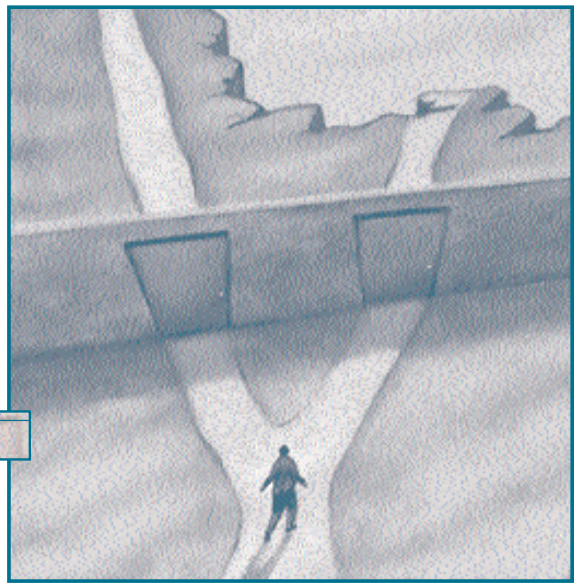
WHEN INTUITION IS NOT ENOUGH:
STRATEGY IN THE AGE OF VOLATILITY



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About the Author:
Eric Bonabeau is the chief scientist at Icosystem Corporation, a Cambridge, Mass. based "idea incubator" that uses complexity science to discover business opportunities and invent the technology to support them. Prior to his current position, Eric was the CEO of Eurobios, a joint venture with Cap Gemini Ernst & Young applying the science of complex adaptive systems to business issues.

Managers have long relied on their intuition to make strategic decisions in complex circumstances, but in today's competitive landscape, your gut is no longer a good enough guide. The pace and scale of change, the speed and diffusion of innovation, and the volatility of financial markets are all increasing, while globalization is making an already dense web of business connectivity even denser. The results are unexpected phenomena and seemingly unpredictable collective events—ranging from fads to the sudden collapse of entire industries to stock market bubbles and bursts—that are emerging more frequently to disrupt the operating environment. Intuition, the ability to use your experience and history to discern patterns where other people may see nothing, is not only unlikely to help, it is often misleading. Human intuition, which arguably has been shaped by biological evolution to deal with the environment of hunters and gatherers, is showing its limits in a world whose dynamics are getting more complex by the minute.

Yet, what most top executives have been chosen for, in the corporate equivalent of natural selection, is their ability to use their intuition to make difficult strategic decisions.

Ironically, the pace of change is the argument top executives use to justify their reliance on intuitive decision-making: "the world is moving too fast; by the time quantitative tools become available to examine a situation and explore options, it's already too late; so you have to rely on your business intuition."[1] But there is something deeply flawed in that argument: When you are faced with a situation you have never, ever encountered before, how can you hope that your intuition will save you? Ask astronauts about applying their intuition of physical space, based on life on earth, to weightlessness: It doesn't work! According to economist John Maynard Keynes, "It is dangerous . . . to apply to the future inductive arguments based on past experience, unless one can distinguish the broad reasons why past experience was what it was."[2] But in a complex, fast changing world, the broad reasons why past experience was what it was are short-lived. And because of its complexity, the current business environment is overly sensitive to small changes . . . ones that happen all the time. Intuition, therefore, is a doomed strategy.

So intuition is dead. But at the other end of the spectrum, strategic planning does not look much more promising. In times of high uncertainty and rapid change, the conventional approach to strategic planning has become an oxymoron. As described by Eric Beinhocker, that approach is based on the traditional military model: You set objectives, gather your resources, narrow your options, and deploy your forces to take the hill.[3] But what if you spend six months planning the attack and six months implementing it, only to discover that the hill has moved or the enemy has disappeared to emerge where you least expect them? Strategy is no longer about making big, hard-to-reverse decisions about where to focus a company's energy, capital, and people.

One thing hasn't changed, though. Strategy is still about creating shareholder value through differentiation on one or more competitive dimensions. While the traditional approach to strategic planning may be outdated, the need is more urgent than ever. It no longer entails designing a road map for the next five years. Instead, strategic planning involves constant redefinition and reconfiguration at all levels and scales in response to change—without confusing your customers. And it demands a new set of processes based on advanced computational tools that don't so much replace intuition but leverage it. Thus, intuition is being reborn. Indeed, there now exists ways to deconstruct intuition and experience into building blocks that can be recombined in billions of different ways; each combination can be tested using computer simulation. The simulation outperforms intuition when it comes to testing strategies while the deconstruction process ensures that intuition and experience are properly represented. That's what Icosystem Corporation, an "idea incubator" that uses complexity science to discover business opportunities and invent the technology to support them, specializes in.

