearly all of its agents have defected to Blue. Time = 2.5 shows Green about the same, but with no agents, while Blue has gained in its number of customers.

After looking at these, and many other runs of the ADC model, the senior leaders of Green decide that the moderate Option 2 would be best. Although Green's executives had originally favored the more aggressive Option 3, the model runs they examined (in addition to the ones shown here) generally indicated that for strategic Option 2, there was at least as great if not greater gain in market share associated with a 50%-50% split investment in electronic and traditional distribution, and that most of the time, there was little if any loss of agents to the Blue competitor (in fact, sometimes, as in Figure 1, Blue

agents defected to Green). The more gradual approach of developing a hybrid distribution of Green's products was the strategic direction that was selected, however, the executive team at Green also developed contingency plans for implementing Option 3 if the market demands for e-commerce suddenly increased beyond the moderate levels currently projected.

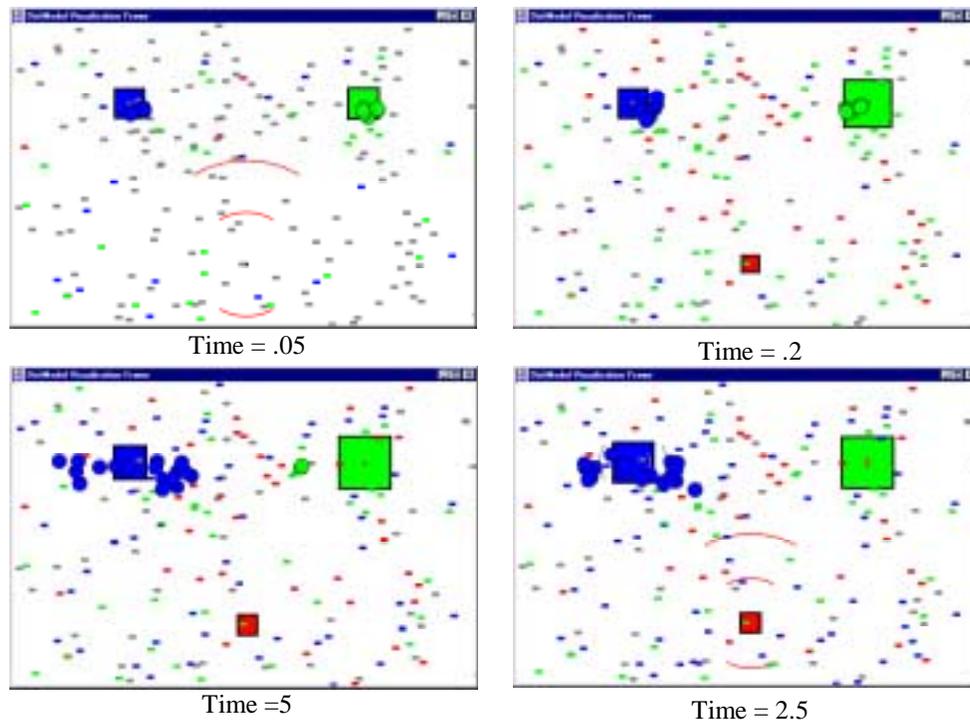


Figure 2. Option 3 ADC model run.

2 Conclusion

The scenario and runs of the Alternate Distribution Channel model described in this paper were intended to illustrate how agent-based modeling might function as a tool to enhance strategic decision making about a complex and changing business ecology. It is important to note that the current ADC model is a small-scale proof-of-concept program with only a selected number of variables and it would need to be significantly enhanced (e.g., add detailed demographic and trend data) in order to actually be used for informing real world strategic decisions.

In addition to the sophistication and data source issues for developing agent-based strategic decision tools, it will also be important to consider the *cognitive mindset* of potential users of such tools. Research suggests that many individuals have what might be called a *clockwork* mindset that consists of beliefs such as systems are controlled from a central source, actions and effects are linear, and actions may be precisely determined (Jacobson, in press). In contrast, scientists who study complex systems have an *ecological* mindset which views systems as achieving order through decentralized interactions, actions and effects as being nonlinear under many conditions, and prediction as being possible only in probabilistic terms. Given agent-based models are fundamentally grounded in complex systems theory and research, it will be important that users of agent-based modeling tools have an appropriate cognitive mindset, otherwise they may have difficulty understanding and appropriately using this type of tool to maximum advantage. However, with appropriate preparation, we believe that the capabilities of agent-based modeling used as a *tool to think with*, specifically strategic thinking, are promising. Just as agent-based modeling is becoming increasingly used in science and military settings, so likewise we expect that agent-based modeling will begin to be used to enhance and inform the decisions that business leaders make as they confront the challenges of complex, multi-faceted, and dynamically changing business markets in the 21st century.

3 Acknowledgement

We would like to thank Bob Sicina and Eric Allison for their encouragement, help, and expertise in developing the model.

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