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A Latticework of Mental Models

In April 1994, at the Marshall School of Business of the University of Southern California (USC), students in Dr. Guilford Babcock's Student Investment Seminar got a rare treat: a powerful dose of real-world knowledge from a man whose thoughts on money are widely considered priceless.

Charles Munger—Charlie, as he is known throughout the investment world—is vice chairman of Berkshire Hathaway, the holding company run by Warren Buffett, the world's most famous investor. Trained originally as an attorney, Charlie is Buffett's business partner, friend, and straight man. He commands attention whenever he speaks.

Charlie Munger is an intellectual jewel somewhat hidden behind his more celebrated partner. The anonymity is not Buffett's fault. Charlie simply prefers the lower profile. Except for his occasional appearances such as the one at USC and his prominent role at Berkshire Hathaway's annual meetings, Charlie remains largely out of public view. Even at those annual meetings, he deliberately keeps his remarks brief, allowing Buffett to answer most of the questions from shareholders. But occasionally Charlie does have something to add, and when he speaks, the shareholders straighten and shift forward to the edge of their seats, straining to get a better view, to catch every word.

In Dr. Babcock's classroom that day in April, the atmosphere was much the same. The students knew whom they were listening to, and they knew they were about to receive the benefit of considerable investment expertise. What they got instead was something infinitely more valuable.

At the outset, Charlie mischievously admitted that he was about to play something of a trick on his audience. Rather than discussing the stock market, he intended to talk about "stock picking as a subdivision of the art of worldly wisdom."[1] For the next hour and a half, he challenged the students to broaden their vision of the market, of finance, and of economics in general and to see them not as separate disciplines but as part of a larger body of knowledge, one that also incorporates physics, biology, social studies, psychology, philosophy, literature, and mathematics.

In this broader view, he suggested, each discipline entwines with, and in the process strengthens, every other. From each discipline the thoughtful person draws significant mental models, the key ideas that combine to produce cohesive understanding. Those who cultivate this broad view are well on their way to achieving worldly wisdom, that solid mental foundation without which success in the market—or anywhere else—is merely a short-lived fluke.

To drive his point home, Charlie used a memorable metaphor to describe this interlocking structure of ideas: a latticework of models. "You've got to have models in your head," he explained, "and you've got to array your experiences—both vicarious and direct—on this latticework of models." So immediate is this visual image that "latticework" has become something of a shorthand term in the investment world, a quick and easily recognized reference to Charlie's approach.

It is a theme he returns to often. At the Berkshire Hathaway annual meetings, for instance, he frequently adds to Buffett's answers by quoting from a book he has recently read. Often the quote at first appears to have no direct link to investing, but with Charlie's explanation it quickly becomes relevant. It is not that Buffett's answers are incomplete. Far from it. It is just that when Charlie is able to connect Buffett's ideas to similar ideas in other disciplines, it tends to elevate the levels of understanding among the group.

Charlie's attention to other disciplines is purposeful. He operates in the firm belief that uniting the mental models from separate disciplines to create a latticework of understanding is a powerful way to achieve superior investment results. Investment decisions are more likely to be correct when ideas from other disciplines lead to the same conclusions. That is the

topmost payoff—broader understanding makes us better investors. It will be immediately obvious, however, that the ramifications are much wider. Those who strive to understand connections are well on the way to worldly wisdom. This makes us not only better investors but better leaders, better citizens, better parents, spouses, and friends.

How does one achieve worldly wisdom? To state the matter concisely, it is an ongoing process of, first, acquiring significant concepts—the models—from many areas of knowledge and then, second, learning to recognize patterns of similarity among them. The first is a matter of educating yourself; the second is a matter of learning to think and see differently.

Acquiring the knowledge of many disciplines may seem a daunting task. Fortunately, you don't have to become an expert in every field. You merely have to learn the fundamental principles—what Charlie calls the big ideas—and learn them so well that they are always with you. The following chapters of this book are intended to be a starting point for this self-education. Each one examines a specific discipline—physics, biology, social studies, psychology, philosophy, literature, and mathematics—from the perspective of its contribution to a latticework of models. Of course, many other sources are available to the intellectual explorer.