Deconstructing the Process

Icosystem's goal is to produce a simulation model that replicates the elements of the real world that are rele-

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vant to the problem an organization is trying to solve. Just as a "one-size-fits-all" strategy doesn't make sense in a dynamic environment (if it ever did), there is no such thing as a general-purpose model. Each model is specific to a purpose, whether you're trying to maximize market share, optimize prices, or solve problems on a much larger scale, and should ultimately deliver a variety of "what if?" scenarios within the framework of a realistic business environment, generating insights into the business sector without costly real-world experiments.

The first step in the process is to capture the right data and transform it into actionable information. The raw data can come from many different sources: from physical sensors, such as Radio Frequency Identification (RFID) tags, scanners, consumer and demographic information gleaned from surveys or online transactions, directional brainstorming, and other sources. Adaptive data mining takes the process to a more sophisticated level, which captures the data in real time as it is being produced so that it can be subjected to real-time analysis.

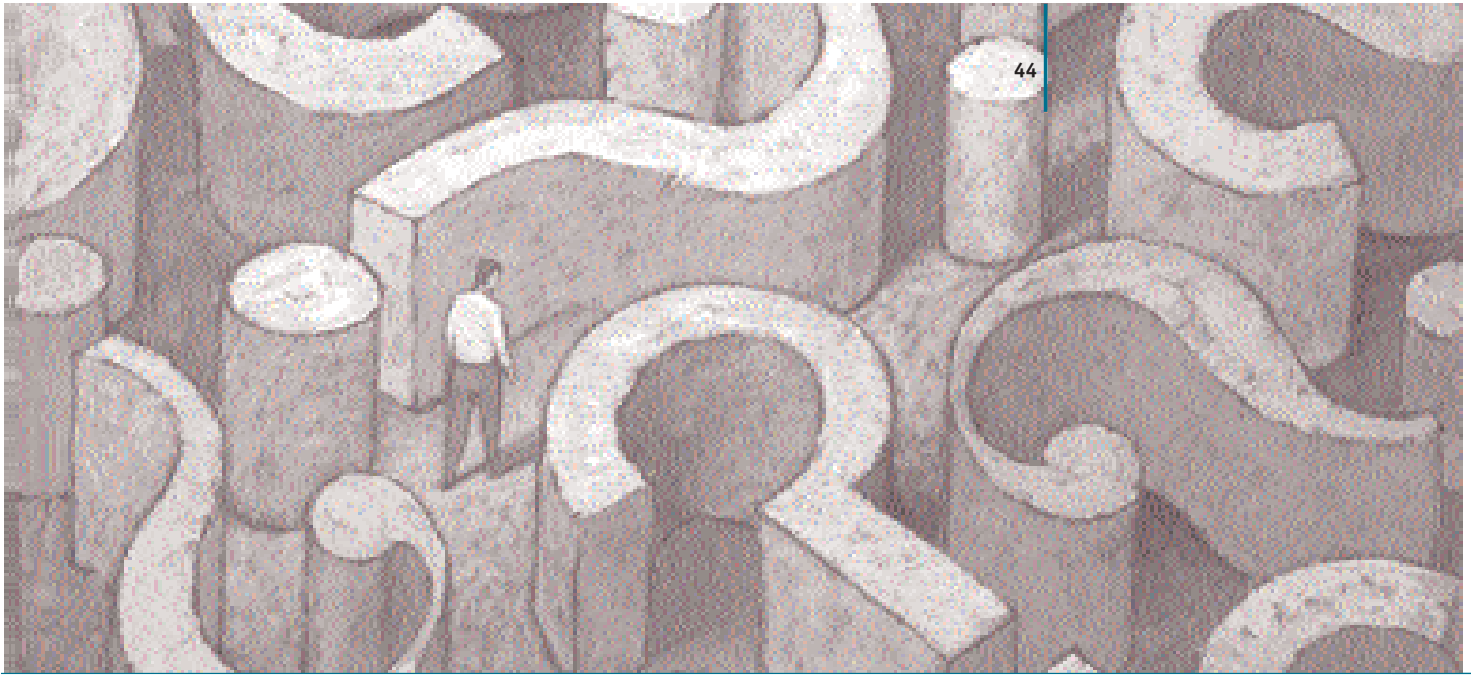
The data is then deconstructed into building blocks—all the variables, functional units, and systemic events that could affect the system under study. Next, other potentially relevant information is converted into building blocks and added, including the probability of unexpected phenomena that could disrupt the eventual plan. These blocks form the foundations of agent-based computer models.

Agent-based models simulate real-life economic situations by replicating the complex behavior patterns of their many participants. These participants' roles are formulated as interacting autonomous software or artificially intelligent agents that can make decisions based on a preordained set of rules. Additionally, agents may change or evolve, allowing unanticipated behaviors to emerge, just as they do in real life. The agent-based approach produces a flexible model that can expand and change just as knowledge of the marketplace evolves.

Once the model has been built, the next step is the exploration phase. Icosystem uses the power of evolutionary computing to manipulate conditions and variables either to investigate very specific scenarios or to explore the consequences of a vast number of strategic options. Thanks to major advances in computing technology, particularly distributed computing over the Internet, millions of simulations can be run in just a few hours. The advantage of these models is that they can encompass a far broader range of alternatives than human decision-makers can. A subtler and even more powerful benefit is that by exploring without human bias or bounds, computational tools can be used to design new operating systems, new organizational structures, and new strategies.

Putting Theory Into Practice

One approach of simulation models is to apply optimization algorithms to explore potential strategies and identify optimal results. Through dynamic opti-



mization, companies can quickly find new, successful solutions to operational problems whose specifications change over time, such as routing traffic through telephone networks, analyzing multiple marketing channels to find the best resource allocation and channel mix within budget limitations, or calculating pricing in supermarkets and drugstores to squeeze maximum profit from every product at any time. For example, with the help of an agent-based model developed by Santa Fe, N.M.-based BiosGroup, Southwest Airlines was able to optimize its cargo activities. The various optimization approaches, which were all based on very simple package-handling rules, were tested against the changing conditions of an airline operation: flight delays and cancellations, weather conditions, and fluctuations in demand. Some of the results were counterintuitive; under certain conditions, the best strategy could be to put a package on a flight not headed in the right geographical direction. Despite being counterintuitive, the optimization rules derived from the model turned out to be quite successful, reducing transfer rates by up to 70 percent and dramatically cutting labor costs.

Another fundamental question that often resists intuitive analysis and that computational tools help answer is: What is the best organizational structure to support a business? Managers are often constrained in their thinking by the status quo. Sometimes, radical departures from the existing norm provide powerful solutions while still taking into account what can be implemented.

For example, Icosystem helped an oil and gas professional services company design a new organizational structure to improve its efficiency. The model analyzed a typical job on an oil rig. This usually involves a crew of two to four engineers and operators, usually on duty for 14 days and then off for seven days. The possible resignations, terminations, transfers, and promotions that affect up to 30 percent of the work force in a year also needed to be accounted for. Each job consists of a number of "services," ranging from rock sampling to nuclear tests, and several tons of equipment must be shipped from rig to shore to accomplish each service. Before and after each job, extensive equipment maintenance is also required. Where and when these jobs happen is often unpredictable more than a few days in advance, and even then, cancellations are always a possibility. All of these characteristics impose strong constraints on how the business operates and influences how the organization can respond to deep changes in its environment, such as a market drop or rebound, and needed to be incorporated in the model.

The business unit we worked with wanted to know what organizational levers—the building blocks in that particular case—it could pull to improve the utilization of its resources, decrease the amount of business turned down, or reduce the number of failures. Levers ranged from changing the 14/7 schedule to adding or shutting down crews, or even changing the pricing policy. The problem was that pulling levers could have consequences that propagated through the organiza-

It is no longer sufficient to rely on intuition and traditional strategic planning to make decisions. These processes rely on past experiences that are less and less applicable as our current economic environment shifts in new directions. However, managers now have the aid of agent-based models, which provide a forum for testing new approaches to a range of corporate challenges. Icosystem's models have provided insight into the reorganization of internal processes and organizational structures, optimum strategies in a particular environment, and how certain industries will likely evolve.

article abstract

tion, leading to nonlinear results. For example, shutting down a crew decreases costs but also reduces the ability of the business unit to service its customers. So, Icosystem built an agent-based model of the organization to explore the consequences of pulling one or more of these levers.

Using a model that recreated this company's challenges, Icosystem tested the impact of the various levers under a variety of scenarios. We discovered, for example, that modifying the 14/7 schedule could have a potentially deleterious impact on the rate of on-the-job service completion. We also found that under a market expansion, the current configuration would do well up to a 10 percent market increase, beyond which recruiting new crews becomes necessary. We were also able to show that by pulling certain levers simultaneously, the organization could significantly improve its operations because of synergies among levers.

The company had considered each change in isolation and could not spot a significant source of improvement: While human beings can be reasonably good at evaluating the impact of pulling one lever, only a computer was able to test all possible combinations of levers.

Simulation models can also be used to monitor the competitive landscape and help shape robust strategies. (Robustness here means that even if the environment changes, the selected strategy will still perform well.) While a particular strategy might produce spectacular results in a given situation, if that situation is volatile and if that strategy performs poorly in most other situations, a robust strategy that performs more consistently across all possible futures will always be preferable. But while robustness should be key to making strategic decisions, understanding its mechanisms and consequences is almost always beyond human intuition.

One of our pharmaceutical clients at Icosystem asked us to design a robust marketplace for the early phases of drug development. Because of the uncertainty around how the different players (companies that specialize in managing clinical trials, academics at universities who do consulting work, and even experts at competing firms) would respond in the marketplace, the model of the marketplace needed enough built-in flexibility to accommodate everyone's characteristics.