A protest is commonly heard at this point. "Isn't that what a college education is supposed to do for us, teach us critical concepts that have been developed over the centuries?" Of course. Most educators will tell you, in passionate terms, that a broad curriculum grounded in the liberal arts is the best way, perhaps the only way, to produce well-educated people. Few would argue with that position in theory. But in reality we have become a society that prefers specialization over breadth.

This is wholly understandable. Because students and parents spend a small fortune on a college education, they expect this investment to pay off promptly in the form of good job offers after graduation. They know that most corporate recruiters want workers with specialized knowledge who can make an immediate and specific contribution to the organization. It is little wonder that most of today's students, faced with this pressure, resist a broad, liberal arts education in favor of a specialty major. Understandable, as I say. Still, I believe we are all the poorer for it.

At one point in our history, we were given a superb model of what constitutes a good education. Perhaps we should have paid better attention.

In the summer of 1749, subscribers to the *Pennsylvania Gazette* received, along with their newspaper, an additional pamphlet written by the

newspaper's publisher, Benjamin Franklin. He described this pamphlet, entitled *Proposals Relating to the Education of Youth in Pensilvania*, as a "Paper of Hints" to address the regret that the "youth of the Province had no academy."[2] The young men in Connecticut and Massachusetts were already attending Yale and Harvard, Virginians had the College of William and Mary, and students in New Jersey were served by the College of New Jersey (later called Princeton). But Philadelphia, the largest and richest city in the Colonies, known as the Athens of America, had no institution for higher learning. In his pamphlet, Franklin explained his proposal to remedy that with the establishment of the Public Academy of Philadelphia.

Franklin's concept was unique for its day. Harvard, Yale, Princeton, and William and Mary were schools for educating the clergy; their curricula stressed the classical studies rather than the practical lessons that prepared young men for business and public service. It was Franklin's hope that the Philadelphia Academy would stress both the traditional classical areas (which he termed "ornamental") as well as the practical. "As to their studies," he wrote, "it would be well if they could be taught everything that is useful and everything that is ornamental. But art is long and their time is short. It is therefore proposed that they learn those things that are likely to be most useful and most ornamental, regard being had to the several professions for which they are intended."

Today Franklin's Public Academy of Philadelphia is the University of Pennsylvania. The former dean of its College of Arts and Sciences, Dr. Richard Beeman, describes the scope of Franklin's achievements.[3] "Benjamin Franklin proposed the first modern-day secular curriculum," he explains, "and the timing was perfect." In the eighteenth century the world's knowledge base was exploding with new discoveries in math and sciences, and the classical curriculum of Greek, Latin, and the Bible was no longer sufficient to explain this new knowledge. Franklin proposed including these new areas in the academy, and then he went further still: he also recommended the students acquire the necessary skill sets to become successful at business and public service. Once students mastered these basic skills, he said, which at that time included writing, drawing, speaking, and arithmetic, then they could devote attention to acquiring knowledge.

"Almost all kinds of useful knowledge would be learned through reading of history," wrote Franklin. But he meant much more than the definition we customarily attach to a history discipline; for Franklin, "history" encompassed all that is meaningful and worthwhile. By encouraging young men to read history, Franklin meant for them to learn philosophy,

logic, mathematics, religion, government, law, chemistry, biology, health, agriculture, physics, and foreign languages. To those who wondered whether such a burdensome task was really necessary, Franklin replied that it was not a burden to learn but a gift. If you read the universal histories, he said, "it would give you a connected idea of human affairs."

Benjamin Franklin was the originator of a "liberal arts education," Beeman points out. "He was in the business of cultivating habits of mind. The Philadelphia Academy was a broadly based platform for lifelong learning. Of course Franklin is the perfect role model. He kept his mind open and his intellectual ambition fully fueled. As an educator he is my hero."

Beeman continues: "Benjamin Franklin's success as an educator was based upon three standing principles. First the student must acquire the basic skill sets: reading, writing, arithmetic, physical education, and public speaking. Then the student was introduced to the bodies of knowledge, and finally the student was taught to cultivate habits of mind by discovering the connections that exist between the bodies of knowledge."

In the 250 years since Franklin's proposal, American educators have continued to debate the best method to train young minds, and college administrators have continued to adjust their curricula in the hope of attracting the best students. Critics of our current education system remain, and many of their criticisms seem valid; yet for all its faults, our education system today has done a reasonably good job of providing skills and producing knowledge—the first two of Franklin's key principles. What is often lacking is his third principle: the "habits of mind" that seek to link together different bodies of knowledge.