We found that because of the diversity of the players, their different motivations, aversion to risk, cost structures, and so on, no such robust solution could exist unless the company's drug development model was drastically transformed into a network of both internal and external participants motivated to help each other (through incentives such as bonuses tied to the success of the entire portfolio of drug molecules). Through further modeling, we found that this solution was, in fact, very robust and could help our client more than double the risk-adjusted value of its portfolio of recently discovered molecules. Based on these results our client decided to invest in a real-

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world test of this new way of organizing early clinical phases. In the end, we helped our client navigate the complexity of the problem by deconstructing its expertise and intuition into building blocks that we then used to explore a variety of strategic options. It turned out that, although the building blocks were correct, their collective dynamics could not be predicted fully with human intuition.

Glimpsing the Future

Optimization works with a small number of predefined parameters, say, up to 50. But what happens if you have 20 billion parameters or if the relevant parameters are not known in advance? By replicating the fundamental mechanisms of evolution—variation, mutation, recombination, and survival of the fittest—in a computer, scientists have not only been able to study biological evolution on a fast-time scale, but have also found a revolutionary way to solve a wide range of extremely complex problems.

One popular example of evolutionary computation is the genetic algorithm. It examines an array of potential solutions to a problem, evaluates their efficacy and performance, and eliminates the undesirable ones. The program slightly mutates the most successful solutions and then lets them "mate" to produce "offspring." Because the offspring of a pair of good solutions inherit features from both of their successful parents, there is a good chance that they will end up being better than their parents. By repeating this process iteratively for many generations, better and better solutions emerge.

Techniques derived from genetic algorithms have been developed over the years to deal with open-ended situations when the parameters of the problem are too numerous or not known ahead of time. Genetic Programming (GP) is one example of such a technique. Icosystem has been refining these techniques to make them practical and applicable to realistic business situations. For example, we developed a simulation model of the Internet Service Provider (ISP) industry to evolve successful ISP business models. We first gathered the data relevant to a typical ISP, including customer attributes (demographics, purchasing behavior, hours of connection, e-mail usage, session length, downloading characteristics, etc.) and the characteristics of the business itself (connection speed, number of servers per users, editorial content, ads, etc.). Data on the actual state of the ISP industry in various countries was also gathered.

From there, we built a model of the different players—ISPs and customers—that showed each of these players engaged in buying, switching, and selling behaviors. These interactions generated results such as market share, revenues, customer churn, and profits. New business models were introduced and tested against the current state of the industry. We selected and crossbred them to spawn new offerings for many generations. Through our analysis of this model, we were able to measure the profitability of niches and business models in the ISP industry, such as servicing extremely demanding but highly affluent customers.

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Then we decided to apply the techniques of evolutionary design to peek into the future and witness the evolution of business strategies and business models. After a number of generations, the industry structure often becomes stable, allowing you to predict the forms that an industry may take in one year or two years or five years from today. Subsequent analysis can also reveal the important drivers that determine which of the possible forms an industry will adopt.

Through our simulation, we discovered the free ISP business model and predicted its instability. The first free ISP that emerged in the simulation differentiated itself from the rest by providing services without charging monthly fees and by making money on advertising. As more free ISPs entered the arena, however, monthly charges among the ISP population were driven downward. While the first free ISP to hit the market was successful, the influx of free or cheap ISPs made it very difficult for the players to differentiate and survive. We found that the free ISP business model eventually disappeared and the average monthly fee exhibited a sharp increase—a phenomenon that actually took place in Europe in February 2001, one week after Icosystem predicted it would happen.

In the increasingly complex environment of today and tomorrow, strategic gut decisions are doomed. Why waste the energy making intuitive decisions in a context in which the possibility of making the right decision is purely random? Why not deconstruct expertise into building blocks that can be manipulated according to different scenarios, including scenarios that predict unthinkable events or events that are exactly opposite to normal behavior?

Computational tools now exist that allow people to explore spaces that are beyond human capability, to leverage human intuition instead of wasting it. These tools enable an organization to find pockets of value that no one else sees, to test their strategies under uncertain circumstances without a crippling investment of time, money, or morale.

Most people trust the computers that manage an automated teller machine or fly airplanes. My dream is that people will also learn to trust strategic decisions made by computers. In any case, they eventually will have to. Volatility is here to stay, and every organization, no matter what industry, will need every advantage to adapt and thrive in a fast-changing world.

1. Hayashi, Alden, "When to trust your gut," *Harvard Business Review*, February 2001.
2. 1925 review of Edgar Lawrence Smith's book *Common Stocks as Long Term Investments*, McMillan, NY.
3. *The McKinsey Quarterly*, 2000, Number 3.