We can change this. Even if our days of formal schooling are behind us, we can search on our own for the linkages between ideas in various arenas, the connections that illuminate real understanding.

It is of course easy to see that cultivating Franklin's "habits of mind," to use Professor Beeman's wonderful phrase, is the key to achieving Charlie Munger's "worldly wisdom." But seeing this is one thing; acting on it is another. For many of us, this goes against the mental grain. After having invested many years in learning one specialty, we are now being asked to teach ourselves others. We are told not to be bound by narrow confines of the discipline we were trained in, but to leap over the intellectual fences and look at what's on the other side.

For investors, the rewards for making the effort are enormous. When you allow yourself to look beyond the immediate fences, you are able to

observe similarities in other fields and recognize patterns of ideas. Then, as one concept is reinforced by another and another and then another, you know you are on the right track. The key is finding the linkages that connect one idea to another. Fortunately for us, the human mind already works this way.

In 1895, a young graduate student named Edward Thorndike began to study animal behavior under the psychologist and philosopher William James at Harvard University. We shall meet William James later in this book, in another capacity; for now our interest in Thorndike is his groundbreaking research into how learning takes place, in humans as well as animals. Thorndike was the first to develop what we now recognize as the stimulus-response framework in which learning occurs when associations—connections—are formed between stimuli and response.

Thorndike continued his studies at Columbia University, where he worked closely with Robert S. Woodworth. Together they investigated the process by which learning is transferred. They concluded, in a paper published in 1901, that learning in one area does not facilitate learning in other areas; rather, they argued, learning is transferred only when both the original and the new situation have similar elements. That is, if we understand A, and recognize something in B that resembles A, then we are well on our way to understanding B. In this view, learning new concepts has less to do with a change in a person's learning ability than with the existence of commonalties. We do not learn new subjects because we have somehow become better learners but because we have become better at recognizing patterns.

Edward Thorndike's theory of learning lies at the core of a contemporary theory in cognitive science called *connectionism*. (The cognitive sciences encompass how the brain works—how we think, learn, reason, remember, and make decisions.) Connectionism, building from Thorndike's studies of stimulus-response patterns, holds that learning is a process of trial and error in which favorable responses to new situations (stimuli) actually alter the neural connections between brain cells. That is, the process of learning affects the synaptic connections between neurons, which are continually adjusting as they recognize familiar patterns and accommodate new information. The brain has the ability to link together related connections into a chain and to transfer what was learned to similar situations; intelligence, therefore, can be viewed as a function of how many connections a person has learned.

Connectionism has received a great deal of attention from business leaders as well as scientists because it is at the heart of a powerful new system of information technology known as *artificial neural networks*. These neural networks, as they are more commonly called, attempt to replicate the workings of the brain more closely than has been possible with traditional computers.

In the brain, neurons function within groups called networks, each with thousands of interconnected neurons. We can therefore think of the brain as a collection of neural networks. Artificial neural networks, in turn, are computers that mimic the basic structure of the brain: they consist of hundreds of processing units (analogous to neurons) that are cross connected into a complex network. (Surprisingly, neurons are several orders of magnitude slower than silicon chips, but the brain makes up for this lack of speed by having a massive number of connections that afford enormous efficiencies.)

The great power of the neural network, and the quality that sets it apart from a traditional computer, is that the weighting of the connections between its units can be adjusted, just as the brain's synapses adjust, becoming weaker or stronger or even rewired altogether as needed to perform different tasks. So, just like the brain, a neural network can learn. Just like the brain, it has the ability to recognize complex patterns, classify new information into patterns, and draw associations between the new data.

We are only beginning to understand how this technology can be applied in the business world. A few examples: A manufacturer of baby foods uses the technology to manage trading cattle futures. Soft drink bottlers use it as an "electronic nose" to catch and analyze unpleasant odors. Credit card companies use it to detect forged signatures and to spot fraud by identifying deviations in spending habits. Airlines use it to forecast flight demand. Postal services use neural networks to decipher sloppy handwriting, and computer companies use them to develop software that will recognize handwritten notes sent via email and engineering schematics sketched on a cocktail napkin.

The process of building and using a latticework of mental models is an innovative approach to thinking, and one that can be intimidating to many, to the point of mental paralysis. Fortunately there is a road map to the process that is easy to understand.

The Santa Fe Institute, Santa Fe, New Mexico, is a multidisciplinary research and education facility where physicists, biologists, mathematicians,

computer scientists, psychologists, and economists come together to study complex adaptive systems. These scientists are attempting to understand and predict immune systems, central nervous systems, ecologies, economies, and the stock market, and they are all keenly interested in new ways of thinking.

John H. Holland, a professor in two fields at the University of Michigan—psychology, and engineering and computer science—is a frequent visitor to the Santa Fe Institute, where he has lectured extensively on innovative thinking. According to Holland, innovative thinking requires us to master two important steps. First, we must understand the basic disciplines from which we are going to draw knowledge; second, we need to be aware of the use and benefit of metaphors.

You will recognize the first step as being exactly the same as the first part of Charlie Munger's process for acquiring worldly wisdom. The ability to link mental models together and then benefit from the connections assumes that you have a basic understanding of each model in the latticework. There is no benefit to stringing mental models together if you have no idea how each model works and what phenomena it describes. Remember, though, it is not necessary to become an expert in each model but merely to understand the fundamentals.

The second step—finding metaphors—may at first seem surprising, especially if it makes you think of your ninth-grade English class. At the simplest level, a metaphor is a way to convey meaning using out-of-ordinary, nonliteral language. When we say that "work was a living hell," we don't really mean to say that we spent the day beating back fire and shoveling ashes, but rather we want to communicate, in no uncertain terms, that it was a hard day at the office. Used this way, a metaphor is a concise, memorable, and often colorful way to express emotions. In a deeper sense, metaphors represent not only language but also thought and action. Writing in *Metaphors We Live By*, the linguists George Lakoff and Mark Johnson suggest that "our ordinary conceptual system, in terms of which we can think and act, is fundamentally metaphorical in nature."[4]

But, Holland argues, metaphors are much more than merely a colorful form of speech, even more than representations of thoughts. They can also help us translate ideas into models. And that, he says, represents the basis of innovative thinking. In the same way that a metaphor helps communicate one concept by comparing it to another concept that is widely understood, using a simple model to describe one idea can help us grasp the complexities of a similar idea. In both cases we are using one concept (the source) to

better understand another (the target). Used this way, metaphors not only express existing ideas, they stimulate new ones.

In the book *Connections*, based on a memorable PBS series, James Burke describes several cases in which inventors were led to a discovery by first observing the similarities that existed between a previous invention (source) and that which the inventor wished to build (target). The automobile is a prime example. The carburetor is linked to a perfume sprayer, which in turn is linked to an eighteenth-century Italian who was trying to understand how to harness the hydraulic power of water. Alessandro Volta's electric pistol, initially created to test the purity of air, eventually sparked the fuel sprayed by the carburetor 125 years later. An automobile's gears are the direct descendant of the waterwheel, and the engine's pistons and cylinders can be traced to Thomas Newcomen's pumping engine, originally designed to drain coal mines. Each major discovery is connected to an earlier idea, a model that stimulated original thinking.

In our case, the main subject we wish to understand better (the target model) is the stock market or the economy. Over the years we have accumulated countless source models within the finance discipline to explain these phenomena, but too often they fail us. In many ways, the operation of markets and economies is still a mystery. Perhaps it is time we expanded the number of disciplines we call upon in our search for understanding. The more disciplines we have to explore, the more likely are we to find commonalties of mechanisms that clarify the mysteries. Innovative thinking, which is our goal, most often occurs when two or more mental models act in combination.

A latticework of mental models is itself a metaphor. And on the surface, quite a simple one at that. Everyone knows what latticework is, and most people have some degree of firsthand experience with it. There is probably not a do-it-yourselfer who hasn't made good use of a four-by-eight sheet of latticework at some point. We use it to decorate fences, to create shade over patios, and to support climbing plants. It is but a very small stretch to envision a metaphorical lattice as the support structure for organizing a set of mental concepts.

Yet, like many ideas that at first seem simple, the more closely we examine the metaphor of latticework, the more complex it becomes and the more difficult it is to retain as a pure mental-model concept. One thing we understand about the human mind is the variability with which it receives and processes information. Any educator knows that the best way to teach a new idea to one student may have no effect whatsoever with another; the

best educators, therefore, carry with them a virtual key ring with many different keys for unlocking individual minds.

In much the same way, I have found myself using various analogies to present the concept of a latticework of mental models. For those with a high-technology background, I often compare the process of constructing a mental latticework to designing a neural network, and they instantly recognize the possibilities for immense power. Talking with mathematicians, I may ask them to think about the concepts first envisioned by George Boole and later formalized by Garrett Birkhoff of Harvard University in his book entitled *Lattice Theory*; this gives us the double reinforcement of a comparable theoretical framework that happens to be called by the very same name. Psychologists easily relate latticework to connectionism; educators link it with the brain's capacity to seek and find patterns. For people whose intellectual comfort zone is firmly planted in the humanities, I talk about the value of metaphors as devices for expanding the scope of our understanding. Many others, nonscientists like myself, often respond best to my description of a real piece of latticework with tiny lights at the junction points.

I hit upon this analogy one afternoon while staring out the window at the fence in our backyard. The entire fence is topped with a decorative strip of latticework that is visually broken into sections that echo the sections of the fence itself as defined by the posts. While looking at this fence and thinking about mental models, I gradually began to see each section of latticework as one area of knowledge; the section nearest the garage became psychology, the next one biology, and so on. Within each section, it was easy to think of the points where two lattice strips connect as nodes. Then, in that marvelous way that our brains skip from one analogy to the next, I suddenly thought of outdoor Christmas decorations, and I began to see, in my mind's eye, miniature lightbulbs at each node.

Suppose I was struggling to understand some marketplace trend or make an investment decision, and I arrayed my uncertainty on that latticework. Looking at the question from my perspective of biology, I might see several lights pop on. When I move to the next section, perhaps psychology, maybe a few other bulbs light up. If I also see lights in a third section, and then a fourth, I would know I could proceed with reasonable confidence, for my original insecure thinking would now have been confirmed and ratified. Conversely, if I saw no lights going on while I pondered the problem, I would take that as a clear indication not to proceed.

That's the power of a latticework of mental models, and it extends far beyond the narrow question of picking stocks. It leads to understanding the full range of market forces—new businesses and trends, emerging markets, the flow of money, international shifts, the economy in general, and the actions of people in markets.

Two years after Charlie Munger startled the finance students at USC by challenging them to consider investing as a subdivision of worldly wisdom, he reprised his notion of a latticework of models at Stanford Law School, this time in some more detail.[5]

He first reiterated his basic theme: true learning and lasting success come to those who make the effort to first build a latticework of mental models and then learn to think in an associative, multidisciplinary manner. It may take some work, he warned, especially if your education has forced you to specialize. But once those models are firmly set in your mind, you are intellectually equipped to deal with many different kinds of situations. "You can reach out and grasp the model that better solves the overall problem. All you have to do is know it and develop the right mental habits." No doubt Benjamin Franklin would approve.

I believe extraordinary rewards are possible for those who are willing to undertake the discovery of combinations between mental models. When that happens, what Charlie calls "especially big forces" take over. This is more than one plus one; it's the explosive power of critical mass, what Charlie—the master of colorful language—calls "the lollapalooza effect."

This is the heart of the investing philosophy that is presented in this book: developing the ability to think of finance and investing as one piece of a unified whole, one segment of a body of knowledge. Done right, it produces nothing short of a lollapalooza effect. I believe it is our best hope for long-term investment success.

Let's give Charlie the final word on the subject. In response to questions from Stanford students concerned about the process of uncovering the models, he remarked:

"Worldly wisdom is mostly very, very simple. There are a relatively small number of disciplines and a relatively small number of truly big ideas. And it's a lot of fun to figure out. Even better, the fun never stops. Furthermore, there's a lot of money in it, as I can testify from my own personal experience.

"What I am urging on you is not that hard to do. And the rewards are awesome. . . . It'll help you in business. It'll help you in law. It'll help you in life. And it'll help you in love. . . . It makes you better able to serve others, it makes you better able to serve yourself, and it makes life more fun."